NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

NEW CASTLE COUNTY MS4

Permit No. DE 0051071

submitted by

NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES

as Lead Permittee

JOINT ANNUAL REPORT FOR CALENDAR YEAR 2012

Volume 2 of 2
DelDOT Report and Appendices

NPDES

Permitees

New Castle County Department of Special Services
Delaware Department of Transportation
The Village of Arden
The Village of Ardentown
The Village of Ardencroft
The Town of Bellefonte
The City of Delaware City
The Town of Elsmere
The Town of Middletown
The Town of Newport
The City of New Castle
The Town of Odessa
The Town of Townsend
The City of Wilmington

Submitted May 1, 2013

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

April 30, 2013

Mr. Bryan Ashby
Manager, Surface Water Discharge Section
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway
Dover, DE 19901

Re: NPDES Phase I Annual Report for Calendar Year 2012
NPDES Permit No. DE 0051071

Dear Mr. Ashby:

Enclosed please find DelDOT's annual NPDES Phase I Report. This volume covers permit activities for calendar year 2012 for the New Castle County MS4.

Sincerely,

Randy Cole
NPDES Program Manager

Enclosures

DelDOT

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CERTIFICATION

I certify under penalty of perjury that this document and all attachments are true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations. As to the identified portions of this document for which I cannot personally verify their truth and accuracy, I certify as Delaware Department of Transportation's official having responsibility for the persons who, acting under my direct instruction, made the verification that this information is true, accurate, and complete.

Brian Urbanek, Asst. Director, Statewide Support Services
Delaware Department of Transportation
800 Bay Road
Dover, DE 19903
(302) 760-2536

Program Summary and Projection of Work

The objective of the Delaware Department of Transportation NPDES Program is to reduce stormwater pollutants from the co-permittees' municipal separate storm sewer system to the maximum extent practicable. This is accomplished through the implementation of a comprehensive stormwater pollution prevention and management program as contained in the NPDES Permit No. DE 0051071 effective May 1, 2001 and EPA Consent Decree effective December 14, 2001.

The Delaware Department of Transportation and New Castle County entered into an Interjurisdictional Agreement for the purposes of identifying duties and responsibilities under the Consent Decree and the stormwater NPDES permit. If any task listed requires consultant services, DelDOT and the County will share all costs equally.

$2.07 million was appropriated to DelDOT to implement program elements of NPDES (Table A). This annual report covers NPDES activities from January 1, 2012 through December 31, 2012.

The purpose of this review and update is to summarize major activities to date through year 2012 and provide a projection of work for calendar year 2013. Work projections for 2013 are provided at the end of this section in Table B.

The following projects have been initiated as a result of the NPDES permit:

Storm Drain Inventory and Inspection

Continued Agreement 1591 to conduct the following tasks:

- Complete Sussex County inventory and inspection
- Inspect recently accepted subdivision streets and storm drain systems in NCCo.
- Conduct annual BMP inspections
- Submit work orders
- Update database/map viewer and provide training as necessary

Injunctive Relief

DelDOT has fulfilled its obligation under the Consent Decree to complete the I-95 Stormwater Project. Please see Annual Report 2001, Volume 3, Appendix U for a complete report and photographic documentation of the I-95 Additional Injunctive Relief Stormwater Controls. The components are identified below:

- Ditches – DelDOT replaced concrete channels with riprap at 18 locations and replaced 8 concrete ditches with vegetated ditches. DelDOT will provide maintenance of these ditches during the term of the Consent Decree.

- Shallow marshes – DelDOT designed and constructed two shallow marshes along I-95 as bioretention areas. DelDOT will provide maintenance of these ditches during the term of the Consent Decree.
- Stone check dams – DelDOT designed and constructed 7 stone check dams along I-95. DelDOT will perform regular inspections and maintenance during the term of the Consent Decree.
- Biofiltration swales – DelDOT has constructed biofiltration swales along I-95 as per the Consent Decree. DelDOT will conduct annual inspections and provide maintenance.

Pesticides, Herbicides and Fertilizers

DelDOT's NPDES Program and the Roadside Environmental Section are working together to develop long-term pesticide reductions strategies, including:

- Guardrail Inventory – An initial inventory of all guardrail sections in the state was completed in 2009. A small professional services agreement was executed in 2011 for a three year term to collect data on new guardrail installations and continue to update the existing database. The data are being used by DelDOT to identify areas where guardrail herbicide application can be reduced or eliminated.
- Guardrail Vegetation Management pilot study – DelDOT and the University of Delaware continued this study in 2012 to test alternative vegetation management strategies for guardrail (including two types of weed block material, hand trimming, low-grow fescue, as well as adding new grass seed mixtures/plugs) to reduce or eliminate herbicide application. If feasible alternatives are found, we hope to use them in environmentally sensitive areas to replace, or reduce, use of herbicides on guardrails.
- A final report studying the impacts of mowing median turf grass at different heights upon water quality and turf quality was completed in July 2012.
- A contract with Weeds, Inc. was executed to treat invasive species on DelDOT-owned BMPs.

Illicit Discharge and Improper Disposal Program

Per agreement with New Castle County, DelDOT is responsible for the illicit discharge detection and elimination (IDDE) program within the DelDOT-owned portion of the stormwater conveyance system. Our dry-weather screening program uses a numerical rating system for water quality parameters in dry weather flow, which provides an index that determines which outfalls are targeted for follow-up evaluation. KCI Technologies, Inc. performs this work for DelDOT. In calendar year 2012, a total of 412 DelDOT-owned outfalls were screened in New Castle County. 53 of these had dry

weather flow. No evidence of illicit connections or discharges was noted at any of these outfalls.

During 2012, nine potential illicit discharges (PIDs) in New Castle County were investigated. These were either reported to the DelDOT NPDES Program or discovered during KCI's MS4 inspection activities. During 2012, two reported potential illicit discharges (PIDs) in New Castle County were investigated (Table 6-1). Each was investigated by KCI crews, and follow-up action was taken where appropriate.

DelDOT also continued a public education program to help eliminate improper disposal and dumping into storm drains. Whenever evidence of improper dumping is discovered, either through routine inspections or citizen complaints, the entire community is canvassed with educational door hangers. In addition, we helped publicize Delaware Solid Waste Authority (DSWA)'s Household Hazardous Waste Collection Program and DNREC's "TrashStoppers" Program.

Sweeping Program

DelDOT is continuing its 4:2:1 frequency on primary, secondary, and tertiary roads. More frequent sweeping occurs on interstate highways. Automatic Vehicle Locating (AVL) systems were installed in all sweepers in New Castle County in anticipation of the new TMDL requirements. Data will be used to track roads swept and to estimate pollutant removal.

Snow and Ice Program

DelDOT has upgraded its existing fleet with ground speed spreader controls, plow balance valves and apply the techniques of anti-icing and pre-wetting in an effort to reduce overall salt usage. New trucks will be fully equipped with ground speed spreader controls and plow balance valves.

Storm Event Monitoring Program

The wet weather storm event monitoring required under the Phase I permit was intended to identify, investigate and address selected water quality parameters of storm water runoff from five outfall locations identified in the Permit Application, representing four developed land use classifications: highway, commercial, industrial and residential.

The wet weather monitoring requirement at the five prescribed outfalls in New Castle County was fully completed by the County and DelDOT in 2009. Therefore, no additional samples were collected in 2012.

BMP Inspection and Maintenance

DelDOT annually inspects its BMP facilities for functionality. BMPs are graded A-D depending on condition. KCI completed the annual inspection of 339 New Castle County BMPs in 2012. In 2011 we altered our inspection schedule to not include BMPs

that had been previously rated C or D because these BMPs would be inspected for quantities and additional work and slated for in-house or contracted maintenance the following year. BMPs are evaluated and placed on contract for maintenance as needed and as money permits. Maintenance functions are performed by the Districts or through contractors specializing in noxious and invasive species control, or maintenance of specific BMP types. We are under contract with Weeds, Inc. to control noxious and invasive species.

In 2012, 17 BMPs that had a total of 9.0 acres of invasive species affecting their performance were treated under the Weeds, Inc. contract. As part of a separate maintenance contract with Grassbusters, Inc., 22 stormwater management ponds were maintained. In December 2012 a stormwater pond contract was awarded to Grassbusters, Inc.. Under this contract 16 additional BMPs in need of major maintenance were added to the Contract. The contract is scheduled for completion in June 2013.

BMP Monitoring Program

DelDOT continues its BMP performance monitoring and assessment program. This includes wet weather monitoring of stormwater outfalls and BMPs (both structural and nonstructural), as well as chemical and biological monitoring of streams that are impacted by stormwater discharges from DelDOT BMPs. In addition to the work performed by KCI Technologies, DelDOT is also partnering with the University of Delaware on BMP monitoring projects.

During calendar year 2012, DelDOT's BMP monitoring program included the following projects. They are discussed in detail in Section 13 of this report.

1. Monitoring of biofiltration practices
2. Study of pollutant removal by grassed highway slide slopes
3. Monitoring of BMP outfalls at DelDOT maintenance facilities
4. Development of a revised street sweeping plan
5. Study of guardrail vegetation control alternatives
6. Study of the impacts of various mowing height practices
7. Study of new bioretention technologies to remove nutrients

TMDL Compliance

DelDOT has been proactive in developing plans and tools for compliance with statewide TMDLs, in anticipation of both a new Phase I permit and future watershed Pollution Control Strategies. The Department's current activities in this area include the following:

- Participation in the AASHTO Stormwater Management Community of Practice (CoP), in which state DOT's share information on emerging issues, including TMDL compliance.
- Assistance to DNREC in development and implementation of a Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDLs.

- A BMP performance and assessment program to provide data on the effectiveness of DelDOT's BMPs in reducing pollutants targeted by TMDLs. This included studies of new technologies and approaches for achieving the required reductions and development of a revised, science-based street sweeping plan.
- Development of tools to track and report nutrient and sediment load reductions achieved through DelDOT's street sweeping program.
- Calculation of drainage areas for all DelDOT-owned BMPs and major outfalls in New Castle County. BMP and monitoring data were shared with DNREC's Watershed Assessment section for use in their TMDL models.
- Completion of a pilot Water Quality Improvement Plan (WQIP) for the Pike Creek watershed. This exercise on a smaller subwatershed was intended to give the co-permittees to better understand the process and challenges of WQIP development. Grant support was received to perform a pilot WQIP for the Appoquinimink watershed.
- NPDES staff members served on the Delaware Nature Society's Watershed Stewardship Committee and on the Chesapeake Bay Program's IDDE Expert Panel.
- Public education and outreach programs specifically designed to result in reduction of nitrogen, phosphorus and bacteria loadings to waterways. The Delaware Livable Lawns Program is a notable example.
- Initiation of an agreement with Versar, Inc., to assess DeDOT's monitoring program and develop a revised monitoring plan for our new SWPP&MP.

Retrofits

Concluded Agreement 1412 with JMT completing the following tasks:

- Ham Run Stream Restoration – Construction in 2013
- Blackbird Creek Stream Restoration – Test project planned for 2013

Executed Agreement 1526 with Parsons Brinckerhoff (PB) to conduct the following tasks:

- Chapman Vehicle Wash Area Retrofit – Constructed in 2012
- Christiana High School Low Impact Development (LID) – Semi-final design completed.
- Leatherman's Run Stream Restoration Design – Preliminary design completed
- BMP Assessments and Retrofit

DelDOT initiated, worked on, and/or completed the following stormwater retrofits in 2012:

1. *Ham Run stream restoration:* Restoration of approximately 500 LF of stream using natural channel techniques, creating two wetland floodplains/stormwater wetlands and creating a filter strip along Duncan Road prior to draining into the relocated stream. In 2012, the channel restoration portion of the Contract was split from the Bridge restoration project until the necessary permits were obtained and turned over to the Department of Natural Resources and Environmental Control (DNREC) to let the project for Construction. DNREC received their Army Corps Permit in April 2012 and the project was awarded to Meadville. The construction of the project will begin in Spring 2013 and be completed in June 2013.

2. *Chapman Vehicle Wash Area Retrofit* – In 2012 construction of the new facility began in Spring 2012. These improvements were necessary because the two existing BMPs in series required weekly maintenance due to high sediment loads from washing maintenance vehicles and equipment. Construction of the new facility was completed by maintenance staff in June 2012.

3. *Christiana High School Low Impact Development (LID)* – In 2012 PB, completed semi-final design of LID storm water quality improvement facilities that could be used to pre-treat stormwater runoff from the high school property adjacent to the stretch of Leatherman's Run that is planned for restoration. The design includes roof top drainage disconnection, 5 biofiltration facilities and a rain garden. PB Americas will begin work on the Final Design Plans in 2013 with a completion Date of April 2013. The contract will be let for bid and constructed in 2013 -2014.

4. *Leatherman's Run Stream Restoration* – In 2012 PB completed semi-final design of a 700 linear foot stream restoration project. The stream reach to be restored is Leatherman's Run between Chapman Road and Interstate 95. This project now includes coordination with New Castle County's sewer division incorporating the restoration of two gravity sewer lines within the limits of construction of the project. The Final Design for the Project will be completed in Summer 2013 with Construction beginning in Spring 2014, permitting the appropriate environmental permits are in hand.

Construction Site Runoff

- Initiated performance evaluations of CCRs using an objective evaluation form.
- Executed two agreements to have third party consultants perform CCR inspections and reporting on DelDOT projects in lieu of contractors.

Public Education and Outreach

DelDOT's public education program includes the following accomplishments for calendar year 2012:

- Delaware Livable Lawns
    - Partnered with the Appoquinimink River Association to manage the Delaware Livable Lawns program during the first half of 2012.
    - Hired the Delaware Nursery Landscape Association to begin management of the Delaware Livable Lawns program in the latter half of 2012.
    - Certified 5 commercial lawn care companies into the Livable Lawns program; developed 3 how-to videos; and held multiple outreach events.
    - Designed and distributed brochures and company business cards.
    - Designed advertisements.
- DelDOT is continuing the "Door hanger campaign" as an educational tool to neighborhoods where illicit disposal are reported.
- Active participation in the newly formed Delaware Association for Environmental Education.
- Completed final recommendations report detailing a stormwater education plan that address major pollutant problems for eight target areas.
- DelDOT staff participated in the following public outreach events:
    - Delaware Rural Water Association – we exhibited our display board and graphics and touch screen stormwater slide show;
    - Technology Students Association – served as judges on environmental and engineering projects.
    - Delaware State Fair – we exhibited our display board and graphics and touch screen stormwater quiz.

Table A. NPDES 2012 Budget

VENDOR	DESCRIPTION	
Beginning Balance	**NPDES**	**2,070,000.00**
Total Available		**2,070,000.00**
1. Phase I NPDES		
KCI		
	Agreement 1591, Task 2	**846,000.00**
	inspect newly approved BMPS (over 100)	
Subtotal		**846,000.00**
2. Storm System Maintenance		
	Transfer of funds to Districts	**0.00**
Subtotal		**0.00**
3. New Permit Plan Development		
EA	SWMP development; cost share with NCCo.	**50,000.00**
Versar	Monitoring Plan development	**30,000.00**
Subtotal		**80,000.00**
4. Sweepers		

		0.00
Subtotal		**0.00**
5. Monitoring		
KCI		
	Agreement 1495	**184,000.00**
	Agreement 1613	**516,000.00**
	KCI Proposal for FY13:	
Atlantic Coast Lab	water quality lab fees	
WEF & ASCE	membership ($236.00 & $220.00)	
Subtotal		**700,000.00**
6. Industrial Compliance and Permitting	-	
DNREC	NOIs	**3,200.00**
PIG	spill kits and decks	**500.00**
Subtotal		**3,700.00**
7. Public Education		
Appoquinimink River Asso.	Agr. 1478 is expired; added $9,900 to complete task for Del. Livable Lawns	**9,900.00**
DNLA	Agr. 1627; Delaware Livable Lawns	**21,000.00**
Graphics & Printing	For the following activities:	**10,000.00**
	activity booklets	
	door hangers	
	Delaware Livable Lawns	

	Fair game/pledge cards	
2013 Harrington Fair		
Contract Vendor	Supplies	**1,000.00**
DIB	public outreach giveaways	**7,000.00**
Appoquinimink River Asso.	Delaware Livable Lawns	**1,418.00**
DRWA	annual dues	**250.00**
Partnership for the Del. Est.	printing costs for Wilmington Earth Day	**3,000.00**
Subtotal		**53,568.00**
8. Staff Training		
DWRA	conference fee	**250.00**
WEFTEC	registration	**925.00**
Subtotal		**1,175.00**
9. Equipment		
Office Depot	office equipment	**500.00**
	binders and tabs for annual reports	**100.00**
	field manuals	**200.00**
Subtotal		**800.00**
10. Retrofits		
Parsons Brinckerhoff	Agreement 1526	**212,394.20**

Suntree	replacement booms and units	**3,225.00**
	add'l booms	**1,000.00**
Subtotal		**216,619.20**
11. Stormwater Ponds		
Weeds, Inc.	Noxious/Invasive Roadside contract to treat stormwater BMPs - Canada thistle	**10,000.00**
	Noxious/Invasive Roadside contract to treat stormwater BMPs - Phragmites/Cattail	**10,000.00**
ACP International	storm drain markers	**2,000.00**
Subtotal		**22,000.00**
12. IRVM/Pesticide/Fertilizer		
U of D	Guardrail Study	**34,412.00**
		7,620.36
	State Fair (Del. Liv. Lawns)	**28,933.00**
	add'l $$ for next year's game development	**17,405.00**
Wallace/Montgomery		
	Agr. 1575, Task 2 - Guardrail inventory	**16,000.00**
	chemical costs for Roadside	**675.00**
Subtotal		**105,045.36**
	Total expenses for Operational Money	**2,028,907.56**
	Difference	41,092.44
Beginning Balance	**NPDES Capital**	
Stormwater pond contract	Grassbusters	222,000.00
North District	5% contingency	24,664.00

	10% CE	25,000.00
Leatherman's Run projects	Christiana H.S.; 8 BMPs	350,000.00
	Leatherman's Run stream restoration	180,000.00
Central District	open end drainage contract	0.00
	BMP maintenance	250,000.00
Maintenance yards	Chapman retrofit	
	Fy13	3,600.00
Subtotal		**1,055,264.00**

Table B. Projection of Work to be performed during Calendar Year 2013.

Storm Drain Inventory and Inspection

- Focus system inventory and inspection outside permitted boundaries in Sussex County in an effort to complete the entire state.
- Inventory new storm drain systems associated with recently constructed roadway improvement projects.
- Continue statewide annual BMP inspections.
- Make modifications, as necessary, to the NPDES map viewer.
- Have DelDOT Survey inventory new construction in lieu of contractor.

Illicit Discharge Detection and Elimination

- Perform dry weather screening on newly inventoried outfalls and continue to investigate potential illicit discharges as they are discovered or reported.
- Use Center for Watershed Protection guidance to revise dry weather screening protocol.

Monitoring

- Continue to enter BMP data into International Stormwater BMP database.
- Use wet weather data to calibrate grassed side slope SWMM model.
- Continue guardrail vegetation control and bioretention research efforts and transition to larger scale field tests.
- Target monitoring and research efforts to provide data needed for compliance with TMDLs and the new Phase I permit.
- Work with consultant(s) to assess our current monitoring plan and develop a revised monitoring plan for the new Phase I permit's SWPP&MP.

Pesticide, Herbicide and Fertilizer Program

- Continue to update the guardrail inventory used in development of a pesticide reduction strategy; continuously review DelDOT projects for any addition of guardrail or new end treatments.
- Continue guardrail research project with University of Delaware – research pilot study to test several treatments under guardrail in development of a pesticide reduction strategy.
- Purchase spill-decks for pesticide storage as needed.

Roadways

- Finalize street sweeping plan for New Castle County to comply with Permit sweeping requirements
- Present plan to Districts

- Conduct pilot study to test feasibility
- Implement plan

Construction Site Erosion and Sediment Controls

- Continue to implement revised Standard Specification 110, Erosion, Sediment Control and Water Pollution. Modifications to this section include:
    - Mandatory pre-construction meeting specifically to discuss E & S controls.
    - Third party CCR conducting weekly E&S inspections.
    - Contractor responsible for fines if as a direct result of the contractor's refusal to implement and maintain the required erosion and sediment control, fails to supply a Site Reviewer, or fails to routinely perform E&S inspections, complete the E & S Reports and correct deficiencies identified in the E & S Reports.
    - Annual CCR performance evaluations.
- Monitor construction site(s) with turbidity meters for continuous in-stream turbidity monitoring

Snow/Ice Program

- Utilize new technologies:
    - Continue to equip new trucks with ground speed controls to reduce salt application.
    - Anti-icing application prior to snow/ice event to reduce overall salt application.
    - Pre-wetting salt with liquid de-icers to increase effectiveness of salt.
    - Continue to equip new trucks with plow balance valves on snow plow blades to reduce road damage thereby reducing particles that can enter waterways.

- Continue fleet snow inspection to ensure proper equipment calibration.

Drainage Program

- Continue to submit and repair work orders resulting from storm system inspections; consultant will prioritize work orders before submitting to Maximo.

Public Education, Outreach & Training

- Continue partnership with the Appoquinimink River Association in development of education and outreach programs.
- Continue “Delaware Livable Lawns” program via an agreement with the Delaware Nursery Landscape Association.

- Participate in outreach events: Delaware Rural Water Association Conference and Delaware State Fair.
- Continue to serve on the Delaware Association for Environmental Education (DAEE) board of directors and executive committee.

Staff training

- Develop and distribute stormwater pollution prevention bulletins to all DelDOT maintenance yards on a semi-annual basis.
- Continue requiring new DelDOT maintenance staff to view stormwater pollution videos.
- Require DelDOT staff to annually view Spill Prevention Control and Countermeasures (SPCC) videos.
- Continue providing NPDES map viewer database access to qualified users.

BMP Inventory and Inspection Program

- Execute stormwater maintenance contract for C-rated BMPs.
- Conduct annual inspections of DelDOT owned BMPs; generate work orders as needed.
- Treat noxious and invasive vegetation as needed using contractor services.

Retrofits

- Finalize Christiana High School stormwater retrofit.
- Finalize design of Leatherman's Run stream restoration.

Maintenance Yards

- Review and update Pollution Prevention Plans (PPPs) and Spill Prevention Control and Countermeasures (SPCC) plans as necessary.
- Continue quarterly wet and dry weather inspections and annual inspections.
- Conduct spot inspections as needed.
- Continue semi-annual wet weather sampling of outfalls.

New NPDES Permit

- Begin Appoquinimink River pilot study for the development a Watershed Implementation Plan.
- Finalize development of a statewide sweeping plan.
- Begin selection process to hire consultant to assist with development of DelDOT/NCCo.'s SWPP&MP.
- Hire consultant to assist with developing the monitoring portion of the SWPP&MP.

SWPP&MP Assessment

This section is an annual review of the current SWPP&MP. Program elements included here describe substantive program improvements and recommendations for program modifications.

Storm Sewer System

Inventory

Our goal for the next two years is to complete the sections of the MS4 not previously inventoried in Sussex County. Right now we are on schedule to complete this by the end of the current consultant agreement deadline. When we are completed in Sussex County, the entire state will have been inventoried and inspected.

We initiated discussions with our DelDOT survey section to inventory new storm sewer construction statewide in lieu of using our consultant. This has several benefits to DelDOT:

- Safer – inventory will be done while the project is under construction and closed to traffic, therefore no MOT costs in most cases
- Assets are more quickly entered into map viewer database for use by maintenance Districts
- More accurate as it's all electronic entry
- Cost savings as we are using in-house staff

Work Orders

DelDOT's inspection consultants report deficient components of the storm sewer system for submittal into our work order system, Maximo. We recently added a feature in our NPDES map viewer database that allows the user to highlight work orders so maintenance supervisors can more efficiently plan daily work schedules for crews. If multiple work orders are in close proximity, this simple feature will save on mobilization and MOT costs. We also added flow direction arrows to pipes that aid users in tracking illicit discharges.

Another upgrade to the Work Order process is loading the Asset ID information from our map viewer database into the work order system. This will allow us to track actual repair costs at locations rather than system wide. This feature will also allow us to push updates from the Maximo work order system back to the map viewer, which we haven't been able to do without the asset ID information. The Asset ID information will be loaded to Maximo in Spring 2013 with an SOP and training planned for the Fall.

Best Management Practices (BMPs)

BMP Inspections

DelDOT and KCI Technologies revised the "Best Management Practices Field Inspection Manual." We use the manual to identify stormwater ponds in need of maintenance and contract preparation. We then verify in the field the proposed maintenance/retrofit recommendations.

Some of our maintenance problems could be avoided and overall maintenance costs reduced if we had a routine schedule for vegetation maintenance. In 2013 the BMPs will be added to DelDOT's work order system, working towards developing an automatic work order generation in our Maximo database. A work order will automatically be generated where the BMP resides so district staff can do annual mowing/vegetation control. This will reduce more costly clearing and grubbing paid to a contractor.

For BMPs inspected in 2012 that required maintenance work outside of routine mowing/vegetation control, a formal inspection was not completed. This type of maintenance includes erosion repair, sediment removal, regarding etc. These facilities have been inspected for quantity calculations and determination of additional work that was not included on the original inspection report. The BMPs were added to the existing BMP Maintenance Contract or a work order was created for District personnel to complete. Once the maintenance work is completed they will be included in the annual BMP inspections.

Assessment of BMP Performance

We are continuing to assess what DelDOT's most important BMP performance data needs will be as we transition into a new Phase I permit. Important goals of the SWPP&MP developed for the new permit will include compliance with TMDL waste load allocations (WLAs) and development of Water Quality Improvement Plans (WQIPs) for two priority watersheds in the county. Critical among our needs are tools and/or models to: (a) determine where additional stormwater treatment and controls are needed; (b) to calculate and report MS4 pollutant loads and reductions; and (c) to determine strategies to achieve maximum pollutant removal from runoff at minimal cost.

As mentioned in last year's annual report, we have gradually transitioned the focus of the DelDOT monitoring program towards assessment of the performance of "Green Technology" BMPs, and newer BMP technologies that are likely to play an increasingly important role in the Department's stormwater design toolbox. We also saw a need to collect more quantitative data on pollutant loads removed by maintenance practices such as street sweeping. To this end, we asked the DelDOT Maintenance Districts to begin reporting on a monthly basis the total weight of street sweeping residuals that they deliver to the New Castle County landfill. Based upon guidance from the Chesapeake Bay Urban Stormwater Group, these weights can then be used to calculate nutrient and sediment load reductions. 2012 was the first full year for which we have the sweeper waste data, and these are included in Sections 3 and 13 of this report.

In addition, we began in 2012 to develop a revised street sweeping plan for the Department to be included in the SWPP&MP for the new Phase I permit. To help verify that the plan requirements are met by the Maintenance Districts, and to track the total curb miles swept each year, DelDOT installed automated vehicle location AVL) devices on all of the sweepers in New Castle County. The data from the AVLs can be viewed and downloaded through the

NetworkFleet service (http://www.networkfleet.com/). In order for the data to be useful to us, we will need to verify that the devices work consistently and accurately and develop a way to analyze and synthesize the data without undue expenditure of time and resources. Preliminary examination of the data indicates that this may be a more difficult task than originally anticipated. We will continue to work on this in the coming year.

In late 2012, we began to negotiate a small professional services agreement with Versar, Inc. (Agreement #1644) to assist us in assessing our BMP and wet-weather monitoring programs and developing a revised monitoring plan for the new Phase I permit. We intend to partner, wherever possible, with other agencies and organizations on watershed monitoring programs. The need for data is intense, and in these fiscally challenging times, cooperation and elimination of duplicate efforts will be of particular importance to all stakeholders in the state.

Pesticide, Herbicide, Fertilizer

DelDOT's Roadside Environmental section manages PHF applications applied by contractors and DelDOT staff. The NPDES Program has the responsibility to develop programs and implement controls through training, policy changes resulting from research, development of SOPs, education, etc. to reduce the pollutants associated with their application and to track trends that can document anomalous spikes in usage or declines in usage due to implementation of programs.

We have implemented several pesticide reduction programs as described below:

1. Guardrail pilot study – Several years ago we began a program with the University of Delaware to investigate methods to reduce the use rates of pesticides and carriers used to treat guardrail vegetation without compromising safety and aesthetics. We have monitored various treatment methods to compare their effectiveness, ease of implementation, aesthetics, cost and longevity (see Section 13.C.5, page 13-6, of this report for details). Several treatments have shown promise in our tests, and we have determined a need now to implement these treatments in some actual DelDOT roadway projects. We will try to select one or more projects in the coming year and revise the Department's specifications so that the new materials can be added to contracts.
2. Guardrail inventory – Treating guardrail accounts for a significant percentage of DelDOT's herbicide treatment program. The NPDES Program saw guardrails as a relatively simple way to reduce herbicide usage. We have inventoried all guardrails statewide and collected attribute data that included material under guardrail and surrounding landscape and environmental features. A consultant helps maintain and update this inventory. We intend to use the database to look for some areas where alternative treatment measures (e.g. hand control, weed barrier, low-grow fescues) can be used in lieu of herbicides. Little progress was made on this during 2012. More focus will be placed on this in 2013 as we begin to develop a revised SWPP&MP for the new Phase I permit.
3. Record keeping – We are continuing to keep records of herbicide quantities to establish baseline herbicide usage (Table 5-1). By tracking herbicide quantities we hope to be able to identify the cause of spikes or declines in usage and use the data to

assess pesticide reduction programs we have implemented. It is therefore important to separate herbicide tracking usage by roadside feature type. These feature types include: (1) Guardrail, islands, signposts; (2) Noxious weeds; (3) Brush; and (4) Landscape beds.

Construction Site Runoff

Erosion and sediment control at DelDOT construction sites falls under the purview of the Division of Transportation Solutions (DOTS). However, the NPDES Program, through its permit and consent decree, is responsible for ensuring E & S control compliance.

In 2011, DelDOT executed agreements with two consulting firms for a three year term to conduct third party erosion and sediment control construction inspections. We have experienced more consistent and timely reporting. The consultant also has the authority to hire a third party contractor, at the prime contractor's expense, to correct E&S deficiencies if the prime contractor refuses.

Public Education

The NPDES Section contracts with non-profit organizations and university staff with expertise in watershed management to assist with development of education and outreach programs. The Appoquinimink River Association (ARA) and the University of Delaware, Water Resource Agency, have specialties in watershed and water quality education. Partnering with these organizations has proven to an effective means of expanding our limited staff resources in a cost effective manner. These organizations also are assisting us with meeting the new draft NPDES permit requirements ahead of receiving the final draft.

As we have limited staff, our outreach efforts target large, multi-day events. In particular, during the Delaware State Fair event, approximately 30,000 people pass through the building giving them the opportunity to observe and/or participate with us and our display and games. In order to maintain the public's interest, we redesigned our buildings' interior to promote the Delaware Livable Lawns program. The theme was a 'Livable Lawn' consisting with native plants and reduced lawn theme. We also partnered with the University of Delaware computer science and art departments in the development of two interactive landscape challenge games to complement the interior landscape as described in Section 11. This has been a success for both the students and DelDOT. The students have the opportunity to work for a real client, while DelDOT receives the benefit by the use of games, at a reasonable cost, at the Delaware State Fair.

Dry Weather Screening and Illicit Discharge Elimination

All of the known DelDOT outfalls in New Castle County were screened during the first 5-year term of the permit. After that first round of screenings was completed, beginning in year six, KCI Technologies re-screened all outfalls that previously had had dry-weather flow. Per our DNREC-approved SWMP (Section V, DelDOT NPDES Phase I MS4 Permit Stormwater Management Plan, revised September 2010), we have continued to inspect and screen new outfalls that were not captured in the initial inventory. In addition, any potential illicit discharges

reported by inspection crews, maintenance staff, the public or co-permittees are screened and investigated. Only a limited number of potential illicit discharges are actually discovered through dry weather screening at this point.

A dry weather screening program that annually evaluates and screens at least 20% of the MS4 will be required by the new Phase I permit. Following the recommendations of the Center for Watershed Protection's IDDE Guidance Manual (2004), we have already begun to plan revisions to DelDOT's IDDE protocols. We will be using mapping and monitoring data to determine areas of the MS4 that have high potential for illicit discharges and improper disposal, and then the dry weather field screening will be targeted to those areas. An assessment of the chemical data from our previous dry weather screening activities has suggested that some of the parameters that we have measured, such as phenols and chlorine, are of limited value in detecting illicit discharges in New Castle County. Therefore, beginning in 2013, we will be modifying our protocols to include a suite of parameters more closely aligned with those recommended by the Center for Watershed Protection.

In assessing the dry weather data, we also uncovered a need for a database for the inspections that will allow querying on water quality data. Although the current NPDES database and map viewer allows one to view the data for a particular outfall, the database structure did not permit us to perform queries. KCI Technologies was tasked to revised the IDDE database to allow queries.

Street Sweeping

DelDOT was tasked with developing a science-based street sweeping program, using a combination of data collection and modeling which will result in maximum pollutant removal, which will be fiscally and operationally feasible. Some of the issues we have with our current program include: (1) Lack of well defined sweeping routes; (2) Verifying the required 4:2:1 sweeping frequency; and (3) Logging the correct information into the Maximo work order system such as miles swept vs. hours swept, and too many sweeping function codes.

To address these issues, we have developed general sweeping routes for sweeper operators based on road type (i.e. interstates/expressways; targeted roadways; local roadways; non-targeted arterial roadways; and low priority roadways) and District boundaries. We installed AVL's on all sweepers to verify the planned routes and we plan to simplify the function codes for the operators when they enter data into Maximo.

1. MS4 Structural Controls

Requirement:

DelDOT shall operate and maintain the MS4 and any structural controls incorporated into the system to reduce the discharge of pollutants (including floatables) to the maximum extent practicable as described in the Application page iv-6, Part 5 (iv) A1, Permit page 5, Part II.A.1. and Consent Decree page 11, Part II 17.

Performance:

A. Stormwater Conveyance Systems

The NPDES Section uses consultant services to inventory and inspect the entire DelDOT-owned system. From these inspections, work orders are generated for repair or maintenance.

DelDOT uses in-house forces and contractors to maintain its stormwater conveyance system.

Drainage Maintenance Contracts

DelDOT uses district maintenance personnel and contractors to maintain the stormwater conveyance system in New Castle County. This work insures the proper operation of the stormwater system and will reduce the pollutants that are carried to waterways. Each of the two districts in New Castle County (North and Canal) has its own drainage contract with an annual budget of $1 million. As necessary, the NPDES Program adds additional money to drainage contracts to repair and maintain the storm sewer system.

This work has three components, (1) open system drainage, (2) closed system drainage, and (3) ponding problems. The open drainage system represents general work to control erosion and cleaning and reshaping of ditches. The stabilization of ditches reduces the amount of sediment that enters the local stream and waterways. Closed drainage represents the underground system that includes pipes, manholes, inlets, catch basins and outfalls. Maintenance includes repairs on misaligned or deteriorating pipes, deteriorating catch basins, sink holes, clogged pipes, etc. Drainage problems reported by citizen complaints are also programmed into the drainage contract.

Storm Sewer System Inventory and Inspection

DelDOT executed Agreement #1591 with KCI Technologies on November 29, 2011 for a three year term to continue the inventory and inspection program. We are focusing this 3-year agreement's efforts on completing Sussex County. However, we added an additional work crew in New Castle County to conduct re-inspections of existing systems and to inventory new storm drain systems associated with recently constructed roadway improvement projects. As part of this contract, a comprehensive GIS database was developed that enables users to view the entire stormwater system, corresponding inspection data and pictures.

The following bulleted list describes the current status of the agreement for calendar year 2012:

- Re-inspected 5,578 structures in 107 subdivisions in NCCo.

- Inventoried and inspected 16,927 new structures in 22 subdivisions and 424 miles of non-subdivison roadways in Kent and Sussex Counties.
- Completed annual inspection of 339[1] BMPs.
- Submitted 396 work orders.

Please refer to Appendix A for a summary report prepared by KCI Technologies on the Storm Drain Inventory/Inspection Project.

Work Orders

Work orders are generated when DelDOT staff or their consultant determines if repair or maintenance is required. A work order is created and entered into Maximo, DelDOT's work order database. They are ranked on scale of 1-5 depending on the severity of the problem. Maintenance supervisors then review and determine if the work order will be completed by DelDOT personnel or contractors.

In 2012, KCI documented 396 storm system deficiencies resulting in Maximo work orders. In 2012, the district maintenance yards completed 351 (264 in NCCo) work orders that were generated during the MS4 inventory and inspections. There were also 195 District generated drainage work orders completed in 2012. Many of these work orders contained multiple structures or pipe runs along a section of roadway. In 2013 we will work with the Districts to determine if it is possible to track work completed by asset.

B. Stormwater Collection and Conveyance Complaint System

The Governors Surface Water Task Force recommended that an assistance program be created to aid each individual with his/her unique drainage or stormwater issue. Once an individual's information has been logged into the system the concern will automatically be forwarded to the proper agency. This program has a telephone number and email address to allow individuals to express their concerns (see Annual Report 2007, Figure 1-1). This provides one central point of contact when seeking solutions to the public's concerns.

When a complaint is called directly into DelDOT, information is gathered that includes location, problem, caller's name and phone number, etc. Once the information is documented, a work order request is generated and entered into DelDOT's Maximo database system. The complaint is investigated and the Operations Supervisor determines what type of repair is necessary. The work is assigned to the appropriate Maintenance District for repair. If no work is needed (no problem found during investigation) a courtesy call is returned to the complainant and the results of the investigation are explained.

C. Maintenance Inspection of Completed Stormwater Facilities

DelDOT has an annual requirement to inspect its constructed best management practice (BMP) devices, structures and stormwater management facilities (Appendix B). This work is currently performed by KCI Technologies.

The purpose of this statewide program is to: (1) inventory, inspect, measure water quality performance, identify noxious and/or invasive species and maintain functionality of

DelDOT's stormwater BMPs such as stormwater ponds, sand filters, infiltration trenches, etc., (2) maintain a comprehensive database, (3) coordinate with the Districts on the submittal of work orders as needed, and (4) provide technical assistance and guidance to the Department regarding appropriate maintenance strategies for stormwater BMPs.

A field inspection manual and forms were developed to effectively perform field inspections to evaluate BMP performance and identify maintenance requirements. The procedures outlined in this manual assist DelDOT with decisions on inspection, maintenance, repair, and retrofit of BMP facilities. As of December 2012 there were 339[1] BMPs inventoried and inspected. KCI Technologies does not do routine inspections of C and D rated ponds once they are on a maintenance contract. However, a separate inspection process requires that we inspect the BMP prior to the contractor beginning the work to determine if there are any other issues since the last inspection, and to calculate quantities. This inspection is conducted by DelDOT NPDES staff. Even though a contract may take over a year to begin, the BMP will be inspected at least once after the BMP has become a C or D. Please refer to Appendix B for a list of all DelDOT constructed facilities.

Overall performance and functionality are graded A-D. Table 1-1 describes the 2012 rating summary by each maintenance district. 98% of the BMPs we inspected in 2012 have an A or B rating, which is the rating that does not require major maintenance. B rated BMPs, which require minor maintenance, are maintained by in-house staff. C and D rated BMPs that require major maintenance are placed on a maintenance contract for restoration. After restoration, if the D rated BMP is not functioning properly, an alternative or retrofit design will be investigated and implemented on a retrofit contract.

Table 1-1. 2012 BMP Inspection Ratings Summary.

BMP TYPE	TOTAL NO.	A	B	C	D
NORTH DISTRICT	**81**	36	43	2	0
CANAL DISTRICT	**131**	59	69	3	0
CENTRAL DISTRICT	**42**	28	14	0	0
SOUTH DISTRICT	**85**	62	21	1	1
TOTAL NO.	**339[1]**	**185**	**147**	**6**	**1**

[1] This table reflects annual routine inspections by KCI Technologies in 2012. BMPs with existing work orders or on contract for maintenance were inspected by DelDOT staff prior to contracted work.

BMPs are evaluated and placed on contract for maintenance as needed and as money permits. Maintenance functions are performed either by the Districts or through general contractors, contractors specializing in noxious and invasive species control, or maintenance of specific manufactured BMP types. Noxious and invasive species are managed either through Roadside Environmental or District staff, or placed under contract with Weeds, Inc. In 2012 a total of 33 BMPs, totaling 2.7 acres, were treated for invasive species affecting performance.

In addition to the BMPs identified for noxious and invasive species, DelDOT identified stormwater BMPs in need of major maintenance. In 2012 there were 7 BMPs identified as requiring maintenance. These 7 BMPs are added to the log of BMPs that will be maintained by a Contractor and completed as funding is available.

Stormwater BMP Contracts

In 2012 we executed a contract to conduct maintenance repairs on all C Rated BMPs in New Castle County. The original contract included maintenance of 16 stormwater management ponds (wet and dry) that required extensive maintenance. The work activities included clearing and grubbing, dewatering and excavation of sediment, energy dissipater replacement, grading and reshaping of inlet and outlet swales and outlet structure repair. 10 additional locations were added to the contract for maintenance under a change order. Total expenditure in 2012 was $520,933.82 (Table 1-2).

In addition to the BMP maintenance contract, work orders for other C-rated BMPs that do not require extensive maintenance were created and were loaded to the Maximo Work Order system for completion by the Districts in 2012. 10 BMP Work Orders were completed in New Castle County by maintenance staff.

The remainder of the New Castle County C-Rated BMPs will be maintained under the existing contract while a new contract will be developed and let for bid for the BMPs in Kent County in 2013.

D. BMP Performance Monitoring and Assessment

The NPDES permit requires DelDOT to monitor the performance of existing stormwater structural controls and BMPs. During calendar year 2012, DelDOT's BMP monitoring and research program included the following projects:

1. Monitoring of biofiltration practices
2. Study of pollutant removal by grassed highway slide slopes
3. Monitoring of BMP outfalls at DelDOT maintenance facilities
4. Development of a revised street sweeping plan
5. Study of guardrail vegetation control alternatives
6. Study of the impacts of various mowing height practices
7. Study of new bioretention technologies to remove nutrients

See Section 13 ("Monitoring") and Section 16 ("Pollution Prevention at the Maintenance Facilities") of this report for a full description of each of these projects and monitoring results.

E. Bridge Maintenance

DelDOT's Bridge Division is federally mandated and follows the Code of Federal Regulations (23 CFR 650.3). DelDOT normally inspects bridges every 24 months or less depending on condition. If a bridge is in a degraded condition, inspection will occur more frequently. Inspectors use a "Structure Inventory and Appraisal Sheet" (see Annual Report

2001, Volume 3, Appendix D) found in the "Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges." The structural integrity of the bridge is evaluated on a scale of 0-9, where a score of 0 describes a failed condition. If repairs are necessary a report is sent to the appropriate Maintenance District where a work order is generated for the repair. Channel and Channel Protection is Item #61 on DelDOT's "Structure Inventory and Appraisal Sheet." This item describes the physical conditions associated with flow of water through the bridge such as stream stability and the condition of the channel, riprap, slope protection, etc. The inspector assesses visible signs of excessive water velocity that may affect undermining of slope protection, erosion of banks, and realignment of the stream. Accumulation of drift and debris on the superstructure and substructure is noted on the appraisal sheet. Item 61 is coded on a scale of 0 to 9. Coding of zero means that the bridge is closed due to channel failure and code 9 means that there are no noticeable deficiencies that affect the condition of the channel. Stream channels are inspected when the bridges are inspected at the same two- year interval.

Table 1-2. 2012 BMP Maintenance.

BMP No.	BMP Type	**2012** Maintenance Action	Previous Rating	Post Rating	Date Completed	Est. Cost
253	Sh. Marsh	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	12-Jun	$22,151.97
6	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub	C	A	4/21/2012	$54,560.89
142	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub	C	A	4/12/2012	$32,629.92
196	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub	C	A	4/20/2012	$19,417.69
166	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	5/18/2012	$27,274.70
162	Bioswale	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	6/1/2012	$22,374.22
163	Bioswale	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	4/13/2012	$4,964.26
84	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	7/10/2012	$11,052.44
85	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	4/16/2012	$6,079.82
86	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	7/16/2012	$23,624.77
193	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	5/7/2012	$48,698.35
202	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	7/17/2012	$49,908.85
90	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	4/9/2012	$33,490.22
127	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	5/21/2012	$23,827.01

BMP No.	BMP Type	**2012** Maintenance Action	Previous Rating	Post Rating	Date Completed	Est. Cost
130	Wet Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	5/24/2012	$18,043.47
230	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	Sept. 2012	$15,841.93
3	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	B	Sept. 2012	$24,249.41
82	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	Sept. 2012	$9,655.50
79	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	Sept. 2012	$4,617.00
38	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	**B**	Sept. 2012	$9,295.25
183	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	B	Sept. 2012	$5,096.50
854	Dry Pond	**Grassbusters, Contract T201280201**; remove sediment, clear and grub, install perm. SCE	C	A	8-Jun	$32,579.65
	Initial Expense					$21,500.00

$520,933.82

2. New Development and Significant Redevelopment

Requirement: DelDOT shall utilize a comprehensive master planning process to develop, implement, and enforce controls to reduce the discharge of pollutants from areas of new development and significant redevelopment. DelDOT shall review watershed assessment reports, relevant wasteload allocations, Total Maximum Daily Load (TMDL), or Pollution Control Strategies and develop a schedule for maintenance or retrofit of structural controls. DelDOT shall assess the water quality impacts of its existing and ongoing development planning activities. DelDOT shall construct and implement BMPs necessary to protect water quality. Additionally, DelDOT shall budget at least $150,000 per year for storm water management retrofit projects as described in the Application page iv-15, Part 5 (iv) A2, Permit page 7, Part II.A.2. and Consent Decree page 16, Part II 18.

Performance:

A. *Assessment and Planning*

- DelDOT has adopted Mobility Friendly Design Standards (see Annual Report 2001, Volume 3, Appendix F) for subdivision and minor collector Subdivision Street. These standards, among other things, are roadway design standards that promote low-impact development strategies such as landscaped areas and narrower pavement widths that support the Statewide Long Range Transportation Plan.
- DelDOT's Planning Section considers water quality when it completes a Categorical Exclusion Evaluation (CEE) report when reviewing new projects.
- DelDOT is a delegated agency under DNREC's State of Delaware Erosion and Sediment Control Program for land disturbance greater than 5000 sq. ft.
- DelDOT's Subdivision Manual regulates development in Delaware that will be turned over for State Maintenance. Before a subdivision is accepted, a DelDOT Inspector inspects the structural integrity of the stormwater system and the pipes are scoped using Closed Circuit Television. If defects are discovered the contractor is responsible for repairs. This ensures the structure is free of defects, joints are watertight, pipes are sediment free, etc.
- Advancements in technology have aided DelDOT's snow fighting practices. Improvements were initiated that achieve DelDOT's objectives of increasing our level of service, establishing more cost effective and efficient practices and overall salt reduction that reduces the impact on the environment and infrastructure. Snow and ice removal strategies include ground speed spreader controls, anti-icing, pre-wetting, brine production, and plow balance valves.
- As part of Enhancing Delaware Highways, DelDOT has reduced mowing along roadsides. This has several positive effects: reduction of grass clipping entering the storm drain; filtering of stormwater from roadways before it enters the storm drain; aesthetic enhancement; reduced maintenance hazards; and diverts budget resources for higher priority needs. Additionally, DelDOT developed a mowing Standard Operating Procedure.

- DelDOT developed a two-part Establishment and Maintenance manual. The Manual explains in detail the necessary steps to establish sustainable roadside vegetation, and manage that vegetation in an environmentally sound, aesthetically pleasing, and fiscally responsible manner. The second part of the manual, Managing Vegetation, describes strategies to minimize the use of pesticides and develop alternative control methods as specified by the NPDES permit. The manual can be viewed at:

  (http://deldot.gov/information/pubs_forms/manuals/edh/index_em.shtml).

B. Retrofit

Per the Consent Decree, DelDOT is required to budget $150,000 per year for stormwater retrofits. In calendar year 2012, DelDOT expended $183,756.37 towards its NPDES retrofit program. Table 2-1 summarizes total costs incurred for design and construction of retrofits from 2007 – 2012. This total amounts to $3,171,375.18.

Projects in 2012 include:

Blackbird Creek – In 2012 DelDOT continued coordination with DNREC on this project consisting of preparing a full plan design for restoration of a main tributary and three (3) tributary branches to Blackbird Creek using natural channel techniques and creation of a wetland floodplain and protect DelDOT's road. DelDOT maintenance crews stabilized the rip rap outfalls immediately adjacent to the creek prior to beginning any stream restoration. DNREC has partnered with the University of Delaware to continue planning restoration projects for the Creek. In early 2013 the project will move forward with a 40-50' test project in the interfluve area using discarded Christmas trees for stabilization. This test project will be monitored for one year before moving forward with the entire project.

Ham Run – This stream restoration project was originally designed to compliment an adjacent bridge restoration project. The channel restoration portion of the Contract was split from the Bridge restoration project until the necessary permits were obtained and turned over to the Department of Natural Resources and Environmental Control (DNREC) to let the project for Construction. DNREC received their Army Corps Permit in April 2012 and the project was awarded to Meadville. They will begin construction in Winter/Spring 2013. Work includes restoration of 600 linear feet of the stream channel using rock and or log cross vanes to redirect stream flows; Bank stabilization; floodplain creation and wetland plantings along the banks.

Chapman Vehicle Wash Area Retrofit – In Spring 2012 Construction began on the replacement BMP for the Chapman Vehicle Wash Area Retrofit. Improvements included replacing the existing sand filter and Stormceptor treatment BMPs with a sediment basin. These improvements were necessary because the two existing BMPs in series required weekly maintenance due to high sediment loads from washing maintenance vehicles and equipment. The new sediment basin is lined with articulated block on the bottom and soil confinement slope protection along the banks for ease of maintenance. The new BMP requires monthly maintenance and can be completed with on-site equipment. Construction of the new facility was completed by maintenance staff in June 2012.

Leatherman's Run Retrofit – In 2012 Parsons Brinckerhoff (PB) completed the preliminary design based on an extensive review of all available studies provided by the DelDOT NPDES group including but not limited to BMP retrofit recommendation reports, stream

assessments, watershed studies, conceptual designs and all available hydrologic, hydraulic, geomorphic, benthic, lentic and pollutant assessment and/or monitoring information to provide retrofit recommendations.

An impaired stream segment along Leatherman's Run between I-95 and Chapman Road, near the local High School, was chosen as the first stream restoration project. The project includes coordination with New Castle County's Special Services Division working to adjust and protect two sanitary sewer line crossings within this stream reach. Final Plans for this project will be completed in 2013 with plans to begin construction in Spring 2014 once the permits have been secured. Improvements will include restoring the stream bottom to historical elevations; armoring the outfall pipe energy dissipater; floodplain creation;

Christiana High School Low Impact Development (LID) – In 2012 PB completed preliminary and semi-final design plans of LID storm water quality improvement facilities that could be used to pre-treat stormwater runoff from the high school property adjacent to the stretch of Leatherman's Run that is planned for restoration. In addition to the benefits of pre-treatment this project will also be used to meet our public education and outreach goals by educating and involving the students and local residents in the purpose of the project as well as participating in the landscaping planning and design. Design and construction of the facilities will be completed in 2013.

Table 2-1. Cost Summary for DelDOT Retrofits, 2007 – 2012.

Project Design/Construction	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Retrofit Design Cost	$ 27,253.18	$167,695.61	$ 63,447.78	$ 44,834.12	$ 33,017.11	$ 117,562.65
Storm drain inserts			$ 6,710.00	$ 5,958.83		
Middletown maintenance facility construction			$ 292,983.35			
Leatherman's Run retrofit planning	$ 54,811.88		$ 52,011.30			
Harrington maintenance facility design			$ 138,517.17			
Harrington Maintenance Yard Stormwater Retrofit – Construction				$ 148,388.53	$ 37,800.00	
Chapman Vehicle Wash Area Retrofit						$ 66,193.72
TOTAL COST	$ 82,065.06	$167,695.61	$ 553,669.60	$ 199,181.48	$ 70,817.11	$ 183,756.37

3. Roadways

Requirement: DelDOT shall operate and maintain public streets, roads, and highways, in such a manner as to reduce, to the maximum extent practicable, the discharge of pollutants as described in the Application page iv-30, Part 5(iv) A3, Permit page 7, Part II.A.5. and Consent Decree page 18, Part II 19.

Performance:

The following programs described below are ways the Department manages and minimizes transport of pollutants associated with road repair and maintenance activities:

A. Road Repair and Maintenance

There are various ways in which the Department maintains the roadways that help reduce the discharge of pollutants. Routine maintenance and improvements reduce the pollutants coming from the roadway in several ways. The patching of potholes and sealing of cracks reduces the amount of pavement that will break away and be transported into the nearest waterway. Repairing potholes will also decrease the wear and tear on vehicles, thus reducing the fluids, miscellaneous sediments, and tire particles that could be dislodged from vehicles.

All road projects are required to follow the Delaware Sediment and Stormwater Regulations. Projects designated as minor, medium or major shall have an approved sediment and stormwater management plan. Medium and major projects must also have a site reviewer who is a Certified Construction Reviewer (CCR).

B. Spills on Roadways

DelDOT follows the manual of Standard Operating Procedures developed for responding and managing spills on the roadways classified as **Category E, Type E-1** incidents (Traffic Hazards, Fuel, Oil or other HAZMAT spills on or near the roadway). Most DelDOT vehicles have been equipped with spill kits in the event of an accidental spill or as a first responder to a vehicle accident; employees have been trained how to respond to spills and protection of water quality.

C. Sweeping Program

DelDOT's street sweeping program reduces pollutants by maintaining the cleanliness of the roadway. The sweeping program includes the roadways, shoulder, intersections, and toll plaza lanes on interstates, arterials, collector and local roads and requires roadways to be swept on the following cycle: roads with ADT (Average Daily Traffic) greater than 20,000 are swept 4 times a year, roads with ADT between 5,000 and 20,000 are swept 2 times a year and roads with ADT less than 5,000 are swept once a year. The current fleet of sweepers in New Castle County consists of 9 mechanical sweepers and 11 regenerative air vacuum sweepers.

A total of 1,544 tons of street sweeping residuals were collected from New Castle County roadways in 2012. Table 13-3 provides details of the total miles swept and tons of street

sweeping wastes collected in New Castle County in calendar year 2012 (see Section 13.C.4, page 13-5 of this report). Using the formulas recommended by the Chesapeake Urban Stormwater Group (memo "Street Sweeping/BMP Era Recommendations, dated 3/1/2011), the estimated pounds of nutrients removed from runoff in 2012 by DelDOT's street sweeping program were 5,404 lbs total nitrogen and 2,162 lbs total phosphorus (Table 3.1).

In an effort to meet the new NPDES permit (draft form) requirements for street sweeping, DelDOT has tasked KCI Technologies to assist with developing an optimum science-based sweeping strategy for pollutant removal. This plan will accomplish the following:

- Prioritize roads to be swept, to be based on optimum water quality benefits with consideration of curbed roads (closed drainage), Average Daily Traffic, Industrial/Commercial or other hotspots
- Develop a roadway sweeping frequency plan for use by the Districts
- Determine equipment requirements
- Provide a cost analysis
- Calculate pollutant removal rates

The Street Sweeping Plan developed by DelDOT and KCI will have three components as follows:

a. **A Street Sweeping Plan for DNREC review.** This plan will include the literature review, the cost analysis, the GIS overlay analysis, a feasibility analysis (plan must be able to be implemented by the Maintenance Districts), the proposed roads to be swept (compared to roads currently swept under the 4:2:1 plan) and a summary that justifies the reasons that the proposed plan is more efficient from a water quality and cost standpoint.

b. **A Street Sweeping Plan for DelDOT Maintenance District Use for Implementation.** This plan would be compiled in an easily understood format with regard to (1) Identification of roads to be swept; (2) Frequency of sweeping; and (3) Time period for sweeping. This information could be assembled in the form of color-coded mapping, checklists, calendars, etc. During this step, KCI will work with DelDOT's GPS provider to develop reports. The final materials for this submission would not be completed until the Street Sweeping Plan above has been approved for implementation by DelDOT and DNREC.

c. **A Street Sweeping Plan Evaluation.** After the first year of implementing the new plan, KCI will compare 2012 (under the current 4:2:1 plan) poundage sent to the landfills to 2013 (under the proposed plan) poundage sent to the landfills.

<u>In 2012 we completed the following</u>:

- Comprehensive literature review in relation to past and present national street sweeping plans and studies

- Developed several scenarios options relative to cost, manpower, and equipment for review by Districts
- Calculated pollutant removal rates for each scenario
- Developed a basic route plan
- Presentation to Districts

Path forward for 2013:

- Modify the chosen scenario based on District comments
- Confirm AVL accuracy
- Confirm sensor functionality
- Pilot a study to test the chosen sweeping scenario

D. Litter Control Programs

DelDOT maintenance staff and prison crews

DelDOT's maintenance staff and prison crews help reduce the discharge of floatables to the MS4 through routine pick up of trash and debris from the roadways, medians and right-of-way. DelDOT staff is also responsible for removal of dead animals and clean up of illegal dump sites from the roadside.

Adopt-a-Highway

Adopt-a-Highway is a cooperative program between DelDOT's Division of Public Relations and volunteers to reduce litter along State roadways and subsequent discharge to waters of the State. This program supplements effort by DelDOT's maintenance forces to control litter. The volunteer groups are required to collect litter a minimum of twice per year and submit activity reports following each cleanup for inclusion in the program. Each group maintains approximately two miles of roadway. DelDOT maintains an Adopt-a-Highway website (www.deldot.gov) and submits press releases to solicit volunteers. There are currently 849 volunteer groups statewide (272 groups in New Castle County) maintaining 1,698 lane miles.

Roadside Clean-up

DelDOT held its seventh annual "Imagine a Litter Free Delaware" cleanup day along roads, highways and community areas in October 2012.

TrashStoppers

DNREC's campaign is an outward appeal to the public for help in stopping illegal trash dumping along Delaware roadways to stop illegal dumping of garbage, debris, and hazardous wastes.

The "TrashStoppers" program relies upon the placement of numerous surveillance cameras. Since the surveillance cameras were deployed in 2009, 14 arrests have been made on 16 illegal dumping charges, all resulting in convictions with guilty pleas.

E. Snow and Ice Program

Effective salt management practices can help reduce the amount of road salt that enters the environment. This translates into savings for DelDOT, protection against liability, and minimization of impacts of salt on our environment. DelDOT has many practices in place, both for the roadway and all maintenance facilities.

DelDOT has developed and instituted advanced snow fighting practices that began during the 2004-2005 winter season to include ground speed spreader controls, anti-icing, pre-wetting, and plow balance valves. These advanced techniques in snow and ice removal help DelDOT meet its goal of improved service to customers, reduce the impact to the infrastructure, and conserve salt which helps meet the goals of the NPDES Program by reducing the impact on the environment:

- Ground speed spreader controls provide accurate control of material usage.
- Anti-icing is the application of liquid deicers (Salt Brine) to road surfaces prior to a precipitation event to prevent the formation or development of bonded snow and ice. The Department uses 6000 gallon tanker trucks and 1300- and 1800-gallon capacity units that slide into the bed of a dump truck.
- Pre-wetting adds moisture to salt to "jump start" the melting action of the salt and causes the salt to stick to the road and prevent scatter or bouncing.
- Plow balance valves decreases the amount of weight that the plow cutting edge bears on the road surface decreasing damage to the road surface.

Salt application rates can vary depending on storm conditions, but the goal is 100 - 400 pounds of salt per lane mile as recommended by AASHTO. The rate is achieved by calibrating the equipment annually and sending maintenance personnel to a one-day seminar provided by The Salt Institute. The seminar instructs on proper salt application procedures and quantities balanced with safety and environment.

All salt stored at the maintenance facilities is under roof. Only during loading and unloading does the potential exist for salt to enter the stormwater system. DelDOT is following the salt management practices established by the "Statewide Salt Best Management Practices for DelDOT Maintenance Yards" plan developed for area maintenance facilities (see Annual Report 2004, Appendix U).

Table 3-1. Estimates of nitrogen and phosphorus removed from New Castle County roadways by street sweeping. The weights reflect tons of material delivered to the DSWA landfill. Calculations are based on based on the recommendations published in the Chesapeake Urban Stormwater Workgroup memo, "Street Sweeping/BMP Era Recommendations," dated 3/1/2011. A factor of 0.7 was used to calculate dry weight.

	Tons of Waste Collected	TN Removed (lbs.)	TP Removed (lbs.)
North District	1,067	3,734	1,494
Canal District	477	1,670	668
Total for NCCo	**1,544**	**5,404**	**2,162**

4. Flood Management

Requirement: DelDOT shall assess and minimize to the maximum extent practicable, the impacts of any flood control projects on receiving water quality as describe in the Application page iv-38, Part 5(iv) A4, Permit page 7, Part II.A.4. and Consent Decree page 19, Part II 20.

Performance: DelDOT does not have a regional flood control program and does not undertake flood control projects. DelDOT's only responsibility is maintenance of existing tide gates and mill pond outfalls. Should DelDOT become involved in any flood control project in the future, consideration will be given to incorporating water quality control measures.

5. Pesticides, Herbicides and Fertilizers

Requirement: DelDOT shall implement controls to reduce, to the maximum extent practicable, the discharge of pollutants related to the application of pesticides, herbicides, and fertilizers by the co-permittee's employees or contractors to public rights of way, parks, and other municipal property or facilities. In addition, the co-permittees shall implement programs to encourage reductions in the discharge of pollutants associated with the commercial application and distribution of pesticides, herbicides and fertilizers as described in the Application page iv-45, Part 5(iv) A6, Permit page 7, Part IIA.5. and Consent Decree page 19, Part II 21.

Performance:

All herbicide applications that are applied to DelDOT rights-of-way by contract applicators are reviewed prior to the award to the lowest bidder to insure that selected herbicides are labeled for the intended use, and that when feasible, a herbicide is selected that can be applied at a low-use rate. This review frequently reduces the total load of herbicide applied to DelDOT's rights-of-way.

DelDOT does not routinely fertilize its roadsides. The only nutrients applied to DelDOT's rights-of-way come as a result of leaving grass clippings on the ground after mowing. Degradation of this vegetative material results in the slow release of organic constituents that are mineralized to plant nutrients by microorganisms and subsequently available to turfgrasses. This natural process results in minimal leaching of nutrients. Also this practice results in minimal surface runoff of nutrients from ground with a slope of 3 horizontal to 1 vertical or less.

Fertilizers are used in establishing turfgrasses from seed on freshly prepared bare ground. This is generally done under contract with a firm using a hydroseeder. DelDOT's specifications require that 50% of the nitrogen product be a slow release form of ureaformaldehyde. The amount of nitrogen applied is 78 kg/ha. Phosphorous pentoxide is applied at 47 kg/ha of available P that is the sum of water soluble and citrate-soluble phosphate. Potassium oxide is applied at 31kg/ha of water soluble potash. In all cases areas that are seeded are covered with a recommended mulch.

Pesticides applied on DelDOT's rights-of-way are done according to label recommendations that are on the product and filed with EPA at the time of product registration. Pesticides applied on DelDOT's rights-of-way are done predominately by contractors that are certified Delaware pesticide applicators. DelDOT employees that apply pesticides to DelDOT's rights-of-way are certified Delaware pesticide applicators or work under the supervision of a DelDOT employee that is a certified Delaware pesticide applicator. Typically, the only pesticides applied by DelDOT fall under the category of herbicides. DelDOT, however, may use other pesticides such as insecticides under certain circumstances.

DelDOT employees take required training courses that serve as credit toward renewal of their Delaware pesticide applicators license. Roadside Environmental Specialists attend conferences and working sessions on pest control technologies that are open to all DOT employees. Opportunities to use reduced amount of pesticides by using new low rate pesticides, adjuvants or surfactants that can enhance efficacy of pesticides and thus reduce rate, or alternatives to chemicals that are cost effective and efficacious are often topics of various sessions these specialists attend.

We began implementing several programmatic initiatives as part of the NPDES pesticide reduction strategy:

1. *Guardrail Inventory* – DelDOT has the responsibility of maintaining a 4' clear zone around the guardrail for both public safety and structural integrity via mowing, hand trimming and herbicides. We executed an agreement with Wallace Montgomery & Associates, LLP in May 2008 to inventory all guardrails statewide. The project was completed in June 2009 and inventoried 310 guardrail miles. Attributes collected included material under guardrail, guardrail type, surrounding environmental features and identification of sensitive/no spray zones. The inventory and attributes collected will be used in development of a pesticide reduction strategy to limit the use of herbicides, particularly around environmental sensitive areas (e.g. streams, wetlands, drinking supply, etc.).

   Since DelDOT is continually upgrading, replacing, or adding new guardrail, we executed a new agreement to update and maintain DelDOT's existing guardrail inventory database. The consultant will compile a field-verified inventory of the new and modified guardrail sections on all DelDOT-maintained roadways in Delaware, to include GPS location data for the beginning and end of each section. At least twice per year, DelDOT's NPDES Section will provide information to the consultant on the locations of new guardrail installations. These will be integrated into the existing guardrail inventory database.

2. *Guardrail Vegetation Management pilot study* – DelDOT and the University of Delaware developed a controlled research study to test the effectiveness of treatment types under guardrail for weed control. Two types of weed block material, asphalt, low-grow fescue, zoysia seed and sod, and natural growth with periodic trimming will be monitored against a control. The results of this study will determine if these materials are effective at reducing herbicide application and can be used in specific locations such as environmental sensitive areas and drinking water supply reservoirs. We have extended this study through at least the next growing season to collect additional data on weed block materials and to test new plots of zoysia grass. A detailed summary report is found in Section 13-C5 of this report.

3. *Training* – In addition to the required training for pesticide license renewal, DelDOT holds or attends periodic training to further educate staff. In 2012, DelDOT Roadside Environmental staff attended three workshops.

4. *NPDES Aquatic Pesticide General Permit Program* – DelDOT is required to comply with the NPDES Aquatic Pesticide General Permit Program. The Environmental Roadside Section is preparing a Pesticide Discharge Management Plan and annual report for submittal to DNREC.

5. *Record keeping and pesticide usage* – Contractors and DelDOT applicators are required to submit records of spraying activities to DelDOT's Environmental Roadside Section. The NPDES Program has begun tracking and reporting herbicide quantities to establish baseline herbicide usage. By tracking herbicide quantities we will be able to identify the cause of spikes or declines in usage and use the data to assess pesticide reduction programs we have implemented. Material quantities used are provided in summary Table 5-1.

Table 5-1. 2012 Herbicide totals for New Castle County.

County	Product Name	EPA Reg. No.	App. Method	Quantity	Unit of Measure
New Castle	41-A	exempt	Land Based Sprayer	1.562	lbs.
New Castle	41-A	exempt	Land Based Sprayer	2.618	lbs.
New Castle	41-A	exempt	Land Based Sprayer	50.715	lbs.
	41-A Total			54.895	
New Castle	Accord	62719-324	Land Based Sprayer	1.6	gals.
	Accord Total			1.6	
New Castle	Aquaneat	278-265	Land Based Sprayer	24.661	gals.
New Castle	Aquaneat	228-365	Land Based Sprayer	0.012	gals.
New Castle	Aquaneat	228-365	Land Based Sprayer	3.37	gals.
New Castle	Aquaneat	228-365	Land Based Sprayer	110.444	gals.
New Castle	Aquaneat	228-365	Land Based Sprayer	7.41	gals.
New Castle	Aquaneat	228-365	Land Based Sprayer	31.3	gals.
	Aquaneat Total			177.197	
New Castle	Basal Oil	exempt	Land Based Sprayer	2.96	gals.
	Basal Oil Total			2.96	
New Castle	Bullseye	exempt	Land Based Sprayer	0.519	gals.
New Castle	Bullseye	exempt	Land Based Sprayer	0.506	gals.
New Castle	Bullseye	exempt	Land Based Sprayer	5.4745	gals.
New Castle	Bullseye	exempt	Land Based Sprayer	0.25	gals.
	Bullseye Total			6.7495	
New Castle	Chemsurf	exempt	Land Based Sprayer	0.25	gals.
	Chemsurf Total			0.25	
New Castle	Clean Slate	228-491	Land Based Sprayer	0.056	gals.

	Clean Slate Total			0.056	
New Castle	Clear Pasture	66222-153-53883	Land Based Sprayer	1	gals.
	Clear Pasture Total			1	
New Castle	Clearcast	241-437	Land Based Sprayer	0.219	gals.
	Clearcast Total			0.219	
New Castle	Diuron	34704-648	Land Based Sprayer	1939.5	lbs.
	Diuron Total			1939.5	
New Castle	Escort XP	352-439	Land Based Sprayer	0.019	lbs.
New Castle	Escort XP	352-439	Land Based Sprayer	0.0117	lbs.
New Castle	Escort XP	352-439	Land Based Sprayer	5.18	lbs.
	Escort XP Total			5.2107	
New Castle	Garlon 3A	62719-37	Land Based Sprayer	12.332	gals.
New Castle	Garlon 3A	62719-37	Land Based Sprayer	0.131	gals.
New Castle	Garlon 3A	67219-37	Land Based Sprayer	0.148	gals.
	Garlon 3A Total			12.611	
New Castle	Garlon 4	62719-40	Land Based Sprayer	1	gals.
	Garlon 4 Total			1	
New Castle	Glyphosate (41%)	multiple	Land Based Sprayer	12.08	gals.
	Glyphosate (41%) Total			12.08	
New Castle	Horsepower	228-313	Land Based Sprayer	6.043	gals.
	Horsepower Total			6.043	
New Castle	Krenite	352-395	Land Based Sprayer	83	gals.
	Krenite Total			83	
New Castle	Method 50SG	352-787	Land Based Sprayer	2.866	lbs.
New Castle	Method 50SG	352-787	Land Based Sprayer	8.784	lbs.
New Castle	Method 50SG	352-787	Land Based Sprayer	1.256	lbs.
	Method 50SG Total			12.906	
New Castle	Methylated Seed Oil	exempt	Land Based Sprayer	0.252	gals.
New	Methylated Seed Oil	exempt	Land Based	0.6628	gals.

Castle			Sprayer		
New Castle	Methylated Seed Oil	exempt	Land Based Sprayer	5.557	gals.
New Castle	Methylated Seed Oil	exempt	Land Based Sprayer	78.25	gals.
	Methylated Seed Oil Total			84.7218	
New Castle	Milestone VM	62719-537	Land Based Sprayer	0.00036	gals.
New Castle	Milestone VM	62719-537	Land Based Sprayer	0.55	gals.
New Castle	Milestone VM	62719-537	Land Based Sprayer	2.431	gals.
	Milestone VM Total			2.98136	
New Castle	Nu-film	exempt	Land Based Sprayer	6.19	gals.
	Nu-film Total			6.19	
New Castle	Oust Extra	352-622	Land Based Sprayer	1.75	lbs.
	Oust Extra Total			1.75	
New Castle	Oust XP	352-601	Land Based Sprayer	8.32	lbs.
	Oust XP Total			8.32	
New Castle	Overdrive	7679-150	Land Based Sprayer	0.32	gals.
	Overdrive Total			0.32	
New Castle	Panoramic	66222-141-81927	Land Based Sprayer	29.079	gals.
	Panoramic Total			29.079	
New Castle	Pathfinder II	67219-176	Land Based Sprayer	0.5	gals.
New Castle	Pathfinder II	67219-176	Land Based Sprayer	2.17	gals.
	Pathfinder II Total			2.67	
New Castle	Pendulum	241-416	Land Based Sprayer	5.1	gals.
New Castle	Pendulum	241-416	Land Based Sprayer	4.793	gals.
	Pendulum Total			9.893	
New Castle	Polaris	228-534	Land Based Sprayer	2.191	gals.
	Polaris Total			2.191	
New Castle	Proclipse	228-434	Land Based Sprayer	382.91	lbs.
	Proclipse Total			382.91	
New	Scythe	10163-25	Land Based	0.07	gals.

Castle			Sprayer		
	Scythe Total			0.07	
New Castle	Stalker	241-398	Land Based Sprayer	0.04	gals.
	Stalker Total			0.04	
New Castle	Surfactant	exempt	Land Based Sprayer	3.688	gals.
New Castle	Surfactant	exempt	Land Based Sprayer	2.85	gals.
	Surfactant Total			6.538	
New Castle	Telar XP	352-654	Land Based Sprayer	0.258	lbs.
New Castle	Telar XP	352-654	Land Based Sprayer	0.8005	lbs.
New Castle	Telar XP	352-654	Land Based Sprayer	0.116	lbs.
	Telar XP Total			1.1745	
New Castle	Thinvert	exempt	Land Based Sprayer	83	gals.
	Thinvert Total			83	
New Castle	Transline	62719-259	Land Based Sprayer	0.41	gals.
	Transline Total			0.41	
New Castle	Triplet	228-409	Land Based Sprayer	1	gals.
	Triplet Total			1	
New Castle	Trooper P+D	228-530	Land Based Sprayer	40	gals.
	Trooper P+D Total			40	

6. Illicit Discharge and Improper Disposal

Requirement:

The co-permittees shall: (1) implement a facility inspection program (*New Castle County only*), (2) implement an on-going program to detect illicit discharges and improper disposal into the storm sewer, (3) implement procedures to limit infiltration of seepage from sanitary sewers, and (4) implement a public education program on proper management and disposal of an array of organic and inorganic materials. These requirements are described in the Application page iv – 30, Part 5(iv) A6, Permit page 7, Part II.A.5., Consent Decree page 19, Part II 22.

Performance:

Per agreement with New Castle County, DelDOT is responsible for the illicit discharge detection and elimination (IDDE) program within the DelDOT-owned portion of the stormwater conveyance system. Similarly, New Castle County manages their IDDE program that includes outfalls of their ownership. DelDOT's IDDE program is performed by KCI Technologies, Inc., under Agreement No. 1495.

DelDOT has the responsibility of eliminating illicit connections to its portion of the MS4. DelDOT first tries to effect these eliminations through administrative action. KCI is instructed to send the potential violator a "Notice of Potential Illicit Discharge" letter. The letter describes the illicit discharge and instructs the resident to eliminate the discharge within 30 days. A follow-up inspection is conducted after the 30-day period. If the illicit discharge is still present, DelDOT's NPDES Section will send a second letter stating if the discharge/illegal connection has not been eliminated or removed after the 30-day period, the enforcement branch of the Department of Natural Resources and Environmental Control (DNREC) will be notified. If that is unsuccessful, we can use police action through DNREC. DelDOT established a Memorandum of Agreement on August 20, 2001 with DNREC to utilize Environmental Protection Officers in the enforcement of the permit. A copy of the MOA was included in Annual Report 2001. DelDOT also coordinates with New Castle County or other co-permittees when needed.

In calendar year 2012, a total of 412 DelDOT-owned outfalls were screened in New Castle County. The dry weather screening procedure and results are described more fully in Section 13 of this report. A total of 53 outfalls were found to have dry-weather flow. No indications of illicit discharges were found for any of these outfalls – most appeared to be flow from groundwater intrusion.

During 2012, two reported potential illicit discharges (PIDs) in New Castle County were investigated (Table 6-1). Each was investigated by KCI crews, and follow-up action was taken where appropriate. The first, a possible sewage connection on Appleby Road, was first reported in 2009 and referred to DelDOT by New Castle County. KCI determined that a sewer pipe discovered in the catch basin probably tied into a sewer connection. DNREC was contacted and an Environmental Enforcement Officer investigated via dye tests. The EPO contacted the DNREC groundwater division. No criminal action was taken. To date, DNREC is working with the owner through a financial assistance fund specific for low income home owners to replace septic systems. In the second instance, educational door-hangers were distributed in one community (Sharpley) after a resident reported to DelDOT that a neighbor had dumped leaves

into a storm drain inlet. More details about the circumstances, location and investigation of each PID can be found KCI's 2012 Outfall Screening Report (Appendix C).

In an effort to encourage Delaware citizens to dispose of hazardous household materials properly, the DelDOT NPDES Section helps publicize Delaware Solid Waste Authority (DSWA)'s Household Hazardous Waste Collection Program. This includes distribution of DSWA brochures that announce the dates and locations of collections in each county.

Another public outreach program aimed at eliminating illegal dumping of trash, debris and hazardous wastes along the state's highways is DNREC's "TrashStoppers" Program. The public is asked to notify DNREC about any roadways or streets used for illegal dumping so the sites can be put under surveillance by digital cameras to aid in identifying trash dumpers. The public is also asked to identify the trash dumpers who are caught in the act in photos posted on the DNREC web site as part of the TrashStoppers campaign: (http://www.awm.delaware.gov/Enforcement/Pages/TrashStoppers.aspx).

Table 6-1. Summary of potential illicit discharges into the DelDOT MS4 investigated in New Castle County in 2012. Note that DNREC reported to DelDOT that the Appleby Road connection was removed in _2013 (see attached email communication, Figure 6-1.

Structure No.	Field Visit Date	Neighborhood	Address	Reported By	Issue Reported	Investigation Results	Determination	Action
86938 & 372	01/16/09	N/A	255 & 229 Appleby Rd	New Castle County	Possible sanitary sewer connection into catch basin	Debris and ice incatch basin preventing inspection.	Unable to pinpoint source	Referred to DelDOT; DelDOT cleaned basin
	02/16/09			New Castle County		Flow observed with sewage odor; Discharge tested high for ammonia and detergents: 24-hour re-test: high ammonia and detergents.	Camera-on-stick utilized-No visable connections observed from residence. Small 8" terracotta pipe coming from property north of 255 Appleby Rd that outfalls to swale, which is part of catch basin conveyance. Source of terracotta pipe could not be determin	Referred to DelDOT
	01/09/12			DelDOT		Catch basin fully submerged; unable to inspect.	Unable to pinpoint source.	Referred to DelDOT; Contractor specializing in sanitary sewers will flush pipe.
	02/02/12					DelDOT notified KCI that catch basin cleaned out. Sample collected from downstream structure 372; tested high for phenols, detergents, ammonia and turbidity. 24-hour re-test: high detergents, ammonia and turbidity.	Field crew traced source of flow back to PVC pipe tied into side of conveyance 51706. PVC probably ties into sewer connection on left side 229 Appleby.	Referred to DelDOT.
	03/02/12					DelDOT contacted DNREC to provide PID information		DNREC to dye test.
	03/02/12					DNREC contacted to KCI to verify address		DNREC to dye test.
60570 & 60571	11/09/12	Sharpley	102 Whitby Road	DelDOT	Resident reported neighbor dumping leaves in catch basin	Leaves were observed inside of Structures 60570 and 60571.	Distributed 10 doorhangers.	No Further Action.
	11/13/12						Distributed 5 doorhangers.	

7. Spill Prevention and Response

Requirement: DelDOT shall implement a program to prevent, contain, and respond to spills that may discharge into the MS4 as described in the Application page iv-59, Part 5(iv) B2, Permit page 9, Part II.A.7., Consent Decree page 20, Part II 23.

Performance:

DelDOT's Transportation Management Center (TMC) is a department wide facility that coordinates operations and shares information among its own personnel as well as various other transportation and public safety-related agencies, serving as the transportation interface among all such agencies in the state. They operate 24-hours per day/7 days per week. They serve as the central communication point for DelDOT during major incidents, special events, and emergencies, and coordinates transportation management activities with other agencies. The TMC has special instrumentation that has been used to develop incident management capability.

The type of incident detected or called in will have a direct effect on the notification process and steps that must be taken in order to be able to respond, assist, and document the incident in an expeditious manner. Incidents have been classified into one of seven categories, and then into sub-categories that further specify the type of incident that has occurred. These categories are listed below:

Category A: Accidents (Emergency)

Category B: Vehicle Fire (Emergency)

Category C: Disable Vehicles (Emergency)

Category D: Police Activity (Emergency)

Category E: Traffic Hazards (Emergency)

Category F: Roadway and Signal Operations (Traffic)

Category G: Delay or Congestion (Traffic)

In June 2001, the TMC developed a manual of Standard Operating Procedures (SOP) that acts as a guideline for handling incidents and systems problems; as a training tool/resource for new employees and as a reference guide for the operations staff. *Category E: Traffic Hazards (Emergency)*, of the SOP describes the notification and documentation procedure involving fuel, oil or other HAZMAT spills on or near the roadway (see Annual Report 2001, Volume 3, Appendix J).

In the event of a spill such as fuel, oil, or HAZ-MAT, the TMC is required to notify the respective police agency since they are responsible for arranging for the particular traffic hazard to be removed. Generally, the police will contact the following agencies: Fire Board, DNREC (Department of Natural Resources and Environmental Control), tow company, and all other agencies that are required to attend such incidents.

In the event of a non-hazardous materials spill DelDOT mobilizes, responds and directs the clean up effort to prevent the material from entering the storm drain system or receiving waters. DelDOT purchased 450 vehicle spill kits for minor oil and/or pesticide spills. If the spill is of questionable material, DelDOT uses procedures as describe for HAZ-MAT spills.

In addition to the TMC's Standard Operating Procedures, the NPDES Program has completed the Spill Prevention Control and Countermeasures Plans for DelDOT facilities that met the above ground storage tank minimums. These plans bring DelDOT into compliance with EPA's Oil Pollution Prevention regulations (40 CFR Part 112) contained within the Clean Water Act.

During our annual inspections of the maintenance facilities, we determine if additional spill decks, kits or other spill prevention equipment or supplies are needed. The NPDES section funds these purchases.

We completed an agreement with CSERT (The Center for Emergency Response Training, Inc.) to develop three videos: (1) *SPCC Regulatory Requirements* - acquaints DelDOT personnel with the regulatory requirements of the Spill Prevention Control and Countermeasures (SPCC) plan, NPDES Permit program and other regulatory initiatives in designated DelDOT facilities; (2) *Spill Response & Emergency Procedures* and *Roadside Events* - trains DelDOT employees on the proper procedures for responding to facility and non-facility (roadway) based emergency events. Videos have been distributed to each maintenance facility, and personnel are required to view them annually.

Spill Incidents

No incidents to report.

8. Industrial and High Risk Runoff

This section pertains to New Castle County only. See Section 8 of New Castle County's annual report for details.

9. Construction Site Runoff

Requirement: DelDOT shall implement a program to reduce, to the maximum extent practicable, the discharge of pollutants from construction sites. DelDOT shall continue to administer a sediment and erosion control program in accordance with Delaware's Sediment and Storm Water Regulations and to notify applicable construction contractors of the NPDES requirements. DelDOT shall continue to implement a program to inspect construction projects for compliance with Delaware's Sediment and Storm Water Regulations and where applicable, requirements of the MS4 NPDES permit as described in the Application page iv-72, Part (iv) D, Permit page 10, Part II.A.9. and Consent Decree page 23, Part II 27.

Performance:

- In Delaware, construction site runoff is controlled under State law, which has been in effect since 1990. The State Law (7 Del. C., ch. 40) meets or exceeds the requirements of the NPDES MS4 permit. The erosion and sediment control and stormwater management programs of DelDOT are managed by the Division of Transportation Solutions (DOTS). This program was delegated to DelDOT in 1991 by the Department of Natural Resources and Environmental Control (DNREC) and was to implement three of the five components of the Delaware Sediment and Stormwater Regulations (see Annual Report 2001, Volume 3, Appendix K). These components are: review and approval of construction plans, review of construction sites, and inspection and maintenance of completed stormwater management facilities. Inspection and maintenance of completed stormwater management facilities is covered in section 1. MS4 Structural Controls. The delegation is reviewed every three years. DelDOT received delegation extension through June 30, 2015.
- Enforcement of construction site erosion and sediment controls is accomplished through each construction contract. Section 110 of the Delaware Department of Transportation Standard Specifications lays out a progressive step-wise approach to gaining compliance with approved plans, regulations, and laws.
- Following a significant revision to Section 110 in 2007, we have since made a change to the Certified Construction Reviewer requirement. Instead of the contractor providing the CCR, we executed agreements to hire two consulting firms to perform the weekly CCR inspections. This has improved compliance with the required weekly and rain event reporting. The consultant also has the authority to hire a third party contractor to correct E&S deficiencies if the prime contractor refuses.
- We finalized a rewrite and reformatting of DelDOT's Erosion and Sediment Control Field Guide. The purpose of the field guide is to provide easily accessible information on installation and maintenance of best management practices (BMPs) for erosion and sediment control and stormwater pollution prevention on construction sites. The field guide was distributed to 199 DelDOT employees and is

available for purchase to consultants and contractors. It is available for viewing at http://www.deldot.gov/stormwater/ES_fieldguide.shtml.

10. Total Maximum Daily Load (TMDL)

Requirement: DelDOT shall comply with any MS4 NPDES permit requirement developed in accordance with relevant wasteload allocation contained in any final TMDL or, as applicable, with any Pollution Control Strategy developed to implement that TMDL as described in the Consent Decree page 24, Part II 28.

Performance:

Table 10-1 identifies the approved TMDLs in New Castle County that specify waste load allocations (WLAs) for MS4 discharges. In addition, the U.S. Environmental Protection Agency established the Chesapeake Bay TMDL for sediment, nitrogen and phosphorus in December 2010. This will impact some watersheds in New Castle County. The WLAs assigned to the regulated stormwater sector, of which the New Castle County/DelDOT MS4 is part, in the Chesapeake Bay TMDL are listed in Table 10-2.

We have continued to be proactive in preparing for compliance with statewide TMDLs in anticipation of both a new Phase I permit (anticipated by summer 2013) and future watershed Pollution Control Strategies. The Department's activities in this area during calendar year 2012 include the following:

- DelDOT continues to be an active participant in the American Association of State Highway and Transportation Officials (AASHTO) Stormwater Management Community of Practice (CoP), which was established recently to create a forum where DOT practitioners can share information on emerging issues, research data needs, and innovative stormwater quality compliance solutions. TMDL compliance is a priority focus area for the CoP. Multi-state conference calls on these issues occur frequently.
- DelDOT staff members have continued to assist DNREC with development and implementation of Delaware's Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDLs. NPDES Section staff serve on the stormwater and communications WIP subcommittees.
- DelDOT has an active BMP performance and assessment program that is described in detail in Section 13 of this report. One of the objectives of this program is to provide data on the effectiveness of the BMPs under study in reducing pollutants targeted by TMDLs adopted for Delaware watersheds. This will allow DelDOT to conduct an analysis of the existing BMPs being implemented and select the most appropriate supplemental BMPs, if necessary, to achieve the numeric WLAs. In 2012, we continued several studies specifically for this purpose:
    - An evaluation of poultry biochar and zero-valent iron amendments to BMP media in order to enhance nitrogen removal.
    - A study to develop a new, more optimized street sweeping plan for New Castle County that will provide greater nutrient and sediment removal, which still is fiscally and operationally practicable for the Department.

- A model and study of the pollutant removal efficiency of roadside grassed slopes and cloverleaf infields. Although these are not actually BMPs, evidence from studies in other states has suggested that they may provide some pollutant removal and perhaps should be counted in some way toward TMDL reductions.

- In addition to developing a new, science-based street sweeping plan to meet the requirements of our new Phase I permit, we are also trying to find better ways to track and report the pollutant load reductions that we achieve through this BMP. GPS trackers were installed on all of our sweeper vehicles, and our goal is to use these devices to track the total miles of roadway swept. The DelDOT Maintenance Districts also were directed in January 2012 to begin reporting to the NPDES Section the total weight of street sweeper wastes taken to the landfills each month. The weights of sweeper residuals collected in New Castle County in calendar year 2012 are reported in Section 13 of this Annual Report.

- The drainage areas of all of the DelDOT-owned BMPs and major outfalls in New Castle County have been calculated. These data are needed for pollutant loading calculations. Drainage areas are included on the DelDOT NPDES Map Viewer. We have shared BMP and monitoring data with the DNREC Watershed Assessment section for use in their TMDL models and have discussed future coordination of monitoring efforts.

- The most recent draft of the new Phase I permit for New Castle County includes requirements for development of Water Quality Improvement Plans (WQIPs) for two priority watersheds. In late 2012, New Castle County, the University of Delaware Water Resources Agency, Duffield Associates, and DelDOT completed a grant-funded project to develop a pilot WQIP for the Pike Creek watershed. A copy of the final project report from Duffield Associates is included here as Appendix D.

  The primary purpose of this pilot project was to develop a process for WRP preparation to identify and resolve issues on a pilot basis before large scale plans are initiated. The objective was not to prepare an actual WRP, and therefore, some components were addressed superficially and not in detail. Furthermore, some aspects such as best management practices (BMPs) sizing and cost estimates are very approximate and intended solely for demonstration purposes.

  A challenge in completing the Pike Creek study was the interpretation of the permit language included in the version released for public comment. Specifically, to be in compliance, the permittees are to provide "at least a 3% decrease in untreated Effective Impervious Area (EIA)." A considerable amount of time was spent creating a methodology that used the water quality PLOAD model as its basis and incorporated aspects of DNREC's Delaware Urban Runoff Management Model (DURMM) to estimate stormwater management of the impervious areas.

  Additional grant funding has been secured to develop a similar pilot WQIP for the Appoquinimink watershed in 2013. Because the southern portion of New Castle County is less urbanized and, because of different soil types, has greater potential for implementing infiltration practices, we wish to understand better what approaches for

watershed improvements may work best there. This WQIP will recognize and build upon the prior efforts and strive to reinvigorate water quality efforts in the watershed.

- In late 2012, we began to negotiate a small professional services agreement with Versar, Inc. to assist us in assessing our BMP and wet-weather monitoring programs and developing a revised monitoring plan for the new Phase I permit.
- Our public education and outreach program is being increasingly targeted toward programs that will result in reduction of nitrogen, phosphorus and bacteria loadings to waterways. An example of this is the Delaware Livable Lawns program, which was launched recently with DelDOT funding. Its primary goal is to promote responsible fertilizer use by both commercial applicators and individual homeowners. The program was expanded in 2013, and outreach to homeowners was begun. See Section 11 of this report for more information about the Delaware Livable Lawns program.
- The DelDOT NPDES Section is represented on the Delaware Nature Society's Watershed Stewardship Committee, which meets quarterly to promote and coordinate water quality improvement efforts in the state.
- The DelDOT NPDES Section's environmental scientist was invited in 2013 to serve on the Chesapeake Bay Program's Illicit Discharge Elimination Expert Panel. The panel is charged with making recommendations on how to better incorporate nutrient loadings from illicit discharges and sanitary sewer overflows into the urban land component of the Chesapeake Bay Watershed Model, and also outlining the qualifying conditions under which a locality can receive a nutrient reduction credit for eliminating it.

Table 10-1. List of New Castle County waterbodies with approved TMDLs and MS4 waste load allocations.

Waterbody	Pollutant	MS4 Wasteload Allocation Specified in Approved TMDL		
		Annual Baseline Load	**Annual TMDL Load**	**Load Reduction**
Appoquinimink River Dissolved Oxygen and Nutrients (updated Dec 2003) Bacteria (Dec 2006)	Total N	131,326 lb/yr	70,251 lb/yr	60%
	Total P	23,300 lb/yr	8,860 lb/yr	60%
	Bacteria	7.52E+12 CFU/yr	6.32+12 CFU/yr	15% (1)
		7.03E+10 CFU/yr	6.06+10 CFU/yr	73% (2)
Army Creek TMDL Analysis for the Watersheds of Army Creek, Red Lion Creek, and Dragon Run Creek, Delaware (August 2006)	Total N	14,782.5 lb/yr	8,833 lb/yr	40%
	Total P	1241 lb/yr	730 lb/yr	40%
	Bacteria	1.1E+13 CFU/yr	5.037E+12 CFU/yr	39%
Blackbird Creek Blackbird Creek Watershed Proposed TMDLs (August 2006)	Total N	63,948 lb/yr	38,362 lb/yr	40%
	Total P	7,081 lb/yr	4,249 lb/yr	40%
	Bacteria	8.54E+13 CFU/yr	4.7E + 13 CFU/yr	80%
Christina River Basin Christina River Nutrient and Low Dissolved Oxygen High-flow TMDL (September 2006) Christina River Bacteria and Sediment TMDL (September 2006)	Total N	180,639 lb/yr	173923 lb/yr	4%
	Total P	11,826 lb/yr	11,643.5 lb/yr	1%
	Bacteria	3.53+15 CFU/yr	8.19E+14 CFU/yr	79%
Delaware River TMDLs for PCBs for Zones 2-5 of the Delaware Tidal River (December 2003)	PCBs	255.5 lb/yr (estuary zone 5)	0.000476 lb/yr	99%

Waterbody	Pollutant	MS4 Wasteload Allocation Specified in Approved TMDL		
		Annual Baseline Load	**Annual TMDL Load**	**Load Reduction**
Dragon Run Creek TMDL Analysis for the Watersheds of Army Creek, Red Lion Creek, and Dragon Run Creek, Delaware (August 2006)	Total Nitrogen	48,435.5 lb/yr	29,054 lb/yr	40%
	Total Phosphorus	2,591.5 lb/yr	1,533 lb/yr	40%
	Bacteria	1.39E+13 CFU/yr	1.08E+13 CFU/yr	15%
Naamans Creek TMDLs Analysis for Naamans Creek (October 2005)	Total Nitrogen	102,784 lb/yr	102,784 lb/yr	0%
	Total Phosphorus	7,227 lb/yr	7,227 lb/yr	0%
	Bacteria (Average flows associated with each quartile available in Table 5-2 on p. 27 of TMDL report)	7.1E+-09 CFU/day (1st quartile)	4.1E+09 CFU/day (1st quartile)	42%
		8.1E+10 CFU/day (2nd quartile)	7.9E+09 (2nd quartile)	90%
		3.1E+10 CFU/day (3rd quartile)	1.5E+10 CFU/day (3rd quartile)	54%
		6.3E+11 CFU/day (4th quartile)	1.4E+11CFU/day (4th quartile)	78%
Red Lion Creek TMDL Analysis for the Watersheds of Army Creek, Red Lion Creek, and Dragon Run Creek, Delaware (August 2006)	Total Nitrogen	73,620.5 lb/yr	44,165 lb/yr	40 %
	Total Phosphorus	2,263 lb/yr	1,350.5 lb/yr	40%
	Bacteria	2.37E+13 CFU/yr	1.23E+13 CFU/yr	40%
Smyrna River Smyrna River Watershed Proposed TMDLs (August 2006)	Total Nitrogen	102,200 lb/yr	61,320 lb/yr	40%
	Total Phosphorus	7,405.9 lb/yr	4,446 lb/yr	40%
	Bacteria	1.12E+14 CFU/yr	2.8E+13 CFU/yr	75%

Waterbody	Pollutant	MS4 Wasteload Allocation Specified in Approved TMDL		
		Annual Baseline Load	**Annual TMDL Load**	**Load Reduction**
Shellpot Creek TMDLs Analysis for Shellpot Creek (October 2005)	Total Nitrogen (See Table 4-1 and 4-2 in TMDL report)	32,631 lb/yr	32,631 lb/yr	0%
		7,008 lb/yr	4,563 lb/yr	35%
	Total Phosphorus (See Table 4-1 and 4-2 in TMDL report)	2,080.5 lb/yr	2,080.5 lb/yr	0%
		730 lb/yr	475 lb/yr (load from upstream sub-watershed, reaches 1-3)	35%
	Bacteria (Flow ranges and average flows associated with each quartile available in Table 5-1 on p. 31 of TMDL report)	3.09E+09 CFU/day (1st quartile)	2.3E+09 CFU/day (1st quartile)	25%
		3.5E+10 CFU/day (2nd quartile)	4.4E+09 CFU/day (2nd quartile)	88%
		7.2E+10 CFU/day (3rd quartile)	8.1E+09 CFU/day (3rd quartile)	89%
		3.0E+11 CFU/day (4th quartile)	4.0E+10 CFU/day (4th quartile)	84%
Chester River TMDL Analysis for Chester, Choptank, and Marshyhope Rivers (December 2005)	Total Nitrogen	257,763 lb/yr	257,763 lb/yr	0%
	Total Phosphorus	19,929 lb/yr	11,789.5 lb/yr	40%
	Bacteria	6.94E+13 CFU/yr	1.68E+13 CFU/yr	37%

Table 10-2. Chesapeake Bay WLAs for waterways in New Castle County, Delaware.

Waterbody	Pollutant	Regulated Stormwater Aggregate WLA Expressed as Annual TMDL Load, in lbs/yr (see Appendix Q of 2010 Chesapeake Bay TMDL)
Bohemia Creek (BOHOH)	Total Nitrogen	5,059
	Total Phosphorus	807
	TSS	65,521
C&D Canal (OH_DE)	Total Nitrogen	5,787.19
	Total Phosphorus	897.32
	TSS	140,065.64
C&D Canal (OH_MD)	Total Nitrogen	15,427.35
	Total Phosphorus	2,323.04
	TSS	336,975.20
Choptank River Tidal Fresh (CHOTF)	Total Nitrogen	3,425.42
	Total Phosphorus	891.80
	TSS	361,329.14
Elk Creek (ELKOH)	Total Nitrogen	2,193.22
	Total Phosphorus	316.90
	TSS	31,853.92
Middle Nanticoke River (NANOH)	Total Nitrogen	3,940.61
	Total Phosphorus	765.13
	TSS	360,996.61
Upper Nanticoke River (NANTF_DE)	Total Nitrogen	87,249.18
	Total Phosphorus	13,720.13
	TSS	10,010,082.38
Upper Pocomoke River (POCTF)	Total Nitrogen	1,045.32
	Total Phosphorus	270.79
	TSS	62,519.65
Sassafras River (SASOH)	Total Nitrogen	265.63
	Total Phosphorus	41.82
	TSS	5,525.02
Wicomico River (WICMH)	Total Nitrogen	1,893.58
	Total Phosphorus	292.59
	TSS	104,196.22

11. Public Education

Requirement: DelDOT shall within six months of entry of the Decree, implement a program to promote, publicize, and facilitate public reporting of illicit discharges having negative impacts on water quality on the MS4 and the proper management of an array of organic and inorganic materials as described in the Application page iv-72, Part 5 (iv) B3, Permit page 11, Part II.A.10. and Consent Decree page 20, Part II 24.

Performance:

A public education program was developed within six months of the effective dates as outlined in the NPDES permit and consent decree. The following public education/outreach activities occurred during calendar year 2012:

- We are continuing our door hanger campaign to residents in subdivisions where an illicit discharge or illegal dumping activity was discovered or reported as part of our outreach program to residents. The front side of the door hanger lists the date and type of pollutant found and water body affected. On the back, the door hanger describes stormwater pollution and guidelines to reduce pollution at the home or workplace (see Annual Report 2007, Volume 2 of 2, Figure 11- 3). In 2012, we distributed 15 door hangers in response to illegal dumping of leaves into the storm sewer.
- Websites
  - DelDOT developed a stormwater quality website (www.deldot.gov/stormwater). A "Report a Problem" link allows the public to email or call to report illegal discharges or dumping and stormwater maintenance problems. In 2012, Google Analytics reported an average of about 403 visits per month (range 329-485), up from 332 in 2011.
  - The Delaware Livable Lawns website had 1,977 visits in 2012 for an average of 165 per month (range 48 in December – 516 in May).
- As part of the storm drain inventory and inspection (Section 1.A.), KCI Technologies is continuing to label each inlet with a storm drain marker that carries a water quality message.
- DelDOT distributed several hundred activity booklets to schools and at public events that highlight stormwater pollution, the water cycle and watersheds.
- Appoquinimink River Association (ARA)

  "Delaware Livable Lawns" Project:

  DelDOT is continuing the Delaware Livable Lawns program that provides information to the public on ways to reduce nonpoint source pollution. This educational/outreach campaign is designed to reduce fertilizer application by changing watershed residents' lawn care practices. The Delaware Livable Lawns Program certifies lawn care companies that follow environmentally-friendly best practices in fertilizer application while educating homeowners on the benefits of

timely and proper fertilizer management with the goal of reducing fertilizer runoff from residential lawns. Phase I of the program targets commercial lawn care companies recognizing them for environmentally friendly lawn care plans (e.g. soil tests, organic products, low or no nitrogen fertilizers, only fall applications, annual reporting, distribution of educational materials, etc.) while also meeting homeowners' needs and educating them on best practices. To date, five companies have applied for certification and have been accepted.

Phase II of the program has begun targeting individuals in housing developments to be demonstration lawns for various types of fertilizer applications and organic products.

Updates for 2012:

- 28 companies expressed interest with 26 of those being viable companies that fit within the program parameters.
- Five commercial contractors are certified.
- The website is available to the public at www.DelawareLivableLawns.org.
- Developed a brochure that will be available to the certified companies to supply their customers and to residential DIY applicators describing the benefits and the parameters of the program.
- Provided vehicle signage for certified companies.
- Printed business cards for certified companies to distribute to potential customers.
- Developed a monthly newsletter as an opportunity to capture the residential customer.
- Developed three how-to videos on taking a soil sample, interpreting a soil test report, and purchasing and applying fertilizer.
- Designed and printed advertisements in two community publications.

Additional work accomplished by the ARA is documented in their 2012 annual progress report (Appendix E).

- DelDOT partnered with the University of Delaware computer science lab and the art department in the development of interactive computer games. The computer science semester course consists entirely of working in teams to develop interactive touch screen games with the 'Delaware Livable Lawns' theme for use at the Delaware State Fair.
- We are continuing our partnership with our co-permittee, New Castle County, to begin development of our education/outreach management plan for the next NPDES permit. We executed an agreement with the University of Delaware, Water Resource Agency, to investigate cost effective social marketing options that are feasible in Delaware to meet the minimum general public "impressions" required by the new permit. This project proposes to assist the co-permittees in achieving the education

requirements of the permit and making these efforts more effective and meaningful for New Castle County, DelDOT and the six municipalities regulated under the permit. The University of Delaware prepared a final recommendations report detailing a stormwater education plan that address major pollutant problems for eight target areas (Appendix F).

- DelDOT staff has been active participants in the founding and development of the Delaware Association for Environmental Education (DAEE). The DelDOT NPDES Environmental Scientist serves on the Board of Directors, assists the group with its communications and outreach, and serves on the planning committee for DAEE's annual statewide conference.
- The NPDES Program has a 10' display board and graphics as well as an interactive kiosk for use at outreach events. In 2012 we participated in the following events:
  - Delaware Rural Water Association – NPDES staff participated in this 2-day event.
  - Delaware State Fair: NPDES staff participated for 10 days and evenings promoting our new "Delaware Livable Lawns" program. We developed a landscaped display utilizing native plants and reduced lawn concept.
- NPDES staff served as judges in the Technology Students Association (TSA) State Conference in April.

12. Training

Requirement: DelDOT shall, within six months of entry of the Consent Decree, initiate training for their respective and appropriate personnel on storm water controls, on the storm water management measures established under the MS4 permit, and on specific requirements for implementing all relevant aspects of the Consent Decree as described on page 24, Part II 29 of the Consent Decree.

Performance:

The following is a list of training workshops and conferences attended by DelDOT staff and training material produced in calendar year 2012:

- All statewide district maintenance staff are required to view the following videos as part of Pollution Prevention Plans: Stormwater Contamination & Spill Prevention, Vegetative Control & Pollution Prevention, and Facility & Vehicle Maintenance.
- All maintenance staff are required to view videos as part of the Spill Prevention Control and Countermeasures Plans. The three topics include: SPCC regulatory requirements, spill response and emergency procedures and roadside events.
- As part of the NPDES industrial permit, the NPDES Section issues training bulletins to each maintenance facility statewide. These bulletins support DelDOT maintenance staff in its efforts to achieve and maintain compliance with the stormwater pollution prevention regulatory requirements. The bulletins are placed in a visible location at each yard. During the 2012 calendar year, one issue on street sweeping was distributed (Appendix G).
- The following training/workshops were attended by NPDES or DOTS stormwater staff:

  Workshops

  - Work Process Improvement Tools and Techniques
  - GIS- TUG Meeting, Bentley Asset management with AssetWise.
  - Annual Transportation Research Board Conference.
  - 2012 Delaware Wetlands Conference, Protecting Our Communities & Coasts for the Future

  Web casts

  - U.S. EPA Webinar on the 2012 Construction General Permit (CGP)
  - FHWA Webinar on Consultant Services Procurement Requirements
  - EPA's Stormwater Pollution Prevention Series: Stormwater, Coal-Tar Sealcoat and Polycyclic Aromatic Hydrocarbons

- Winter Maintenance – Snow & Ice
- U.S. EPA Watershed Academy Webcast: Using the Clean Water Act State Revolving Fund for Nonpoint Source and National Estuary Projects
- Water Environment Research Foundation (WERF) refining Expectations for Urban Stormwater BMP Performance in the Chesapeake Bay
- U.S. EPA Watershed Academy Webcast: Recovery Potential Screening – A Tool for Comparing Impaired Waters Restorability
- U.S. EPA Watershed Academy Webcast: 'How's My Waterway' and Other Water Quality Apps
- U.S. EPA Watershed Academy Webcast: New Recreational Criteria to Better Protect Public Health

- The Roadside Environmental Section staff attended various courses and workshops for re-certification, pesticide credits, and International Society of Arboriculture credits including:
    1. Horticulture Industry Expo and Pesticide Conference, Dover, DE
    2. Summer Turf and Nursery Expo, Georgetown, DE
    3. Delaware Ornamental and Turf Workshop, Hockession, DE

13. Monitoring

Requirements: The co-permittees shall implement a wet weather and dry weather monitoring program, and an industrial and high-risk runoff monitoring program as described in the Permit page 11, Part II.A.11. and Consent Decree page 20, Part II 22b. DelDOT shall also monitor the performance of and discharge from existing structural controls (BMPs), in accordance with Permit page 6, Part II.A.1.a.

Performance:

During calendar year 2012, DelDOT's monitoring activities included the following components:

- Dry weather screening of stormwater outfalls
- BMP performance monitoring and research

Each of these components is described in more detail below.

A. Dry Weather Screening

DelDOT is responsible for illicit discharge detection and elimination (IDDE), including inventory of new outfalls and dry weather outfall screening, within the DelDOT-owned portion of the stormwater conveyance system. The dry weather screening and tracking of potential illicit discharges and connections continues to be conducted for DelDOT by KCI Technologies.

The dry weather screening protocol was the same as that used in previous years. When dry weather flow is observed, a "Dry Weather Flow Evaluation" is performed in two stages: an initial screening at the time of first observation and a follow-up re-screening performed 4 to 24 hours later. Where appropriate, this includes flow rate estimation, field screening of discharge water quality using LaMotte stormwater sampling kits, and upstream visual review and evaluation. A numerical rating system for discharge water quality parameters provides an index that determines which outfalls are targeted for follow-up evaluation (Table 13-1). Once an illicit discharge is confirmed, our consultant is responsible for tracking it to the source and taking the initial step in effecting its elimination. This may include: (1) referring it to the appropriate municipality; or (2) going to the source and informing the polluter verbally and in writing to remove the illicit connection with a time limit to comply. The consultant will conduct a follow-up investigation. If the connection is not removed, enforcement action can be initiated.

All of the known DelDOT outfalls in New Castle County were screened during the first 5-year term of the permit. After that first round of screenings was completed, beginning in year six, KCI Technologies re-screened all outfalls that previously had had dry-weather flow. Per our DNREC-approved SWMP (Section V, DelDOT NPDES Phase I MS4 Permit Stormwater Management Plan, revised September 2010), we have continued to inspect and screen new outfalls that were not captured in the initial inventory. In addition, any potential illicit discharges reported by inspection crews, maintenance staff, the public or co-permittees are screened and investigated.

In calendar year 2012, our inventory efforts were focused on completing the MS4 mapping and inspection in Sussex County and re-inspecting older parts of the MS4 in New

Castle County. A total of 412 outfalls in New Castle County were inventoried, inspected and screened for dry weather flow (Table 13-2). 53 of these had dry weather flow. No evidence of illicit connections or discharges was noted at any of these outfalls.

Additional information on DelDOT's Illicit Discharge Detection and Elimination (IDDE) program during 2012 is provided in Section 6 of this report and in Appendix C.

B. Storm Event Monitoring

The wet weather storm event monitoring required under the Phase I permit was intended to identify, investigate and address selected water quality parameters of storm water runoff from five outfall locations identified in the Permit Application, representing four developed land use classifications: highway, commercial, industrial and residential.

The wet weather monitoring requirement at the five prescribed outfalls in New Castle County was fully completed by the County and DelDOT in 2009. Therefore, no additional samples were collected in 2012.

C. BMP Performance Monitoring and Assessment

The NPDES permit requires DelDOT to monitor the performance of existing stormwater structural controls and BMPs. During calendar year 2012, DelDOT's BMP monitoring and research program included the following projects:

1. Monitoring of biofiltration practices
2. Study of pollutant removal by grassed highway slide slopes
3. Monitoring of BMP outfalls at DelDOT maintenance facilities
4. Development of a revised street sweeping plan
5. Study of guardrail vegetation control alternatives
6. Study of the impacts of various mowing height practices
7. Study of new bioretention technologies to remove nutrients

Projects 1 through 4 were conducted with assistance from KCI Technologies under Agreements 1495 and 1613. Projects 5 through 7 were performed by the University of Delaware, using DelDOT funding.

Each of the different BMP monitoring/research projects is described below in greater detail.

1. Monitoring of Biofiltration Practices

DelDOT requires that all stormwater management measures in its projects be designed in accordance with the latest version of the Delaware Sediment and Stormwater Regulations. In accordance with these regulations, the preferred options for water quality protection are "Green Technology BMP's." Other practices generally are considered only after preferred practices have been eliminated for engineering or hardship reasons. "Green Technology" BMPs are practices that achieve stormwater management objectives by applying the principles of filtration, infiltration and storage most often associated with

natural vegetation and undisturbed soils, while minimizing a reliance on structural components.

As a result, a large proportion of the new BMPs being added to the DelDOT inventory are biofiltration swales. These BMPs are easy to incorporate into a linear highway right-of-way and also are relatively easy and inexpensive to maintain. The DelDOT NPDES Program felt that more data were need on the pollutant removal efficiency of the types of bioswales and other Green Technology BMPs installed by the Department. In 2012 we continued an ongoing study of these practices begun two years ago.

The BMP that we have been monitoring is a bioswale along Valley Road and Lancaster Pike in New Castle County (BMP #104). This bioswale provides treatment for stormwater runoff from Lancaster Pike and a portion of the surrounding residential developments, with a drainage area of approximately 9.4 acres. The purpose of the monitoring of this BMP is to collect field data on the efficiency of bioswales of this design in the removal of pollutants and in the reduction of flow rates for stormwater runoff. The study includes continuous base flow monitoring and automated wet weather monitoring.

The monitoring protocol and data from these wet weather events are included and summarized in KCI Technologies' 2012 Green Technology Monitoring Annual Report (Appendix H). Samples are collected at both the inflow and outflow of the swale, and parameters measured include flow, pH, turbidity, TSS, TDS, COD, BOD, chloride, oil and grease, TKN, ammonia, TP, dissolved P, ortho-phosphate, and selected metals. Five storms were sampled at this site during 2012.

Figure 13-1. Bioswale (BMP #104), showing wier constructed to measure flow at the outflow end.

Preliminary analyses so far appear to show load reductions TSS, nitrogen and phosphorus. The quality of the data collected, however, has been compromised by several issues. These include: inconsistencies in recorded storm flow volumes between the inflow and outflow (due to intruding sheet flow); clogging of equipment by sediment and debris; equipment problems that occur during cold weather; and site maintenance issues.

We intend to continue monitoring this swale to obtain additional sample events that will hopefully allow a more accurate evaluation of the effectiveness of the BMP in removing pollutants from roadway runoff. Although issues obtaining consistent storm flow volumes have occurred, the EMC's and pollutant load evaluation indicate positive performance from BMP 104 in reducing pollutants.

2. Study of Pollutant Removal by Grassed Highway Buffers

Studies conducted recently in several other states have demonstrated that existing vegetated areas adjacent to highways can provide some stormwater quality treatment, even though they are not designed for that function. Compliance with TMDL waste load allocations (WLAs) in New Castle County will require future reporting of both current stormwater pollutant loadings and future load reductions. Therefore we believe that better quantification of pollutant removal efficiencies of grassed side slopes, medians and buffers adjacent to roadways is needed. These data can then be incorporated into TMDL models and reporting. In addition, DelDOT is interested in identifying minimum design requirements for grassed buffers needed to obtain substantial pollutant reduction.

A test site was set up on Route 299 in Odessa to monitor the performance of a grassed side slope in removing pollutants from roadway runoff. This site was chosen for the study because of its moderate slope, established grass, lack of curb and the presence of a grass-lined ditch that allows for a concentrated outflow sample point. The sample site captures sheet flow runoff from two eastbound travel lanes, a left hand turn lane and an eight foot shoulder along a portion of Route 299.

Figure 13-2. Grassed side slope monitoring site on Rt. 299 in Odessa.

Three storm events were monitored in 2012. Wet weather samples are analyzed for the following parameters: Metals (Cu, Pb, Cd, Zn), Nutrients (TN, TP, TKN, Ortho-P) and Total Suspended Solids. A modeling component for the Route 299 site has also been added to the study. A SWMM model for the grassed side slopes was developed by Dr. William Frost of KCI Technologies. The wet weather data that we collect will be used to calibrate the model.

Additional details of this study and summaries of 2012 wet weather data are included in KCI Technologies' 2012 Green Technology Monitoring Annual Report (Appendix H).

3. Monitoring of BMP Outfalls at DelDOT Maintenance Facilities

DelDOT also performs wet weather monitoring at selected maintenance yard outfalls, in compliance with its industrial permits. See Section 16 of this report ("Pollution Prevention at Maintenance Facilities") for details on this and data for calendar year 2012. The monitoring data are provided in Table 16-1.

4. Development of Revised Street Sweeping Plan and Monitoring

DelDOT and New Castle County anticipate being issued a new Phase I permit for New Castle County sometime in 2013. The current draft of the permit will require DelDOT to develop a numeric, measurable street sweeping regime as part of the new SWPP&MP. The Department must demonstrate by research, modeling, or otherwise appropriate scientific literature that substantiates the adequacy for pollutant removal and improved water quality.

In anticipation of this permit requirement, DelDOT began working with KCI Technologies this past year on a study to develop an efficient, cost-effective Street Sweeper Plan to remove as many pollutants as feasible and to develop methods for monitoring the effectiveness of the program and calculating pollutant load reductions attributable to this BMP.

The purpose of the Street Sweeping Study is to find the optimum science-based street sweeping strategy for pollutant removal for State-owned roadways, using a combination of data collection, modeling and literature review. The effort is designed to do the following:

- Identify the highest priority roads to be swept;
- Determine the equipment to be used;
- Develop a Standard Operating Procedure for sweeping;
- Develop a method of scenario modeling to forecast results, and,
- Produce a method for reporting results that will qualify for credit for DelDOT's NPDES permit and applicable TMDL allocations.

In 2012, KCI conducted an extensive Literature Review, Cost Analysis and GIS Analysis to determine targeted roads for the Street Sweeping Plan. A Draft New Castle County Street Sweeping Plan was presented to the Districts in December 2012 to obtain maintenance staff input and recommendations. A finalized will be developed in early 2013 for incorporation into the new SWPP&MP.

In 2012, DelDOT followed the 4:2:1 street sweeping plan prescribed in the Department's current, DNREC-approved SWMP (Section III.C, DelDOT NPDES Phase I MS4 Permit Stormwater Management Plan, revised September 2010). DelDOT's total expenditure on sweeper waste disposal in New Castle County, in addition to tons of material, are included in Table 13-3. This is the first year that we have tracked sweeper residuals separately from other wastes taken to the landfill.

Using the formulas recommended by the Chesapeake Urban Stormwater Group (memo "Street Sweeping/BMP Era Recommendations, dated 3/1/2011), the estimated pounds of nutrients removed from runoff in 2012 by DelDOT's street sweeping program were 5,404 lbs total nitrogen and 2,162 lbs total phosphorus (See Section 3 of this report, Table 3.1).

The Delaware Solid Waste Authority considers street sweeping residuals a Special Solid Waste and requires that chemical analyses of the material be submitted before approval is granted to deliver the wastes to DSWA landfills. DelDOT collects and analyzes representative samples of sweeper waste stockpiles on an annual basis and submits the data to DSWA. A copy of the 2012 data and the DSWA approval letter are

provided in Appendix I. The chemical data, along with records of tons of material collected from County Roadways will allow us in future years to estimate pollutant load reductions achieved by roadway sweeping and to better assess the effectiveness of DelDOT's street sweeping program.

5. *Study of Alternatives for Managing Vegetation Under Guardrails*

In 2012, we continued a study of alternative vegetation management strategies for guardrail, as part of DelDOT's pesticide reduction strategy. The area under and adjacent to guardrail must be kept clear of tall vegetation to allow clear visibility of the barrier. Currently growth of vegetation under and around these structures is controlled by annual applications of herbicides. The goal of our study is to find ways to reduce the use of pesticides used to treat guardrail vegetation without compromising safety and aesthetics. The study is being performed by Dr. Susan Barton and Valann Budischak of the University of Delaware Department of Plant and Soil Sciences.

Treatments being evaluated include several types of weed control barriers, chemicals, low-growth vegetation, and hand cutting of existing vegetation. They are being compared based on effectiveness, ease of implementation, aesthetics, cost and longevity. Test locations were selected to represent typical roadway settings in which guardrails are utilized.

In 2008, twenty-four guardrail plots were established on Delaware roadsides at two different sites. Treatments have included three formulations of herbicide, four weed barriers, hand trimming, pavement, low fescue turf, zoysiagrass and a control. There were three replications of each treatment, located at different sections of guardrail and split between the two sites.

Test plots have been monitored and data taken throughout the growing seasons. The researchers recorded on a scale of 1 to 5 each plot's compliance with DelDOT guardrail standards and the weed level present. They also recorded predominant weed species. Each plot was photographed with each data collection visit.

An article summarizing the study and major results to date was written for the trade journal *Roads and Bridges* and is included with this report as Appendix J. A detailed technical report is being prepared by Dr. Barton for release in 2013. That report will be included next year with our 2013 Annual Report.

Herbicide treatments, while effective, resulted in a bare ground condition for much of the year and also left an unsightly edge between dead and live vegetation in the median. Weed control barriers performance varied, but two products (U-Teck WeedEnder and TrafFix barriers) provided adequate control when they when properly installed. Weed barriers that were not installed up to the pavement surface allowed a strip of vegetation to grow between the barrier and the roadway. Low fescue turfgrass was difficult to establish reliably under the guardrails, but once established it provided an attractive, uniform cover with minimal maintenance. Zoysia sod established successfully and almost entirely eliminated weeds under the guardrail. It required no trimming durting the first year. Another , proprietary, low-growth turf product, FlightTurf (www.flightturf.com), was established at the end of the 2012 growing season on several

plots and will be monitored in the coming seasons. Hand-trimming was an effective control when done once or twice per year, depending on the site, weather and timing.

The study will continue to determine the longevity of weed barrierproducts, to evaluate the ability of low fescue and zoysiagrass to outcompete taller weeds, and to evaluate the FlightTurf as an alternative groundcover on Delaware roadsides.

6. Study of the Impacts of Differing Mowing Height Practices

DelDOT mowing policy calls for roadside utility turfgrass to be routinely maintained at 6 inches height. However in actuality, compliance with this policy by DelDOT maintenance crews is inconsistent, and, despite extensive training of staff, roadside turf is often mowed to a height closer to 2-3 inches. The general public often perceives shorter grass to be more attractive. And maintenance crews often feel that mowing the turf shorter is easier and more efficient.

In addition to the potential water quality benefits of taller turf, DelDOT's Roadside Environmental Section and the University of Delaware Enhancing Delaware Highways (EDH) team believe that mowing at a minimum of 6 inches height results, over the long term, in healthier turf with fewer weeds and invasive species. Turf is mowed infrequently enough that long clippings often lay on the mowed turf, excluding light and causing turf grass injury. This injury often results in dead patches that allow weed incursion and the final result is a degraded turf grass condition. Thus, herbicide use potentially could be reduced by better turf maintenance practices.

In order to test this, DelDOT funded a study, conducted from 2009 through 2011, to evaluate the longer term impacts of mowing turf areas in highway rights of way at different heights. The study was performed by a team led by Dr. Susan Barton of the University of Delaware's Department of Plant and Soil Sciences. The objective of this study was to compare roadside turf mowed to a height of 6 inches and to a height of 2 inches, evaluating turf quality and weed presence with the two different mowing regimes.

Test plots were maintained in two locations—SR 1 at the Milford bypass in Kent County (6 plots) and Interstate-95 medians in New Castle County (6 plots). Each plot was approximately 200 feet. At each location, three plots were mowed to a height of 6 inches, and three plots mowed to a height of 2 inches.

A copy of the final project report, with details on methods and results, can be found in Appendix K.

After two full seasons, it was difficult to see species composition changes in the amount of time the turf was managed with 2-inch mowing and 6-inch mowing. There was already a significant weed population in the turf at the start of the experiment so it was hard to document increased weeds with the 2" mowing. The study could have been improved by starting with newly planted.

These results do support the recommendation to maintain roadside turf at a height of 6 inches, reducing the unsightly clippings that lay on the turf after mowing; preventing matting of clippings that kill vegetation below and provide an opportunity for weed

incursion; and reducing stress on vegetation so it stays green longer under drought conditions.

7. Study of New Bioretention Technologies to Remove Nutrients

Since late 2011, DelDOT has funded a proposal from Dr. Daniel Cha and Dr. Paul Imhoff (University of Delaware, Department of Civil and Environmental Engineering) to evaluate two promising technologies involving the addition of biochar (generated from pyrolysis of poultry litter) and/or zero-valent iron (ZVI) to existing and new stormwater facilities. The hypothesis is that incorporation of these materials into soil or media used in bioretention cells, sand filters or bioswales will significantly enhance removal of nitrogen from stormwater runoff. If successful, these technologies could allow DelDOT to meet TMDL reduction requirements using fewer or smaller BMPs.

The first year of the project involved laboratory testing of the concepts in Results of these experiments were extremely promising and demonstrated the utility of these technologies in laboratory settings.

In first year of the study, laboratory experiments were conducted to evaluate the ability of poultry litter (PL) biochar to remove nitrogen compounds from synthetic stormwater. Soil columns were designed to mimic the conditions found in bioretention cells and sand filters. Data indicate that addition of 10% PL biochar by mass to sand increases removal of ammonium nitrogen by 50%. Without removal, much of this nitrogen would be converted to nitrate in the subsurface. Thus, the PL biochar removes an important precursor to nitrate in the vadose zone of green stormwater facilities, before it can be converted to nitrate.

ZVI is also proposed as an amendment to bioretention media, but is instead contained in an anoxic zone. Here, ZVI granules are mixed with soil where ZVI produces hydrogen that facilitates microbial transformation of nitrate to nitrogen gas:

$$H2 + NO_3^- \rightarrow N_2 + H_2O$$

Figure 13-3. Experimental soil columns used to test the effect of ZVI on nitrogen removal from synthetic stormwater.

Anoxic soil columns were used to simulate nitrate removal in the saturated zone (i.e. bottom) of bioretention cells. Each column was packed with a mixture of ZVI and soil. In order to determine the optimum iron-to-sand ratio in the column for extended operations, three iron contents were tested (volume basis): 5% iron: 95% sand, 10% iron:90% sand, 2and 0% iron:80% sand. A control column without any ZVI addition was also operated in parallel. Synthetic stormwater runoff containing 15 mg/L NO_3^--N was pumped to the bottom of all four soil columns using a peristaltic pump for an upflow operation.

All three columns containing ZVI were effective in completely removing nitrate from the feed solution as negligible amounts of nitrate were detected in the effluents (Figure 13-4). On the other hand, minimal reduction in nitrate concentration was observed in the control column. These results suggest that ZVI-integrated bioretention system may be a viable option for enhancing the removal of nitrate in stormwater runoff.

The laboratory work is being continued into 2013, in order to advance understanding of the processes. A pilot-scale field test site at an existing DelDOT stormwater facility is also being set up to establish the utility of these technologies in the field over multiple seasons. The field tests will begin in early 2013. Data from such tests are critical for establishing the usefulness of these technologies in real field settings.

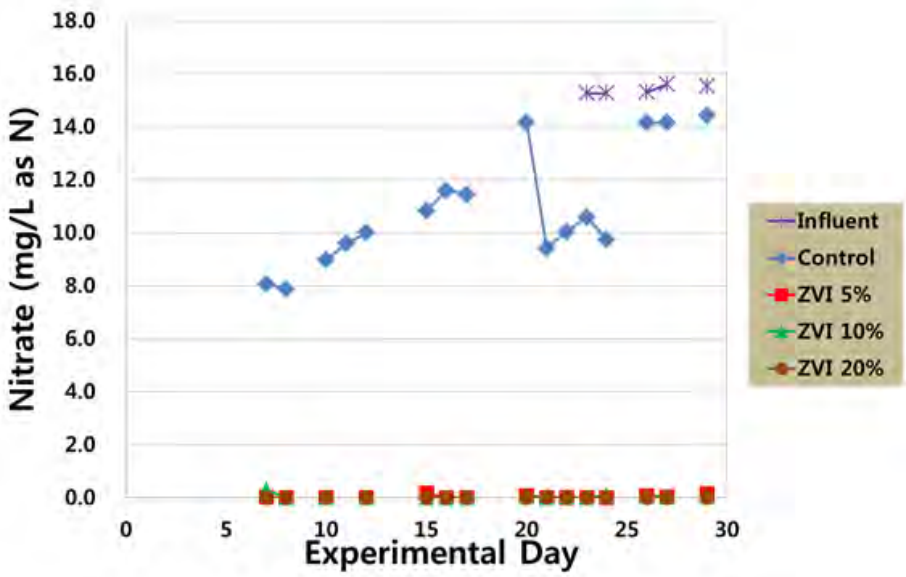


Figure 13-4. Nitrate removal in soil columns amended with zero-valent iron (ZVI).

Table 13-1. Dry weather flow rating system used in DelDOT's outfall screening program. An outfall sum of all parameters ≥4 triggers follow-up evaluation.

Parameter	Range	Value
Flow	< 0.022 cfs	0
	≥ 0.022 cfs	4
pH	< 4.5	4
	>8.5	4
	Change ≥ 2.0 units	1
Phenols	< 0.3 ppm	0
	≥ 0.3 ppm	4
Copper	< 0.01 ppm	0
	≥ 0.01 ppm	4
Chlorine	< 0.5 ppm	0
	≥ 0.5 ppm	4
Detergent	< 0.2 ppm	0
	0.2 – 0.4 ppm	1
	≥ 0.5 ppm	4
Odors	Gasoline	4
	Sewage	4
	Oil	2
	Chemical	2
Clarity	Opaque	1
Floatables	Sewage	4
	Oil	4
Stains	Oil	3
	Chemical	3
Ammonia	< 0.05 – 0.1ppm	0
	≥ 0.1 – 1.0 ppm	1
	≥ 1.0 – 2.99 ppm	2
	≥ 3.0 ppm	4

Table 13-2. Summary of dry weather outfall inspections conducted statewide in 2012.

NEW CASTLE COUNTY						
Month (2012)	Outfalls Inventoried	Total Non-DelDOT	Total With Flow	Targeted by Rating System	PID	Groundwater
January	-	-	-	-	-	-
February	-	-	-	-	-	-
March	107	0	2	0	0	2
Total 1st Quarter	**107**	**0**	**2**	**0**	**0**	**2**
April	62	0	11	0	0	11
May	69	0	7	0	0	7
June	40	0	15	TBD	TBD	TBD
Total 2nd Quarter	**171**	**0**	**33**	**0**	**0**	**18**
July	10	0	2	TBD	TBD	TBD
August	38	0	3	TBD	TBD	TBD
September	31	0	6	TBD	TBD	TBD
Total 3rd Quarter	**79**	**0**	**11**	**0**	**0**	**0**
October	25	0	0	0	0	0
November	30	0	7	TBD	TBD	TBD
December						
Total 4th Quarter	**55**	**0**	**7**	**0**	**0**	**0**
2012 TOTAL	**412**	**0**	**53**	**0**	**0**	**20**

KENT COUNTY						
Month (2012)	Outfalls Inventoried	Total Non-DelDOT	Total With Flow	Targeted by Rating System	PID	Groundwater
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	0	0	0	0	0	0
Total 1st Quarter	**0**	**0**	**0**	**0**	**0**	**0**
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	0	0	0	0	0
Total 2nd Quarter	**0**	**0**	**0**	**0**	**0**	**0**
July	0	0	0	0	0	0
August	0	0	0	0	0	0
September	0	0	0	0	0	0
Total 3rd Quarter	**0**	**0**	**0**	**0**	**0**	**0**
October	0	0	0	0	0	0
November	0	0	0	0	0	0
December						
Total 4th Quarter	**0**	**0**	**0**	**0**	**0**	**0**
2012 TOTAL	**0**	**0**	**0**	**0**	**0**	**0**

SUSSEX COUNTY						
Month (2012)	Outfalls Inventoried	Total Non-DelDOT	Total With Flow	Targeted by Rating System	PID	Groundwater
January	-	-	-	-	-	
February	-	-	-	-	-	
March	330	0	0	0	0	0
Total 1st Quarter	**330**	**0**	**0**	**0**	**0**	**0**
April	138	0	0	0	0	0
May	85	0	2	TBD	TBD	TBD
June	101	0	2	TBD	TBD	TBD
Total 2nd Quarter	**324**	**0**	**4**	**0**	**0**	**0**
July	60	0	2	TBD	TBD	TBD
August	352	0	0	0	0	0
September	83	0	0	0	0	0
Total 3rd Quarter	**495**	**0**	**2**	**0**	**0**	**0**
October	95	0	0	0	0	0
November	77	0	3	TBD	TBD	TBD
December						
Total 4th Quarter	**172**	**0**	**3**	**0**	**0**	**0**
2012 TOTAL	**1321**	**0**	**9**	**0**	**0**	**0**

Table 13-3. New Castle County street sweeper waste totals delivered to the Delaware Solid Waste Authority for landfill disposal in calendar year 2012. Weights are taken from the landfill tickets. Tipping fee was $84 per ton.

	North District		Canal District			
Month	**Tipping Fees**	**Tons***	**Tipping Fees**	**Tons***	**Monthly Totals (Cost)**	**Monthly Totals (tons)**
January	$926.60	11.03	$7,079.88	84.28	**$8,006.48**	**95.32**
February	$1,932.74	23.01	$9,618.60	114.51	**$11,551.34**	**137.52**
March	$2,734.70	32.56	$6,701.04	79.77	**$9,435.74**	**112.33**
April	$12,559.94	149.52	$1,235.74	14.71	**$13,795.68**	**164.23**
May	$0.00	0.00	$12,673.28	150.87	**$12,673.28**	**150.87**
June	$2,021.30	24.06	$0.00	0.00	**$2,021.30**	**24.06**
July	$9,929.38	118.21	$388.48	4.62	**$10,317.86**	**122.83**
August	$7,014.84	83.51	$0.00	0.00	**$7,014.84**	**83.51**
September	$0.00	0.00	$2,371.32	28.23	**$2,371.32**	**28.23**
October	$4,449.48	52.97	$0.00	0.00	**$4,449.48**	**52.97**
November	$40,520.76	482.39	$0.00	0.00	**$40,520.76**	**482.39**
December	$7,534.80	89.70	$0.00	0.00	**$7,534.80**	**89.70**
Totals	**$89,624.54**	**1,066.96**	**$40,068.34**	**477.00**	**$129,692.88**	**1,543.96**

14. Supplemental Environmental Project

This section pertains to New Castle County only. See Section 14 of New Castle Counties annual report for details.

15. Additional Injunctive Relief

Requirement: Within one year from the date of entry of the Consent Decree, DelDOT shall complete a stormwater retrofit project for a 5.58 mile long section of I-95 incorporating water quality considerations in design and construction of its stormwater management structures as described in the Consent Decree page 25, Part III 30.

Performance: This project is complete. See Annual Report 2001, Volume 3, Appendix U for a complete report and photographic documentation of the I-95 Additional Injunctive Relief Stormwater Controls.

16. Pollution Prevention at the Maintenance Facilities

A. Pollution Prevention Plans

DelDOT's NPDES Program manages a Stormwater Pollution Prevention Program (SWPPP) at all 16 DelDOT maintenance facilities. Development, implementation, and maintenance of the SWPPP provides the maintenance yards with the tools to reduce pollutants contained in stormwater discharges and comply with the requirements of Delaware's "Regulations Governing Storm Water Discharges Associated with Industrial Activity." The program includes a written plan, timeline for plan implementation, inspection schedules, training and monitoring requirements, and proper storage and housekeeping measures. Each SWPPP has a pollution prevention team with designated responsibilities to carry out the plan.

B. Inspections

Pollution Prevention Plan Team members are required to conduct quarterly inspections during dry and wet weather events to look for evidence of stormwater contamination. These inspections began in October 2003 and continued through the 2012 calendar year.

In addition, DelDOT NPDES Program staff annually conducts thorough SWPPP compliance inspections of each facility. Annual inspections were completed for all DelDOT maintenance facilities on November 26, 29, and December 4, 2012. A "Summary of Action Items," if any, is noted on the inspection form and gives specific instructions to the facility team and supervisors for corrective action. Three facilities (Bear, Cheswold, Middletown) received comments and a list of action items to resolve. Follow-up correspondence with District managers will be conducted to ensure the action items were corrected.

C. Spill Prevention, Control and Countermeasures (SPCC)

DelDOT hired BrightFields, Inc. to assist the Department in complying with EPA's Oil Pollution Prevention regulations (40 CFR 112) contained within the Clean Water Act. An SPCC Plan discusses how the maintenance facility conforms to oil spill prevention and containment procedures. Each SPCC Plan is unique to the facility. Brightfields, completed a full investigation and developed site-specific plans for maintenance facilities that met the above ground storage minimums requiring a SPCC plan. All plans were completed and distributed in 2007.

D. Training

The NPDES Program, with assistance from the Center for Safety & Emergency Response Training (CSERT), developed six training videos for our maintenance staff. The videos provide training on protection of stormwater quality in the following areas:

1. Facility and vehicle maintenance
2. Stormwater contamination and spill prevention
3. Vegetation control and pollution prevention on public roads and highways

4. The regulatory requirements of the Spill Prevention Control and Countermeasures (SPCC) plans developed for each maintenance yard
5. Spill response and emergency procedures
6. The proper procedures for responding to facility and non-facility (roadway) based emergency events.

Each maintenance facility has copies of the videos, and current DelDOT personnel and new hires are required to view them. In addition, the NPDES Program also prepares training posters on elements of the PPP and SPCC Plans and distributes them to the yards several times per year.

E. Monitoring

The Pollution Prevention Plans currently require wet weather stormwater monitoring at four maintenance facilities. These facilities were chosen as representative of the 16 facilities located throughout the state. The four yards are: Kiamensi, Bear, Cheswold, and Harrington.

Monitoring was conducted during 2012 at each of the pond outfalls. Sampling techniques were performed in accordance with the Environmental Protection Agency (EPA) *Stormwater Sampling Guidance Document*, EPA 833-B-92-001 (July 1992). Semi-annual samples were collected once in each of the following six-month periods: January through June, and July through December.

The wet weather monitoring protocol includes 72 hours of antecedently dry conditions, minimum predicted rainfall depth of 0.10 inches, and two full days of standard maintenance yard operations since the last rainfall event. A first flush sample was collected within 30 minutes from the first noticeable flow, and delivered to the laboratory for analysis of total suspended solids, surfactants, chloride, pH, and total petroleum hydrocarbons: gasoline and diesel range organics. Measurements of flow, air temperature, water temperature, pH and turbidity were recorded on-site at the time of sample collection.

Table 16-1 displays the first flush concentrations measured during 2012 for all parameters at each of the four sites.

The total suspended solids (TSS) levels measured in samples collected at Cheswold (Area 8) and Bear (Area 10) yard outfalls slightly exceeded the benchmark value of 100 mg/L. Operations at both yards were investigated shortly after the test results were received in order to determine the source(s) of the excess sediment discharge. In addition, detailed annual inspections were conducted by NPDES and DNREC staff in the autumn of 2012. No specific sources were found at Bear yard, although stockpiling and movement of materials by construction contractors were thought to be contributing factors. An eroding channel on the pond side slope was also found, and the Area 10 Supervisor was directed to stabilize this slope. Inspections of Cheswold yard revealed a lapse in maintenance of catch basin filters and wash pad area. NPDES staff directed the Area 8 Supervisor to clean all catch basins and the wash pad, as well as clean and replace the riprap in the spillway will continue to inspect the yards periodically to determine if any additional BMPs are needed at these sites.

F. Vehicle Wash Water Plan

In July of 2005, DelDOT submitted a report entitled *Statewide Vehicle Wash Water Practices for DelDOT Maintenance Yards* to DNREC (Section V, DelDOT NPDES Phase I MS4 Permit Stormwater Management Plan, revised September 2010). This plan outlined the Department's proposal for treating vehicle wash water on-site at our sixteen (16) maintenance facilities. Our goal was to develop options to treat vehicle wash water and stormwater to acceptable levels before it exits our site and enters receiving waters. To meet this objective we developed a stormwater "treatment train" at each maintenance facility. This method incorporates multiple Best Management Practices (BMPs) to treat wash water to the maximum extent practicable. In several cases, existing practices, together with proposed policy changes and employee training, were sufficient to treat the vehicle wash water. In other cases, there is a need to design and construct retrofits at the facilities.

In 2012, construction of the Chapman Yard Vehicle Wash Area Retrofit was completed. In order to improve the maintenance cycle of the facility from weekly to monthly, the existing treatment train of a Hydrodynamic Separator (Stromceptor) and from there to a Delaware Sand Filter was replaced with a sediment basin. The new sediment basin is lined with articulated block on the bottom and soil confinement slope protection along the banks for ease of maintenance.

Table 16-1. 2012 wet weather monitoring results from DelDOT maintenance facility BMP outfalls. The samples were collected once in each of the following six-month periods: January through June, and July through December. All results are reported in mg/L.

PARAMETER	KIAMENSI		BEAR		CHESWOLD		HARRINGTON	
	2/29/12	8/14/12	2/29/12	8/14/12	4/22/12	9/18/12	4/22/12	11/7/12
Total Suspended Solids	52.0	90.8	122.8*	113.0*	163.0*	221.0*	17.2	<4.0
Surfactants, MBAs	0.99	0.17	0.13	0.13	0.35	0.23	0.11	0.09
Chloride	9660	1190	2420	30.0	1050	45.4	1130	37.1
TPH-Gasoline Range Organics	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10
TPH-Diesel Range Organics	0.49	<0.5	0.43	<0.5	1.13	<0.5	<0.5	<0.5
pH	7.45	7.34	7.18	7.30	6.94	7.80	7.39	7.27

*Exceeds benchmark value.

Benchmark Values:

TSS – 100 mg/L
Surfactants – 1.0 mg/L
Chlorides – no benchmark exists
Oil and Grease – 15 mg/L
pH – 6 to 9 s.u.

Appendix A. KCI Technologies storm drain inventory and inspection project summary report for 2012.

DELDOT AGREEMENT 1591

STATEWIDE MS4 / BMP INVENTORY & INSPECTION

2012 ANNUAL REPORT

The following is a summary of work performed by KCI Technologies, Inc. (KCI) and Century Engineering, Inc. (CEI) from January 1 to December 31, 2012 for Delaware Department of Transportation (DelDOT) Agreement 1591. The KCI/CEI Team was awarded Agreement 1591 in November 2011.

A. PROJECT MANAGEMENT

In 2012, KCI submitted an *Agreement 1591 2011 Annual Report* and a *2011 Annual BMP Inventory & Inspection Report*, as well as several Memorandums. In addition, KCI conducted six project status meetings **(Table 1).**

TABLE 1
PROJECT STATUS MEETINGS

Project Status Meetings
02/08/12 (#42)
03/29/12 (#43)
04/19/12 (#44)
06/26/12 (#45)
08/30/12 (#46)
12/11/12 (#47)

The project status meetings were held with DelDOT, KCI, and CEI to discuss work completed and outstanding issues. KCI distributed an agenda at least two days prior to each meeting and prepared meeting minutes for each meeting within 48 hours, including an Action Item List highlighting necessary actions, responsible parties, and target completion dates. These meetings have been highly effective in coordinating with DelDOT, identifying priority work, and resolving issues in a timely manner.

Table 2 lists the deliverables transmitted to DelDOT in 2012. A majority of these deliverables related to BMP inspections and reports. Other deliverables pertinent to Agreement 1591 are included in the *Agreement 1495 Environmental and Water Quality Monitoring 2012 Annual Report*, which includes outfall screening and illicit discharge investigations, some of which originated from Agreement 1591 inventory and inspection.

TABLE 2
DELIVERABLES

Date	Deliverable
01/03/12	Map Viewer Log In Request Processing
01/05/12	Final MWOs for Loading into Maximo
01/12/12	Map Viewer Log In Request Processing
01/13/12	Map Viewer Updates: flow arrows on conveyances; red color for MWO submitted; green for MWO completed.
01/26/12	Map Viewer User List 01-26-12
02/08/12	2011 Individual BMP Inspection Reports/Summary Tables for each District
02/16/12	Canada Thistle Maps-Spreadsheets
02/27/12	Map Viewer User List 02-23-12
03/23/12	Notification that map of Bower's Beach DelDOT owned structures in need of maintenance was posted on KCI's FTP site
03/26/12	Map Viewer User List 03-26-12
04/24/12	North District Annual Report 2011 BMP Master List
04/25/12	Annual Report 2011 BMP Master List - All Districts
05/01/12	Map of DelDOT BMPs in Town of Middletown
05/02/12	Map Viewer User List 04-30-12
05/02/12	List and Map of North District SWP Ponds (Hardcopy-CD)
05/03/12	Map Viewer: Notification ability to turn structure labels on/off by checking/unchecking "Structure Layers"
05/29/12	BMP Field Inventory & Inspection Technical Manual (V6 May 2012)
06/22/12	Notification that Revised 2012 Canada Thistle Map posted on KCI's ftp site in DelDOT folder
06/26/12	Map Viewer User List 06-26-12
08/30/12	Newly Accepted Roadways and Drainage from Archive Drive
09/07/12	Total Number Structures and BMPs Inspected for FY 2012 (09/07/12 Email)
09/10/12	2006-2011 NCCo Drainage Project Plan List Annotated with Projects Needing Plans
09/25/12	09/25/12 Map Viewer User List
09/28/12	Complete List BMPs with Access Issues and Description of Problem
10/01/12	BMP Spray Location Map
10/08/12	Revised BMP Spray Location Map
10/09/12	BMP Inspection Reports for BMP Nos. 848, 850, 851, 853 and 855
10/30/12	Notification that BMP 225 has approximately 5000 sq. ft. cattails.
10/31/12	DelDOT BMP Data for DNREC Annual Submission to Chesapeake Bay Program
12/17/12	Submittal of Sussex Inventory-Inspection GIS Map November 2012
12/21/12	BMP 104 2012 Inspection Report

B. NPDES DATABASE MANAGEMENT

In 2007, KCI's Technology Services division developed a field application using advanced hardware, redesigned the existing NPDES Database structure to allow for re-inspections, migrated all existing data into the new NPDES Database design, and began development of a new field application to fit the new NPDES Database design.

In 2008, KCI's Technology Services division completed the development of the Field Application, Version 2 and developed a Web-based Map Viewer to replace and upgrade DelDOT's existing Map Viewer. In 2009, DelDOT expressed a desire for KCI to simplify the Map Viewer, especially the querying capabilities.

In 2010, KCI completed the refinements to the Map Viewer including simplifying querying and report creation for BMPs, conveyances and structures, and adding a drainage area layer for BMPs and Major Outfalls. In addition, KCI developed a *Map Viewer User's Guide* to assist with the use of the viewer.

In 2011, KCI assisted DelDOT in formal training sessions to educate DelDOT design and maintenance staff on the use of the Map Viewer.

In 2011/2012, KCI updated the Map Viewer by migrating the ArcGIS Server 9.3.1 webADF codebase to ESRI's ArcGIS Server 10.0 SP2 Javascript API in preparation for the ESRI's webADF deprecation at ArcGIS Server 10.1. This The Javascript API version of the DelDOT NPDES web viewer will be put into production in early 2013. KCI and DelDOT developed a method for conducting desktop inventory for new drainage structures along roadway improvement projects, by overlaying electronic construction plans on the DelDOT NPDES Database.

C. BEST MANAGEMENT PRACTICE (BMP) INVENTORY AND INSPECTION

In early 2013 under separate cover, KCI will submit the *2012 Annual BMP Inventory & Inspection Report*. The 2012 Annual Report will summarize the 2012 inspections for each BMP and provide recommended actions for BMPs in four categories:

- BMPs requiring **MAINTENANCE** by DelDOT maintenance staff (Maintenance Work Orders),
- BMPs requiring **INVASIVE SPECIES** to be eradicated by third party contractor,
- BMPs requiring **CONTRACTED WORK** by a third party contractor, and
- BMPs requiring **RETROFIT** evaluations by DelDOT's Stormwater Quality Program staff.

BMPs are assigned a summary rating based on the recommended actions identified during the inspections. These ratings are defined in **Table 3**. In 2012, KCI inspected only those BMPs that were rated A and B in 2011 as well as recently accepted BMPs. BMPs rated C and D are being scheduled for maintenance as part of a separate DelDOT maintenance contract. **Table 4**

summarizes the BMP inspections conducted in 2012 by KCI and CEI. A total of 339 BMPs inspections were conducted, 84 of which were new inspections. The ratings shown in **Table 4** are preliminary at this stage, and will be reviewed and finalized during DelDOT's review and completion of the *2012 Annual BMP Inventory & Inspection Report.*

TABLE 3
OVERALL BMP RATING SYSTEM

Rating	Description
A	**No Performance Issues** BMP with No Issues affecting performance.
B	**Minor Maintenance** BMP with Minor Maintenance required; repaired by DelDOT maintenance district or third party invasive spray contractor.
C	**Major Maintenance** BMP with Major Maintenance required; repaired by third party contractor.
D	**Retrofit** BMP with Retrofit requirements; BMP is failing; needs to be redesigned or re-built with input from DelDOT Stormwater Quality Program.

TABLE 4
2012 BMP INSPECTIONS AND RATINGS

District	Total BMPs Inspected	BMP Performance Rating			
		A	B	C	D
North	**81**	36	43	2	0
Canal	**131**	59	69	3	0
Central	**42**	28	14	0	0
South	**85**	62	21	1	1
TOTAL	**339**	**185**	**147**	**6**	**1**

D. NEW CASTLE COUNTY RE-INSPECTION

KCI began re-inspection of DelDOT's MS4 in New Castle County subdivisions in February 2008, based on KCI's Subdivision Re-inspection Schedule **(Table 5)**. The re-inspection schedule is based on a 5- and 10-year re-inspection cycle for subdivisions according to the acceptance date of the subdivisions. The subdivisions planned for re-inspection in 2009 (subdivisions accepted from 1951-1965) were completed in March 2010. In October 2010, DelDOT requested that KCI dedicate both KCI field crews to Kent County Initial Inventory and Inspection work. In 2012, KCI assigned a field crew to New Castle County to continue re-inspecting the 1966-1980 subdivisions; this work was completed in January 2013. KCI plans to complete the 1981-1995 subdivisions in 2013. **Table 6** summarizes the re-inspection work performed by one KCI field crew in 2012.

TABLE 5
SUBDIVISION RE-INSPECTION SCHEDULE

Year	Subdivisions	Cycle	Re-inspect?	Date Completed
1	Database Re-design	--	--	December 2007
2	1935-1950	5	Yes	December 2008
3	1951-1965	5	Yes	May 2010
4	1966-1980	5	Yes	December 2012
5	1981-1995	10	Yes	--
5	1996-2005	10	No	--

TABLE 6
NEW CASTLE COUNTY RE-INSPECTION TOTALS

Month (2012)	Number of Subdivisions	Number of Miles of Non-Subdivision Roadways	Number of Structures
January	1	0.0	116
February	9	0.0	400
March	15	0.5	503
April	18	0.0	434
May	16	0.0	546
June	11	0.3	334
July	9	0.0	331
August	3	0.0	429
September	0	0.0	668
October	5	0.0	644
November	9	0.0	491
December	11	0.0	682
2012 Total	**107**	**0.8**	**5,578**

E. NEW CASTLE COUNTY INITIAL INVENTORY AND INSPECTION

KCI suspended Initial Inventory and Inspection work in New Castle County in October 2010 in order to focus on completing Kent County Initial Inventory and Inspection work by the end of 2011. In 2012, KCI and DelDOT explored several options for conducting a desktop approach to the inventory of newly-accepted drainage associated with roadway improvement projects, by overlaying electronic construction plans on the DelDOT NPDES Database. This process began in early 2013 for I-95 from the Christiana Mall area to Wilmington, and has saved time and money by eliminating Maintenance of Traffic. During the field re-inspection of the MS4 in New Castle County, KCI's field crew did perform some initial inspection that totaled 1.3 miles of non-subdivision roadway and 45 structures. In 2013, KCI will perform initial inventory in New Castle County using a Desktop methodology; and using a Field Team at seven recently accepted subdivisions having drainage warranties expiring in 2013.

F. KENT / SUSSEX COUNTIES INITIAL INVENTORY AND INSPECTION

KCI and CEI completed the Initial Inventory and Inspection work in Kent County in early 2012. One KCI Field Team and one CEI Field Team moved to Sussex County in February 2012. In 2012, the teams inventoried and inspected DelDOT storm systems in 11 subdivisions and along 376.5 miles of non-subdivision roadways, for a total of 20,149 structures in Kent and Sussex Counties **(Table 7)**.

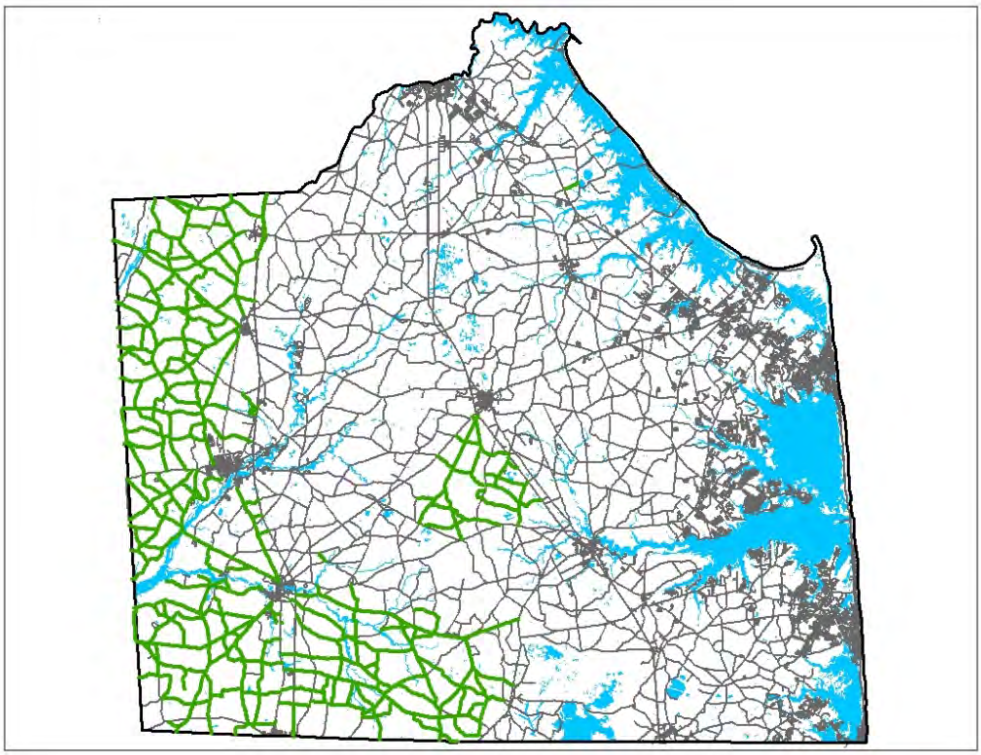
Starting in 2012, KCI and CEI concentrated on completing the inventory & inspection of Sussex County within three years. CEI previously inventoried/inspected Sussex County subdivisions during Agreement 1354. The KCI field team is inventorying/inspecting drainage north of State Route 20 (from Millsboro west) and north of State Route 24 (from Millsboro east); CEI is inventorying south of these routes and the major roadways such as Sussex Highway (State Route 13) throughout the County.

TABLE 7
2012 KENT / SUSSEX COUNTIES INITIAL INVENTORY / INSPECTION TOTALS

Month (2012)	Subdivisions	Non-Subdivision Roadway Miles	Structures
January	3	22.4	1,152
February	0	36.4	1,484
March	0	27.0	887
April	1	54.2	1,707
May	11	38.4	1,552
June	6	49.3	1,740
July	0	19.0	784
August	0	45.0	1,971
September	0	40.6	1,533
October	1	46.6	1,837
November	0	24.2	1,204
December	0	21.1	1,076
TOTAL	**22**	**424.2**	**16,927**

The goal is to complete Sussex County by the end of Agreement 1591 (December 2014). KCI has implemented a process where two field staff travel to Sussex County and act as two independent field teams. Each person has a Panasonic Toughbook and digital camera to inventory and inspect open drainage along the same stretch of roadway; one field staff on each side of the roadway. At the end of the week, the data collected on the two toughbooks is merged and cross pipes are connected. KCI has found that this method has significantly improved production. CEI has focused on Sussex Highway (State Route 13) in addition to minor roadways in the southern half of the County. **Figure 1** shows Sussex County roadway drainage that is completed (green) versus not completed (gray).

FIGURE 1
MS4 COMPLETED IN SUSSEX COUNTY



G. 2012 MAINTENANCE WORK ORDERS

During the MS4 Inventory and Inspection process, storm drain system deficiencies identified by KCI are submitted to DelDOT for upload to their Maintenance Work Order system, MAXIMO. MAXIMO delivers the work order to the appropriate maintenance district, lists the concern, identifies a remedial action, and rates the concern (minor to severe). **Table 8** lists the maintenance work orders submitted to DelDOT and completed by DelDOT in 2012. Some issues related to safety (i.e., missing or broken catch basin grate) are considered Immediate Action concerns, and the appropriate maintenance district staff is notified as soon as these safety issues are identified. In 2012, DelDOT requested KCI to submit NPDES structure assets for loading into MAXIMO. This will permit the work orders in DelDOT's NPDES Database to correlate to the work orders in DelDOT's MAXIMO system, allowing better record-keeping for completed work orders.

TABLE 8
2012 MAINTENANCE WORK ORDERS (NO.)

Type	North District	Canal District	Central District	South District
Submitted to DelDOT	222	24	142	8
Completed by DelDOT	242*	14	95	0

***** This number includes previously submitted MS4 work orders from 2011 that were not completed until 2012.

H. STATEWIDE INVENTORY SUMMARY

Tables 9, 10, and **11** summarize the number of BMPs, Structures and Conveyances contained in the DelDOT NPDES Database.

TABLE 9
STATEWIDE STRUCTURES (NO.)

Category	New Castle	Kent	Sussex
Inlet	43,685	19,494	6,349
Outfall	8,277	11,464	4,918
Manhole	5,183	786	64
Swale End	4,516	2,754	605
TOTAL	**61,661**	**34,498**	**11,936**

TABLE 10
STATEWIDE CONVEYANCES (LF.)

Type	New Castle	Kent	Sussex
Open	2,319,352	8,355,455	3,859,253
Closed	4,705,120	1,550,160	383,730
TOTAL	**7,024,472**	**9,905,615**	**4,242,983**

TABLE 11
STATEWIDE BMP (NO.)

Type	New Castle	Kent	Sussex
BaySaver	1	0	0
Check Dam	6	0	0
Bioswale	54	23	57
Bioretention	23	4	2
Dry Pond	47	6	2
Filter Strip	1	2	15
Infiltration Basin / Trench	0	0	0
Sand Filter	66	1	1
Sediment Forebay	4	0	3
Wet Pond	88	23	8
Wet Pond / Wetland	2	0	0
Infiltration Trench	9	0	0
Infiltration Basin	0	1	0
Underground Storage/Infiltration	5	0	0
Shallow Marsh	2	0	0
TOTAL	**308**	**60**	**88**

Appendix B. Statewide list of constructed DelDOT BMPs.

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
1	SNR4166	Fieldsboro Rd	Canal	New Castle	Bioretention	1.68	1.17	North of Fieldsboro Road, between Robin Road and N. Odessa Blvd		
2	SNR4166	Fieldsboro Rd	Canal	New Castle	Bioretention	1.5	0.32	At intersection of Fieldsboro Rd and Rt 9 (Taylor's Bridge Rd)	50'l x 20'w, tear drop shaped	
3	20-119-01	Church Rd	Canal	New Castle	Dry Pond	13.13		Just south of Church Rd & US 40 Intersection, next to May B. Leasure elementary (combined pond agreement w/ school)	400'l x 160'w x 5'd	
4	23-034-03	I-95 Service Plaza	North	New Castle	Bioretention	1.03		Along north shoulder of access road from I-95 southbound to I-95 service plaza.	Bio-retention = 170'l x 2'-8'w x 2'd, z=3	
5	20-045-01	Walker Road	Central	Kent	Wet Pond	4.58		North side of Walker Rd about 425' west of intersection with Independence Blvd.	195'l x 90'-180'w x 4'd, trapezoidal shape	
6	89-021-01	#324 - Ebenzer Church Rd, #13 - Paper Mill Rd	North	New Castle	Wet Pond	27.83		Southeast corner of Ebeneezer Church Rd and Paper Mill Rd intersection	300'l x 90'w x 2'd, kidney bean shaped	
7	89-110-03	SR 1	Central	Kent	Wet Pond	478.62		N of intersection of SR1 and Twin Willows Rd (next to SB lane)	1300' x 240', 10' deep, very large outlet structure	
8	89-110-04 (modified under 98-110-01)	Sr 1 NB off-ramp to south Smyrna	Central	Kent	Wet Pond	31.51		South Smyrna Interchange, just south of Smyrna, inside of Sr 1 to Smyrna off-ramp	840' x 820', 24' deep, very small outlet structure on east side of pond	
9	89-110-04	#80 - Sr 1, #1 - US 13	Canal	New Castle	Wet Pond	43.48		Between SR 1 NB and US 13 NB, N of Smyrna Rest Area	400' x 200', 12' deep, outlet structure at southeast side of pond	
10	89-110-02	SR 1	Central	Kent	Dry Pond	54.41		N of Dover Downs & in between SR1 and Leipsic Rd		
11	91-110-17	Bayview Rd (423), Vance Neck Rd (37), US 13 (22)	Canal	New Castle	Wet Pond	32.35		1200' E of US 13 on relocated Bayview Rd (N423)	300' x 150', 5' deep	
12	91-110-17	US 13 (22), SR1 (82), Pole Bridge Rd (420)	Canal	New Castle	Wet Pond	141.41		600' E of US 13, N of Pole Bridge Rd & W of SR 1	440' x 180, 4' deep	
13	91-110-17	SR1 (82), Pole Bridge Rd (420), US 13 (22)	Canal	New Castle	Wet Pond	20.68		600' E of US 13, N of Pond #12 & Pole Bridge Rd, W of SR 1	250' x 150', 4' deep	
14	91-110-17	Hyetts Corner Rd (413)	Canal	New Castle	Wet Pond	173.08		200' W of US 13, E of relocated Hyetts Corner Rd	450' x 200', 5' deep, triangular shaped	
15	95-110-10	SR1 (82), Lorewood Grove Rd (412)	Canal	New Castle	Wet Pond	42.46		SE corner of Lorewood Grove Rd and SR1 exit ramp	200' x150', 5' deep	
16	95-110-10	SR1 (82), Lorewood Grove Rd (412)	Canal	New Castle	Wet Pond	14.57		W of SR1 @ St. Georges/US 13 exit ramp, S of Lorewood Grove Rd	400' x 120', 3' deep	
17	92-110-12 (modified under 93-110-05 & 22-110-01)	SR 1	Central	Kent	Wet Pond	11.34		Intersection of Rt 8 & SR 1, in between SR1 SB and SR1 SB off-ramp	700' x 180', 2' deep, outlet structure is pipe on west side of pond	
18	92-110-12 (modified under 93-110-05 & 22-110-01)	SR 1	Central	Kent	Wet Pond	9.76		Intersection of Rt 8 & SR 1, in between SR1 NB and SR1 NB on-ramp	900' x 170', 2' deep, outlet structure is pipe at south side of pond	
19	95-110-10	Lorewood Grove Rd (412), US 13 (34), SR1 (82)	Canal	New Castle	Dry Pond	3.65		E of SR1, S of Lorewood Grove Rd, W of US 13		
20	developer	Lantana Square	North	New Castle	Dry Pond	6.97		Northeast of Sr 7 and Lantana Dr intersection. Next to South entrance of Lantana Square shopping center.	280'l x 110'w x 5'd, rectangular	
21	93-115-01	Paper Mill Rd (13), Possum Park Rd (314)	North	New Castle	Wet Pond	45.02		SW of intersection, behind service station & Connectiv power substation	150'l x 50'w x 3'd	
22	85-102-03	Naamans Rd	North	New Castle	Dry Pond	2.50		SE of Naamans Rd & Grubb Rd intersection	150'l x 55'w x 1'd	
23	85-102-03	Naamans Rd	North	New Castle	Dry Pond	33.17		380' E of Smith Lane & Naamans Rd intersection & S of Naamans Rd, BMP includes a diverter box located on the ourside right shoulder of EB Naamans Rd	290' x 120', 4' deep	
24	85-102-03	Naamans Rd	North	New Castle	Dry Pond	11.51		NW of Naamans Rd & Channin Dr intersection and 380' E of Naamans Rd & Dartmouth Woods Rd intersection, BMP includes a diverter box located on the outside shoulder of WB Naamans Rd	140' x 120', 6' deep	
25	85-102-03	Naamans Rd	North	New Castle	Dry Pond	12.37		SE of Naamans Rd & Mousley Place Dr intersection and N of West Overlook Dr	270' x 90', 6' deep	
26	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	2.45		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	
27	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	2.81		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
28	89-021-01	#324 - Ebenezer Church Rd, #13 - Paper Mill Rd	North	New Castle	Dry Pond	18.27		Approx. 3000' ft East of Pond #6 (along Ebenezer Church Rd) and 60' North of Road	80'l x 40'w, triangular shaped w/ berm constructed on one side (berm contains interceptor ditch)	
29	89-021-01	South Carter's Rd	Central	Kent	Wet Pond	6.32		Approx. 2500' Southeast of Carter Rd & Sunnyside Rd intersection. On North side of road and on West side of ditch that runs to Lake Como (ponds now belong to developer as per agreement signed July 2005, DelDOT will still make sure that ponds maintain our road runoff)	triangular shaped	
30	93-102-01	Naamans Rd	North	New Castle	Dry Pond	5.77		SE of Naamans Rd & Pin Oak Dr intersection and E of church parking lot, BMP inlcudes a diverter box located in a catch basin on right shoulder along edge of roadway	180' x 65', 4' deep	
31	93-102-01	Naamans Rd	North	New Castle	Wet Pond	12.46		SW of Naamans Rd & Betchel Park entrance intersection. Accessible by entrance to Darley Swim club.	80' x 120', 8' deep	
32	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	2.34		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	
33	93-102-01	Naamans Rd	North	New Castle	Dry Pond	15.90		550' S of Naamans Rd and E of Marsh Rd, BMP includes a diverter box	270' x 120', 5' deep	
34	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	2.30		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	
35	93-102-01	Naamans Rd	North	New Castle	Sediment Forebay	1.56		400' South of Nammans Rd and 140	Sediment Forebay	
36	22-119-01	Walther Road	Canal	New Castle	Biofiltration Swale			STA 1+00 to 7+25, south of Walther Road		Christina River
37	86-107-01	Sr 273	North	New Castle	Biofiltration Swale	10.58		S side of SR 273 & 1000' W of Avon entrance	600' length & 5' bottom width, 3.75' depth	
38	86-107-01	Sr 273	North	New Castle	Dry Pond	22.62		N side of SR 273 & 1000' W of Avon entrance	200' x 150'	
39	79-107-01	Sr 273	Canal	New Castle	Wet Pond	13.68		In between Rt 4, Rt 273 off-ramp and Old Christiana Rd	240' x 190', 6' deep	
40	79-107-01	Sr 273	Canal	New Castle	Wet Pond	2.31		Just S of ramp going from Rt 4 onto Rt 273	570' x 130', 6' deep	
41	79-107-01	Sr 273	Canal	New Castle	Wet Pond	2.71		W of Rt 273 and N of Rt 273 & New Red Mill Rd extension	140' x 330', 6' deep	
42	79-107-01	Sr 273	Canal	New Castle	Wet Pond	13.73		On opposite side of road from pond # 41.	380' x 130', 4' deep	
43	79-107-01	Sr 273	Canal	New Castle	Wet Pond	72.01		Just S of pond # 42	780' x 260', 4' deep	
44	79-107-01	Sr 273	Canal	New Castle	Wet Pond	12.26		NE corner of SR 273 & New Ruthar Dr.	400' x 240', 16' deep	
45	24-119-04	Walther Road	Canal	New Castle	Biofiltration Swale	4.12	3.34	STA 98+50 to 99+50	260'L x 4'w, 4:1 side slope	Christina River
46	21-034-04	273	Canal	New Castle	Sand Filter	1.93		273 and 7 Park and Ride		
47	developer	Sr 54	South	Sussex	Biofiltration Swale	3.02		Approximately 500' west corner of Rt 54 and Rt 20 intersection on south side of road between commercial entrance and outlet ditch	8 ft bottom width, 7.5:1 side slopes	
48	24-500-06	Talley Rd	North	New Castle	Baysaver			Next to maintenance building		Christina River
49	92-118-01	Lancaster Pike	North	New Castle	Infiltration Trench	4.75		Along Lancaster Pike	83' x 6', 6' high	
50	23-500-38	301 weigh station	Canal	New Castle	Biofiltration Swale	2.81		STA 130+00 to 136+50, around backside of weigh station		Sassafras River
51	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	2.26		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	
52	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.25			6' x 6' units	
54	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.23			6' x6' units	
55	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.27			6' x 6' units	
56	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.23			7' x 6' units	
57	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.26			7' x 6' units	
58	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.10			2' x 6' units	
59	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.11			2 x 6' units	
60	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.07			3 x 6' units	
61	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.06			2 x 6' units	
62	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.26			6 x 6' units	
63	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.09			5 x 6' units	
64	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.29			5 x 6' units	
65	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.38			10 x 6' units	
66	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.59			19 x 6' units	
67	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.19			6 x 6' units	
68	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.19			5 x 6' units	
69	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.32			5 x 6' units	

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
70	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.15			4 x 6' units	
71	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.20			6 x 6' units	
72	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.33			11 x 6' units	
73	92-118-01	Lancaster Pike	North	New Castle	Sand Filter	0.28			8 x 6' units	
74	SSR1965	US 113	South	Sussex	Biofiltration Swale			STA 8+50 to STA 20+50		
75	92-118-01	Lancaster Pike	North	New Castle	Biofiltration Swale	3.16		65' N of WB Lancaster Pike, BMP also has a divertoer box located in the manhole	200' x 12', 1-1/2' deep	
76		Kiamensi	North	New Castle	Wet Pond	4.00		Kiamensi Yard		
77	91-042-01	#104 - Kenton Rd, #157 - Walker Rd	Central	Kent	Wet Pond	7.94		Southeast corner of Kenton Rd and Walker Rd intersection	65'l x 40'w x 3'd	
78		Chapman	North	New Castle	Wet Pond	7.66		Chapman Maintenance Yard		
79	78-021-25	Valley Road	North	New Castle	Dry Pond	16.61		SE corner of Valley Rd & Evanson La. Intersection	260' x 120', 8' deep	
80	78-021-25	Valley Road	North	New Castle	Biofiltration Swale	11.29			15' x 160', 3' deep	
81	in-house	Magnolia yard	Central	Kent	Wet Pond	20.39		Magnolia Maintenance Yard		
82	93-021-01	Valley Road	North	New Castle	Dry Pond	6.90		While heading N on Valley rd, pond will be on right side & approximately 0.5 miles S of Evanson La.	260' x 155', 12' deep	
83	89-021-01	South Carter's Rd	Central	Kent	Wet Pond	29.74		Approx. 2500' Southeast of Carter Rd & Sunnyside Rd intersection. On North side of road and on East side of ditch that runs to Lake Como (ponds now belong to developer as per agreement signed July 2005, DelDOT will still make sure that ponds maintain our road runoff)	circular w/ cast iron cover over low flow orifice	
84	88-108-03	Sr 896	Canal	New Castle	Dry Pond	1.78		SE corner of Rt 896 & Corporate Blvd. On right side of entrance road into DuPont facility.	175' x 105', 3' deep	
85	88-108-03	Sr 896	Canal	New Castle	Dry Pond	11.53		SE corner of intersection of Rt 896 & Old Coochs Bridge Rd.	225' x 90', 5' deep	
86	88-108-03	Sr 896	Canal	New Castle	Dry Pond	4.22		Just N of pond # 85. (E of Rt 896 and N of tributary to Muddy Creek)	220' x 85', 4' deep	
87	88-108-03	Sr 896	Canal	New Castle	Wet Pond	55.78		In between Rt 896 and Old Coochs Bridge Rd.	460' x 130', 9' deep	
88	88-108-03	Sr 896	Canal	New Castle	Wet Pond	17.87		NW of Rt 896 & Old Baltimore Pike intersection.	240' x 105', 6' deep	
89	91-061-10	Porter Rd	Canal	New Castle	Wet Pond	5.43		SE corner of Rt 896 & Porter Rd intersection.	500' x 100', 4' deep	
90	25-071-01	St Annes Church Rd	Canal	New Castle	Wet Pond	153.98		SE corner of Br 1-503 and RR intersection. Shared use facility with Cricklewood.	300' x 100', 4' deep (oblong horseshoe shape)	
91	91-061-11	Porter Rd	Canal	New Castle	Wet Pond	33.44		SE corner of Rt 72 & Porter Rd intersection		
92	90-061-11	Cedar Lane Rd	Canal	New Castle	Dry Pond	80.72		In front of Cedar Lane Elementary school.	300' x 100', 2' deep	
93	94-071-13	Fleming's Landing Bridge Rd.	Canal	New Castle	Biofiltration Swale	0.49		Located on North side of bridge, left side of road if headed south on SR 9	Two 200' long swales	
94	28-035-01	Harrington yard	Central	Kent	Dry Pond	10.93		Harrington Maintenance Yard		
95	91-110-14	SR 1	Canal	New Castle	Wet Pond	33.03		East side of Sr 1, 2000' North of ramps to US 13, North of Smyrna	550' x 220', 4' deep	
96	91-110-14	SR 1	Canal	New Castle	Wet Pond	11.87		East side of Sr 1, 1.1 miles North of ramps to US 13, North of Smyrna	600' x 150', 4' deep	
97	91-110-14	SR 1	Canal	New Castle	Wet Pond	13.69		East side of Sr 1, 2.1 miles North of ramps to US 13, North of Smyrna	500' x 200', 4' deep	
98	91-110-14	SR 1	Canal	New Castle	Wet Pond	11.46		West side of Sr 1, 2.4 miles North of ramps to US 13, North of Smyrna	700' x 250', 4' deep	
99	91-110-14	SR 1	Canal	New Castle	Wet Pond	13.52		East side of Sr 1, 3.1 miles North of ramps to US 13, North of Smyrna	400' x 200', 4' deep	
100	91-110-14	SR 1	Canal	New Castle	Wet Pond	21.86		East side of Sr 1, 3.3 miles North of ramps to US 13, North of Smyrna	400' x 250', 3' deep	
101	91-110-14	SR 1	Canal	New Castle	Wet Pond	36.72		East side of Sr 1 at exit ramps to US 13, 2500' North of Sr 1 bridge over US 13	700' x 300', 4' deep	
102	29-500-01	Middletown	Canal	New Castle	Dry Pond	7.4		Middletown Maintenance Yard		
103	21-046-01	Sand Hill Rd	South	Sussex	Biofiltration Swale	0.321	0.226	STA 3+50 to STA 5+75 LT		Broadkill River
104	20-007-02	Lancaster Pike	North	New Castle	Biofiltration Swale	9.41		In a triangular piece bounded by Lancaster Pike, Valley Road and Old Lancaster Pike	220'l x 7'w x 1.5'd, z=3	
105	20-007-03	Lancaster Pike	North	New Castle	Wet Pond	32.85		400' West of Lancaster Pike and 500' South of Wilmington & Western Railroad tracks	230'l x 120'w x 3'd, rectangular shape	
106	21-042-01	Rt 15	Central	Kent	Infiltration Basin	22.52		Northeast corner of Milford-Harrington Highway (Rt 14) & Rt 15 intersection.	400'l x 120'w x 2'd	
107	22-041-01	Salem Church Rd	North	New Castle	Biofiltration Swale	4.23		Along West shoulder of Salem Church Rd across from Sandalwood Dr	350'l x 2'w x 2'd, z=4, outlets into wetland	
108	79-107-01	273	Canal	New Castle	Wet Pond	15.98				
109	23-500-38	301 weigh station	Canal	New Castle	Biofiltration Swale	0.13		STA 130+25 to 131+75		Sassafras River

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
110	23-500-38	301 weigh station	Canal	New Castle	Biofiltration Swale	0.71		STA 131+75 to 136+50		Sassafras River
111	95-110-06	US 13	Canal	New Castle	Wet Pond	12.99		northeast of US 13 and Blackbird Landing Road		
112	24-122-04	SR 1	Central	Kent	Bioretention			Sr 1 & Rt 9 intersection, NE corner.		
113	24-122-04	SR 1	Central	Kent	Bioretention			Sr 1 & Rt 9 intersection, SE corner.		
114	24-122-04	SR 1	Central	Kent	Bioretention			Sr 1 & Rt 9 intersection, NW corner.		
115	24-122-04	SR 1	Central	Kent	Bioretention			Sr 1 & Rt 9 intersection, SW corner.		
118	95-110-07	SR 1	Canal	New Castle	Dry Pond	6.17			Dry Extended Detention Pond	
119	95-110-07	SR 1	Canal	New Castle	Infiltration Trench	2.33			Three Infiltration trenches	
120	95-110-07	SR 1	Canal	New Castle	Dry Pond	10.64		120' W of Frontage Rd	Dry Extended Detention Pond	
121	95-110-07	SR 1	Canal	New Castle	Dry Pond	11.45			Dry Extended Detention Pond	
122	95-110-07	SR 1	Canal	New Castle	Dry Pond	1.44			175' x 125' x 2' deep	
123	95-110-07	SR 1	Canal	New Castle	Dry Pond	2.96			200' x 175' x 0.8' deep	
124	95-110-07	SR 1	Canal	New Castle	Dry Pond	2.67			300' x 100' x 6' deep	
125	95-110-07	SR 1	Canal	New Castle	Dry Pond	2.24			175' x 200' x 7' deep	
126	22-036-02	Anchorage Ave., Sr 1	South	Sussex	Sediment Forebay	58.65		Southwest of Sr 1 and Anchorage Avenue intersection (South Bethany). Next to timber bulkhead	120' x 15', concrete base	
127	95-110-07	SR 1	Canal	New Castle	Wet Pond	1.95			225' x 200' x 6' deep	
128	95-110-07	SR 1	Canal	New Castle	Wet Pond	5.09			275' x 175' x 6' deep	
129	95-110-07	SR 1	Canal	New Castle	Dry Pond	10.66			300' x 100' x 2' deep	
130	95-110-07	SR 1	Canal	New Castle	Wet Pond	5.29			200' x 150' x 5' deep	
131	95-110-07	SR 1	Canal	New Castle	Wet Pond	5.22			200' x 150' x 5' deep	
132	91-110-16	SR 1	Canal	New Castle	Dry Pond	6.62		Next to on-ramp from 299 to SR1 Northbound and Sr 1 intersection. (200' E of SR1 & 600' S of 299)	250' x 100' x 4' deep	
133	91-110-16	SR 1	Canal	New Castle	Dry Pond	23.65		In between SR1 SB and exit ramp #136. (90' W of SR1 and 510' N of Rt 299)	250' x 90', 5' deep	
134	91-110-16	SR 1	Canal	New Castle	Dry Pond	21.43		On E side of SR1, just N of Pond #132.	310' x 110', 5' deep	
135	91-110-16 & T200901901	SR 1	Canal	New Castle	Dry Pond	2.46		In between park & ride, Rt 299 and park & ride access road. (180' N of Rt 299 and 100' S of park & ride access road)	160' x 160', 3' deep	
136	91-110-16	SR 1	Canal	New Castle	Dry Pond	4.12		Between Sr 1 & US 13 and E of Marl Pit Road & US 13 intersection.	200' x 160', 3' deep	
137	22-111-02	Churchman's Rd	Canal	New Castle	Wet Pond			East side of Churchman's Rd and approximately 900' North of intersection with King St.		
138	91-110-16	SR 1	Canal	New Castle	Dry Pond	29.78		260' W of SR1 and 700' S of Pond #140.	250'x80', 4' deep	
139	22-111-02	#56 - Airport Rd	Canal	New Castle	Wet Pond	1.61		North side of Airport Rd, approx. 700' West of intersection with Churchman's Road	310'l x 130'w x 4'd, rectangular shape	
140	91-110-16	SR 1	Canal	New Castle	Dry Pond	6.74		170' W of SR1 and 450' S of Drawyers Creek.	200' x 80', 4' deep	
141	91-110-16	SR 1	Canal	New Castle	Wet Pond	54.63		180' E of SR1 and 1870' N of Drawyers Creek.	400' x 150', 7' deep	
142	92-031-01	Sears Blvd.	North	New Castle	Wet Pond	10.78		North side of Sears Blvd, just before Hershey Run	145' x 65', 2'deep, no outlet structure	
143		SR 141	North	New Castle	Wet Pond	43.48		north of 141 by Barley Mill Road		
145	92-033-04	Vaughn Rd	South	Sussex	Dry Pond	13.63		Along Rd 520 on left side of entrance to DelTech.	115' x 35', 3.5' deep (kidney shaped)	
146	92-033-04	Vaughn Rd	South	Sussex	Dry Pond	5.18		Along Rd 520 on right side of entrance to DelTech.	300' x 30', 3.5' deep	
147	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	1.21		70' - 100' E of NB Rt 896.	3600' with stone check dam	
148	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	2.59		80' - 100' E of SB Rt 896.	1000' length with stone check dam	
149	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	1.52		SE of Rt 896 & DuPont entrance intersection.	630' length with stone check dam	
150	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	1.89		60' - 90' E of NB Rt 896.	1300' length with stone check dam	
151	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.92		35' - 50' W of Access Dr. to Corporate Park.	135' length with stone check dam	
152	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.76		25' W of Access Dr. to Corporate Park	770' length with stone check dam	
153	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	3.05		20' - 40' E side of Access Dr to Corporate Park.	440' length with stone damcheck	
154	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.86		25' - 30' W of Access Dr. to Corporate Park.	450' length with stone check dam	
155	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.41		30' - 50' W of SB Rt 896.	900' length with stone check dam	
156	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.52		70' - 85' E of NB Rt 896.	1200' length with stone check dam	
160	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	0.94		40' - 50' E of NB Rt 896.	740' length with stone check dam	
162	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	1.07		30' E of NB 896, from Old Baltimore Pike	2480' length with stone check dam	
163	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale	4.75		30' W of SB 896, beginning at Old Baltimore Pike.	2400' length with stone check dam	
164	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale			Between NB 896 & I-95 NB.	300' length with stone check dam	
165	88-108-03	Sr 896	Canal	New Castle	Biofiltration Swale			50' W of SB Rt 896, beginning at I-95.	550' length with stone check dam	
166	88-108-03	Sr 896	Canal	New Castle	Dry Pond	39.45		From 896 NB, take I-95 on-ramp. Pond will be on right side as going through curve.	120' x 160'	

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
167	91-110-18	SR 1	Central	Kent	Wet Pond			Around main toll facility building in Dover on Sr 1.	740' x 50', 4.5' deep (outlet - S side of building	
168	92-096-03	Rehoboth Park-n-Ride	South	Sussex	Sand Filter	5.77		In the Rehobeth park & ride facility @ the intersection of Shuttle Rd & Country Club Rd, just off of SR1.	80' L sand filter	
169	23-119-05	School Bell Road	Canal	New Castle	Wet Pond					
170	23-119-05	School Bell Road	Canal	New Castle						
171		Rt 40	Canal	New Castle	Wet Pond	4.34				
172	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 6+00 to 12+85 Lt		
173		Rt 40	Canal	New Castle	Wet Pond	11.62				
174	24-112-07	Sr 26	South	Sussex	Biofiltration Swale			On Northeast and Southeast side of Sr 26 (Vines Creek Road) & Sr 20 (Main St.) intersection. Swales flow to a pipe which outlets into Pepper Creek.	650'l	
176	93-062-07	White Oak Road (66)	Central	Kent	Wet Pond	0.24		This pond was suppossedly taken over by the City of Dover. There are also sand filters at the intersection of US 13 and White Oak Rd. (ours?).	220' x 190' x 7' deep	
177	89-110-02	SR 1	Central	Kent	Dry Pond	81.80		Denny's Road Toll Facility, located between Sr 1 northbound, exit ramp from Sr1 south to US 13 and exit ramp from Sr 1 northbound to US 13	330' x 130'	
178	89-110-01	SR 1	Central	Kent	Dry Pond	24.22		Northwest quadrant of where Sr 1 crosses over Rt 10 and inside loop. Loop carries traffic from Rt 10 onto Sr 1 South.	420'l x 200'w, outlet located on West side of pond which is 36" RCP w/ weir and also includes a 6" PVC under No. 3 strone.	
179		Christiana Mall	Canal	New Castle	Wet Pond	9.43		east of the mall		
180	92-112-02	Sr 404	South	Sussex	Wet Pond	13.74		NW corner of intersection of Rt 404A & Rd 583.	400' x 600', 6' deep (V-shaped w/ pennisula)	
181	87-061-10 & 25-128-04	US 301	Canal	New Castle	Wet Pond	1.82	2.36	SE corner of intersection of US 301 & Rt 299 (In front of WAWA).		
182	91-101-04	Sr 7	North	New Castle	Wet Pond	62.90		NE quadrant of SR7 & Churchman's Rd Intersection.	390' x 245', 5' deep (tear drop shaped)	
183	91-101-04	Sr 7	North	New Castle	Dry Pond	58.41		SE quadrant of SR7 & Service Road A intersection (Service Road A goes from SR 7 NB to DelTech).	475'l x 130'w x 4'd, tear drop shapped	
184	91-101-04	Sr 7	North	New Castle	Biofiltration Swale	2.42		Along NB SR7, N of entrance to JP Morgan Services, Inc.	330' L x 4'w, z=4, w/ stone check dam	
185	95-110-05	SR1, Pine Tree Rd (25), South Frontage Rd	Canal	New Castle	Wet Pond	27.30		Pond is bounded by Pine Tree Rd, South Frontage Rd and SR1.	1200' x 200' (trapezoidal)	
186	95-110-05	SR1, Noxontown Rd. (38), South Frontage Rd	Canal	New Castle	Wet Pond	19.79		Bounded by SR1, Noxontown Rd and South Frontage Rd.	1100' x 150' (rectangular)	
187	95-110-05	South Frontage Rd., Noxontown Rd. (38)	Canal	New Castle	Wet Pond	5.72		NW quadrant of intersection of South Frontage Rd & Noxontown Rd.	300' x 150' (slanted "L" shape)	
188	95-110-05	US 13 (1), Old State Rd (441)	Canal	New Castle	Dry Pond	12.93		E of US 13 and about 800' S of Old State Rd.	350' x 100' (rectangular)	
189	95-110-05	US 13, South Frontage Rd, Old State Rd (441)	Canal	New Castle	Wet Pond	7.91		W of South Frontage Rd (about even with intersection of US 13 and Old State Rd).	200' x 150' (trapezoidal)	
190	95-110-05	US 13 (1), Sycamore Lane	Canal	New Castle	Dry Pond	11.53		E of US 13 and about 1400' S of Sycamore Lane.	250' x 80' ("C" shaped)	
191	95-110-05	SR1, US 13 (1), Sycamore Lane	Canal	New Castle	Wet Pond	14.67		W of South Frontage Rd and about 800' S of Sycamore Lane & US 13 intersection.		
192	96-118-02	Lancaster Pike	North	New Castle	Bioretention	1.66		south of lancaster pike by another road		
193	92-007-03	US 40	Canal	New Castle	Dry Pond	8.08		NW quadrant of US 40 & Rt 72 intersection.	180' x 130', 4' deep (trapezoidal)	
194	85-102-05	Naamans Rd	North	New Castle	Wet Pond	11.92		NE quadrant of Naamans Rd & Foulk Rd intersection.	240' x 180', 3.5' deep	
196	96-512-01	College Ave	Canal	New Castle	Dry Pond	4.65		along south college ave, across from crysler plant		
197	97-002-01	Dennys Road	Central	Kent	Bioswale	58.58		SW corner of Dennys road and McKee Road intersection		
198	91-101-02	Sr 7	North	New Castle	Wet Pond	48.84		NW quadrant of SR 7 / Valley Rd intersection (N of Mill Creek).	120' x 340', 6' deep (rectangular)	
199	91-101-02	Sr 7	North	New Castle	Wet Pond	3.98		NW quadrant of SR 7 / Valley Rd intersection (S of Mill Creek).	150' x 150', 6' deep (triangular)	
200	24-531-02	US 113	South	Sussex	Wet Pond	8.36		Behind South District office next to motor-v lane.	320' x 80', 2' deep (eliptical)	
201	24-531-02	US 113	South	Sussex	Wet Pond	5.42		In front of South District Office.	135' x 60', 1' deep ("L" shaped)	
202	97-119-01	Sr 71	Canal	New Castle	Wet Pond	18.70		In between US 13, SR 71 and SR1 ramp to SR 71 (near Tybotts corner).	295'l x 180'w x 7.5'd, irregular shape	

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
203	91-110-13	US 13 (3), Puncheon Run Connector	Central	Kent	Wet Pond	9.93		NE quadrant of US 13 & Puncheon Run intersection.	290' x 150', 4.5' deep (trapezoidal)	
204	91-110-13	Puncheon Run Connector	Central	Kent	Wet Pond	4.97		Between Puncheon Run and Puncheon Run Connector.	320' x 140', 4' deep (trapezoidal)	
205	91-110-13	Puncheon Run Connector	Central	Kent	Wet Pond	11.88		S of Puncheon Run Connector and W of St. Jones River.	360' x 120', 4.5' deep (rectangular)	
206	91-110-13	Puncheon Run Connector	Central	Kent	Wet Pond	26.84		S of Puncheon Run Connector and E of St. Jones River.	330' x 170', 4' deep (rectangular)	
207	91-110-13	US 113 (7), Puncheon Run Connector	Central	Kent	Wet Pond	9.80		N of ramp from Puncheon Run Connector to US 113 north-bound	480' x 360', 4' deep (elliptical)	
208	91-110-13	Puncheon Run Connector, SR1	Central	Kent	Wet Pond	11.94		Between SR1 and Puncheon Run Connector ramp to SR1 N-bound.	840' x 100', 4' deep, (trapezoidal)	
209	91-110-13	Puncheon Run Connector, US 113 (7), SR1 (150)	Central	Kent	Wet Pond	11.96		In between Puncheon Run Connector EB, US 113 and SR1 SB.	560' x 240', 7' deep (trapezoidal)	
210	83-012-01	Scarborough Rd	Central	Kent	Wet Pond	6.99		E of Scarborough Rd & about 800' N of its' intersection with College Rd (behind elementary school)	180' x 200', 4' deep (rectangular)	
211	83-012-01	Scarborough Rd	Central	Kent	Wet Pond	18.49		NW quadrant of Scarborough Rd & McKee Rd intersection.	650' x 200', 5' deep (triangular)	
212	83-012-01	Scarborough Rd	Central	Kent	Wet Pond	48.82		SE quadrant of Scarborough Rd & DelTech connector intersection.	450' x 150', 4' deep (rectangular)	
213	95-200-18	Virginia Ave.	South	Sussex	Wet Pond			Along Virginia Ave., 900' E of Seaford High School and next to the track	200' x 100', 2.5 ' deep (triangular)	
215	T200911201	Cedar Grove Road	South	Sussex	Infiltration Basin	13.94	3.96	STA 210+20 to STA 214+61 Rt, offset 12ft	383'L x 124'w; 6:1 side slopes	Rehoboth Bay
216	97-042-01	College Rd	Central	Kent	Biofiltration Swale	4.16		On both sides of College Rd @ intersection w/ side entrance that goes into DSU.	825' swales, 3' flat bottom	
217	96-118-02	Lancaster Pike	North	New Castle	Wet Pond	1.48		200' NE of Lancaster Pike & Hercules Rd intersection.	75' x 75', 6" deep, (constructed wetland)	
218	96-118-02	Lancaster Pike	North	New Castle	Wet Pond	2.26		S of Lancaster Pike and about 0.42 miles E of bridge over Red Clay Creek.	110' x 26' (constructed wetland)	
219	98-502-01	#34 - US 13, #356 - Sr 72 (Wrangle Hill Rd)	Canal	New Castle	Wet Pond	21.70		Inside DTC facility at Southwest quadrant of Sr 72 and US 13 intersedtion	3'd	
221	24-041-01	Summit Bridge Rd	Canal	New Castle	Wet Pond	5.99		Southeast quadrant of Summit Bridge Rd and Boyds Corner Rd intersection	240'l x 230'w x 3'd	
222	26-500-01	Bear Yard	Canal	New Castle	Wet Pond	15.27		back of the Bear Yard		
223	91-101-02	Sr 7	North	New Castle	Wet Pond	4.42		App. 600' E of SR 7 & Rt 72 intersection. Just behind DE Trust Co.	120' dia., 6' deep	
224	91-101-02	Sr 7	North	New Castle	Wet Pond	17.77		App. 1200' N (and 400' NE offset) of SR 7 & Rt 72 intersection. App. 1300' S of Mendenhall Village entrance.	250' dia., 10' deep	
225	91-101-02	Sr 7	North	New Castle	Dry Pond	36.30		App. 800' W of SR 7 & Little Baltimore Rd intersection. Pond is on S side of Little Baltimore Rd.	300' dia., 12' deep	
226	96-112-01	Sr 54	South	Sussex	Wet Pond			North of Sr 54 and across from old Sr 54 / Lincoln Ave. / Wilson Ave. intersection.	150' x 85', 12" deep w/ 3 micro-pools (constructed wetland)	
227	96-112-01	Sr 54	South	Sussex	Biofiltration Swale			North of Sr 54 & 350' East of Sr 54 / Keen Wik Rd intersection. Northwest corner of Sr 54 / Mallard Lakes intersection	Trapezoidal swale, 200' length, 3' bottom width	
228	96-112-01	Sr 54	South	Sussex	Biofiltration Swale			North of Sr 54 & 1280' East of Sr 54 / Treasure Beach RV Park intersection. Approx. 25' South of existing billboard.	Trapezoidal swale, 167' length, 5' bottom width	
229	90-031-11	Cauffied Estate Connector (24)	North	New Castle	Biofiltration Swale	4.74		Adjacent & along South shoulder of the road. Begins about 380' E of Philadelphia Pike and ends about 2130' E of Phl. Pike.	bioswales, 2' bottom width, 4:1 side slopes	
230	90-031-11	Cauffied Estate Connector (24), Philadelphia Pike	North	New Castle	Dry Pond	4.56		Adjacent & North of Cauffield Estate Connector and 425' E of Philadelphia Pike.	160' x 40', 2' depth @ emergency spillway	
232	99-512-02	Claymont Rail Station	North	New Castle	Filter Strip	1.57		Next to satellite parking lot for Claymount Rail Station. Parking lot is along Governor Printz Blvd. extension.	620' length, 50' - 110' width	
233	99-512-03	Claymont Rail Station	North	New Castle	Sediment Forebay	2.76		Located between the parking lot and the tracks at the Claymount Rail Station.	3' deep in 2 micropools & 2' deep in middle pool	
234	98-118-02	Lancaster Pike	North	New Castle	Wet Pond	3.03		Northeast of intersection at Lancaster Pike nad Old Wilmington Rd. (relocated).	200'l x 100'w x 5'd	
235	20-126-01	Sr 7	Canal	New Castle	Wet Pond	12.91		Northeast quadrant of SR7 and Songsmith Drive intersection	180' wide x 360' long x 4' deep	
236	96-122-01	SR 1	South	Sussex	Wet Pond			East of SR1 off-ramp to Sr 1 Business / Sr 30.		
237	99-690-06	Sr 9	Canal	New Castle	Biofiltration Swale	1.70		Southeast quadrant of intersection of Rt 9 & Cherry Lane.	380' length, 6' bottom width, 1' flow depth	

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
238	99-690-06	Sr 9	Canal	New Castle	Biofiltration Swale	4.22		Along East shoulder of Cherry lane and about 1800' S of Rt 9.	225' length, 5' bottom width, 1.22' flow depth	
239	20-126-01	Sr 7	Canal	New Castle	Wet Pond	7.88		Southeast quadrant of Sr 7 & Songsmith Drive intersection. Approx. 800' N of US 40	220' x 300', 3' depth	
240	20-126-01	Sr 7	Canal	New Castle	Wet Pond	19.11		Southeast quadrant of US 40 & Sr 7 intersection.	520' x 200', 3' depth	
241	20-126-01	Sr 7	Canal	New Castle	Wet Pond	13.58		East of Sr 7 and Rivers End Drive intersection.	260' x 550', 3' depth	
242	97-061-14	Porter Rd	Canal	New Castle	Wet Pond	10.60		N shoulder of Porter Rd, about 0.5 miles E of Porter Rd & Rt 72 intersection.	270' x 70', 3' depth	
243	97-200-06	Ransom Lane, Kent Street	Central	Kent	Dry Pond	49.25		SW quadrant of Ransom Lane and Kent Street intersection at St. Polycarp Catholic Church (Smyrna).	Triangular, 180' x 180' x 220' (about 5' deep)	
244	20-091-03	I-497	North	New Castle	Wet Pond	3.15		Bounded by: SB I495 ramp to NB US 13, US 13 and tidal ditch.	2'd, 8" Al outlet, 3" orifice (constructed wetland)	
245	20-042-01	New Linden Hill Rd	North	New Castle	Bioretention	0.95		Northeast of New Linden Hill Rd and Poly Drummond Rd intersection. South edge of shopping center parking lot (Zingos grocery).	160'l x 13'w	
246	98-045-01	North Street	Central	Kent	Wet Pond	11.82		Southwest of North St and West St intersection and next to RR tracks.	650'l x 360'w x 3'd, traingular shaped	
247	91-003-01	Sr 24	South	Sussex	Wet Pond			Northeast corner of Sr 24 and Sr 23 intersection and just North of convienence store		
248	20-013-05	Sr 18	South	Sussex	Bioretention	0.45		Southeast corner of Rt 18 and entrance to DelTech	855 sf, rectangular shape	
253	98-091-01	I-95	North	New Castle	Shallow Marsh	7.82				
254	98-091-01	I-95	North	New Castle	Shallow Marsh	66.20				
291	22-120-01	Choptank Rd	Canal	New Castle	Bioretention	6.81		From plan set: sht 32, sta 891+00 - 893+50 Rt		
295	22-125-01	Sr 1, #268 - Kings Highway	South	Sussex	Sediment Forebay			West of Sr 1 SB lane near intersection of Kings Highway (Rd 268) and Sr 1 NB.		
296	22-125-01	SR 1	South	Sussex	Sediment Forebay			West of Sr 1 SB lane near intersection of Wescoats Rd (Rd 12) and Sr 1 NB.		
297		Tweeds Park				3.88				
298		Tweeds Park				3.98				
299		Tweeds Park				2.29				
300	21-045-01	#315 - Tower Hill Rd	Central	Kent	Biofiltration Swale			2 Bioswales, North side of Tower Hill Rd -1) 100' East and West of entrance to culvert 2) 120' East and 360' West of culvert (approx. 100' East of Fairground Entrance Rd).	500'l x 2'w, z=4 (front) and 3 (back), drains into 2 cross culverts	
301	21-045-01	#314 - Farmington Rd, #315 - Tower Hill Rd	Central	Kent	Biofiltration Swale			2 Bioswales, East and West side of Tower Hill and Farmington Road intersection. 1) about 100' East of 14"x23" RCEP 2) West of Farmington Rd about 50' South of int.	200'l x 2'w, z=4 (front) and 3 (back)	
302	21-045-01	#314 - Farmington Rd	Central	Kent	Biofiltration Swale			2 Bioswales. West side of Farmington Rd. 100' North and South of 14"x23" RCEP cross culvert, which is approx. 500' North of Tower Hill and Farmington Rd intersection.	250'l x 2'w, z=4 (front) and 3 (back)	
303	21-045-01	#314 - Farmington Rd	Central	Kent	Biofiltration Swale			4 Bioswales. All 4 quadrants of cross culvert (14"x23" RCEP) at approx. 2730' North of Tower Hill and Farmington Rd intersection. (ditch is flowing east to RR tracks)	300'l x 2'w, z=4 (front) and 3 (back)	
304	21-045-01	#314 - Farmington Rd	Central	Kent	Biofiltration Swale			2 Bioswales. East side of Farmington Rd. Both sides of 14"x23" RCEP cross culvert, which is approx. 4230' (0.8mi) North of Tower Hill and Farmington Rd intersection.	250'l x 2'w, z=4 (front) and 3 (back)	
305	22-124-06	East Service Road	South	Sussex	Biofiltration Swale	1.2	0.64	STA 338+00 to 342+00 Rt	387'L x 9'w, 0.2% slope	Nanticoke River
306	22-124-06	East Service Road	South	Sussex	Biofiltration Swale	1.49	0.86	STA 342+00 to 345+50 Rt	318'L x 9'w, 0.3% slope	Nanticoke River
307	22-124-06	East Service Road	South	Sussex	Wet Pond	10.55	2.2	STA 331+00 to 329+00		Nanticoke River
308	22-124-06	Business 404	South	Sussex	Biofiltration Swale	0.49	0.26	STA 108+00 to 110+50 Rt	250'L x 4'w, 0.3% slope	Nanticoke River
309	22-124-06	Rt 404	South	Sussex	Biofiltration Swale	2.55	1.14	STA 135+00 to 138+00 Rt	391'L x 12'w, 0.13% slope	Nanticoke River
310	22-124-06	Rt 404	South	Sussex	Biofiltration Swale	3.32	0.87	STA 145+50 to 149+00 Rt	370'L x 6'w, 0.4% slope	Nanticoke River
311	94-071-13	Fleming's Landing Bridge Rd.	Canal	New Castle	Biofiltration Swale	0.72		Located on North side of bridge, right side of road if headed south on SR 9	200' long swale	
312	97-042-01	College Rd	Central	Kent	Biofiltration Swale	0.60		On both sides of College Rd @ intersection w/ side entrance that goes into DSU. SEE BMP 216	825' swales, 3' flat bottom	
313	93-102-01	Naamans Rd	North	New Castle	Sediment Forebay	0.87		400' South of Nammans Rd and 140	Sediment Forebay	
314	93-102-01	Naamans Rd	North	New Castle	Sediment Forebay	0.33		400' South of Nammans Rd and 140	Sediment Forebay	
315	25-090-01	I-95	North	New Castle	Wet Pond	8.87				

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
316	25-090-01	I-95	North	New Castle	Bioswale	0.89				
318	25-090-01	I-95	North	New Castle	Wet Pond					
319	25-128-03	Levels Road	Canal	New Castle	Infiltation Trench					
320	24-531-02	US 113	South	Sussex	Filter Strip					
321	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			2 Bioswales, North side of Tower Hill Rd -1) 100' East and West of entrance to culvert 2) 120' East and 360' West of culvert (approx. 100' East of Fairground Entrance Rd). SEE BMP 300	500'l x 2'w, z=4 (front) and 3 (back), drains into 2 cross culverts	
322	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			2 Bioswales, East and West side of Tower Hill and Farmington Road intersection. 1) about 100' East of 14"x23" RCEP 2) West of Farmington Rd about 50' South of int. SEE BMP 301	200'l x 2'w, z=4 (front) and 3 (back)	
323	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			2 Bioswales. West side of Farmington Rd. 100' North and South of 14"x23" RCEP cross culvert, which is approx. 500' North of Tower Hill and Farmington Rd intersection. SEE BMP 302	250'l x 2'w, z=4 (front) and 3 (back)	
324	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			4 Bioswales. All 4 quadrants of cross culvert (14"x23" RCEP) at approx. 2730' North of Tower Hill and Farmington Rd intersection. (ditch is flowing east to RR tracks) SEE BMP 303	300'l x 2'w, z=4 (front) and 3 (back)	
325	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			4 Bioswales. All 4 quadrants of cross culvert (14"x23" RCEP) at approx. 2730' North of Tower Hill and Farmington Rd intersection. (ditch is flowing east to RR tracks) SEE BMP 303	300'l x 2'w, z=4 (front) and 3 (back)	
327	21-045-01	Harrington Truck Rt	Central	Kent	Biofiltration Swale			2 Bioswales. East side of Farmington Rd. Both sides of 14"x23" RCEP cross culvert, which is approx. 4230' (0.8mi) North of Tower Hill and Farmington Rd intersection. SEE BMP 304	250'l x 2'w, z=4 (front) and 3 (back)	
328	97-042-01	College Rd	Central	Kent	Biofiltration Swale	4.63		On both sides of College Rd @ intersection w/ side entrance that goes into DSU. SEE BMP 216	825' swales, 3' flat bottom	
329	26-500-12	Cheswold Yard	Central	Kent	Dry Pond	7.56		Cheswold Maintenance Yard		
335	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.71	0.39	STA 745+00 to STA 747+80, median		Appoquinimink River
337	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	1.09	0.51	STA 743+50 to STA 746+60, Rt		Appoquinimink River
339	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	1.46	0.8	STA 777+00 to STA 779+00, median		Appoquinimink River
340	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 779+00 to STA 782+00, median		Appoquinimink River
341	25-128-04	US 301	Canal	New Castle	Wet Pond	4.34	0.95	Corner of Bunker Hill and 301		Appoquinimink River
342	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	1.71	1.18	STA 816+00 to STA 819+00, median		Appoquinimink River
343	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 819+00 to STA 823+00, median		Appoquinimink River
344	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.49	0.29	STA 827+00 to STA 829+00, median		Appoquinimink River
345	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 829+00 to STA 832+00, median		Appoquinimink River
346	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.17	0.4	STA 832+00 to STA 833+00, median		Appoquinimink River
347	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.28	0.07	STA 833+00 to STA 835+00, median		Appoquinimink River
348	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 835+00 to STA 837+00, median		Appoquinimink River
349	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	1.77	0.43	STA 825+50 to STA 829+00, Rt		Appoquinimink River
350	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 829+00 to STA 832+00, Rt		Appoquinimink River
351	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.27	0.15	STA 832+00 to STA 833+50, Rt		Appoquinimink River
352	25-128-04	US 301	Canal	New Castle	Biofiltration Swale	0.35	0.22	STA 833+50 to STA 835+00, Rt		Appoquinimink River
353	25-128-04	US 301	Canal	New Castle	Infiltration Trench			STA 835+00 to STA 837+00, Rt		Appoquinimink River
354	98-091-01	I-95	North	New Castle	check dam	1.24				
355	98-091-01	I-95	North	New Castle	check dam	1.41				
357	98-091-01	I-95	North	New Castle	check dam	10.22				
358	98-091-01	I-95	North	New Castle	check dam	0.71				
359	98-091-01	I-95	North	New Castle	check dam	0.64				
360	98-091-01	I-95	North	New Castle	check dam	0.83				
364	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.15				
365	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.19				
366	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.17				
367	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.32				
368	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.06				
369	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.15				
370	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.07				

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
371	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
372	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.09				
373	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.22				
374	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.10				
375	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.13				
376	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.03				
377	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.05				
378	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.10				
379	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.06				
380	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.09				
381	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.10				
382	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.06				
383	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
384	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
385	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.03				
386	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.16				
387	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.28				
388	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.13				
389	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.10				
390	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.12				
391	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
392	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.13				
393	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.12				
394	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.09				
395	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
396	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.10				
397	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.02				
398	95-110-02	Marl Pit Road	Canal	New Castle	Dry Pond	21.07				
399	95-110-02	Marl Pit Road	Canal	New Castle	Dry Pond	13.30				
400	95-110-02	Marl Pit Road	Canal	New Castle	Dry Pond	5.70				
401	23-110-01	SR 1	Central	Kent	Filter Strip			SR 1 Dover toll Plaza - West side of SR 1		
402	23-110-01	SR 1	Central	Kent	Bioswale			SR 1 Dover toll Plaza		
403	23-110-01	SR 1	Central	Kent	Bioswale			SR 1 Dover toll Plaza		
404	23-110-01	SR 1	Central	Kent	Bioswale			SR 1 Dover toll Plaza		
405	93-033-02	Rd 534	South	Sussex	Bioswale	1.78				
406	93-033-02	Rd 534	South	Sussex	Bioswale	0.68				
407	93-033-02	Rd 534	South	Sussex	Bioswale	7.15				
408	93-033-02	Rd 534	South	Sussex	Bioswale	0.39				
409	93-033-02	Rd 534	South	Sussex	Bioswale	0.43				
410	93-033-02	Rd 534	South	Sussex	Bioswale	2.15				
411	93-033-02	Rd 534	South	Sussex	Bioswale	0.58				
412	93-033-02	Rd 534	South	Sussex	Bioswale	2.32				
413	93-033-02	Rd 534	South	Sussex	Bioswale	0.86				
414	93-033-02	Rd 534	South	Sussex	Bioswale	4.05				
415	93-033-02	Rd 534	South	Sussex	Bioswale	3.91				
420	24-500-06	Talley Rd	North	New Castle	Filter Strip	0.36	0.29	South side of Talley Maintenance Yard, next to truck shed	330' length x 10' width	Christina River
421	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.04				
422	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.03				
423	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
424	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.14				
425	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
426	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.16				
427	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.14				
428	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.13				
429	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.08				
430	91-001-02	Kennett Pike	North	New Castle	Sand Filter	0.28				
431	95-110-07	SR-1	Canal	New Castle	Dry Pond	66.26		Approximately ¾ mile N. of Appoquinimink River.		
432	23-019-02	Smyrna Rest Area	Canal	New Castle	Bioswale	3.79		Smyrna Rest Area - around outer edge of parking expansion		
433	23-106-01	141	North	New Castle	Bioretention	12.58				
434	23-106-01	141	North	New Castle	Wet Pond	1.73				
435	23-106-01	141	North	New Castle	Bioretention	1.40				
436	23-106-01	141	North	New Castle	Wet Pond	22.56				
437	23-106-01	141	North	New Castle	Bioretention	2.54				

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
438	23-106-01	141	North	New Castle	Wet Pond	5.97				
439	89-110-02	SR-1	Central	Kent	Wet Pond	35.12		South of the SR-8 interchange on the south bound side		
454	SKR 2020	Carpenters Pit Rd	South	Sussex	Biofiltration Swale	0.39		STA 208+00 to STA 210+00		Mispillion River
464	29-500-01	Middletown	Canal	New Castle	Bioretention	7.4		Middletown Maintenance Yard		
465	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
466	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
467	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
468	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
469	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
470	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
471	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
472	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
473	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
474	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
475	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
476	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
477	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
478	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
479	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
480	25-128-03	Levels Road	Canal	New Castle	Biofiltration Swale			reference BMP 321 on plans		
481	25-128-03	Levels Road	Canal	New Castle	Biofiltration Swale			reference BMP 322 on plans		
482	25-128-03	Levels Road	Canal	New Castle	Biofiltration Swale			reference BMP 323 on plans		
483	25-128-05	Levels Road	Canal	New Castle	Biofiltration Swale			located along Levels road drains into Deep Creek		
484	25-128-03	Levels Road	Canal	New Castle	Biofiltration Swale			reference BMP325 on plans		
485	25-128-03	Levels Road	Canal	New Castle	Biofiltration Swale			reference BMP 326 on plans		
487	23-110-01	SR 1	Central	Kent	Filter Strip			SR 1 Dover toll Plaza - East side of SR 1		
488	88-110-15	SR 1	Central	Kent	Dry Pond	44.88		SR1 NB, just south of SR 6 Overpass		
489	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.3	0.179	STA 3+25 to STA 6+10 Rt		Broadkill River
490	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.18	0.065	STA 20+00 to STA 21+20 Lt		Broadkill River
491	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.149	0.51	STA 21+20 to STA 22+50 Lt		Broadkill River
492	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.346	0.184	STA 24+40 to STA 28+10 Lt		Broadkill River
493	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.103	0.065	STA 20+00 to STA 21+20 Rt		Broadkill River
494	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.116	0.051	STA 21+20 to STA 22+50 Rt		Broadkill River
495	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.32	0.182	STA 24+40 to STA 28+40 Rt		Broadkill River
496	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.235	0.096	STA 28+25 to STA 30+15 Lt		Broadkill River
497	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.145	0.089	STA 30+15 to STA 31+18 Lt		Broadkill River
498	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.26	0.154	STA 32+15 to STA 32+90 Lt		Broadkill River
499	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.102	0.054	STA 28+25 to STA 30+15 Rt		Broadkill River
500	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.054	0.022	STA 30+15 to STA 31+25 Rt		Broadkill River
501	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.181	0.059	STA 31+25 to STA 34+38 Rt		Broadkill River
502	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.326	0.125	STA 39+65 to STA 42+35 Lt		Broadkill River
503	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.301	0.169	STA 42+35 to STA 46+35 Lt		Broadkill River
504	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.362	0.175	STA 36+65 to STA 42+35 Rt		Broadkill River
505	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.309	0.175	STA 42+35 to STA 46+35 Rt		Broadkill River
506	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.216	0.138	STA 49+90 to STA 52+90 Lt		Broadkill River
507	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.288	0.118	STA 52+90 to STA 55+60 Lt		Broadkill River
508	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.227	0.138	STA 49+90 to STA 52+90 Rt		Broadkill River
509	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.243	0.143	STA 52+90 to STA 55+35 Rt		Broadkill River
510	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.224	0.107	STA 55+60 to STA 58+30 Lt		Broadkill River
511	21-046-01	Sand Hill Road	South	Sussex	Biofiltration Swale	0.189	0.107	STA 55+60 to STA 58+30 Rt		Broadkill River
512	24-122-03	SR-1	Central	Kent	Biofiltration Swale			North Frederica Grade separated Intersection		
513	24-122-03	SR-1	Central	Kent	Biofiltration Swale			North Frederica Grade separated Intersection		

Facility Number	Project Number	Road Name	District	County	Facility Type	Drainage Area (acres)	Paved Area (acres)	Facility Location	Facility Size	Watershed
514	24-122-03	SR-1	Central	Kent	Biofiltration Swale			North Frederica Grade separated Intersection		
515	24-122-03	SR-1	Central	Kent	Biofiltration Swale			North Frederica Grade separated Intersection		
516	I-95 Welcome Center	I-95	North	New Castle	Bioretention			I-95 service plaza		
524	29-090-02	I-95	North	New Castle	Wet Pond			Corner of Southbound I-95 and Otts Chapel Road		
525	29-090-02	I-95	North	New Castle	Wet Pond			Within loop of Southbound I-95 and 896 interchange		
527	30-125-01	Rehoboth Park-n-Ride	South	Sussex	Bioretention			New entrance road.		
555	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	8.68	5.37	STA 2+31 to STA 5+97 LT; offset 32'/45.1'	365' L x 6' w x 4.2' d, 4:1 side slopes	Little Assawoman
556	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	20.24	14.42	STA 7+19.75 to STA 14+97.62 LT; offset 43'/38.7'	874' L x 6' w x 5.5' d, 3:1 side slopes	Little Assawoman
557	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	21.18	15.1	STA 16+46.95 to STA 18+62.86 LT; offset 39.4'/25.4'	220' L x 4' w x 4' d, 3:1 side slopes	Little Assawoman
558	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	29.03	21.16	STA 18+82.12 to STA 21+31.2 LT; offset 27'/28'	250' L x 4' w x 4.5' d, 2:1 side slopes	Little Assawoman
559	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	31.59	23.03	STA 21+30 to STA 23+65.5 LT; offset 28.2'/20'	240' L x 3' w x 4.5' d, 2:1 side slopes	Little Assawoman
560	NPDES Section Project	Pennsylvania Ave	South	Sussex	Biofiltration Swale	35.11	25.59	STA 23+65 to STA 25+74 LT; offset 20'	200' L x 6' w x 5' d, 2:1 side slopes	Little Assawoman
835	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 13+15 to STA 22+65 Lt		
836	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 23+00 to STA 32+00 Lt		
837	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 32+25 to STA 32+90 Lt		
838	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 33+15 to STA 33+75 Lt		
839	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 34+15 to STA 37+27 Lt		
840	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 2+00 to STA 4+00 Rt		
841	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 4+15 to STA 8+90 Rt		
842	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 11+15 to STA 14+00 Rt		
843	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 18+00 to STA 22+60 Rt		
844	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 22+80 to STA 25+75 Rt		
845	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 26+50 to STA 29+50 Rt		
846	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 34+00 to STA 35+50 Rt		
847	developer	Holland Glade Rd	South	Sussex	Filter Strip			STA 35+85 to STA 37+27 Rt		
848	22-106-01	West Park Drive	North	New Castle	Wet Pond	32.97		northeast quadrant of West Park Drive and 141		Brandywine Creek
849	22-106-01	West Park Drive	North	New Castle	Wet Pond	57.66		east of W. Park Drive, south of 141		Brandywine Creek
850	22-106-01	West Park Drive	North	New Castle	Wet Pond	26.96		west of W. Park Drive south of 141		Brandywine Creek
851	23-106-01	East Park Drive	North	New Castle	Wet Pond			South of intersection of E Park Drive and Welden, East side of E Park Drive		Shellpot Creek
852	23-106-01	East Park Drive	North	New Castle	Wet Pond			South of BMP 851, East of E. Park Drive		Shellpot Creek
853	23-106-01	East Park Drive	North	New Castle	Wet Pond			Near intersection of East Park Drive and Carruthers lane		Shellpot Creek
854	developer agreement	202	North	New Castle	Wet Pond			intersection of 202 and Murphy Road, by AstraZenenca		
855	developer agreement	141	North	New Castle	Wet Pond			north of 141 near the intersection of 202		
856	24-106-05	202	North	New Castle	Wet Pond			between 202 and ramp from I-95 to 202 N		Brandywine Creek
857	22-124-06	Business 404	South	Sussex	Biofiltration Swale	4.44	1.02	STA 111+00 to 114+50 Rt	366' L x 8'w, 0.3% slope	Nanticoke River
858	22-124-06	Business 404	South	Sussex	Biofiltration Swale	9.1	1.2	STA 112+00 to 114+50 Lt	225'L x 8'w, 0.3% slope	Nanticoke River
859	22-124-06	US 13 SB	South	Sussex	Biofiltration Swale	27.54	3.27	STA 18+00 to 24+00 Lt	670'L x 9'w, 0.12% slope	Nanticoke River
860	22-124-06	Rt 404	South	Sussex	Biofiltration Swale	2.09	1.52	STA 151+00 to 154+00 Lt	300'L x 9'w, 0.3% slope	Nanticoke River
861	22-124-06	East Service Road	South	Sussex	Biofiltration Swale	1.73	1.07	STA 314+00 to 317+00 Lt	273'L x 10'w, 0.4% slope	Nanticoke River
862	22-124-06	US 13 SB	South	Sussex	Biofiltration Swale	9.47	2.18	STA 12+50 to 18+00 Lt	798'L x 9'w, 0.3% slope	Nanticoke River

Appendix C. KCI Technologies outfall screening annual report for 2012.

DELDOT AGREEMENT 1613
ENVIRONMENTAL AND WATER QUALITY MONITORING

OUTFALL SCREENING

2012 ANNUAL REPORT

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Correspondence, Field Information and Documentation - Tab Dividers 1-4

(See **Table 1** for PID Corresponding Tab Divider No.)

DELDOT AGREEMENT 1613
ENVIRONMENTAL AND WATER QUALITY MONITORING

OUTFALL SCREENING

2012 ANNUAL REPORT

As part of the Delaware Department of Transportation's National Pollutant Discharge Elimination System (NPDES) General Permit Program Regulations Governing Stormwater Discharge, KCI Technologies, Inc. was contracted to conduct dry weather outfall inspection and monitoring of DelDOT-owned storm drain outfalls. Other activities conducted under this task include investigation of Potential Illicit Discharges (PIDs) and NPDES Flyer Awareness Distribution.

A. OUTFALL SCREENING & POTENTIAL ILLICIT DISCHARGES

In 2012, 1,854 outfalls (442 in New Castle County; 1,412 in Sussex County) were screened as part of the inventory, inspection and re-inspection tasks under Agreement 1591.

A total of 71 outfalls were found to have dry weather flow. To-date, none of these have been determined to be illicit discharges, and all are assumed to be groundwater.

In 2012, three PIDs were investigated under Agreement 1613. Two of the PIDs were a continuation of previous PID coordination from the year prior.

Outfall Screening

Table 1 lists the three PIDs and investigation results. Detailed correspondence, field investigation information and documentation regarding PIDs are provided in **Appendix A. Table 1** indicates the corresponding **Appendix A** tab divider number (1-3) for each PID listed.

PID Appleby Road
02/02/12

PID Bi-State Boulevard
12/04/12

TABLE 1
DELAWARE DEPARTMENT OF TRANSPORTATION
2012 POTENTIAL ILLICIT DISCHARGE INVESTIGATIONS
Agreement Nos. 1495 / 1613

Structure No.	Field Visit Date	Neighborhood	Address	Reported By	Issue Reported	Investigation Results	Determination	Action	2012 Annual Report Binder Tab #
NEW CASTLE COUNTY									
86938 & 372	01/16/09	N/A	255 & 229 Appleby Rd	New Castle County	Possible sanitary sewer connection into catch basin	Debris and ice incatch basin preventing inspection.	Unable to pinpoint source	Referred to DelDOT; DelDOT cleaned basin	1
	02/16/09			New Castle County		Flow observed with sewage odor; Discharge tested high for ammonia and detergents: 24-hour re-test: high ammonia and detergents.	Camera-on-stick utilized-No visable connections observed from residence. Small 8" terracotta pipe coming from property north of 255 Appleby Rd that outfalls to swale, which is part of catch basin conveyance. Source of terracotta pipe could not be determined.	Referred to DelDOT	
	01/09/12			DelDOT		Catch basin fully submerged; unable to inspect.	Unable to pinpoint source.	Referred to DelDOT; Contractor specializing in sanitary sewers will flush pipe.	
	02/02/12					DelDOT notified KCI that catch basin cleaned out. Sample collected from downstream structure 372; tested high for phenols, detergents, ammonia and turbidity. 24-hour re-test: high detergents, ammonia and turbidity.	Field crew traced source of flow back to PVC pipe tied into side of conveyance 51706. PVC probably ties into sewer connection on left side 229 Appleby.	Referred to DelDOT.	
	03/02/12					DelDOT contacted DNREC to provide PID information		DNREC to dye test.	
	03/02/12					DNREC contacted to KCI to verify address		DNREC to dye test.	
60570 & 60571	11/09/12	Sharpley	102 Whitby Road	DelDOT	Resident reported neighbor dumping leaves in catch basin	Leaves were observed inside of Structures 60570 and 60571.	Distributed 10 doorhangers.	No Further Action.	4
	11/13/12						Distributed 5 doorhangers.		

TABLE 1
DELAWARE DEPARTMENT OF TRANSPORTATION
2012 POTENTIAL ILLICIT DISCHARGE INVESTIGATIONS
Agreement Nos. 1495 / 1613

Structure No.	Field Visit Date	Neighborhood	Address	Reported By	Issue Reported	Investigation Results	Determination	Action	2012 Annual Report Binder Tab #
KENT COUNTY									
520110114081352	03/24/11	N/A	2777 Andrewsville Road Greenwood, DE	Agr 1354 Field Crew	Possible sewage connection into stormdrain system	Clumps toilet paper in bottom of catch basin with strong sewage odor. Sample tested high for ammonia, detergents and turbidity.	Possible septic tank overflow.	Forwarded to DelDOT. DNREC investigated-recommend having pipe closed by DelDOT. 05/20/11: Attempted to send DelDOT Illicit Discharge notice by US Certified Mail-Returned by Post Office "No Mail Receptacle-Unable to Forward" 06/14/11: Sent regular US Mail.	2
	04/07/11					Strong sewage odor. Sample tested high for ammonia, detergents, turbidity and phenols.			
	04/13/11					DNREC investigated/spoke w/resident; recommended to have pipe closed.	DNREC recommends pipe closure.	Schedule push camera inspection.	
	06/29/11					Tri State Grouting push camera inspection.	Junction box discovered connecting to what appears to be an additional sewage pipe.	Will continue to try to notify homeowner of the requirement to correct within 30 days.	
	11/22/11					DNREC contacted homeowner (Tim Carrington 302-382-9649) and recommended he call DelDOT. DelDOT confirmed with Mr. Carrington that DelDOT intends to plug pipe; and any potential problems that may occur from back-ups would be homeowner's responsibility. Mr. Carrington acknowledged he understood this and is OK with DelDOT plugging pipe.		DelDOT to plug pipe.	
	10/22/12					DelDOT contractor plugged pipes and placed aluminum plate in front of each pipe. In juntion box, there was no activie residue or waste; however odor was present; therefore other pipes plugged as well.		No Further Action.	
SUSSEX COUNTY									
420121101135958	12/04/12	N/A	32772 Bi-State Blvd.	CEI	Illegal connection to storm drain; stagnant water with sewage smell	No flow from 4" illegal connection; discharge ponded in bottom catch basin smelled like sewage, had disintegrated paper, and tested high for turbidity, detergents and ammonia; 4 hour re-test: high turbidty, ammonia and detergents.	Notified DelDOT; requested KCI sent Illicit Discharge Notice	Mailed Illicit Discharge Notice via 2-day FedEX 12/12/12; will revisit site in 30 days	3

B. NPDES FLYER AWARENESS DISTRIBUTION

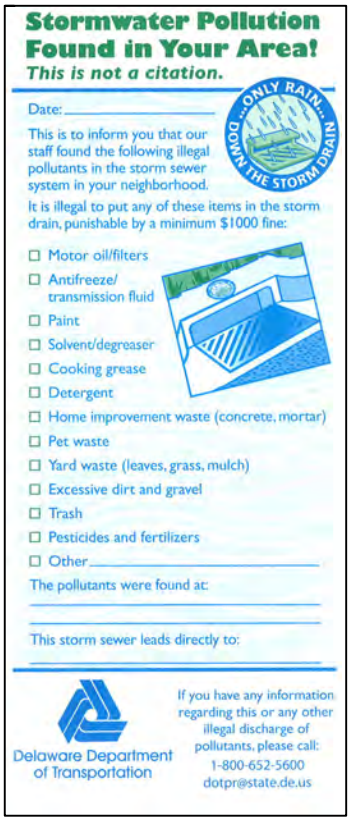
The purpose of the NPDES flyer awareness distribution (doorhangers) is to inform the public and increase awareness of illegal dumping of pollutants into the surrounding storm sewer systems.

Doorhangers were distributed to those areas where suspected illegal discharge/dumping had occurred, as observed by the general public and/or field crews performing storm drain inventories.

In 2012, 15 doorhangers were distributed in the Sharpley neighborhood in New Castle County due to a resident complaint about a neighbor dumping leaves in a catch basin.

Table 1 lists the leaf dumping investigation results. Correspondence, field investigation information and documentation regarding the dumping is provided in **Appendix A. Table 1** indicates the corresponding **Appendix A** tab divider number (4) for the dumping listed.

Doorhanger Distribution
Sharpley Neighborhood



Stormwater Pollution Found in Your Area!
This is not a citation.

ONLY RAIN DOWN THE STORM DRAIN

Date: _____

This is to inform you that our staff found the following illegal pollutants in the storm sewer system in your neighborhood.

It is illegal to put any of these items in the storm drain, punishable by a minimum $1000 fine:

- ☐ Motor oil/filters
- ☐ Antifreeze/ transmission fluid
- ☐ Paint
- ☐ Solvent/degreaser
- ☐ Cooking grease
- ☐ Detergent
- ☐ Home improvement waste (concrete, mortar)
- ☐ Pet waste
- ☐ Yard waste (leaves, grass, mulch)
- ☐ Excessive dirt and gravel
- ☐ Trash
- ☐ Pesticides and fertilizers
- ☐ Other _____

The pollutants were found at:

_____

This storm sewer leads directly to:

_____

Delaware Department of Transportation

If you have any information regarding this or any other illegal discharge of pollutants, please call:
1-800-652-5600
dotpr@state.de.us

C. NEXT STEPS

KCI will continue to provide as-needed outfall screening activities in 2013. This includes investigating dry weather flow and potential illicit discharges at outfalls and storm drain structures discovered by KCI field crews, DelDOT maintenance staff or the public.

OUTFALL SCREENING

2011 ANNUAL REPORT

APPENDIX A

POTENTIAL ILLICIT DISCHARGE INVESTIGATIONS

CORRESPONDENCE, FIELD INFORMATION AND DOCUMENTATION

Structures 86938 & 372

255 & 229 Appleby Road

DELDOT AGR. 1613 / KCI 17121613A

POTENTIAL ILLICIT DISCHARGE INVESTIGATION DOCUMENTATION CHECKLIST

PID Structure No(s). 86938 & 372

Subdivision: N/A

PID Address: 255 & 229 Appleby Road

City: Bear

Zip Code: 19701

PHOTOGRAPHS:

☑	Landscape	Required
☑	Structure	Required

DOCUMENTATION ATTACHED:

☑	IDDE Tracking Form	Required
☑	Location Map from NPDES Map Viewer	Required
☑	Dry Weather Flow Field Test Sheet	Required for Flow
☑	Summary Memorandum with Photographs	Required
☐	Door Hanger	As Applicable
☐	Certified Letter	As Applicable
☑	OTHER: DelDOT Appleby Road Plans, Property Tax Parcel Information, and Email Correspondence	

Illicit Discharge Incident Tracking Sheet

Date: 01/16/09, 02/16/09, 01/09/12, 02/02/12 03/02/12 Logged by: Matt Ortynsky 302-731-9176 Incident ID:

Caller contact information:

01/16/09 Referred by NCCo via Randy Cole

01/09/12 Referred by Richard Fain (DelDOT Canal District)

Subdivision: N/A

County: New Castle County

ADC Map No./Grid: 12 D-13

Incident Location

Primary Location Description

- ☑ Storm drain
- ☐ Outfall
- ☐ Other _____
- ☐ In stream
- ☐ Along bank
- ☐ Stormwater pond
- ☐ Upland

Outfall / inlet ID# : Catch basins 86938 & 372

Closest street address: 255 & 229 Appleby R Bear, DE 19701

Watershed name: Army Creek Impacted Stream name: Army Creek

Nearby landmark: Route 40

Narrative description of location

Catch basin 86938 located directly in front yard of 255 Appleby Rd. Additional investigation traced flow source to catch basin 372 at 229/231 Appleby Rd.

Description of problem

Visual

- ☐ Oil / Oil sheen
- ☐ Soap
- ☐ Paint
- ☐ Flotables (toilet paper, etc.)
- ☐ Algae
- ☐ Dead fish
- ☑ Cloudy
- ☑ Flow ----------> Precipitation in last 48-hours? No
- ☐ Anti-freeze
- ☐ Yard waste
- ☐ Other _____

Odor

- ☑ Sewage
- ☐ Sulfide ("rotten egg")
- ☐ Gas/oil
- ☐ None
- ☐ Other (describe) _____

Narrative description/comments of problem

Jan 2009: Address forwarded to KCI by Randy Cole (DelDOT NPDES), who was contacted by NCCo. Debris/ice filled catch basin.KCI observed flow in the catchbasin; flow tested high for ammonia and detergents. KCI was unable to directly pinpiont the source. **Feb 2009:** Flow observed with sewage odor. sample collected from catch basin 86938 tested high from ammonia/detergents. 24-hr re-visit also tested high for ammonia/detergents. Camera-on-stick used to inspect-inconclusive. 8' terracotta pipe coming from another property north of 255 Appleby that outalls to swale; source terra cotta could not be determined.

Plan of Action (check all that apply)

- ☐ Sample
- ☐ Contact DNREC
- ☑ Contact NPDES Manager
- ☐ Photos
- ☐ Door hangers
- ☐ GPS Coordinates
- ☐ Other (describe)

Follow-up Action

01/02/12:: Richard Fain (Canal District) informed Randy Cole of possible sanitary sewer connection into catch basin 86938 at 255 Appleby Rd. Randy forwarded information to KCI for further investigation.

01/09/12: KCI crew visited 255 Appleby Road. Catch basin 86938 fully submerged; therefore source could not be determined. Randy Cole will have contractor flush pipe. KCI field personnel will re-visit after pipe cleaned out.

02/02/12: KCI crew traced flow source to PVC pipe tied into side of conveyance 51706. PVC pipe probably ties into sewer connection on left side of 229 Appleby Road (when facing house front). Sample collected from downstream structure 372 tested high for phenols, detergents, ammonia, and turbidity. The 24-hour re-visit tested high for detergents, ammonia, and turbidity. KCI notified Randy Cole on February 6, 2012.

03/02/12: Randy Cole contacted Casey Fountain, DNREC EPO, to provide PID information for potential dye testing by DNREC. KCI was contacted by DNREC regarding PID to verify address.

KCI TECHNOLOGIES

MEMORANDUM

TO: Randy Cole, DelDOT

FROM: Matt Ortynsky, KCI

DATE: January 16, 2009
February 16, 2009 Re-visit
January 9, 2012 Re-visit
February 2 Re-visit

SUBJECT: **Potential Illicit Discharge**
255 & 229 Appleby Rd.
Structures 86938 & 372
Agreement 1495/KCI Project 0203019I

The purpose of this Memo is to summarize the field investigations regarding a Potential Illicit Discharge (PID) at 255 Appleby Road in New Castle County.

January 15, 2009 Status Meeting: Randy Cole informed KCI of a PID at 255 Appleby Road. New Castle County alerted Randy that the residence at 255 Appleby Road had a connection from the house directly tied into the catch basin.

January 16, 2009: KCI crew visited catch basin 86938 at 255 Appleby Road. Debris and ice filled the catch basin, which could not be inspected. KCI contacted Randy Cole regarding the investigation results. DelDOT scheduled basin cleaning the following week.

February 16, 2009: KCI crew re-visited 255 Appleby Road. Flow was observed in the catch basin, along with a sewage odor. The sample collected from the catch basin flow tested high for ammonia and detergents. The 24 hour re-visit tested high for ammonia and detergents.

No visible connections were observed from the residence. KCI used the camera on a stick to inspect the upstream side of the conveyance leading into the catch basin. This did not result in any conclusive observations. There is a small 8" terracotta pipe coming from another property north of 255 Appleby Road that outfalls into a swale, which is part of the same conveyance system as the catch basin. The source of the terracotta pipe could not be determined.

January 5, 2012: Richard Fain, DelDOT Canal District, informed Randy Cole of a possible sanitary sewer connection into catch basin 86938 located at 255 Appleby Road. Randy forwarded this information to KCI for further investigation.

January 9, 2012: KCI crew visited 255 Appleby Road. The PID source was not determined because catch basin 86938 was fully submerged (**Photos 1** and **2**). The crew observed a patch of recently disturbed ground on the back left corner of 255 Appleby Road; it is uncertain if it is related to the PID source (**Photo 3**). KCI notified DelDOT about the clogged catch basin; a sanitary sewer contractor will flush the pipe.

January 27, 2012: Randy Cole notified KCI that catch basin 86938 was cleaned out.

February 2, 2012: KCI crew traced the source of flow to a PVC pipe tied into the side of conveyance 51706 (**Photo 4**). Upon further investigation, it was discovered that the PVC pipe probably ties into a sewer connection on the left side of 229 Appleby Road (when facing the house front) (**Photo 5**). The sample collected from the downstream structure 372 (**Photo 6**) tested high for phenols, detergents, ammonia, and turbidity. The 24-hour re-visit tested high for detergents, ammonia, and turbidity. KCI notified Randy Cole on February 6, 2012.

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Photo 1

Photo 2

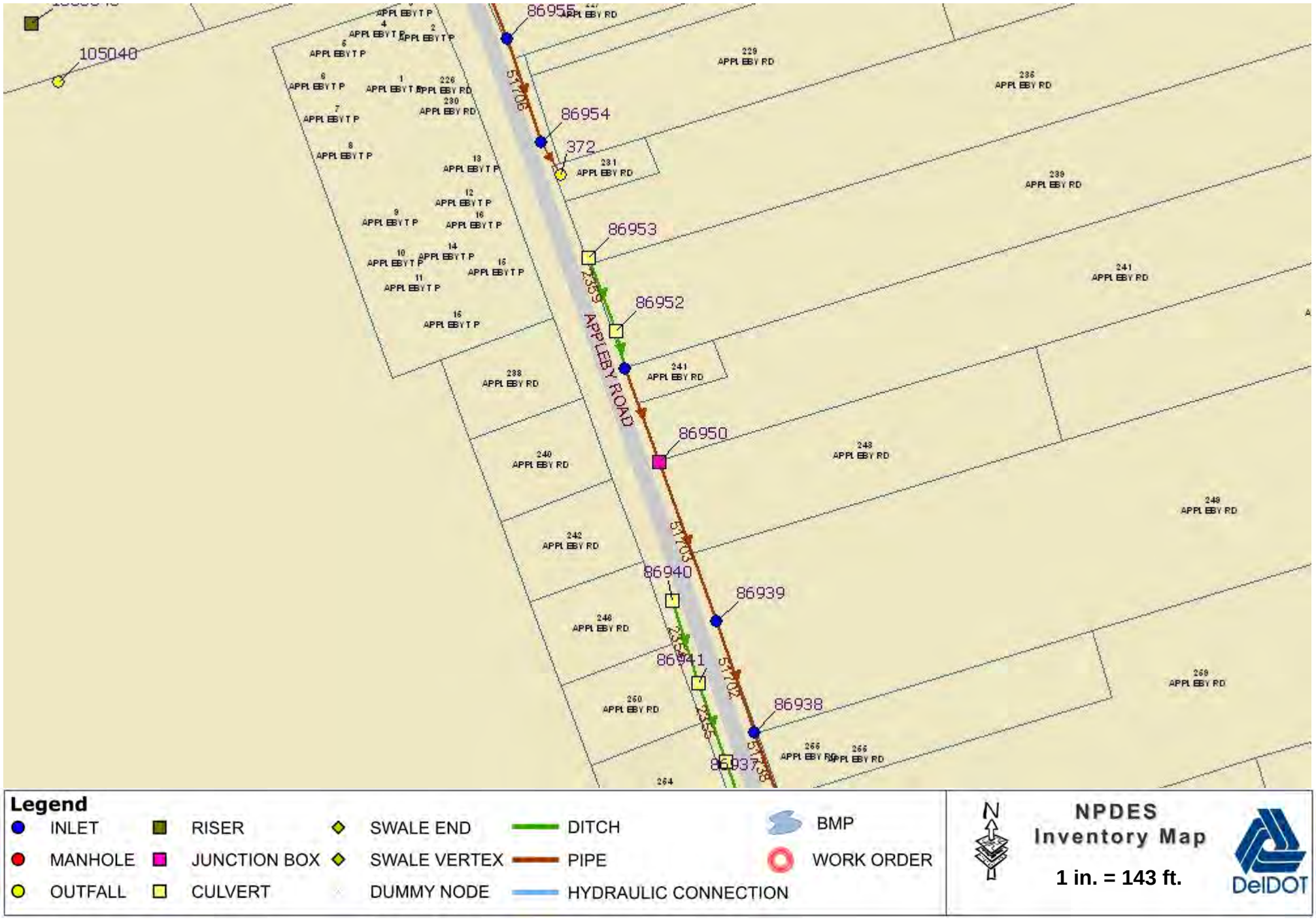
Photo 3

Photo 4

Photo 5

Photo 6

Appleby Road PID



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DelDOT

DELDOT AGREEMENT 1495
POTENTIAL ILLICIT DISCHARGE FIELD DATA SHEET

Structure/Outfall ID Number: 372

Address/Location Description: 229 / 231 Appleby Rd

Outfall Data	
Digital picture? (Y/N):	Y
Camera Number:	
Picture Number:	
Personnel:	Gordon R. + Brie B.
Date (MM/DD/YY):	2/2/12
Time:	12:30pm
Date of Last Rain >0.10" (MM/DD/YY):	01/27/12
Follow Up Screen Date (MM/DD/YY):	2/3/12
Follow Up Field Screen Time:	8:30 AM
Follow Up Personnel:	Brad B. + Brie B.
Outfall Dimensions (in):	
Outfall Shape: Round (R), Oval (O), Box (B), V-Ditch (VD), Trap Ditch (TD), Other Ditch (OD)	R
Outfall Type (CMP, RCP, PVC, Other):	PVC
Flow Observed? (Y/N):	Y
Follow Up Flow Observed? (Y/N):	N
Flow Source	Possible Septic Overflow
Structural Condition: Normal (N), Concrete Spauling (SP), Peeling Paint (PP), Concrete Cracking (CC), Outfall Damaged (OD), Submerged (S), Metal Corrosion (MC), Other (O-explain)	N
Erosion (Outfall Area): None (N), Moderate (M), Severe (S)	N
Odor: None (N)=0, Rancid-Sour (RS)=4, Gas (G)=4, Sewage (S)=4, Oil (O)=4, Sulfur (S)=4, Other (Other-explain)	S = 4
Deposits / Stains: None (N)=0, Sediment (S)=2, Oil (OY)=3, Other (O-explain)	N = 0
Algae Growth? (Y/N):	N
Vegetative Condition (Outfall Area): Normal (N), Inhibited Growth (IG), Excessive Growth (EG), Other (O-explain)	N
Land Use: Industrial (I), Commercial (C), Residential (R), Other (O-explain)	R
Specific Land Use:	

DelDOT

Outfall ID No. 372

	Result 1	Val.	Result 2	Val. 2
Flow Rate (cfs): <0.022 cfs=0; ≥0.022 cfs=4	<0.022	0	<0.022	0
Water Temperature (Farenheit):	55.7	–	44.2	–
pH: <4.5=4; >8.5=4; change ≥ 2 units=1	6.98	–	7.01	0
Phenol (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4	0.7	4	0	0
Chlorine (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4	0	0	0	0
Detergents (mg/L): <0.2=0; 0.2 - 0.4=1; ≥0.5 mg/L=4	0.55	4	0.55	4
Copper (mg/L): <0.01 mg/L=0; ≥0.01 mg/L=4	0	0	0	0
Ammonia (mg/L): <0.05-0.1 mg/L=0; 0.1-1.0 mg/L=1; 1.0-2.99 mg/L=2; ≥3.0 mg/L=4	>3.0	4	73.0	4
Turbidity: 0-10 ntu=0; 11-40=1; 41-150=3; >150=4	156.2	4	349.3	4
Color: Clear (C)=0, Gray (G)=1, Red (R)=1, Yellow (Y)=1, Brown (B)=1, Green (GR=1), Other (O-explain)	Y	1	G	1
Floatables: None (N)=0, Oil Sheen (OS)=4, Sewage (S)=4, Trash (T)=2, Other (O-explain)	S	4	S	4

FIELD SKETCH

DELDOT NPDES FY 07 AGREEMENT 1351 – TASK 08
RE-VISIT DUFFIELD OUTFALLS FIELD DATA SHEET

Duffield Outfall ID Number: 255 Appleby Rd.
Structure # 86938

Outfall Data	
Digital picture? (Y/N):	Y
Camera Number:	ES-1
Picture Number:	
Personnel:	RG, CB
Date (MM/DD/YY):	2-16-07
Time:	
Date of Last Rain >0.10" (MM/DD/YY):	
Follow Up Screen Date (MM/DD/YY):	
Follow Up Field Screen Time:	
Outfall Dimensions (in):	Catchbasin-86938
Outfall Shape: Round (R), Oval (O), Box (B), V-Ditch (VD), Trap Ditch (TD), Other Ditch (OD)	
Outfall Type (CMP, RCP, PVC, Other):	
Flow Observed? (Y/N):	N
Follow Up Flow Observed? (Y/N):	N
Flow Source	Could not locate
Structural Condition: Normal (N), Concrete Spauling (SP), Peeling Paint (PP), Concrete Cracking (CC), Outfall Damaged (OD), Submerged (S), Metal Corrosion (MC), Other (O-explain)	N
Erosion (Outfall Area): None (N), Moderate (M), Severe (S)	N
Odor: None (N)=0, Rancid-Sour (RS)=4, Gas (G)=4, Sewage (S)=4, Oil (O)=4, Sulfur (S)=4, Other (Other-explain)	S
Deposits / Stains: None (N)=0, Sediment (S)=2, Oil (OY)=3, Other (O-explain)	N
Algae Growth? (Y/N):	N
Vegetative Condition (Outfall Area): Normal (N), Inhibited Growth (IG), Excessive Growth (EG), Other (O-explain)	N
Land Use: Industrial (I), Commercial (C), Residential (R), Other (O-explain)	R
Specific Land Use:	

DelDOT

Outfall ID No. _____

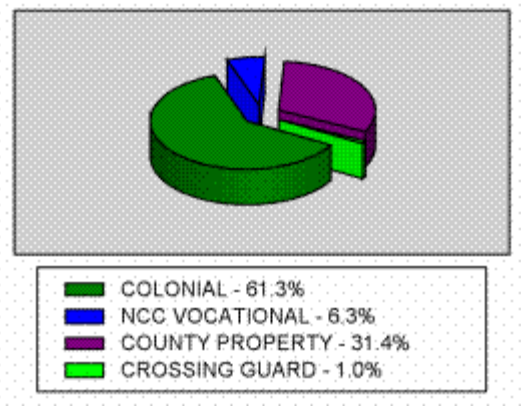
	Result 1	255-1 Val.	255-2 Result 2	241 Val. 2
Flow Rate (cfs): <0.022 cfs=0; ≥0.022 cfs=4				
Water Temperature (Farenheit):		42.5	45.4	46.2
pH: <4.5=4; >8.5=4; change ≥ 2 units=1		7.71	7.65	7.78
Phenol (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4		0	0	0
Chlorine (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4		0	0	0
Detergents (mg/L): <0.2=0; 0.2 - 0.4=1; ≥0.5 mg/L=4		>1.3	>1.3	1.3
Copper (mg/L): <0.01 mg/L=0; ≥0.01 mg/L=4		0	0	0
Ammonia (mg/L): <0.05-0.1 mg/L=0; 0.1-1.0 mg/L=1; 1.0-2.99 mg/L=2; ≥3.0 mg/L=4		>3.0	>3.0	>3.0
Turbidity: 0-10 ntu=0; 11-40=1; 41-150=3; >150=4		158.4	139.5	151.1
Color: Clear (C)=0, Gray (G)=1, Red (R)=1, Yellow (Y)=1, Brown (B)=1, Green (GR=1), Other (O-explain)	G	1	G	1 G
Floatables: None (N)=0, Oil Sheen (OS)=4, Sewage (S)=4, Trash (T)=2, Other (O-explain)	Other (debris)	1	other (debris)	other (debris)

FIELD SKETCH

Parcel # 1003400107

Property Address: 229 A APPLEBY RD
NEW CASTLE, DE 19720-
Subdivision: MELANCON SUBD
Owner: TE ANH
Owner Address: 70 WORTHINGTON PARK RD
NEWARK, DE 19711
Municipal Info: Unincorporated

2011 - 2012 Tax Summary



Lot #: 2
Location:
Map Grid: 09003380
Block:
Census Tract: 149.08
Street Type:
Water:
Microfilm #: 012162

Property Class: RESIDENTIAL
Lot Size: 1.84
Lot Depth: 993.20
Lot Frontage: 25
Street Finish:

District & Zoning Info

Districts

- **COLONIAL SCHOOL DIST-TRES**
- **COUNCIL 7 - GEORGE SMILEY**
- **FIRE/RESCUE - CHRISTIANA**
- NORTH OF C&D CANAL
- SEWER DISTRICT NORTHERN-ASMT
- BLUELINE STREAM 100FT BUFFER
- DE SEN 13-DAVID B MCBRIDE
- DE REP 05-MELANIE L GEORGE
- PLANNING 2 - NEW CASTLE
- TRAFFIC ZONE T163 (YR2000)

Zoning

- NC21 - UDC - SINGLE FAMILY - 1/2 ACRE

Sales History

Owner	Deed	Current Owner?	Multi?	Sale Date	Sale Amount
MELANCON MICHAEL J & BARBARA	585 26	N	Y	8/1/1987	$10.00
WILLIAMS MARTIN S & GEORGIA L	20041020 0114304	N	N	10/1/2004	$45,000.00
TE ANITA	20060614 0056954	N	N	5/9/2006	$47,500.00

TE ANH	20070111 0003237	Y	N	1/9/2007	$10.00

Tax/Assessment Info

Assessment

Land:	9600
Structure:	0
Homesite:	0
Total:	9600
County Taxable:	9600
School Taxable:	9600

Tax History as of 2/9/2012 6:21:02 AM

	County				School			
Tax Year	**Principal Due**	**Penalty Due**	**Date Paid**	**Amt Paid**	**Principal Due**	**Penalty Due**	**Date Paid**	**Amt Paid**
2007A	$0.00	$0.00	9/26/2007	$56.28	$0.00	$0.00	9/26/2007	$146.88
2008A	$0.00	$0.00	9/23/2008	$55.85	$0.00	$0.00	9/23/2008	$150.24
2009A	$0.00	$0.00	9/30/2009	$68.32	$0.00	$0.00	9/30/2009	$148.70
2010A	$0.00	$0.00	8/19/2010	$68.77	$0.00	$0.00	8/19/2010	$147.17
2011A	$0.00	$0.00	9/27/2011	$69.35	$0.00	$0.00	9/27/2011	$144.68

County Balance Due: $0.00

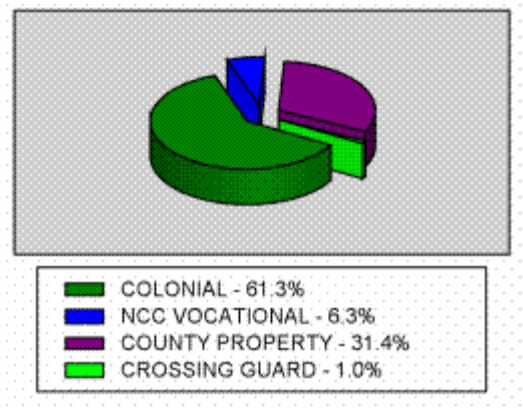
School Balance Due: $0.00

Accounts with delinquent balances do not reflect the most recent statutory penalty, which was imposed on the first of the month. To obtain the exact amount necessary to pay the account in full, please call New Castle County's Treasury Division at (302) 323-2600.

Parcel # 1003400038

Property Address: 229 APPLEBY RD
NEW CASTLE, DE 19720-
Subdivision: MELANCON SUBD
Owner: JOHNSON BRENDA L
Owner Address: 229 APPLEBY RD
NEW CASTLE, DE 19720
Municipal Info: Unincorporated

2011 - 2012 Tax Summary



Lot #: 1
Location:
Map Grid: 09003380
Block:
Census Tract: 149.08
Street Type: ARTERIAL
Water: PUBLIC
Microfilm #: 012162

Property Class: RESIDENTIAL
Lot Size: 1.11
Lot Depth: 471.80
Lot Frontage: 102.80
Street Finish:

District & Zoning Info

Districts

- **COLONIAL SCHOOL DIST-TRES**
- **COUNCIL 7 - GEORGE SMILEY**
- **FIRE/RESCUE - CHRISTIANA**
- NORTH OF C&D CANAL
- SEWER DISTRICT NORTHERN-ASMT
- DE SEN 13-DAVID B MCBRIDE
- DE REP 05-MELANIE L GEORGE
- PLANNING 2 - NEW CASTLE
- TRAFFIC ZONE T163 (YR2000)

Zoning

- NC21 - UDC - SINGLE FAMILY - 1/2 ACRE

Sales History

Owner	Deed	Current Owner?	Multi?	Sale Date	Sale Amount
		N	N	3/1/1987	$60,000.00
MELANCON MICHAEL J & BARBARA	585 26	N	N	8/1/1987	$10.00
JOHNSON BRENDA L	2089 320	Y	N	4/24/1996	$90,000.00

Tax/Assessment Info

Assessment

Land:	5800
Structure:	28200
Homesite:	0
Total:	34000
County Taxable:	34000
School Taxable:	34000

Tax History as of 2/9/2012 6:21:02 AM

Tax Year	County				School			
	Principal Due	Penalty Due	Date Paid	Amt Paid	Principal Due	Penalty Due	Date Paid	Amt Paid
2007A	$0.00	$0.00	9/26/2007	$199.35	$0.00	$0.00	9/26/2007	$520.20
2008A	$0.00	$0.00	9/29/2008	$197.81	$0.00	$0.00	9/29/2008	$532.10
2009A	$0.00	$0.00	9/25/2009	$241.96	$0.00	$0.00	9/25/2009	$526.66
2010A	$0.00	$0.00	9/24/2010	$243.56	$0.00	$0.00	9/24/2010	$521.22
2011A	$0.00	$0.00	9/26/2011	$245.62	$0.00	$0.00	9/26/2011	$512.38

County Balance Due: $0.00

School Balance Due: $0.00

Accounts with delinquent balances do not reflect the most recent statutory penalty, which was imposed on the first of the month. To obtain the exact amount necessary to pay the account in full, please call New Castle County's Treasury Division at (302) 323-2600.

Residence Characteristics

Residence 1

Building Design:	BUNGALOW	**Residence Class:**	SFD ON 1.01-5.00 AC.
Grade:	FAIR	**Condition:**	AVERAGE
Year Built:	1943	**# Stories:**	1
Total Area (sq. ft.):	1075	**Main Floor Area:**	804
# Rooms:	6	**# Bedrooms:**	3
# 1/2 Baths:	0	**# Full Baths:**	2
# Fam. Rooms:	0	**# Fixtures:**	8
Roof Type:	GABLE	**Roof Material**	ASPHALT
Exterior Wall:	ASBESTOS	**Interior Wall Finish:**	PLASTER
Floor Finish:	WOOD	**Foundation:**	SLAB
Garage Capacity:	0	**Basement %:**	
Basement % Finished:		**Basement Finish Type:**	NO BASEMENT FINISH
Attic % Finished:	100%		
Unfinished %:		**Unfinished Area:**	0
Heat Type:	HOTWATER	**Air Conditioning:**	
Remodel Year:	0		

From: Cole Randy (DelDOT) [mailto:Randy.Cole@state.de.us]
Sent: Tuesday, January 10, 2012 8:53 AM
To: Matthew Ortynsky
Cc: Bruce R. Thompson
Subject: FW: Appleby Rd (N343)

Matt – Here are the plan sheets for Appleby Road we discussed and Rich Fain's email to me.

From: Gilliam LaTonya (DelDOT)
Sent: Friday, January 06, 2012 8:49 AM
To: Cole Randy (DelDOT)
Subject: RE: Appleby Rd (N343)

Randy,

I am attaching 3 plan sheets.

The first is the plan sheet from Contract # 1074 – where it shows the existing septic pipes out letting to the drainage ditch.
The second plan sheet is from Contract 8800101 where you can see a sanitary sewer line, but no septic connections. The only pay items on this contract for anything other than the new storm sewer were for 20 roof drainsa that were installaed along Appleby Road.

The third plan sheet is the most recent Appleby Rd construction project Contract # 22-119-05. This was one of Brian Urbanek's Contracts. There is a note on the pplan sheet about connecting the existing 6" terracotta pipe to the drainage inlet, however I don't know if that is a sere pipe or a roof drain pipe. House 255 Appleby Road is Parcel 10-029.110-027 owned by George M. and Janice P. Dick. You could have Real Estate pull up the ROW agreement, but it doesn't look like there was a ROW take fro this property so there may not be one. There is a sewer & Drainage Easement along the east side of their property shown so they must be tied into the sewer system.

LaTonya

From: Cole Randy (DelDOT)
Sent: Friday, January 06, 2012 8:02 AM
To: Gilliam LaTonya (DelDOT)
Subject: FW: Appleby Rd (N343)

Are you able to open these attachments?

From: Fain Richard (DelDOT)
Sent: Thursday, January 05, 2012 4:32 PM
To: Cole Randy (DelDOT)
Cc: Anthony Wayne (DelDOT)
Subject: Appleby Rd (N343)

Randy –

Wayne Anthony, Area 10 supervisor, recently brought me a problem I think you can help with, or at least I should bring to your attention.

We received a call about a clogged pipe along the east side of Appleby Rd just north of US 40. Upon investigation, the flusher crew found what appeared to be grease in the pipe. They spoke to the resident at #255 who claimed that this is caused by the homes whose septic system overflows are tied into the storm sewer. She stated that DNREC is aware of it. Though she herself is not tied into the storm sewer, several of her neighbors appear to be.

Since I have never heard of this, I attempted to find some plans to verify if this was true or not, and thinking that if we did the work, it would indicate that we allowed the connection. I've attached what I found. One sheet is from Contract #1074 in 1950. It looks like it was open drainage at the time, but you can see the septic system overflows outletting into the ditch. The second is from Contract #88-001-01. You'll notice the installation of a cleanout and 6" PVC pipe into CB 1. I'm thinking this is a septic system. Also, in looking at structure #86934 on the NPDES inventory, you can see a PVC pipe tied into the basin.

This raises a few questions:

1) Are you aware of this situation and is it allowed? If it's not allowed, I'm not sure what we would do about it.
2) Should DelDOT be maintaining this given what may be in the pipe, or is this something DNREC should be involved in?
3) If it is ours, do we need to take special precautions when flushing the pipe? We're thinking that we should use a contractor that specializes in sanitary sewer to flush the pipe.

Your thoughts on this matter are appreciated. If you have any questions, let me know.

Rich

Structure 520110114081352

2777 Andrewsville Road

Structure 520110114081352

DELDOT AGR. 1495 / KCI 0203019H-I

POTENTIAL ILLICIT DISCHARGE INVESTIGATION DOCUMENTATION CHECKLIST

PID Structure No(s). 520110114081352

Subdivision: N/A

PID Address: 2777 Andrewsville Drive

City: Greenwood

Zip Code: 19950

PHOTOGRAPHS:

☑	Landscape	Required
☑	Structure	Required

DOCUMENTATION ATTACHED:

☑	IDDE Tracking Form	Required
☑	Summary Memorandum with Photographs	Required
☑	Location Map from NPDES Map Viewer	Required
☑	Dry Weather Flow Test Field Sheet	Required for Flow
☐	Door Hanger	As Applicable
☑	Certified Letter	As Applicable
☑	OTHER: ○ 10-22-12 Pipe Plug Email ○ 10-22-12 Pipe Plug Photos	

Lydia Hill

From: Bruce R. Thompson
Sent: Monday, October 22, 2012 1:14 PM
To: Matthew Ortynsky; Lydia Hill
Subject: FW: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE
Attachments: downsized951022120916.jpg; 1022120917.jpg; 1022120917a.jpg

Case Closed

From: Cole Randy (DelDOT) [mailto:Randy.Cole@state.de.us]
Sent: Monday, October 22, 2012 12:46 PM
To: Bruce R. Thompson
Subject: FW: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE

Bruce – FYI.

From: Cohee Carolyn (DelDOT)
Sent: Monday, October 22, 2012 12:04 PM
To: Gilliam LaTonya (DelDOT)
Cc: Stynchula Timothy (DelDOT); Cole Randy (DelDOT); Taavoni Shahin (DelDOT)
Subject: RE: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE

LaTonya, this location's fix is complete. Today, the contractor filled the pipes with a mixture of hydraulic cement and Sacrete and, then, placed an aluminum plate with masonry screws in front of each pipe. In the junction box, there is no active residue or waste; however, the odor was present, which is why the other pipes were done, as well. Mr. Carrington is appreciative of the fix. Attached is a couple photos from today's work.
Feel free to pass along to DNREC or whomever.
Thanks.
Carolyn

From: Gilliam LaTonya (DelDOT)
Sent: Thursday, September 06, 2012 11:32 AM
To: Taavoni Shahin (DelDOT)
Cc: Cohee Carolyn (DelDOT); Stynchula Timothy (DelDOT); Cole Randy (DelDOT)
Subject: RE: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE

Good Morning Shahin,

Thank you again for taking care of this drainage issue under your contracts for us. I have attached a letter that I plan to send to the homeowner today. If the homeowner is agreeable to signing the temporary trespass agreement letter (H-22 form attached), plugging the pipe at the junction box will yield better results.

Timothy Carrington's phone number is 302-398-6120 if you need to contact him in advance of heading out to the site.

Please feel free to contact me if you need more information.

LaTonya

From: Taavoni Shahin (DelDOT)
Sent: Thursday, September 06, 2012 8:54 AM
To: Stynchula Timothy (DelDOT)
Cc: Cohee Carolyn (DelDOT); Gilliam LaTonya (DelDOT)
Subject: FW: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE

Tim,

We need to take care of this issue either with CTF or our Drainage Contract.

Thanks

Shahin

From: Gilliam LaTonya (DelDOT)
Sent: Wednesday, September 05, 2012 2:18 PM
To: Taavoni Shahin (DelDOT)
Cc: Cole Randy (DelDOT)
Subject: FW: Potential Illicit Discharge - Suspected Sewage - 2777 Andrewsville Rd, Harrington DE

Good Afternoon Shahin,

Attached to this e-mail is the illicit discharge memo that gives the location information and photographs for the catch basin that has the illegal septic tap in. David Moyer, DNREC enforcement office, has contacted the homeowner, Tim Carrington, and informed him that DelDOT would be plugging the pipe. The homeowner does not have a problem with us doing this, since he was unaware that the pipe existed. (He bought the property 6 years ago.

The work would be limited to having the contractor plug the 4" clay pipe and then the Contractor or District can remove the sewage and debris from the catch basin. Once completed, we would like a picture of the drainage inlet after the pipe has been plugged and the basin cleaned.

If you need any additional information please feel free to call or send me an e-mail. Thank you in advance for your assistance with this.

LaTonya

LaTonya Gilliam, P.E.
NPDES Engineer
Phone: 302.760.2191

2777 ADREWSVILLE ROAD

OCTOBER 2012

DELDOT PLUG PIPE AND INSTALL STEEL PLATE

2777 ADREWSVILLE ROAD

OCTOBER 2012

DELDOT PLUG PIPE AND INSTALL STEEL PLATE

Illicit Discharge Incident Tracking Sheet

Date: 04/08/11 & 03/24/2011 Logged by: Matt Ortynsky Contact #: 302-731-9176 Incident ID:

Caller contact information:

Subdivision: N/A
County: Kent
ADC Map No./Grid: 41-K7

Incident Location

Primary Location Description

- ☑ Storm drain
- ☐ In stream
- ☐ Stormwater pond
- ☐ Outfall
- ☐ Along bank
- ☐ Upland
- ☐ Other _____

Outfall / inlet ID# : 520110114081352

Closest street address: 2777 Andrewsville Road

City: Greenwood, DE 19950

Watershed name: Marshyhope Creek Impacted Stream name: Tomahawk Branch

Nearby landmark: In front of residence (2777 Andrewsville Road)

Narrative description of location

In catch basin in front yard of residence at 2777 Andrewsville Road

Description of problem

Visual

- ☐ Oil / Oil sheen
- ☐ Paint
- ☐ Algae
- ☑ Cloudy
- ☐ Anti-freeze
- ☐ Yard waste
- ☐ Soap
- ☑ Floatables (toilet paper, etc.)
- ☐ Dead fish
- ☑ Flow ----------> Precipitation in last 48-hours? Yes / No
- ☐ Other _____

Odor

- ☑ Sewage
- ☐ None
- ☐ Sulfide ("rotten egg")
- ☐ Other (describe) _____
- ☐ Gas/oil

Narrative description/comments of problem

02/11/11: CEI observed 4" clay pipe coming from residence at 2777 Andrewsville Rd tying into catch basin 520110114081352. Strong sewage smell observed along with cloudy water/toilet paper in bottom of basin.
03/24/11: KCI visited location and confirmed apparent sewage discharge into catch basin 520110114081352. Discharge tested high for ammonia, detergents, and turbidity.
04/07/11: KCI observed strong sewage odor/toilet paper. Discharge tested high for ammonia, detergents, turbidity, and phenols.

Plan of Action (check all that apply)

- ☑ Sample
- ☑ Photos
- ☐ Other (describe)
- ☐ Contact DNREC
- ☐ Door hangers
- ☑ Contact NPDES Manager
- ☐ GPS Coordinates

Follow-up Action

04/08/11: KCI contacted DelDOT via telephone to relay field investigation results. Submitted information to DelDOT in 04/08/11 email. DelDOT will evaluate issue and determine future action.
04/13/11: DNREC investigated area and spoke with owner of 2777 Andrewville Rd, who did not know about pipe in catch basin. DRNEC informed resident of their recommendation to have pipe closed by DelDOT. If resident has problems with septic-will confirm origination from his system. If anyone else contacts either DNREC or DelDOT once it's closed off, then DNREC will consider enforcement action at that time, because this would show someone knew pipe was there.
05/20/11: KCI attempted to send DelDOT Illicit Discharge notice by Certified Mail. Letter returned by Post Office "No Mail Receptacle-Unable to Forward". **06/14/11:** Sent regular mail.
11/22/11: DNREC contacted homeowner (Tim Carrington 302-382-9649) and recommended he call DelDOT. DelDOT confirmed with Mr. Carrington that DelDOT intends to plug the pipe and any potential problems that may occur from back-ups would be homeowner's responsibility. Mr. Carrington acknowledged that he understood this and is OK with DelDOT plugging pipe. DelDOT to plug pipe.

DelDOT

DELDOT AGREEMENT 1495
POTENTIAL ILLICIT DISCHARGE FIELD DATA SHEET

Structure/Outfall ID Number: 52011011408135 2

Address/Location Description: 2777 Andrewsville Rd.

Outfall Data	
Digital picture? (Y/N):	Y
Camera Number:	
Picture Number:	
Personnel:	CB/MO
Date (MM/DD/YY):	3/24/11
Time:	10:35am
Date of Last Rain >0.10" (MM/DD/YY):	
Follow Up Screen Date (MM/DD/YY):	4/7/11
Follow Up Field Screen Time:	11:00am
Outfall Dimensions (in):	4"
Outfall Shape: Round (R), Oval (O), Box (B), V-Ditch (VD), Trap Ditch (TD), Other Ditch (OD)	Round
Outfall Type (CMP, RCP, PVC, Other):	Clay
Flow Observed? (Y/N):	Y
Follow Up Flow Observed? (Y/N):	Y
Flow Source	Possible septic system
Structural Condition: Normal (N), Concrete Spauling (SP), Peeling Paint (PP), Concrete Cracking (CC), Outfall Damaged (OD), Submerged (S), Metal Corrosion (MC), Other (O-explain)	
Erosion (Outfall Area): None (N), Moderate (M), Severe (S)	N
Odor: None (N)=0, Rancid-Sour (RS)=4, Gas (G)=4, Sewage (S)=4, Oil (O)=4, Sulfur (S)=4, Other (Other-explain)	Sewage
Deposits / Stains: None (N)=0, Sediment (S)=2, Oil (OY)=3, Other (O-explain)	White Cloudy Discharge/Staining in pipe
Algae Growth? (Y/N):	N
Vegetative Condition (Outfall Area): Normal (N), Inhibited Growth (IG), Excessive Growth (EG), Other (O-explain)	N
Land Use: Industrial (I), Commercial (C), Residential (R), Other (O-explain)	Res.
Specific Land Use:	Along roadside from residential area

DelDOT

Outfall ID No. 52011014081352

	Result 1	Val.	Result 2	Val. 2
Flow Rate (cfs): <0.022 cfs=0; ≥0.022 cfs=4	<.022	0	<.022	0
Water Temperature (Farenheit):	44.2°	-	69°	-
pH: <4.5=4; >8.5=4; change ≥ 2 units=1	7.42	0	7.52	0
Phenol (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4	0	0	.5 mg/L	4
Chlorine (mg/L): <0.3 mg/L=0; ≥0.3 mg/L=4	0	0	0	0
Detergents (mg/L): <0.2=0; 0.2 - 0.4=1; ≥0.5 mg/L=4	>1.3	4	>1.3	4
Copper (mg/L): <0.01 mg/L=0; ≥0.01 mg/L=4	0	0	0	0
Ammonia (mg/L): <0.05-0.1 mg/L=0; 0.1-1.0 mg/L=1; 1.0-2.99 mg/L=2; ≥3.0 mg/L=4	>3.0	4	>3.0	4
Turbidity: 0-10 ntu=0; 11-40=1; 41-150=3; >150=4	89.10	3	141.3	3
Color: Clear (C)=0, Gray (G)=1, Red (R)=1, Yellow (Y)=1, Brown (B)=1, Green (GR=1), Other (O-explain)	G/white Cloudy	1	G/white Cloudy	1
Floatables: None (N)=0, Oil Sheen (OS)=4, Sewage (S)=4, Trash (T)=2, Other (O-explain)	N	0	N	0

FIELD SKETCH

KCI

MEMORANDUM

TO: Randy Cole
Marianne Walch
DelDOT Stormwater Quality Program

FROM: Matthew Ortynsky
Environmental Scientist

DATE: June 29, 2011 through November 22, 2011

SUBJECT: **2777 Andrewsville Road PID Summary**
Structure No. 520110114081352
Agreement 1495 / KCI Project 0203019H/0203019I

The purpose of this Memo is to summarize the investigation of a Potential Illicit Discharge (PID) at 2777 Andrewsville Road (Figures 1-2).

March 15, 2011: CEI identified a PID at 2777 Andrewsville Road. Field crew observed what appeared to be clumps of toilet paper and cloudy water in the bottom of Structure No. 520110114081352. A strong sewage odor was detected.

March 24, 2011: KCI inspected the catch basin and noticed a 4" clay pipe with a small amount of cloudy discharge (Figure 3). There appeared to be clumps of toilet paper in the bottom of the catch basin and a strong sewage odor was detected. The sample collected tested high for levels of ammonia, detergents, and turbidity. The source of the discharge could not be determined, but was suspected to be from septic tank overflow.

April 7, 2011: KCI detected a strong sewage odor. The sample collected tested high for levels of ammonia, detergents, turbidity and phenol (the latter of which was undetected 03/24/11 but high on 04/07/11).

April 8, 2011: KCI contacted DelDOT to relay the field investigation observations.

April 13, 2011: DNREC investigated area and spoke with owner of 2777 Andrewville Rd, who did not know about pipe in catch basin. DRNEC informed resident of their recommendation to have pipe closed by DelDOT. If resident has problems with septic-will confirm origination from his system. If anyone else contacts either DNREC or DelDOT once it's closed off, then DNREC will consider enforcement action at that time, because this would show someone knew pipe was there.

May 20, 2011: KCI attempted to send via certified mail a DelDOT Illicit Discharge Notice, which was returned to sender with message "No mail receptacle-unable to forward".

June 14, 2011: KCI attempted to send via regular mail a DelDOT Illicit Discharge Notice.

June 29, 2011: KCI and Tri State Grouting conducted a push camera inspection. At approximately 83' 6" a junction box was discovered that connects to what appears to be an additional sewage pipe (Figure 4). Upon further investigation, a metal cover was found at the area where the junction box should be located. There is a septic tank at the rear of the house (Figure 5).

November 22, 2011: DNREC contacted homeowner (Tim Carrington 302-382-9649) and recommended he call DelDOT. DelDOT confirmed with Mr. Carrington that DelDOT intends to plug the pipe and any potential problems that may occur from back-ups would be the homeowner's responsibility. Mr. Carrington acknowledged that he understood this and is OK with DelDOT plugging pipe.

Figure 1. Aerial View

Figure 2. Landscape

Figure 3. Structure View

Figure 4. Junction Box

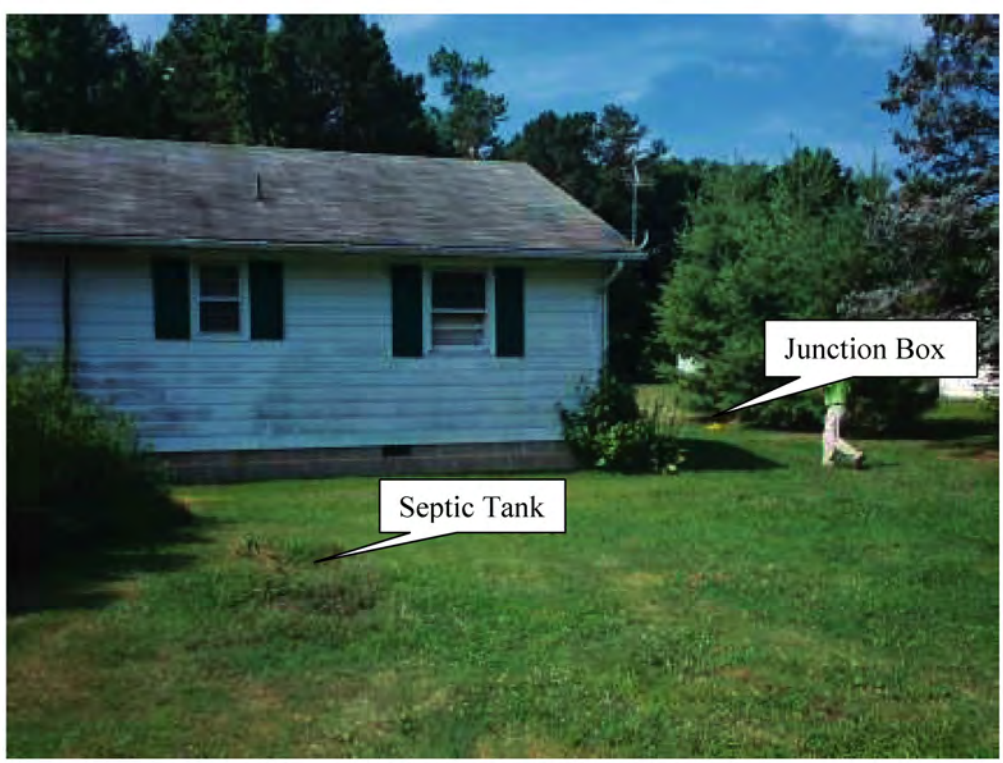


Figure 5. Septic Tank / Junction Box

2777 Andrewsville Road PID

© 2011

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

CAROLANN WICKS, P.E.
SECRETARY

June 14, 2011

NOTICE OF POTENTIAL ILLEGAL DISCHARGE

Timothy O. & Angela F. Carrington
2777 Andrewsville Road
Harrington, Delaware 19952

The Delaware Department of Transportation (DelDOT) is responsible for maintaining not only roadways, but also the extensive storm drain and pipe networks located within State rights-of-way. The Federal National Pollutant Discharge Elimination System (NPDES) Program, which is a component of the Clean Water Act of 1972, requires DelDOT to control the amount of pollutants entering the drainage system. Part of this charge is the detection and elimination of *illegal discharges* or connections to the system that may contain pollutants or are otherwise not allowed. Left uncorrected, any pollutants entering the system will ultimately impact nearby streams, as storm drainage is not treated at any sort of treatment facility.

DelDOT has contracted with the engineering firm KCI Technologies, Inc. to survey and inspect the drainage system and to check for illegal discharges or connections. Upon inspection, KCI Technologies, Inc. found a 4 inch pipe with what appears to have a sewage discharge and odor. KCI Technologies, Inc. along with Tri State Utilities will be conducting an inspection with a camera to determine the origin of this 4 inch pipe leading into a catch basin in front of 2777 Andrewsville Road. If you have any questions regarding this matter please contact:

Bruce Thompson
KCI Technologies, Inc.
1352 Marrows Road, Suite 100
Newark, DE 19711
(302) 731-9176 (voice); (302) 731-7807 (fax)
bruce.thompson@kci.com

Thank you for helping us preserve Delaware's environment.

DelDOT

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

CAROLANN WICKS, P.E.
SECRETARY

NOTICE OF POTENTIAL ILLEGAL DISCHARGE

The Delaware Department of Transportation (DelDOT) is responsible for maintaining not only roadways, but also the extensive storm drain and pipe networks located within State rights-of-way. The Federal National Pollutant Discharge Elimination System (NPDES) Program, which is a component of the Clean Water Act of 1972, requires DelDOT to control the amount of pollutants entering the drainage system. Part of this charge is the detection and elimination of *illegal discharges* or connections to the system that may contain pollutants or are otherwise not allowed. Left uncorrected, any pollutants entering the system will ultimately impact nearby streams, as storm drainage is not treated at any sort of treatment facility.

DelDOT has contracted with the engineering firm KCI Technologies, Inc. to survey and inspect the drainage system and to check for illegal discharges or connections. Upon inspection, KCI Technologies, Inc. found a 4" pipe with what appears to have a sewage discharge and odor. KCI Technologies, Inc. along with Tri State Utilities will be conducting an inspection with a camera to determine the origin of this 4" pipe leading into a catch basin in front of 2777 Andrewsville Road. If you have any questions regarding this matter please contact:

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(302) 731-9176 (voice); (302) 731-7807 (fax)
bruce.thompson@kci.com

Thank you for helping us preserve Delaware's environment.

DelDOT

KCI

MEMORANDUM

TO: Randy Cole
Environmental Program Manager
DelDOT Stormwater Quality Program

FROM: Matthew Ortynsky
Environmental Scientist

DATE: April 8, 2011

SUBJECT: 2777 Andrewsville Road PID
Structure No. 520110114081352
Agreement 1495 / KCI Project 0203019H

The purpose of this Memo is to summarize the investigation of a potential illicit discharge at 2777 Andrewsville Road.

While performing Agreement 1354 Re-inspections, a Century field crew identified a potential illicit discharge (PID) located at 2777 Andrewsville Road. Century field crews observed what appeared to be clumps of toilet paper and cloudy water in the bottom of Structure ID No. 520110114081352. A strong sewage odor was also observed. Alex Schmidt from Century notified Bruce Thompson of KCI on Tuesday March 15, 2011 of this PID.

On Thursday March 24, 2011, KCI field crews inspected the catch basin and noticed a 4" clay pipe with a small amount of cloudy discharge. There appeared to be clumps of toilet paper in the bottom of the catch basin and a strong sewage odor was observed. KCI collected a sample to be tested. The sample tested high for levels of ammonia, detergents, and turbidity. KCI was unable to pin point the source of the discharge, but it is suspected that the discharge is coming from a septic tank overflow. KCI will retest the discharge in the future.

On Thursday April 7, 2011, KCI field crews conducted a follow up visit on the catch basin. KCI observed a strong sewage odor and collected another sample to be tested. The sample tested high for levels of ammonia, detergents, turbidity and phenols. Phenols were undetected on Thursday March 24, 2011, but tested high during the follow up visit.

KCI contacted Randy Cole on April 8, 2011 to relay the field investigation observations. Randy stated that DelDOT will evaluate this issue and determine the appropriate action.

Figure 1. Landscape

Figure 2. Structure View

Structure 420121101135958

32772 Bi-State Boulevard

Laurel, DE 19956

DELDOT AGR. 1613 / KCI 17121613A

POTENTIAL ILLICIT DISCHARGE INVESTIGATION DOCUMENTATION CHECKLIST

PID Structure No(s). 420121101135958

Subdivision: N/A

PID Address: 32772 Bi-state Boulevard

City: Laurel

Zip Code: 19956

PHOTOGRAPHS:

☑	Landscape	Required
☑	Structure	Required

DOCUMENTATION ATTACHED:

☑	IDDE Tracking Form	Required
☑	Location Map from NPDES Map Viewer	Required
☑	Dry Weather Flow Field Test Sheet	Required for Flow
☑	Summary Memorandum with Photographs	Required
☐	Door Hanger	As Applicable
☑	Notice of Potential Illegal Discharge Letter	As Applicable
☑	OTHER: ○ Property Tax Parcel Information ○ 01-08-13 Telephone Memorandum	

KCI TECHNOLOGIES

TELEPHONE MEMORANDUM

TO: The Files

FROM: Bruce Thompson

DATE: January 8, 2013

TIME: 11:50 AM

SUBJECT: **Potential Illicit Discharge – Sussex County**
32772 Bi-State Boulevard, Laurel DE 19956
Structure 420121101135958
Agreement 1613 / KCI Project 17121613A

The purpose of this Telephone Memo is to summarize the conversation between Bruce Thompson and Mr. Massey, homeowner at 32772 Bi-State Boulevard in Sussex County.

The following items were discussed:

- Mr. Massey received the IDDE Notice delivered via FedEx.
- Mr. Massey was not aware of the pipe in the catch basin in front of his house.
- Mr. Massey stated the pipe in the catch basin was connected to the washer and the sink in the house by the previous homeowner.
- Mr. Massey will fix the situation and notify Bruce Thompson when it is repaired. He anticipates this repair to be completed by the end of February 2013.
- Bruce Thompson stated that KCI field staff will come out to inspect the catch basin upon notification by Mr. Massey of repair.
- Bruce Thompson stated that DelDOT would eventually plug the pipe in the catch basin.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

December 12, 2012

NOTICE OF POTENTIAL ILLEGAL DISCHARGE

The Delaware Department of Transportation (DelDOT) is responsible for maintaining not only roadways, but also the extensive storm drain and pipe networks located within State rights-of-way. The Federal National Pollutant Discharge Elimination System (NPDES) Program, which is a component of the Clean Water Act of 1972, requires DelDOT to control the amount of pollutants entering the drainage system. Part of this charge is the detection and elimination of *illegal discharges* or connections to the system that may contain pollutants or are otherwise not allowed. Left uncorrected, any pollutants entering the system will ultimately impact nearby streams, as storm drainage is not treated at any sort of treatment facility.

DelDOT has contracted with the engineering firm KCI Technologies, Inc. to survey and inspect the drainage system and to check for illegal discharges or connections. Please review the following checked items that pertain to you:

☑ ***You are receiving this notice because a potential illegal discharge or connection from your property was detected during a recent investigation. Please see details below.***

Date: 12/04/12 Outfall No: 420121101135958 Address: 32772 Bi-state Boulevard Laurel, DE 19956

Indicators or Source: 4" connection; discharge has strong sewage smell; gray disintegrated paper; tested high for turbidity, detergents and ammonia.

☑ ***This discharge or connection must be ceased or removed within 30 days. A follow up investigation will be conducted after that time to ensure compliance.***

☐ ***We are requesting access to your property to assist in our determination. Within seven days, please contact KCI Technologies, Inc. as shown below to make the appropriate arrangements.***

Bruce Thompson
KCI Technologies, Inc.
1352 Marrows Road, Suite 100
Newark, DE 19711
(302) 731-9176 (voice); (302) 731-7807 (fax)
bruce.thompson@kci.com

If the illegal discharge or connection cannot be removed within 30 days, you do not understand this notice, or you disagree that an illegal discharge or connection exists at your property, please contact KCI Technologies, Inc. with further details or explanation.

Program information can be obtained by contacting DelDOT's Project Manager, Randy Cole, by calling (302) 760-2194, or by email at randy.cole@state.de.us.

Thank you for helping us preserve Delaware's environment.

DelDOT

Lydia Hill

From: trackingupdates@fedex.com
Sent: Friday, December 14, 2012 4:10 PM
To: Lydia Hill
Subject: FedEx Shipment 794280103707 Delivered

This tracking update has been requested by:

Company Name:	KCI Technologies, Inc.
Name:	Bruce R. Thompson
E-mail:	bruce.thompson@kci.com

Our records indicate that the following shipment has been delivered:

Reference:	99909-00 P916
Ship (P/U) date:	Dec 12, 2012
Delivery date:	Dec 14, 2012 4:05 PM
Sign for by:	Signature not required
Delivery location:	LAUREL, DE
Delivered to:	Residence
Service type:	FedEx 2Day
Packaging type:	FedEx Envelope
Number of pieces:	1
Weight:	0.50 lb.
Special handling/Services:	Deliver Weekday Residential Delivery
Tracking number:	794280103707

Shipper Information	Recipient Information
Bruce R. Thompson	Harley Pete and Norma Jean Massey
KCI Technologies, Inc.	32772 Bi State Boulevard
1352 Marrows Road	LAUREL
Suite 100	DE
Newark	US
DE	19956
US	
19711	

Please do not respond to this message. This email was sent from an unattended mailbox. This report was generated at approximately 3:09 PM CST on 12/14/2012.

To learn more about FedEx Express, please visit our website at fedex.com.

All weights are estimated.

To track the latest status of your shipment, click on the tracking number above, or visit us at fedex.com.

This tracking update has been sent to you by FedEx on the behalf of the Requestor noted above. FedEx does not validate the authenticity of the requestor and does not validate, guarantee or warrant the authenticity of the request, the requestor's message, or the accuracy of this tracking update. For tracking results and fedex.com's terms of use, go to fedex.com.

Thank you for your business.

Illicit Discharge Incident Tracking Sheet

Date: 11/28/2012 **Logged by:** J. Widerman **Contact #:** 302-734-9188 **Incident ID:**

Caller contact information:
Logged during routine drainage inventory

Subdivision: N/A
County: Sussex
ADC Map No./Grid: 37 D1

Incident Location

Primary Location Description

- ☒ Storm drain
- ☐ In stream
- ☐ Stormwater pond
- ☐ Outfall
- ☐ Along bank
- ☐ Upland
- ☐ Other _____

Outfall / inlet ID# : 420121101135958

Closest street address: 32772 Bi-state Boulevard
Laurel, DE

Watershed name: Broad Creek

Impacted Stream name: Rossakatum Branch

Nearby landmark: In front of residence (32772 Bi-State Boulevard)

Narrative description of location

In catchbasin in front yard of residence at 32772 Bi-State Boulevard.

Description of problem

Visual

- ☐ Oil / Oil sheen
- ☐ Paint
- ☐ Algae
- ☒ Cloudy
- ☐ Anti-freeze
- ☐ Yard waste
- ☐ Soap
- ☐ Flotables (toilet paper, etc.)
- ☐ Dead fish
- ☐ Flow ----------> Precipitation in last 48-hours? Yes / No
- ☒ Other Black scum

Odor

- ☒ Sewage
- ☐ None
- ☐ Sulfide ("rotten egg")
- ☐ Gas/oil
- ☐ Other (describe) _____

Narrative description/comments of problem

4" diameter pipe appears to leave residence and connects to storm drain. Cloudy water has collected in bottom of basin. Strong stagnant water smell. Appears to be a washing machine connection or basement sump connection.

Plan of Action (check all that apply)

- ☒ Sample
- ☐ Contact DNREC
- ☒ Contact NPDES Manager
- ☒ Photos
- ☐ Door hangers
- ☒ GPS Coordinates
- ☐ Other (describe)

Follow-up Action

Photos and GPS coordinates taken. Suggest notification of NPDES manager and sampling to determine nature of effluent.

KCI TECHNOLOGIES

MEMORANDUM

TO: Randy Cole, DelDOT

FROM: Matt Ortynsky, KCI

DATE: December 5, 2012

SUBJECT: **Potential Illicit Discharge – Sussex County**
32772 Bi-State Boulevard, Laurel DE 19956
Structure 420121101135958
Agreement 1613 / KCI Project 17121613A

The purpose of this Memo is to summarize the field investigations regarding a Potential Illicit Discharge (PID) at 32772 Bi-State Boulevard in Sussex County. The following documentation is attached:

- Location Map from Map Viewer
- 11-28-12 CEI IDDE Tracking Form and Camera on a Stick Photograph
- 12-04-12 KCI IDDE Field Data Sheet
- General Information from http://www.sussexcountyde.gov/e-service/propertytaxes/taxsearch/index.cfm?CFID=8299225&CFTOKEN=97100465

November 28, 2012 - CEI Agr. 1591 Routine Drainage Inventory: CEI field staff observed a catch basin in front of the above address (see attached Map) with a 4" pipe that appeared to be connected from the residence to the storm drain. Cloudy water with a sewage smell was observed in the bottom of the basin (see attached 11-28-12 IDDE Tracking Form).

December 4, 2012 – KCI Agr 1613 PID Investigation: KCI field staff visited the above catch basin and recorded the following observations:

- There is a 4" pipe in concrete wall that appears to originate from the residence.
- No flow was observed from the 4" pipe.
- At the bottom of the catch basin was stagnant gray, cloudy water, combined with wads of disintegrated paper, and a strong sewage smell.
- The sample collected from the stagnant water at the bottom of the catch basin tested high for turbidity, detergents and ammonia. The total rating was 16 (see attached field sheet).
- The second sample collected for the re-visit (between 4-24 hours) also tested high for turbidity, detergents and ammonia. The total rating was 16 (see attached field sheet).

32772 Bi-State Boulevard - Structure 420121101135958 in Foreground

Structure 420121101135958 with 4" Tie-In

4" Tie-In with Gray Disintegrated Paper

Gray Disintegrated Paper with Strong Sewage Smell in Upstream end of Conveyance

Possible Septic Tank in Back Yard along Gravel Driveway approximately 100 feet from Structure 420121101135958

Looking from Possible Septic Tank to Structure 420121101135958

Pipe coming into Structure 420121101135958
probably from Residence at 32772 Bi-State Boulevard, Laurel DE 19956

Structure 420121101135958

Legend

- INLET
- MANHOLE
- OUTFALL
- RISER
- JUNCTION BOX
- CULVERT
- SWALE END
- SWALE VERTEX
- DUMMY NODE
- DITCH
- PIPE
- HYDRAULIC CONNECTION
- BMP
- WORK ORDER

N

NPDES Inventory Map

3 Dec, 2012

0 60 120 240 Feet

DelDOT

Illicit Discharge Incident Tracking Sheet

Date: 11/28/2012 **Logged by:** J. Widerman **Contact #:** 302-734-9188 **Incident ID:**

Caller contact information:
Logged during routine drainage inventory

Subdivision: N/A
County: Sussex
ADC Map No./Grid: 37 D1

Incident Location

Primary Location Description

- ☒ Storm drain
- ☐ In stream
- ☐ Stormwater pond
- ☐ Outfall
- ☐ Along bank
- ☐ Upland
- ☐ Other _____

Outfall / inlet ID# : 420121101135958

Closest street address: 32772 Bi-state Boulevard
Laurel, DE

Watershed name: Broad Creek Impacted Stream name: Rossakatum Branch

Nearby landmark: In front of residence (32772 Bi-State Boulevard)

Narrative description of location

In catchbasin in front yard of residence at 32772 Bi-State Boulevard.

Description of problem

Visual

- ☐ Oil / Oil sheen
- ☐ Paint
- ☐ Algae
- ☒ Cloudy
- ☐ Anti-freeze
- ☐ Yard waste
- ☐ Soap
- ☐ Flotables (toilet paper, etc.)
- ☐ Dead fish
- ☐ Flow ----------> Precipitation in last 48-hours? Yes / No
- ☒ Other Black scum

Odor

- ☒ Sewage
- ☐ None
- ☐ Sulfide ("rotten egg")
- ☐ Other (describe) _____
- ☐ Gas/oil

Narrative description/comments of problem

4" diameter pipe appears to leave residence and connects to storm drain. Cloudy water has collected in bottom of basin. Strong stagnant water smell. Appears to be a washing machine connection or basement sump connection.

Plan of Action (check all that apply)

- ☒ Sample
- ☒ Photos
- ☐ Other (describe)
- ☐ Contact DNREC
- ☐ Door hangers
- ☒ Contact NPDES Manager
- ☒ GPS Coordinates

Follow-up Action

Photos and GPS coordinates taken. Suggest notification of NPDES manager and sampling to determine nature of effluent.

Pipe coming into the basin from the residence on Bi-State Boulevard

DELDOT AGREEMENT 1613
DRY WEATHER SCREENING / PID FIELD SHEET

Structure Number: 42012110135958

County: SUSSEX

Subdivision: N/A

Address/Location 32772 Bi-state Blvd.

Personnel		MD / LH
Date		9:30 AM
Time		12-04-12
Digital picture	Yes(Y), No(N)	YES
Air Temperature	(F)	63°
Date Last Rain >0.10"		11-27-12
Outfall Dimensions	(inches)	4"
Outfall Shape	Round(R), Oval(O), Box(B), V-Ditch(VD), Trap Ditch(TD)	R
Outfall Type	Corrugated Metal Pipe(CMP), Reinforced Concrete Pipe(RCP) Polyvinyl Chloride Pipe(PVC), Other(O-explain)	RCP
Flow Observed/Sample 1 SAMPLED STAGNANT POOL	Yes(Y), No(N)	N
Flow Source APPEARS TO BE FROM RESIDENCE		
Sample 2 Date/Time	(if Sample 1 = Total Rating ≥4; collect w/in 4-24 hrs)	12-04-12 1:30 PM
Land Use	Industrial(I), Commercial(C), Residential(R), Other(O-explain)	R
Structural Condition	Normal(N), Concrete Spauling(SP) Peeling Paint(PP), Concrete Cracking(CC) Outfall Damaged(OD), Submerged(S), Metal Corrosion(MC), Other(O-explain)	—
Erosion (Outfall Area)	None(N), Moderate(M), Severe(S)	—
Algae Growth	Yes(Y), No(N)	—
Vegetative Condition (Outfall Area)	Normal(N), Inhibited Growth(IG) Excessive Growth(EG), Other(O-explain)	—

WATER QUALITY PARAMETERS		**Sample 1**	**Rating**	**Sample 2**	**Rating**
Water Temperature (F)		55.3	—	56.4	—
Flow Rate (cfs)	<0.022 cfs=**0**; ≥0.022 cfs=**4**	<0.022	0	<0.022	0
pH (units)	4.5-8.5=**0**; change ≥ 2=**1**, <4.5=**4**; >8.5=**4**	6.85	0	6.88	0
Phenol (mg/L)	<0.3=**0**; ≥0.3=**4**	0	0	0	0
Chlorine (mg/L)	<0.5=**0**; ≥0.5=**4**	0	0	0	0
Detergent (mg/L)	<0.2=**0**; 0.2-0.4=**1**; ≥0.5=**4**	>1.3	4	>1.3	4
Copper (mg/L)	<0.01=**0**; ≥0.01=**4**	0	0	0	0
Ammonia (mg/L)	<0.05-0.1=**0**; ≥0.1-1.0=**1** ≥1.0-2.99=**2**; ≥3.0=**4**	2.6	2	2.8	2
Turbidity (ntu)	0-10=**0**; 11-40=**1**; 41-150=**3**; >150=**4**	28.88	1	31.24	1
Odor	None(N)=**0**, Rancid-Sour(RS)=**4**, Gas(G)=**4** Sewage(S)=**4**, Oil(O)=**4**, Sulfur(S)=**4**, Other(O-explain)	S	4	S	4
Deposits/Stains	None(N)=**0**, Sediment(S)=**2** Oil(OY)=**3**, Other(O-explain)	0	0	0	0
Color	Clear(C)=**0**, Gray(G)=**1**, Red(R)=**1**, Yellow(Y)=**1** Brown(B)=**1**, Green(GR)=**1**, Other(O-explain)	G	1	G	1
Floatables	None(N)=**0**, Trash(T)=**2** Oil Sheen(OS)=**4**, Sewage(S)=**4**, , Other(O-explain)	S	4	S	4
	TOTAL RATING =	16		16	

STRONG SEWAGE SMELL - GRAY DISINTEGRATED PAPER

General Information

District-Map-Parcel:	3-32 3.00 13.00
Owner(s) Names	MASSEY , HARLEY PETE JR & NORMA JEAN
Property Address	OSCAR EVANS PLOT, LOTS 1-4,W/RT. 13A,
Billing Address	32772 BI STATE BLVD LAUREL , DE 19956
Land Use	Residential, Single dwelling & lot
Zoning	Agricultural/Residential
Town/Municipality	-No Town or Municipality Specified-
Fire District(s)	Laurel Fire District
Tax Ditch(es)	-No Ditch Records-
Sewer/Water District	-No Sewer Records-

PROPERTY DETAILS

- General Information
- Payment Status
- Appraisal & Assessment Info
- Sales Info
- Property Description
- Council District
- Tax Summary
- County Taxes
- School Taxes
- Change Billing Address
- Map of Property

SEARCH

Quick Links

Illicit Discharge Incident Tracking Sheet

Date: **Logged by:** **Contact #:** **Incident ID:**

Caller contact information:
DelDOT NPDES Program Manager Randy Cole

Subdivision: Sharpley
County: New Castle County
ADC Map No./Grid: 3F12

Incident Location

Primary Location Description

- ☑ Storm drain
- ☐ In stream
- ☐ Stormwater pond
- ☐ Outfall
- ☐ Along bank
- ☐ Upland
- ☐ Other _____

Outfall / inlet ID# : 60570

Closest street address: 102 Whitby Drive

City: Wilmington

Watershed name: Brandywine-Christina Impacted Stream name: Brandywine Creek

Nearby landmark:

Narrative description of location

Description of problem

Visual

- ☐ Oil / Oil sheen
- ☐ Paint
- ☐ Algae
- ☐ Cloudy
- ☐ Anti-freeze
- ☑ Yard waste
- ☐ Soap
- ☐ Floatables (toilet paper, etc.)
- ☐ Dead fish
- ☐ Flow
- ☐ Precip w/in 72 hrs
- ☐ Other _____

Odor

- ☐ Sewage
- ☑ None
- ☐ Sulfide ("rotten egg")
- ☐ Other (describe) _____
- ☐ Gas/oil

Narrative description/comments of problem

Leaves were reported to have been dumped in a catch basin.

Plan of Action (check all that apply)

- ☐ Sample
- ☑ Photos
- ☐ Other (describe)
- ☐ Contact DNREC
- ☑ Door hangers
- ☐ Contact NPDES Manager
- ☐ GPS Coordinates

Follow-up Action

No Further Action Required.

DELDOT AGR. 1613/KCI 17121613A

DRY WEATHER SCREENING/POTENTIAL ILLICIT DISCHARGE

Date: Nov 9, 2012 and Nov 13, 2013

Structure No(s): 60570

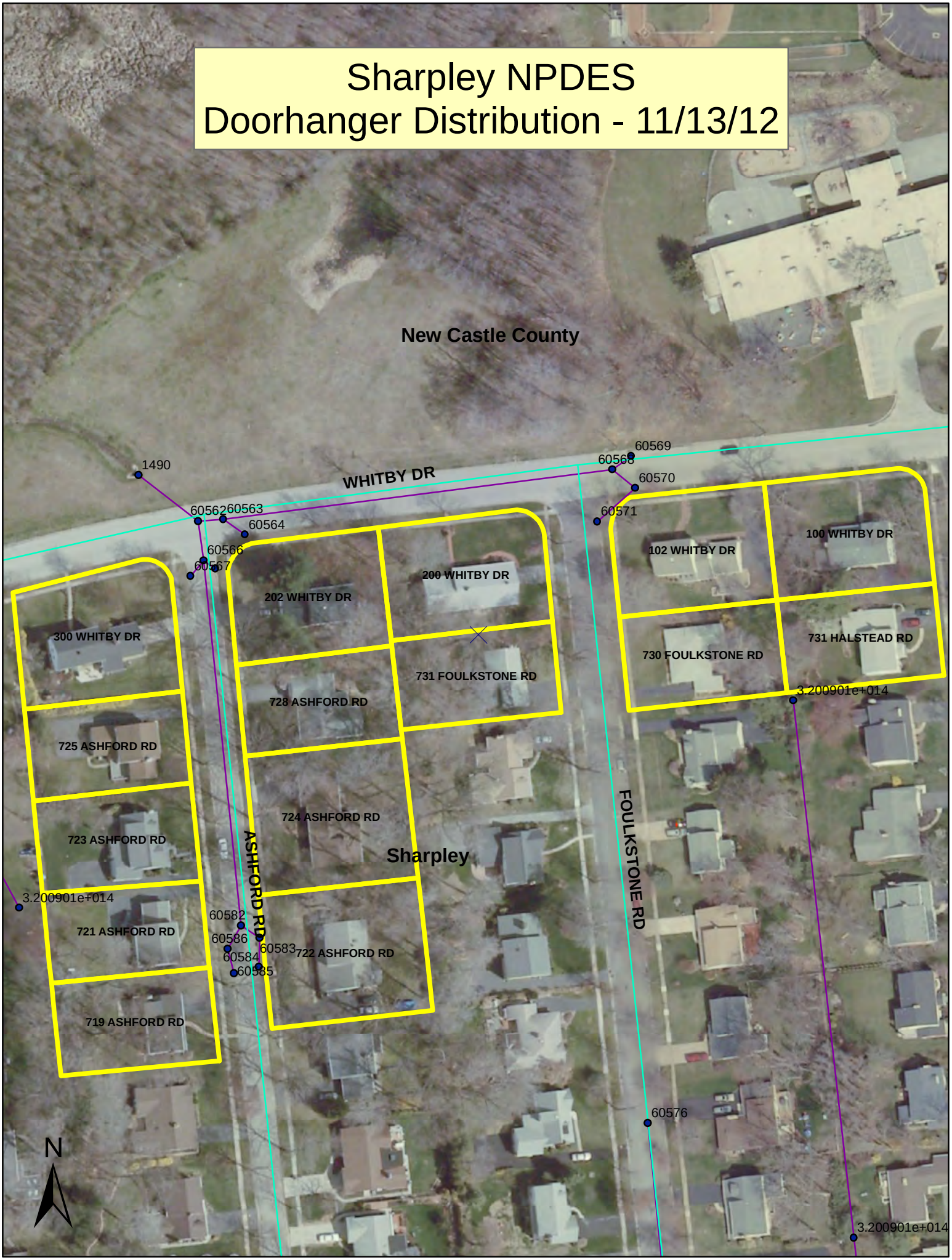
County: New Castle

Subdivision: Sharpley

Address: 102 Whitby Drive

Determination: Leaves were found in the catch basin at 102 Whitby Drive. Door hangers were left at 15 houses in the surrounding area.

Sharpley NPDES
Doorhanger Distribution - 11/13/12



Appendix D. Pike Creek Water Quality Improvement Plan (WQIP) pilot project final report from Duffield Associates.

PIKE CREEK

WATER QUALITY IMPROVEMENT PLAN

PILOT PROJECT FINAL REPORT

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EXECUTIVE SUMMARY

Overview

In March 2011, an application was submitted to the Delaware Clean Water Advisory Council through the State of Delaware, Department of Natural Resources and Environmental Control (DNREC) for preparation of a pilot Watershed Retrofit Plan (WRP) for the Pike Creek watershed, based on the requirements stated in the December 2010 draft of the New Castle County / DelDOT (henceforth referred to as the "Principal Permittees") NPDES permit for stormwater discharges. At that time, the Principal Permittees decided to prepare for the permit by proceeding with an evaluation to better understand the complexities of developing WRPs. These agencies enlisted the assistance of the University of Delaware Water Resources Agency (WRA), as well as the consulting firms Duffield Associates, Inc. (Duffield Associates), and KCI Technologies, Inc. (KCI), to conduct the study. Duffield Associates and WRA were responsible for the preparation of this report.

The primary purpose of this pilot project was to develop a process for WRP preparation to identify and resolve issues on a pilot basis before large scale plans are initiated. These goals were accomplished. The objective was not to prepare an actual WRP, and therefore, some components were addressed superficially and not in detail. Furthermore, some aspects such as best management practices (BMPs) sizing and cost estimates are very approximate and intended solely for demonstration purposes.

This WRP was renamed Water Quality Improvement Plan (WQIP) due to changes in terminology in various drafts of the joint NPDES permit. The permit has been the subject of on-going negotiations between the Principal Permittees and DNREC, and as of the date of submittal of this report, requirements of WQIPs still have not been finalized. On August 29, 2012, a second grant application was submitted to the Clean Water Advisory Council for the preparation of a similar WQIP for the Appoquinimink watershed. If funded, this WQIP will recognize and build upon the prior efforts and strive to reinvigorate water quality efforts in the watershed.

A hindrance to completion of the Pike Creek study was the interpretation of the permit language included in the version released for public comment. Specifically, to be in compliance, the permittees are to provide "at least a 3% decrease in untreated Effective Impervious Area (EIA)." It is noted that a considerable amount of time was spent creating a methodology that used the water quality PLOAD model as its basis and incorporated aspects of DNREC's Delaware Urban Runoff Management Model (DURMM) to estimate stormwater management of the impervious areas.

Development of Watershed Models

The entire Pike Creek watershed was divided into smaller subwatersheds or catchments. Each subwatershed was characterized into one of three types: 1) *BMP catchment,* which comprises the area which drains to a single BMP; 2) *outflow drainage,* which is directed to a single discharge point by inlets and pipes but not treated by a BMP; and 3) *direct discharge.* in which runoff flows directly overland to a perennially flowing waterbody. Using an existing County and DelDOT inventory and verifying with field visits along with LIDAR-based Digital Elevation Models (DEMs), the areas that drain to all identified BMPs and outfalls were delineated through a combination of automated and manual techniques.

WRA evaluated the wide variety of stormwater runoff models available including HSPF, SPARROW, L-THIA, CAST, and PLOAD to assess the required parameters of the WQIP. Parameters of interest included the loading rates of pollutants addressed by current total maximum daily loading (TMDL) regulations: total nitrogen (TN), total phosphorous (TP), and enterococcus bacteria. After careful consideration of these options, WRA settled upon a modified version of PLOAD. Advantages of this model are its flexibility in incorporating GIS data, its transparency, and its applicability at a variety of scales and locations.

At the direction of DNREC, a methodology was developed in order to quantify runoff reduction volumes that utilized PLOAD, as its basis, but incorporated aspects of DURMM to estimate the runoff reduction effectiveness of various BMPs. The resulting spreadsheet developed is termed the DURMM/WQIP model and is shown in Appendix A. Since DURMM was intended to be a screening level model, a method to approximate BMP sizes and costs was needed. One model that correlates watershed area with structure size is the BMP-REALCOST model developed by the Urban Drainage Flood Control District in Denver. The formulas obtained from the BMP-REALCOST model were used to estimate storage volume (in cubic feet) and capital costs.

Prioritization of Subwatersheds and Potential Retrofit Locations

In conjunction with the pollutant loading modeling, a GIS-based desktop evaluation of jurisdictional, physical, and natural resource GIS data layers was utilized in an effort to prioritize potential BMP retrofit opportunities and locate areas for new BMPs. The desktop evaluation used a two-tiered scaled approach that initially examined the watershed, as a whole, by prioritizing the 183 catchment areas and then analyzed and ranked all the New Castle County tax parcels falling within a subset of 183 catchment areas. Upon completion of the parcel prioritization, those that ranked the highest were mapped and targeted for field reconnaissance to evaluate the area's feasibility for BMPs and/or retrofit.

Field Reconnaissance

In an effort to field-locate the 37 stormwater outfalls and nine dry pond BMPs associated with the 46 catchment areas, a "Map Book," or a group of maps containing specific location information, was developed and has been included in Appendix B. To verify GIS data and assess the applicability of installing a new BMP or retrofit, Duffield Associates performed a three-day field reconnaissance effort in July 2012 that included visits to the 46 locations. The field reconnaissance forms have been included as Appendix C.

In general, the feasibility for implementing BMPs in the Pike Creek Watershed is anticipated to be limited due to the availability of land. Additionally, as the majority of the untreated stormwater outfalls discharge directly into the Pike Creek (or tributaries), the seasonal high water table in the adjacent areas is expected to be very shallow, further restricting infiltration-type stormwater management practices. It is noted that throughout the watershed, highly eroded stream channels and bank failures were commonly observed.

Effects of Preliminary BMPs and Retrofits

An iterative process was used to identify possible BMPs, involving results of the site prioritization, field reconnaissance (summarized in the map book and field forms), and the DURMM/WQIP model.

The site prioritization and field reconnaissance yielded potential BMP or retrofit locations where the DURMM/WQIP model numerically demonstrated BMP or retrofit effects or impacts. Based on conversations with DNREC, it was determined that six acre-feet of runoff reduction volume would be needed to meet the 3% decrease in untreated Effective Impervious Area (EIA)"

Of the 46 locations visited, 6 existing dry basin conversions to infiltration, 16 new infiltration facilities, 5 vegetated channels and 1 constructed wetland were identified as example projects. Using the BMP-REALCOST structure sizing and cost approximations, based on drainage area, it was found that the 6 conversions would provide 1.77 acre-feet of storage while the 16 infiltration facilities would result in 3.87 acre-feet of storage. Runoff reduction practices placed after October 1998 (end of the sampling which formed the basis for the TMDL) were estimated to result in approximately a half-acre foot of storage. The non-infiltrating BMPs do not receive runoff reduction credits in DURMM, and therefore, do not count towards the six acre-feet goal. However, their removal efficiencies were factored into the pollutant reduction calculations.

The BMP-REALCOST structure sizing and cost approximations were used to develop a budgetary cost estimate for many of the example BMPs and retrofits. It is stressed that this sizing and cost information, based on "best fit" curves, is very imprecise in nature and intended as a planning tool only. Using these data and assumptions, the six locations identified for dry pond retrofits to infiltration would cost approximately $400,000 to construct, and the 16 example infiltration facilities would cost just under $3 million. The five vegetated channels and one constructed wetland were estimated to cost approximately $100,000 and $36,000, respectively.

Using values for reductions that have been approved by DNREC, it was found that the example retrofits and BMPs would result in 272 and 150 lb/year reductions in total nitrogen and total phosphorous loadings and a 2,575 billion (bn) CFU/year reduction in enterococcus bacteria. All told, the retrofits and new facilities described above, if able to be constructed, would cost approximately $3.5 million. This equates to $640,000 per acre-foot runoff reduction, $12,900 and $23,300 per pound total nitrogen and total phosphorous reduction per year, and $1,400 bn CFU annual reduction in enterococcus bacteria.

Conclusions and Recommendations

The following recommendations are made as a result of the Pike Creek WQIP:

- Evaluate processes for updating plans;
- Develop procedures for benchmarking Effective Impervious Area (EIA);
- Begin collecting volume or size of basin or BMP in future inventories;
- Use up-to-date topographic and land use maps;
- Prioritize the retrofit of existing dry basins;
- Limit sizes of drainage areas in delineations;
- Incorporate groundwater depths in BMP and retrofit feasibility assessments; and
- Use broad range of BMP and retrofit options.

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I. OVERVIEW

A. Background

In March 2011, an application was submitted to the Delaware Clean Water Advisory Council through DNREC for preparation of a pilot Watershed Retrofit Plan (WRP) for the Pike Creek watershed. This application was based on the requirements stated in the December 2010 draft of the New Castle County / DelDOT (henceforth referred to as the "Principal Permittees") National Pollutant Discharge Elimination System (NPDES) Phase I permit for stormwater discharges, which were the latest version of the permit when the grant application was prepared. It required the preparation of a schedule of WRP development for all 21 County watersheds within 15 months of permit issuance, and the completion of three Plans within the permit term of five years (changed to two plans in subsequent permit drafts). At that time, the Principal Permittees decided to prepare for the permit by proceeding with an evaluation to better understand the complexities in developing WRPs. These agencies enlisted the assistance of the University of Delaware Water Resources Agency (WRA), as well as the consulting firms Duffield Associates, Inc., and KCI Technologies, Inc., to conduct the study. Duffield Associates and WRA were responsible for the preparation of this report.

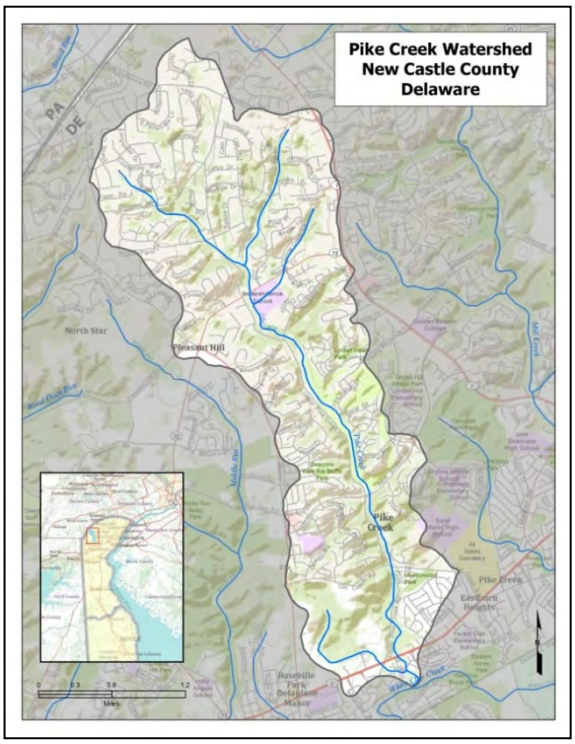

Figure 1 -- The Pike Creek watershed, New Castle County, Delaware.

The Pike Creek in northern New Castle County was chosen for the pilot project due to a combination of its manageable size, varied land uses, and availability of existing information and data. It is a tributary to the White Clay Creek, which in turn is a tributary to the Christina River. The Christina River Basin contains waters impaired by nutrients and low dissolved oxygen that are listed on the EPA 303(d) list. A total maximum daily load (TMDL) was developed in 2006 that calls for reductions in nitrogen and phosphorous as well as bacteria. Nitrogen and phosphorous reductions were not needed for the Pike Creek subwatershed per the TMDL, but since these pollutants are a major consideration in other watersheds, the pilot project included their evaluation.

The primary purpose of this pilot project was to develop a process for WRP preparation to identify and resolve issues on a pilot basis before large scale plans are initiated. These goals were accomplished. The objective was not to prepare an actual WRP, and therefore, some components were addressed superficially and not in detail. Furthermore, some

aspects, such as best management practices (BMPs) sizing and cost estimates, are very approximate and intended more for demonstration purposes.

B. Water Quality Improvement Plan Overview

This WRP was renamed Water Quality Improvement Plan (WQIP) due to changes in terminology in various drafts of the joint NPDES permit. The permit has been the subject of on-going negotiations between the Principal Permittees and DNREC and, as of the date of submittal of this report, requirements of WQIPs still have not been finalized.

One aspect of WQIP preparation that has not wavered is that the plans will "aim toward meeting TMDL allocations and applicable WQS [water quality standards]." TMDL allocations for the Pike Creek were based on sampling conducted between 1994 and 1998. Regarding nitrogen, phosphorous, and bacteria loadings and reductions, DNREC's position has been that treatment provided by BMPs placed after October 1998 may be counted. In other words, the Principal Permittees will get credit for these practices as they aim toward meeting TMDL allocations.

A meeting to discuss preliminary results of the Pike Creek WQIP was held on April 16, 2012. In attendance were numerous representatives from DNREC Divisions of Water and Watershed Stewardship, U.S. Environmental Protection Agency (EPA) Region 3 via telephone connection, the Principal Permittees, UDWRA, and Duffield Associates. UDWRA presented a summary of modeling efforts, which focused on the selection of the water quality model PLOAD as the most appropriate way to quantify nitrogen and phosphorous pollutant loadings in the watershed. Duffield Associates presented their general project approach which entailed prioritizing subwatersheds using PLOAD data, as well as identifying existing basins and BMPs for retrofits and existing outfalls for new stormwater management, based on a ranking criteria. Also discussed was the then proposed permit requirement to provide treatment of "3% of the Effective Impervious Area (EIA)."

C. Challenges and Difficulties

A hindrance to completion of the Pike Creek study was the interpretation of the permit language included in the version released for public comment. Specifically, to be in compliance, the permittees are to provide "at least a 3% decrease in untreated EIA." It is noted that a considerable amount of time was spent creating a methodology that used the water quality PLOAD model as its basis and incorporated aspects of DNREC's Delaware Urban Runoff Management Model (DURMM) to estimate stormwater management of the impervious areas.

Representatives from DNREC's Division of Watershed Stewardship indicated that the Pike Creek WQIP could not simply propose stormwater management BMPs accepting runoff from 3% of the impervious area in the watershed. Instead, any proposed BMPs would need to be sized such that they provide cumulative storage volume equivalent to 3% of the *Resource Protection Volume* (RPv) resulting from runoff from the impervious surfaces in the watershed. It was indicated that DNREC's DURMM would be the most appropriate way to demonstrate compliance.

The spreadsheet resulting from blending PLOAD and DURMM is termed the DURMM/WQIP model. This presented many challenges as DURMM is intended more as a site design tool and is not configured for a several thousand acre watershed. Regardless, it was found that 3% of the RPv from impervious surfaces in the watershed represents roughly six acre-feet. However, practices such as infiltration and bioretention with infiltration (collectively referred to as *runoff reduction* practices) placed after 1998 were estimated to result in about a half acre-foot of storage (given certain assumptions as stated in Section V). To obtain the remaining 5.5 acre-feet of storage, runoff reduction practices were specified at various outfalls. Many of the dry ponds in the watershed were specified to be converted to infiltration. This process is further explained also in Section V.

While the storage volume associated with runoff reduction practices is relatively straight-forward to determine in DURMM, other practices such as wetlands or soil amendments which are effective pollutant removal techniques, do not have a runoff reduction component. DURMM calculates their reduction in a more convoluted manner. The grant that funded the Pike Creek WQIP mandated that all work be completed within one year, and this schedule along with budget limitations did not allow for these more complex calculations to be incorporated into the DURMM/WQIP model.

Another challenge was addressing bacteria. The 2006 Christina River Basin TMDL calls for a 79% reduction in bacteria watershed-wide, but an 86% reduction in the Pike Creek subwatershed. Reduction estimates for bacteria loadings are provided in Section V that show an approximate 11% reduction associated with implementation of various structural BMPs. The review of research literature reinforces the position that structural BMPs alone will be very unlikely to meet bacteria reduction goals. Clearly, nonstructural BMPs need to be included in any comprehensive program to meet this TMDL requirement.

D. Future Activities

Due to some of the challenges and difficulties identified, the WQIP approach described herein is considered a work in progress. On August 29, 2012, a second grant application was submitted to the Delaware Clean Water Advisory Council for the preparation of a similar WQIP for the Appoquinimink watershed. If funded, this WQIP will recognize and build upon the prior efforts. Its objectives will be to:

- Obtain funds for continued refinement of the DURMM/WQIP model. Based on direction from DNREC, a method needs to be developed that quantifies the effects of BMPs and retrofits per DURMM, but does so on a much larger scale;
- Correlate the DURMM/WQIP model, which is focused on calculating reductions in retention reduction volumes, with PLOAD (or other watershed-based water quality model), which better demonstrate pollutant loadings and reductions;
- More accurately ascertain the practical side of meeting the 3% of EIA goal. Soils in a Coastal Plain watershed (such as the Appoquinimink) are generally more conducive to infiltration than those in the Piedmont (such as the Pike Creek);
- Explore the use of alternative nonstructural BMPs in the context of effective impervious area reductions and develop methodologies for DNREC review; and
- Refine the process developed as part of the Pike Creek study such that the methodology can be used in other WQIPs in Delaware.

II. DEVELOPMENT OF WATERSHED MODELS

A. Subwatershed Drainage Area Delineations

1. *BMP and catchment delineation*

In order to enable a site-based analysis of stormwater improvement projects across the entire Pike Creek watershed (see Figure 2), it was helpful to establish a fine-grained, GIS-based network of drainage catchments within which runoff volumes and pollutant loads could be determined. Each subwatershed was characterized into one of three types:

1) *BMP catchment*, which comprises the area that drains to a single BMP, such as a dry or wet pond, bioretention basin, infiltration basin, etc.,

2) *Outflow drainage*, which is directed to a single discharge point by infrastructure (e.g., by stormwater pipes or channels), but which does not attenuate runoff volume or pollution loading, and

3) *Direct discharge*, in which runoff flows directly overland to a perennially flowing waterbody. These areas comprise those within the Pike Creek that do not flow into a BMP or through an outfall.

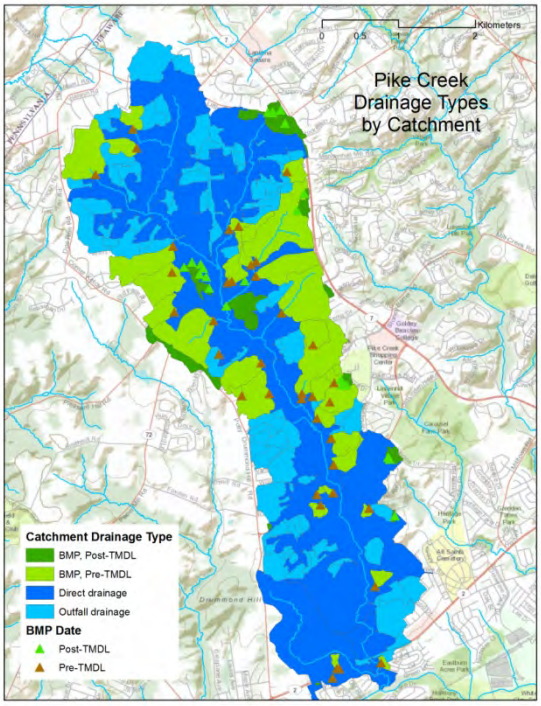

Figure 2 -- Categorized stormwater catchments in the Pike Creek watershed. BMPs and their catchments are differentiated by date to indicate pre- v. post-TMDL implementation.

KCI delineated this set of catchments by collecting, field verifying, and compiling a complete inventory of BMPs, which included facilities from both New Castle County and DelDOT. Using this information, along with other stormwater infrastructure such as conveyances, and LIDAR-based Digital Elevation Models (DEMs), the areas that drain to all identified BMPs and outfalls were delineated through a combination of automated and manual techniques.

It was found that the locations of some BMPs required field verification, since some of the data were found to be insufficiently accurate. Without highly accurate locations, the actual drainage area and resultant runoff and pollutant load cannot be estimated within reasonable accuracy.

Due to differences in delineation techniques, as well as the presence of underground conveyances that may transport stormwater into or out of the Pike Creek watershed, the outline of the catchments developed by KCI do not coincide exactly with the existing Pike Creek watershed boundary. Differences between the various outlines of the Pike Creek watershed were considered negligible. All runoff volumes, pollution loadings, and reductions were based on the catchments delineated by KCI. To allow for the most fine-grained analysis, BMPs were considered individually, as opposed to in series for a given site. That is, each BMP was given a catchment and subsequent loading and reduction values, even if they were connected hydrologically, such as a chain of wet ponds along a stream in a golf course.

2. *Ancillary data*

Other data sets were compiled to enable the determination of loading rates, as well as to guide recommendations about example BMPs and retrofits.

The Pike Creek was divided into seven subwatersheds roughly similar in size and land use composition, to allow for subsequent comparisons at a level of granularity between the catchment level and the whole watershed. Delineation was based on existing monitoring sites, major confluences, changes in land cover characteristics, and road crossings. The watershed extent was determined using highly accurate LIDAR data, and internal sub-watershed boundaries were constrained to conform to the catchments as delineated by KCI.

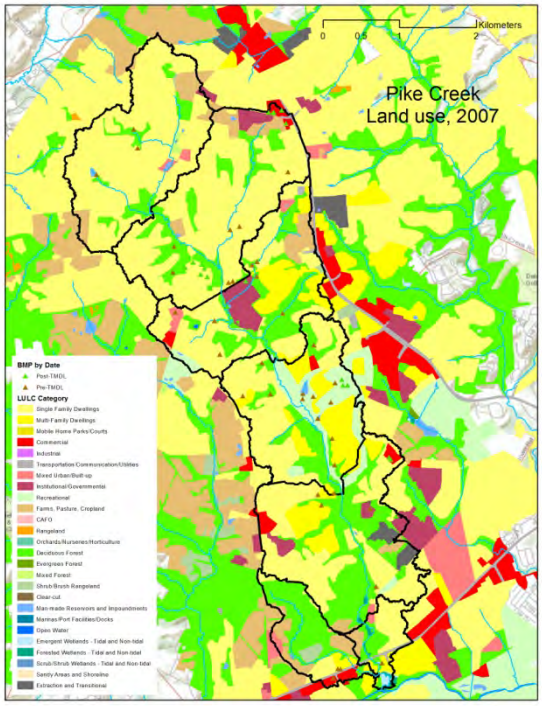

Figure 3 -- Land use in the Pike Creek watershed, 2007.

a. <u>Land use and land cover</u>

Land use and land cover (LULC) data comprise a critical element in the loading rates associated with Total Nitrogen, Total Phosphorous, and Bacteria within an individual catchment. Several data layers were identified and used to allow for assessment of the effects of input land cover classification on predicted loading:

Delaware Land Use, 2007 – Considered the most accurate and detailed layer for purposes of determining loading rates. See Figure 3 for a depiction of 2007 land use for the Pike Creek watershed.

2001 National Land Cover Dataset (NLCD) – Created by a consortium of federal agencies, this dataset is based on Landsat 30 m satellite data. While not considered

as accurate as the 2007 land use dataset, many models incorporate these data, which are useful since they are consistent across the entire country.

1996 UD-WRA Photo-interpretation – This land cover dataset was created by the UD-WRA for the Christina Basin, based on 1996 aerial photography in support of the development of the TMDL for the Basin.

b. Soils data

The latest SSURGO soils data for Delaware were compiled and categorized according to Hydrologic Soil Group (HSG) classification. Consideration of HSG is important in determining runoff volumes for several stormwater models, since this classification relates to the ability of a soil to infiltrate stormwater. Group A soils are the most permeable, while Group D soils are the least.

c. Public and Private Open lands

This dataset is useful in the analysis of areas likely to be candidates for new BMPs or retrofits. These lands tend to be larger, with more reduction potential, and with owners who are more likely to participate.

d. New Castle County Parcels

Tax parcel boundaries were obtained to allow a highly-detailed, site-by-site consideration of potential future stormwater improvement projects.

e. BMP Installation Dates

In some cases the dates for the installation of BMPs were not captured in the GIS. New Castle County assisted in acquiring the missing dates for installed BMPs in the Pike Creek watershed. The date of the BMP is important since only those installed before October 1998 were used to derive the TMDL for the White Clay Creek (of which Pike Creek is a part). BMPs installed from October 1998 count toward any load reductions required by the TMDL allocation. Based on the full inventory of installation dates, the catchments delineated by KCI were then further categorized as being "pre-TMDL" (i.e., having been installed before October 1998) or "post-TMDL." Figure 2 on page 4 illustrates the locations of BMPs in the Pike Creek watershed, and characterizes stormwater catchments according to their drainage.

B. Assessment of Water Quality Model Options

WRA evaluated the wide variety of stormwater runoff models available to assess the required parameters of the WQIP. Parameters of interest included the loading rates of pollutants addressed by current TMDL regulations: total nitrogen (TN), total phosphorous (TP), and enterococcus bacteria. These models range from quite simple to very complex. The simplest cases consider general surface cover, runoff potential, and rainfall, while more complex models include soils characteristics, overland and channelized flow

dynamics, time of concentration, interception, chemical interaction, slope, and highly localized meteorological conditions at a short time-step interval. An important component of the more complex models is calibration using water quality measurements.

For the purposes of this project, a key feature of any model adopted is its ease of implementation across a wide variety of watersheds and scales. A further requirement is that the model be flexible enough to easily allow for creation of multiple scenarios (i.e., implementation of new BMPs and retrofits), and that loads and reductions can be calculated on a user-defined, small-scale network of catchments for individual site analysis.

1. HSPF

   The Hydrological Simulation Program – Fortran (HSPF) incorporates a large suite of algorithms to allow for highly detailed predictions of pollution loading, based on many parameters. This model, developed by the U.S. Environmental Protection Agency (USEPA) and the U.S. Geological Society (USGS), has been used for many decades, and provides a wide range of input and output options. In Delaware and elsewhere this model has provided the basis for developing Waste Load Allocations for waterways requiring TMDLs. The Christina Basin TMDL (of which White Clay Creek, Red Clay Creek, Brandywine River, and Christina River are components) was based on the development of a highly calibrated model prepared for the state by the USGS.

   This process took several years and cost approximately $1 million. Regulatory requirements for pollutant reductions made this level of analysis necessary. The time and cost of repeating this procedure using updated information given the necessity of eventually developing plans for 21 watersheds, would be prohibitive. A brief assessment of HSPF was performed using data derived from the BASINS software interface, without calibration. The inability of the software to easily accommodate the stormwater catchments created for the project makes a site-by-site assessment problematic.

2. PLOAD

   The BASINS GIS-based modeling interface provides a front-end for several models, including automatic data downloads and a wizard like interface to generate tabular and spatial results. The Pollutant Loading Estimator (PLOAD) is one of these models. This model provides a simple method for estimating loading rates on an annual basis, using one of two calculation methods: Event Mean Concentrations (i.e., the "Simple Method" used by the USEPA) and Export Coefficients (which specifies an annual load expected from given land cover types). While the simplicity of the modeling approach does not allow for as many factors as more complex models, the PLOAD model allows the running of multiple scenarios easily. The lack of temporal resolution (i.e., small time step) results in a more generalized model that can be readily applied to a variety of locations and catchment sizes.

3. SPARROW

The Spatially Referenced Regressions On Watershed attributes (SPARROW) model was developed by the USGS to address regional watershed modeling efforts for TMDL development across the country. This is an online-based interface, which incorporates regional studies of extensive monitoring data to derive empirical models for various parameters and areas of the United States. The interface allows for the breakdowns on a sub-catchment basis, and rapid generation of loads using a GIS-based mapping interface. Detailed source information (e.g., atmosphere, agriculture, municipal sources, etc.) is presented through the mapping interface, along with predicted total loads.

While SPARROW is well suited for large, regional analysis (e.g., at the scale of the Delaware Basin), it is generally not considered appropriate for smaller scale analysis. Other drawbacks to the current project include the inability to specify customized catchments, a limited number of models allowing for analysis of contaminants (for instance, there is no option to determine bacteria loads). The model is also not well suited to the incorporation of BMP information to allow for easy estimation of reductions.

4. L-THIA

The Long Term Hydrologic Impact Analysis (L-THIA) model was developed at Purdue to estimate runoff, recharge, and pollution loading. The model is implemented as a web-based tool which takes land use, soils data, and regional meteorological data as inputs. This model is flexible and easy to use, and generates runoff amounts and loading rates for several pollutants. The interface provides the opportunity to input several scenarios based on changes in land cover type.

Shortcomings of the model for use in the Pike Creek study include the fact that input data (land cover information) would have to be calculated for each catchment individually. Since the watershed has been divided into 183 catchments this would be cumbersome. The online nature of the interface also limits the ability to alter parameters such as rainfall and soil characteristics.

5. CAST

The Chesapeake Assessment Scenario Tool (CAST) was examined for its suitability in the Pike Creek study. CAST was developed for use in the Chesapeake Watershed Implementation Plan (WIP). The model has the advantage of having been developed for all of the watersheds of Delaware (even those outside the Chesapeake Basin). CAST is an online model which generates pollution loading rates, based on easily customized scenarios.

The drawbacks of this model approach in the Pike Creek include the fact that inputs and implementation are largely hidden to the user. It is therefore difficult to implement at the level of arbitrary catchments. Data are not entered in GIS (i.e., spatially explicit) form, so the 183 catchments which were carefully delineated cannot be easily incorporated. The land use classification used is not customizable—using a variety of

land use layers that can be translated among each other is useful to assess the model's sensitivity to land cover inputs. Finally, the data such as land use and BMP areas are expressed as a percentage of the watershed, rather than in acres, so further processing of each catchment would be even more involved.

The chart in Figure 4 illustrates a comparison of results among several of the models examined. The red line shows the published TMDL in kilograms per year for Pike Creek, while the blue line indicates the annual Total Nitrogen (TN) load based on 10 years of STORET monitoring data. The PLOAD model (both using Event Mean Concentration and Export Coefficient methods) was compared using three different land use input layers, and the L-THIA model was implemented with two different land use layers. Note that the best level of agreement between modeled and measured values of total nitrogen loads for the time period results from using the modified PLOAD model. All models examined except SPARROW result in a Waste Load below the Waste Load Allocation specified in the TMDL for total nitrogen in the Pike Creek watershed.

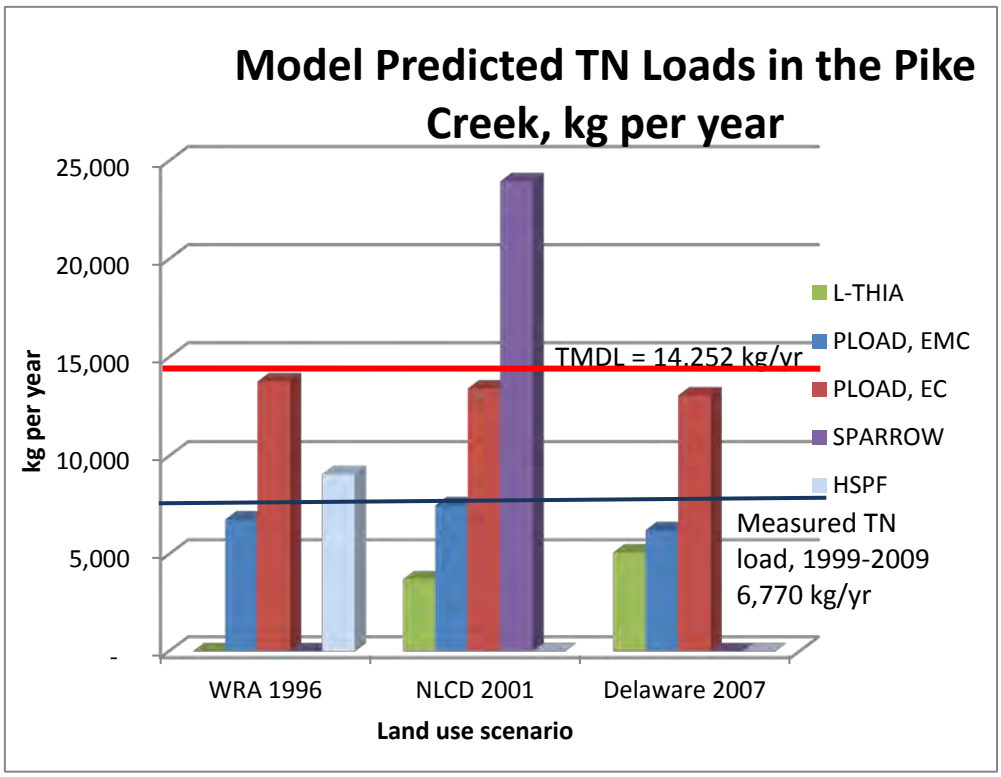

Figure 2 -- Comparison of several total nitrogen loading models, under several land use scenarios.

C. Use of the PLOAD "Simple Method" Model

The model that was used for developing predicted loads and reductions for the Pike Creek WQIP is a modification of the PLOAD model, as discussed above. To allow for the flexibility of using GIS layers as input, the Event Mean Concentration (or "Simple Method") approach was implemented. As described above, the loading rates are calculated on a highly individualized set of catchments, which are characterized by their drainage type

(to a BMP, through an outlet, or directly to a stream). Further refinement of the BMP data included an installation date to differentiate those features installed before versus after implementation of the TMDL. This distinction is important, since reductions realized after the implementation of the TMDL should be counted toward the final reduction requirement (if any) for a given pollutant (i.e., total nitrogen, total phosphorous and bacteria).

The advantages of the modified PLOAD model are its flexibility in incorporating GIS data, its transparency, and its applicability at a variety of scales and locations. The GIS-based model uses data layers for catchments and the location of BMPs and other stormwater infrastructure, as well as streams and water bodies. Information can be generated in tabular form and linked back to the original catchments, including land cover and runoff-based loads and reductions based on published efficiencies.

The following formulae summarize the implementation of the PLOAD model for the Pike Creek WQIP study.

$$L = 0.226 * R * C * A$$

For nutrients (TN and TP), where:

L = Annual load (lbs.)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

And

$$L = 1.03 * 10^3 * R * C * A$$

For bacteria, where:

L = Annual load (billion colonies)
R = Annual runoff (inches)
C = Bacteria concentration (colonies/100ml)
A = Area (acres)
$1.03 * 10^3$ = Unit conversion factor

Runoff volumes (R) were calculated using following formula:

$$R = P * Pj * Rv$$

Where:

R = Annual runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff
Rv = Runoff coefficient

The runoff coefficient (Rv) was derived as follows:

$$Rv = 0.05 + 0.9 * Ia$$

Where:

Rv = Runoff coefficient
I_a = Percent impervious (in decimal form) draining to the BMP or pour point

The PLOAD/Simple Method model, as with most land cover based models, is highly sensitive to the source land cover dataset used and to the development of runoff coefficients for given land cover types. Depending on which land use codes are used for a land use layer, as well as the Event Mean Concentration values for given land uses quite different results are possible.

To enable assessment of the loads associated with land cover classes in the Delaware 2007 Land Use layer using the modified PLOAD model, a mapping scheme was employed to assign each category to a land cover type for which published loading rates were available. Table 1 shows the category in the Delaware 2007 Land Use layer and its associated land cover type used to calculate loadings and Table 2 presents the loading rates for TN, TP, and enterococcus bacteria used in the Pike Creek modeling exercise.

Table 1 -- Land uses from the Delaware 2007 Land Use layer, with the corresponding category from the "Simple Method" land cover classification scheme. The category "Paved" represents an aggregation of impervious classes.

Delaware 2007 Land Use	Model Class
Farmsteads and Farm Related Buildings	Residential
Multi Family Dwellings	Residential
Single Family Dwellings	Residential
Commercial	Commercial, Institutional, Mixed Urban
Institutional/Governmental	Commercial, Institutional, Mixed Urban
Mixed Urban or Built-up Land	Commercial, Institutional, Mixed Urban
Other Urban or Built-up Land	Commercial, Institutional, Mixed Urban
Retail Sales/Wholesale/Professional Services	Commercial, Institutional, Mixed Urban
Utilities	Industrial, Utilities
Warehouses and Temporary Storage	Industrial, Utilities
Herbaceous Rangeland	Open Space, Recreation, Transitional
Recreational	Open Space, Recreation, Transitional
Shrub/Brush Rangeland	Open Space, Recreation, Transitional
Transitional	Open Space, Recreation, Transitional
Cropland	Agricultural
Idle Fields	Agricultural
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest
Man-made Reservoirs and Impoundments	Water and Wetlands
Natural Lakes and Ponds	Water and Wetlands
Non-tidal Emergent Wetland	Water and Wetlands
Non-tidal Forested Wetland	Water and Wetlands
Non-tidal Open Water	Water and Wetlands
Non-tidal Scrub/Shrub Wetland	Water and Wetlands
Waterways/Streams/Canals	Water and Wetlands
Communication - antennas	Paved
Highways/Roads/etc.	Paved

Table 2 -- Loading rates based on published values. Source: Schueler, 2007. Note ‡Enterococcus loading rates were derived from published values for fecal coliform loading rates (Most Probable Number, or MPN, per 100ml) according to the following formula: Log(E) = 0.719883*Log(FC), where E = concentration of enterococcus, in colonies/100ml and FC = concentration of fecal coliform, in colonies /100ml. This relationship is based on an empirical study for the Willapa River in Washington State. Fecal coliform loading rates are noted parenthetically. *The category "Paved" represents an aggregation of impervious classes.

Land Cover Category	TN (mg/l)	TP (mg/l)	Bacteria (MPN/100ml)‡
Residential	2.1	0.31	586 (7000)
Commercial	2.1	0.22	433 (4600)
Industrial	2.1	0.25	271 (2400)
Open Space	2.3	0.31	212 (1700)
Agricultural	4.3	0.6	812 (11000)
Forest	1.1	0.12	123 (800)
Water/Wetland	0	0	0 (0)
Paved*	1.875	0.42	226 (1860)

D. Development of Runoff Reduction Model with DURMM as Basis

The final draft of the NPDES permit stated that the WQIP would propose "at least a 3% decrease in untreated EIA." Discussions with DNREC indicated that any proposed BMPs would need to be sized such that they provide cumulative storage volume equivalent to 3% of the *Resource Protection Volume* (RPv) resulting from runoff from the impervious surfaces in the watershed. It was indicated that DNREC's DURMM model would be the most appropriate way to demonstrate compliance. A considerable amount of time was spent creating a methodology that used PLOAD as its basis but incorporated aspects of DURMM. The resulting spreadsheet, developed by Duffield Associates, was termed the DURMM/WQIP model and is shown in Appendix A. This presented many challenges as DURMM is intended more as a site design tool and is not configured for a several thousand acre watershed.

Many of the routines in DURMM were copied into the DURMM/WQIP spreadsheet to allow for evaluations on the watershed level. Since the spreadsheet was intended to be a screening level model, a method to approximate BMP sizes and costs was needed. This was difficult as most existing data does not consider watershed area but compares structure size with costs. One model that does correlate watershed area with structure size is the BMP – REALCOST model developed by the Urban Drainage Flood Control District in Denver in conjunction with the Urban Watersheds Research Institute, Colorado Stormwater Council, and Colorado State University. Aspects of this model were incorporated into the DURMM/WQIP model.

Using the methodology detailed in the DURMM model, the Resource Protection Event Volume (RPv) in inches and the Retention Reduction Volume in acre-feet were computed for each of the example retrofits or new BMPs. The formulas obtained from the BMP-REALCOST model were used to estimate storage volume (in cubic feet) and capital costs for construction using the Engineering News Record Construction Cost Index as a primary input. See Table 3. In general these calculations were based on the combination of the BMP type and impervious acreage associated a catchment area. An interactive workbook of the DURMM/WQIP model which includes the details discussed above was developed. Static print-outs for demonstration purposes are presented in Appendix A.

Table 3 – Sample BMP-REALCOST Capital Costs and Structure Volumes for Porous Landscape Detention (i.e., Infiltration).

Impervious Area	Costs	Volumes (ft^3)
0.1	$14,240	217.8
0.2	$16,629	435.6
0.3	$19,017	653.4
0.4	$21,406	871.2
0.5	$23,795	1,089
0.6	$26,184	1,306.8
0.7	$28,573	1,524.6
0.8	$30,962	1,742.4
0.9	$33,351	1,960.2
1	$35,740	2,178
2	$59,629	4,356
3	$83,517	6,534
4	$107,406	8,712
5	$131,295	10,890
6	$155,184	13,068
7	$179,073	15,246
8	$202,962	17,424
9	$226,850	19,602
10	$250,739	21,780

III. PRIORITIZATION OF SUBWATERSHEDS AND POTENTIAL RETROFIT LOCATIONS

A. General

In conjunction with the pollutant loading modeling, a Geographic Information System (GIS), based desktop evaluation of jurisdictional, physical, and natural resource GIS data layers were utilized by Duffield Associates, in an effort to prioritize potential BMP retrofit opportunities and locate areas for new BMPs. The desktop evaluation used a two-tiered scaled approach that initially examined the watershed, as a whole, by prioritizing the 183 catchment areas then analyzed and ranked all the New Castle County tax parcels falling within a subset of 183 catchment areas.

B. Subwatershed/Catchment Prioritization

Using the State of Delaware's Office of Management and Budget published 2007 Impervious Surface for New Castle County's GIS dataset; Duffield Associates computed the total percentage of impervious coverage for each of the 183 catchment/drainage areas within the Pike Creek Watershed. Additionally, via a desktop screening of 2010-2011 orthophotography data, "hot spots" or areas anticipated to generally produce high amounts of runoff (i.e., strip malls or high density housing) were identified and selected. For the purposes of this project, only those catchment areas that were associated with either a stormwater outfall with no treatment structure or BMPs classified as a "Dry Pond" were prioritized for further analysis.

The DURMM/WQIP print-outs provided in Appendix A identify the locations of the 46 catchments selected for additional desktop evaluation.

C. Tax Parcel Prioritization

For each of the 46 prioritized catchments, a ranking was performed on all New Castle County Tax Parcels in an attempt to prioritize locations for new BMPs or retrofits. A weighted scoring matrix was developed to yield an objective value for each parcel. Utilizing a number of GIS geoprocessing tools, scores were assigned based on a list of factors that includes: Slope, Parcel Size, Proximity to BMP or Outfall Structure, "Public Land" or "Open Space", Hydrologic Soil Group Classification, and underlying Water Resource Protection Areas (WRPAs).

As the factors varied in relative importance, a weight scale of 100% was applied in effort to emphasize some conditions over others (i.e., Slope has a 20% weight versus WRPAs 5% weight). For each factor, values were classified, or grouped, resulting in a higher score for a generally more suitable condition. For example, a parcel that has a majority percentage of hydrologic soil group "A" would be assigned a value of 4; if a neighboring parcel has a majority percentage of hydrologic soil group "D" a value of 1 would be tallied. Table 4 summarizes the ranking factors, classifications and weights used for this study.

Table 4 – Prioritization of Parcels.

Factor	General Description	Classification	Scale	Weight
Depth to Groundwater where applicable (i.e. southern New Castle County)	Areas with a greater depth to groundwater rank higher	0'-5' = 1 6'-10' = 2 10'-15' = 3 >15' = 4	Site	0.2
Slope - Flat Areas preferred/steep eliminated?	Areas with lower slope average rank higher; those with x or higher are eliminated	>40% = 1 40-30% = 2 30 -20% = 3 <20% = 4	Site	0.2
NRCS Soils	Well drained soils rank higher	Type D = 1 Type C = 2 Type B = 3 Type A = 4	Site	0.2
Distance to Outfall or BMP?	Shorter distance rank higher	>500' = 1 500'-250' = 2 250' -50' = 3 <50) = 4	Site	0.15
County/State Open Space	Areas within rank higher	Out = 1 In = 4	Site	0.1
Parcel Size	Larger parcels rank higher	<0.5ac = 1 0.5ac-1ac = 2 1ac -1.5ac = 3 >1.5ac = 4	Site	0.1
Water Resource Protection Areas (WRPA) - Cockeysville Formation/WHPA	Areas within rank lower	In = 0 Out = 4	Site	0.05

It should be noted that due to the hydrogeologic variability associated with the Piedmont region, a depth to groundwater surface is not currently available for desktop analysis nor is one anticipated to be. As such, depth to water was not considered in the desktop parcel prioritization. However, for future projects located in the coastal plain (generally those areas south of the C&D Canal), the Delaware Geological Survey's Digital Water-Table Data for New Castle County, Delaware (Digital Data Product No. 05-04) should be incorporated into the parcel scoring.

Upon completion of the parcel prioritization, those that ranked the highest were mapped and targeted for field reconnaissance to evaluate the area's feasibility for BMPs and/or retrofit.

IV. FIELD RECONNAISSANCE

A. Summary of Activities

To refine the results of the desktop analysis, a list of 46 prioritized sites were mapped and visited in the field to evaluate the feasibility of implementing new or retrofitting existing stormwater management practices.

B. Site Mapping

In an effort to field locate the 37 stormwater outfalls and nine dry pond BMPs associated to the 46 catchment areas, a "Map Book," or a group of maps containing specific location information, was developed to provide field ready drawings as a platform to record site notes and sketches. Using the highest ranking parcels as focal points, 46 unique maps were created that detail the structure type (BMP or stormwater outfall), delineated catchment area and accompanying impervious acres. A copy of the Map Book has been included in Appendix B.

C. Site Visits and Inspections

To verify GIS data and assess the applicability of installing a new BMP or retrofit, Duffield Associates performed a three-day field reconnaissance effort in July 2012 that included visits to the 46 locations. Using the Center for Watershed Protection Retrofit Reconnaissance Investigation Form as a reference, an adapted "Field Reconnaissance Investigation Form" was created to capture general site information such as the address, tax parcel identifier, site constraints, and any existing stormwater management practice or potential thereof. The field reconnaissance forms have been included with this report as Appendix C.

In general, as land use within the Pike Creek watershed is largely dominated by urban/suburban classifications, many of the visited sites were surrounded by developed areas. As such, the feasibility for implementing BMP is anticipated to be limited due to the availability of land. Additionally as the majority of the untreated stormwater outfalls discharge directly into the Pike Creek (or tributaries), the seasonal high water table in the adjacent areas is expected to be very shallow, further restricting infiltration-type stormwater management practices.

It is noted that throughout the watershed, highly eroded stream channels and bank failures were commonly observed. This is likely due to the high impervious percentage throughout the watershed coupled with the generally steep slopes associated with streams at or near the "fall line" or geologic transition zone between the Piedmont and Atlantic Coastal Plain.

The results of the field reconnaissance, specifically regarding the feasibility of creating or retrofitting a stormwater management practice were summarized and used as inputs in the Runoff Reduction Model (to be discussed in the following sections).

V. EFFECTS OF PRELIMINARY BMPS AND RETROFITS

A. Reductions in Resource Protection Volume

An iterative process was used to identify possible BMPs that involved results of the site prioritization, field reconnaissance (summarized in the map book and field forms), and the DURMM/WQIP model. The site prioritization and field reconnaissance yielded potential BMP or retrofit locations, whereas the DURMM/WQIP model numerically demonstrated BMP or retrofit effects or impacts.

Using drainage areas developed for the PLOAD model, it was found that there are roughly 980 acres of impervious area in the watershed. For a runoff curve number of 98 (the default value for impervious surface regardless of soil type), the RPv is 2.46 inches. This translates to approximately six acre-feet. However, practices such as infiltration and bioretention with infiltration (collectively referred to as *runoff reduction* practices) placed after 1998 (end of the sampling which formed the basis for the TMDL) were estimated to result in about a half acre-foot of storage. To obtain the remaining 5.5 acre-feet of storage, runoff reduction practices were specified at various outfalls as described below.

Since land is already available for existing dry basins and their nutrient uptake capabilities are not significant, these structures were the first to be identified for retrofits. Of the 46 locations visited, nine were existing dry basins. Six of these were identified for retrofits to infiltration but the remaining three each had drainage areas in excess of 10 acres which was considered too large for infiltration. Using the BMP-REALCOST structure sizing and cost approximations based on drainage area, it was found that these six conversions would provide 1.77 acre-feet of storage.

The remaining priority sites were evaluated and BMPs or retrofits assigned to locations deemed most appropriate until the six acre-foot sum was reached. As previously noted, runoff reduction practices placed after 1998 were estimated to result in about a half acre-foot of storage, and therefore, the goal of this exercise was to provide an additional 5.5 acre-feet of storage.

This process resulted in 16 example infiltration facilities which, again using the BMP-REALCOST data would result in 3.87 acre-feet of storage. Outfalls located in very wet areas where infiltration would not be at all feasible were assigned other types of BMPs. This process resulted in five vegetated channels and one constructed wetland. These types of BMPs get no runoff reduction credits in DURMM, and therefore, do not count towards the six acre-feet goal. However their pollutant removal efficiencies were factored into the nitrogen, phosphorous, and bacteria calculations described in the next section.

All told and including runoff reduction practices placed after 1998, the retrofits and new facilities described above, if able to be constructed in the field, would provide just over six acre feet of storage. Print outs from the DURMM/WQIP model showing locations and types of retrofits or new facilities are provided in Appendix A.

While in theory a BMP storage equivalent to 3% of the RPv from impervious surfaces in the watershed can be attained, it is stressed that the above assessment is conceptual only. The feasibility of converting dry basins to infiltration or providing new infiltration facilities would require soils and groundwater analyses beyond the scope of this pilot project. Furthermore, hydrologic and hydraulic calculations would be needed for individual locations to assess the feasibility of a BMP (i.e., infiltration) to handle the capacity and flow associated with its corresponding drainage area. The size of each drainage area will likely play a key role in selecting and implementing a BMP. For example, the Maryland Department of the Environment (MDE) uses five acres as the maximum drainage area size for infiltration trenches and ten acres for infiltration basins in its BMP manual.

B. Reductions in Pollutant Loadings

The methodology developed to determine loading rates for total nitrogen (TN), total phosphorous (TP), and enterococcus bacteria in the Pike Creek watershed enabled the incorporation of pollutant reductions associated with BMPs, either existing or suggested, on a catchment by catchment basis. Using published values for reductions that have been approved by the DNREC Division of Watershed Stewardship, the total pollutant loads for each of the 183 stormwater catchments in the Pike Creek watershed were determined by multiplying the load for each catchment by the pollutant reduction value(s) for each constituent.

Table 5 summarizes the values used to determine pollutant reduction efficiencies for given BMPs.

Table 5 -- Reduction efficiency rates for TN, TP, and bacteria, for selected BMP technologies used in the Pike Creek model. The low and high ranges for reduction efficiencies are shown.

BMP Technology	TN, low	TN, high	TP, low	TP, high	Bacteria, low	Bacteria, high
Dry Pond	10%	10%	15%	15%	0%	0%
Wet Pond	30%	40%	50%	75%	44%	99%
Bioretention	40%	60%	25%	50%	99%	99%
Biofiltration	40%	60%	25%	50%	99%	99%
Sand filter	30%	45%	60%	65%	36%	83%
Level spreader	40%	60%	25%	50%	25%	25%
Infiltration basin	15%	15%	25%	25%	99%	99%
Vegetated channel	20%	20%	15%	15%	0%	0%
Wetlands	25%	55%	50%	75%	78%	90%

Table 6 shows the total annual loads for selected parameters (TN, TP, and Enterococcus bacteria) for both the high and low loading condition. The three scenarios shown include the load at the time of the implementation of the TMDL for the White Clay Creek (October, 1998), the load reflecting BMPs installed after October 1998, and the resultant loads based on installation of suggested BMPs and retrofits.

Table 6 -- Total annual loads for selected parameters (TN, TP, and Enterococcus bacteria).

Parameter	October 1998 Baseline Load (low)	October 1998 Baseline Load (high)	Load with post-TMDL BMPs (low)	Load with post-TMDL BMPs (high)	Load with New BMPs (low)	Load with New BMPs (high)
Total Nitrogen, lbs/year	16,251	16,066	15,951	15,655	15,676	15,386
Total Phosphorous, lbs/year	2,301	2,274	2,261	2,219	2,133	2,048
Enterococcus Bacteria, billion CFU/year	24,621	23,734	23,149	21,994	20,563	19,429

Table 7 shows the pollution reductions and percentages from post-TMDL BMPS, as well as the suggested BMPs and retrofits for both the low and high ranges of removal percentages.

Table 7 -- Pollution reductions from all BMPS in the post-TMDL period, and for all additional BMPs and retrofits. Percentages, in parentheses, reflect the net reduction from the preceding time period (i.e., from the baseline in October, 1998 to current conditions, and from current conditions to conditions under suggested BMPs and retrofits).

Parameter	Reduction from post-TMDL BMPs (low)	Reduction from post-TMDL BMPs (high)	Reduction from New BMPs (low)	Reduction from New BMPs (high)
Total Nitrogen, lbs/year	300 (1.8%)	411 (2.6%)	275 (1.7%)	269 (1.7%)
Total Phosphorous, lbs/year	40 (1.7%)	55 (2.4%)	128 (5.7%)	171 (7.7%)
Enterococcus Bacteria, billion CFU/year	1471 (6%)	1739 (7.3%)	2586 (11.2%)	2565 (11.7%)

The first two columns in Table 7 show the reductions resulting from BMPs installed after the October 1998 baseline. The third and fourth columns show additional reductions resulting exclusively from suggested BMPs and retrofits. The percentage reductions for the first two columns, in parentheses, reflect the difference between the load in October 1998 and current conditions. The percentage differences in the second two columns reflect the net effect of suggested new BMPs and retrofits.

These data present BMP reductions and resulting loads using the latest and best available land cover data, based on currently existing BMPs. Prioritization of new installations and retrofits can be guided by examining the expected load reductions from implementation of new measures, and can be quantified on an approximate cost per unit reduction basis.

C. Budgetary Cost Estimate

The BMP-REALCOST structure sizing and cost approximations were used to develop a budgetary cost estimate for many of the example BMPs and retrofits. It is stressed that this sizing and cost information is very imprecise in nature and is intended as a planning tool only. Through the efforts of a consultant, the Urban Drainage Flood Control District in Denver developed "best fit" curves that sought to correlate structure sizing and cost approximations with impervious area in the watershed draining to BMPs. In some instances such as vegetated channels, level spreader, and sand filters, a lump-sum cost of $20,000 was used since these types of structures are not included in the BMP-REALCOST model.

Using these data and assumptions, the six locations identified for dry pond retrofits to infiltration would cost approximately $400,000 to construct and the 16 example infiltration facilities would cost just under $3 million. The five vegetated channels and one constructed wetlands were estimated to be approximately $100,000 for the vegetated channels and $36,000 for the wetlands.

All told, the retrofits and new facilities described above, if able to be constructed in the field, would cost approximately $3.5 million. These expenditures would be intended to provide benefits described herein and are summarized in Table 8 (average between low and high values used for pollutants):

Table 8 – Per unit reduction costs of suggested BMPs.

	Reduction	Per Unit Cost
Runoff Reduction	5.5 acre-feet	$640,000
Total Nitrogen	272 lbs/year	$12,900
Total Phosphorous	150 lbs/year	$23,300
Enterococcus Bacteria	2,575 bn CFU/year	$1,400

For comparison, the "Nutrient Credit Trading for the Chesapeake Bay – An Economic Study," prepared in May 2012 for the Chesapeake Bay Commission, indicated that infiltration costs for nitrogen and phosphorous removal in urban environments were on the order of $200 to $600 and $5,000 to $20,000, respectively. As stressed, much of the cost information used in this report is very approximate and sometimes unsubstantiated and intended for demonstration purposes. Fine tuning of the WQIP approach would be expected to provide more reliable data.

Assuming a 20-year time frame and 3% interest rate, the Principal Permittees would need to invest about $240,000 each year to implement this plan. It is important to note that these capital costs do not include annual maintenance costs.

VI. CONCLUSIONS AND RECOMMENDATIONS

Numerous recommendations are made as a result of the Pike Creek WQIP for use in subsequent plans. They are as follows:

Evaluate processes for updating plans. A WQIP should be considered a living document and not static in nature. The process for preparing plans needs to allow for updating as new data becomes available. For example, as development and redevelopment occurs in any given watershed, those proposing the plans will need to demonstrate pollutant load reductions using DURMM. The New Castle County Department of Land Use reviews the development plans, whereas the Department of Special Services is responsible for the WQIPs. A formalized communication channel would be helpful in quantifying reductions gained through development and redevelopment over time.

Develop procedures for benchmarking Effective Impervious Area (EIA). It was found that there are about 980 impervious acres in the Pike Creek watershed. Direction from DNREC indicated that proposed BMPs would need to be sized such that they cumulatively provide storage volume equivalent to 3% of the *Resource Protection Volume* (RPv) resulting from runoff from the impervious surfaces in the watershed. However, this process does not recognize that all impervious areas are not necessarily EIA as defined in the permit.

Begin collecting volume or size of basin or BMP in future inventories. Information regarding existing basins and BMPs available for the Pike Creek WQIP was limited to type of structure, location, year built, and contributing drainage area. While retrofit or construction costs were estimated based in part on the BMP-REALCOST model from Denver using drainage area, this approach is considered very approximate. Most cost data that exists is based on volume of basins, square footage of infiltration, etc. This information would make cost estimates for retrofits more accurate and would be expected to provide more reliable data.

Use up-to-date topographic and land use maps. The TMDL for the White Clay Creek (of which the Pike Creek is a subwatershed) is based on 1998 information. Topographic information such as LiDAR data is readily available and, in many cases, more accurate than contours used in 1998. It was found that the boundaries of the Pike Creek were slightly different between the two. This was not considered a significant discrepancy as the area differences were small and over time and with multiple WQIPs being prepared, overlaps would self-correct. The use of current land use maps necessitates an assessment of how changes in land use since 1998 affects the TMDL allocations.

Prioritize the retrofit of existing dry basins. Opportunities for new BMPs in existing developed areas may be limited depending on the watershed. In the Pike Creek watershed, many delineated subwatersheds were comprised entirely of developed lands and had limited to no public or private open space. Since land is already available for existing dry basins and their nutrient uptake capabilities are not significant, these structures should be prioritized for retrofits.

Limit sizes of drainage areas in delineations. The approach should be altered so overly large areas are further broken down. Also, though rare, there are instances when storm sewers cross ridge lines. The locations of storm inlets and pipes could be overlaid on a map of drainage areas to find such occurrences, but this could be a tedious process.

Incorporate groundwater depths in BMP and retrofit feasibility assessments. Since the Pike Creek is a Piedmont stream with hydrogeologic variability, a depth to groundwater surface is not currently available for desktop analysis nor is one anticipated to be. For future projects located in the coastal plain (generally those areas south of the C&D Canal) the Delaware Geological Survey's Digital Water-Table Data for New Castle County, Delaware (Digital Data Product No. 05-04) should be incorporated into the parcel scoring.

Use broad range of BMP and retrofit options. Due to budgetary constraints, the evaluations described herein were limited to retrofitting existing basins and placing BMPs at storm sewer outfalls. While these should continue to be the focus for future WQIPs, other opportunities such as roadway crossings of streams should be considered as well. Similarly, there are numerous nonstructural BMPs that others have sought to develop impervious area equivalency factors for their use. For example, in June 2011, the MDE published the draft document "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated." This guidance manual provides impervious acre equivalents for many BMPs such as buffers and shoreline stabilizations. In other words, MDE found that successful implementation of these and other BMPs yields results similar to elimination of impervious acreage. Overreliance on volume-reducing BMPs potentially at the expense of other BMPs may result in lower overall dollars per pound pollutant removed efficiency.

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APPENDIX A

WQIP / DURMM
SPREADSHEET MODEL

Pike Creek Water Quality Improvement Plan

DURMM / WQIP Model

Drainage Area ID	Performed Field Reconnaissance?	Type	PLOAD Nitrogen Load (low)	PLOAD Nitrogen Load (high)	Drainage Area (ac)	Impervious Area (ac)	Curve Number	Post 1998 BMP (Yes/No)	RPv (in.)	Storage Volume (cu. Ft.)	Existing BMP Type
1	NO	BMP	59.57	39.71	16.6	5.3	98	Yes	2.46	N/A	Levelspreader
2	NO	BMP	247.89	212.48	73.8	19.5	98	No	2.46		Wet Pond
3	NO	BMP	81.87	81.87	17.8	5	98	No	2.46		Dry Pond
4	NO	BMP	72.59	72.59	17.4	4.4	98	No	2.46		Dry Pond
5	YES	BMP	65.37	65.37	7.6	4	98	Yes	2.46	8,712	Dry Pond
6	NO	BMP	23.25	15.50	3.9	2.1	98	Yes	2.46	4,574	Bioretention - Underdrain
7	NO	BMP	9.85	6.57	1.5	0.9	98	No	2.46		Bioretention - Underdrain
8	YES	BMP	81.32	81.32	15	4.8	98	No	2.46	10,454	Dry Pond
9	NO	BMP	8.49	5.66	4.1	0.8	98	Yes	2.46	1,742	Bioretention - Infiltration
10	NO	BMP	4.82	3.21	1.1	0.4	98	Yes	2.46	871	Bioretention - Infiltration
11	NO	BMP	6.47	4.31	1.3	0.6	98	Yes	2.46	1,307	Bioretention - Infiltration
12	NO	BMP	6.94	4.62	1.6	0.6	98	Yes	2.46	1,307	Bioretention - Infiltration
13	NO	Direct	1069.11	1069.11	477.2	60.2	98	No	2.46		
14	NO	BMP	8.13	5.42	1.7	0.7	98	Yes	2.46	1,525	Bioretention - Infiltration
15	NO	BMP	9.60	6.40	1.7	0.9	98	Yes	2.46	1,960	Bioretention - Infiltration
16	NO	BMP	117.82	117.82	24.9	7	98	No	2.46		Dry Pond
17	NO	BMP	168.48	168.48	49.6	11	98	No	2.46		Dry Pond
18	NO	BMP	269.13	269.13	59.2	17.4	98	No	2.46		Dry Pond
19	NO	BMP	74.30	63.69	19.4	5.9	98	No	2.46		Wet Pond
20	YES	BMP	29.82	29.82	9.6	1.8	98	No	2.46	3,920	Dry Pond
21	NO	BMP	59.91	51.36	27.6	5.5	98	No	2.46		Wet Pond
22	YES	BMP	127.32	127.32	16.2	7.5	98	No	2.46	16,335	Dry Pond
23	NO	BMP	1.80	1.41	0.1	0.1	98	No	2.46		Sand Filter
24	NO	Direct	546.20	546.20	262.5	30.8	98	No	2.46		
25	NO	BMP	32.36	32.36	3.9	2	98	No	2.46		Dry Pond
26	NO	BMP	91.30	91.30	10.1	5.5	98	No	2.46		Dry Pond
27	NO	BMP	31.60	31.60	4.2	1.9	98	No	2.46		Dry Pond
28	NO	BMP	67.27	57.66	13	5.3	98	No	2.46		Wet Pond
29	NO	BMP	85.56	73.34	32.8	6.2	98	No	2.46		Wet Pond
30	NO	BMP	24.45	24.45	2.8	1.5	98	No	2.46		Dry Pond
31	NO	BMP	9.26	9.26	2.2	0.6	98	No	2.46		Dry Pond
32	NO	BMP	13.37	11.46	7.9	1	98	No	2.46		Wet Pond
33	NO	BMP	0.86	0.74	1.1	0.1	98	No	2.46		Wet Pond
34	NO	BMP	2.98	2.56	3	0.2	98	No	2.46		Wet Pond
35	NO	BMP	224.66	192.57	72.1	19.2	98	No	2.46		Wet Pond
36	NO	BMP	5.24	3.50	0.6	0.5	98	Yes	2.46	1,089	Bioretention - Underdrain
37	NO	BMP	2.10	1.40	0.2	0.2	98	Yes	2.46	436	Bioretention - Underdrain
38	NO	BMP	8.59	5.72	2.2	0.7	98	Yes	2.46	1,525	Bioretention - Underdrain
39	NO	BMP	11.90	7.94	1.1	1	98	No	2.46		Bioretention - Underdrain
40	NO	BMP	11.92	11.92	1.4	0.7	98	Yes	2.46	N/A	Dry Pond
41	NO	BMP	22.37	22.37	4.9	1.3	98	No	2.46		Dry Pond
42	YES	BMP	144.03	144.03	17.2	9.1	98	No	2.46	19,820	Dry Pond
43	YES	BMP	137.81	137.81	22.4	8.1	98	No	2.46	17,642	Dry Pond
44	NO	BMP	1.82	1.82	0.4	0.1	98	No	2.46		Dry Pond
45	NO	BMP	18.76	12.51	3.9	1.7	98	Yes	2.46	3,703	Bioretention - Underdrain
46	NO	BMP	32.07	32.07	4.4	1.8	98	Yes	2.46	N/A	Dry Pond
47	NO	BMP	25.76	17.18	2.5	2.1	98	Yes	2.46	4,574	Bioretention - Underdrain
48	NO	BMP	24.87	16.58	2.3	2.1	98	No	2.46		Bioretention - Underdrain

Drainage Area ID	Performed Field Reconnaissance?	Type	PLOAD Nitrogen Load (low)	PLOAD Nitrogen Load (high)	Drainage Area (ac)	Impervious Area (ac)	Curve Number	Post 1998 BMP (Yes/No)	RPv (in.)	Storage Volume (cu. Ft.)	Existing BMP Type
49	NO	BMP	132.93	113.94	38.4	10.5	98	No	2.46		Wet Pond
50	YES	BMP	224.17	224.17	49	14.7	98	No	2.46	N/A	Dry Pond
51	NO	BMP	3.00	2.57	0.8	0.2	98	No	2.46		Wet Pond
52	YES	BMP	173.77	173.77	25.2	10.9	98	Yes	2.46	N/A	Dry Pond
53	NO	BMP	9.94	9.94	6.7	0.7	98	No	2.46		Dry Pond
54	NO	BMP	296.12	296.12	112.5	16.7	98	No	2.46		Dry Pond
55	NO	BMP	183.54	157.32	49	13.8	98	No	2.46		Wet Pond
56	NO	BMP	289.31	289.31	87.5	20.7	98	No	2.46		Dry Pond
57	YES	BMP	291.65	291.65	82.1	18.1	98	No	2.46	N/A	Dry Pond
58	NO	BMP	83.22	83.22	8.1	5.1	98	No	2.46		Dry Pond
59	NO	BMP	110.63	94.83	27.8	8	98	No	2.46		Dry Pond
60	NO	BMP	9.52	6.35	0.9	0.9	98	No	2.46		Bioretention - Underdrain
61	NO	BMP	186.57	159.91	34.1	11.3	98	No	2.46		Bioretention - Underdrain
62	NO	BMP	22.67	15.12	4.9	2	98	Yes	2.46	4,356	Bioretention - Underdrain
63	NO	BMP	0.79	0.79	0.7	0	98	No	2.46		Dry Pond
64	NO	BMP	15.42	15.42	1.9	0.9	98	No	2.46		Bioretention - Underdrain
65	NO	BMP	16.58	11.05	3.9	1.5	98	Yes	2.46	3,267	Bioretention - Infiltration
66	NO	BMP	0.27	0.23	7.6	0	98	No	2.46		Wet Pond
67	NO	BMP	1.82	1.21	0.2	0.2	98	No	2.46		Bioretention - Underdrain
68	NO	BMP	1.91	1.27	0.7	0.2	98	No	2.46		Bioretention - Underdrain
69	NO	BMP	6.28	6.28	0.8	0.4	98	No	2.46		Dry Pond
70	NO	BMP	3.43	2.29	0.5	0.3	98	No	2.46		Bioretention - Infiltration
71	NO	Non-BMP	66.04	66.04	7.9	3.6	98	No	2.46		
72	NO	Non-BMP	2.37	2.37	0.2	0.1	98	No	2.46		
73	NO	Direct	17.77	17.77	19.4	2.3	98	No	2.46		
74	NO	Non-BMP	31.52	31.52	3.3	2	98	No	2.46		
75	NO	Non-BMP	79.62	79.62	6	4.4	98	No	2.46		
76	NO	Direct	59.24	59.24	52.7	3.7	98	No	2.46		
77	NO	Non-BMP	75.94	75.94	7.7	4.1	98	No	2.46		
78	YES	Non-BMP	400.46	400.46	44	21.6	98	No	2.46		
79	YES	Non-BMP	22.33	22.33	2.2	1.2	98	No	2.46		
80	YES	Non-BMP	137.44	137.44	14.9	7.3	98	No	2.46	15,899	
81	YES	Non-BMP	184.31	184.31	18.8	9.9	98	No	2.46	21,562	
82	NO	Non-BMP	92.95	92.95	9.3	5	98	No	2.46		
83	NO	Non-BMP	57.55	57.55	7.4	3.2	98	No	2.46		
84	YES	Non-BMP	33.47	33.47	4	1.9	98	No	2.46		
85	YES	Non-BMP	30.15	30.15	4.1	1.6	98	No	2.46		
86	NO	Direct	1604.28	1604.28	763.7	127.1	98	No	2.46		
87	YES	Non-BMP	55.21	55.21	7.9	2.9	98	No	2.46		
88	NO	Non-BMP	25.23	25.23	2.5	1.4	98	No	2.46		
89	NO	Non-BMP	62.84	62.84	6	3.4	98	No	2.46		
90	NO	Non-BMP	47.11	47.11	4.6	2.5	98	No	2.46		
91	NO	Non-BMP	52.57	52.57	5.5	2.8	98	No	2.46		
92	NO	Non-BMP	66.51	66.51	6	3.6	98	No	2.46		
93	NO	Non-BMP	128.21	128.21	19.1	6.5	98	No	2.46		
94	YES	Non-BMP	33.16	33.16	2.5	1.8	98	No	2.46	3,920	
95	YES	Non-BMP	22.94	22.94	2.9	1.2	98	No	2.46	2,614	
96	NO	Non-BMP	20.98	20.98	2.8	1.1	98	No	2.46		

Drainage Area ID	Performed Field Reconnaissance?	Type	PLOAD Nitrogen Load (low)	PLOAD Nitrogen Load (high)	Drainage Area (ac)	Impervious Area (ac)	Curve Number	Post 1998 BMP (Yes/No)	RPv (in.)	Storage Volume (cu. Ft.)	Existing BMP Type
97	NO	Non-BMP	179.40	179.40	26.9	10	98	No	2.46		
98	NO	Non-BMP	95.52	95.52	16.1	5.2	98	No	2.46		
99	NO	Non-BMP	12.19	12.19	1.6	0.7	98	No	2.46		
100	NO	Direct	379.74	379.74	217.4	24.6	98	No	2.46		
101	NO	Non-BMP	11.26	11.26	1.2	0.6	98	No	2.46		
102	NO	Non-BMP	26.21	26.21	2.8	1.4	98	No	2.46		
103	NO	Non-BMP	40.33	40.33	5.9	2.2	98	No	2.46		
104	NO	Non-BMP	119.69	119.69	11.8	6.5	98	No	2.46		
105	NO	Non-BMP	35.79	35.79	4.6	1.9	98	No	2.46		
106	YES	Non-BMP	9.37	9.37	1.2	0.5	98	No	2.46	1,271	
107	YES	Non-BMP	326.03	326.03	36.8	17.6	98	No	2.46	38,333	
108	YES	Non-BMP	15.94	15.94	1.5	0.9	98	No	2.46		
109	YES	Non-BMP	51.55	51.55	6.6	2.8	98	No	2.46	6,098	
110	YES	Non-BMP	42.38	42.38	12	2.6	98	No	2.46		
111	NO	Non-BMP	6.58	6.58	0.5	0.4	98	No	2.46		
112	NO	Non-BMP	107.98	107.98	21.9	5.8	98	No	2.46		
113	YES	Non-BMP	16.75	16.75	2.1	0.9	98	No	2.46	1,960	
114	YES	Non-BMP	39.49	39.49	6.4	2.1	98	No	2.46	4,574	
115	NO	Non-BMP	32.10	32.10	5.1	1.7	98	No	2.46		
116	NO	Non-BMP	25.06	25.06	4.2	1.3	98	No	2.46		
117	NO	Non-BMP	11.75	11.75	1.4	0.6	98	No	2.46		
118	NO	Non-BMP	10.92	10.92	1.3	0.6	98	No	2.46		
119	YES	Non-BMP	12.16	12.16	1.5	0.7	98	No	2.46	0	
120	NO	Non-BMP	46.09	46.09	8.1	2.5	98	No	2.46		
121	NO	Non-BMP	32.51	32.51	5.6	1.8	98	No	2.46		
122	NO	Non-BMP	33.61	33.61	4.4	1.8	98	No	2.46		
123	NO	Non-BMP	21.50	21.50	3.9	1.2	98	No	2.46		
124	NO	Non-BMP	7.37	7.37	1	0.4	98	No	2.46		
125	NO	Non-BMP	15.45	15.45	3.3	0.8	98	No	2.46		
126	NO	Non-BMP	17.69	17.69	3.1	1	98	No	2.46		
127	NO	Non-BMP	60.12	60.12	16	3.3	98	No	2.46		
128	NO	Non-BMP	18.70	18.70	4.6	1	98	No	2.46		
129	NO	Non-BMP	10.61	10.61	2	0.6	98	No	2.46		
130	NO	Non-BMP	21.75	21.75	2.9	1.2	98	No	2.46		
131	NO	Non-BMP	37.44	37.44	8.9	2	98	No	2.46		
132	NO	Non-BMP	18.34	18.34	2.8	1	98	No	2.46		
133	NO	Non-BMP	44.41	44.41	9.2	2.5	98	No	2.46		
134	YES	Non-BMP	6.61	6.61	1	0.4	98	No	2.46	871	
135	NO	Non-BMP	34.92	34.92	7.1	1.9	98	No	2.46		
136	NO	Non-BMP	56.94	56.94	11.4	3.1	98	No	2.46		
137	NO	Non-BMP	54.78	54.78	10.9	3	98	No	2.46		
138	NO	Non-BMP	5.09	5.09	0.7	0.3	98	No	2.46		
139	YES	Non-BMP	106.95	106.95	24.2	5.1	98	No	2.46		
140	NO	Non-BMP	64.98	64.98	19	3.6	98	No	2.46		
141	NO	Non-BMP	42.34	42.34	10.7	2.3	98	No	2.46		
142	NO	Non-BMP	53.06	53.06	7.3	2.8	98	No	2.46		
143	NO	Non-BMP	107.63	107.63	16.9	5.8	98	No	2.46		
144	YES	Non-BMP	11.77	11.77	1.4	0.6	98	No	2.46	0	

Pike Creek Water Quality Improvement Plan

DURMM / WQIP Model

Drainage Area ID	Performed Field Reconnaissance?	Type	PLOAD Nitrogen Load (low)	PLOAD Nitrogen Load (high)	Drainage Area (ac)	Impervious Area (ac)	Curve Number	Post 1998 BMP (Yes/No)	RPv (in.)	Storage Volume (cu. Ft.)	Existing BMP Type
145	YES	Non-BMP	54.43	54.43	12.5	3	98	No	2.46		
146	NO	Non-BMP	36.38	36.38	7.8	2	98	No	2.46		
147	NO	Non-BMP	38.82	38.82	5.1	2.1	98	No	2.46		
148	NO	Non-BMP	22.16	22.16	3.7	1.2	98	No	2.46		
149	NO	Direct	1030.24	1030.24	382.3	57.1	98	No	2.46		
150	NO	Non-BMP	28.31	28.31	5.6	1.5	98	No	2.46		
151	NO	Non-BMP	49.56	49.56	9.3	2.8	98	No	2.46		
152	NO	Non-BMP	10.12	10.12	1.4	0.5	98	No	2.46		
153	YES	Non-BMP	41.93	41.93	13.1	2.3	98	No	2.46	5,009	
154	NO	Non-BMP	31.95	31.95	3.5	1.8	98	No	2.46		
155	YES	Non-BMP	50.62	50.62	7.6	2.8	98	No	2.46		
156	YES	Non-BMP	114.14	114.14	13.7	6.2	98	No	2.46		
157	YES	Non-BMP	80.07	80.07	10	4.3	98	No	2.46		
158	YES	Non-BMP	64.70	64.70	8.1	3.5	98	No	2.46		
159	YES	Non-BMP	112.40	112.40	16.2	6	98	No	2.46		
160	YES	Non-BMP	20.56	20.56	2.4	1.2	98	No	2.46		
161	NO	Non-BMP	131.99	131.99	28.9	8.1	98	No	2.46		
162	YES	Non-BMP	216.78	216.78	29.6	11.6	98	No	2.46	25,265	
163	NO	Non-BMP	63.59	63.59	16.9	3.6	98	No	2.46		
164	NO	Non-BMP	36.67	36.67	4.2	2	98	No	2.46		
165	NO	Non-BMP	170.72	170.72	25.3	9.2	98	No	2.46		
166	NO	Non-BMP	9.67	9.67	1.5	0.5	98	No	2.46		
167	NO	Non-BMP	7.45	7.45	1.4	0.4	98	No	2.46		
168	NO	Non-BMP	20.12	20.12	3	1.1	98	No	2.46		
169	YES	Non-BMP	24.60	24.60	4.4	1.3	98	No	2.46	0	
170	NO	Non-BMP	24.85	24.85	4.9	1.4	98	No	2.46		
171	NO	Non-BMP	16.64	16.64	3.9	0.9	98	No	2.46		
172	YES	Non-BMP	56.89	56.89	6.8	3.1	98	No	2.46	6,752	
173	YES	Non-BMP	85.63	85.63	13.4	4.2	98	No	2.46	9,148	
174	YES	Non-BMP	309.61	309.61	56.7	16.2	98	No	2.46	0	
175	YES	Non-BMP	47.43	47.43	9.5	2.5	98	No	2.46	5,445	
176	YES	Non-BMP	28.22	28.22	6.2	1.5	98	No	2.46	0	
177	NO	Non-BMP	17.09	17.09	10.2	1.4	98	No	2.46		
178	NO	Non-BMP	12.70	12.70	1.6	0.7	98	No	2.46		
179	YES	Non-BMP	191.89	191.89	39.2	7.5	98	No	2.46	16,335	
180	NO	Non-BMP	63.00	63.00	15.7	3.4	98	No	2.46		
181	YES	Non-BMP	40.15	40.15	6.6	2.2	98	No	2.46	4,792	
182	NO	Non-BMP	17.44	17.44	2.5	0.9	98	No	2.46		
183	NO	Direct	378.28	378.28	191.5	24.9	98	No	2.46		
		TOTAL:	15951.31	15655.07	4460.10	981.90				278,966	

Total Runoff Reduction Required 6.05

Pike Creek Water Quality Improvement Plan

DURMM / WQIP Model

Drainage Area ID	Performed Field Reconnaissance?	Type	Proposed BMP Type	BMP Retrofit (Yes/NO)	Retention Reduction Volume (ac-ft)	*Existing Retention Reduction Volume (ac-ft)	**Estimated Capital Costs	Comments from Field Notes
1	NO	BMP	Levelspreader	No	N/A	N/A		
2	NO	BMP			N/A	N/A		
3	NO	BMP			N/A	N/A		
4	NO	BMP			N/A	N/A		
5	YES	BMP	Infiltration	Yes	0.20	N/A	$52,000	Dry pond retrofit
6	NO	BMP	Bioretention - Underdrain	No	N/A	0.05		
7	NO	BMP			N/A	N/A		
8	YES	BMP	Infiltration	Yes	0.24	N/A	$61,333	Dry pond retrofit
9	NO	BMP	Bioretention - Infiltration	No	N/A	0.04		
10	NO	BMP	Bioretention - Infiltration	No	N/A	0.02		
11	NO	BMP	Bioretention - Infiltration	No	N/A	0.03		
12	NO	BMP	Bioretention - Infiltration	No	N/A	0.03		
13	NO	Direct			N/A	N/A		
14	NO	BMP	Bioretention - Infiltration	No	N/A	0.04		
15	NO	BMP	Bioretention - Infiltration	No	N/A	0.05		
16	NO	BMP			N/A	N/A		
17	NO	BMP			N/A	N/A		
18	NO	BMP			N/A	N/A		
19	NO	BMP			N/A	N/A		
20	YES	BMP	Infiltration	Yes	0.09	N/A	$26,667	Dry pond retrofit
21	NO	BMP			N/A	N/A		
22	YES	BMP	Infiltration	Yes	0.38	N/A	$92,333	Dry pond retrofit
23	NO	BMP			N/A	N/A		
24	NO	Direct			N/A	N/A		
25	NO	BMP			N/A	N/A		
26	NO	BMP			N/A	N/A		
27	NO	BMP			N/A	N/A		
28	NO	BMP			N/A	N/A		
29	NO	BMP			N/A	N/A		
30	NO	BMP			N/A	N/A		
31	NO	BMP			N/A	N/A		
32	NO	BMP			N/A	N/A		
33	NO	BMP			N/A	N/A		
34	NO	BMP			N/A	N/A		
35	NO	BMP			N/A	N/A		
36	NO	BMP	Bioretention - Underdrain	No	N/A	0.01		
37	NO	BMP	Bioretention - Underdrain	No	N/A	0.01		
38	NO	BMP	Bioretention - Underdrain	No	N/A	0.02		
39	NO	BMP			N/A	N/A		
40	NO	BMP	Dry Pond	No	N/A	N/A		
41	NO	BMP			N/A	N/A		
42	YES	BMP	Infiltration	Yes	0.46	N/A	$111,000	Dry pond retrofit
43	YES	BMP	Infiltration	Yes	0.41	N/A	$99,333	Dry pond retrofit
44	NO	BMP			N/A	N/A		
45	NO	BMP	Bioretention - Underdrain	No	N/A	0.04		
46	NO	BMP	Dry Pond	No	N/A	N/A		
47	NO	BMP	Bioretention - Underdrain	No	N/A	0.05		
48	NO	BMP			N/A	N/A		

Drainage Area ID	Performed Field Reconnaissance?	Type	Proposed BMP Type	BMP Retrofit (Yes/NO)	Retention Reduction Volume (ac-ft)	*Existing Retention Reduction Volume (ac-ft)	**Estimated Capital Costs	Comments from Field Notes
49	NO	BMP			N/A	N/A		
50	YES	BMP	Dry Pond	No	N/A	N/A		Drainage area too large for dry pond to infiltration retrofit
51	NO	BMP			N/A	N/A		
52	YES	BMP	Dry Pond	No	N/A	N/A		Drainage area too large for dry pond to infiltration retrofit
53	NO	BMP			N/A	N/A		
54	NO	BMP			N/A	N/A		
55	NO	BMP			N/A	N/A		
56	NO	BMP			N/A	N/A		
57	YES	BMP	Dry Pond	No	N/A	N/A		Drainage area too large for dry pond to infiltration retrofit
58	NO	BMP			N/A	N/A		
59	NO	BMP			N/A	N/A		
60	NO	BMP			N/A	N/A		
61	NO	BMP			N/A	N/A		
62	NO	BMP	Bioretention - Underdrain	No	N/A	0.05		
63	NO	BMP			N/A	N/A		
64	NO	BMP			N/A	N/A		
65	NO	BMP	Bioretention - Infiltration	No	N/A	0.08		
66	NO	BMP			N/A	N/A		
67	NO	BMP			N/A	N/A		
68	NO	BMP			N/A	N/A		
69	NO	BMP			N/A	N/A		
70	NO	BMP			N/A	N/A		
71	NO	Non-BMP			N/A	N/A		
72	NO	Non-BMP			N/A	N/A		
73	NO	Direct			N/A	N/A		
74	NO	Non-BMP			N/A	N/A		
75	NO	Non-BMP			N/A	N/A		
76	NO	Direct			N/A	N/A		
77	NO	Non-BMP			N/A	N/A		
78	YES	Non-BMP			N/A	N/A		Limited space
79	YES	Non-BMP			N/A	N/A		Limited space
80	YES	Non-BMP	Infiltration	No	0.37	N/A	$270,000	Potential candidate - field adjacent to outfall
81	YES	Non-BMP	Infiltration	No	0.50	N/A	$360,000	Potential candidate - field adjacent to outfall
82	NO	Non-BMP			N/A	N/A		
83	NO	Non-BMP			N/A	N/A		
84	YES	Non-BMP			N/A	N/A		Incised channel
85	YES	Non-BMP			N/A	N/A		Incised channel
86	NO	Direct			N/A	N/A		
87	YES	Non-BMP			N/A	N/A		Incised channel
88	NO	Non-BMP			N/A	N/A		
89	NO	Non-BMP			N/A	N/A		
90	NO	Non-BMP			N/A	N/A		
91	NO	Non-BMP			N/A	N/A		
92	NO	Non-BMP			N/A	N/A		
93	NO	Non-BMP			N/A	N/A		
94	YES	Non-BMP	Infiltration	No	0.09	N/A	$80,000	Potential candidate - adjacent to golf course
95	YES	Non-BMP	Infiltration	No	0.06	N/A	$59,000	Potential candidate - adjacent to golf course
96	NO	Non-BMP			N/A	N/A		

Drainage Area ID	Performed Field Reconnaissance?	Type	Proposed BMP Type	BMP Retrofit (Yes/NO)	Retention Reduction Volume (ac-ft)	*Existing Retention Reduction Volume (ac-ft)	**Estimated Capital Costs	Comments from Field Notes
97	NO	Non-BMP			N/A	N/A		
98	NO	Non-BMP			N/A	N/A		
99	NO	Non-BMP			N/A	N/A		
100	NO	Direct			N/A	N/A		
101	NO	Non-BMP			N/A	N/A		
102	NO	Non-BMP			N/A	N/A		
103	NO	Non-BMP			N/A	N/A		
104	NO	Non-BMP			N/A	N/A		
105	NO	Non-BMP			N/A	N/A		
106	YES	Non-BMP	Wetlands	No	0.00	N/A	$36,000	Potential candidate - wet area - biofiltration
107	YES	Non-BMP	Infiltration	No	0.88	N/A	$627,000	Potential candidate - field adjacent to outfall - multi structures
108	YES	Non-BMP			N/A	N/A		Limited space
109	YES	Non-BMP	Infiltration	No	0.14	N/A	$114,000	Potential candidate - field adjacent to outfall
110	YES	Non-BMP			N/A	N/A		Very steep - not Potential candidate
111	NO	Non-BMP			N/A	N/A		
112	NO	Non-BMP			N/A	N/A		
113	YES	Non-BMP	Infiltration	No	0.05	N/A	$48,000	Potential candidate - field adjacent to outfall
114	YES	Non-BMP	Infiltration	No	0.11	N/A	$90,000	Potential candidate - field adjacent to outfall
115	NO	Non-BMP			N/A	N/A		
116	NO	Non-BMP			N/A	N/A		
117	NO	Non-BMP			N/A	N/A		
118	NO	Non-BMP			N/A	N/A		
119	YES	Non-BMP	Vegetated Channels	No	N/A	N/A	$20,000	Concrete channel - convert to biofiltration
120	NO	Non-BMP			N/A	N/A		
121	NO	Non-BMP			N/A	N/A		
122	NO	Non-BMP			N/A	N/A		
123	NO	Non-BMP			N/A	N/A		
124	NO	Non-BMP			N/A	N/A		
125	NO	Non-BMP			N/A	N/A		
126	NO	Non-BMP			N/A	N/A		
127	NO	Non-BMP			N/A	N/A		
128	NO	Non-BMP			N/A	N/A		
129	NO	Non-BMP			N/A	N/A		
130	NO	Non-BMP			N/A	N/A		
131	NO	Non-BMP			N/A	N/A		
132	NO	Non-BMP			N/A	N/A		
133	NO	Non-BMP			N/A	N/A		
134	YES	Non-BMP	Infiltration	No	0.02	N/A	$31,000	Potential candidate - field adjacent to outfall
135	NO	Non-BMP			N/A	N/A		
136	NO	Non-BMP			N/A	N/A		
137	NO	Non-BMP			N/A	N/A		
138	NO	Non-BMP			N/A	N/A		
139	YES	Non-BMP			N/A	N/A		Incised channel
140	NO	Non-BMP			N/A	N/A		
141	NO	Non-BMP			N/A	N/A		
142	NO	Non-BMP			N/A	N/A		
143	NO	Non-BMP			N/A	N/A		
144	YES	Non-BMP	Vegetated Channels	No	N/A	N/A	$20,000	Concrete channel - convert to biofiltration

Pike Creek Water Quality Improvement Plan

DURMM / WQIP Model

Drainage Area ID	Performed Field Reconnaissance?	Type	Proposed BMP Type	BMP Retrofit (Yes/NO)	Retention Reduction Volume (ac-ft)	*Existing Retention Reduction Volume (ac-ft)	**Estimated Capital Costs	Comments from Field Notes
145	YES	Non-BMP			N/A	N/A		Incised stream but open area
146	NO	Non-BMP			N/A	N/A		
147	NO	Non-BMP			N/A	N/A		
148	NO	Non-BMP			N/A	N/A		
149	NO	Direct			N/A	N/A		
150	NO	Non-BMP			N/A	N/A		
151	NO	Non-BMP			N/A	N/A		
152	NO	Non-BMP			N/A	N/A		
153	YES	Non-BMP	Infiltration	No	0.12	N/A	$97,000	Potential candidate - open area but wooded
154	NO	Non-BMP			N/A	N/A		
155	YES	Non-BMP			N/A	N/A		Incised channel
156	YES	Non-BMP			N/A	N/A		Incised channel
157	YES	Non-BMP			N/A	N/A		Incised channel
158	YES	Non-BMP			N/A	N/A		Incised channel
159	YES	Non-BMP			N/A	N/A		Incised channel
160	YES	Non-BMP			N/A	N/A		Incised channel
161	NO	Non-BMP			N/A	N/A		
162	YES	Non-BMP	Infiltration	No	0.58	N/A	$419,000	Potential candidate - field adjacent to outfall - multi structures
163	NO	Non-BMP			N/A	N/A		
164	NO	Non-BMP			N/A	N/A		
165	NO	Non-BMP			N/A	N/A		
166	NO	Non-BMP			N/A	N/A		
167	NO	Non-BMP			N/A	N/A		
168	NO	Non-BMP			N/A	N/A		
169	YES	Non-BMP	Vegetated Channels	No	N/A	N/A	$20,000	Potential candidate - wet area - biofiltration
170	NO	Non-BMP			N/A	N/A		
171	NO	Non-BMP			N/A	N/A		
172	YES	Non-BMP	Infiltration	No	0.16	N/A	$125,000	Potential candidate - field adjacent to outfall
173	YES	Non-BMP	Infiltration	No	0.21	N/A	$163,000	Potential candidate - field adjacent to outfall
174	YES	Non-BMP	Vegetated Channels	No	N/A	N/A	$20,000	Potential candidate - wet area - biofiltration
175	YES	Non-BMP	Infiltration	No	0.13	N/A	$104,000	Potential candidate - field adjacent to outfall
176	YES	Non-BMP	Vegetated Channels	No	N/A	N/A	$20,000	Potential candidate - wet area - biofiltration
177	NO	Non-BMP			N/A	N/A		
178	NO	Non-BMP			N/A	N/A		
179	YES	Non-BMP	Infiltration	No	0.38	N/A	$277,000	Potential candidate - field adjacent to outfall
180	NO	Non-BMP			N/A	N/A		
181	YES	Non-BMP	Infiltration	No	0.11	N/A	$93,000	Potential candidate - field adjacent to outfall
182	NO	Non-BMP			N/A	N/A		
183	NO	Direct			N/A	N/A		
		TOTAL:			5.64	0.5075	$3,535,667	

Total Runoff Reduction Provided 6.14

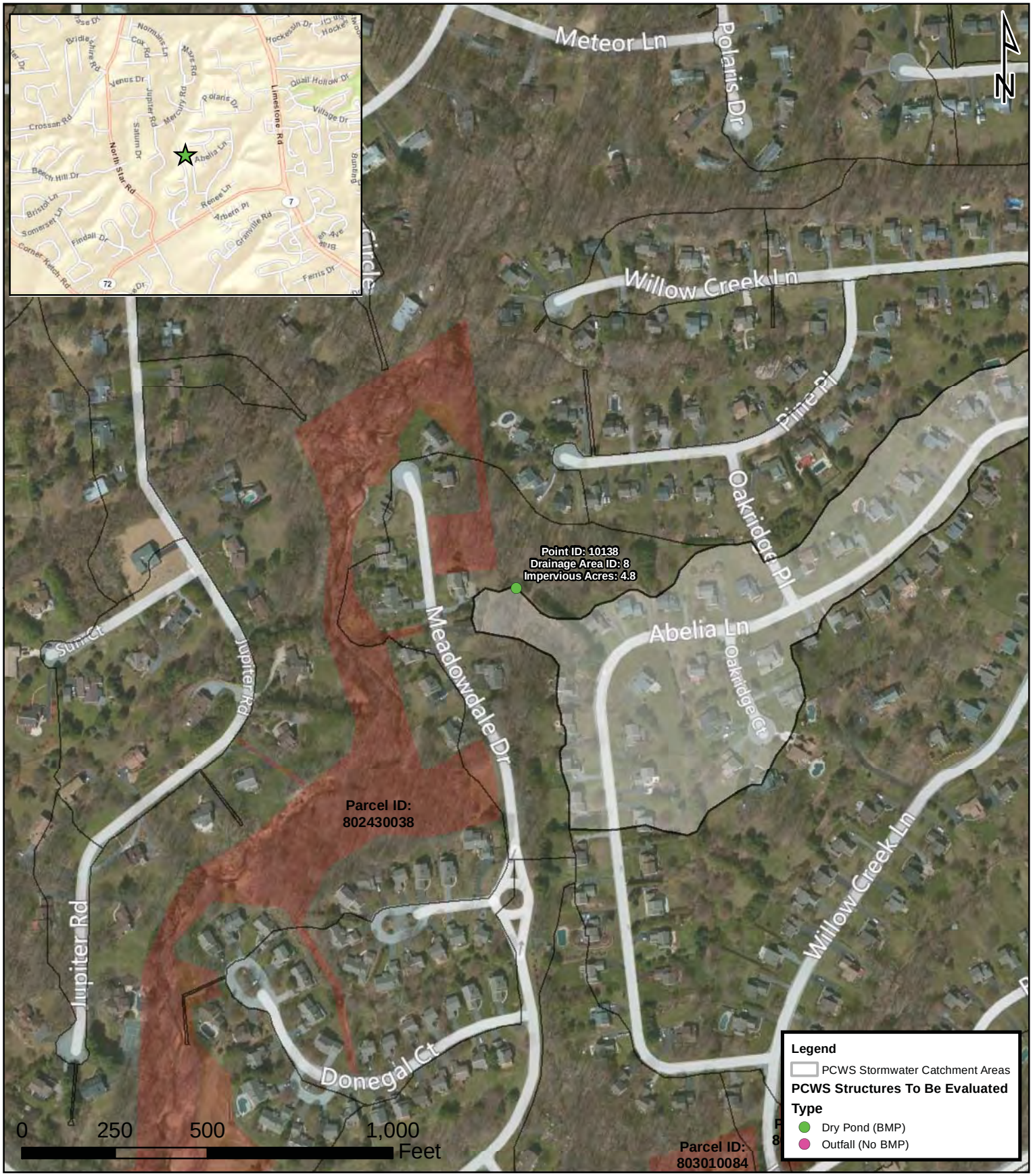
*Indicates that a BMP exists and was constructed after 1998

**Per the UDFCD BMP-Rational Estimation of Approximate
Likely Costs of Stormwater Control (BMP-REALCOST) Model
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156B Denver, Colorado USA 80211

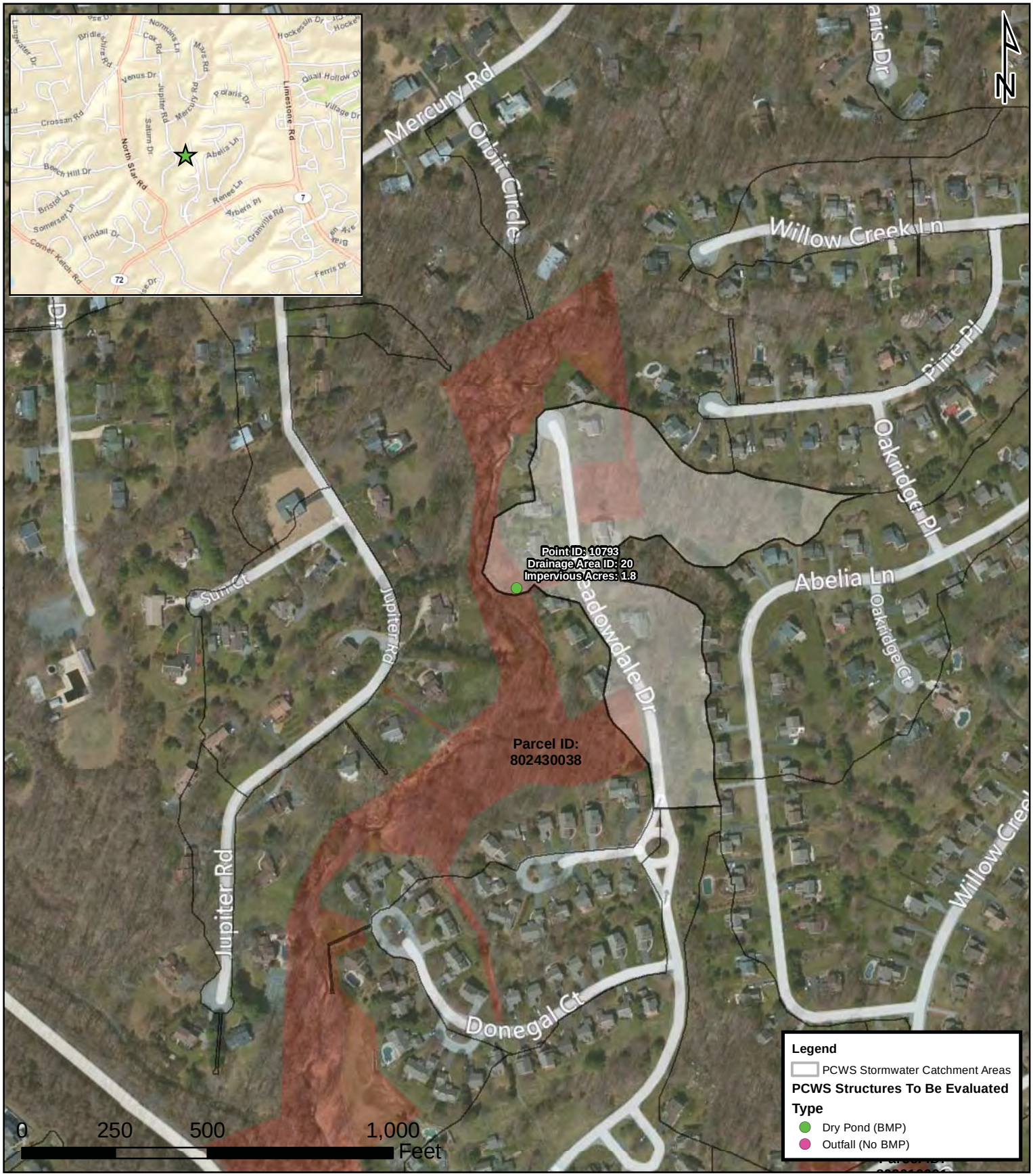
APPENDIX B

MAP BOOK

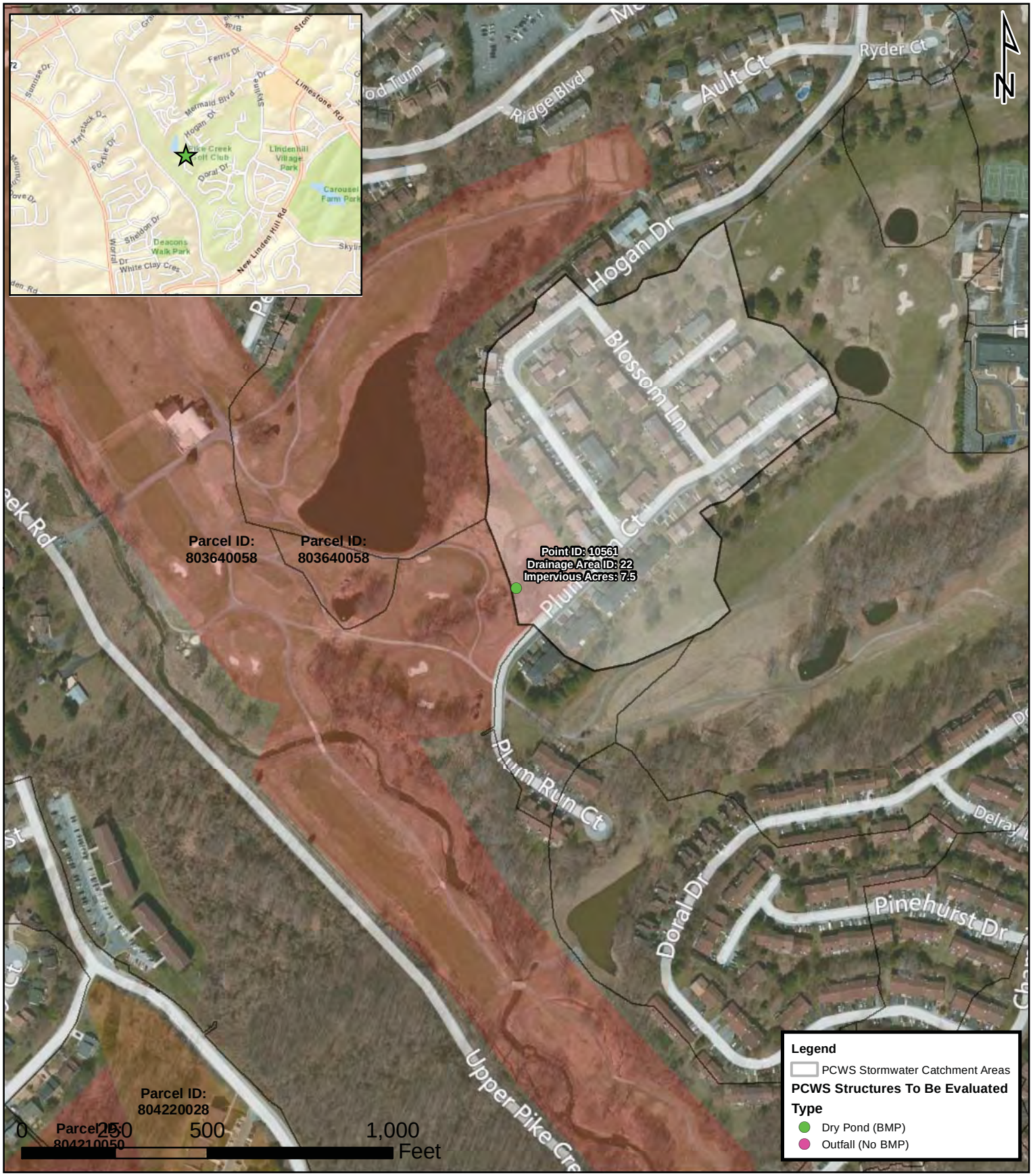
DATE: 7/31/2012	**Drainage Area ID: 5**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 1 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 8**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 2 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 20**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 3 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

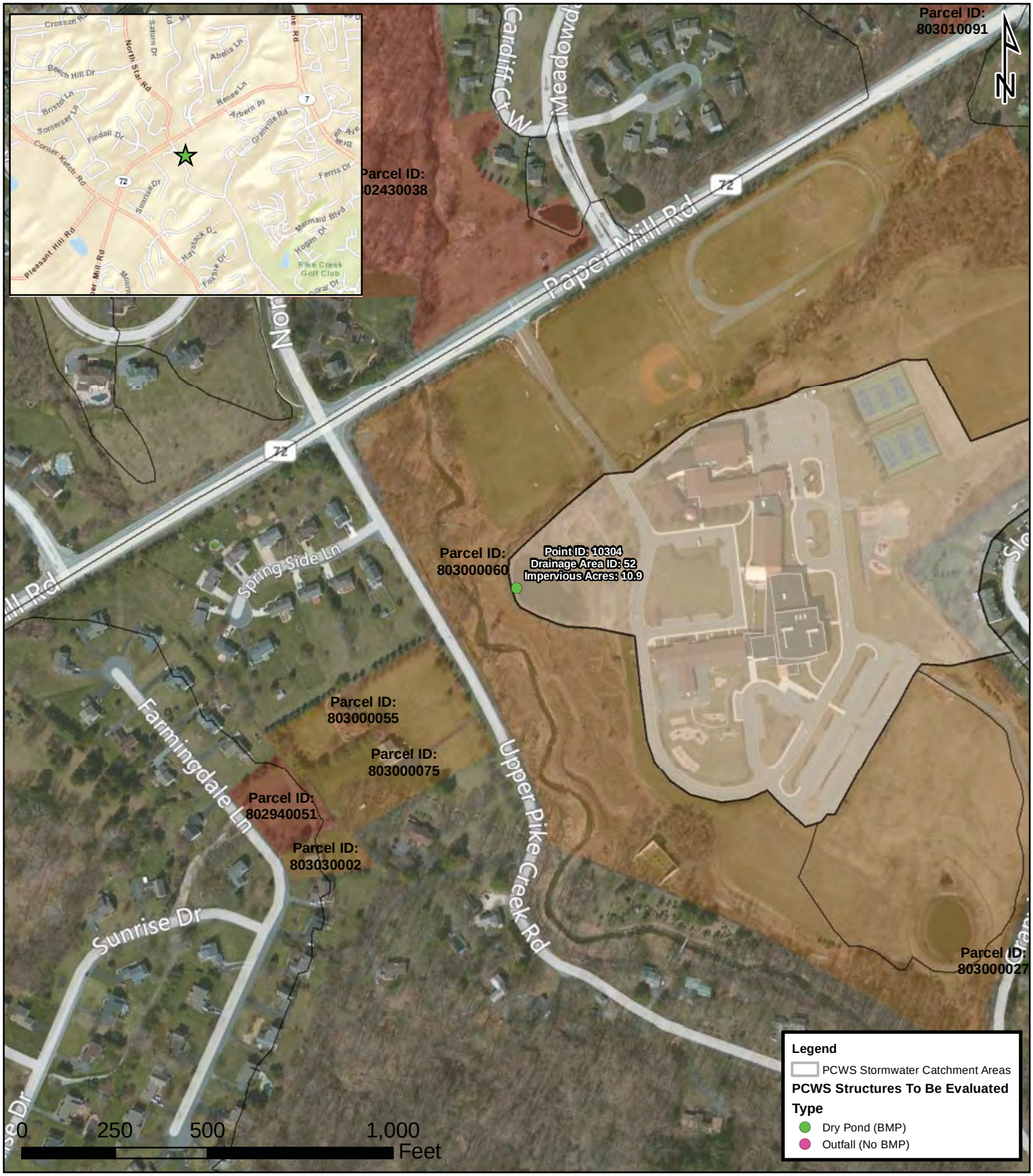


DATE: 7/31/2012	**Drainage Area ID: 22**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 4 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

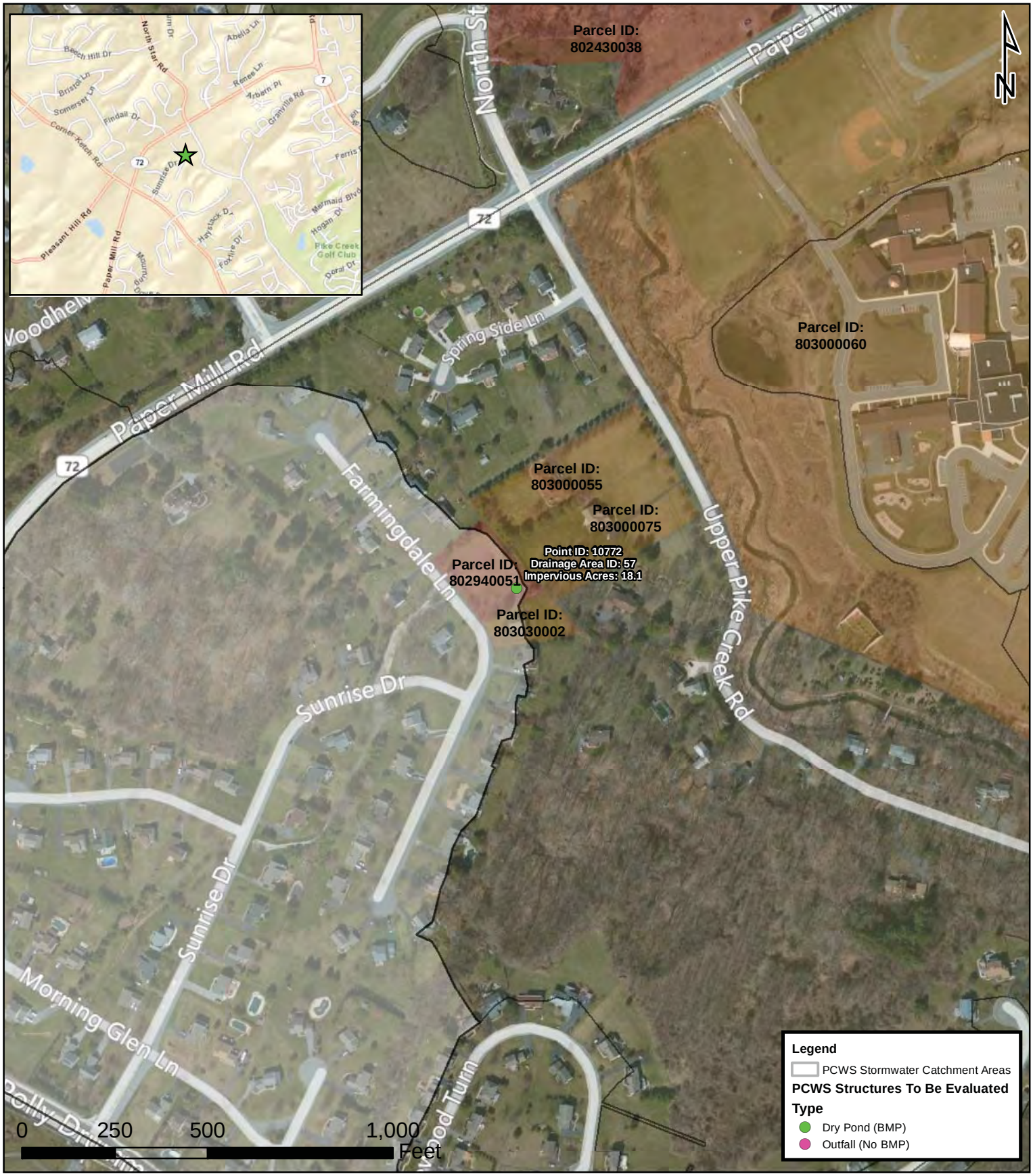
DATE: 7/31/2012	**Drainage Area ID: 42**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 5 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

DATE: 7/31/2012	**Drainage Area ID: 43**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 6 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

DATE: 7/31/2012	**Drainage Area ID: 50**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 7 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 52**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 8 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 57**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
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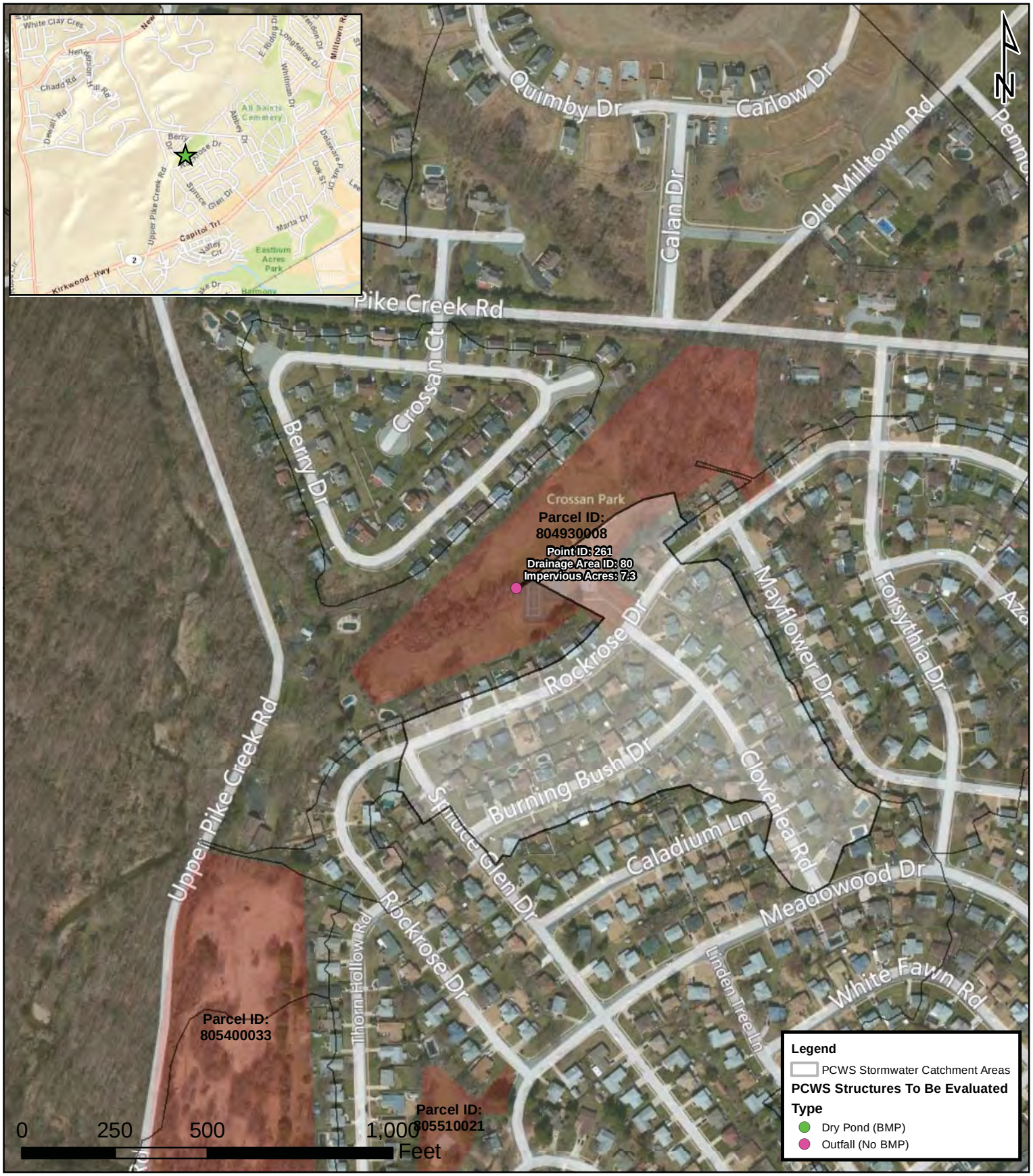
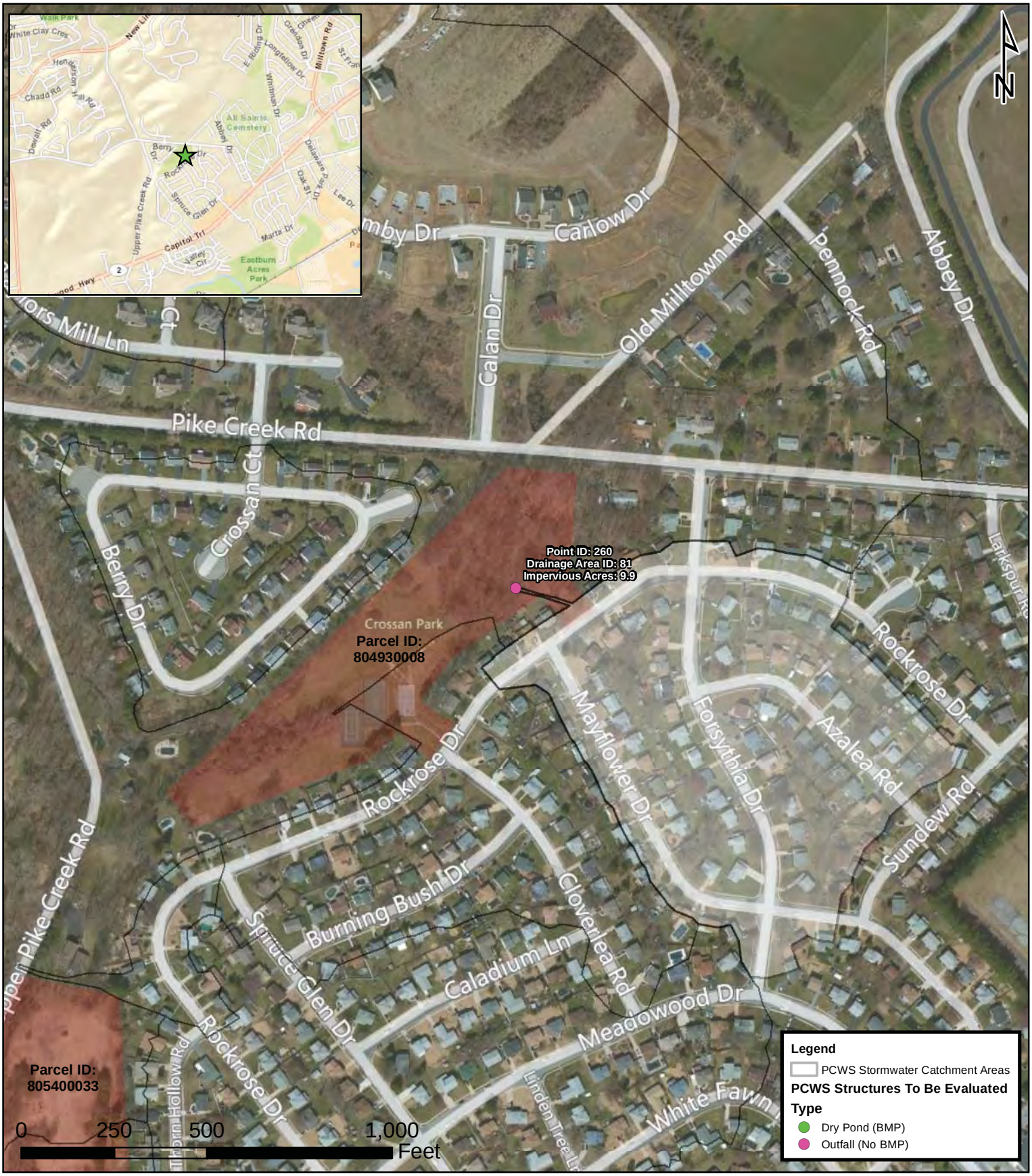
DATE: 7/31/2012	**Drainage Area ID: 78**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 14 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

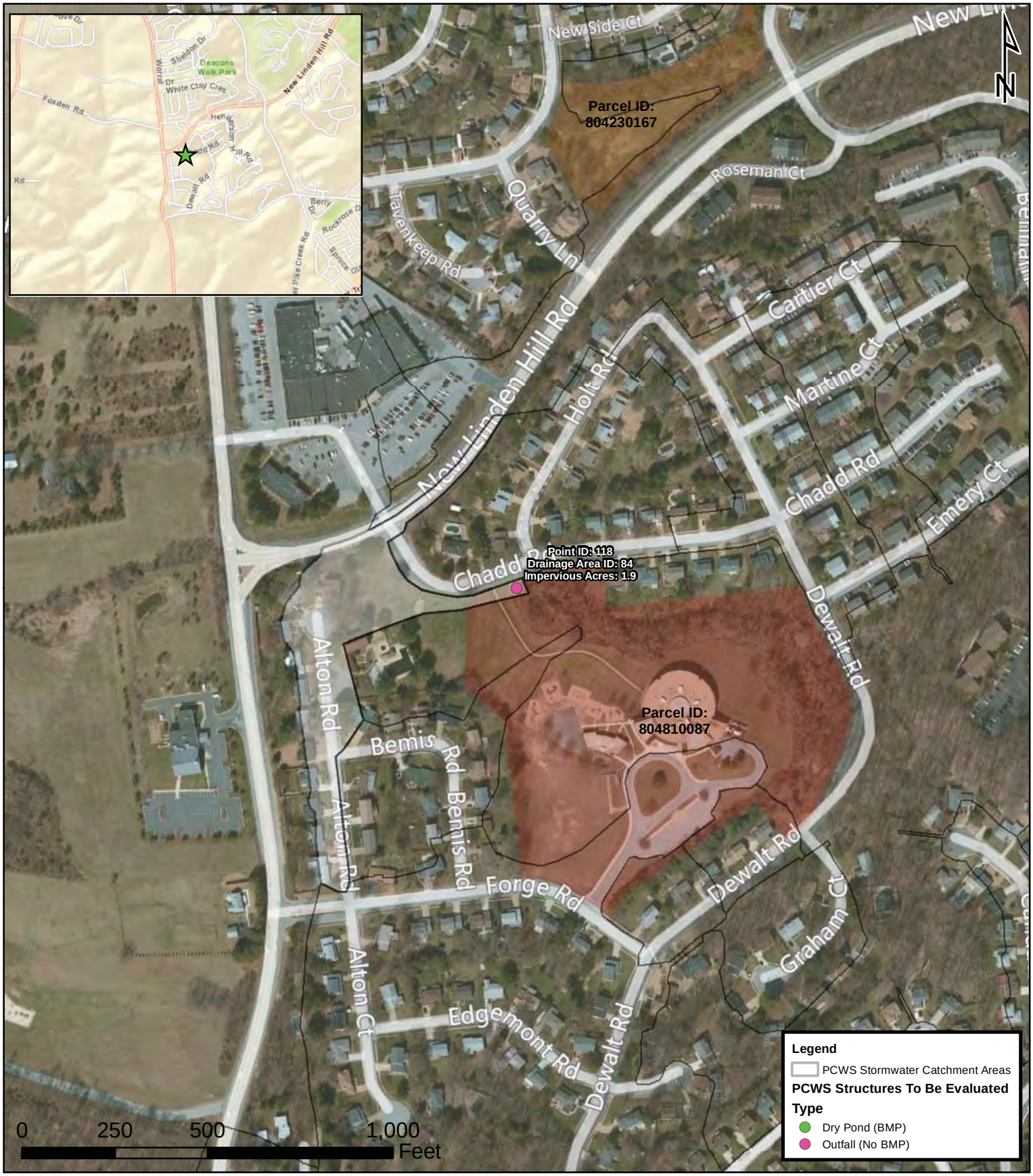
DATE: 7/31/2012	**Drainage Area ID: 79**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 15 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 80**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 16 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 81**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 17 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 84**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
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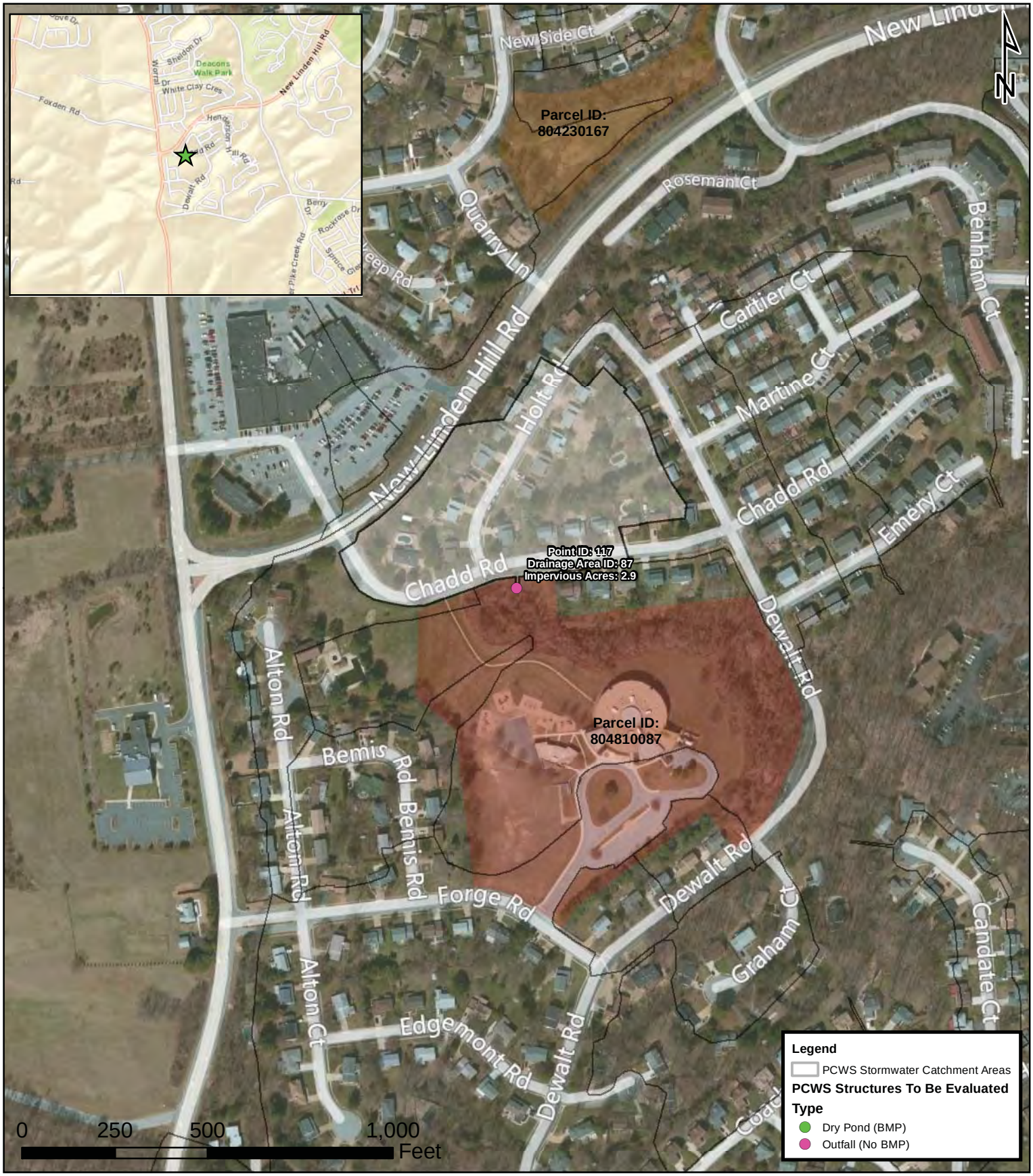
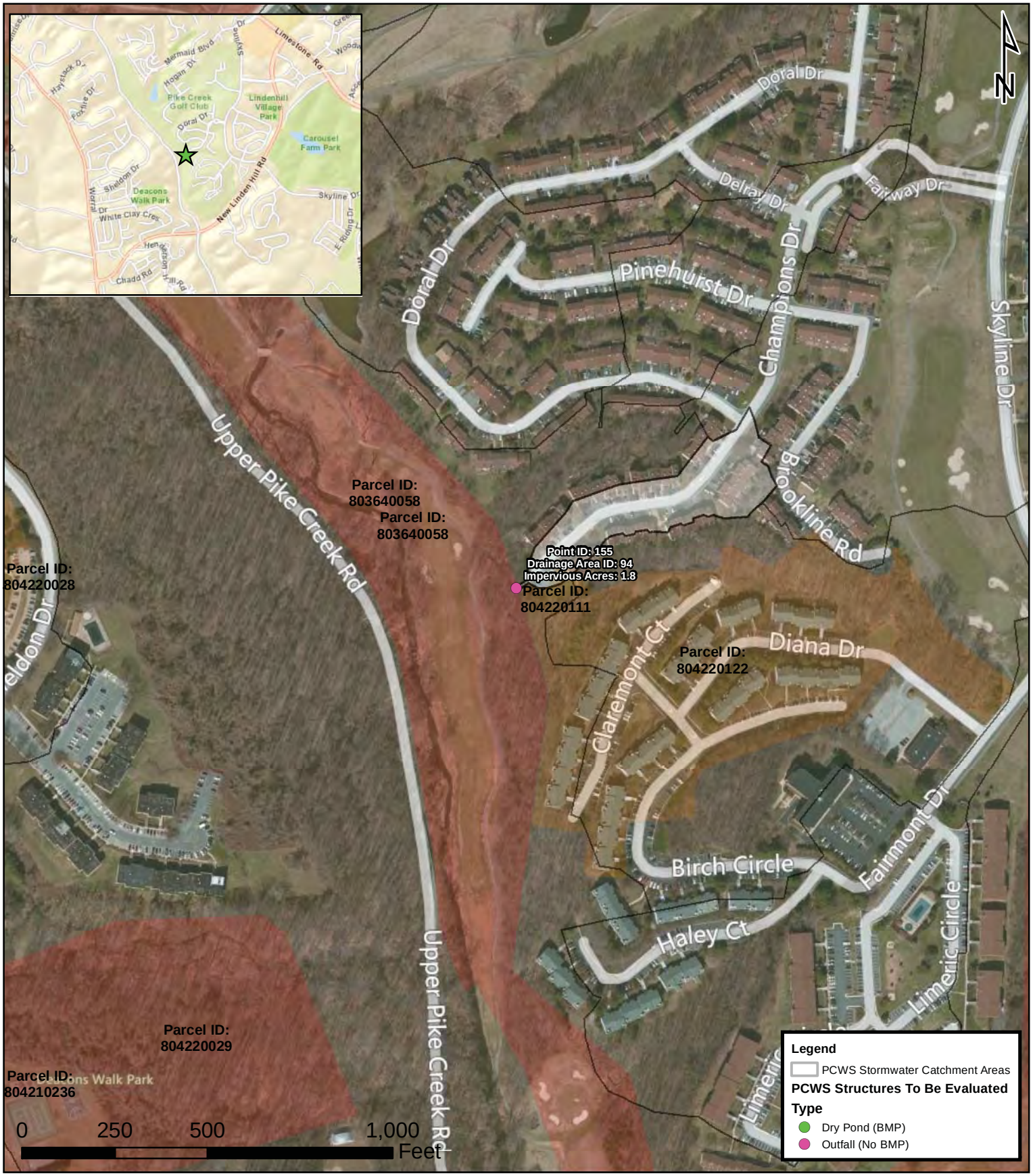
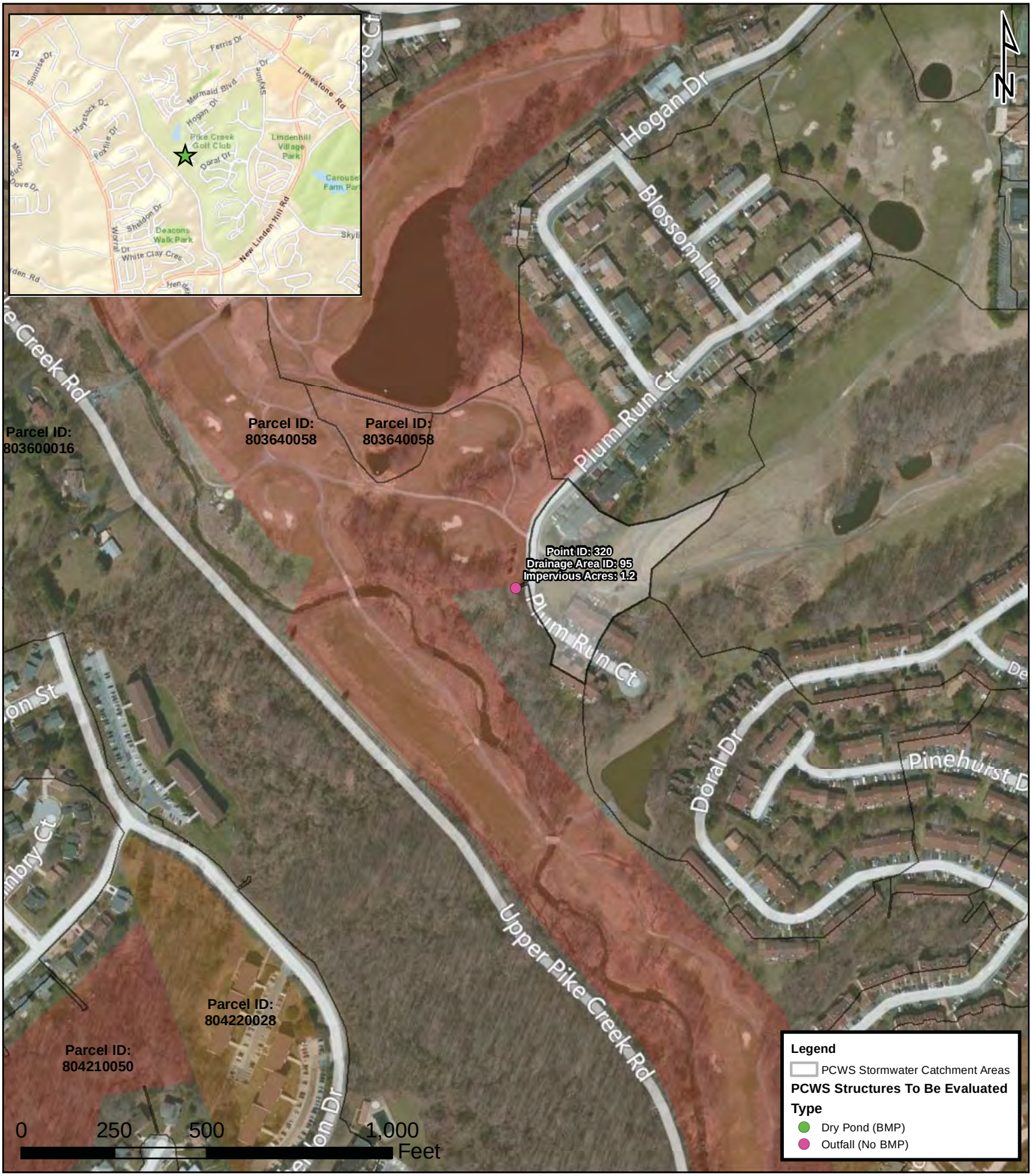
DATE: 7/31/2012	**Drainage Area ID: 85**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 19 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 87**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 20 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 94**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 21 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 95**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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DATE: 7/31/2012	**Drainage Area ID: 106**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
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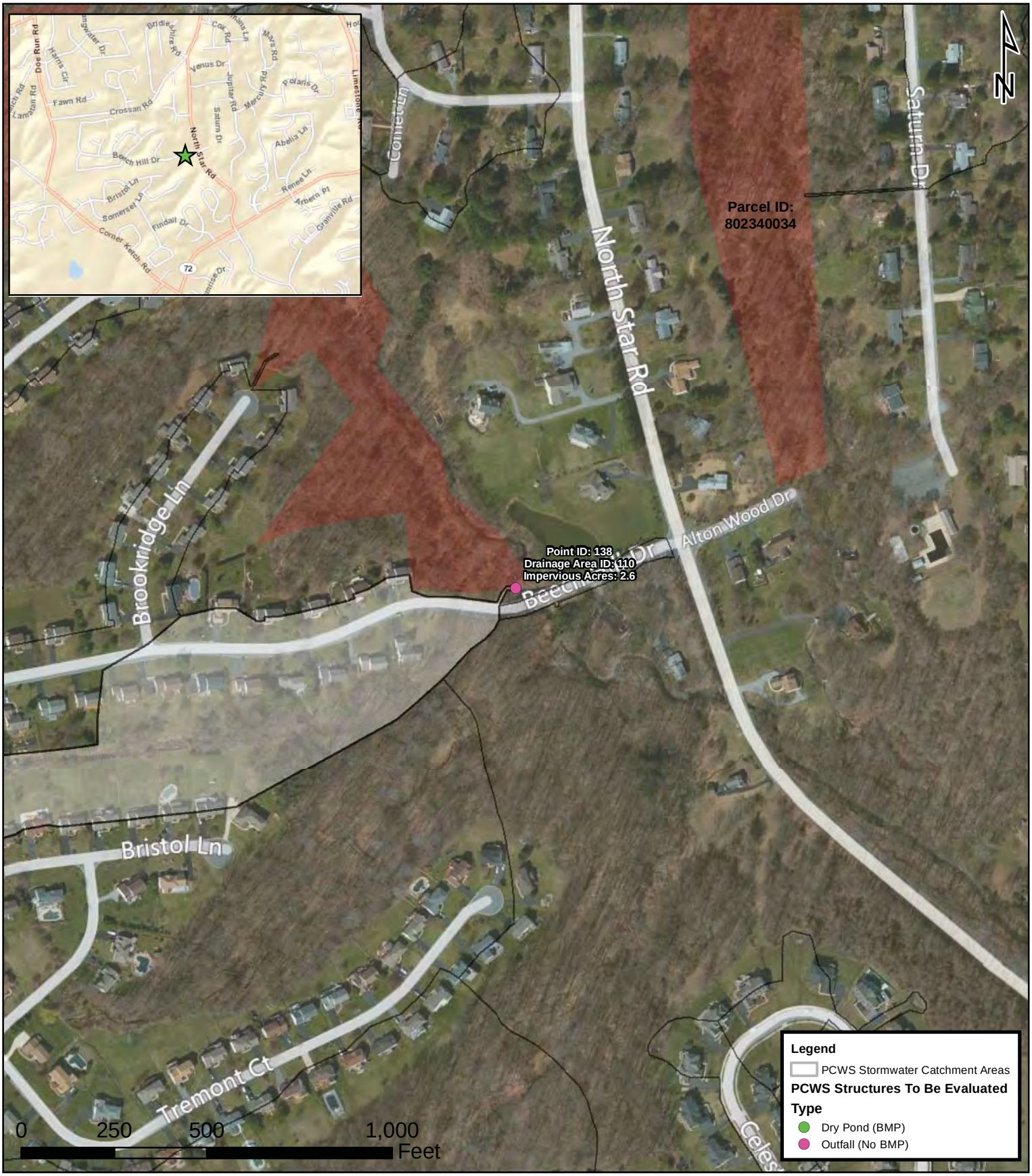
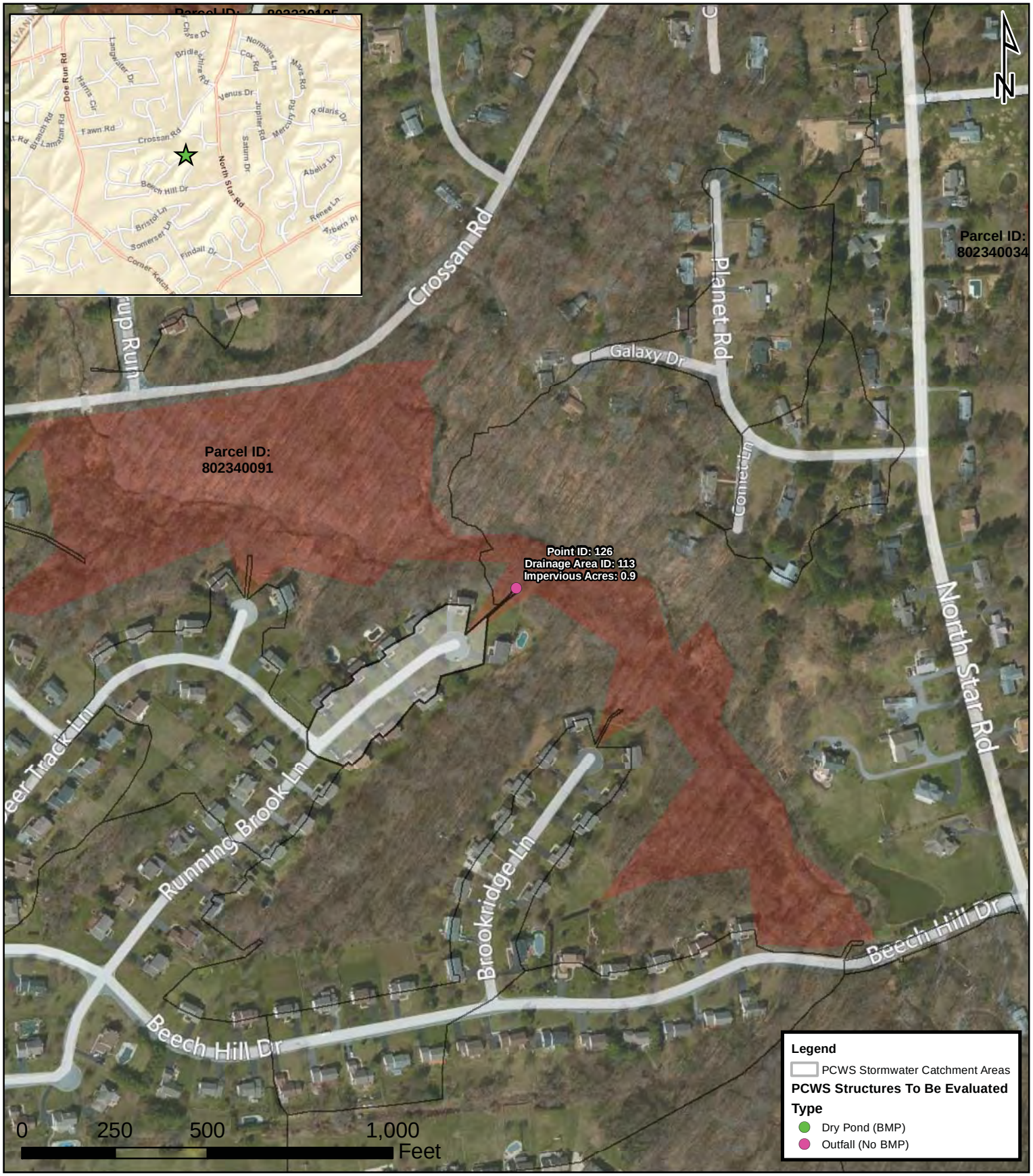
DATE: 7/31/2012	**Drainage Area ID: 107**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 26 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

DATE: 7/31/2012	**Drainage Area ID: 108**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 27 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY

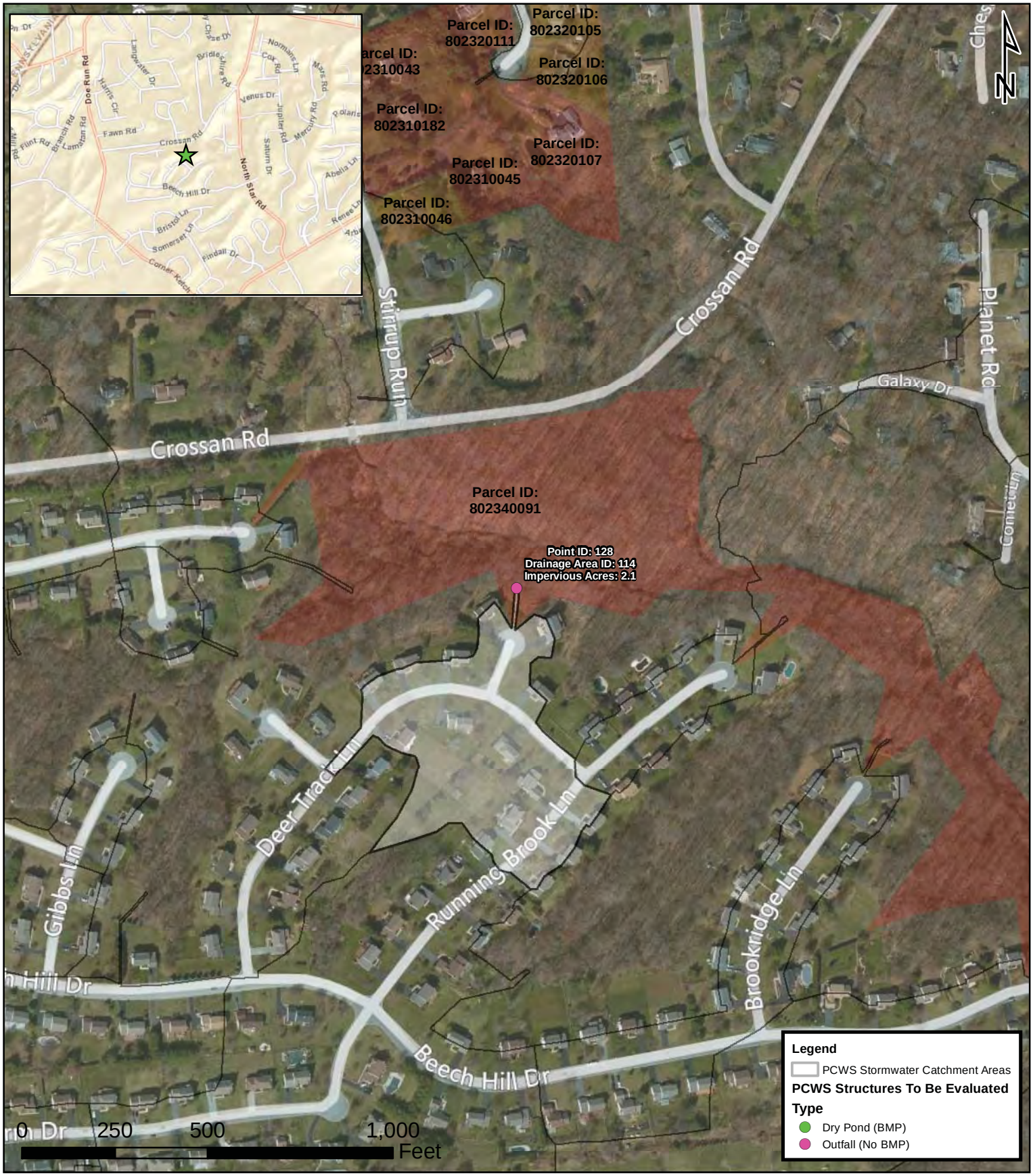
DATE: 7/31/2012	**Drainage Area ID: 109**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 28 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



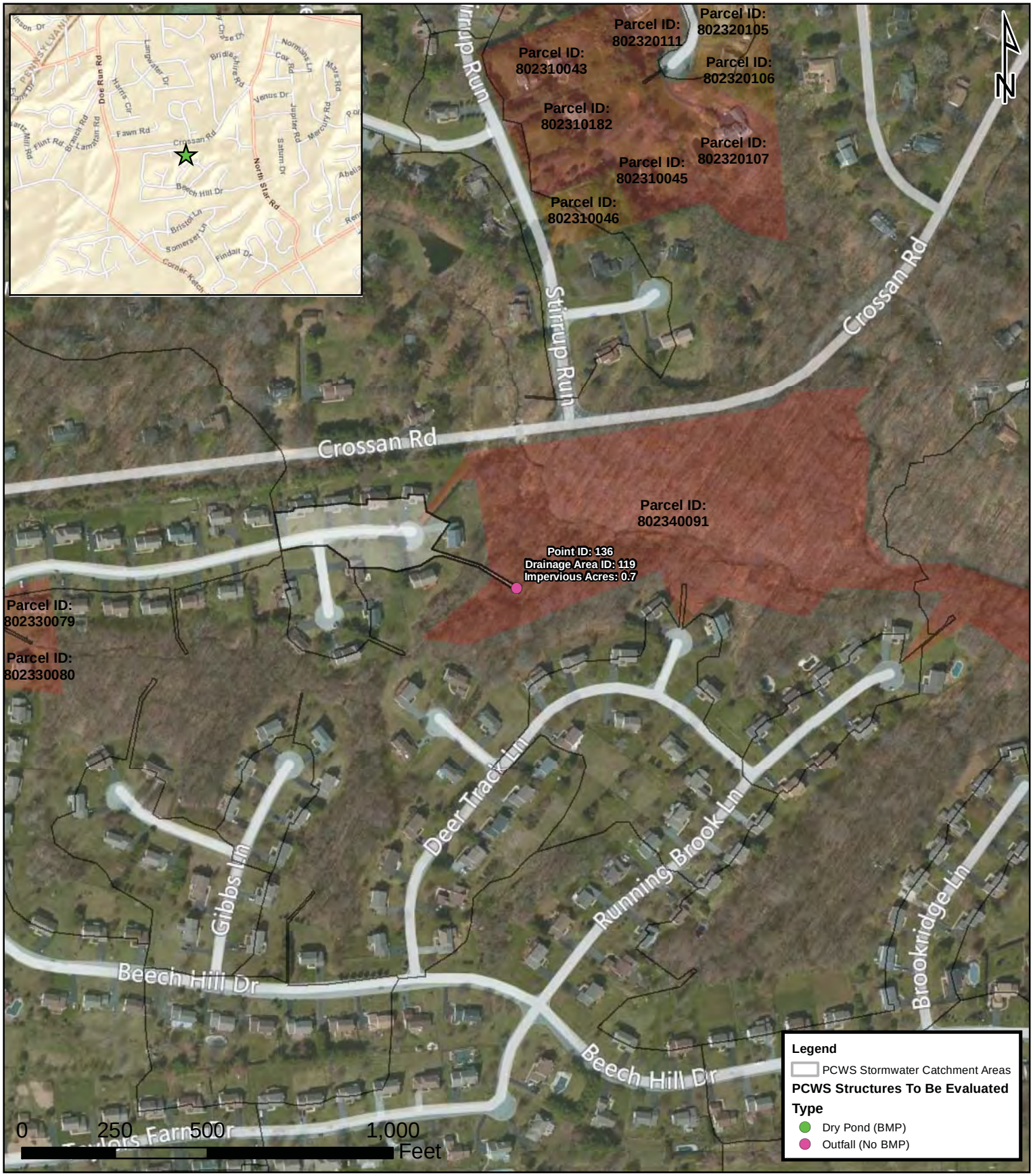
DATE: 7/31/2012	**Drainage Area ID: 110**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 29 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 113**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 30 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 114**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 31 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 119**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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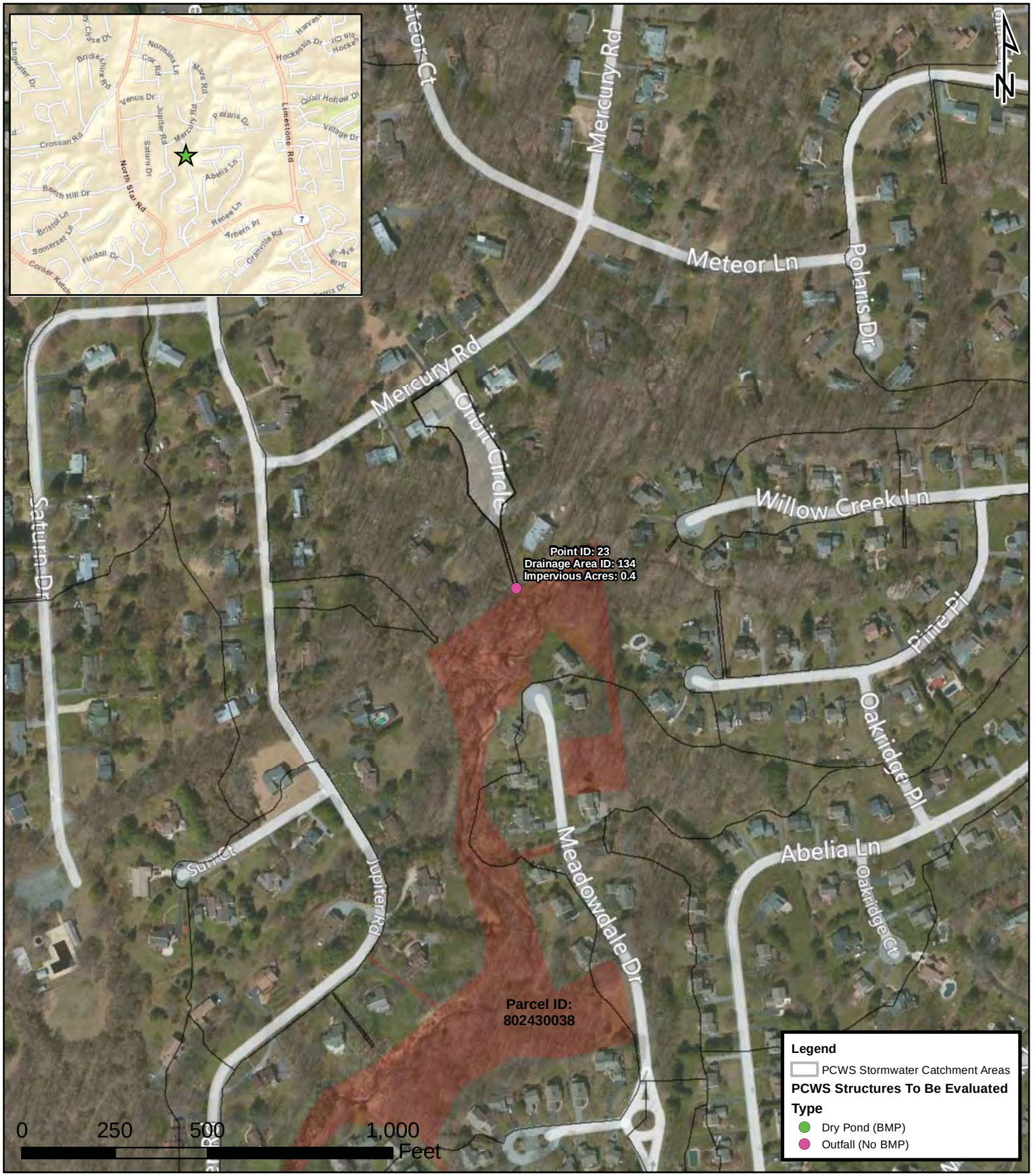
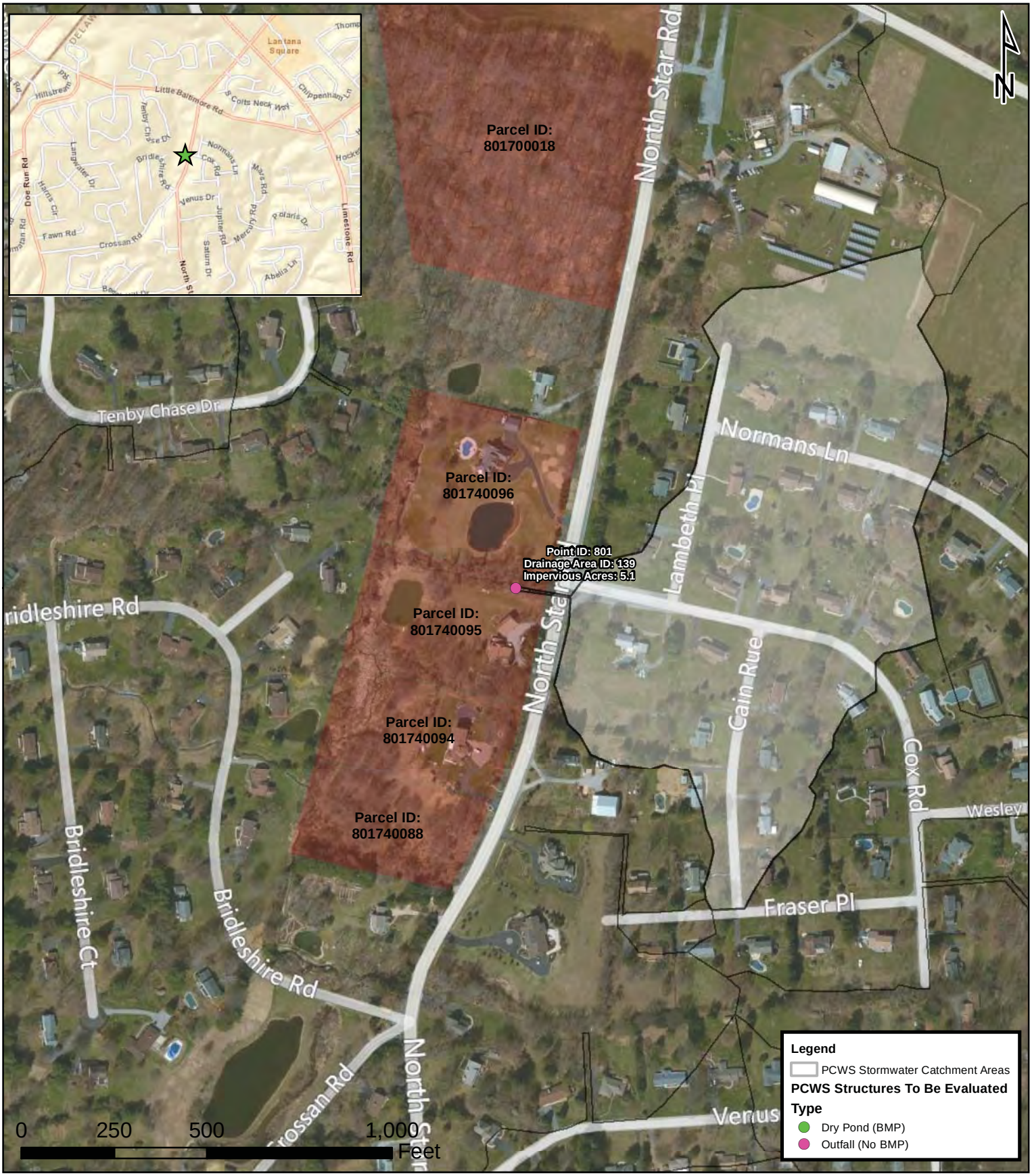
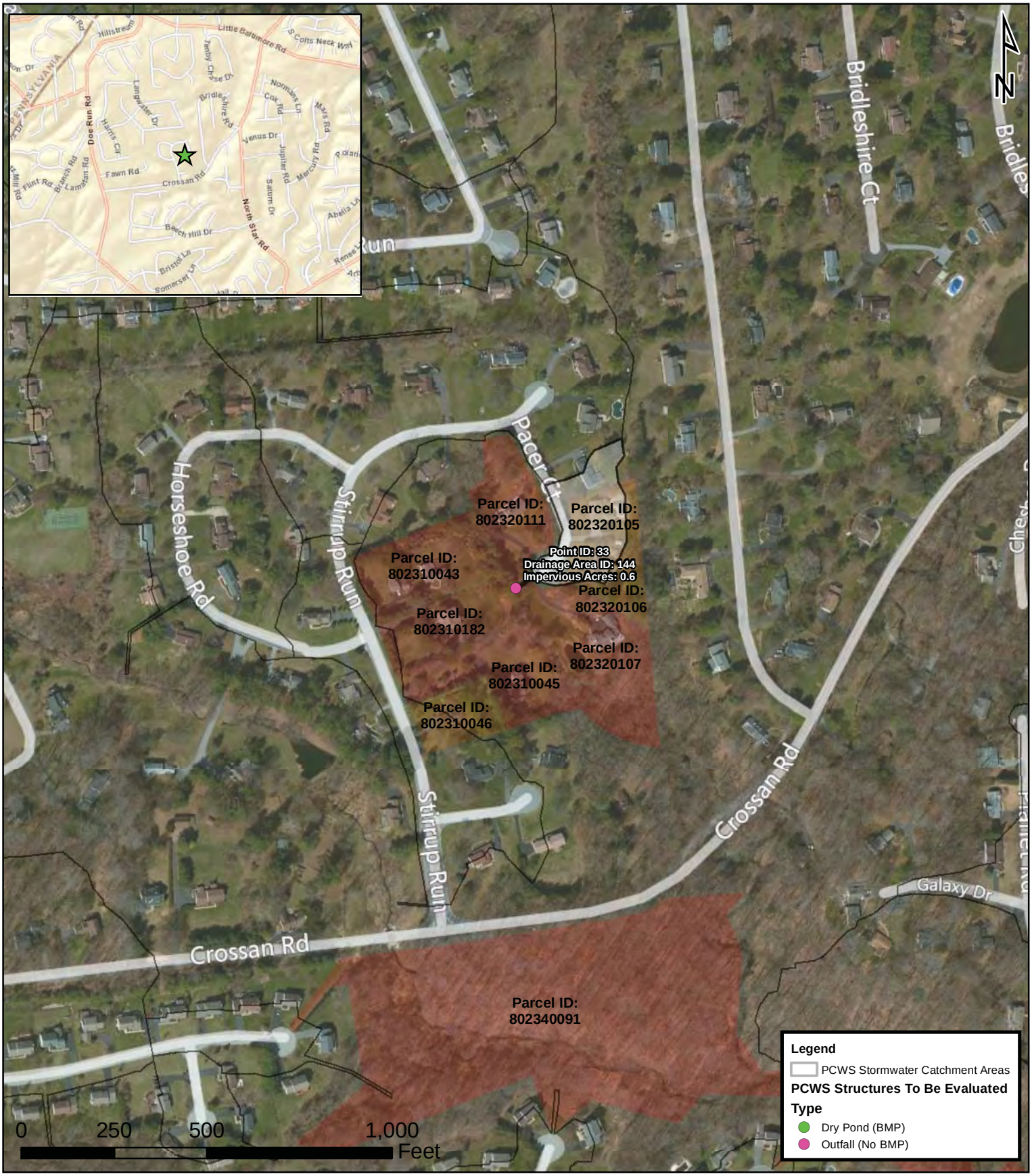


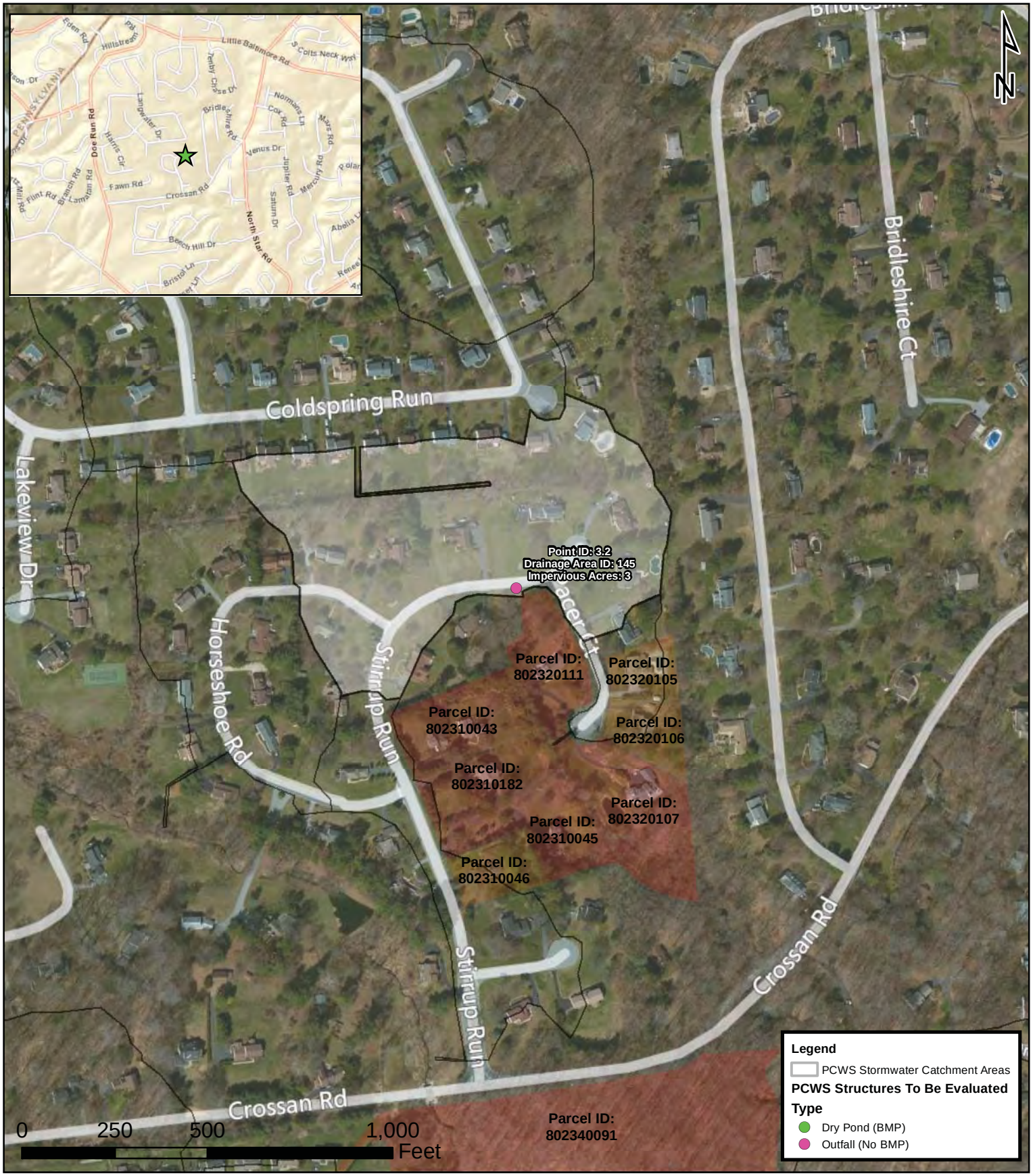
DATE: 7/31/2012	**Drainage Area ID: 134**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 33 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 139**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 34 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 144**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
SHEET: Page 35 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 145**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
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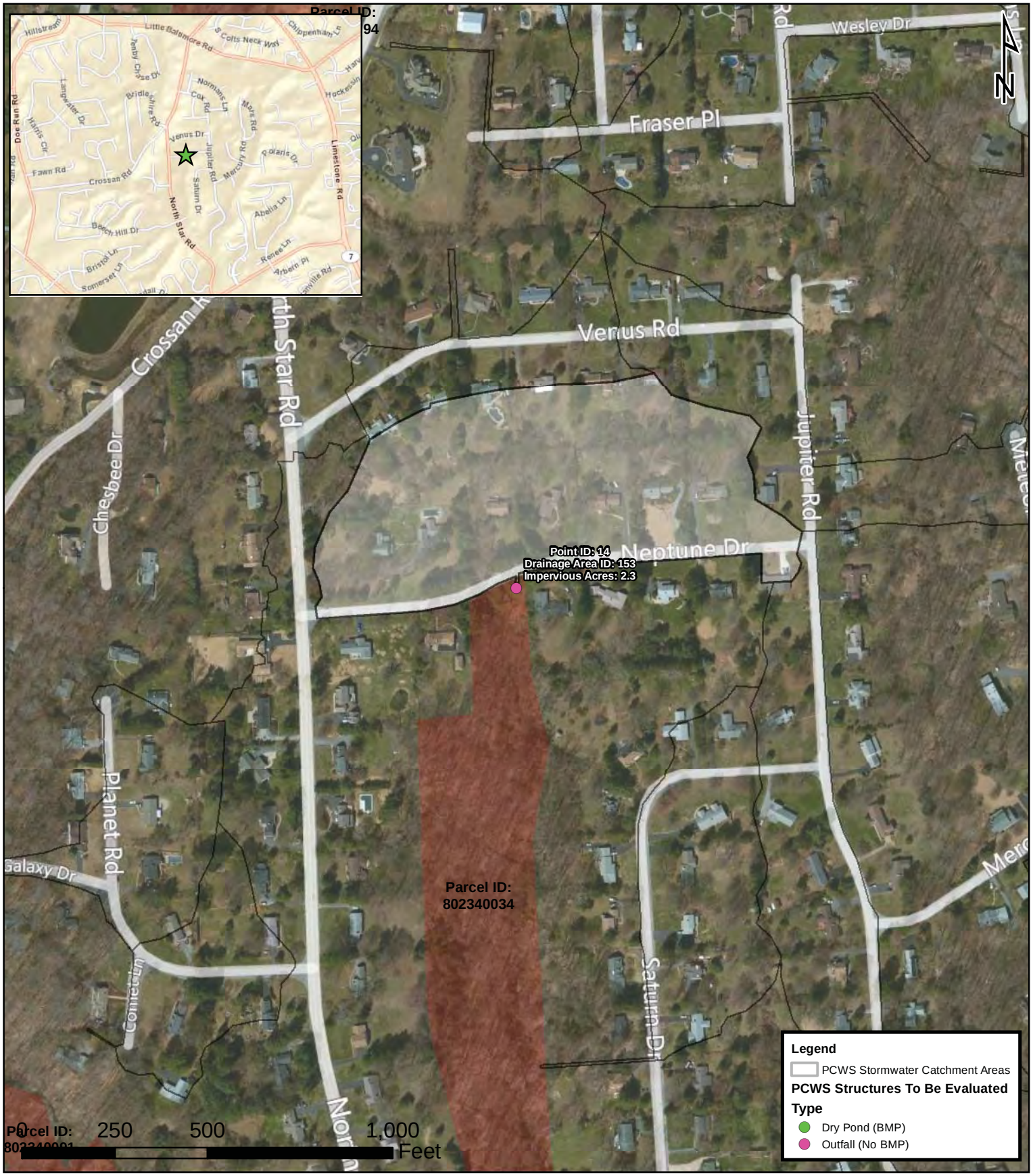

DATE: 7/31/2012	**Drainage Area ID: 153**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
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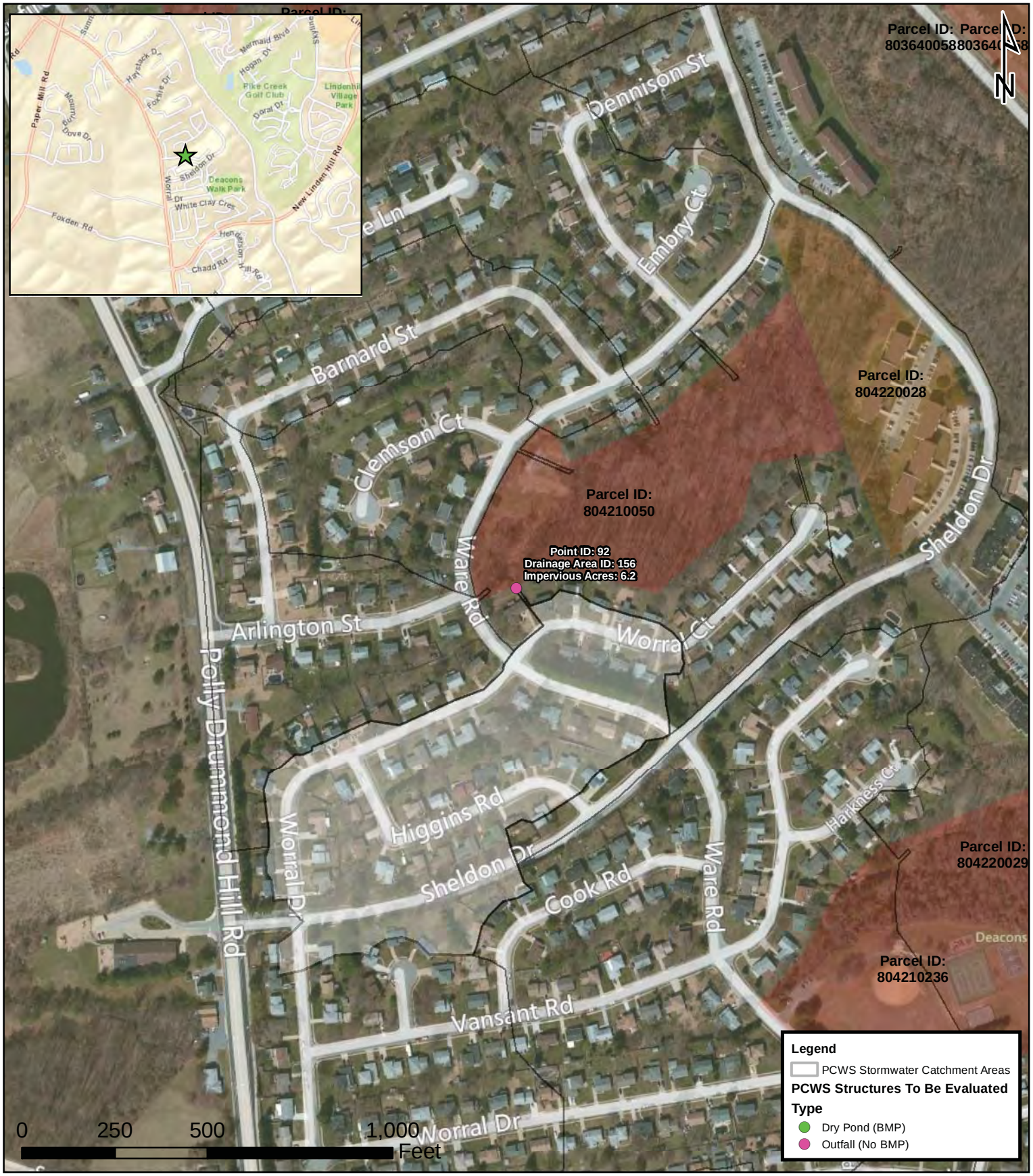
DATE: 7/31/2012	**Drainage Area ID: 155**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 38 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 156**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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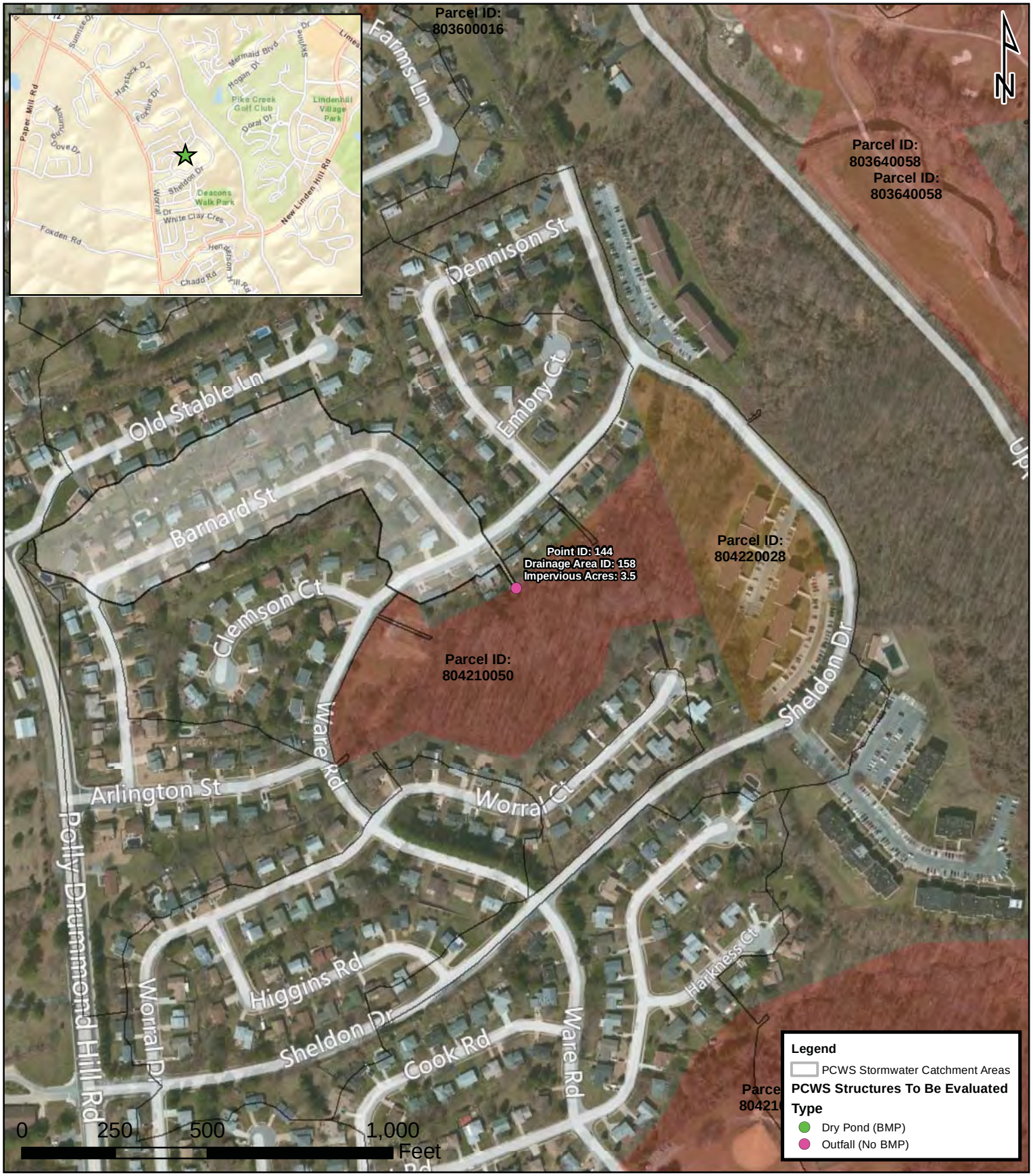
DATE: 7/31/2012	**Drainage Area ID: 157**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 40 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 158**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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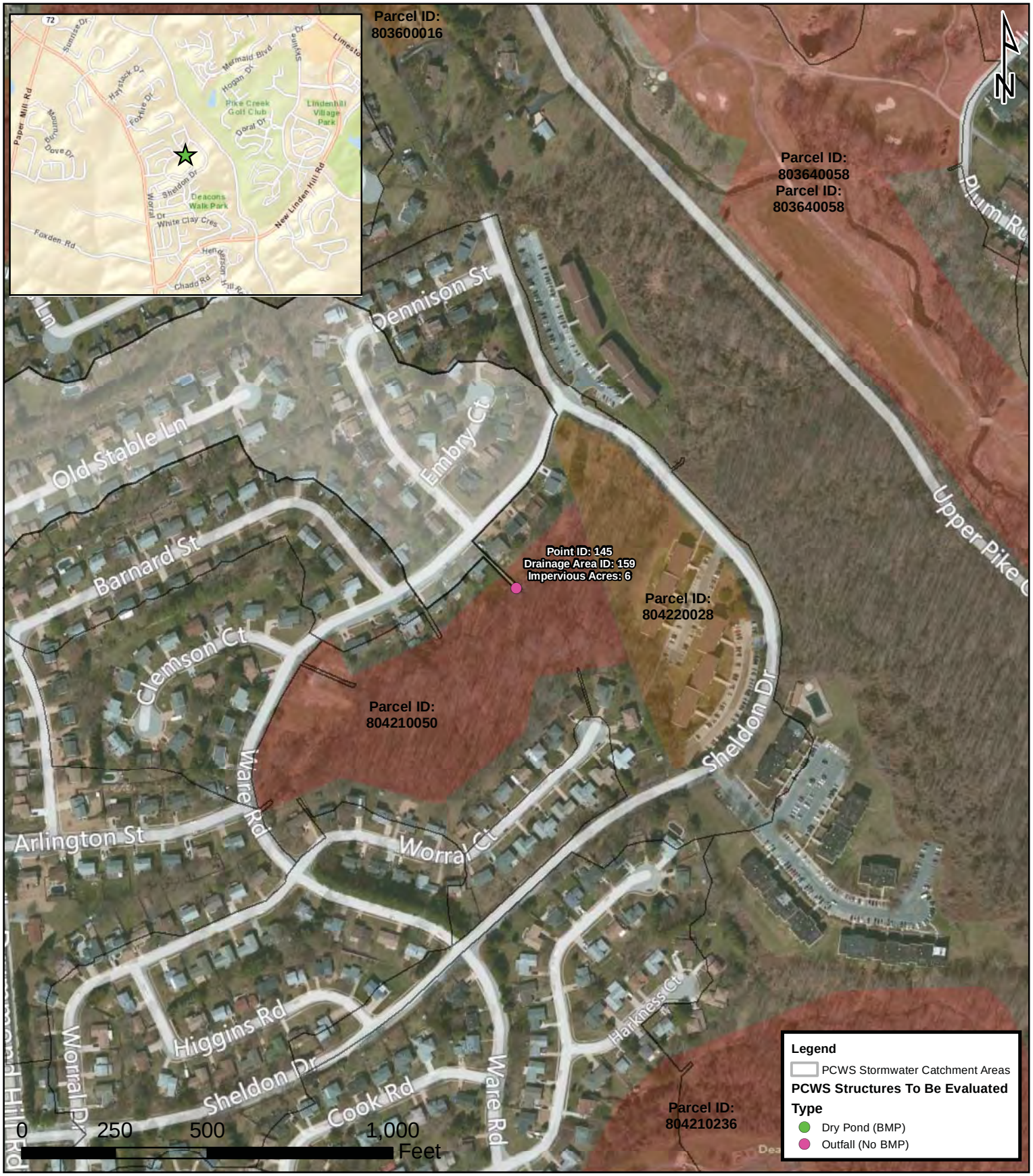

DATE: 7/31/2012	**Drainage Area ID: 159**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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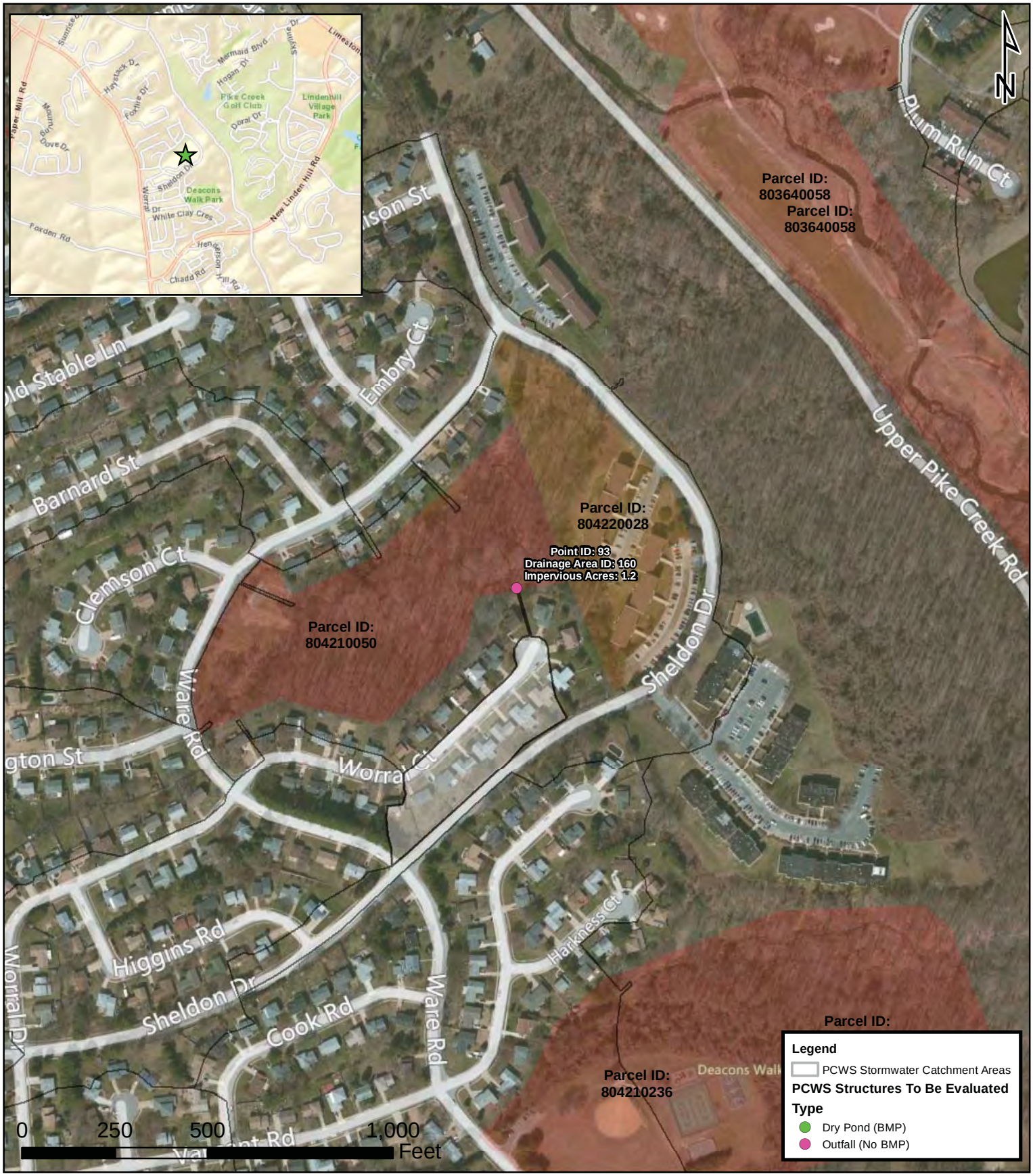

DATE: 7/31/2012	**Drainage Area ID: 160**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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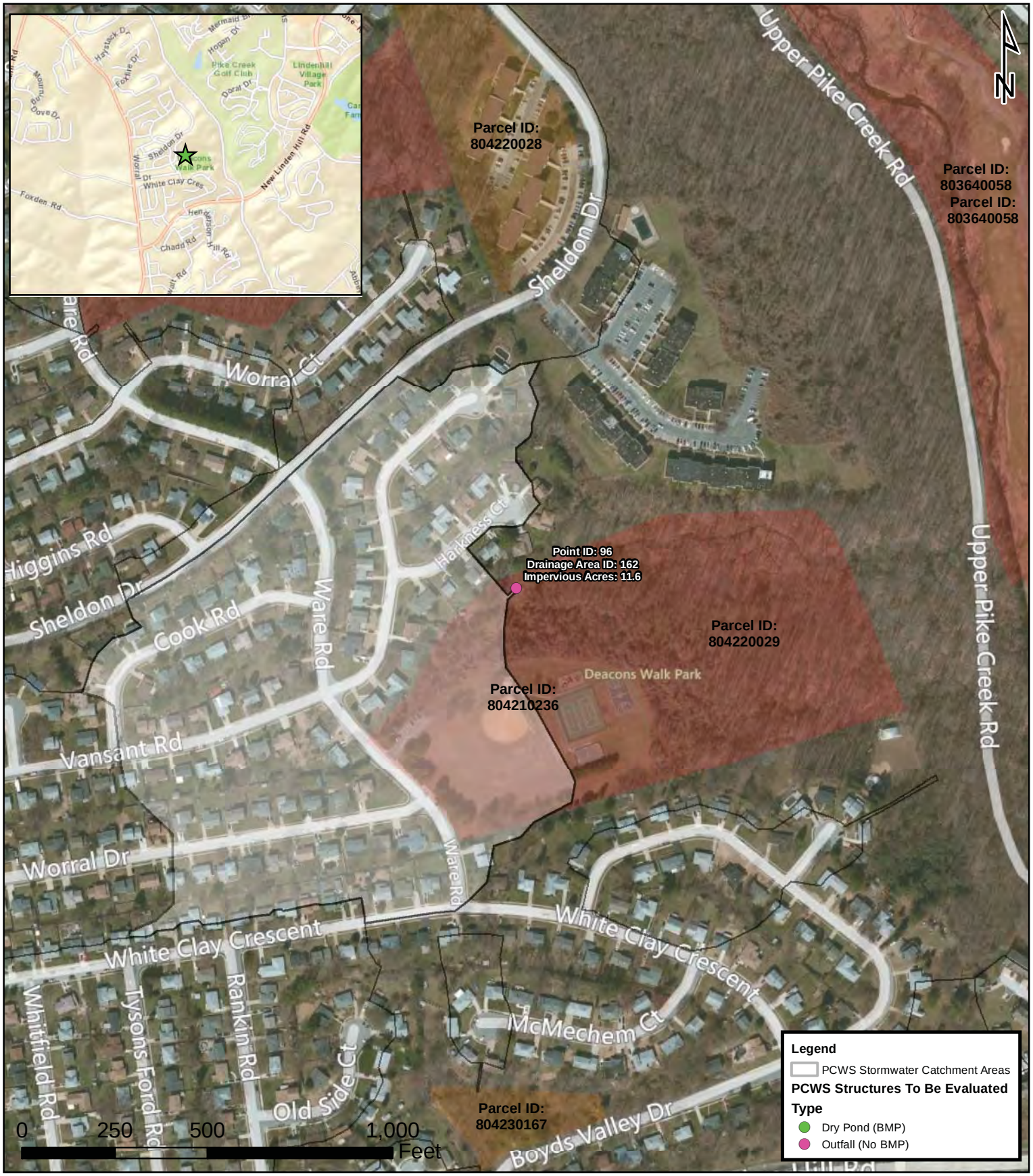

DATE: 7/31/2012	**Drainage Area ID: 162**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
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DATE: 7/31/2012	**Drainage Area ID: 169**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
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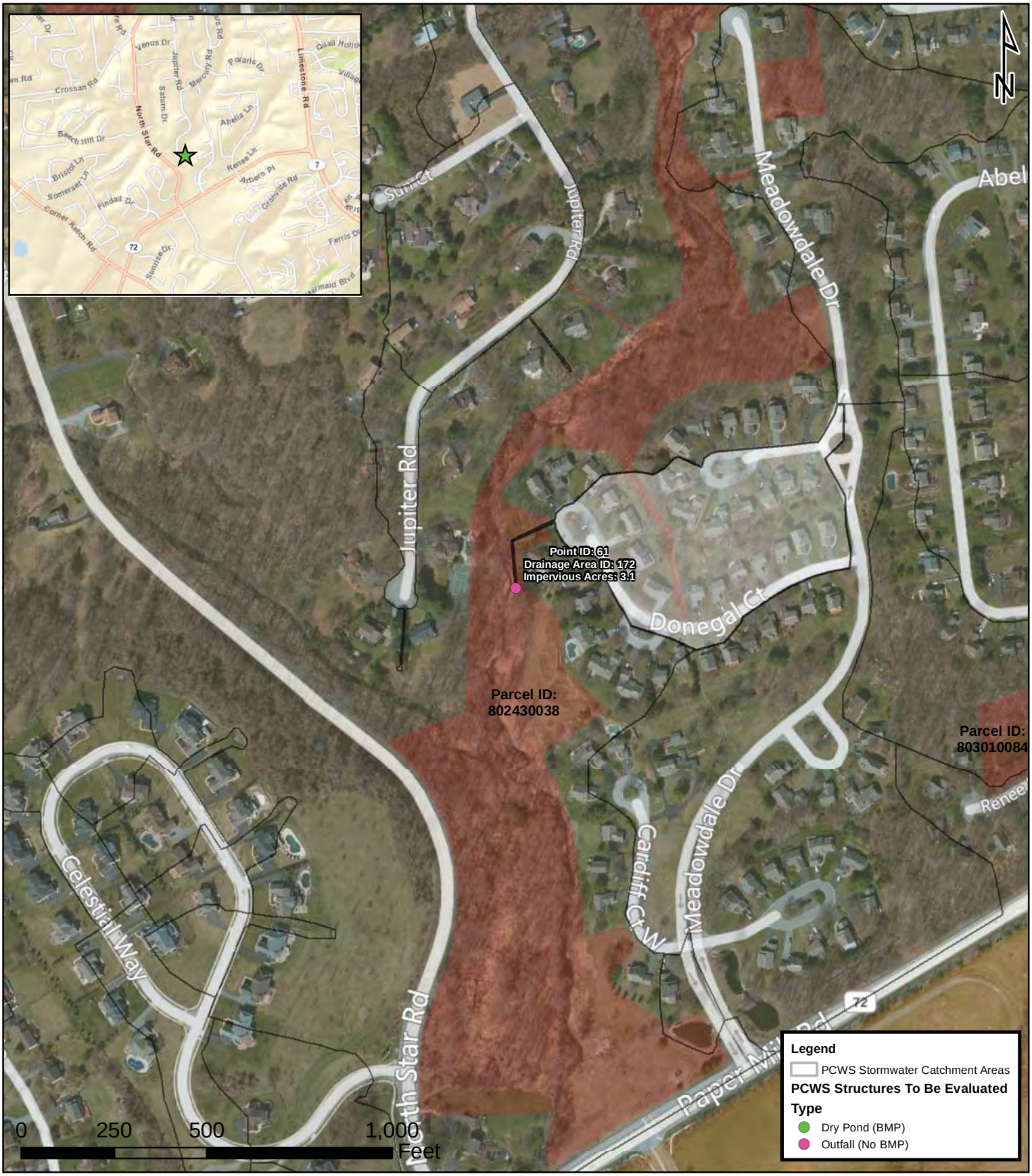
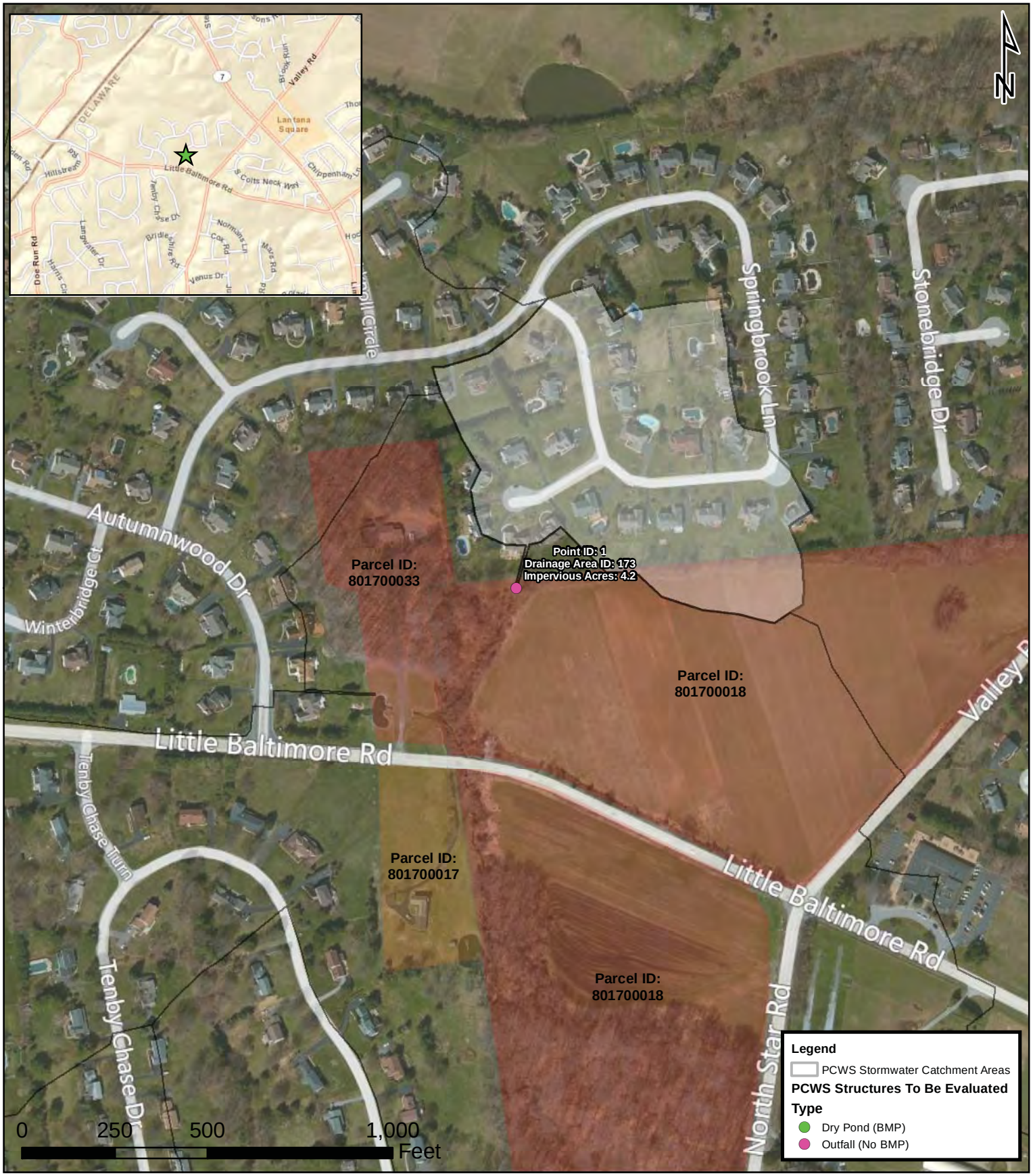
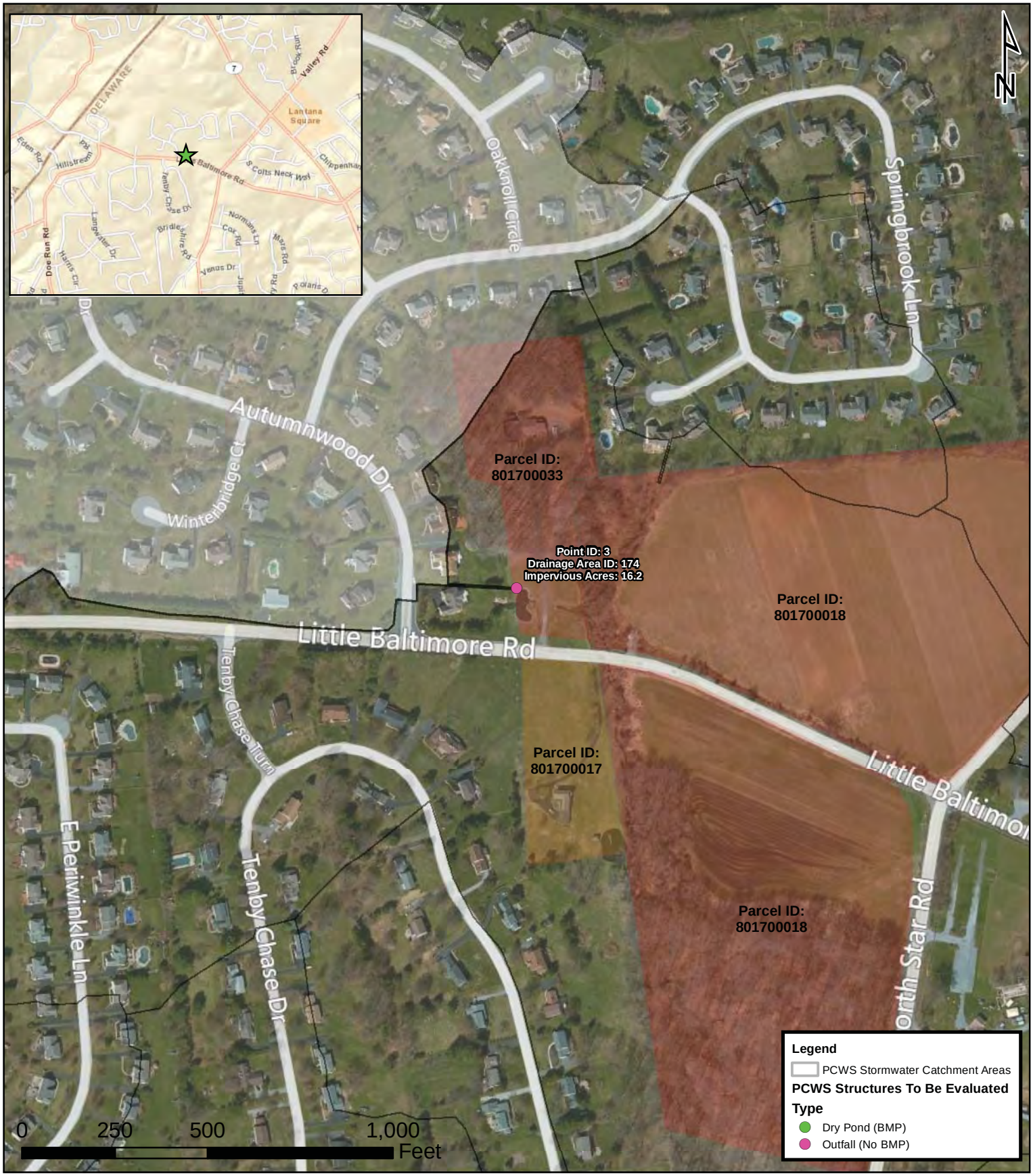


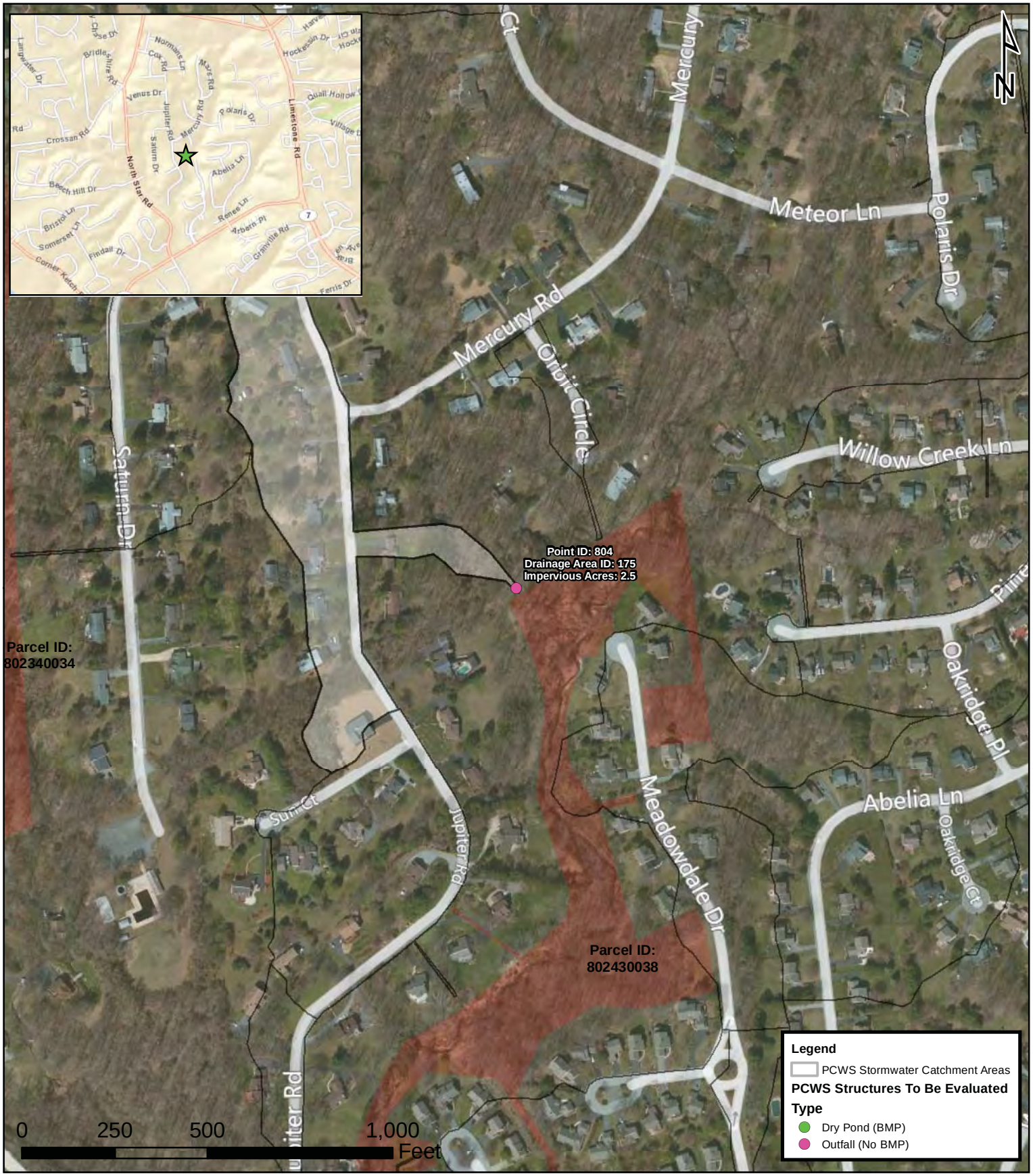
DATE: 7/31/2012	**Drainage Area ID: 172**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 46 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 173**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 47 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 174**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
SHEET: Page 48 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 175**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
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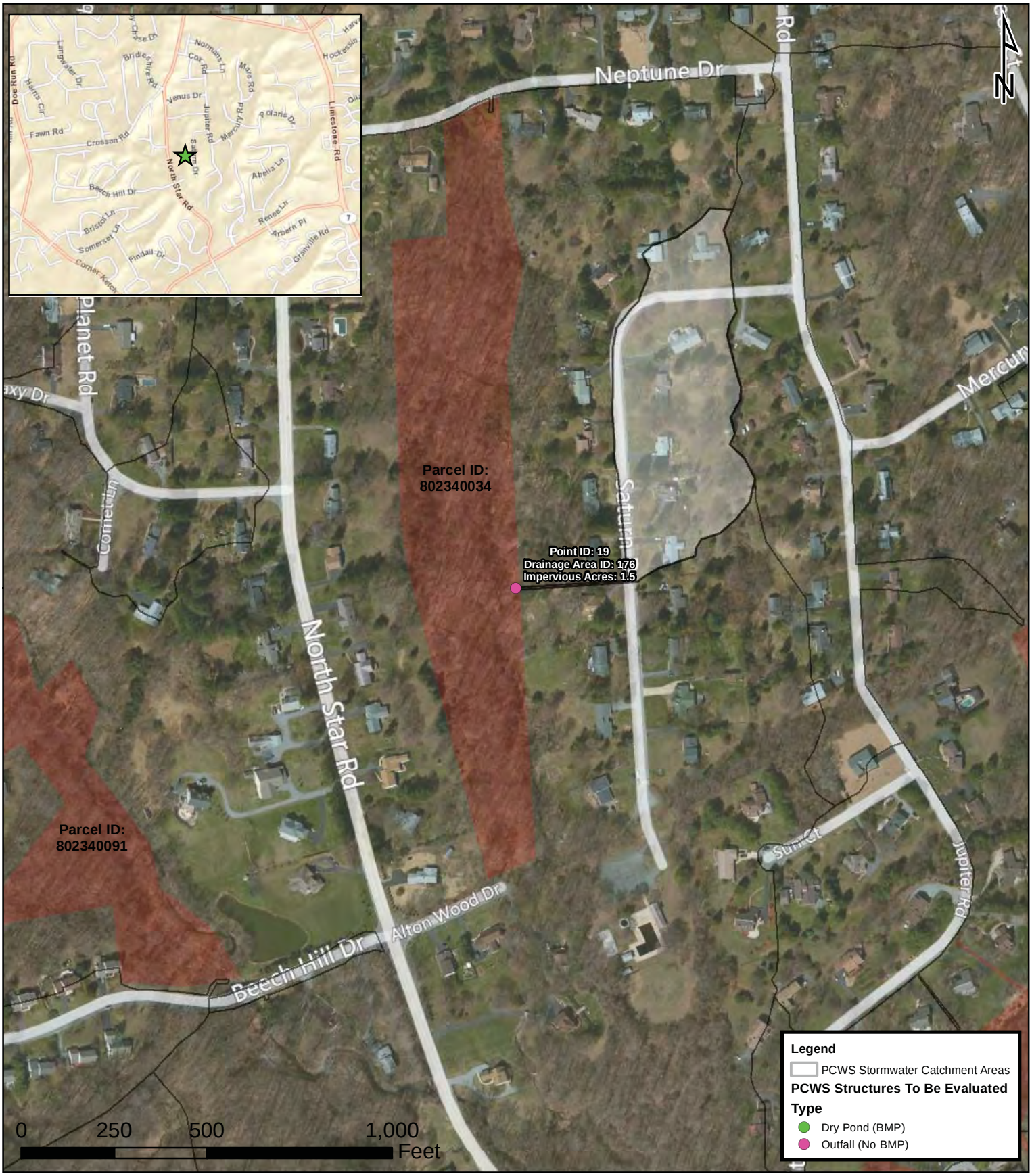
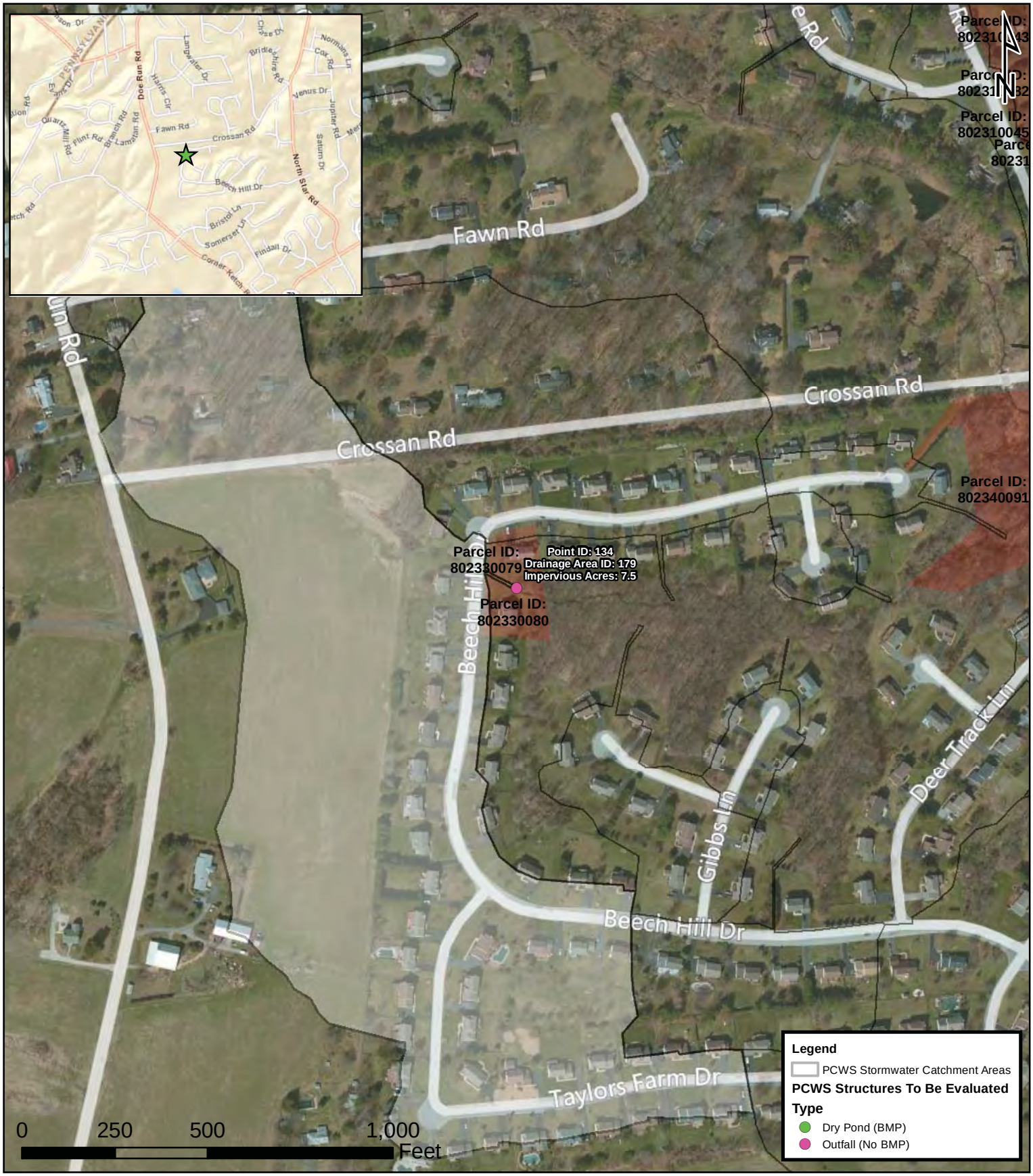


DATE: 7/31/2012	**Drainage Area ID: 176**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD** **WILMINGTON, DE 19808**
SHEET: Page 50 of 52	New Castle County-Delaware	FILE: 8568YC_CityofLewes.MXD	OFFICES IN DELAWARE, PENNSYLVANIA, MARYLAND, & NEW JERSEY



DATE: 7/31/2012	**Drainage Area ID: 179**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	**5400 LIMESTONE RD WILMINGTON, DE 19808**
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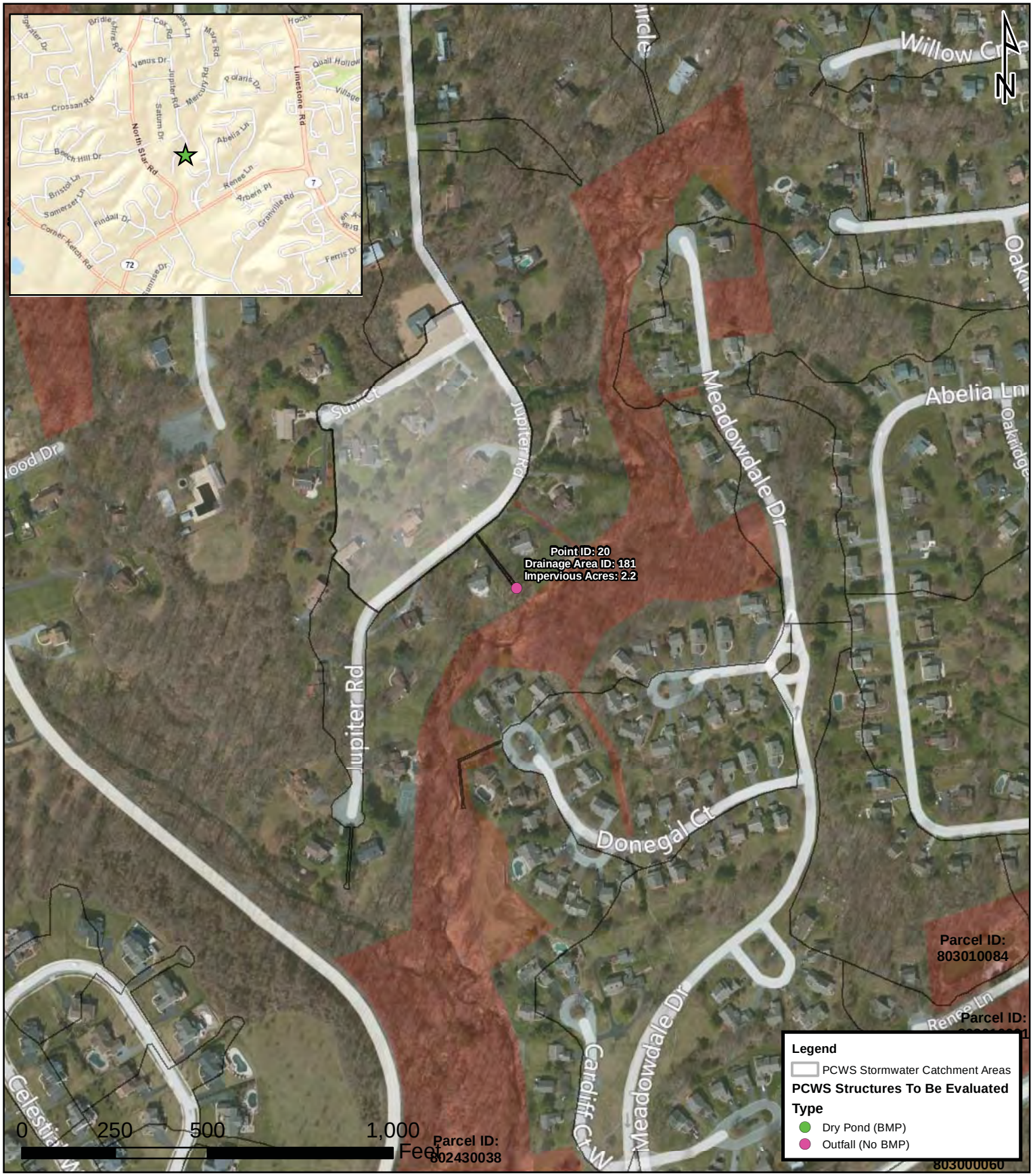

DATE: 7/31/2012	**Drainage Area ID: 181**	CREATED BY: DAI	DUFFIELD ASSOCIATES
SCALE: 1 inch = 350 feet	**PCWS Pilot Water Quality Improvement Plan**	BASEMAP: ArcGIS Online Bing Hybrid Basemap	5400 LIMESTONE RD WILMINGTON, DE 19808
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APPENDIX C

FIELD RECONNAISSANCE FORMS

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 5	SITE ID: 10818
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 57-65

SITE DESCRIPTION

NAME:

ADDRESS: Shannonbridge Drive

TAX PARCEL NUMBER: 802430168; 802440275

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***330229*** ***7.6 ac***
IMPERVIOUSNESS = ***52.13%***
IMPERVIOUS AREA (ft^2)= ***172162***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:
Dry Pond; Townhome community; Potential retrofit to Bio infiltration/Meandering stream channel/ created wetland dry pond measuring roughly 75'x200'. Surrounded by berm roughly 5.5-6' tall. Potential for Bio infiltration/wet pond

EXISTING PIPES / CULVERTS

_X_	Circular	***X***	Concrete	Pipe Size: _____	
___	Elliptical	___	Corrugated Metal	***Flared End Section***	Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:	
Other: _____		___	HDPE (Smooth)		
		___	Ductile Iron	Riprap Outfall	***Yes*** No
		Other: _____		If Yes, Approximate Size:	***6-24"***

Notes:
Basin has generally direct flow through small channel from inlets to outfall structure.

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
1 inlet pipe; 2 sheet flow riprap covered inlets. 1 overflow spillway approx. 45' wide and 1 outlet structure
Dry pond grass base is actively mowed and maintained; small channel exists that provides preferential flow from inlet to outlet.
Basin discharges into woods southwest of outlet structure.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 5	SITE ID: 10818

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 8	SITE ID: 10138
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 156-166

SITE DESCRIPTION

NAME:

ADDRESS: Meadowdale

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***653382*** ***15 ac***
IMPERVIOUSNESS = ***32.21%***
IMPERVIOUS AREA (ft^2)= ***210463***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***
If Yes, Describe:
Dry pond with 2' wide perennial stream running trough middle, bermed with 20" concrete outlet into caged gabion wall roughly 70' wide.

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: 30"	
___	Elliptical	___	Corrugated Metal	Flared End Section	***Open Outfall***
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:	
Other: _____		___	HDPE (Smooth)		
		___	Ductile Iron	Riprap Outfall	***Yes*** No
		Other: _____		If Yes, Approximate Size:	***6-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Large flat but bermed area behind residential homes used to contain stormwater. Large gabion wall retains water as it discharges through 30" RCP. Small stream runs through middle of "dry pond"; very shallow water table expected

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 8	SITE ID: 10138

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***	
Recharge	Channel Protection	Other: _____	

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Permissions from property owners

ACCESS: No Constraints

Constraints Due To: Slope ***Structures*** ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	____	Impacts to Specimen Trees
		How Many: _____5-10_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 20	SITE ID: 10793
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 146-155

SITE DESCRIPTION

NAME:

ADDRESS: Meadowdale Dr

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***418788*** ***9.6 ac***
IMPERVIOUSNESS = ***26.37%***
IMPERVIOUS AREA (ft^2)= ***110447***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***
If Yes, Describe:
Flow enters into "Dry Pond" via 24" CMP inlet and flows through 1' wide flowing stream that flows through 12" CMP to Pike Creek. Constructed Berm to hold flow in "Dry Pond" when inflow exceeds out.

EXISTING PIPES / CULVERTS

_X_ Circular	___ Concrete	Pipe Size: 24" & 12"		
___ Elliptical	_X_ Corrugated Metal	***Flared End Section***	Open Outfall	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	***Yes***	No
	Other: _____	If Yes, Approximate Size:		***21-24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall flows beneath public path to Dry Pond. Parallel to path, adjacent property owner constructed rain grade to divert flow that spills over catch basin. Possible BMP measures include widening channel in Dry Pond and/or raising outfall.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 20	SITE ID: 10793

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***	
Recharge	Channel Protection	Other: _____	

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Permissions from property owners

ACCESS: No Constraints

Constraints Due To: Slope ***Structures*** ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____5-10_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 22	SITE ID: 10561
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 90-103

SITE DESCRIPTION

NAME:

ADDRESS: Plum Run Ct

TAX PARCEL NUMBER: 803640058

OWNERSHIP:	Public	Private	***Unknown***	Other: _____
	Local	State	DOT	

PROPOSED RETROFIT LOCATION:

Existing Pond	Swale	Yard Drainage Pipe
Stormwater Outfall	Bio retention Area	*Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) =	***705579***	***16.2 ac***
IMPERVIOUSNESS =	***46.15%***	
IMPERVIOUS AREA (ft^2)=	***325638***	

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:

Large 150' x 180' dry pond. Severely overgrown with various saplings, briers, grasses and 4-8" diameter trees.
Retrofit potential: Bio infiltration/ rain garden / created wetlands. Maintenance is urgently needed.

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size:	***24"***
___	Elliptical		Corrugated Metal	***Flared End Section***	Open Outfall
___	Box		HDPE (Corrugated)	Condition of Pipe End:	
Other: _____		___	HDPE (Smooth)		***Concrete channel***
		___	Ductile Iron	Riprap Outfall	***Yes*** No
		Other: _____		If Yes, Approximate Size:	***12-18"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Bermed Dry pond adjacent to Plum Run Ct. Severely overgrown with vegetation. Yard waste/litter disposed in pond. Pond has 1 CMP inlet (captures surface flow from surrounding townhomes) and one outlet structure surrounded by steel cage.
No apparent emergency overflow observed. Berms approximately 7-8 feet high.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 22	SITE ID: 10561

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 42	SITE ID: 10071
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 53-72

SITE DESCRIPTION

NAME:

ADDRESS: Haley Ct

TAX PARCEL NUMBER: 803640058

OWNERSHIP:	Public	Private	***Unknown***	Other: _____
	Local	State	DOT	

PROPOSED RETROFIT LOCATION:

Existing Pond	Swale	Yard Drainage Pipe
Stormwater Outfall	Bio retention Area	*Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) =	***747546***	***17.2 ac***
IMPERVIOUSNESS =	***53.28%***	
IMPERVIOUS AREA (ft^2)=	***398284***	

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:

2000 square foot dry pond surrounded by ~ 7 foot high gabion wall. Bottom overgrown with phragmites and 4-8" diameter trees soil appears dry and generally sandy. High retrofit potential: Bio infiltration/Rain Garden/ Wet Pond

EXISTING PIPES / CULVERTS

_X_	Circular	___	Concrete	Pipe Size: ***15"***
___	Elliptical	_X_	Corrugated Metal	Flared End Section ***Open Outfall***
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Large "Dry Pond" surrounded by gabion wall. 1 inlet pipe and 1 channelized flow through riprap (6-18"). Pond is roughly 30 feet below parking/building grade and adjacent to abandoned golf course.

Pond has one 60" outlet structure with one 3' outfall

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 42	SITE ID: 10071

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	_X_	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 43	SITE ID: 10072
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 75-85

SITE DESCRIPTION

NAME:

ADDRESS: Claremont Ct

TAX PARCEL NUMBER: 804220111

OWNERSHIP:	Public	Private	***Unknown***	Other: _____
	Local	State	DOT	

PROPOSED RETROFIT LOCATION:

Existing Pond	Swale	Yard Drainage Pipe
Stormwater Outfall	Bio retention Area	*Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***977806*** ***22.4 ac***

IMPERVIOUSNESS = ***36.10%***

IMPERVIOUS AREA (ft^2)= ***352983***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:

Bermed dry pond overgrown with vegetation (10+ 4"-8" trees, various ground cover and briers.

Possible location for retrofit: Bio infiltration/wet pond/rain garden

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: ***24"***
___	Elliptical	___	Corrugated Metal	***Flared End Section*** Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall ***Yes*** No
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Large 15 yard x 40 yard "Dry Pond" two channelized flow inlets (controlled w/ riprap) and one outlet structure that outfalls by DelDOT outfall #155. Outfall structure appears higher in elevation than emergency spillway

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 43	SITE ID: 10072

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 50	SITE ID: 10213
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 69-91

SITE DESCRIPTION

NAME:

ADDRESS: Drummond Farms Ln

TAX PARCEL NUMBER: 803630169

OWNERSHIP:	Public	***Private***	***Unknown***	Other: _____
	Local	State	DOT	

PROPOSED RETROFIT LOCATION:

Existing Pond	Swale	Yard Drainage Pipe
Stormwater Outfall	Bio retention Area	*Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) =	***2135287***	***49 ac***
IMPERVIOUSNESS =	***29.95%***	
IMPERVIOUS AREA (ft^2)=	***639427***	

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:

2 outfalls observed entering woods; 1 appears abandoned with large boulder blocking. Outfall discharges to highly eroded channel that runs approximately 100' to "Dry Pond"/deeply eroded bermed area with 6' outlet structure (4' inner); need of retrofit

EXISTING PIPES / CULVERTS

_X_	Circular	___	Concrete	Pipe Size: _30"	
___	Elliptical	**X**	Corrugated Metal	***Flared End Section***	Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:	
Other: _____		___	HDPE (Smooth)		
		___	Ductile Iron	Riprap Outfall	Yes ***No***
		Other: _____		If Yes, Approximate Size:	6-24"

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

"Dry Pond/ BMP" bottom of slope that is fed by channel (groundwater seeps noticeable); Abundant amount of debris surrounds structure.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 50	SITE ID: 10213

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** ***Structures*** ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	_____	Impacts to Wetlands
X	_____	Impacts to Stream
X	_____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	_____	Impacts to Specimen Trees
	_____	How Many: _____5-10_____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 52	SITE ID: 10304
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES:

SITE DESCRIPTION

NAME: Independence School

ADDRESS: Upper Pike Creek Rd and Paper Mill Rd

TAX PARCEL NUMBER: 803000060

OWNERSHIP: ***Public*** ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1096730*** ***25.2 ac***
IMPERVIOUSNESS = ***43.43%***
IMPERVIOUS AREA (ft^2)= ***476344***

NOTES:

DRAINAGE AREA LAND USE:

Residential	***Institutional***
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No Possible
If Yes, Describe:
Bio infiltration/retention pond with created wetland filter. Pond surrounded by berm with outfall draining into Pike Creek

EXISTING PIPES / CULVERTS

___ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: _____
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall Yes No
If Yes, Approximate Size: 12-24"

Notes:
Catch basin identified but outfall into existing wet pond not observed

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 52	SITE ID: 10304

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	***Institutional***	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To: Slope, Structures, Tree Impacts, Utilities, Space, Property Ownership, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	_____	Impacts to Wetlands
X	_____	Impacts to Stream
	_____	Floodplain Fill
___	_____	Dam Safety Permits
___	_____	Impacts to Forest
X	_____	Impacts to Specimen Trees
		How Many: _____2-10+_____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 57	SITE ID: 10772
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 221-234

SITE DESCRIPTION

NAME:

ADDRESS: Farmingdale Ln

TAX PARCEL NUMBER: 802940051

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***3576555*** ***82.1 ac***
IMPERVIOUSNESS = ***22.10%***
IMPERVIOUS AREA (ft^2)= ***790359***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***
If Yes, Describe:
Dry Pond; Neighborhood stormwater handled through riprap covered swale throughout communities. 5 inlets enter dry pond measuring roughly 135'x200'. Surrounded by berm roughly 4-5' tall. Potential for Bio infiltration/wet pond

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
_X_ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: _(1) 24"; (2) 36"; (1) 34"; (1) 30"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***12-24"***

Notes:
Basin has generally direct flow through small channel from inlets to outfall structure.

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Grass bottom dry pond with 1 main channel running to outfall structure. No overtopping observed. 2 outfalls from pond to stream/channel. Channel is heavily eroded. Many swimming pools noted in neighborhood, SHWT possibly shallow.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 57	SITE ID: 10772

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 78	SITE ID: 263
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 44-49

SITE DESCRIPTION

NAME:

ADDRESS: Thorn Hallow Rd

TAX PARCEL NUMBER: 805400033

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1918568*** ***44 ac***
IMPERVIOUSNESS = ***49.06%***
IMPERVIOUS AREA (ft^2)= ***941211***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***

If Yes, Describe:
Cut pipe and create BMP structure in Meadowood Park III and treat a portion of the catchment area

EXISTING PIPES / CULVERTS

_X_	Circular	___	Concrete	Pipe Size: ***48"***
___	Elliptical	_X_	Corrugated Metal	***Flared End Section*** Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	***Detached***
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall roughly 2 feet above ground surface discharges into ponding area surrounded by concrete approximately 60 feet from Pike Creek. Flowing water was observed from pipe at time of visit. Area within Pike Creek floodplain and surrounded by Wetlands

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 78	SITE ID: 263

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	***Park***	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access issues due to slope/stream/wetlands and property ownership

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space Property Ownership
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
_X_	_____	Floodplain Fill
___	_____	Dam Safety Permits
___	_____	Impacts to Forest
_X_	_____	Impacts to Specimen Trees
		How Many: _____3_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 79	SITE ID: 262
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 50-52

SITE DESCRIPTION

NAME:

ADDRESS: Haley Ct

TAX PARCEL NUMBER: 804800058

OWNERSHIP: Public Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***95188*** ***2.2 ac***
IMPERVIOUSNESS = ***55.42%***
IMPERVIOUS AREA (ft^2)= ***52755***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***18"***
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***8-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall pipe runs directly under Upper Pike Creek Rd discharges roughly 15' west of road and runs approximately 20 yards prior to discharging into Pike Creek. Channel width is roughly 2.5' wide and 1'-3' deep. Seepage or running water not observed.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 79	SITE ID: 262

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***
If Yes, describe:

ACCESS: No Constraints
Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	_X_	Sewer
___	_X_	Water
___	_X_	Gas
___	___	Cable
___	___	Electric (Underground)
___	_X_	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
_X_	_____	Floodplain Fill
___	_____	Dam Safety Permits
___	_____	Impacts to Forest
___	_____	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 80	SITE ID: 261
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES:

SITE DESCRIPTION

NAME:

ADDRESS: Rockrose Drive

TAX PARCEL NUMBER: 804930008

OWNERSHIP: **Public** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***648747*** ***14.9 ac***
IMPERVIOUSNESS = ***49.16%***
IMPERVIOUS AREA (ft^2)= ***318915***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Site at outfall to create BMP structure to treat Outfall #261 & 260

EXISTING PIPES / CULVERTS

_X_ Circular	___ Concrete	Pipe Size: ***36"***		
___ Elliptical	_X_ Corrugated Metal	***Flared End Section***	Open Outfall	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)		***Bottom rusted***	
	___ Ductile Iron	Riprap Outfall	Yes	***No***
	Other: _____	If Yes, Approximate Size:		

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall is the combined flow from outfall #260 and associated stream and drainage area matched with outfall #261.
Pipe network also incorporates runoff into surface catch basins in grass within park boundary.
Channel has flowing water (stream) roughly 10' wide x 4' deep.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 80	SITE ID: 261

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	***Park***	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: Slope, Structures, ***Tree Impacts***, Utilities, Space, Property Ownership, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
_X_	_____	Floodplain Fill
	_____	Dam Safety Permits
___	_____	Impacts to Forest
_X_	_____	Impacts to Specimen Trees
		How Many: _____*2-10+* __

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 81	SITE ID: 260
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 33-

SITE DESCRIPTION

NAME:

ADDRESS: Rockrose Drive

TAX PARCEL NUMBER: 804930008

OWNERSHIP: **Public** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***820070*** ***18.8 ac***
IMPERVIOUSNESS = ***52.67%***
IMPERVIOUS AREA (ft^2)= ***431941***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Site has BMP potential if pipe is cut back into county park. Possible rain garden/ created wetland/bio swale

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***30"***
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Concrete outfall with concrete headwall discharges into flowing stream. Stream channel incised roughly 3' and is approx. 8' wide. Significant erosion was observed. Groundwater is anticipated to be very shallow (<2' b.e.g.s)
Discussion with adjacent home owner noted that during large rain events (coupled with clogging of culvert inlet) yard and park flood approximately 60 yards into adjacent floodplain.
Stream is then channelized underground through via CMP underneath public park

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 81	SITE ID: 260

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	***Park***	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

Access issues due to slope/stream/wetlands and property ownership

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
_X_	_____	Floodplain Fill
	_____	Dam Safety Permits
___	_____	Impacts to Forest
_X_	_____	Impacts to Specimen Trees
		How Many: _____*2-10+* __

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 84	SITE ID: 118
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 24-27

SITE DESCRIPTION

NAME:

ADDRESS: Chadd Rd

TAX PARCEL NUMBER: 804810087

OWNERSHIP: **Public** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***176225*** ***4 ac***
IMPERVIOUSNESS = ***45.98%***
IMPERVIOUS AREA (ft^2)= ***81032***

NOTES:

DRAINAGE AREA LAND USE:

Residential	***Institutional***
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
If pipe is cut back it would be possible to build a created wetlands/rain garden

EXISTING PIPES / CULVERTS

_X_ Circular	___ Concrete	Pipe Size: ***48"***		
___ Elliptical	_X_ Corrugated Metal	Flared End Section	***Open Outfall***	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	***Yes***	No
	Other: _____	If Yes, Approximate Size:		***12-24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfalls into 6' incised channel surrounded by riprap. Overgrown with various saplings/byers and 8-12" trees. No flow observed at time of visit. Surrounding area maintained by Public/Institution.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 84	SITE ID: 118

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	***Institutional***	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To: Slope, Structures, Tree Impacts, Utilities, Space, Property Ownership, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____ __

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 85	SITE ID: 116
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 28-32

SITE DESCRIPTION

NAME:

ADDRESS: Chadd Rd

TAX PARCEL NUMBER: 804810087

OWNERSHIP: **Public** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***178005*** ***4.1 ac***
IMPERVIOUSNESS = ***39.95%***
IMPERVIOUS AREA (ft^2)= ***71115***

NOTES:

DRAINAGE AREA LAND USE:

Residential	***Institutional***
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
If pipe is cut back it would be possible to build a created wetlands/rain garden

EXISTING PIPES / CULVERTS

_X_ Circular	_X_ Concrete	Pipe Size: ***18"***		
___ Elliptical	___ Corrugated Metal	Flared End Section	***Open Outfall***	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)		***Flared Concrete Headwall***	
	___ Ductile Iron	Riprap Outfall	Yes	***No***
	Other: _____	If Yes, Approximate Size:		

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Discharges into incised channel (dry) which extends roughly 60 yards to flowing stream. Area lush with saplings and brier. Catch Basins within grass area capture additional flow from school yard and playground.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 85	SITE ID: 116

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	***Institutional***	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To: Slope, Structures, Tree Impacts, Utilities, Space, Property Ownership, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
_X_	_____	Impacts to Specimen Trees
		How Many: _____*1* __

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 87	SITE ID: 117
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 20-23

SITE DESCRIPTION

NAME:

ADDRESS: Chadd Rd

TAX PARCEL NUMBER: 804810087

OWNERSHIP: **Public** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***343170*** ***7.9 ac***
IMPERVIOUSNESS = ***37.43%***
IMPERVIOUS AREA (ft^2)= ***128455***

NOTES:

DRAINAGE AREA LAND USE:

Residential	***Institutional***
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular	_X_ Concrete	Pipe Size: ***21"***		
___ Elliptical	___ Corrugated Metal	Flared End Section	***Open Outfall***	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	Yes	***No***
	Other: _____	If Yes, Approximate Size:		

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfalls drains into 15-20' channel then drops 5-8 feet into highly eroded channel. Erosion is starting to undercut aforementioned channel. Large amount of sapling and byer present. No water is flowing from pipe.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 87	SITE ID: 117

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	***Institutional***	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures Tree Impacts
Utilities Space Property Ownership
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____ __

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 94	SITE ID: 155
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 73-74

SITE DESCRIPTION

NAME:

ADDRESS: Champions Dr

TAX PARCEL NUMBER: 803640058

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***110068*** ***2.5 ac***
IMPERVIOUSNESS = ***71.88%***
IMPERVIOUS AREA (ft^2)= ***79116***

NOTES:

DRAINAGE AREA LAND USE:
Residential | Institutional
SFH (<1 AC Lot) | Industrial
SFH (>1 AC Lot) | Transport-Related
Townhouses | Park
Multi-Family | Undeveloped
Commercial | Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes | ***No*** | Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***30" (outfall) & 36" (site 10072)***
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:
Orange (rusty) seep flowing from 30" outfall

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall combines with outfall from dry pond (10072) to discharge in ponded area that flows to dry incised channel.
Access to the outfall is available from trail going from cul-de-sac to golf course.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 94	SITE ID: 155

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	_____	Impacts to Wetlands
	_____	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	_____	Impacts to Specimen Trees
		How Many: _____3-5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 95	SITE ID: 320
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 86-89

SITE DESCRIPTION

NAME:

ADDRESS: Plum Run Ct

TAX PARCEL NUMBER: 803640058

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***127794*** ***2.9 ac***
IMPERVIOUSNESS = ***41.12%***
IMPERVIOUS AREA (ft^2)= ***52547***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
_X_ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 18"
Flared End Section ***Open Outfall***
Condition of Pipe End:
Pipe crushed by tree at outfall point
Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges into incised valley (very steep) roughly 40 feet. Very steep slopes are present.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 95	SITE ID: 320

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	***Other: Abandoned Golf Course***

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 106	SITE ID: 101
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 7-10

SITE DESCRIPTION

NAME:

ADDRESS: McMechem Ct

TAX PARCEL NUMBER: 804230167

OWNERSHIP: Public Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***53850*** ***1.2 ac***
IMPERVIOUSNESS = ***41.06%***
IMPERVIOUS AREA (ft^2)= ***22110***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
_X_ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***18"***
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall, with concrete headwall, discharges into woods behind residential property via eroded channel into likely wetlands.
Groundwater seeps surrounding outfall. No water was flowing from outfall at the time of visit.
Site is overgrown with vegetation.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 106	SITE ID: 101

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***	
Recharge	Channel Protection	Other: _____	

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
_X_	_____	Impacts to Specimen Trees
		How Many: ___*3*__

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 107	SITE ID: 607
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 14-19

SITE DESCRIPTION

NAME:

ADDRESS: New Linden Hill Rd

TAX PARCEL NUMBER: 804230167

OWNERSHIP: Public, Private, ***Unknown***, Other: _____
Local, State, DOT

PROPOSED RETROFIT LOCATION:
Existing Pond, Swale, Yard Drainage Pipe
Stormwater Outfall, Bio retention Area, *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1603091*** ***36.8 ac***
IMPERVIOUSNESS = ***47.95%***
IMPERVIOUS AREA (ft^2)= ***768641***

NOTES:

DRAINAGE AREA LAND USE:
Residential, Institutional
SFH (<1 AC Lot), Industrial
SFH (>1 AC Lot), Transport-Related
Townhouses, Park
Multi-Family, Undeveloped
Commercial, Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Large (generally flat) approximately 150'x300' area adjacent to pipeline and outfall.
BMP potential: Bio infiltration/wet pond/ rain garden/ created wetland

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***30"***
Flared End Section ***Open Outfall***
Condition of Pipe End:
concrete swale
Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
30" outfall with concrete headwall discharges into concrete channel. Surrounding area is generally flat and very suitable for stormwater management. Flowing water from outfall observed during site visit.
Open space bounded by residential property and new lindon hill rd.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 107	SITE ID: 607

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	Property Ownership
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____ __

Other Factors: ***Possibly Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 108	SITE ID: 100
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 11-13

SITE DESCRIPTION

NAME:

ADDRESS: New Side Ct/Boyds Valley Drive

TAX PARCEL NUMBER: 804230167

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***63646*** ***1.5 ac***
IMPERVIOUSNESS = ***58.19%***
IMPERVIOUS AREA (ft^2)= ***37035***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes | ***No*** | Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: ***15"***
___	Elliptical	___	Corrugated Metal	Flared End Section ***Open Outfall***
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges into flowing 2 foot stream. Steep slope above outfall suggest overland flow above pipe. Pipe discharges into slightly eroded area which is funneled into 24" culvert with concrete head wall. Access to outfall is suggested via Boyds Valley Rd.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 108	SITE ID: 100

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space Property Ownership
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
_X_	_____	Impacts to Stream
_X_	_____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____ __

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 109	SITE ID: 125
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 191-201

SITE DESCRIPTION

NAME:

ADDRESS: Running Brook Ln

TAX PARCEL NUMBER: 802340091

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***91381*** ***2.1 ac***
IMPERVIOUSNESS = ***44.03%***
IMPERVIOUS AREA (ft^2)= ***40238***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Roughly 180' exists between catch basin and outfall; generally flat topography is conducive for a bio retention or rain garden

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 18"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***12"- 16"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges to riprap covered "pooling" area that splits to a "Y" and drains downslope (dominant side is to the right going down grade). A significant slope is present as channel drains to trib. to pike creek

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 109	SITE ID: 125

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 110	SITE ID: 138
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 173-185

SITE DESCRIPTION

NAME:

ADDRESS: Running Brook Ln

TAX PARCEL NUMBER: 802340091

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***522380*** ***12 ac***
IMPERVIOUSNESS = ***21.45%***
IMPERVIOUS AREA (ft^2)= ***112049***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 27"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***12"- 16"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall is approximately 24" above stream bottom, pipe enters stream with concrete pad in channel (broken). Very steep. Very difficult for BMP.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 110	SITE ID: 138

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	**X**	Impacts to Wetlands
X	**X**	Impacts to Stream
X	**X**	Floodplain Fill
___	____	Dam Safety Permits
___	____	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____10+_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 113	SITE ID: 126
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 191-201

SITE DESCRIPTION

NAME:

ADDRESS: Running Brook Ln

TAX PARCEL NUMBER: 802340091

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***91381*** ***2.1 ac***
IMPERVIOUSNESS = ***44.03%***
IMPERVIOUS AREA (ft^2)= ***40238***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Roughly 180' exists between catch basin and outfall; generally flat topography is conducive for a bio retention or rain garden

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 18"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***12"- 16"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges to riprap covered "pooling" area that splits to a "Y" and drains downslope (dominant side is to the right going down grade). A significant slope is present as channel drains to trib. to pike creek

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 113	SITE ID: 126

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 114	SITE ID: 128
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 202-210

SITE DESCRIPTION

NAME:

ADDRESS: Fair Oaks Ct

TAX PARCEL NUMBER: 802340091

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***277572*** ***6.4 ac***
IMPERVIOUSNESS = ***33.35%***
IMPERVIOUS AREA (ft^2)= ***92562***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 27"
Flared End Section Open Outfall
Condition of Pipe End: ***Detached***

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***6-24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges to riprap covered "pooling" area that splits to a "Y" and drains downslope (dominant side is to the left; going down grade). A significant slope is present as channel drains to trib. to pike creek site has immediate flood plain of roughly 45' feet of flat area surrounding creek.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 114	SITE ID: 128

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____1-2_____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 119	SITE ID: 136
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 210-216

SITE DESCRIPTION

NAME:

ADDRESS: Beech Hill Drive

TAX PARCEL NUMBER: 802340091

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***66788*** ***1.5 ac***
IMPERVIOUSNESS = ***44.25%***
IMPERVIOUS AREA (ft^2)= ***29555***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Potential for bio retention/rain garden/ controlled wetlands

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: 12"
___	Elliptical	___	Corrugated Metal	***Flared End Section*** Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall and Trib. underlay floodplain of trib. Outfall discharges directly into trib. Base is surrounded by poured concrete. Trib. channel is highly eroded and deep beneath outfall.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 119	SITE ID: 136

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	____	Dam Safety Permits
___	____	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____2-5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 134	SITE ID: 23
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 139-145

SITE DESCRIPTION

NAME:

ADDRESS: Orbit Circle

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***43720*** ***1 ac***
IMPERVIOUSNESS = ***34.92%***
IMPERVIOUS AREA (ft^2)= ***15268***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: 15"
___	Elliptical	___	Corrugated Metal	***Flared End Section*** Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	***Lost Pipe Section Broken @ Joint***
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe outlet from residential street stormwater @ bottom of cul-de-sac into slightly incised stream bed, currently dry
Empties into flowing tributary approx. 200' from outfall. Any BMP would need to accommodate stream also.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 134	SITE ID: 23

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____5+_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 139	SITE ID: 801
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 32-38

SITE DESCRIPTION

NAME:

ADDRESS: North Star Road & Cox Rd

TAX PARCEL NUMBER: 801740095; 801740096

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1053563*** ***24.2 ac***
IMPERVIOUSNESS = ***21.08%***
IMPERVIOUS AREA (ft^2)= ***222115***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: 36"
___	Elliptical	___	Corrugated Metal	***Flared End Section*** Open Outfall
___	Box	___	HDPE (Corrugated)	Condition of Pipe End: ***Detached***
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:
Site has potential for Rain Garden; Created Wetlands; Bios wale

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Piping runs along residential property line and discharges into wooded strip of land. Pipe discharges into a 25' wide and 4-5' deep incised channel which narrows to 2'. Small channel has some standing and slowly moving water that drains into wetlands surrounding western portion of property. Large algae rich pond on site; likely fed by groundwater

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 139	SITE ID: 801

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	***Space***	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____2-5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 144	SITE ID: 33
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 28-31

SITE DESCRIPTION

NAME:

ADDRESS: Pacer Ct

TAX PARCEL NUMBER: 802320111

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***61754*** ***1.4 ac***
IMPERVIOUSNESS = ***45.11%***
IMPERVIOUS AREA (ft^2)= ***27857***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 15"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***8-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges directly into trib. of Pike Creek. Channel has concrete base and runs approx. 45 feet.
Trib. has moving water and appears to be perennially wet. An unidentified CMP was observed 130' downstream of outfall #33.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 144	SITE ID: 33

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	***Structures***	Tree Impacts
Utilities	***Space***	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
___	X	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 145	SITE ID: 3.2
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 15-27

SITE DESCRIPTION

NAME:

ADDRESS: Pacer Ct

TAX PARCEL NUMBER: 802320111

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***543675*** ***12.5 ac***
IMPERVIOUSNESS = ***23.75%***
IMPERVIOUS AREA (ft^2)= ***129117***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Bank Stabilization; step pool application; flow retention structure

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: (3 pipes) 12"; 15"; 24"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***6" - 24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Three inlets draining into riprap runoff area (15'x30'). High flows resulting in extreme erosion and bank failure
Walls roughly 5-6' high with a stream bed of 15-20' wide, exposed roots. Discussion with adjacent property owner indicated that the riprap and work around the inlets was performed in June/July 2012. Riprap likely too small for flows from inlets.
Flow drains to trib. of pike creek with slight perennial flow.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 145	SITE ID: 3.2

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To: Slope ***Structures*** ***Tree Impacts***
Utilities ***Space*** ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	_X_	Sewer
___	_X_	Water
___	_X_	Gas
___	_X_	Cable
___	_X_	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
___	X	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
___	X	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 153	SITE ID: 14
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 1-4

SITE DESCRIPTION

NAME:

ADDRESS: North Star Road & Cox Rd

TAX PARCEL NUMBER: 801740095; 801740096

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***571741*** ***13.1 ac***
IMPERVIOUSNESS = ***17.74%***
IMPERVIOUS AREA (ft^2)= ***101399***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 30
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:
Potential for rain garden/controlled wetlands

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges into 5' wide x 20' long x2.5' deep concrete channel that runs through meandering channel vegetated and maintained approximately 100-150' long. Widens to 5' and 3-4' deep going into woods and trib. to Pike Creek. Site is generally flat with slight grade towards woods. Area surrounding channel is maintained and landscaped.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 153	SITE ID: 14

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	***Space***	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____2-5_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 155	SITE ID: 143
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 107-112

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd and Barnard St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***332210*** ***7.6 ac***
IMPERVIOUSNESS = ***36.33%***
IMPERVIOUS AREA (ft^2)= ***120705***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_ Circular	_X_ Concrete	Pipe Size: 18"		
___ Elliptical	___ Corrugated Metal	Flared End Section	***Open Outfall***	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	Yes	***No***
	Other: _____	If Yes, Approximate Size:		

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into a highly eroded channel feeding directly into trib of Pike creek. (2.5' drop pipe to ground surface)
Stream is apparently perennial and has constant flow; Bank failure and highly eroded channels suggest high flows
during large rain events. Eroded roughly 6-10'

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 155	SITE ID: 143

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 156	SITE ID: 92
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 92-95

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd and Barnard St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***595872*** ***13.7 ac***
IMPERVIOUSNESS = ***45.23%***
IMPERVIOUS AREA (ft^2)= ***269530***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 24"
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall ***YES*** No
If Yes, Approximate Size: ***12-18"***

Notes:
Observed concrete runoff channel (broken) below pipe

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into a highly eroded channel feeding directly into trib of Pike creek.
Stream is apparently perennial and has constant flow; Bank failure and highly eroded channels suggest high flows during large rain events. Channel is roughly 10-15' deep in locations;

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 156	SITE ID: 92

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 157	SITE ID: 142
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 96-98;106

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd and Barnard St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***435264*** ***10 ac***
IMPERVIOUSNESS = ***42.75%***
IMPERVIOUS AREA (ft^2)= ***186088***

NOTES:

DRAINAGE AREA LAND USE:
Residential | Institutional
SFH (<1 AC Lot) | Industrial
SFH (>1 AC Lot) | Transport-Related
Townhouses | Park
Multi-Family | Undeveloped
Commercial | Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_ Circular | _X_ Concrete | Pipe Size: 24"
___ Elliptical | ___ Corrugated Metal | Flared End Section ***Open Outfall***
___ Box | ___ HDPE (Corrugated) | Condition of Pipe End:
Other: _____ | ___ HDPE (Smooth)
___ Ductile Iron | Riprap Outfall ***YES*** No
Other: _____ | If Yes, Approximate Size: ***12-24"***

Notes:
Observed concrete runoff channel (broken) below pipe

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into a highly eroded channel feeding directly into trib of Pike creek.
Stream is apparently perennial and has constant flow; Bank failure and highly eroded channels suggest high flows during large rain events. Channel is overgrown with vegetation.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 157	SITE ID: 142

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To: Slope, Structures, ***Tree Impacts***, Utilities, Space, ***Property Ownership***, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 158	SITE ID: 144
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 102-105

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd and Barnard St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***352417*** ***8.1 ac***
IMPERVIOUSNESS = ***43.08%***
IMPERVIOUS AREA (ft^2)= ***151820***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_ Circular	_X_ Concrete	Pipe Size: 24"		
___ Elliptical	___ Corrugated Metal	Flared End Section	***Open Outfall***	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	Yes	***No***
	Other: _____	If Yes, Approximate Size:		

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into a highly eroded channel feeding directly into trib of Pike creek. (4.5' drop pipe to ground surface)
Stream is apparently perennial and has constant flow; Bank failure and highly eroded channels suggest high flows
during large rain events.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 158	SITE ID: 144

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 159	SITE ID: 145
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 99-101

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd & Dennison St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***707493*** ***16.2 ac***
IMPERVIOUSNESS = ***37.07%***
IMPERVIOUS AREA (ft^2)= ***262235***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_	Circular	___	Concrete	Pipe Size: 27"
___	Elliptical	_X_	Corrugated Metal	Flared End Section ***Open Outfall***
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall Yes ***No***
		Other: _____		If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges 5' directly (5' drop) into a highly eroded channel feeding directly into trib of Pike creek.
Stream is apparently perennial and has constant flow; Bank failure and highly eroded channels suggest high flows during large rain events.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 159	SITE ID: 145

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 160	SITE ID: 93
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 113-121

SITE DESCRIPTION

NAME:

ADDRESS: Ware Rd and Barnard St

TAX PARCEL NUMBER: 804210050

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***103050*** ***2.4 ac***
IMPERVIOUSNESS = ***48.61%***
IMPERVIOUS AREA (ft^2)= ***50096***

NOTES:

DRAINAGE AREA LAND USE:
Residential | Institutional
SFH (<1 AC Lot) | Industrial
SFH (>1 AC Lot) | Transport-Related
Townhouses | Park
Multi-Family | Undeveloped
Commercial | Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Step Pools; Stream Restoration

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 15"
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall YES ***No***
If Yes, Approximate Size: 12-18"

Notes:
Observed concrete runoff channel (broken) below pipe

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into a highly eroded channel feeding directly into trib of Pike creek.
Generally dry channel; Bank failure and highly eroded channels suggest high flows
during large rain events. Channel is roughly 5' deep in locations and overgrown with vegetation

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 160	SITE ID: 93

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 162	SITE ID: 96
DATE: 7/16/2012	ASSESSED BY: MPN/PJM	PICTURES: 1-6

SITE DESCRIPTION

NAME:

ADDRESS: Harkness Ct

TAX PARCEL NUMBER: 804210236

OWNERSHIP: Public / Private / ***Unknown*** / Other: _____
Local / State / DOT

PROPOSED RETROFIT LOCATION:
Existing Pond / Swale / Yard Drainage Pipe
Stormwater Outfall / Bio retention Area / *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1289821*** ***29.6 ac***
IMPERVIOUSNESS = ***39.30%***
IMPERVIOUS AREA (ft^2)= ***506870***

NOTES:

DRAINAGE AREA LAND USE:
Residential / Institutional
SFH (<1 AC Lot) / Industrial
SFH (>1 AC Lot) / Transport-Related
Townhouses / ***Park***
Multi-Family / Undeveloped
Commercial / Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes / ***No*** / ***Possible***
If Yes, Describe:
Large open adjacent to outfall. Potential area for rain garden/ created wetland.

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
_X_ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: ***36"***
Flared End Section ***Open Outfall***
Condition of Pipe End:
Bottom rusted out
Riprap Outfall ***Yes*** / No
If Yes, Approximate Size: ***8-24"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall located behind residential property (adjacent to Decons Walk Park). Area is overgrown with vegetation.
Flowing water from outfall observed at time of inspection. Various debris observed at outfall location.
Stream channel incised roughly 3' deep and is approximately 1 to 4' wide.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 162	SITE ID: 96

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	***Park***	Other:

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: ***Access permissions***

ACCESS: No Constraints

Constraints Due To: Slope, Structures, Tree Impacts, Utilities, Space, ***Property Ownership***, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
_X_	_____	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 169	SITE ID: 36
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 66-68

SITE DESCRIPTION

NAME:

ADDRESS: Haileys Trail

TAX PARCEL NUMBER: 802410116

OWNERSHIP: Public Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***190639*** ***4.4 ac***
IMPERVIOUSNESS = ***29.82%***
IMPERVIOUS AREA (ft^2)= ***56850***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

___ Concrete
_X_ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 15"
Flared End Section Open Outfall
Condition of Pipe End:
Rusted
Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***6-12"***

Notes:
4' x8' long runoff section of riprap.

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe runs under residential property into wetlands. Yard waste (branches/yard clippings) scattered around outfall. outfall overgrown with vegetation.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 169	SITE ID: 36

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe:

Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	X	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 172	SITE ID: 61
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 167-

SITE DESCRIPTION

NAME:

ADDRESS: Donegal Ct

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***295680*** ***6.8 ac***
IMPERVIOUSNESS = ***45.60%***
IMPERVIOUS AREA (ft^2)= ***134827***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Potential for rain garden/ swale if pipe is cut 100' from catch basin

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 24"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe discharges directly into Pike Creek. Roughly 100' from catch basin pipe makes approx. 45 degree turn south towards pike creek. Neighbor noted minor sinkholes (likely due to backfill material used during installation.)

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 172	SITE ID: 61

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: Slope, Structures, ***Tree Impacts***, Utilities, Space, ***Property Ownership***, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
X	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 173	SITE ID: 1
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 48-53

SITE DESCRIPTION

NAME:

ADDRESS: Naudain Circle

TAX PARCEL NUMBER: 801700018

OWNERSHIP: Public | Private | ***Unknown*** | Other: _____
Local | State | DOT

PROPOSED RETROFIT LOCATION:
Existing Pond | Swale | Yard Drainage Pipe
Stormwater Outfall | Bio retention Area | Other: _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***583173*** ***13.4 ac***
IMPERVIOUSNESS = ***31.73%***
IMPERVIOUS AREA (ft^2)= ***185059***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***

If Yes, Describe:
Stormwater discharge into 1' wide channel roughly 6" to 1' deep.
Potential for small rain garden, as large field is adjacent to outfall. Note Drainage Area is generally small.

EXISTING PIPES / CULVERTS

_X_ Circular	_X_ Concrete	Pipe Size: 24"		
___ Elliptical	___ Corrugated Metal	***Flared End Section***	Open Outfall	
___ Box	___ HDPE (Corrugated)	Condition of Pipe End:		
Other: _____	___ HDPE (Smooth)			
	___ Ductile Iron	Riprap Outfall	***Yes***	No
	Other: _____	If Yes, Approximate Size:		***4-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Outfall discharges into small trib. at rear of private yard towards little Baltimore road. Constant small flow observed. Owner pointed out small "sinkholes" above pipeline as it travels under yard. Neighborhood stormwater is managed via grass swales then directed into catch basins prior to outfall location. A large field is adjacent to the site.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 173	SITE ID: 1

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: ***No Constraints***

Constraints Due To: Slope, Structures, Tree Impacts, Utilities, Space, Property Ownership, Other: _____

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	_X_	Impacts to Wetlands
___	_X_	Impacts to Stream
___	_X_	Floodplain Fill
___	_X_	Dam Safety Permits
___	_X_	Impacts to Forest
___	_X_	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 174	SITE ID: 3
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 39-47

SITE DESCRIPTION

NAME:

ADDRESS: Autumnwood Drive & Little Baltimore Rd

TAX PARCEL NUMBER: 801700033

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***2469766*** ***56.7 ac***
IMPERVIOUSNESS = ***28.51%***
IMPERVIOUS AREA (ft^2)= ***704125***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: ***Yes*** No ***Possible***

If Yes, Describe:
A failing wet pond or spillway with high amounts of algae and sediment. Water appears stagnant and is failing around overflow structure (bypassing). Possible retrofit opportunity? Remove sediment/re-grade bottom.

EXISTING PIPES / CULVERTS

_X_	Circular	_X_	Concrete	Pipe Size: (1) 48"/ (3) 24"
___	Elliptical	___	Corrugated Metal	***Flared End Section*** ***Open Outfall***
___	Box	___	HDPE (Corrugated)	Condition of Pipe End:
Other: _____		___	HDPE (Smooth)	
		___	Ductile Iron	Riprap Outfall ***Yes*** No
		Other: _____		If Yes, Approximate Size: ***12-20"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
A large stormwater outfalls discharges into a "wet pond" or spillway/retaining area that has three outfalls to grass swale (1-2' wide;6-1' deep). Some erosion observed. Channel fed continuously by groundwater seeps.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 174	SITE ID: 3

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	Tree Impacts
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	**X**	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 175	SITE ID: 804
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 131-138

SITE DESCRIPTION

NAME:

ADDRESS: Orbit Circle

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***413579*** ***9.5 ac***
IMPERVIOUSNESS = ***26.71%***
IMPERVIOUS AREA (ft^2)= ***110447***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Possible location for 1 or 2 step pools

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: _ 22"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***8-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Water drops approximately 2' into riprap basin approximately 18' long and 16' wide (bottom clogged with dirt, pine needles). End of basin severely eroded. Leaving basin water drops an additional 3' and enters eroded channel approx. 4' wide.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 175	SITE ID: 804

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***	
Recharge	Channel Protection	Other: _____	

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***
If Yes, describe:

ACCESS: No Constraints
Constraints Due To: ***Slope*** Structures ***Tree Impacts***
Utilities Space ***Property Ownership***
Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	____	Impacts to Wetlands
___	X	Impacts to Stream
___	X	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____3_____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 176	SITE ID: 19
DATE: 7/6/2012	ASSESSED BY: MPN/PJM	PICTURES: 28-31

SITE DESCRIPTION

NAME:

ADDRESS: Saturn Drive

TAX PARCEL NUMBER: 802340034

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***270504*** ***6.2 ac***
IMPERVIOUSNESS = ***24.92%***
IMPERVIOUS AREA (ft^2)= ***67405***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Potential area to control stormwater flow if pipe is cut.
Rain garden/controlled wetlands/bio retention - approximately 175' of mowed area for possible BMP

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 24"
Flared End Section ***Open Outfall***
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipes runs underneath residential property and daylights into woods. Woods are densely vegetated with abundant understory. Outfall discharges into 4' wide x 5' deep channel. No riprap observed.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 176	SITE ID: 19

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___	___	Electric (Overhead)
___	_X_	Other: _____septic___
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
___	X	Impacts to Stream
___	X	Floodplain Fill
___	X	Dam Safety Permits
___	X	Impacts to Forest
___	X	Impacts to Specimen Trees
		How Many: _____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 179	SITE ID: 134
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 217

SITE DESCRIPTION

NAME:

ADDRESS: Beech Hill Drive

TAX PARCEL NUMBER: 802330079; 80230080

OWNERSHIP: Public ***Private*** ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***1705896*** ***39.2 ac***
IMPERVIOUSNESS = ***19.16%***
IMPERVIOUS AREA (ft^2)= ***326925***

NOTES:

DRAINAGE AREA LAND USE:

Residential	Institutional
SFH (<1 AC Lot)	Industrial
SFH (>1 AC Lot)	Transport-Related
Townhouses	Park
Multi-Family	Undeveloped
Commercial	Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** Possible
If Yes, Describe:

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 36"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall ***Yes*** No
If Yes, Approximate Size: ***6-12"***

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
RCP outfall discharges to riprap channel incised roughly 4.5 - 5' deep. Slope is generally flat as channel enters into woods. Potential shallow groundwater as small seeps noticeable down stream. Opposite side of Beech Hill Dr is vegetated swale.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 179	SITE ID: 134

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: ***Yes*** No

If Yes, describe: Access Permissions

ACCESS: No Constraints

Constraints Due To:

Slope	Structures	***Tree Impacts***
Utilities	Space	***Property Ownership***
Other: _____		

CONFLICTS W/ EXISTING UTILITIES None Unknown

Yes	Possible	
___	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
___	**X**	Impacts to Wetlands
___	**X**	Impacts to Stream
___	**X**	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
X	____	Impacts to Specimen Trees
		How Many: _____2-3_____

Other Factors: ***Likely Shallow Seasonal High Water Table***

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 181	SITE ID: 20
DATE: 7/5/2012	ASSESSED BY: MPN/PJM	PICTURES: 12-14

SITE DESCRIPTION

NAME:

ADDRESS: Donegal Ct

TAX PARCEL NUMBER: 802430038

OWNERSHIP: ***Public*** Private ***Unknown*** Other: _____
Local State DOT

PROPOSED RETROFIT LOCATION:
Existing Pond Swale Yard Drainage Pipe
Stormwater Outfall Bio retention Area *Other:* _____

DRAINAGE AREA TO PROPOSED RETROFIT

DRAINAGE AREA (ft^2) = ***287794*** ***6.6 ac***
IMPERVIOUSNESS = ***33.10%***
IMPERVIOUS AREA (ft^2)= ***95265***

NOTES:

DRAINAGE AREA LAND USE:
Residential Institutional
SFH (<1 AC Lot) Industrial
SFH (>1 AC Lot) Transport-Related
Townhouses Park
Multi-Family Undeveloped
Commercial Other: _____

EXISTING STORMWATER MANAGEMENT

EXISTING STORMWATER PRACTICE: Yes ***No*** ***Possible***
If Yes, Describe:
Potential for rain garden/ swale if pipe is cut 100' from catch basin

EXISTING PIPES / CULVERTS

_X_ Circular
___ Elliptical
___ Box
Other: _____

_X_ Concrete
___ Corrugated Metal
___ HDPE (Corrugated)
___ HDPE (Smooth)
___ Ductile Iron
Other: _____

Pipe Size: 20"
Flared End Section Open Outfall
Condition of Pipe End:

Riprap Outfall Yes ***No***
If Yes, Approximate Size:

Notes:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Pipe drops 20 feet in catch basin to discharge in flat area adjacent to residential yards. Channel meanders slightly for 150-200' Channels is approximately 3' wide by 1-1.5' deep. Runoff area drains into woods where it drops 3+ feet into larger drainage channel.

Existing Head Available and Points Where Measured:

PIKE CREEK WATER QUALITY IMPROVEMENT PLAN
FIELD RECONNAISSANCE INVESTIGATION FORM

SUBWATERSHED: Pike Creek	BASINID: 181	SITE ID: 20

PURPOSE OF RETROFIT

Water Quality	Repair	***Flood Control***
Recharge	Channel Protection	Other: _____

SITE CONSTRAINTS

ADJACENT LAND USE:

Residential	Industrial	Institutional	***Undeveloped/Open Space***
Commercial	Transportation Related	Park	Other: _____

POSSIBLE CONFLICTS DUE TO ADJACENT LAND USE: Yes ***No***

If Yes, describe:

ACCESS: No Constraints

Constraints Due To: Slope, Structures, ***Tree Impacts***, Utilities, Space, ***Property Ownership***, Other: _____

CONFLICTS W/ EXISTING UTILITIES None ***Unknown***

Yes	Possible	
X	___	Sewer
___	___	Water
___	___	Gas
___	___	Cable
___	___	Electric (Underground)
___		Electric (Overhead)
___	___	Other: _____
___	___	

POTENTIAL PERMITTING FACTORS

Probable	Not Probable	
X	____	Impacts to Wetlands
X	____	Impacts to Stream
X	____	Floodplain Fill
___	**X**	Dam Safety Permits
___	**X**	Impacts to Forest
___	____	Impacts to Specimen Trees
		How Many: _____

Other Factors:

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

___	Confirm Property Ownership	___	Obtain Existing Stormwater As-Builts
___	Confirm Drainage Area	___	Obtain Site As-Builts
___	Confirm DA Impervious Cover	___	Obtain Survey
___	Confirm Outlet Inverts Elevations	___	Obtain Utility Mapping
___	Complete Concept Sketch	___	Confirm Soil Types

Other:

Appendix E. Appoquinimink River Association's public education annual report.

Appoquinimink River Association 2013 Report

Livable Lawns Campaign – Improper fertilization of lawns and open spaces is a huge problem in the entire state. The Appoquinimink River Association, Department of Natural Resources and Environmental Control, Department of Transportation NPDES Program, Delaware Nursery and Landscape Association, Delaware Grounds Management Association, University of Delaware, USDA-Natural Resource Conservation Service, Nutrient Management Commission, Delaware Nature Society and New Castle Conservation District continued meeting and created a system to recognize those commercial applicators that are being environmentally friendly. The campaign also started its homeowner education portion of the campaign including advertising, outreach materials and events.

2012 brought the following accomplishments:

Livable Lawns Presentations/Outreach Events:

1/26/2012 – Dover, DE – DE Horticulture Industry Expo - 289 attendees
2/28/2012 – Dover, DE – John Deere Sales Meeting – 35 attendees
3/5/2012 – Newark, DE – UD Cooperative Extension Short Course
3/9/2012 – Georgetown, DE – UD Cooperative Extension Sussex County Turf Conference
3/20/2012 – Felton, DE – DNREC Nonpoint Source Program – 30 attendees
4/23/2012 – Stanton, DE – Del Tech Earth Day event
7/30/2012 – Carvel Center, Georgetown – MG & General Public presentation - 23 attended
8/8/2012 – Wilmington, DE – Green Jobs Students
8/16/2012 – Georgetown, DE – DNLA Summer Turf & Nursery Expo – 102 attendees

Promotional Materials:

- Residential brochures developed and printed -2/12
- Brochures were distributed at 4/23, 4/28 (AgDay), State Fair, 7/30
- Business cards certified companies developed 3/12/12
- Three "how to" videos filmed – 1/18/12 and 3/21/12
- Display booth was purchased and display materials developed – 4/12
- Commerical brochures (2,000) were reprinted – 6/12
- Ads designed by Janet Hughes & Associates – 9/12
- DE State News ad & Gatehouse (Community pubs. 30,000 exposures) Ad Campaign – 10/12

Companies:

- 28 companies expressed interest with 26 of those being viable companies that fit w/in the parameters
- To date, 5 are certified (2 have recertified + 3 new certified companies)

Pet Waste Education – Alongside the Departments of Natural Resources and Environmental Control and Transportation, the Appoquinimink River Association continued an intensive pet waste education campaign throughout southern New Castle County. Over 3,400 portable pet waste collection bag holders were distributed to training facilities (300), shelters (3,000) and at outreach events (100) including the Blackbird Fall Festival.

Appendix F. Public Education Strategy Final Report.

NPDES and Education on Stormwater Pollution

May 2012

written by

Martha Corrozi Narvaez *and* Andrew Homsey

with

Erin McVey

of IPA's

Water Resources Agency

This project is funded by the Delaware Department of Transportation and the Delaware Center for Transportation

Institute for Public Administration
School of Public Policy & Administration
College of Arts & Sciences
University of Delaware

serving the public good, shaping tomorrow's leaders

www.ipa.udel.edu

NPDES and Education on Stormwater Pollution

May 2012

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Delaware Department of Transportation
and the
Delaware Center for Transportation

Preface

It is the mission of the Institute for Public Administration's Water Resources Agency (WRA) at the University of Delaware to provide water-resources policy and planning assistance to governments and entities throughout Delaware and the region. In keeping with WRA's mission, IPA presents this report to provide guidance to DelDOT, New Castle County, and six municipalities in meeting the National Pollutant Discharge Elimination System (NPDES) education and outreach requirements.

As authorized under the Clean Water Act, the NPDES controls water pollution by regulating stormwater, which discharges directly into surface waters. New Castle County, DelDOT and six municipalities—Bellefonte, Delaware City, the Town of Elsmere, the City of Middletown, the City of New Castle, and the City of Wilmington—are Phase I co-permittees for the discharge of stormwater from and through all portions of the municipal separate storm-sewer system (MS4) in New Castle County, as authorized under the NPDES and the laws of the State of Delaware. This report provides guidance for DelDOT and the co-permittees to achieve the education and outreach requirements of the NPDES permit. It intends to make the education and outreach efforts more effective and meaningful for New Castle County, DelDOT and the six municipalities regulated under the permit.

This report discusses the following project components:

- Stormwater-education initiatives undertaken by DelDOT;
- Stormwater-education campaigns conducted by government and nongovernment organizations in Delaware and throughout the country;
- Workshop held for the co-permittees and the key concepts learned to develop an effective education campaign; and
- Recommendations on how to achieve the stormwater-education requirements in the eight Target Areas defined in the permit.

The information contained in this report provides guidance toward the development of a refined Stormwater Education and Outreach Plan, as required by the NPDES Phase I permit.

I would like to acknowledge the project team members. While a research assistant at IPA, Erin McVey researched and collected data for this report. Associate policy scientists Martha Corrozi Narvaez and Andrew Homsey led the project team and authored this important document. This report demonstrates a collaborative effort among IPA's Water Resources Agency, DelDOT, and New Castle County to assist DelDOT and co-permitees in meeting the education requirements as set forth in the NPDES in an effective and efficient manner. DelDOT and the Delaware Center for Transportation provided the funding for this project.

It is our hope that this partnership will continue and will result in an informed public, reduced pollution, and cleaner rivers and streams throughout Delaware.

Jerome R. Lewis, Ph.D.
Director, Institute for Public Administration

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Executive Summary

Controlling and managing stormwater that runs off roadways—impervious surfaces—into the state's surface waters are a major part of DelDOT's responsibilities. As authorized under the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) controls water pollution by regulating stormwater that discharges directly into surface waters. New Castle County, DelDOT, and six municipalities—Bellefonte, Delaware City, the Town of Elsmere, the City of Middletown, the City of New Castle, and the City of Wilmington—are Phase I co-permittees for the discharge of stormwater from and through all portions of the municipal separate storm-sewer system (MS4) in New Castle County as authorized under the NPDES and the laws of the State of Delaware. In order to meet the requirements of the NPDES permit, the co-permittees (named above) must meet specific education and outreach requirements outlined in the NPDES permit.

This report provides guidance for DelDOT and the co-permittees for achieving the education and outreach requirements of the NPDES permit. It intends to make the education and outreach efforts more effective and meaningful for New Castle County, DelDOT and the six municipalities regulated under the permit.

Though the University of Delaware served as the lead agency, this project was conducted using a team approach, with direct consultation provided by representatives from DelDOT and New Castle County. This report discusses the following project components:

- Stormwater-education initiatives undertaken by DelDOT
- Stormwater-education campaigns conducted by government and non-government organizations in Delaware and throughout the country
- Workshop held for the co-permittees and the key concepts learned to develop an effective education campaign
- Recommendations on how to achieve the stormwater-education requirements in the eight Target Areas defined in the permit

DelDOT currently undertakes a variety of education and outreach efforts surrounding stormwater issues. Augmenting and enhancing existing resources and programs are crucial tools in the development of any further educational efforts. Additionally, there are a number of nationally recognized stormwater education programs that can be used as a model for DelDOT to implement Delaware-specific programs based on those which have proven most successful and cost-effective elsewhere.

At a workshop hosted by Water Words that Work, LLC, the project team and co-permitees learned about effective outreach and marketing techniques for environmental issues. DelDOT, the co-permittees, and the project team came to understand the importance of the following concepts for an effective education campaign:

- Know your target audience.
- Use new data and innovative web tools to focus in on your target audience.
- Ensure effective design of all outreach materials (e.g., graphics and slogans).
- Be aware of "the slope," or the rate of conversion of people whose behavior is actually changed.

- Keep in mind the costs versus the benefits of any campaign.
- Leverage existing resources (don't "reinvent the wheel").
- Conduct surveys to assess the effectiveness of your message.

Using this information, a set of eight recommendations was developed for each of the following Target Areas, which are derived from the educational requirements of the NPDES permit:

1. Illicit Discharges
2. Motor Oil/Hazardous Waste
3. Yard/Pet Waste
4. Lawn Irrigation/Car Washing
5. Lawn Care
6. Public Participation/Stream Clean-Ups
7. BMP Maintenance
8. LID/Green Technology

In this report each of the eight Target Areas is addressed. For each one of these the goal, target audience, recommended approach, scale of impressions, and costs are discussed in detail. Each one of these recommended approaches provides guidance toward the development of a refined Stormwater Education and Outreach Plan, as required by the NPDES Phase I permit.

Chapter 1 – Project Introduction

1.1 Overview

DelDOT owns and operates nearly all the roadway systems in Delaware, comprising over 5,000 miles of roads and associated storm drainage systems. Controlling and managing stormwater that runs off these impervious surfaces into the state's surface waters are a major part of DelDOT's highway construction budget.

Impervious cover is any surface in the landscape that cannot effectively absorb or infiltrate rainfall. This includes driveways, roads, parking lots, rooftops, and sidewalks. When natural landscapes are intact, rainfall is absorbed into the soil and vegetation. These natural mediums, or pervious cover, naturally slow down, spread out, and soak up precipitation and runoff. Water percolating into the soil becomes a stable supply of groundwater, and the runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays. A growing body of scientific literature has shown that groundwater recharge, stream base flow, and water quality measurably degrade as impervious cover increases.

As authorized under the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) controls water pollution by regulating point sources that discharge directly into surface waters. New Castle County, DelDOT, and six municipalities—Bellefonte, Delaware City, the Town of Elsmere, the City of Middletown, the City of New Castle, and the City of Wilmington—are co-permittees for the discharge of stormwater from and through all portions of the municipal separate storm-sewer system (MS4) as authorized under the NPDES and the laws of the State of Delaware. The Delaware Center for Transportation's (DCT) 2007 Transportation Education, Research and Security Forum identifies NPDES and education of nonpoint source pollution for the public as important issues related to the transportation system in Delaware and the Northeast Corridor.

In order to meet the requirements of the NPDES permit, the co-permittees (named above) must meet the education and public outreach requirements outlined in the NPDES permit. This report proposes to assist the co-permittees in achieving the education requirements of the permit and making these efforts more effective and meaningful for New Castle County, DelDOT and the six municipalities regulated under the permit while addressing important issues named in DCT's 2007 forum.

1.2 Project Details, Methodology, and Outcomes

This project, NPDES and Education on Nonpoint-Source Pollution, was led by the University of Delaware with funding provided by DCT and DelDOT.

The University of Delaware's Water Resources Agency (WRA), a unit of the School of Public Policy & Administration's Institute for Public Administration (IPA), served as the lead entity. However, the project was conducted using a team approach, with consultation provided by DelDOT and New Castle County representatives. WRA staff—associate policy scientists Martha Corrozi Narvaez and Andrew

Homsey served as the project leads. While an IPA research assistant, Erin McVey conducted valuable research for this project. Marianne Walch served as the lead contact on behalf of DelDOT. Additional team members who provided feedback and consultation throughout the project include Randy Cole (DelDOT), Ellie Mortazavi (New Castle County), and Michael Harris (New Castle County).

The project team met on a regular basis to discuss project progress, research findings, workshop information, and the final report. Below is a list of project meeting dates and times:

- October 10, 2010
- November 15, 2010
- July 12, 2011
- September 28, 2011
- January 31, 2012

The project methodology comprised four distinct tasks:

Task 1: Research stormwater-education initiatives that have been undertaken by DelDOT for NPDES compliance and related to nonpoint-source runoff.

Task 2: Conduct a literature review of education campaigns about stormwater runoff that other municipalities and towns in Delaware and throughout the country have implemented both for general education and to meet the requirements of the NPDES permit.

Task 3: Host a workshop for the co-permittees to discuss critical components of developing an education campaign, such as identifying the target audience, selecting the best communication method, using the right tools, and turning simple actions into meaningful results.

Task 4: Compile a report that brings together the information collected in Task 1 and 2, the lessons learned at the workshop, and the feedback provided at the workshop. With this information and further analysis, provide a recommended path forward to meet the education requirements in the NPDES permit.

Through the expertise of the project team and the established methodology there are several expected outcomes for this project. These include the following:

- Identify NPDES and non-NPDES stormwater-quality education programs.
- Determine the applicability of specific stormwater-education programs in Delaware.
- Coordinate key stakeholders and NPDES co-permittees (public-private partnerships).
- Recommend an implementation plan for DelDOT and the NPDES co-permittees to achieve the NPDES education requirements and conduct the most effective stormwater-quality-education program.

This report will provide information on each one of the above project outcomes.

Chapter 2 – NPDES Program and Education Requirements

2.1 NPDES Summary

The NPDES permit program is an effort to improve the quality of water running off into waterways of the United States. Discharge from a point source into federal waters always requires a NPDES permit, and discharge into a municipal stormwater system may require a permit, depending on the contents of the discharge. There are two phases (Phase I and II) of the NPDES program, which are designated by the size of the population in the area covered by the permit. In 1990 the Phase I Regulations were issued to include municipalities with a population of 100,000 or more. The Phase I permit program requires industries and municipalities to acquire a permit for the water discharged into a waterway. In 1999 Phase II permit requirements were issued to smaller municipalities with municipal separate storm-sewer systems (MS4s). Not all smaller municipalities with MS4s require a NPDES permit, and this is determined by the "quantity and nature" of the runoff and the "nature of the receiving water" (Part 122.26 of Chapter 1, Title 40). The NPDES program requires a permit if the discharge is associated with an industrial activity, is from a large municipal MS4, or is from a medium MS4. The EPA defines a large MS4 as located in an incorporated place with a population of 250,000 or more. A medium MS4 is located in an incorporated place with a population of 100,000 or more but less than 250,000 (Part 122.26 of Chapter 1, Title 40). If an industrial activity does not generate runoff into an MS4, an individual permit is needed.

DelDOT has a Phase I permit, issued in 2001, that covers all of New Castle County and a Phase II permit, issued in 2003, that covers heavily populated areas of Kent and Sussex Counties. The Phase I permit requires DELDOT to work with New Castle County and the municipalities included in the permit to develop a Stormwater Pollution Prevention and Management Program.

2.2 DelDOT's Phase I Public-Education Requirements

As authorized under the Clean Water Act, New Castle County, DelDOT, and six municipalities—Bellefonte, Delaware City, the Town of Elsmere, the City of Middletown, the City of New Castle, and the City of Wilmington—are co-permittees for the discharge of stormwater from and through all portions of the MS4 under the NPDES and the laws of the State of Delaware. In order to meet these requirements, these entities must meet specific public education and public involvement requirements outlined in the permit.

According to the permit, the permittees must develop and implement an education and outreach program utilizing available media to

1. Increase the knowledge of the target communities regarding MS4s, impacts of urban runoff on receiving waters, and potential BMP solutions,
2. Change the behavior of target communities to reduce pollutant releases to MS4s and the environment, and
3. Decrease the discharge of pollutants to the MS4 by engaging the public.

The Stormwater Pollution Prevention and Management Plan developed and implemented by the co-permittees must include the following components:

- Clear goals and objectives
- Identified target audiences
- Message(s) specific to the target audiences
- Packaging and distribution of the message(s)
- Evaluation of the outreach plan

With the above objectives in mind, there are specific topic areas, or pollution sources, where the co-permittees must focus their public education and outreach efforts. Based on the language in the permit, these include

1. Public reporting of the presence of illicit discharges or improper disposal of materials, including floatables, into the MS4;
2. Proper management and disposal of used motor-vehicle fluids and household hazardous wastes;
3. Proper management and disposal of grass clippings, leaf litter and domestic animal wastes;
4. Proper use of water to limit excess non-stormwater water discharges from activities such as washing cars and lawn irrigation, from entering the storm-sewer system;
5. Proper use, application, and disposal of pesticides, herbicides, and fertilizers by commercial and private applicators and distributors;
6. Public participation events, such as stream cleanups, drain stenciling, etc.
7. Proper maintenance of BMPs directed toward private- and commercial-property owners, and state or municipal entities responsible for maintenance; and
8. Opportunities for residential installation of low-impact development (LID) practices, and the use of Green Technology best management practices (BMPs) that reduce runoff and mimic natural hydrology.

In addition to reaching the public and target audiences about these topic areas the permit requires that the education and outreach program shall include at least two public workshops each year and shall ensure that a minimum of 250,000 impressions per year are made on the general public about stormwater quality via print, local TV access, local radio, Internet, or other appropriate media.

Finally, the co-permittees are required to carry out a statistically valid public-education survey to evaluate the effectiveness of the education and outreach program in increasing public awareness and changing behaviors about stormwater pollution. The baseline survey must be conducted within 18 months of the effective date of the permit with the results submitted to the Department six months after the survey starts. A second survey will be conducted beginning within approximately 3.5 years of the permit (two years after the first survey). Survey results must be submitted to DNREC six months after the survey begins. According to the permit, the two surveys shall be consistent so that results are comparable, and if, upon comparison of the two surveys, no measurable difference in public awareness and behavior is evident, the permittees shall reevaluate their public education and outreach program in order to determine more effective methods of conveying their message.

No later than 12 months from the effective date of the permit, DelDOT and the co-permittees must develop and implement a process for the public to review and comment on the draft Stormwater Pollution Prevention and Management Plan (SWPP&MP). The permittees must also develop and implement a process for consideration of public comments on the SWPP&MP. The education and outreach program must be updated as necessary to remain effective and relevant to current conditions.

Based on the education requirements described above, DelDOT and the co-permittees will need to work cooperatively to develop an effective education campaign. The following chapters provide information on programs that have been implemented statewide and nationwide that the co-permittees can gain insight from or possibly use information from so that new efforts are not redundant or the co-permittees don't "re-invent" the wheel. Recommendations on approaches that focus on the eight Target Areas and achieve the NPDES education requirements, incorporating some of the previous efforts as well as key concepts learned from the workshop, is detailed in Chapter 5.

Chapter 3 – Existing Efforts Toward Stormwater Education

3.1 Introduction and Data Collection

When considering strategies to educate the public about issues related to controlling stormwater, it is important to be aware of similar efforts currently or previously undertaken. In this way one can avoid "reinventing the wheel" and ensure that any new efforts complement or enhance existing programs. The process of educational-outreach review also necessarily includes an assessment of the efficacy of these programs. By evaluating public feedback and speaking with those involved in implementation or assessment, it is possible to determine which approaches are the most effective, both from a cost perspective and in terms of influencing behavior. For the current study, efforts by DelDOT as well as other groups regionally and nationally were considered.

To gather information about DelDOT's current or past efforts in stormwater education and outreach, members of the project team were consulted. Similar canvassing was performed to determine efforts on the part of DelDOT's co-permittees in the NPDES stormwater-permitting process. In addition, on annual report review and online searches were performed to find additional programs not discussed and to augment the understanding of the nature of each identified educational effort. Detailed information on these programs is included in Section 3.2.

Information on stormwater-education efforts beyond Delaware was also considered. Information on these programs was found through online searches, the professional expertise of the project team, and discussions with DelDOT and New Castle County personnel. A series of programs for comparable educational and outreach efforts was identified. Contact was made with individuals at those programs, which included other departments of transportation and local or regional government public works departments. A list of these departments and contacts are included in Appendix A. A series of questions was put to the representative(s) of each comparable program. The questions touched on the following key areas:

- Reason for implementation
- Difficulty of implementation
- Problem areas
- Cost
- Number of impressions
- Public Feedback

The detailed list of questions is provided in Appendix B, and the information gathered specific to each program is provided in detail in Section 3.3.

3.2 DelDOT Public Education Programs

Over time, DelDOT has engaged in numerous public education programs to reduce stormwater pollution. DelDOT has worked independently on numerous initiatives yet has also had the foresight to

partner with organizations throughout the state to accomplish its stormwater-education goals in an efficient and effective manner.

DelDOT is currently active in promoting stormwater education and outreach efforts to citizens. It has created a website with several useful and important links and actively seeks to disseminate information about the importance of keeping pollutants out of the storm-sewer systems through various programs and outreach campaigns. This website and many other education and outreach efforts go toward meeting the requirements of the NPDES permit. An inventory of these efforts was compiled from annual reports (2002-2011), Internet research, WRA staff expertise, and correspondence with DelDOT staff. This information is described in detail below, and Table 1 provides an abbreviated list of the programs.

Stormwater Website

DelDOT's stormwater website (*www.deldot.gov/stormwater*) provides a central point for the public dissemination of information about stormwater and the NPDES program. The site outlines the major components of DelDOT's stormwater system and the importance of protecting it from contamination. There is information on regulations, efforts underway to control contaminants and monitor problems, BMP descriptions for stormwater control, and many links to educational materials for teachers and educators. The site is a repository for publications about stormwater-related topics and for steps individuals can take to protect the watershed, including tips on waste disposal and contacts for reporting problems or illicit discharges. Many of the resources on the site are available for download, including those that are distributed by DelDOT and may be downloaded and used by educators and the public.

This site also includes a link, "Report a Problem," to report problems with the stormwater system (e.g., clogs, illicit discharges, maintenance, etc.). This link, while combined with reporting for other DelDOT issues such as road conditions, is an easy way to connect with the public and enhance feedback and responsiveness.

Stormdrain Inventory and Marking

To support operation and maintenance efforts by DelDOT, a system-wide inventory of stormwater assets, including inlets, outfalls, pipes, swales, and manholes was compiled in GIS and spatially located with GPS. DelDOT has worked in cooperation with URS Corporation and KCI Technologies on the program to inventory and mark the stormdrains. Such asset inventory provides a critical basis for designing education and outreach programs. Stormdrain marking requires a detailed inventory so that the decals can be applied and maintained in the most efficient manner.

DelDOT worked with the Partnership for the Delaware Estuary to design the stormdrain markers. The markers display the phrase "only rain down the drain" and have been placed on stormdrains to provide a cohesive visual reminder that the storm-sewer system is an interconnected network that leads to Delaware waterways. In 2003 a storm drain marker event was held to kick-off the storm-drain marking.

Tax Bill Insert

With the Delaware Nature Society and New Castle County, DelDOT placed an insert in New Castle County residents' tax bills. This tax bill insert reaches a broad cross-section of households and is likely to be read since it is included with a high-priority mailing.

Doorhangers

Doorhangers (Figure 1) are passed out to homes where an illicit discharge or illegal dumping has occurred. The front side of the door hanger lists the pollutant found, and the back provides information about stormwater pollution and suggestions on how the homeowners can help minimize the problem. This is an important effort because it educates citizens on how to become aware of potential problems in the future.

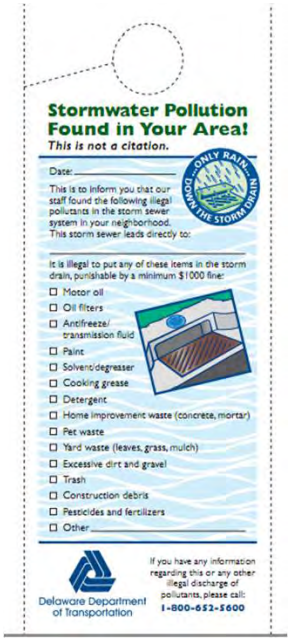

Figure 1. Illicit-discharge doorhanger

Tipcards

DelDOT developed tipcards containing information on how to improve water quality and help reduce the negative impacts of stormwater runoff. These materials are printed in bulk and distributed at various public outreach events (such as the State Fair, Coast Day, Community Days, etc.). The tipcards are also disseminated in state employee paychecks.

Public Events

DelDOT is active in disseminating stormwater information throughout Delaware at various public events. Activities at these events include displayed material (boards), an interactive touch-screen stormwater slideshow, an interactive stormwater quiz, and giveaways for visitors. These venues include, but are not limited to, the Delaware Rural Water Association, University of Delaware Coast Day, and the Delaware State Fair.

Anti-Litter-Education Program

In 2005 DelDOT developed an anti-litter-education program for elementary school students across Delaware to educate them about the harmful effects of littering and encouraged participation in the Adopt-A-Highway program. As part of this campaign, DelDOT publishes anti-litter, quarter-page newspaper advertisements in the *Delaware State News*.

Book Covers

DelDOT distributed 4,000 book covers to schools and the general public that highlight stormwater pollution, the water cycle, and watersheds.

Media Outlets

DelDOT has disseminated stormwater-education information through various media outlets, including:

- Public service announcements and ads in several local newspapers, including *Delaware State News*, *Cape Gazette*, and the *Dover Post*.
- TV commercials through Clear Channel Broadcasting and radio spots on WGMD-FM.
- Ads that appear on DART First State buses with the Partnership for the Delaware Estuary.

Appoquinimink River Association

An important component to DelDOT's outreach efforts is working with organizations such as the Appoquinimink River Association (ARA) to help promote its message. With DNREC, DelDOT funded and hired a BMP Outreach and Implementation Specialist for the Appoquinimink River watershed. The role of ARA is to lead and execute an education and outreach program to provide information to the public on ways to reduce nonpoint source pollution. ARA has assisted DelDOT in the following ways:

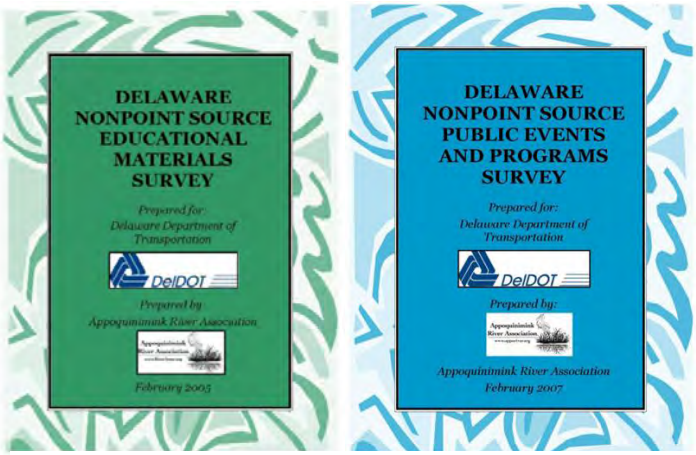

Figure 2. Compilation of Nonpoint-Source Education Materials and Programs

- Developed a "Nonpoint Source Public Events and Programs" manual, printed CDs and hard copies, and distributed (Figure 2).
- Organized a watershed cleanup and DelDOT supported this with manpower, equipment and payment for disposal.
- Developed a watershed presentation for schools and community groups. Once delivered, a follow-up survey was distributed to determine the effectiveness of the presentation.
- Developed an education education/outreach campaign to reduce fertilizer application by changing watershed residents' lawn-care practices. The target audience is both lawn-care companies and residents. This program, established in 2009, is now known as *Delaware Livable Lawns*.
- Implemented a pet-waste campaign. Using the dog-license database, residents in Middletown were sent dog-waste bags, "Bags on Board," and tip cards to help reduce bacteria loads in the watershed.

Adopt-A-Highway Program

DelDOT has established an Adopt-A-Highway program to reduce litter on Delaware's roadways. In-line with this program, Delaware hosted an "Imagine a Litter Free Delaware" day, which was a cleanup day along roads, highways, and community areas in 2005 and 2006.

Interactive Water-Quality Games

DelDOT has developed interactive water-quality games that are used at public events, such as the Delaware State Fair. These games help convey key nonpoint-source-pollution-reduction messages in a fun and hands on way to the public, specifically aimed at children and adults.

Watershed Clean-up

DelDOT supports watershed clean-ups in the Appoquinimink River, Christina River, White Clay Creek and Red Clay Creek watersheds. DelDOT provides manpower and equipment and in the Appoquinimink River watershed it pays for disposal.

Activity Books and Placemats
With the Partnership for the Delaware, DelDOT developed activity books and placemats that provide information about topic such as watersheds, stormwater pollution, and the water cycle (Figure 3). The activity books and placemats are distributed to schools, restaurants, and the public.

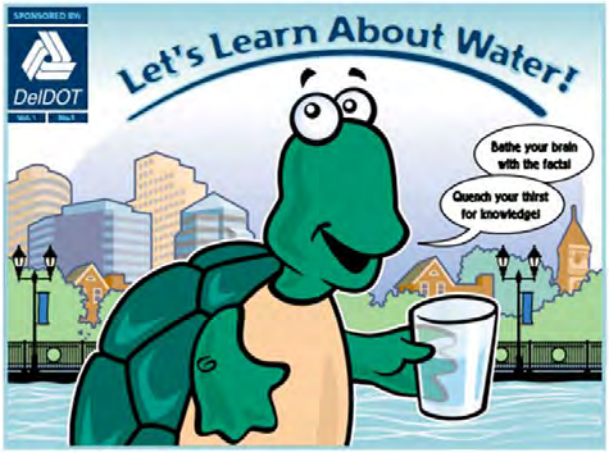

Figure 3. Stormwater Activity Book

Watershed Training Course
With the Delaware Nature Society, DelDOT has developed and delivered a watershed training course to DelDOT and New Castle County employees.

Clean Water Begins and Ends with You
With the Partnership for the Delaware Estuary, DelDOT hosts an annual stormwater drawing contest. Sixteen winners are selected and their drawings are compiled into a calendar. The first place winner's drawing is displayed on a DART First State bus and used as a public-education piece.

Dog Waste–Collection Program
With the Partnership for the Delaware Estuary and the Appoquinimink River Association, DelDOT has developed a dog waste collection program to reduce the bacteria input to the Pike Creek watershed and multiple watersheds in the state. Activities related to implementing this program include the following:

- Purchase pet waste–bag dispensers (Dogipots).
- Conduct outreach and education effectiveness.
- Conduct microbiolgical monitoring.
- Produce and distribute a brochure/tipcards.
- Install dispensers in neighborhoods and New Castle County parks.
- Purchase pet-waste bags, "Bags on Board."

Stormwater FYI Brochure
DelDOT developed an outreach brochure describing stormwater-drain efforts, this was distributed to approximately 20,000 New Castle County residents and at venues including, but not limited to:

- Bear Glasgow Civic Council-Rutledge Community
- DNREC's Watershed Assessment Section for distribution at Peach Festival
- DNREC Nonpoint Source Program

Stormwater Display Board
In 2006 DelDOT hired a graphic designer to create a new display, which includes ten placards, each depicting a water quality message. DelDOT purchased a 10-foot poster display board, graphics, and a watershed model to be used at outreach events. It has been used at over 30 events from 2002-2011, including, but not limited to, the following events:

- Delaware State Fair
- Delaware Rural Water Association

- Harvest Moon Festival
- Delaware Water Festival
- University of Delaware Coast Day
- Earth Day events

Technology Students Association (TSA) State Conference
DelDOT staff have served as judges in the TSA State Conference (2002-2011). In 2002 as part of this event, students competed in the development of a children's coloring book and a restaurant placemat related to NPDES and water quality.

Educational Bookmark
With the Delaware Nature Society, DelDOT developed bookmarks for distribution to early education students (Figure 4). The bookmarks serve as a complement to the state-mandated Delaware-watershed curriculum and Delaware Nature Society programs where they were also distributed.

Figure 4. Stormwater Bookmark

Articles
DelDOT staff have authored articles in publications such as Estuary News, DelDOT Dispatch, and the Nonpoint Education for Municipal Officials (NEMO) publication.

Stormwater-Education Presentations
DelDOT presents stormwater-education information to various groups, including:
- Pike Creek Civic Association
- Brandywine Rotary Club
- Camden-Wyoming Rotary Club

DSWA Brochure Distribution
DelDOT coordinates with the Delaware Solid Waste Authority (DSWA) to receive and distribute their "Household Hazardous Waste Collection" program brochure. The brochure is distributed at public events and educates citizens on the proper disposal of household hazardous materials.

Water Resources Agency
In 2010 through the Delaware Center for Transportation, DelDOT funded the University of Delaware's Water Resources Agency, a unit of the School of Public Policy & Administration's Institute for Public Administration, to investigate cost-effective social-marketing options that are feasible in Delaware to meet the minimum general public "impressions" required by the new NPDES Phase I permit. This project proposes to assist co-permitees in meeting the education requirements of the NPDES permit.

Delaware Association for Environmental Education
DelDOT staff have been active participants in founding and developing the Delaware Association for Environmental Education (DAEE). The DelDOT Environmental Scientist serves on the Board of Directors, assists the group with its communication and outreach, and served on the planning committee for DAEE's first annual statewide conference (February 2010).

Environmental-Education Consultant
Since 2002, DelDOT has hired an education consultant every year. For several years the Partnership for the Delaware Estuary served in this role, followed by the Appoquinimink River Association, and the University of Delaware's Water Resources Agency. The role of this consultant has varied but in general it provides assistance related to meeting the education goals outlined in the NPDES permit.

Table 1. ***DelDOT Programs and Initiatives***

Stormwater Website
Stormdrain Inventory and Marking
Tax Bill Insert
Doorhangers
Tipcards
Public Events
Anti-Litter Education Program
Book Covers
Media Outlets
Appoquinimink River Association
Adopt-A-Highway Program
Interactive Water-Quality Games
Watershed Clean-up
Activity Books and Placemats
Watershed Training Course
Clean Water Begins and Ends with You
Dog Waste–Collection Program
Stormwater FYI Brochure
Stormwater Display Board
Technology Students Association State Conference
Educational Bookmark
Articles
Stormwater-Education Presentations
DSWA Brochure Distribution
Water Resources Agency
Delaware Association for Environmental Education
Environmental Education Consultant

3.3 Stormwater-Education Programs in Delaware

There are numerous programs throughout Delaware with for curbing nonpoint-source pollution and reduce stormwater runoff. It is valuable to have an inventory of these programs in order to work in a coordinated fashion and avoid duplicating existing efforts. Understanding the existing programs also enables DelDOT and the co-permittees to work with these partners and enhance the existing programs and make more efficient use of resources. Many nonprofit organizations in Delaware, such as the Appoquinimink River Association, Delaware Nature Society, and the Partnership for the Delaware Estuary, have multiple stormwater-education programs that are implemented throughout the state. As such these organizations are valuable partners in this effort. In addition, there are many stormwater-education programs throughout the state that will enhance DelDOT and the co-permitees stormwater-education efforts in the future. A summary table of stormwater-education programs in Delaware is provided in Table 2 at the end of this section. The Appoquinimink River Association has also developed a valuable resource that inventories all pertinent nonpoint source programs and events in Delaware. The inventory, developed in 2007 at the request of DelDOT, focuses on nonpoint-source programs and events available and applicable for participation in Delaware. This survey brings focus to all the programs and events available and illustrates specific topics of programs and events of need that are absent. This publication, viewable at *www.apporiver.org/projects/PastProjects/Projects_P_Stormwater Materials_Survey.html*, provides a comprehensive review of Delaware's stormwater-education programs. For the purposes of this report, a select group of stormwater-education programs, based on the newness of the program, comprehensiveness, and applicability to the NPDES permit requirements are discussed in more detail in this section.

Livable Lawns

The goal of Delaware Livable Lawns is simple—reduce fertilizer and pesticide runoff from lawns. This goal is achieved through extensive education that:

- Certifies lawn-care companies that follow environmentally friendly practices in fertilizer application while educating property owners.
- Provides homeowners with the necessary information to make small changes in their lawn-care practices so that they can be better stewards of the environment.

Educating applicators (homeowner and commercial) is the lynchpin to adopting a new approach to lawn care. Delaware Livable Lawns initiative is a partnership among the following organizations:

- DNREC's Division of Watershed Stewardship
- Department of Transportation's NPDES Program
- Department of Agriculture Nutrient Management Commission
- Delaware Grounds Management Association
- USDA's Natural Resource Conservation Service
- New Castle Conservation District
- Appoquinimink River Association
- University of Delaware's Water Resources Agency
- University of Delaware's Cooperative Extension
- Delaware Nature Society

The requirements for a lawn-care company to be certified as part of the Delaware Livable Lawns program are as follows (certification will be administered and managed by the Delaware Nursery & Landscape Association):

- Keep fertilizer and grass clippings off any impervious surfaces (for example, sidewalks and driveways).
- For all new accounts (individual lawns previously not treated), test the soil for phosphorus, potassium, and pH prior to application. For established accounts (individual lawns that have been treated within a year or are currently treating), test the soil once every three years to determine the specific needs of the lawn.
- Apply nutrients based on the requirements outlined in the program.
- Calibrate spreaders for correct application rates and record the pounds of nutrients applied to each lawn.
- Have a certified Commercial Nutrient Handler employed within the company.

Once certified, companies will receive recognition through free newspaper advertising, listings on the initiative's website (*www.delawarelivablelawns.org*), and other publications. Companies will have complimentary use of the program logo for their own marketing materials. They will receive free leave-behind educational materials, truck decals, and signage.

Property owners will be provided with the information they need to apply the right product, in the correct quantities, at the ideal time. By implementing these lawn-care practices, they can maintain their healthy, beautify lawns and partner in protecting the environment. Point-of-sale signage will be developed incorporating QR Codes (scannable codes used by smartphones) linking to the Delaware Livable Lawns website and other resources. Mobile applications for smartphones will be developed with the State of Delaware's assistance, giving property owners easy access to program information, a fertilizer calculator, and a listing of certified applicators. Doorhangers will be designed and produced that will feature fertilizer facts and tips.

The recently developed Delaware Livable Lawns website (*www.delawarelivablelawns.org*) provides a plethora of information to assist both commercial applicators and homeowners with product selection, calculations, application instructions, and soil sampling instructions. It also offers links to other resources**,** publications and videos.

City of Wilmington Green Jobs Program

The City of Wilmington's Green Jobs Program engages the city's youth (14-18 years old) by providing green-collar work opportunities. In this six-week program (25 hours/week), the youth earn minimum wage and participate in hands-on work experience and classroom environmental education that introduces them to environmental issues and careers. By participating in this program, Wilmington's youth can help to transform the city into a greener, cleaner, safer community while experiencing meaningful employment and education opportunities.

Projects the Green Jobs Program's interns participate in include

- Maintaining street and park trees throughout the city (watering, pruning, mulching)

- Labeling storm drains to prevent pollution
- Learning essential professional expertise (public speaking, resume writing)
- Carrying out outreach
- Installing rain gardens
- Removing invasive plant species
- Learning about environmental careers
- Discovering and working with GIS
- Exploring the city's water and wastewater systems
- Gardening in community gardens

The success of this project is dependent upon the host organizations and the partnerships formed within the Green Jobs Program. Project partners for the 2011 and 2012 programs:

- City of Wilmington, Department of Parks and Recreation
- City of Wilmington, Public Works Department
- Delaware Center for Horticulture
- Delaware Department of Natural Resources and Environmental Control (DNREC)
- Partnership for the Delaware Estuary
- University of Delaware's Water Resources Agency
- Urban Environmental Center
- The Challenge Program
- Delaware Nature Society

Delaware's Seventh-Grade Watershed Curriculum

The State of Delaware's Department of Education requires that all schools that are Science Coalition members teach a watershed unit as part of the seventh-grade science curriculum. This watershed curriculum was designed by the State Department of Education and covers key concepts of watersheds. This includes the impacts of stormwater runoff and sources of stormwater pollution.

White Clay Creek Watershed Management Committee

The White Clay Creek is one of only two National Wild and Scenic Rivers protected in its entirety. National Wild and Scenic River designation encourages the appropriate development of land that can coexist with the river. This federal designation helps to preserve watershed features that enhance water quality, natural resources, and the overall quality of life. This approach takes into account changing land uses and the effects they can have on river habitat.

The White Clay Creek Watershed Management Committee is made up of local citizens, representatives of conservation organizations and other interested parties, and delegates from state and local governments, including all 13 watershed municipalities. The National Park Service provides staff to help link the committee to other agencies and the public, and it also provides technical and financial support.

Together the National Park Service, Management Committee, and partner organizations work to implement the goals and objectives of the Management Plan:

- Improve and conserve water quality and water quantity.
- Conserve open space, woodlands, wetlands, and geologic features.
- Protect native plant and animal species.
- Preserve cultural, historical, and archaeological sites.
- Enhance outdoor-recreation opportunities.
- Encourage environmental education and watershed awareness.

In addition to the broad goals of the management plan listed above, the White Clay Creek Management Plan Coordinator has pledged assistance to DelDOT and the co-permittees in the following areas:

- Development of outreach and education programs and coordination/selection of stakeholders for educational activities and outreach
- Scheduling and conducting educational and outreach events, workshops, and seminars for stakeholders
- Development of a path forward pertaining to the evaluation of the programs and outreach to gage impressions

Each one of these programs discussed in detail above can be a useful program supplement in meeting the NPDES requirements. Each program has a captive audience and an established message related to reducing stormwater pollution. It would be to the benefit of DelDOT and the co-permitees to develop a partnership or maintain the existing partnership with these programs and those listed in Table 2.

Table 2. ***Stormwater-Education Programs in Delaware***

Delaware Livable Lawns
City of Wilmington Green Jobs Program
Seventh Grade Watershed Curriculum
Christina River Watershed Cleanup
Delaware Department of Agriculture Education Programs
New Castle Conservation District Education Programs
DNREC Education Programs
Envirothon
White Clay Creek Watershed Management Committee
New Castle County Programs
Statewide Workshops and Seminars
City of Newark Community Habitat
Municipal and Local Government Programs
Appoquinimink River Association
• Water-friendly Interactive House
• Gardening for the Environment
• Townsend Community Habitats
• Water Education in the Classroom
Raingardens for the Bay
Delaware Nature Society

• Backyard Habitat
• Stream Watch
• Summer Camps
• Education Programs
Delaware Center for Horticulture
• Green Skills and Jobs Training
• Community Trees
• School Gardens
Partnership for the Delaware Estuary
• Art contest
• Schoolyard Habitat
• Stormdrain Marking
• Dog Waste Control
• CESP Program (Corporate & Community Environmental Stewardship Program)
• Teacher Training
Public Education and Outreach Events (specifically focused on water)
• Earth Day
• Creekfest
• Ag Day
• Coast Day
• "Make a Splash" Festival
DNREC's Delaware National Estuarine Research Reserve
• TYDB (Thank You Delaware Bay)
• School Programs
• Community Programs
• Teacher Professional Development Training
Center for the Inland Bays
• Schoolyard Habitat
• James Farm Outdoor Education Program
• 1,000 Raingardens for the Inland Bays

3.4 Stormwater Public-Education Efforts Nationwide

Nationwide, state, county, and local governments and organizations have undertaken efforts to address the importance of controlling nonpoint-source pollution from stormwater runoff. Many of these programs seek to fulfill the education and outreach requirements of the NPDES permitting process, but have wide reaching benefits beyond simply meeting regulatory requirements. To effectively assess the nature of a representative sample of these programs, a Web survey was conducted to identify organizations that were actively developing and promoting outreach efforts. Based on assessment of the comprehensiveness of such programs, as well as their direct applicability to the NPDES permitting requirements, several program managers were contacted to further assess their nature, scope, and measured effectiveness.

The intent of this analysis was not to perform an exhaustive national search but to take a sampling of programs from which lessons and information could be gleaned. The programs focused on in this section include those that are considered comparable to DelDOT's in terms of scope and scale, have a presence on the Web, and we were able to make contact and discuss the programs. There were several programs that are not included in this analysis because we were unable to make contact or the information was not available or current via the web or through contact with the organization.

A review of some of these programs follows. Entries with an asterisk (*) were based primarily on telephone interviews. The questions posed to the organization's contact are provided in Appendix B.

3.4.1 Programs Through State Departments of Transportation

Maryland State Highway Administration*

The Maryland State Highway Administration (SHA) is currently operating under an NPDES permit that has a stormwater-education requirement. The formal program has largely been limited to an Earth Day conference but there have been other programs which SHA has been involved in::

- Adopt-a-Highway, which seeks to limit litter.
  - Highway plantings: SHA administers the Federal Transportation Fund to create a Transportation Enhancement Program (TEP). Under this program funding, is distributed to counties and municipalities to support environmental programs.
- The SHA has partnered in the "Maryland Bay Game," a summer activity for kids to play while in the car.

Program effectiveness has never been investigated. The Maryland SHA does not have a formal way of measuring success, other than quantifying the amount of money spent on stormwater-education programs. To date, the SHA has not received feedback from the public.

California Department of Transportation (Caltrans)

Caltrans has implemented several programs and used several tools to reduce nonpoint source pollution, including:

- The "Don't Trash California" campaign, which aims to discourage citizens from littering the roadways.
- Using mass media, hosting special events, and reaching out to communities to spread the message, the following mediums have been used:
  - Radio (30- and 60-second spots) and 30-second television ads
  - Highway billboards
  - Theater slides
  - Trash can wraps
  - Online advertising

Connecticut Department of Transportation (ConnDOT)

ConnDOT's Stormwater Management Plan includes public education and outreach. ConnDOT uses brochures, posters at bus and train stations, public service announcements for radio, television, and print,

storm-drain markers, and tributary signage (e.g., "entering public drinking water protection area") to distribute the stormwater-education message.

Texas Department of Transportation "Don't Mess with Texas" Anti-litter Campaign
Since 1985, the Texas Department of Transportation (TxDOT) has sponsored the "Don't Mess with Texas" campaign to educate the public and fight litter on state roads. This effort has proven to be one of the nation's most highly recognized, longest running, and most successful efforts at using outreach to affect behavior. Beyond a beautification campaign, effective litter reduction can save money on highway maintenance and reduce the volume of floatables and other debris that get into the stormwater system. By tapping into the existing image of Texas as a proud and independent state, the marketing campaign was able to reach a very wide audience. The primary motto of the program ("Don't Mess with Texas") is a federally registered trademark. The phrase has proven so popular that it is often used without permission, requiring TxDOT to periodically take legal action to maintain its "ownership" of the brand.

Some salient features of the program:

- Highly interactive website including children's games
- Partnerships with major private entities such as McDonald's, Southwest Airlines, and Coca Cola
- Merchandising efforts such as provision of free bumper stickers, decals, and trashbags to Texas residents
- Electronic media including desktop icons, e-cards, and smart-phone applications
- A Facebook group with over 14,000 followers
- Community programs such as Adopt-a-Highway, photo contests, annual competitive clean-up days ("Trash-Off")
- School-based programs around anti-litter education
- Scholarships for high school seniors sponsored by the program
- Celebrity endorsements including from Willie Nelson, Stevie Ray Vaughn, Lee Ann Womack
- Long-running research efforts to assess the types and amount of litter on the roads as well as surveys of public attitudes and behaviors to monitor the effectiveness of the campaign

This program is a model for other, similar programs. Its success can be attributed at least in part to its narrow focus, use of excellent marketing tools, emphasis on partnerships and community buy-in, and use of research tools to measure efficacy.

3.4.2 Municipal, County, and Regional Programs

Washington, D.C.
Washington, D.C., has implemented programs on stormwater-education in schools, including teacher training. They have supported environmental/conservation programs, including Project Learning Tree, Water Education for Teachers (WET), Project WILD, Pollution Prevention (P2), and Schoolyard Habitats.

City of Los Angeles

The City of Los Angeles hosts a comprehensive stormwater-education website targeted at meeting NPDES permitting requirements. Materials and programs highlighted on the website include:

- Distributable materials such as brochures, magnets, posters, and a refrigerator dry-erase board with stormwater facts and important phone numbers/contacts (for instance, see Figure 5 showing a storm-drain medallion)
- "Adopt-a-Beach School Assembly Program"
    - The city sponsors 45-minute school assemblies for elementary schools. The assembly topics cover the stormwater/stormdrain system and how it relates to the city and beach, how recycling promotes healthy stormwater, and how each student can make a difference by not littering and passing along the message to family and friends. The city also shows a slideshow explaining how pollution harms plants and animals.
    - Before the assembly, teachers are encouraged to participate in a workshop. The teachers are given a review of what will be taught during the assembly and are supplied with in-classroom activities to use before and after the assembly.

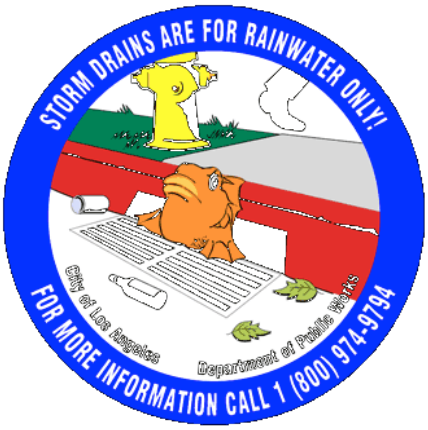

Figure 5. City of Los Angeles Storm-drain Medallion

City of Chesapeake, Va.*

The City of Chesapeake has implemented several programs to increase stormwater awareness under the Virginia Stormwater Management Program. Most efforts were not undertaken specifically to meet the requirement of the NPDES permits, but more specifically to meet the regulation's education and outreach provisions. Some of the efforts include

- Education programs: Education programs in schools in which technicians are sent to schools for 40-minute sessions as part of a third-grade science class. The program is not directly related to managing stormwater, but is about educating children about the importance of soil, water, and the environment. The program considers reaching a young audience a very important component of public education. The program reaches 1,200 students a year over the course of 2½ months, with the average class size around 20-25 students. It is important to note that there are more classrooms requesting the program than the program is capable of visiting.
    - To implement a similar program, it is suggested that a science coordinator be identified who will serve as a liaison between the program and the teachers at the schools. This coordinator would maintain contact with teachers and work out the logistics of setting up the program at the schools, a step that is critical but often difficult.
- Adopt-a-Highway program: This program has grown in the past few years, and 70 active groups are currently participating in it. The effort is focused on decreasing ditch litter.
- Portable ashtrays: This program provides portable ashtrays that fit in the cup holder of a car. They are marketed at city events, and are intended to keep cigarette filters out of the storm sewer system.

- Distributable materials include drain markers, bill inserts, and printed ads designed by elementary and middle school students.

Seattle, Wash., Public Utilities*

In Seattle, public education programs were implemented to meet NPDES permit requirements. One area in particular that needed attention was automotive maintenance and runoff related to car washes.

- Three specific BMP programs have been implemented:
  - Car-wash program
  - Pet-waste program
  - Automotive-maintenance program
- The City actively identifies the target audience and seeks them out.
- The City is developing a survey to determine if the target audience has received the message. The city is not required to meet a set number of impressions, but it does have to measure behavior change.

Baltimore County, Md.*

Baltimore County has implemented several programs to address stormwater and NPDES permitting issues. The County has developed a set of standards that it notes are more restrictive than what is required by the EPA. Significant programs implemented include:

- Maryland Green Schools Program: the statewide nonprofit Maryland Association for Environmental and Outdoor Education works towards teaching schools and ideally has them implement BMPs. In addition to implementing BMPs, it is the hope that the schools will work stormwater education and water conservation into the curriculum. The goal is that schools will make connections to each student's watershed and will educate them about the watershed, specifically about water conservation and stormwater-pollution prevention.
- Storm drain–stenciling program: the County at one time coordinated efforts to stencil drain markers but found that these had to be reapplied every few years. Currently plastic disks are affixed with glue. The markers inform readers that water entering the drain flows directly to a stream, not a treatment plant.
- Community events: Representatives from Baltimore County attend various community events where they assist local watershed groups in educating the public, for instance handing out brochures and other educational material.

Gwinnett County, Ga.*

Stormwater-education programs are implemented to meet NPDES requirements and requirements set by the Metropolitan North Georgia Water Planning District. The county is currently in the process of creating a stormwater-education plan, and the goal is to be proactive, rather than reactive, to problems. To fulfill this goal, the county has initiated several programs and events:

- Six distinct workshops are held throughout the year. The County advertises and organizes the workshops and invites outside presenters to speak on various topics. The workshops are broadcast on local government–access TV. Workshop topic areas include:
  - Septic-tank maintenance (presented two times/year)
  - Detention-pond maintenance

  - Fall gardening/composting
  - Rain gardens
  - Spring cleaning/waste management
  - Lawn-care/integrated pest management (Gwinnett County Cooperative Extension, in collaboration with the University of Georgia, makes this presentation)
- Brochures have been created by both the county and the Clean Water Campaign for various workshops, for example:
  - Gardening/lawn care for both the public and the lawn-care industry
  - Auto repair
  - "Clean Water Begins with You" and "When it Rains, It Drains"
- The Stormwater Department consistently has at least one article in the "County Connections" newsletter on subjects such as watershed health or the adopt-a-stream program. The newsletter is inserted into the water bills.
  - Requests are made for contributions to the internal county newsletter and education on the county's efforts and goals.
- The County hosts an essay contest in conjunction with the Metropolitan North Georgia Water Planning District.
  - All jurisdictions were welcome to participate.
  - The Stormwater Department presents an award at the winner's school.
- Radio announcements have been developed, for which there has been positive public feedback.
- Stormwater Department personnel conduct "tours" to senior centers and community centers to talk about their activities and aims.

The County relies on the Planning District to gauge public awareness and program effectiveness.

Metropolitan North Georgia Water Planning District/Clean Water Campaign

The Metropolitan Water District's campaign is different from many other programs around the country because it covers a region, not just one government or municipality. There are over 100 local governments that make up the district. The local governments pay dues, and in return the Clean Water Campaign, which is the outreach effort in the district, helps the co-permittees meet the public-education requirements of the municipalities' MS4 permits. The District provides brochures and other materials to the municipalities, and the municipalities hand them out to schools or communities at various events.

Each local government must meet the NPDES permit's number of impressions criteria as administered by the Georgia Environmental Protection Division. The Water District conducts a regional telephone poll to assess how effectively it reaches the residents. Efforts include:

- Three primary areas of outreach: public-awareness campaigns, outreach and education to key target groups, and primary and secondary education.
- The public-awareness campaign has included ads on cable television and radio, highway billboards, press releases, bus-stop signage, utility-bill inserts, and websites.
- In 2010 the District conducted an essay contest titled "Water—Use it Wisely."

More specific information on particular programs is maintained by the individual member localities.

Chapter 4 – Workshop Overview/Lessons Learned

4.1 Workshop Overview

On September 28, 2011, WRA hosted a workshop to discuss stormwater education and public outreach. This workshop specifically involved discussion of tools and methods to meet the stormwater-education requirements of the NPDES permit. The workshop was funded through an award from the Delaware Center for Transportation (DCT).

This workshop was an interactive approach to educate the participants about the tools that are available to help meet the public education and outreach requirements in the NPDES permit. There were 18 participants from a variety of organizations, including DelDOT, New Castle County, the City of Wilmington, Delaware City, the Town of Elsmere, the Town of Middletown, the University of Delaware, and the White Clay Wild and Scenic Management Committee. Eric Eckyl (of Water Words That Work, LLC) led the workshop. Names and affiliated organizations of the workshop attendees are included in Appendix C.

The workshop participants learned about several essential components of marketing and educating the public about specific topics that relate directly to the stormwater goals of the permit. Eckyl discussed the importance of creating a focused message and targeting a specific audience or group with this message. Eckyl discussed a multitude of available information sources about the audience one is targeting. For example, he provided statistics on the population of New Castle County, one specific area in which the outreach and education campaign will be focusing. Eckyl noted that according to the 2010 U.S. Census, New Castle County's population is 538,479, it is 66 percent white, and the demographic information of those who are age 25 and older is as follows:

- 32% have earned a four-year degree or higher.
- 88% have a high school degree or higher.
- 12% did not complete high school.
- Per capita income is $31,071.
- Home ownership rate is 71%.
- 10% live below the poverty level.

Each of these factors is critical in developing a campaign that will reach and be meaningful to the residents in New Castle County. This type of information was also provided for the state of Delaware, City of Newark, and Town of Middletown.

In addition to knowing one's target audience, Eckyl discussed the importance of making a "real" impression and changing behavior based on the message one develops. For example, how many people had read the newspaper ad or heard the commercial and then volunteered at the event or signed the pollution-prevention pledge? Moving people to act based on an ad or commercial or some other marketing tool is critical to getting the message out and achieving a successful education and outreach campaign.

4.2 Workshop Recommendations and Lessons Learned

As discussed in Section 4.1, the workshop held on September 28th discussed tools that are available to help meet the public education and outreach requirements in the NPDES permit. At the workshop, Eric Eckyl provided expertise on critical concepts that must be considered when developing an education campaign to meet the NPDES requirements. This section briefly summarizes these concepts discussed.

Know Your Target Audience
The take-home advice is that most messages should go to a very limited interest group. Precision in a message is important. The universe of interested/affected parties (the target) is typically very small in comparison to the general population receiving the message. Focusing on a targeted group saves money and effort. Outreach efforts that are "big & sloppy," such as newspaper ads and PSAs may reach a wide audience, but if the topic only pertains to a select group of people it is a wasted effort. Use a targeted approach to minimize collateral/non-target audiences. Targeting a specific audience requires forethought to define the target group.

Use New Data and Web Tools to Focus on Your Target Audience
Fortunately, many Web-based tools and powerful data sources are available to assist in refining the target audience. For example, readily available U.S. Census information, Agricultural Census data, Bureau of Labor Statistics, offer information such as per capita income, homeownership rates, vehicle ownership, education levels, race, etc., all of which might guide where marketing should occur. Facebook provides powerful tools to assess individuals' particular political leanings, environmental interest, hobbies, etc. With these tools, it is possible at no cost to determine the number of users that fit a particular profile. To distribute messages to your target audience, ad space can be purchased that is charged on a per-click basis, so that the only messages that incur a cost are those that are actively sought. Google also provides similar tools to help refine the target audience and message. Private marketers can also be retained to assist in refining methods for most effectively finding your audience.

Ensure Effective Design (i.e., Marketing Aspect)
Once a target population is identified, it is important to be aware of the types of marketing strategies that will be effective based on the known demographics and interest areas of your audience. Be aware that different approaches will be necessary based on the audience, the medium used, and the message itself. Retaining the services of professional graphics or advertising agencies can be a worthwhile investment.

Be Aware of "The Slope"
Once a marketing strategy is developed for your target audience, it is important to understand the need to ensure that the message is not simply heard but is likely to affect behavior. Eric Eckyl has described a four-step process that a message undergoes, which he calls "The Slope":

1. Impression – The message is made public.
2. Conversion – The audience is aware of the message, and responds in some way.

3. Retention/Cultivation – For audience members who have become aware of the message and follow-up (e.g., by visiting a website or making contact), this relationship is encouraged and a next step presented.
4. Commitment – The individual message recipients take positive action based on the intent of the message. Ideally, there is lasting behavior change on the part of the individual.

Cost/Benefit

Since it might be deemed that different campaign tactics are appropriate in different situations, a close consideration of the costs involved compared to the expected outcome is paramount. For example, a low-cost campaign that does not have a high "conversion rate," might be less cost-effective than a much higher-priced effort that reaches fewer people but changes their behavior.

Leverage Existing Resources

- Identify key organizations and individuals – There are many people and groups across Delaware working to reduce the effects of stormwater runoff. Establishing contact with these groups and their activities is one of the most effective means to reach the widest group of people with the least effort. For instance, a list of associations working in the field of water resources in Delaware is contained in Appendix D.
- Coordinate the message – By working closely with these groups, a unified message on particular topics can be coordinated across disparate groups. DelDOT is in a unique position to provide this type of leadership and coordination.
- Leverage existing programs – Many groups (towns/townships/watershed teams, etc.) have well-developed campaigns. The effective approach to foster these activities might often be to participate materially (through in-kind service or direct funding).
- Maintain contact lists – An up-to-date list of contacts is vital to retain communication with these groups as well as a wider target audience. This can be achieved in a variety of ways, either by maintaining spreadsheets in-house, or by using software and services that provide powerful tools for maintaining and contacting your audience. Careful maintenance and culling of these lists is important.

Survey

Evaluation of effectiveness requires a survey of the population. There are two basic approaches that differ in level of effort and effectiveness at gauging the success of the stormwater-education efforts.

- Population survey – To see how widely your message is being disseminated in the public's perception, large-scale survey methods must be used. This involves retaining the services of a marketing research group with experience conducting large-scale, statistically valid surveys (such as the University of Delaware's Center for Applied Demography & Survey Research). This needs to be performed before the message is disseminated and within 18 months of the date of the permit. A second survey will need to be conducted beginning within approximately 3.5 years of the permit (two years after the survey).
- Group survey – A cost-effective way to gauge the effectiveness of specific messages is to conduct a survey on a targeted group getting a specific message, for instance, by administering a

survey before and after a stormwater workshop, stream cleanup, or other stormwater-related activity.

Chapter 5 – Stormwater-Education Recommendations

5.1 Stormwater Recommendations by Target Area

In order to meet the requirements of the Phase I NPDES permit the education and outreach campaign must focus on specific areas related to stormwater pollution. According to the permit, these include the following:

1. Public reporting of the presence of illicit discharges or improper disposal of materials
2. Proper management and disposal of used motor vehicle fluids and household hazardous wastes
3. Proper management and disposal of grass clippings, leaf litter and domestic animal wastes
4. Proper use of water to limit excess non-stormwater water discharges from activities such as washing cars and lawn irrigation, from entering the storm sewer system
5. Proper use, application, and disposal of pesticides, herbicides, and fertilizers by commercial and private applicators and distributors
6. Public participation events, such as stream clean-ups, drain stenciling, etc.
7. Proper maintenance of BMPs directed toward private and commercial property owners, and state or municipal entities responsible for maintenance
8. Opportunities for residential installation of LID practices, and the use of Green Technology BMPs that reduce runoff and mimic natural hydrology

This chapter provides a detailed approach for each one of the Target Areas listed above. Each approach specifically addresses the following categories:

- Goal
- Target Audience
- Recommended Approach
- Targeted Scale of Impressions (high, medium, low)[1]
- Cost (high, low)[2]

The recommended approach for each Target Area includes a variety of tools that will be effective in reaching the target audiences in order to change a specific behavior related to stormwater education. Existing resources and programs, such as those discussed in Chapter 3 and concepts learned at the workshop, laid out in Chapter 4, are used to develop the recommended approach for each Target Area.

[1]The targeted scale of impressions is a general estimate of the magnitude of individual impressions that should be made to reach the target population with the recommended approach. In general, educational campaigns targeted at a wider audience will have a higher value.

[2]Based on the recommendations the cost category reflects the magnitude of the time and money for implementing the recommendations.

TARGET AREA 1
Illicit Discharges (Public Reporting)

Goal
Public reporting of incidents of illicit discharges or improper disposal of materials, including floatables into the storm-sewer system.

Target Audience
Businesses and the public at large

Recommended Approach
Illicit discharges are defined by the EPA for the purposes of NPDES permitting as "any discharge to a municipal separate storm sewer that is not composed entirely of stormwater." The nature of these discharges can be quite varied, and they include intentional routing of waste products, including sanitary-sewer outflow, wash water, or industrial waste products, to the storm-sewer system, unintentional spills or incidental runoff from industrial or other facilities, and intentional, episodic releases (so-called "midnight dumping"). Illicit discharges typically come from businesses or individuals. Incidents from businesses (particularly those that deal with large amounts of hazardous waste, such as automotive facilities or industrial processing operations) tend to be more persistent, while incidents from individual citizens are far more intermittent and widely dispersed.

Illicit discharges can introduce toxics, pathogens, nutrients, surfactants, and floatable debris into the stormwater system, ultimately degrading overall water quality. The effects can be quite large, especially since these discharges create dry-weather flow, so that concentrations, in the absence of high flows that dilute pollutants, are relatively higher.

DelDOT has applied considerable focus both to the detection and amelioration of illicit discharges and their effects, as well as campaigns to educate the public on the importance of reporting incidents that threaten the waters of the state, including:

1. Monitoring and inventory of outfall locations with indications of discharges (e.g., dry-weather flow, presence of detritus, oil sheens, odors, etc.). A complete inventory of all such outfalls and presence of evidence of illicit discharges was completed in 2007.

2. Door hangers passed out to homes in the vicinity of an illicit discharge or illegal dumping incident. The front side of the door hanger lists the pollutant found, and the back provides information about stormwater pollution and suggestions on how the homeowners can help minimize the problem. This is an important effort because it educates citizens on how to come to become aware of potential problems in the future.

3. Storm-drain markers with the phrase "only rain down the drain" placed on storm drains, which provide a cohesive visual reminder that the storm sewer system is an interconnected network that leads to Delaware waterways.

4. Participation in and support of public outreach such as presentations to civic groups and Adopt-a-Highway programs.

5. Online reporting form for problems with stormwater system (e.g., clogs, illicit discharges, etc.). This link, while combined with reporting for other DelDOT issues such as road conditions, is an easy way to connect with the public and enhance feedback and responsiveness.

Such efforts should be continued and enhanced. The existing website offers a comprehensive overview of these programs as well as educational and other material for distribution. Identifying problem areas and educating the sectors and individuals who help prevent or report illicit discharges will serve to reduce the overall costs for stormwater control, particularly by reducing the need for extensive retrofits.

Using data collected and maintained by DelDOT and its contractors on the location and nature of problem areas (i.e., "hot-spots" of discharge activity and dry-weather flows), DelDOT can develop a prioritized strategy for developing educational campaigns. Targets should include both the likely producers of illicit discharges as well as the public at large. Education should focus on the importance of protecting the stormwater system from discharges, as well as on encouraging the citizenry to be vigilant about potential problems.

Emphasis should be in areas where past or potential future violations can occur and can include training on the signs of illicit discharges and the avenues for reporting incidents. Institutional groups, and schools in particular, are an important target group, since they represent potential violators as well as a pool of individuals who can help monitor violations. Using innovative technology to help individuals report incidents, such as a smartphone app, will also make it easier for individuals to feel empowered. Convincing the people who might potentially pollute or report incidents that there is a shared responsibility will help effectively address this problem. Education efforts should help individuals realize that they can make a difference and that small improvements can cumulatively make a big difference.

The value of vigilance for the common good should be emphasized. The point that this is a public health issue, and one that disproportionately affects vulnerable populations such as children and the elderly, can increase awareness and the likelihood of reportage. Focus should be on areas of high population density and stable demographics near "hot-spots."

The economic argument for stopping illicit discharges includes the fact that clean water encourages businesses development, lowers costs of cleanup, enhances recreation and recreation-related economic activities, increases property values, and fosters the desirability of an area as a place to live.

Targeted Scale of Impressions (high, medium, low)
High

Cost (high, medium, low)
Medium

TARGET AREA 2
Used Motor-Vehicle Oil and Household Hazardous Waste

Goal
Keep oil and hazardous waste produced by individuals/citizens out of the water bodies and stormwater system.

Target Audience
Homeowners, vehicle owners, business owners

Recommended Approach
These pollutants become a problem through intentional and unintentional introduction of oil and household hazardous wastes (paints, solvents, poisons, etc.) into stormdrains, improper vehicle maintenance resulting in leaked fluids that get washed into drains and waterways, and improper handling or disposal of solid waste (e.g., household electronics) that can leach hazardous materials such as mercury into the stormwater system.

In order to effectively educate the public about minimizing this risk, a wide-ranging approach is most effective, since its source can come from a broad range of people and activities. To achieve this broad effect, it is advisable to leverage existing information and programs. In fact, there are already many existing websites, fact sheets and other educational material that adequately cover the issues and recommended solutions to mitigate this type of environmental pollutant.

DNREC, New Castle County Conservation District, Partnership for the Delaware Estuary, Delaware Solid Waste Authority, and many MS4 municipalities, among other groups, provide a wide range of information addressing these issues. Materials already available on DelDOT's Stormwater Quality website (*deldot.gov/stormwater*) address ways to keep oil and household hazardous wastes out of the storm-sewer system. These materials address a wide range of audiences and are distributable through many means.

To make the best use of existing resources to meet the NPDES permitting requirements for education and outreach, DelDOT, as a primary permittee, can act as a coordinator for the many valuable resources produced by other agencies and organizations. Developing and maintaining communication channels with and among these stakeholder groups ensures that the messages are coordinated, complementary, and can thus be most effective.

In particular, DelDOT should focus on the activities of their co-permittees, such as MS4 municipalities, many of which have developed education and outreach materials and programs, yet which might not have the resources to most effectively produce, implement, and distribute them adequately. One common approach many communities have taken to increase awareness about the dangers of dumping hazardous materials into the storm drain system is affixing stormwater medallions to intakes. These can be effective deterrents to illicit or unintentional introduction of hazardous materials but require an initial financial outlay and ongoing maintenance. DelDOT could assist smaller MS4 communities in such

simple, yet effective, programs, for instance, by helping defray costs, assisting with the standardization of medallion design and application methods, and developing a maintenance strategy.

DelDOT can serve as the centralized "umbrella" organization to the implementation of stormwater marking (or other) efforts. Direct education and outreach about the medallions and storm drain–marking efforts can be achieved through newspaper articles, PSAs, billboard ads, bus-stop posters and other media. In this way, a variety of separate but similar initiatives can be presented under a unified outreach campaign.

Similarly, DelDOT can help coordinate other efforts related to educating the public about oil and hazardous household–waste disposal. Importantly, by maintaining contacts with and among stakeholders, DelDOT can respond specifically to the individual needs of the co-permittees and provide material support and guidance to a wide range of efforts aimed at a broad cross-section of the public.

Targeted Scale of Impressions (high, medium, low)
Medium

Cost (high, medium, low)
Low

TARGET AREA 3
Yard and Pet Waste

Goal
To encourage the proper disposal of potential pollutants, including yard and domestic pet waste.

Target Audience
Homeowners and pet owners (children and adults)

Recommended Approach
It is recommended that yard- and pet-waste-reduction programs be addressed separately. These sources of pollution come from two distinct target audiences, and the approach would be most effective with campaigns targeting each behavior separately. As a starting point though, for both of these Target Areas, it is critical to inventory and assess the existing yard- and pet-waste-reduction programs in Delaware.

Yard Waste
Yard debris (grass clippings, plant matter, and tree and shrub trimmings) can be a significant source of stormwater pollution. Decomposing vegetative matter leaches excess nutrients. Excess yard waste and debris can clog culverts, storm drains, and pipes, resulting in flooding. Overall, it is a best practice to compost yard waste or dispose of yard waste via a public or private utility.

Since the yard-waste ban has taken effect in New Castle County, there have been several resources developed to educate homeowners about the best ways to dispose of yard waste. Websites, such as DNREC and the University of Delaware's Cooperative Extension, provide links to private and public drop-off locations and utilities that will dispose of your yard waste, as well as tips and tools for composting and disposing of your yard waste onsite. It is recommended that DelDOT and the co-permittees develop strategies to disseminate the existing educational material and information more effectively.

Pet Waste
When pet waste is left on the ground, rain and snowmelt wash this and the associated bacteria into storm drains and directly into local rivers and streams. There are several existing pet waste programs in Delaware. One of the most publicized programs is the Partnership for the Delaware Estuary's Dog Waste Control Program. This program reaches out to pet owners and communities to help reduce the negative impacts of pet waste by providing the necessary tools to handle it. This program provides signage templates, supplier information, and tip-card templates and solutions. It would be most effective if DelDOT and the co-permittees worked through the existing pet waste–control programs and provided funding support to make the program more well known and to get it into more communities throughout Delaware. By working through established programs like the Partnership for the Delaware Estuary's Dog Waste Control Program, DelDOT and the co-permittees would have a greater impact in carrying out its message.

In many homes, children play a major role in pet care; therefore, children are a critical target audience for a message. So, in addition to partnering with existing programs, the pet-waste campaign should be brought to schools where possible. As discussed in Chapter 3, several groups have school programs that target children with a specific stormwater message (Baltimore County, Md., City of Chesapeake, Va., and Gwinnett County, Ga.). For example, the City of Chesapeake, Va., has implemented education programs in schools in which technicians are sent to schools for 40-minute sessions as part of a third-grade science class. The program considers reaching a young audience a very important component of public education. The program reaches 1,200 students a year over the course of 2½ months. A program similar to this, yet with a focus on reducing pet waste, could be conducted in schools in New Castle County. This issue could also be incorporated into Delaware's seventh-grade Watershed Curriculum, which requires that all schools that are Science Coalition Members teach a watershed unit as part of the seventh-grade science curriculum. DelDOT also has a number of resources that have been used to educate students in the past, including activity books and bookmarks. These publications could be slightly altered to include information on the negative impacts of pet waste. Finally, one other method to reach young people is through the Green Jobs program. Within this program, which includes approximately 10 interns and during the six-week program, there could be a day dedicated to disseminating outreach material related to reducing pet waste. This would be an effective way of reaching the general public with this message as well as educating the Green Jobs interns during the process.

Targeted Scale of Impressions (high, medium, low)
Medium

Cost (high, medium, low)
Low

TARGET AREA 4
Lawn Irrigation/Car Washing

Goal
Reduce the amount of runoff entering the storm sewer system from irrigation of lawns and washing of cars on impervious surfaces.

Target Audience
Homeowners, vehicle owners

Recommended Approach
Runoff from residential lawn irrigation and the washing of cars represents a significant source of pollution to the stormwater system. While the nature of nonpoint source pollution such as runoff from residential water use makes the direct effects difficult to quantify, a best practices approach, using fairly simple and low-cost techniques will improve both the quality as well as reduce the quantity of water entering the stormwater system. DelDOT is already involved with a variety of programs that address these issues, such as the Delaware Livable Lawns initiative discussed in Chapter 3. DelDOT's stormwater website also has a variety of information on creating lower-impact lawns for homeowners and tips to reduce the loads on the storm sewer system and on water quality from washing cars.

Lawn Irrigation
The issue of limiting the watering of residential lawns to reduce the amount of runoff and associated pollutants that enter the system fits into a larger scheme of coordinated landscaping strategies which seek to mitigate the effects of pesticides, herbicides, and nutrients (fertilizers) applied to lawns and outdoor landscaping. The Delaware Livable Lawns program takes a comprehensive approach to this issue. Other programs, such as rain barrel promotions (by DNREC and many municipalities), Backyard Habitat designation (e.g., by the Delaware Nature Society), programs that promote native plants and healthy habitat (e.g., the Brandywine Valley Association's BasinScapes program) address a broad range of ways to reduce the harmful impacts of residential landscapes.

Strategies to address the problems of lawn irrigation, therefore, can best be developed within the framework of these broader initiatives. Coordination with stakeholder groups (such as local NGOs and Tributary Action Teams) as well as co-permittees is critical. Working with water purveyors and groups such as the Delaware Rural Water Association can be effective for developing strategies to reduce the application of irrigation water.

Since water use for irrigation of lawns is most intensive in the first few years after residential development occurs, dropping off sharply after that, emphasis should be placed on areas of most recent development. Approaches that educate about fertilizer and pesticide application (e.g., home-improvement stores) should be coupled with educational materials about proper water use and the handling of runoff (e.g., the use of rain barrels to capture, then reapply roof runoff, or the disconnection of downspouts from driveways and hardened surfaces).

Car washing
Car washing is a significant and often under-appreciated source of contaminants entering the stormwater system. The EPA estimates that perhaps 60 percent of U.S. households wash cars at home on a regular basis. Improper washing habits, including parking on a hardened surface with direct runoff to a storm drain, using non-biodegradable cleaning solutions, and over use of water (for example if the hose used lacks a shutoff nozzle), lead to the introduction of surfactants, metals, and hydrocarbons into the stormwater system. A barrier to reducing the effects of this is the lack of understanding polluting effects of this activity; people are often under the mistaken impression that the activity is innocuous from a water-quality perspective.

Education campaigns, therefore, are essential, but they can be very effective, since the solutions to the problem are relatively simple. The EPA recommends approaches such as using a commercial car-wash facility (automated or self-serve), which are required to properly handle their runoff, parking on permeable surfaces (gravel or grass), using eco-friendly cleaning products, and keeping rinse water to a minimum.

Typically, information about car washing is promulgated to the public through broader education campaigns (such as educational posters on how to reduce environmental impacts around the home). Targeted approaches that address car washing to a narrower audience could also be effective. Brochures or other outreach at auto-supply stores would target the automotive "do-it-yourself" population. Another concentrated source of car-washing activity stems from charity fundraiser groups who host carwashes, often at local gas stations or other business establishments. Concentrating on the groups that host the fundraisers and on the businesses where they operate is an effective way to efficiently reduce impacts. Since these ad-hoc car-wash fundraisers are often run by student groups, the opportunity for effective education is enhanced.

Targeted Scale of Impressions (high, medium, low)
Medium

Cost (high, medium, low)
Medium

TARGET AREA 5
Lawn Care

Goal
Reduce herbicide, pesticide, and fertilizer use.

Target Audience
Homeowners, homeowner associations, golf courses, office parks, institutional entities with open space holdings, commercial and private applicators, and distributors of lawn care products

Recommended Approach
This issue has been a long-standing threat to the water quality in Delaware. The excessive use and misapplication of pesticides and fertilizer on residential and commercial properties results in increased toxins and nutrient loads in stormwater that runs off directly to the waterways.

In Delaware there is a group of nonprofit, state, and private stakeholders working together on this very issue. The goal of the Delaware Livable Lawns program is to reduce pesticide and fertilizer runoff from lawns. More specifically the Delaware Livable Lawns program aims to do the following:

- Certify lawn-care companies that follow environmentally friendly practices in fertilizer application.
- Provide homeowners with the necessary information to make small changes in lawn care practices so we can all be better stewards of our environment.

The most effective approach to achieving the goal set forth in the NPDES permit is for DelDOT and the co-permittees to participate in this partnership and fund specific efforts of this group, so that it can achieve the program goals.

DelDOT provided initial funding for this program, and it is supported by the efforts of many partners. The Delaware Livable Lawns Program Advisory Group includes:

- Delaware Department of Transportation (DelDOT)
- Delaware Department of Natural Resources & Environmental Control
- Appoquinimink River Association
- Delaware Department of Agriculture Nutrient Management Commission
- New Castle Conservation District
- U.S. Department of Agriculture Natural Resources Conservation Service
- University of Delaware Water Resources Agency
- University of Delaware Cooperative Extension
- Delaware Grounds Management Association
- Delaware Nursery & Landscape Association
- Delaware Nature Society

Delaware Livable Lawns has currently undertaken the following efforts:

- Advocate for reduced pesticides and fertilizer in stormwater runoff.
- Develop and produce outreach materials (including brochures, magnets, store signs, etc.).

- Produce educational video.
- Held information session and workshop for commercial applicators.
- Develop a website.

This program will need additional funding to sustain and grow it as needed throughout the state of Delaware, and this is a critical role that the NPDES co-permittees can play in achieving the goals of this Target Area of the NPDES permit.

Targeted Scale of Impressions (high, medium, low)
Medium

Cost (high, medium, low)
Low

TARGET AREA 6
Public Participation Events/Stream Clean-Ups

Goal
To encourage the general public's participation in stormwater-related public events (such as stream clean-ups and workshops).

Target Audience
The public at large

Recommended Approach
There are many public events related to pollution prevention, and specifically curbing stormwater pollution, throughout Delaware. Developing new public participation events and stream clean ups are not necessary, but conducting an inventory of and coordinating with existing events is the most effective approach for this Target Area.

As discussed in Chapter 4, nationally and locally, many state agencies and local groups host and participate in public outreach activities related to stormwater pollution (e.g., public lectures, workshops, and stream clean ups). It is critical that information about events related to stormwater pollution (e.g., DE AWRA symposia, University of Delaware lectures, nonprofit lecture series, stream clean-ups, etc.) is disseminated and highlighted. For these events, it is essential that DelDOT and the co-permittees play a key role in assisting in the dissemination of information, including advertising, mailings to existing contact lists, posting on DelDOT's website (e.g., through an events calendar), coordinating with co-permittees to encourage participation at the local level, and providing in-kind or direct funding (based on the needs of the organizing group). Additional ways to disseminate information about events is to revive methods previously utilized by DelDOT, such as:

1. Insert in New Castle County residents' tax bills—this method can be effective, because, as a high-priority mailing, it reaches a broad cross-section of households and is likely to be read.

2. Disseminate information throughout Delaware at various venues, such as:
    - Delaware Rural Water Association
    - Delaware State Fair

3. Disseminate information through various media outlets:
    a. Public service announcements and ads in several local newspapers, including *Delaware State News*, *Cape Gazette*, and the *Dover Post*.
    b. TV commercials through Clear Channel Broadcasting and radio spots on WGMD-FM.

The White Clay Creek Management Plan Coordinator has also pledged assistance to DelDOT and the co-permittees in the following areas:

- Development of outreach and educational programs and coordination/selection of stakeholders for educational activities and outreach.
- Scheduling and conducting educational and outreach events, workshops, and seminars for stakeholders.
- Developing a path forward pertaining to the evaluation of the programs and outreach to guage impressions.

Recognizing this commitment of support and therefore utilizing this group to disseminate information about public events is important. Additionally, sponsorship (in-kind and direct funding) of White Clay Creek outreach programs will provide additional outreach opportunities for the public with little effort and at a lower cost.

Stream Clean-Ups
The Christina River Clean-Up is a county-wide clean-up that began in 1992. The clean-up includes the Christina River, White Clay Creek, Red Clay Creek, and Brandywine Creek watersheds and other tributaries. More than 12,000 volunteers have participated in this event over the years. This clean-up is well established, and DelDOT is an event sponsor. Continued support of this clean-up and other local clean-ups is highly recommended.

Targeted Scale of Impressions (high, medium, low)
High

Cost (high, medium, low)
Low

TARGET AREA 7
BMP Maintenance

Goal
Ensure the proper functioning (flow control and pollutant reduction) of stormwater-control BMPs through maintenance and monitoring.

Target Audience
HOAs, land holding companies, industries, office parks

Recommended Approach
Maintaining stormwater control BMPs is essential because a poorly maintained BMP negatively impacts the performance and decreases the pollution-reduction capacity of the BMP. Sediment accumulation, litter, and debris are often major factors in reducing the effectiveness of stormwater BMPs.

DelDOT's NPDES permit requires annual BMP inspection. DelDOT owns, inspects, and maintains all of its own BMPs. In 2007 DelDOT developed a statewide stormwater BMP–inspection/maintenance program that provides a consistent protocol for inventorying, inspecting, and maintaining its BMPs.

In New Castle County, the County is responsible for making sure that privately owned BMPs in the county are inspected and maintained. New Castle County will perform major maintenance (sediment removal and structural repair) for BMP's located in residential private open space when their maintenance corporation signs up for the County's Amnesty Program and agrees to perform minor maintenance. Additionally, New Castle County maintains BMPs located in public open space.

New Castle County holds workshops on BMP maintenance. The County also holds two maintenance seminars in the fall for commercial and residential BMP owners. There are several approaches to improve stormwater-BMP maintenance and to educate those who are responsible for BMP maintenance. The approaches recommended in this section apply primarily to the county and municipalities:

- Identify BMPs that have not been maintained due to communal or uncertain ownership/responsibility. Develop a database of these BMPs so they may be inventoried and tracked.
- Inventory the co-permittees' existing programs that monitor, inspect, and/or maintain BMPs within their jurisdictions. Review existing stormwater-BMP operation and maintenance ordinances. For jurisdictions without an ordinance, develop a stormwater-BMP operation and maintenance ordinance, based on existing prototypes. For those with an ordinance there may be a need to improve the ordinance. Education of the responsible parties (community or private group) that they are required to perform maintenance and adhere to the ordinance is also an important component.
- Develop an "Adopt-a-Pond" program that will establish a network of volunteers that will "adopt" stormwater BMPs and help perform annual inspections and maintenance. See the Center for Watershed Protection guidebook for detailed information, *www.cwp.org/documents/cat_view/78-other-center-publications.html*.

- Assess existing educational materials on stormwater-BMP maintenance and develop new ones as necessary. Education materials should be posted on DelDOT's and the co-permittees' websites and distributed to the target audience (communities or businesses with BMPs).
- Actively publicize any existing workshops and educational efforts on BMP maintenance.
    - For existing workshops conducted, assess effectiveness through pre- and post-workshop participant surveys.
- Assess sufficiency of workshops by canvassing responsible jurisdictions or organizations.
    - If needed (or if there is a demand), develop educational workshops in coordination with partner organizations with topics that include technical and legal aspects, funding options, maintenance options (e.g., self-support, county, private contractor, etc.).

Targeted Scale of Impressions (high, medium, low)
Low

Cost (high, medium, low)
High

TARGET AREA 8
Residential Low-Impact Development (LID)/Green Technology BMPs that reduce runoff and mimic natural hydrology

Goal
To encourage homeowners to install LID and Green Technology BMPs to reduce stormwater runoff from their property by mimicking natural hydrology.

Target Audience
Homeowners

Recommended Approach
Low-impact development (LID) techniques and the use of "green technology" BMPs constitute part of the emerging trend of ecologically and socially friendly design (such as complete streets and other smart-growth approaches). These designs can be quite effective at reducing the negative impacts of stormwater runoff by reducing volume (through diversion, storage, infiltration, or evapotransporation) and pollutant loads (through filtering, settling, bio-uptake, or mechanical removal).

Drawbacks or impediments to implementation include the cost involved in installing many of these measures (e.g., bioswales, bioretention basins, tree trenches, filters, green roofs, constructed wetlands, etc.) as well as the fact that to be most effective they must be large-scale or aggregated (e.g., there need to be many properties in an area to make an appreciable difference in flows or loadings). Most installations, therefore, are undertaken by large institutional or commercial enterprises or are included in initial designs of residential developments. Lower-cost approaches can be effectively implemented by individual homeowners, including small rain gardens, water cisterns or rain barrels, etc. Larger private groups such as homeowner associations (HOAs) are often able to implement more extensive, but still lower-cost, BMPs such as grass filter strips or roadside swales.

Emphasis on the education and outreach relating to LID and "green" BMPs can best be implemented by highlighting the benefits of the technologies and techniques to the public and encouraging institutions and businesses, as well as co-permittees, to adopt them where feasible. Existing outlets such as the website can be augmented with information on funding opportunities and cost sharing programs from federal, state, local sources and nonprofit foundations. In addition to consultant lists, engineering and design information can provide material information for groups seeking to initiate these projects. It is important to highlight ambitious, large-scale examples, such as the City of Philadelphia Water Department's Green City, Clean Waters program, and regional examples of successful implementations by businesses.

To promote awareness in the public at large, it is important to emphasize the aesthetic appeal and environmental benefits, both of larger, highly engineered projects, as well as attractive, easy-to-implement residential-scale projects which are within the ability of homeowners to implement. An area of the website should be dedicated to such "green technologies," highlighting BMPs, as is currently done, but also making the linkage to the green movement more explicit. If possible, compile examples

of case studies in which attractive and ecologically friendly design has led to increased property values or other benefits (including tax benefits) to homeowners and businesses. Develop a brochure for distribution at events such as Earth Day, Creek Fest, Delaware State Fair, Coast Day, Ag Day and other venues promoting these technologies. Inventory and highlight site-specific problems (such as persistent erosion or flow-volume issues) that these approaches have solved.

Targeted Scale of Impressions (high, medium, low)
Medium

Cost (high, medium, low)
High

5.2 Conclusions and Discussion

This report summarizes information from existing education and outreach campaigns throughout Delaware and the nation. Additionally, critical concepts and tools learned from the workshop held on September 28, 2011, are summarized and analyzed. Using this information, approaches have been developed for each of the eight NPDES Target Areas.

Using lessons learned from the marketing workshop, each component of the Target Area list was addressed specifically. Table 5.1 outlines these lessons, their associated strategies, and specific Target Areas where they apply.

Table 3. ***Effective Strategies for Developing NPDES Education and Outreach Programs***

Lesson Learned	Strategy	Target Area
Prioritize	Understand the nature of a given pollution problem to allow assessment of the costs and benefits (i.e., reduction of contamination) involved.	This strategy applies generally to all thematic areas.
Leverage	Use existing programs developed by others; enhance or promote these to quickly and cost-effectively implement educational campaigns.	Lawn Care, Motor Oil, and Hazardous Waste Disposal
Participate	Get involved with initiatives such as stream cleanups, either by organizing or providing funding and personnel.	Stream Clean-up
Target	Focus outreach efforts at the smallest possible interest group to maximize message retention.	Lawn Irrigation/Car Washing, Pet and Yard Waste
Recruit	Involve citizens in the protection of stormwater quality to promote buy-in and give people in affected areas a sense of ownership of the problem.	Illicit Discharges (Public Reporting)
Provide Expertise	In some cases, DelDOT may have knowledge and expertise in specific technical areas of stormwater control and treatment. By providing direct outreach and technical support in these cases, affected populations are most effectively reached.	BMP Maintenance, Low-Impact Development

Table 5.2 summarizes the recommended approaches from Section 5.1 to provide a sense of the Target Areas that provide the highest number of impressions for the least cost (biggest "bang for the buck"). For example, the approach recommended in Target Area 6 (Public Participation/Stream Clean-Ups) gives the highest number of impressions at the lowest cost, whereas Target Area 7 (BMP Maintenance) gives relatively few impressions and generally requires a higher-cost approach to achieve these impressions. This does not imply that one Target Area is of lesser importance; it simply indicates that the number of impressions and cost are important components to consider when developing a campaign and trying to meet the NPDES requirements in the most cost-effective way.

Table 4. ***Target-Area Impression and Cost Comparison***

Target Area	Impression	Cost
1 –Illicit Discharges (Public Reporting)	**High**	**Medium**
2 - Motor Oil/Hazardous Waste	**Medium**	**Low**
3 - Yard/Pet Waste	**Medium**	**Low**
4 - Lawn Irrigation/Car Washing	**Medium**	**Medium**
5 - Lawn Care	**Medium**	**Low**
6 - Public Participation/Stream Clean-Ups	**High**	**Low**
7 - BMP Maintenance	**Low**	**High**
8 - LID/Green Technology	**Medium**	**High**

The NPDES permitting requirements specify that a Public Education and Outreach Plan be developed that will incorporate the information collected in this project. This written plan will include measurable goals and constitute a component of the full Stormwater Pollution Prevention and Management Plan for DelDOT's NPDES permit. The recommended approaches outlined in this report and the impression-versus-cost analysis will serve as starting points for the Public Education and Outreach Plan. In order to develop this refined plan, the approaches in this report will need further detail. For example, defined action items, specific organizations to work with, stakeholder groups to target, costs, campaign materials, and program areas to develop are critical components to a refined approach. The information in this report can be used to direct this further effort.

Appendix A – Nationwide Programs Referenced

Organization	Contact	Website
Programs Through State Departments of Transportation		
Maryland State Highway Administration	Karen Kauffman, Highway Hydraulics Division (410)545-8407	
	Joan Armacost, Baltimore County (410)887-4488	
	Gale Engels, Carroll County (410)386-2756	
California Department of Transportation (Caltrans)		*www.donttrashcalifornia.info*
Connecticut Department of Transportation (ConnDOT)		*www.ct.gov/dot/cwp/view.asp?a=1383&q=386458*
Texas Department of Transportation		*www.dontmesswithtexas.org*
Municipal, County, and Regional Programs		
Washington, D.C.	Evelyn MacKnight, U.S. EPA Region 3, Water Protection Division, Office of Watersheds, (215)814-5717	
City of Los Angeles	(800)974-9794	*www.lastormwater.org/siteorg/education/genpub.htm*
City of Chesapeake, Va.	Tammy Barry; (757)382-6983	*www.chesapeake.va.us/services/depart/pub-wrks/stormwatermanagement-publiceducation.shtml*
Seattle, Wash., Public Utilities	Gretchen Muller (206)684-0570	
Baltimore County, Md.	Lamar Lewis, Stormwater Engineering (410)887-4488	
	Gene Armacost (410)887-4488	
Gwinnett County, Ga.	John Butler (678)376-6914, john.butler@gwinnettcounty.com	
Metropolitan North Georgia Water Planning District/Clean Water Campaign	Charlene (404)463-3259	*www.northgeorgiawater.com/html/159.htm*
	John Butler, Gwinnett County (678)376-6914	

Appendix B – Representative Questions

1. Reason for implementing the stormwater-education/outreach program:
    a. To meet NPDES permitting requirements?
    b. Other reasons?

2. Relative difficulty of implementation:
    a. What were the easiest programs or program components to implement?
    b. What were the most difficult programs or program components to implement?

3. What were some specific challenges encountered?

4. Were there aspects that proved problematic that you did not anticipate?

5. Program effectiveness:
    a. Is this program deemed effective?
        i. If yes, to what degree, and why?
        ii. If no, why not?
    b. How is program effectiveness monitored and measured?

6. Program cost considerations:
    a. What is the approximate cost of the program, if known?
    b. If known, what are the relative costs of particular elements (e.g., proportions of materials, printing, time)?

7. Is the program required to meet a certain number of impressions?
    a. If yes, how was the number of impressions measured?

8. Did you receive public feedback about the program?
    a. If yes, was there any feedback related to how the program could be improved?
    b. Were any such suggestions considered?

9. Additional program details:
    a. Are there any additions/changes to the program that are not shown on the website?
    b. Are there any additional programs that are not listed on the website that you use to educate the public about stormwater?

10. Is there any additional information that may be useful to DelDOT in implementing similar stormwater-education programs?

Appendix C – NPDES Stormwater-Education and Public-Outreach Workshop Attendees

City of Wilmington
Mary Neutz
Delaware City
Richard Cathcart
DelDOT
Randy Cole
Marianne Walch
LaTonya Gilliam
Town of Elsmere
John S. Giles, Jr.
Diana Poole
Tina Law
Town of Middletown
Tim DeSchepper
New Castle County
Ellie Mortazavi
Janice Catherman
Bernadette Casella
Carolyn Magnotti
Michael Harris
University of Delaware's Water Resources Agency
Martha Corrozi Narvaez
Andrew Homsey
White Clay Wild and Scenic
Jennifer Egan
Linda Stapleford

Appendix D – Watershed Organizations in Delaware and Working in Delaware Water Resources

Watershed Organization	Town
Appoquinimink River Association	Middletown
Brandywine Valley Association	West Chester (Pa.)
Brandywine Conservancy	Chadds Ford (Pa.)
Christina Conservancy, Inc.	Wilmington
Chesapeake Bay Foundation	Annapolis (Md.)
Coalition for Natural Stream Valleys	Newark
Delaware Audubon Society	Wilmington
Delaware Bass Federation	-
Delaware Center for Horticulture	Wilmington
Delaware Center for the Inland Bays	Rehoboth Beach
Delaware Chapter of the Sierra Club	Wilmington
Delaware Greenways	Wilmington
Delaware Low-Impact Tourism Experiences (DLITE)	Salisbury (Md.)
Delaware Native Plant Society	Dover
Delaware Nature Society	Hockessin
Delmarva Ornithological Society	-
Delaware Riverkeeper Network	Bristol (Pa.)
Delaware Rural Water Association	Milford
Delaware Wild Lands	Odessa
Ducks Unlimited	-
Fairfield Watershed Association	Newark
Friends of Bombay Hook	Smyrna
Friends of the Delaware Bay	Sussex County
Friends of Lums Pond	Bear
Friends of Prime Hook National Wildlife Refuge	Milton

Watershed Organization	Town
Friends of the Nanticoke River	Nanticoke (Md.)
Friends of White Clay Creek State Park	Newark
Green Delaware	Wilmington
League of Women Voters of Delaware	Wilmington
Naamans Creek Watershed Association	Arden
Nanticoke River Watershed Preservation Group	-
Nanticoke Watershed Alliance	Vienna (Md.)
National Wildlife Federation	Annapolis (Md.)
Partnership for the Delaware Estuary	Wilmington
Red Clay Valley Association	West Chester (Pa.)
Save Wetlands and Bays	Millsboro
St. Jones River Greenway Commission	Magnolia
St. Jones River Watershed Association	Dover
Surfrider Foundation Delaware Chapter	Millsboro
The Academy of Natural Sciences	Philadelphia (Pa.)
The Conservation Fund	Centreville
The Nature Conservancy - Delaware Chapter	Wilmington
Urban Environmental Center	Wilmington
Waterfront Watch of Wilmington	Wilmington
White Clay Creek Watershed Association	Newark
White Clay Creek Watershed Management Committee	Newark
White Clay Flyfishers	Landenburg (Pa.)
Widener Environmental and Natural Resources Law Clinic	Wilmington

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Appendix G. Street Sweeping Maintenance Bulletin used to train DelDOT maintenance staff.

Stormwater Pollution Prevention Bulletin

For DelDOT Maintenance Staff

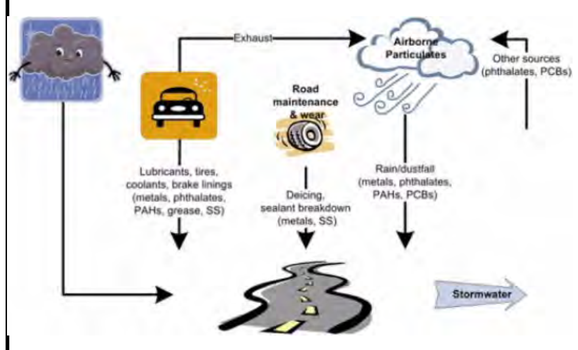
Issue 18 / February 2012

STREET SWEEPING

Why We Sweep

Street sweeping is part of DelDOT maintenance, not only for aesthetics, but to meet NPDES permit requirements by removing harmful pollutants from our roadways. DelDOT uses two types of sweepers, mechanical broom & regenerative air. Sweeper waste contents are seasonably variable, but can consist of:

- Road dirt such as sand, gravel, silt
- Deicing materials like salt and sand
- Leaves and grass clippings
- Pollutants from vehicles such as oil, coolant, tires, exhaust, brake linings, etc.



Critical Operating Requirements

- Always use water to suppress dust and reduce machine wear.
- To optimize pollutant removal, sweep prior to rain. Do not sweep during rain events.
- While sweeping, keep operating speeds a maximum of **8 mph**.

Sweeping Frequency & Timing

We are currently required to sweep on the following schedule:

- 4X/year on major roads (Rt. 1, Rt. 13, interstates such as I-95, etc.)
- 2X/year on collector roads (Routes 52, 8, 9)
- 1X/year on subdivision roads

Mechanical broom sweeper

Material Storage & Disposal

- Stockpile street sweepings at the designated storage area
- Stockpile area must be bermed or silt fenced to prevent stormwater impacts
- Storage of street sweepings at the maintenance facility must be temporary
- Street sweepings must be disposed of at the Delaware Solid Waste Authority landfill
- All operators must carry the DSWA authorization letter to dispose of material at the landfill

Sweeper waste stockpile

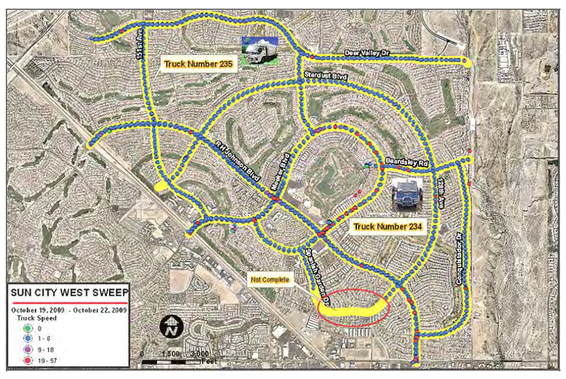
Vehicle Maintenance

- Wash sweeper in designated areas containing water quality BMPs to prevent stormwater impacts
- Always use water while sweeping to reduce metal abrasion

Vacuum sweeper

Data Collection

- Sweepers equipped with GPS tracking will be used by the NPDES Program to estimate pollutant removal



- Analytical testing of sweeper waste material will be periodically performed

Sweeper waste sampling

DelDOT
Stormwater Quality Program

Additional information is available from the DelDOT NPDES Section.
Questions or comments may be directed to Randy Cole, NPDES Program Manager, (302) 760-2194 or Randy.Cole@state.de.us.
www.deldot.gov/stormwater

Appendix H. KCI Technologies green technologies BMP monitoring report for 2012.

DELDOT AGREEMENT 1613
ENVIRONMENTAL AND WATER QUALITY MONITORING

GREEN TECHNOLOGY

2012 ANNUAL REPORT

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   Sample Site Map

2. **WWWM Sampling Methodology**
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GREEN TECHNOLOGY
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RT 299 Pollutant Removal Efficiency Box & Whisker Plots

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DELDOT AGREEMENT 1613
ENVIRONMENTAL AND WATER QUALITY MONITORING

GREEN TECHNOLOGIES

2012 ANNUAL REPORT

As part of the Delaware Department of Transportation's National Pollutant Discharge Elimination System General Permit Program Regulations Governing Stormwater Discharge, KCI Technologies, Inc. was contracted to perform the following Green Technologies Best Management Practices (BMPs) Performance Studies:

- Bioswale Study at BMP 104 (BMP 104 Study)
- Route 299 Grass Side Slope Study / Green Technology Modeling

A. BIOSWALE 104 STUDY

The purpose of the BMP 104 Study is to determine the efficiency of a bioswale in the removal of pollutants and in the reduction of flow rates for stormwater runoff. The study includes continuous base flow monitoring and Automated Wet Weather Monitoring (WWM).

BMP 104 is a swale located at the intersection of Valley Road and Lancaster Pike in Hockessin. BMP 104 provides treatment for stormwater runoff from Lancaster Pike, and partial drainage from surrounding residential developments. The drainage area for BMP 104 encompasses approximately 9.4 acres.

BMP 104

Detailed information regarding Project Objectives, Sample Site Locations, Sampling Equipment, General Sampling Procedures, Sample Collection, Sample Analysis, Field Data Sheets, Quality Assurance, and Safety are located in the *Bioswale 104 Study Standard Operating Procedures and Site Safety and Health Plan* (October 2012)

1. Sample Site Locations

The sample site locations are depicted on the **Sample Site Map** and described below.

BIOSWALE 104 STUDY
SAMPLE SITE MAP

BMP 104 IN

BMP 104 IN is monitored and sampled from a manhole located at the upstream end of the bioswale, which receives direct pipe drainage from Lancaster Pike and surrounding residential developments. An Isco 6712 sampler was installed and secured in a locked storage box adjacent to the manhole at the upstream end of the bioswale. The Isco performs two functions at this site:

- Records storm flow, base flow (if present) and precipitation data.
- Collects and stores composite samples.

BMP 104 IN 08/06/12

Inside the manhole, a 90° V-Notch weir was installed to the face of an 18" inflow concrete pipe. On the upstream side of the weir, a bubbler line and suction line connected to the Isco were installed to measure flow and collect samples during the WWM events.

BMP 104 OUT

BMP 104 OUT is monitored and sampled at the base of the bioswale prior to flowing into a catch basin inlet. The flow that enters the upper end of the bioswale travels through the system and is filtered by various types of vegetation and two rock check dams. An Isco 6712 sampler was installed and secured in a locked storage box at the base of the bioswale adjacent to the catch basin inlet. This Isco performs two functions:

- Records storm flow and base flow (if present) data.
- Collects and stores composite samples during WWM events.

BMP 104 OUT 08/06/12

At the OUT location, a 12 ft. stainless steel 90° V-Notch weir was installed prior to the catch basin inlet. On the upstream side of the weir, a bubbler line and air-line connected to the Isco was installed to measure flow and collect samples during the WWM events.

2. Automated WWM Methodology

Sampling techniques are performed in accordance with the Environmental Protection Agency (EPA) *Stormwater Sampling Guidance Document*, EPA 833-B-92-001 (July 1992). WWM sampling protocol includes 72 hours of antecedently dry conditions and minimum predicted rainfall depth of 0.10 inches.

Prior to the start of each potential WWM event, the sample sites and monitoring equipment are inspected for potential issues and any unusual conditions are noted. At both the IN and OUT, the battery power supply is checked to ensure sufficient battery life for the duration of a storm event. Batteries at the site are continuously rotated with fully charged batteries on a bi-weekly basis. If low battery power is detected, a fully charged battery is installed. The sampling bottles at both the IN and OUT located in the base of each Isco 6712 sampler are cleaned and inspected for any foreign objects or liquid that could potentially contaminate the samples. Suction lines and air-lines are inspected for leaks or blockages.

BMP 104

The 90° V-Notch weir located in the 18" concrete pipe inside the manhole at the IN location is checked for any possible blockage or sediment accumulation that could interfere with the suction line for collecting water samples or bubbler air-line for determining water level. At the OUT location, any overgrowth of vegetation is removed from behind the v-notch weir to eliminate obstruction of flow over the weir.

After correcting any potential issues at the IN and OUT sample locations, the field crew calibrates the water level readings to reflect current conditions. Each Isco sampler is programmed to perform flow weighted composite sampling according to the predicted duration and intensity of precipitation, with an appropriate flow point set to trigger sampling. A field crew is generally not present at BMP 104 during the rain event, so that field staff can focus on manual sample collection at other WWM locations throughout the state.

The site is re-visited within 24-hours of the storm event to determine if sampling occurred. If sampling was successful, the storm event data (i.e. flow, sample times and precipitation) is downloaded and the composite samples are transferred to the appropriate sample kits provided by the lab. The kits are placed in a cooler and iced until they are delivered to the lab. Prior to leaving the site, the equipment is recalibrated as necessary to continue baseline flow monitoring, and the sample bottles are rinsed and replaced in the Isco sampler for the next storm event.

The field crew returns to the office and uploads the storm event data using Isco FlowLink software. The date and time of the first sample collected at both the IN and OUT are retrieved and documented on the chain of custody for QC Laboratories for use during their analysis. Once the chain of custody is completed, the iced samples are delivered to QC Laboratories for further analysis. A storm event graph and memorandum are generated for each individual storm event using the storm event data uploaded to FlowLink. This information is then uploaded to the SharePoint website.

During dry periods between storm events, any base flow that occurred through the bioswale is monitored and recorded. A field crew visits the site approximately once a week and downloads the recorded base flow data and performs routine maintenance. While on site, the crew inspects the site and equipment for any potential issues and confirms the equipment is properly calibrated. The base flow data is then uploaded using the FlowLink software. Weekly base flow graphs and reports are generated documenting any issues or equipment down time that may have occurred during each weekly monitoring period. This information is then uploaded to the SharePoint website.

The following information is recorded on the BMP 104 IN and OUT field data sheets for successful WWM events:

- Time: Determined from FlowLink
- Flow: Determined from FlowLink
- Volume: Determined from FlowLink
- Total Precipitation Determined from FlowLink
- Air Temperature: Measured during retrieval of samples
- Water Temperature: Measured during retrieval of samples
- pH: Measured during retrieval of samples
- Turbidity: Measured during retrieval of samples

The samples are analyzed for the following parameters by QC Laboratories:

Total Suspended Solids (TSS)	Ammonia
Total Dissolved Solids (TDS)	Total Phosphorus
Chemical Oxygen Demand (COD)	Dissolved Phosphorus
Biological Oxygen Demand (BOD)	Ortho-Phosphate
Chloride	Total Cadmium
Oil & Grease (O & G)	Total Copper
pH	Total Lead
Total Kjeldahl Nitrogen (TKN)	Total Zinc

3. WWM Event History

WWM Event Memorandums, FlowLink Graphs, Field Data Sheets, and Laboratory Data for each sampling event are located in the Project's Technical Files. Five WWM Events were conducted at BMP 104 on the following dates in 2012. There were no False Starts in 2012.

Winter	January 11, 2012
Spring	May 9, 2012
Summer	July 15, 2012
Fall	October 19, 2012
Winter	December 20, 2012

4. WWM Laboratory Data and BMP Efficiency Evaluation

The 2012 BMP 104 WWM data is located in **Appendix A.** WWM Event-specific laboratory data for all parameters at each sample site is located in **Appendix A, Tables 1A-B.** The Mean and Standard Deviation Summary Table is located in **Appendix A, Table 2.**

The performance of BMP 104 was evaluated based on the successful automated WWM Events through the use of Efficiency Ratios (ER) and Efficiency of Individual Storm Load calculations. An in-depth statistical analysis of the storm loads and reductions was not performed due to the limited sample size. Issues that contributed to the limited sample size include the following:

- Altered sampling methodology from time-weighted to flow-weighted sampling.
- Significant difference in recorded storm flow volumes between the IN &. OUT.
- Sediment/debris accumulation leading to clogging issues.
- Equipment issues occurring during the winter months.
- Improper site maintenance

The individual storm event Storm Load calculations and Event Mean Concentrations (EMC) at the IN and OUT are provided in **Appendix A, Table 3**. A summary of the Pollutant Removal Efficiency Ratios based on the IN and OUT EMC is provided in **Appendix A, Table 4**. The Sum of Loads Efficiency is provided in **Appendix A, Table 5.**

- Twelve of the 16 parameters were included in the BMP Efficiency Evaluation:

Total Suspended Solids	Dissolved Phosphorus
Total Dissolved Solids	Ortho-Phosphate
Chloride	Total Cadmium
Total Kjeldahl Nitrogen	Total Copper
Ammonia	Total Lead
Total Phosphorus	Total Zinc

- Oil & Grease levels were below Reporting Limit.
- Chemical Oxygen Demand, Biological Oxygen Demand and pH: The analysis was not applicable; therefore they were not evaluated.

The results of the analysis appear to show a Load Reduction in Total Suspended Solids, Total Kjeldahl Nitrogen, Ammonia, Total Phosphorus, Dissolved Phosphorus, Total Copper, Total Zinc, and Total Lead, while a minor or even a negative Load Reduction are shown for Total Dissolved Solids, Chloride, Ortho-phosphate, and Total Cadmium.

Although it appears BMP 104 is effective at pollutant removal for some parameters, it cannot be concluded that the Load Reduction values shown in **Appendix A, Table 5** are an accurate evaluation for BMP 104. One area of concern pertains to the recorded storm volume differences between the IN and the OUT. Three of the five storm events recorded significantly higher volumes at the OUT when compared to the IN, while one event recorded a significantly higher volume at the IN when compared to the OUT. This significant difference in storm volumes at BMP 104 is believed to be the result of one of the following:

- Sheet flow entering the swale past the IN measuring point resulting in higher volumes at the OUT.
- Clogging of the catch basin at the OUT causing measuring equipment to become inundated with stormwater resulting in higher volumes at the OUT.
- The inflow pipe at the IN becoming clogged with debris resulting in higher storm volumes at the IN.

5. Box and Whiskers Plots

The BMP 104 laboratory data collected in 2012 was organized into two sets of Box and Whisker Plots **(Appendix B)**. The first set represents Pollutant Removal Efficiency, and the second Event Mean Concentrations.

6. Next Steps

KCI plans to continue monitoring BMP 104 to obtain additional sample events which will further assist in an accurate evaluation of the effectiveness of BMP 104 in the removal of pollutants from roadway runoff. As data is obtained through future successful WWM events, a larger sample size will allow KCI to compare the data for statistical significance. Although issues obtaining consistent storm flow volumes occurred in 2012, the EMC's and pollutant load evaluation indicate positive performance from BMP 104 in reducing pollutants. To reduce the number of issues from occurring at BMP 104 resulting in unsuccessful events and discrepancies in data, KCI suggests the following:

- Visit the site during the next couple WWM events to observe additional inflow points.
- Perform BMP 104 maintenance - invasive species removal, proper vegetation height, and sediment/organic debris removal.
- Evaluate data on weekly basis to ensure consistent data and catch potential future issues.

B. ROUTE 299 GRASS SIDE SLOPE STUDY

The purpose of the Route 299 Grass Side Slope Study is to determine the efficiency of a grass side slope in the removal of pollutants and in the reduction of flow rates for stormwater runoff. The study includes Wet Weather Monitoring (WWM) and Modeling.

The grass side slope along Route 299 adjacent to the Odessa Maintenance Yard in Middletown was chosen for the study because of its moderate slope, established grass, no curb and a grass line ditch allowing for a concentrated OUT sample point. The stormwater samples are analyzed for the following parameters: Metals (Cu, Pb, Cd, Zn), Nutrients (TN, TP, TKN, Ortho-P) and Total Suspended Solids. The sample site captures sheet flow runoff from two eastbound travel lanes, a left hand turn lane and an eight foot shoulder along a portion of Route 299.

Route 299 Side Slope

Detailed information regarding Project Objectives, Sample Site Locations, Sampling Equipment, General Sampling Procedures, Sample Collection, Sample Analysis, Field Data Sheets, Quality Assurance, and Safety are located in the *Route 299 Grass Side Slope Study Standard Operating Procedures and Site Safety and Health Plan* (October 2012)

1. Sample Site Locations

The sample site locations are depicted on the **Sample Site Map** and described below.

ROUTE 299 IN

The IN site is located directly at the Route. 299 edge of pavement where it transitions to the grass side slope.

The influent sample site drainage area consists of approximately 0.12 acres of roadway runoff from the westbound lanes and shoulder of Route 299 prior to any potential treatment.

To measure flow and collect samples of sheet flow runoff, a temporary curbing

Route 299 Side Slope IN 05-21-12

system is installed along the Route 299 edge of pavement prior to each storm event. The 100' long curbing system directs sheet flow runoff from Route 299 into a fabricated concrete swale with an attached 90^0 V-Notch weir. An Isco sampler uses a bubbler line and suction line attached to the base of the concrete swale for composite sample collection and flow measurement throughout a WWM event.

As the water exits the concrete swale, it flows down to a grass swale that receives drainage from the grass side slope. A dam structure is installed in the grass swale just downstream of the influent discharge point which dams the influent sample. A bypass system, comprised of two 2" PVC pipes, is installed at the base of the dam and extends along the bottom of the grass swale through the base of the V-Notch weir at the effluent sample site. This bypass allows for the dammed influent water to discharge past the effluent sample site without contamination.

ROUTE 299 OUT

The OUT sample site is located in the same grass swale approximately 100' downstream from the IN bypass dam.

Route 299 OUT 05/21/12

The effluent sample site drainage area consists of approximately 0.12 acres of Route 299 roadway runoff (adjacent to the influent drainage area) and approximately 0.10 acres of treatment area.

As the Route 299 sheet-flow travels off the pavement, it enters the grass side slope treatment area where it is potentially filtered, and collects at the bottom of the treatment area in a grass swale. In this swale, a 90^0 V-Notch weir is installed as a flow control device for measuring flow and collecting samples. A bubbler line and strainer are installed behind the V-Notch weir and connected to an Isco 6712 sampler. The sampler is programmed to collect flow-weighted composite samples throughout a WWM event.

ROUTE 299 GRASS SIDE SLOPE STUDY
SAMPLE SITE MAP

2. WWM Sampling Methodology

Sampling techniques are performed in accordance with the Environmental Protection Agency (EPA) *Stormwater Sampling Guidance Document*, EPA 833-B-92-001 (July 1992). WWM sampling protocol includes 72 hours of antecedently dry conditions and minimum predicted rainfall depth of 0.10 inches. However, due to the nature of this site a significant amount of precipitation upwards of 0.50 inches is required to achieve a successful event.

The field crew installs the sampling equipment and performs monitoring of the site during a WWM event. Upon completion of equipment installation and site set up, the crew continues to monitor the weather for any changes in the forecast and precipitation accumulation. Any changes in either affects the Isco sampler program for flow-weighted composite sampling.

The field crew begins sampling when sufficient flow exists at the influent and effluent sites to measure and collect an adequate volume of sample. According to previous wet weather observations, the effluent sample site can take approximately an hour or more to begin flowing once the influent site has commenced sampling.

The field crew samples continuously for the duration of the storm system or until the system becomes inundated, to ensure the entire hydrograph is captured, including the falling limb. The site is monitored during the sampling event to inspect the equipment for issues, replace sampling jars as necessary to prevent overflow, check sampler battery life, and monitor site flow control devices. Once sampling is complete, the composite samples located in the base of the Isco sampler are transferred to the appropriate sample kits to be iced and delivered to the lab for analysis. During the transfer of the samples, the field crew tests the composite sample for pH, turbidity, and air/water temperature. Prior to leaving the site, all installed equipment and hardware is removed due to safety concerns and to prevent tampering of the site.

Rainfall data is obtained from the on-site rain gauge; however if issues occur with the rain gauge, the data is obtained through the Delaware Environmental Observing System Network.

The field crew returns to the office and uploads the storm event data using Isco FlowLink software. The date and time of the first sample collected at both the IN and OUT is retrieved and documented on the chain of custody for QC Laboratories for use during their analysis. Once the chain of custody has been completed, the iced samples are delivered to QC Laboratories for further analysis. A storm event graph and memorandum are generated for each individual storm event using the storm event data uploaded to FlowLink. This information is then uploaded to the SharePoint website.

3. WWM Event History

WWM Event Memorandums, FlowLink Graphs, Field Data Sheets, and Laboratory Data for each sampling event are located in the Project's Technical Files. Three WWM Events were conducted at Route 299 on the following dates in 2012:

Spring	April 22, 2012
Summer	September 19, 2012
Winter	December 20, 2012

There were two False Starts at Route 299 in 2012: October 2, 2012 and November 7, 2012

4. WWM Laboratory Data and BMP Efficiency Evaluation

The 2012 Route 299 WWM data is located in **Appendix C.** WWM Event-specific laboratory data for all parameters at each sample site is located in **Appendix C, Tables 6A-B.** The Mean and Standard Deviation Summary Table is located in **Appendix C, Table 7.**

During the 2012 monitoring period KCI collected three WWM events at Route 299. However, the first two events were used to assess potential issues with site conditions and develop improvements at the site. Issues that were observed during the first two events include the following:

- Drainage area was not sufficient for sample collection during smaller storms.
- Uneven pavement caused high spots restricting flow to the IN flow measuring device.
- Temporary curbing was not high enough, which allowed stormwater to spill over and bypass the IN and flow to the OUT sample site.
- A single 2" PVC bypass pipe was not sufficient to discharge water that accumulated upstream of the dam.
- Light precipitation does not result in sufficient run-off to measure flows and collect samples.

Therefore the results obtained are not an accurate comparison of each storm event or of the current state of the site. Due to the limited sample size and issues that occurred during sampling, the results of the three WWM events during the 2012 monitoring period show loading occurring at the Route 299 sample site for all analyzed parameters.

The individual storm event Storm Load calculations and Event Mean Concentrations (EMC) at the IN and OUT are provided in **Appendix C, Table 8**. A summary of the Pollutant Removal Efficiency Ratios based on the IN and OUT EMC is provided in **Appendix C, Table 9**. The Sum of Loads Efficiency is provided in **Appendix C, Table 10.**

5. Box and Whisker Plots

The Route 299 laboratory data collected in 2012 was organized into two sets of Box and Whisker Plots **(Appendix D)**. The first set represents Pollutant Removal Efficiency, and the second Event Mean Concentrations.

6. Next Steps

KCI will continue to monitor Route 299 during WWM events through 2013 to obtain sufficient data and evaluate the performance efficiency of the Route 299 grass side slope and to provide annual loading and reduction estimates of the analyzed parameters.

The data from the WWM events will also be used to continue building and calibrating the Stormwater Management Model (SWMM) for grass side slopes. In 2012, a SWMM model was created for the sampling site including the two routed and un-routed sections; based on the roadway plans. The sampling site was changed and the model was updated to reflect those changes. Two storms, one for calibration and the other one for validation, were run in the SWMM model - September 18 and April 22. Once the Runoff is calibrated KCI will move forward with the pollutant modeling.

GREEN TECHNOLOGY
2012 ANNUAL REPORT

APPENDIX A

BIOSWALE 104 STUDY

WWM LABORATORY DATA, STATISTICAL SUMMARY & BMP EFFICIENCY EVALUATION

- **Table 1A** BMP 104 IN WWM Laboratory Data
- **Table 1B** BMP 104 OUT WWM Laboratory Data
- **Table 2** BMP 104 WWM Mean and Standard Deviation
- **Table 3** BMP 104 Individual Storm Event Storm Loads/Event Mean Concentrations
- **Table 4** BMP 104 Pollutant Removal Efficiency Ratios
- **Table 5** BMP 104 Sum of Loads Efficiency

TABLE 1A

WWM LABORATORY RESULTS

BIOSWALE 104 IN

PARAMETER	Units	01/11/12	05/09/12	07/15/12	10/19/12	12/20/12
		COMP	COMP	COMP	COMP	COMP
TOTAL SUSPENDED SOLIDS	mg/L	135.0	88.0	212.0	39.0	54.0
TOTAL DISSOLVED SOLIDS	mg/L	1297	66	157	95.0	82.0
CHEMICAL OXYGEN DEMAND	mg/L	129	56	147	90.6	70.0
BIOLOGICAL OXYGEN DEMAND	mg/L	13.6	8.0	16.0	10.0	8.00
CHLORIDE	mg/L	898.00	16.40	14.60	13.70	12.70
OIL & GREASE	mg/L	<5	<5	<5	<5	<5.00
pH	units	6.85	7.23	6.95	7.04	6.91
TOTAL KJELDAHL NITROGEN	mg/L as N	2.50	1.21	3.92	1.70	1.44
AMMONIA	mg/L as N	0.68	<0.2	0.612	<0.2	<0.200
TOTAL PHOSPHORUS	mg/L as P	0.42	0.21	0.751	0.272	0.187
DISSOLVED PHOSPHORUS	mg/L as P	0.09	0.13	0.385	0.270	0.059
ORTHO-PHOSPHATE	mg/L	0.06	0.06	0.54	0.17	0.0700
TOTAL CADMIUM	mg/L	<0.004	<0.004	0.000259 B	<0.00200	<0.00200
TOTAL COPPER	mg/L	0.045	0.025	0.0374	0.0181	0.0332
TOTAL LEAD	mg/L	<0.01	<0.01	0.00610	0.01300	0.00530
TOTAL ZINC	mg/L	0.186	0.092	0.154	0.044	0.0583

TABLE 1B

WWM LABORATORY RESULTS

BIOSWALE 104 OUT

01/11/12	05/09/12	07/15/12	10/19/12	12/20/12
COMP	COMP	COMP	COMP	COMP
77.0	140.3	49.8	16.0	43.0
811	27	157	114.0	53.0
38	82	151	48.0	43.7
10.3	7.0	11.0	5.0	<4.00
543.00	1.18	16.40	14.10	<10.0
<5	<5	<5	<5	<5
7.24	6.99	6.81	7.41	7.12
1.22	1.33	2.12	1.29	0.683
0.41	<0.2	<0.200	<0.200	<0.200
0.24	0.25	0.479	0.328	0.169
0.10	8.63	0.31	0.276	0.088
0.09	0.06	0.320	0.200	0.100
<0.004	<0.004	0.000323 B	<0.00200	<0.00200
0.018	0.018	0.00320 B	0.00960	0.00550
<0.01	<0.01	0.0021 B	0.00660 B	<0.00500
0.057	0.068	0.0464	0.0105	0.0254

BIOSWALE 104 STUDY
WET WEATHER MONITORING
Mean & Standard Deviation

TABLE 2

PARAMETERS	BMP 104 IN		BMP 104 OUT	
	Composite		Composite	
	Mean	SD	Mean	SD
Total Suspended Solids	65.22	47.250	65.22	47.25
Total Dissolved Solids	232.40	327.440	232.40	327.44
Chemical Oxygen Demand	72.54	47.100	72.54	47.10
Biological Oxygen Demand	7.06	3.740	7.06	3.74
Chloride	115.94	238.820	116	238.82
Oil & Grease	ND	ND	ND	ND
pH	7.11	0.230	7.11	0.23
Total Kjeldahl Nitrogen	1.33	0.510	1.33	0.510
Ammonia	0.16	0.140	0.16	0.140
Total Phosphorus	0.29	0.120	0.29	0.120
Dissolved Phosphorus	1.88	3.770	1.88	3.770
Ortho-Phosphate	0.15	0.110	0.15	0.110
Total Cadmium	ND	ND	ND	ND
Total Copper	0.010	0.0100	0.011	0.0100
Total Lead	0.000	0.0000	0.000	0.0000
Total Zinc	0.040	0.0200	0.040	0.0200
	n = 5		n = 5	

n = number of samples collected

SD = Standard Deviation

ND = Not Detected: Parameter levels were less than laboratory equipment detection limit for all WWM Events

Mean calculation: For those parameters with levels less than and greater than the detection limit, the ND data were assumed to be one half of the limit of detection

TABLE 3

BMP 104 INDIVIDUAL STORM EVENT LOADS / EVENT MEAN CONCENTRATION

Bioswale 104 INPUT

Note: Oil and Grease not included because all samples below MDL

Storm No.	Date	Storm Flow Volume (cf)	Storm Flow Volume (L)	TSS			TDS			Chloride			TKN			Ammonia			Total P			Dissolved P			Ortho-P			Cadmium			Copper			Lead			Zinc		
				EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)
1	1/11/2012	2973.0	84186	135.0	11.37	25.06	1297.0	109.19	240.72	898.0	75.60	166.67	2.50	0.210	0.464	0.680	0.057	0.126	0.42	0.035	0.078	0.09	0.008	0.017	0.06	0.005	0.011	0.00014	0.000	0.000	0.045	0.0038	0.0084	0.0009	0.0001	0.0002	0.186	0.0157	0.0345
2	5/9/2012	506.0	14328	88.0	1.26	2.78	66.0	0.95	2.08	16.4	0.23	0.52	1.21	0.017	0.038	0.025	0.000	0.001	0.21	0.003	0.007	0.13	0.002	0.004	0.06	0.001	0.002	0.00014	0.000	0.000	0.025	0.0004	0.0008	0.0009	0.0000	0.0000	0.092	0.0013	0.0029
3	7/15/2012	1114.0	31545	212.0	6.69	14.74	157.0	4.95	10.92	14.6	0.46	1.02	3.92	0.124	0.273	0.612	0.019	0.043	0.751	0.024	0.052	0.385	0.012	0.027	0.54	0.017	0.038	0.00026	0.000	0.000	0.0374	0.0012	0.0026	0.0061	0.0002	0.0004	0.154	0.0049	0.0107
4	10/19/2012	6484.0	183606	39.0	7.16	15.79	95.0	17.44	38.45	13.7	2.52	5.55	1.70	0.312	0.688	0.025	0.005	0.010	0.272	0.050	0.110	0.27	0.050	0.109	0.17	0.031	0.069	0.00014	0.000	0.000	0.0181	0.0033	0.0073	0.0130	0.0024	0.0053	0.0441	0.0081	0.0179
5	12/20/2012	1623.0	45958	54.0	2.48	5.47	82.0	3.77	8.31	12.7	0.58	1.29	1.44	0.066	0.146	0.025	0.001	0.003	0.187	0.009	0.019	0.0586	0.003	0.006	0.07	0.003	0.007	0.00008	0.000	0.000	0.0332	0.0015	0.0034	0.0053	0.0002	0.0005	0.0583	0.0027	0.0059
Average EMC In				**105.6**			**339.4**			**191.1**			**2.15**			**0.273**			**0.37**			**0.19**			**0.18**			**0.000152**			**0.032**			**0.0052**			**0.107**		
Sum of Loads In					**28.96**	**63.84**		**136.30**	**300.49**		**79.39**	**175.03**		**0.730**	**1.609**		**0.083**	**0.182**		**0.121**	**0.266**		**0.074**	**0.163**		**0.057**	**0.126**		**0.000**	**0.000**		**0.010**	**0.022**		**0.003**	**0.006**		**0.033**	**0.072**

Bioswale 104 OUTPUT

Note: Oil and Grease not included because all samples below MDL

Storm No.	Date	Storm Flow Volume (cf)	Storm Flow Volume (L)	TSS			TDS			Chloride			TKN			Ammonia			Total P			Dissolved P			Ortho-P			Cadmium			Copper			Lead			Zinc		
				EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)
1	1/11/2012	4701.0	133117	77.0	10.25	22.60	811.0	107.96	238.01	543.0	72.28	159.36	1.22	0.162	0.358	0.410	0.055	0.120	0.24	0.032	0.070	0.10	0.013	0.029	0.09	0.012	0.026	0.00014	0.000	0.000	0.018	0.0024	0.0053	0.0009	0.0001	0.0003	0.057	0.0076	0.0167
2	5/9/2012	913.0	25853	140.3	3.63	8.00	27.0	0.70	1.54	1.18	0.03	0.07	1.33	0.034	0.076	0.025	0.001	0.001	0.25	0.006	0.014	*	0.000	0.000	0.06	0.002	0.003	0.00014	0.000	0.000	0.018	0.0005	0.0010	0.0009	0.0000	0.0001	0.068	0.0018	0.0039
3	7/15/2012	1867.8	52890	49.8	2.63	5.81	157.0	8.30	18.31	16.4	0.87	1.91	2.12	0.112	0.247	0.025	0.001	0.003	0.479	0.025	0.056	0.305	0.016	0.036	0.32	0.017	0.037	0.00032	0.000	0.000	*	0.0000	0.0000	0.0021	0.0001	0.0002	0.0464	0.0025	0.0054
4	10/19/2012	2936.0	83138	16.0	1.33	2.93	114.0	9.48	20.89	14.1	1.17	2.58	1.29	0.107	0.236	0.025	0.002	0.005	0.328	0.027	0.060	0.276	0.023	0.051	0.20	0.017	0.037	0.00014	0.000	0.000	0.0096	0.0008	0.0018	0.0066	0.0005	0.0012	0.0096	0.0008	0.0018
5	12/20/2012	1507.0	42673	43.0	1.83	4.05	53.0	2.26	4.99	0.5	0.02	0.05	0.683	0.029	0.064	0.025	0.001	0.002	0.169	0.007	0.016	0.088	0.004	0.008	0.10	0.004	0.009	0.00008	0.000	0.000	0.0055	0.0002	0.0005	0.0010	0.0000	0.0001	0.0055	0.0002	0.0005
Average EMC In				**65.2**			**232.4**			**115.0**			**1.33**			**0.102**			**0.29**			**0.19**			**0.15**			**0.00016**			**0.013**			**0.0023**			**0.037**		
Sum of Loads In					**19.68**	**43.38**		**128.70**	**283.73**		**74.37**	**163.97**		**0.445**	**0.982**		**0.060**	**0.132**		**0.098**	**0.217**		**0.056**	**0.124**		**0.051**	**0.113**		**0.000**	**0.000**		**0.004**	**0.009**		**0.001**	**0.002**		**0.013**	**0.028**

Storm No.	Date	TSS			TDS			Chloride			TKN			Ammonia			Total P			Dissolved P			Ortho-P			Cadmium			Copper			Lead			Zinc		
		Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)
1	1/11/2012	43.0	1.12	2.46	37.5	1.23	2.71	39.5	3.32	7.31	51.2	0.05	0.11	39.71	0.00	0.01	42.9	0.00	0.01	-11.1	-0.01	-0.01	-50.0	-0.01	-0.02	0.00	0.00	0.00	60.0	0.00	0.00	0.00	0.00	0.00	69.4	0.01	0.02
2	5/9/2012	-59.4	-2.37	-5.22	59.1	0.25	0.55	92.8	0.20	0.45	-9.9	-0.02	-0.04	0.00	0.00	0.00	-19.0	0.00	-0.01	#VALUE!	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	28.0	0.00	0.00	0.00	0.00	0.00	26.1	0.00	0.00
3	7/15/2012	76.5	4.05	8.94	0.0	-3.35	-7.39	-12.3	-0.41	-0.90	45.9	0.01	0.03	95.92	0.02	0.04	36.2	0.00	0.00	20.8	0.00	-0.01	40.7	0.00	0.00	-24.71	0.00	0.00	#VALUE!	0.00	0.00	65.57	0.00	0.00	69.9	0.00	0.01
4	10/19/2012	59.0	5.83	12.85	-20.0	7.96	17.56	-2.9	1.34	2.96	24.1	0.20	0.45	0.00	0.00	0.01	-20.6	0.02	0.05	-2.2	0.03	0.06	-17.6	0.01	0.03	0.00	0.00	0.00	47.0	0.00	0.01	49.23	0.00	0.00	78.2	0.01	0.02
5	12/20/2012	20.4	0.65	1.43	35.4	1.51	3.32	96.1	0.56	1.24	52.6	0.04	0.08	0.00	0.00	0.00	9.6	0.00	0.00	-50.2	0.00	0.00	-42.9	0.00	0.00	0.00	0.00	0.00	83.4	0.00	0.00	100.43	0.00	0.00	90.6	0.00	0.01
Efficiency Ratio		**38.2**			**31.5**			**39.8**			**38.3**			**62.6920263**			**20.3**			**-3.0**			**14.4**			**-8.437705999**			**59.8**			**56.11**			**65.1**		
SOL Efficiency				**32.0**			**5.6**			**6.3**			**39.0**			**27.8**			**18.5**			**24.0**			**10.5**			**-5.9**			**61.7**			**71.0**			**60.6**

Indicates values were below reporting limits therefore half the DL was used for analysis

Indicates value missing from laboratory analysis

TABLE 4

Bioswale 104 Pollutant Removal Efficiency Ratios

Parameter	Average Inlet EMC (mg/L)	Average Outlet EMC (mg/L)	Efficiency Ratio
TSS	105.60	65.22	38%
TDS	339.40	232.40	32%
Chloride	191.08	115.04	40%
TKN	2.15	1.33	38%
Ammonia	0.273	0.102	63%
Total P	0.37	0.29	20%
Dissolved P	0.187	0.192	-3%
Ortho-P	0.180	0.154	14%
Cadmium	0.000	0.000	-8%
Copper	0.032	0.013	60%
Lead	0.005	0.002	56%
Zinc	0.107	0.037	65%

Note: Oil and Grease not included because all samples below MDL

TABLE 5

Bioswale 104 Sum of Loads Efficiency

Parameter	Sum of Inlet Loads (lbs)	Sum of Outlet Loads (lbs)	SOL Efficiency
TSS	63.84	43.38	32%
TDS	300.49	283.73	6%
Chloride	175.03	163.97	6%
TKN	1.61	0.98	39%
Ammonia	0.18	0.13	28%
Total P	0.27	0.22	19%
Dissolved P	0.163	0.124	24%
Ortho-P	0.126	0.113	10%
Cadmium	0.000	0.000	-6%
Copper	0.022	0.009	62%
Lead	0.006	0.002	71%
Zinc	0.072	0.028	61%

Note: Oil and Grease not included because all samples below MDL

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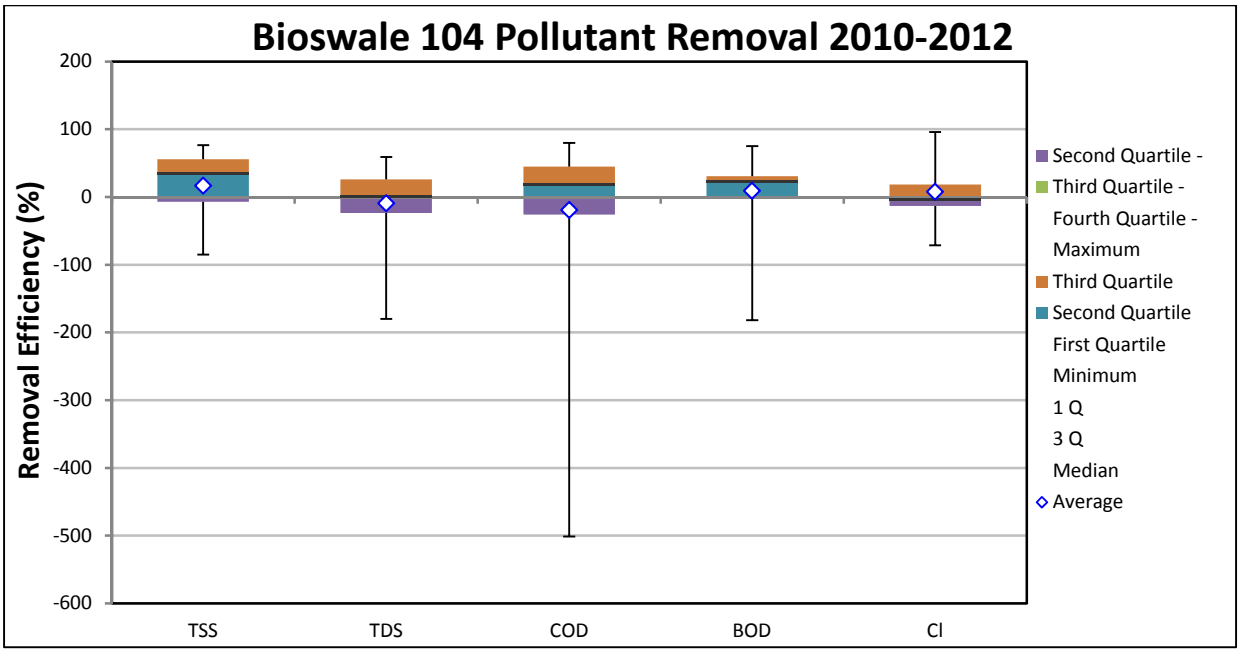
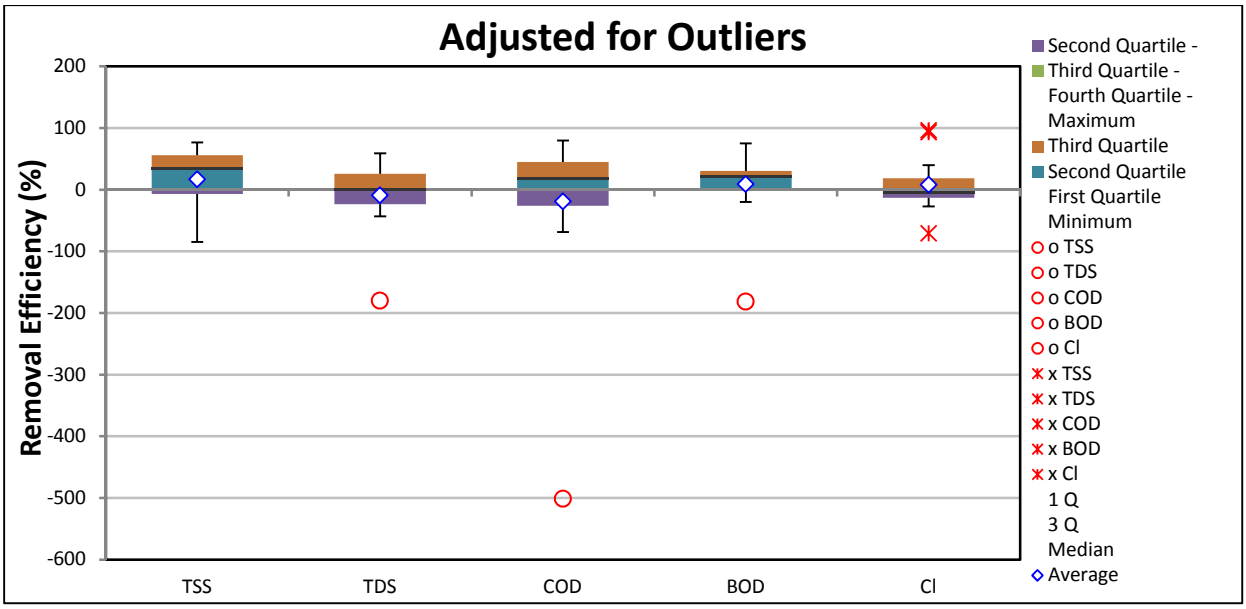
APPENDIX B

BIOSWALE 104 STUDY

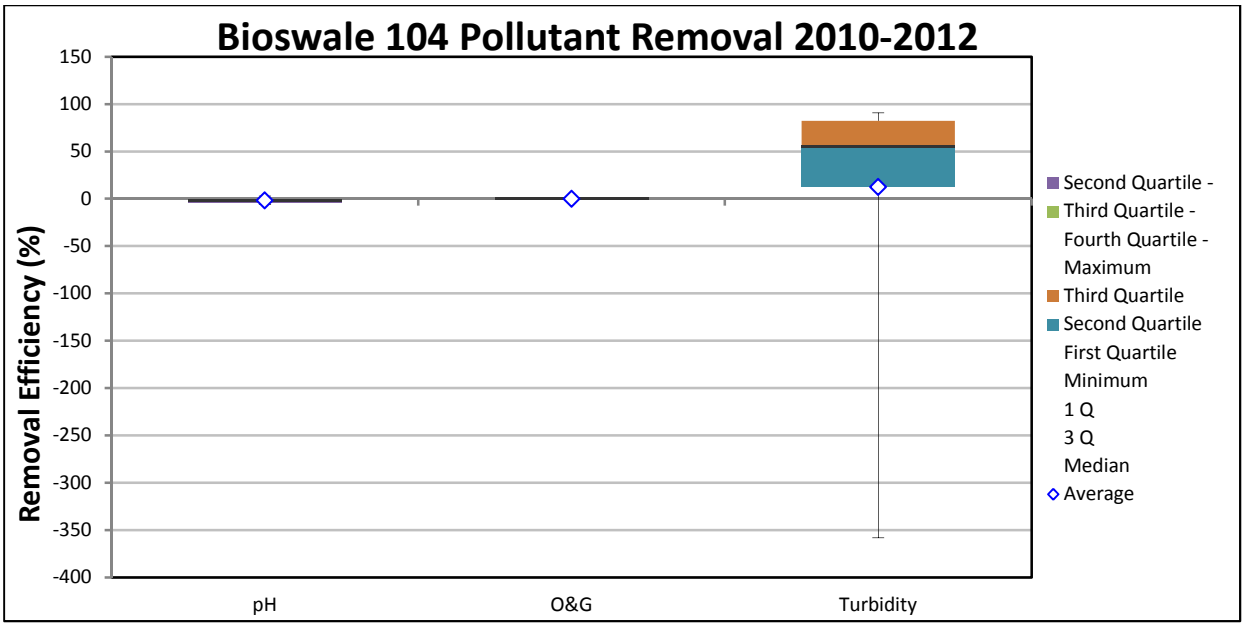
BOX AND WHISKER PLOTS

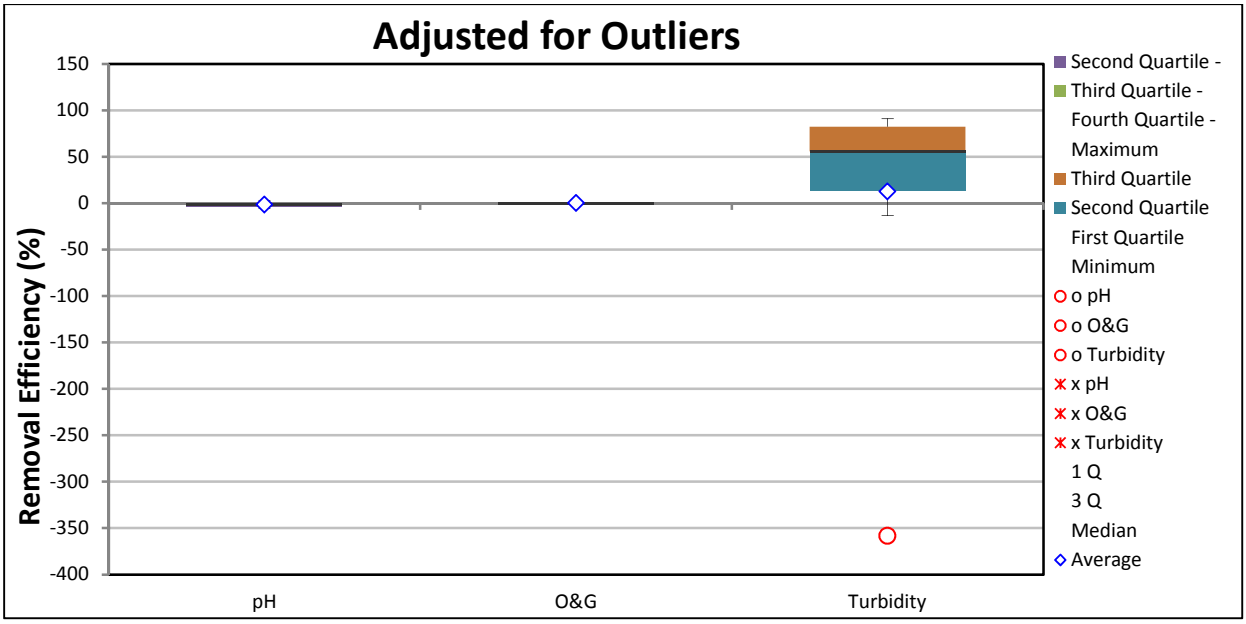
- **POLLUTANT REMOVAL EFFICIENCY: 2010-2012**
- **EVENT MEAN CONCENTRATIONS: 2012**





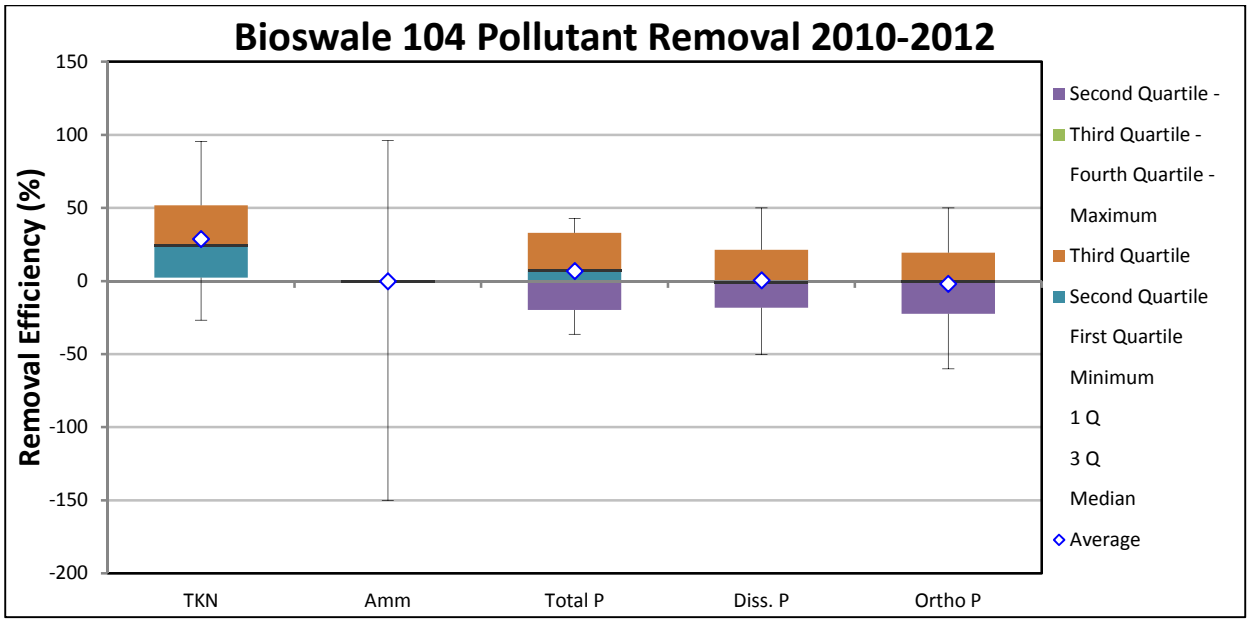
Removal Efficiency Statistical Data					
	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Chemical Oxygen Demand (COD)	Biological Oxygen Demand (BOD)	Chloride (Cl)
Count	15	15	15	15	13
Min	-85.00	-180.00	-501.32	-181.67	-71.10
1 Q	-7.15	-23.55	-26.16	0.00	-13.29
Median	34.04	0.00	18.06	22.22	-3.81
3 Q	55.95	25.85	44.84	30.63	18.35
Max	76.51	59.09	79.70	75.00	96.06
Mean	16.71	-9.39	-18.99	9.10	7.67
SD	54.03	56.49	141.32	57.62	46.13

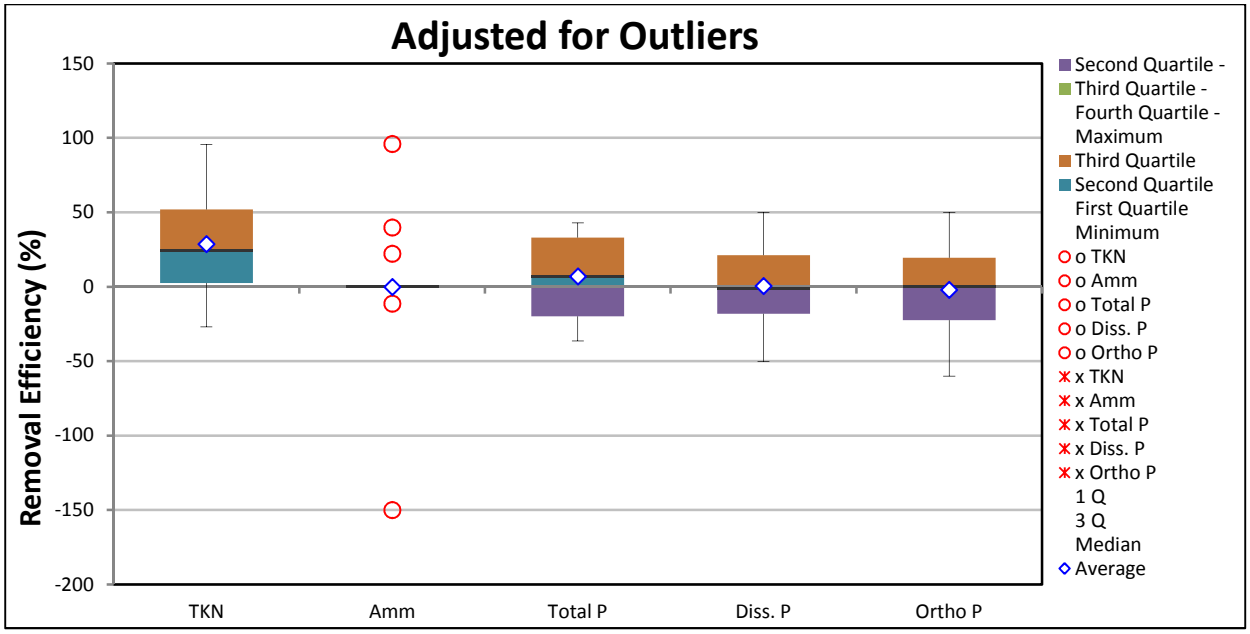




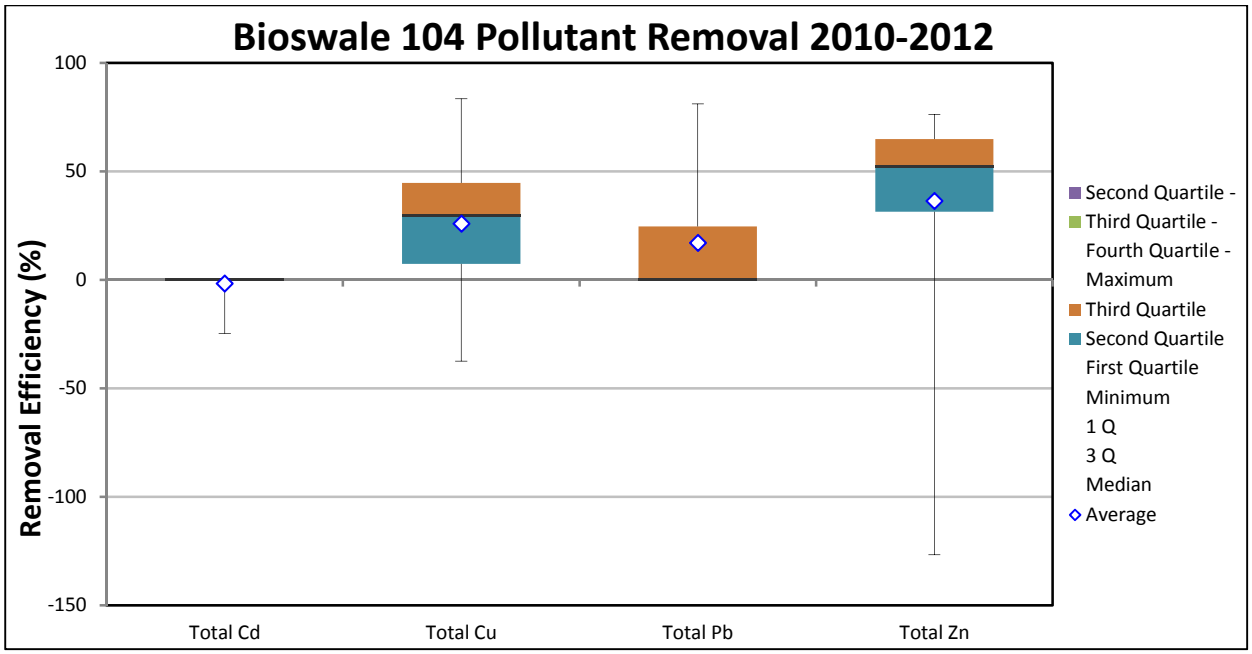
Removal Efficiency Statistical Data			
	pH	**Oil & Grease (O&G)**	**Turbidity**
Count	15	12	10
Min	-5.78	**ND**	-358.30
1 Q	-4.39	**ND**	13.12
Median	-1.38	**ND**	55.62
3 Q	0.71	**ND**	82.26
Max	2.92	**ND**	90.77
Mean	-1.63	**ND**	12.53
SD	3.16	**ND**	134.96

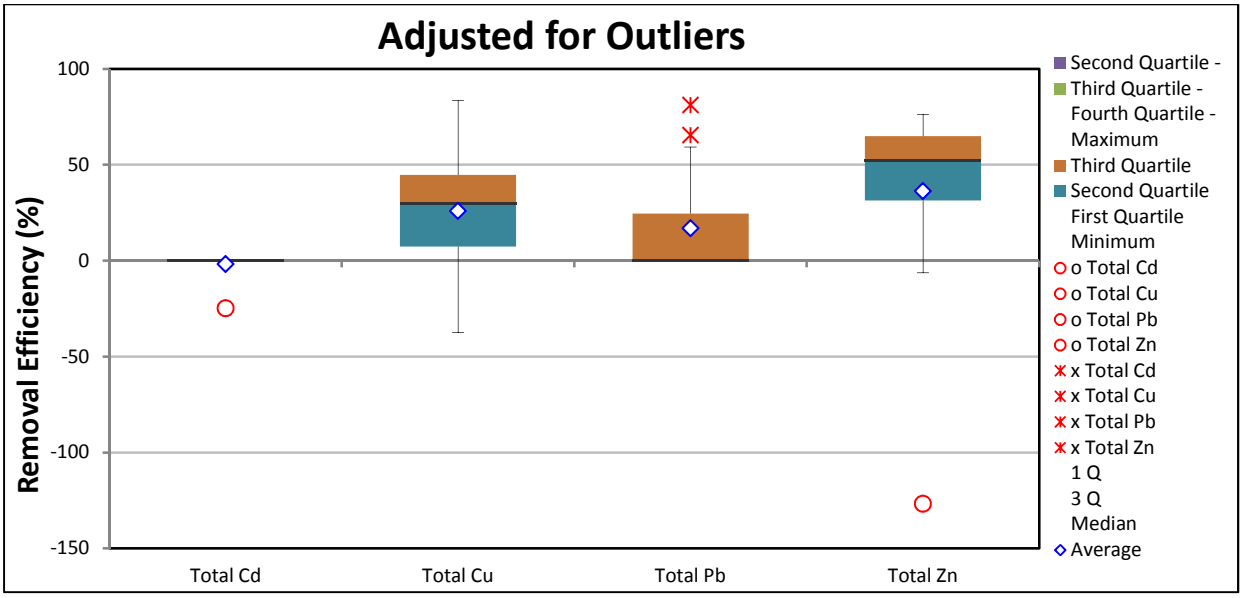
ND = Not Detected



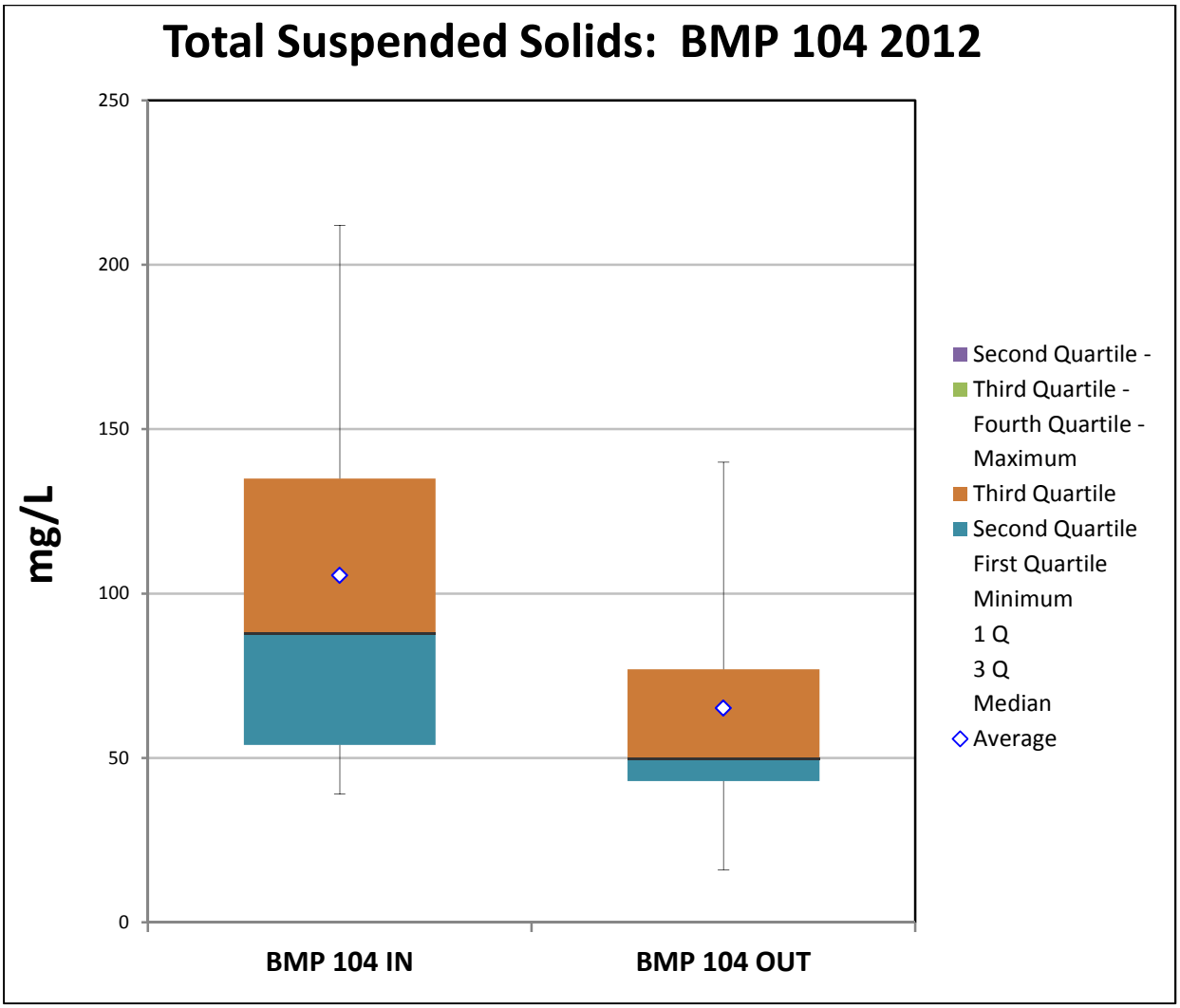


Removal Efficiency Statistical Data					
	Total Kjeldahl Nitrogen (TKN)	Ammonia (Amm)	Total Phosphorus (Total P)	Dissolved Phosphorus (Diss. P)	Ortho-Phosphate (Ortho P)
Count	15	15	15	14	15
Min	-26.87	-150.00	-36.36	-50.17	-60.00
1 Q	2.43	0.00	-19.82	-18.27	-22.46
Median	24.12	0.00	6.82	-1.11	0.00
3 Q	51.88	0.00	33.07	21.27	19.39
Max	95.48	95.92	42.86	50.00	50.00
Mean	28.64	-0.24	6.91	0.41	-2.05
SD	36.78	49.21	27.67	30.05	34.27



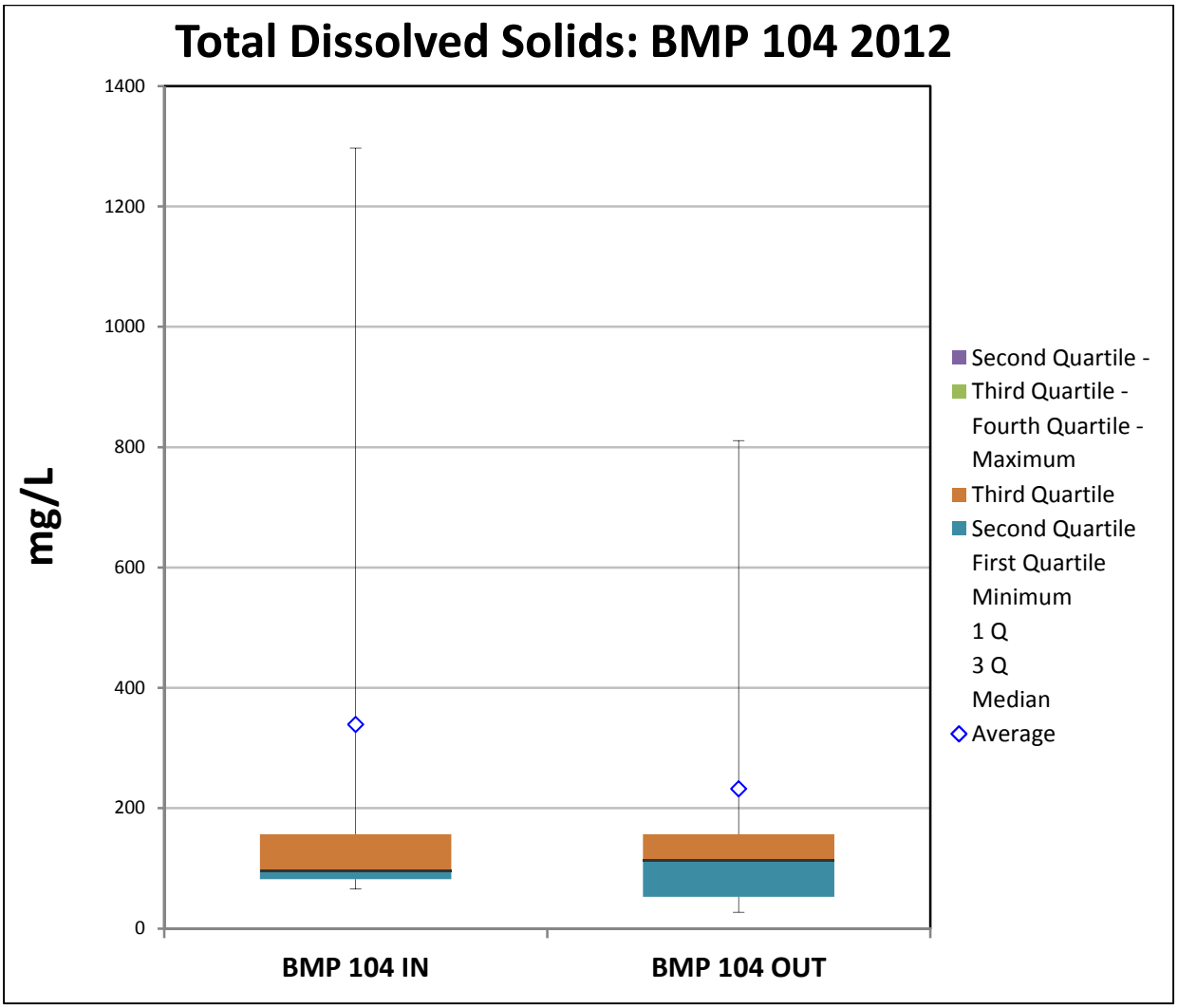


Statistical Data				
	Total Cadmium (Total Cd)	**Total Copper (Total Cu)**	**Total Lead (Total Pb)**	**Total Zinc (Total Zn)**
Count	15	14	15	15
Min	-24.71	-37.50	0.00	-126.67
1 Q	0.00	7.30	0.00	31.42
Median	0.00	29.79	0.00	52.38
3 Q	0.00	44.71	24.62	64.88
Max	0.00	83.43	81.13	76.19
Mean	-1.65	25.92	17.01	36.26
SD	6.38	30.97	29.85	50.32



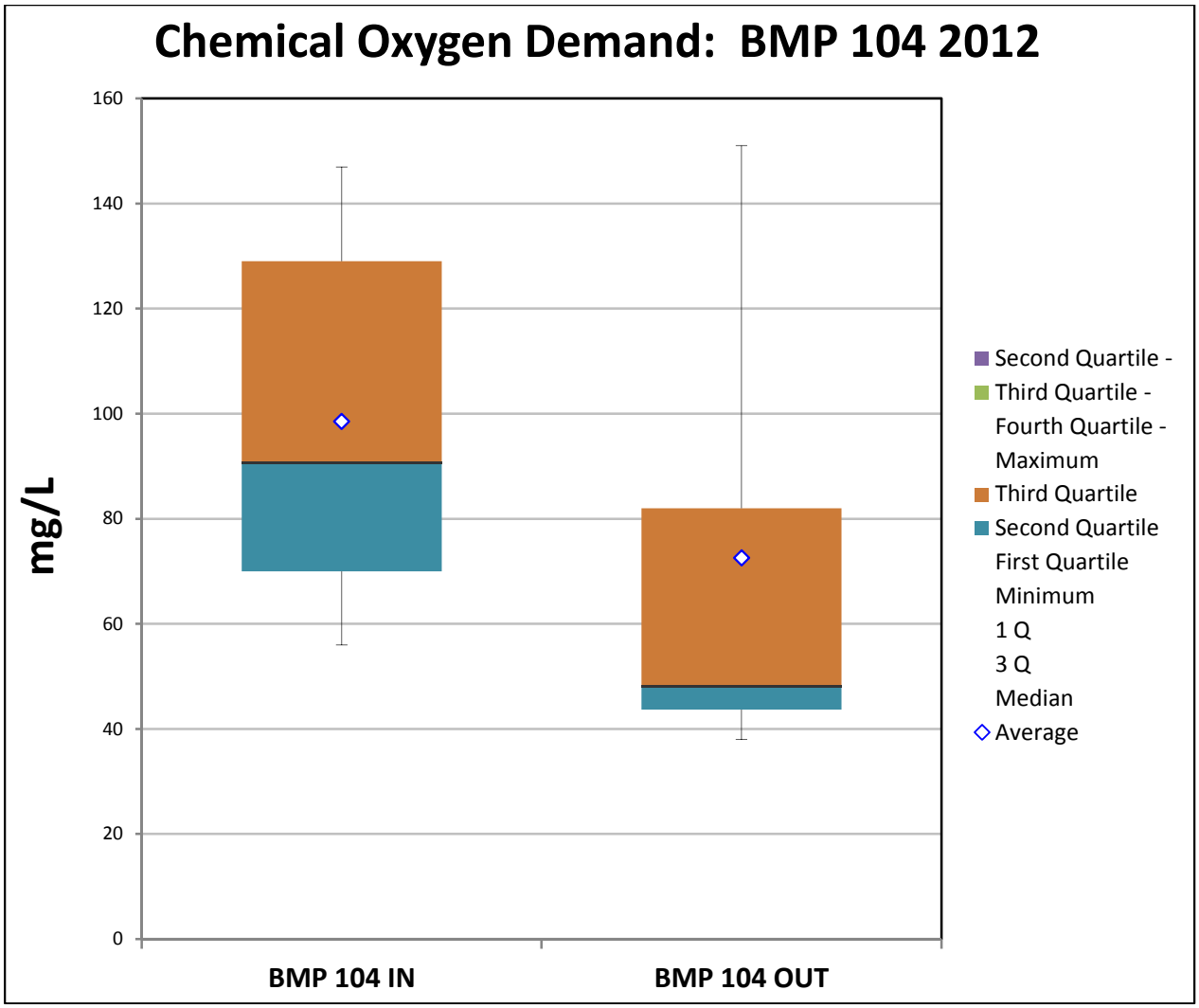
Statistical Data		
	BMP 104 IN	BMP 104 OUT
Count	5	5
Min	39	16
1 Q	54	43
Median	88	49.8
3 Q	135	77
Max	212	140
Mean	105.6	65.16
SD	69.98785609	47.12990558

Laboratory Data					
	1/11/2012	5/9/2012	7/15/2012	10/19/2012	12/20/2012
	mg/L	mg/L	mg/L	mg/L	mg/L
BMP 104 IN	135	88	212	39	54
BMP 104 OUT	77	140	49.8	16	43



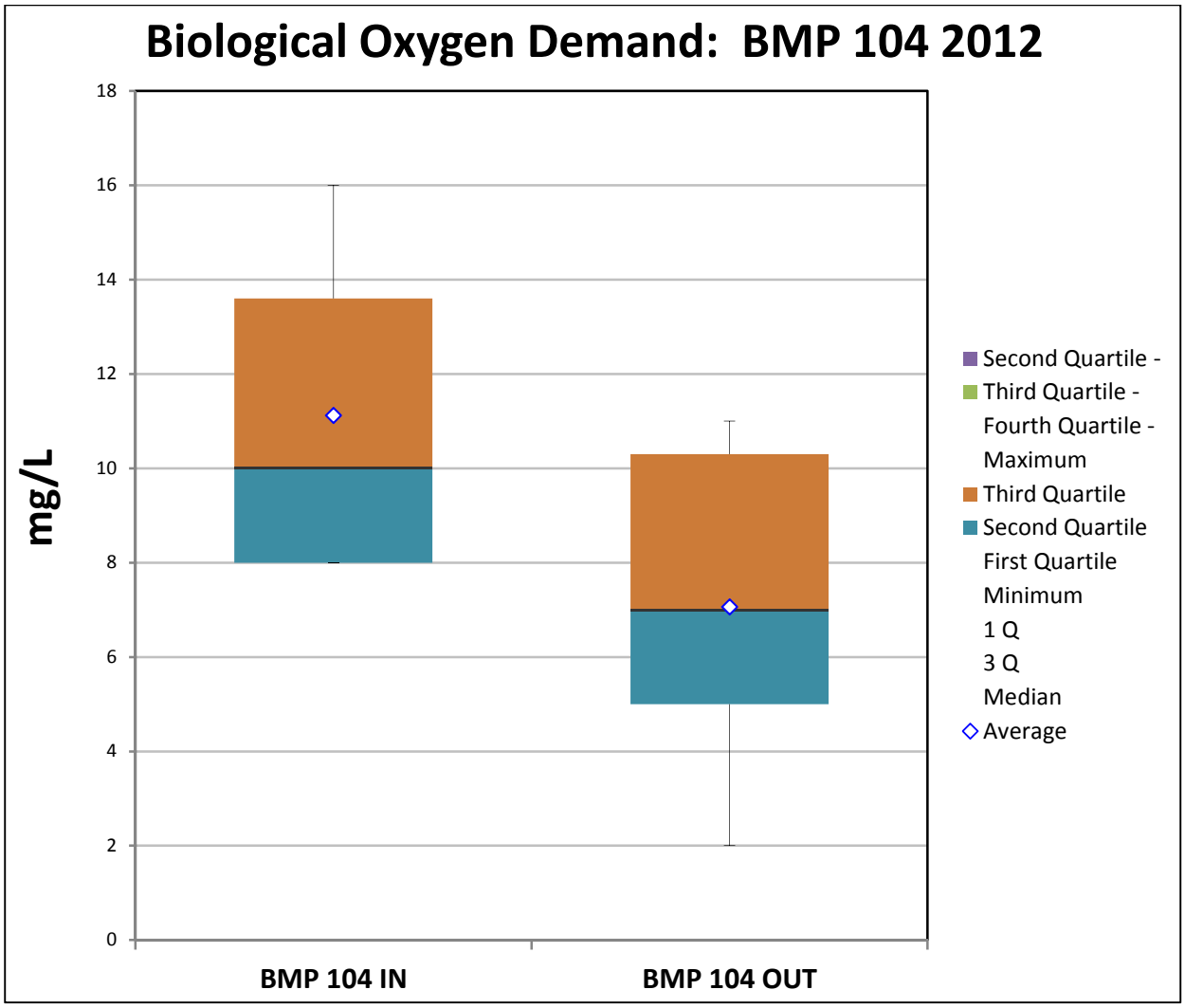
Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	66	27
1 Q	82	53
Median	95	114
3 Q	157	157
Max	1297	811
Mean	339.4	232.4
SD	536.4236199	327.4351844

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	1297	66	157	95	82
BMP 104 OUT	811	27	157	114	53



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	56	38
1 Q	70	43.7
Median	90.6	48
3 Q	129	82
Max	147	151
Mean	98.52	72.54
SD	38.61155268	47.09679395

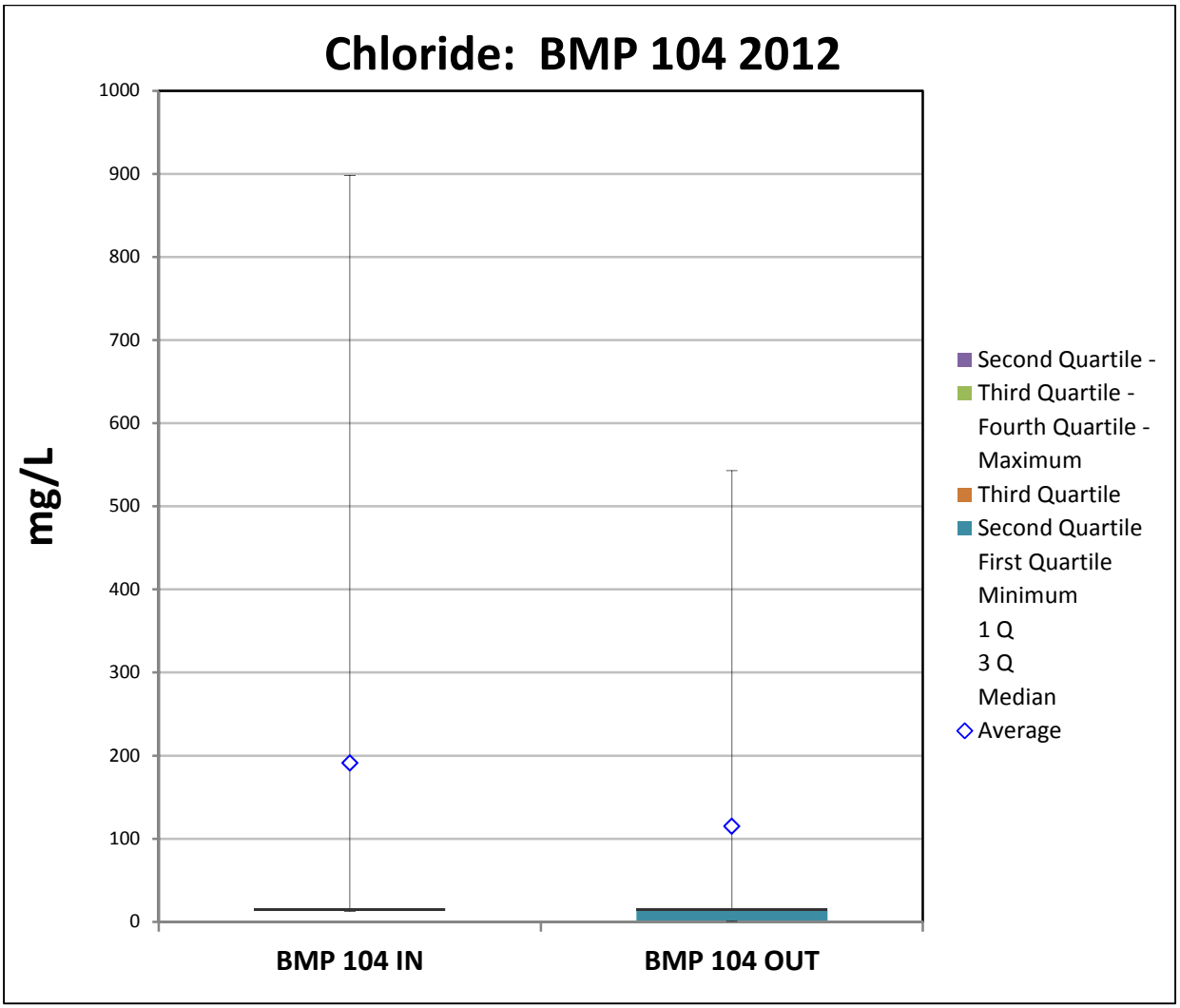
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	129	56	147	90.6	70
BMP 104 OUT	38	82	151	48	43.7



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	8	2
1 Q	8	5
Median	10	7
3 Q	13.6	10.3
Max	16	11
Mean	11.12	7.06
SD	3.559775274	3.737378761

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	13.6	8	16	10	8
BMP 104 OUT	10.3	7	11	5	**2**

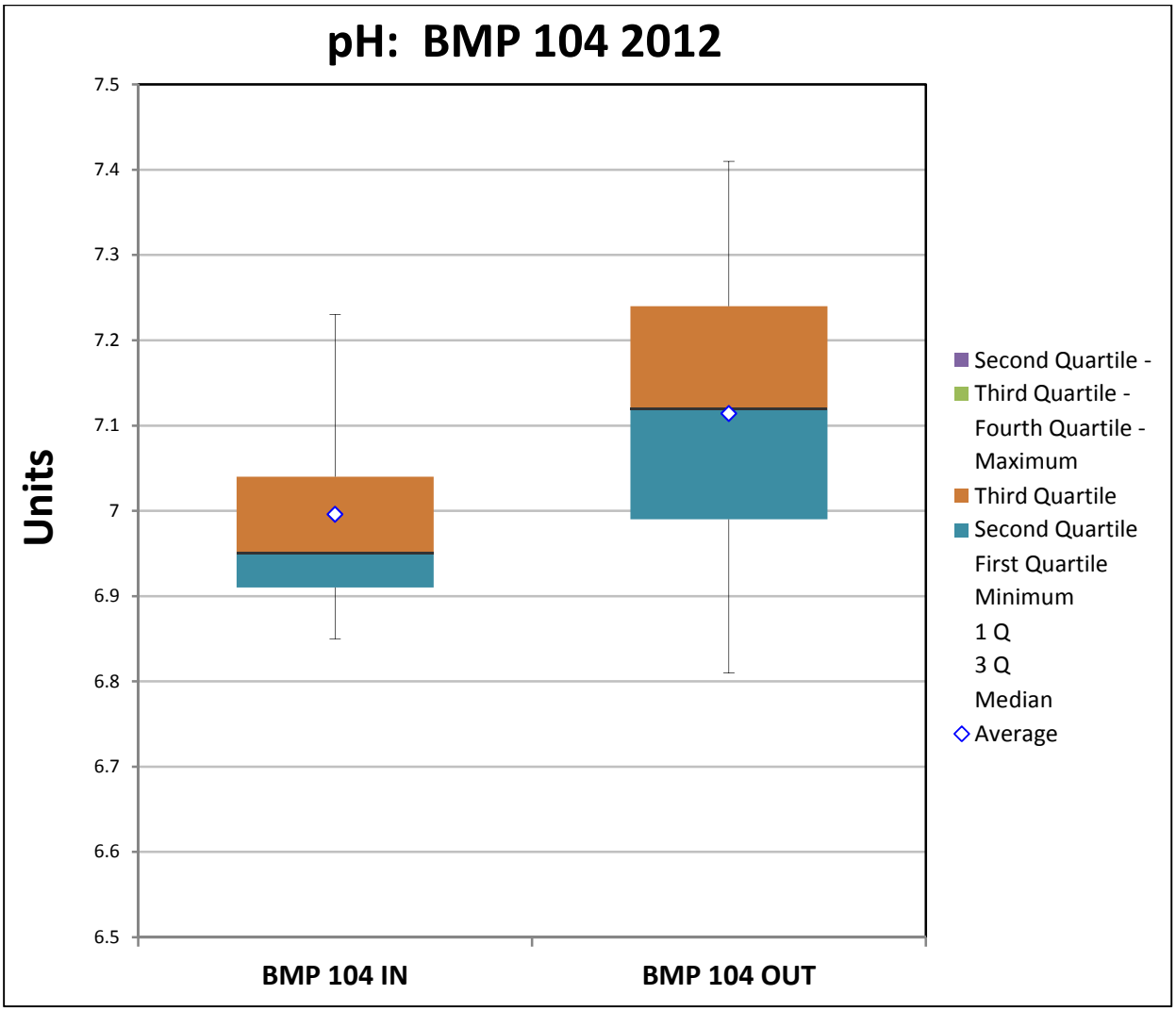
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	12.7	0.5
1 Q	13.7	1.18
Median	14.6	14.1
3 Q	16.4	16.4
Max	898	543
Mean	191.08	115.036
SD	395.1826375	239.3491205

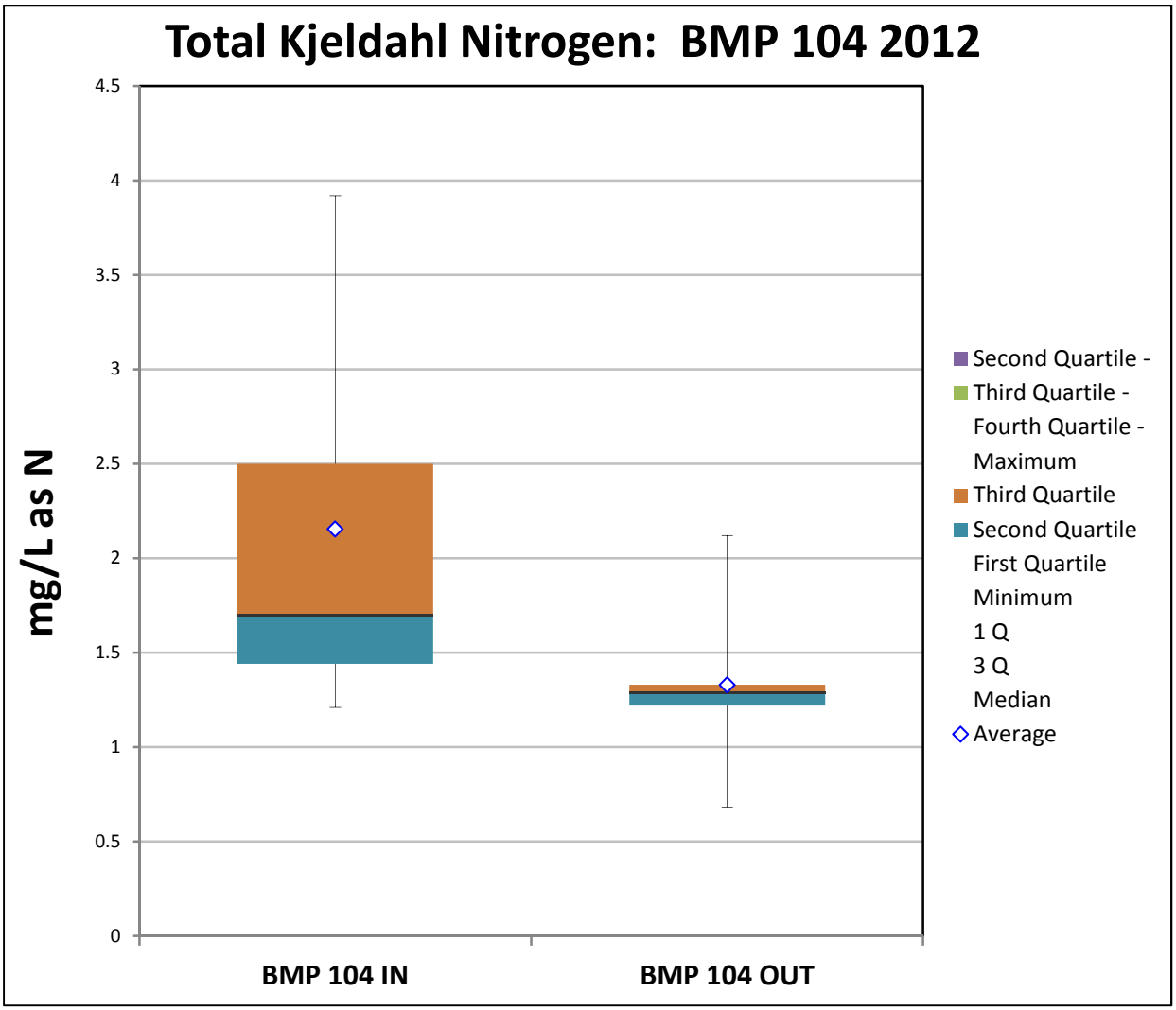
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	898	16.4	14.6	13.7	12.7
BMP 104 OUT	543	1.18	16.4	14.1	**0.5**

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



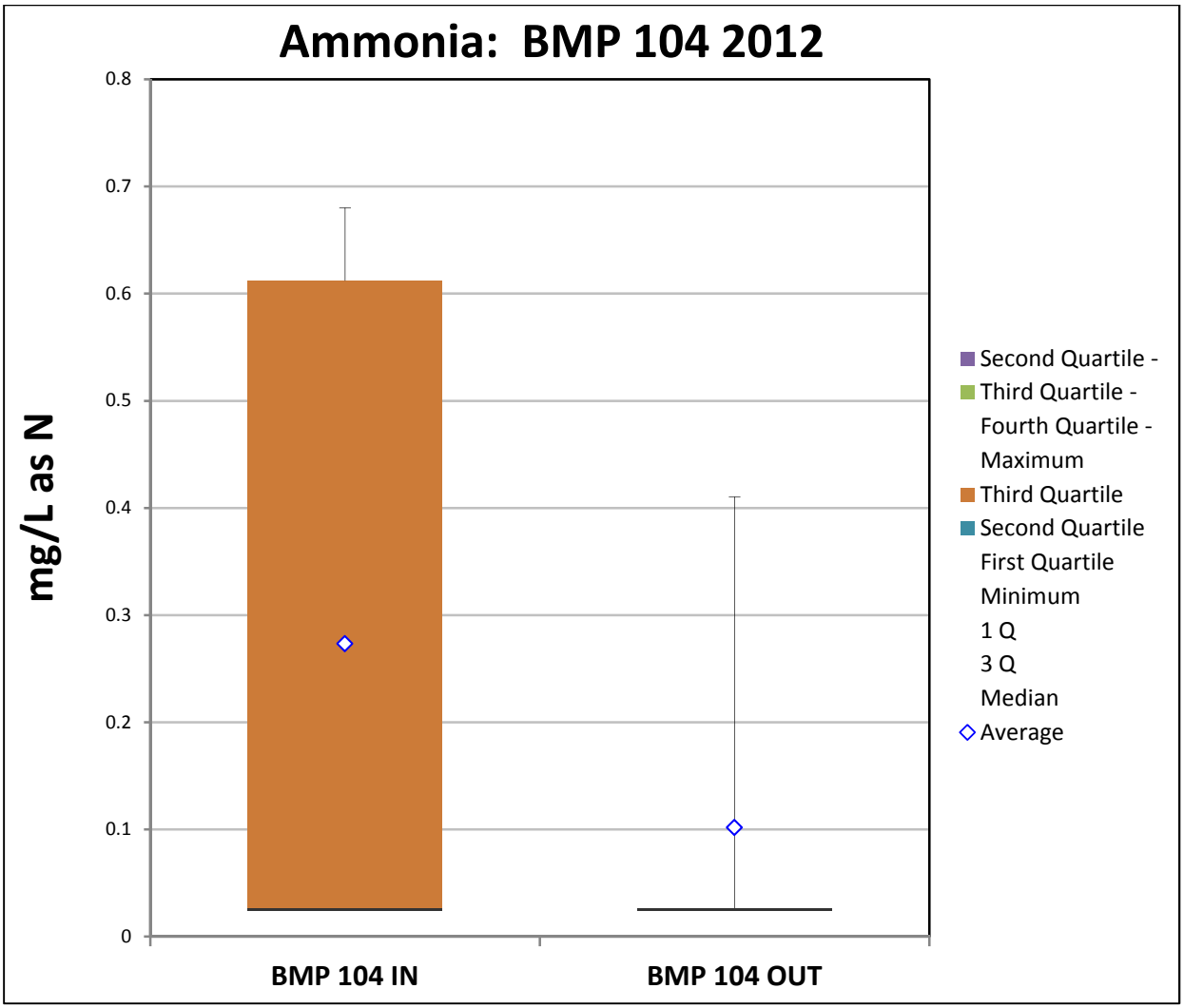
Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	6.85	6.81
1 Q	6.91	6.99
Median	6.95	7.12
3 Q	7.04	7.24
Max	7.23	7.41
Mean	6.996	7.114
SD	0.147918897	0.229847776

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	Units	**Units**	**Units**	**Units**	**Units**
BMP 104 IN	6.85	7.23	6.95	7.04	6.91
BMP 104 OUT	7.24	6.99	6.81	7.41	7.12



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	1.21	0.683
1 Q	1.44	1.22
Median	1.7	1.29
3 Q	2.5	1.33
Max	3.92	2.12
Mean	2.154	1.3286
SD	1.100627094	0.513906412

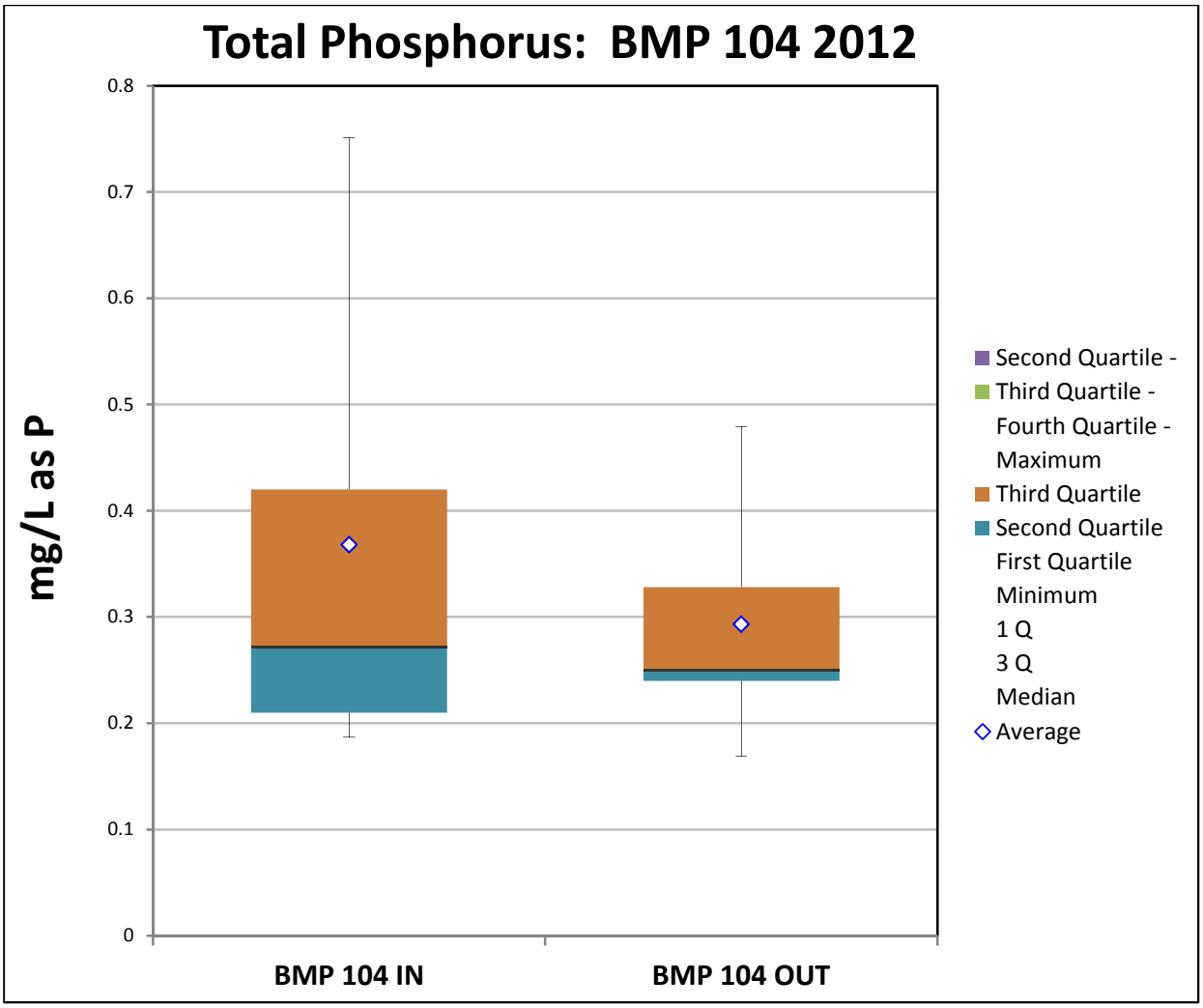
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	2.5	1.21	3.92	1.7	1.44
BMP 104 OUT	1.22	1.33	2.12	1.29	0.683



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	0.025	0.025
1 Q	0.025	0.025
Median	0.025	0.025
3 Q	0.612	0.025
Max	0.68	0.41
Mean	0.2734	0.102
SD	0.34098431	0.172177234

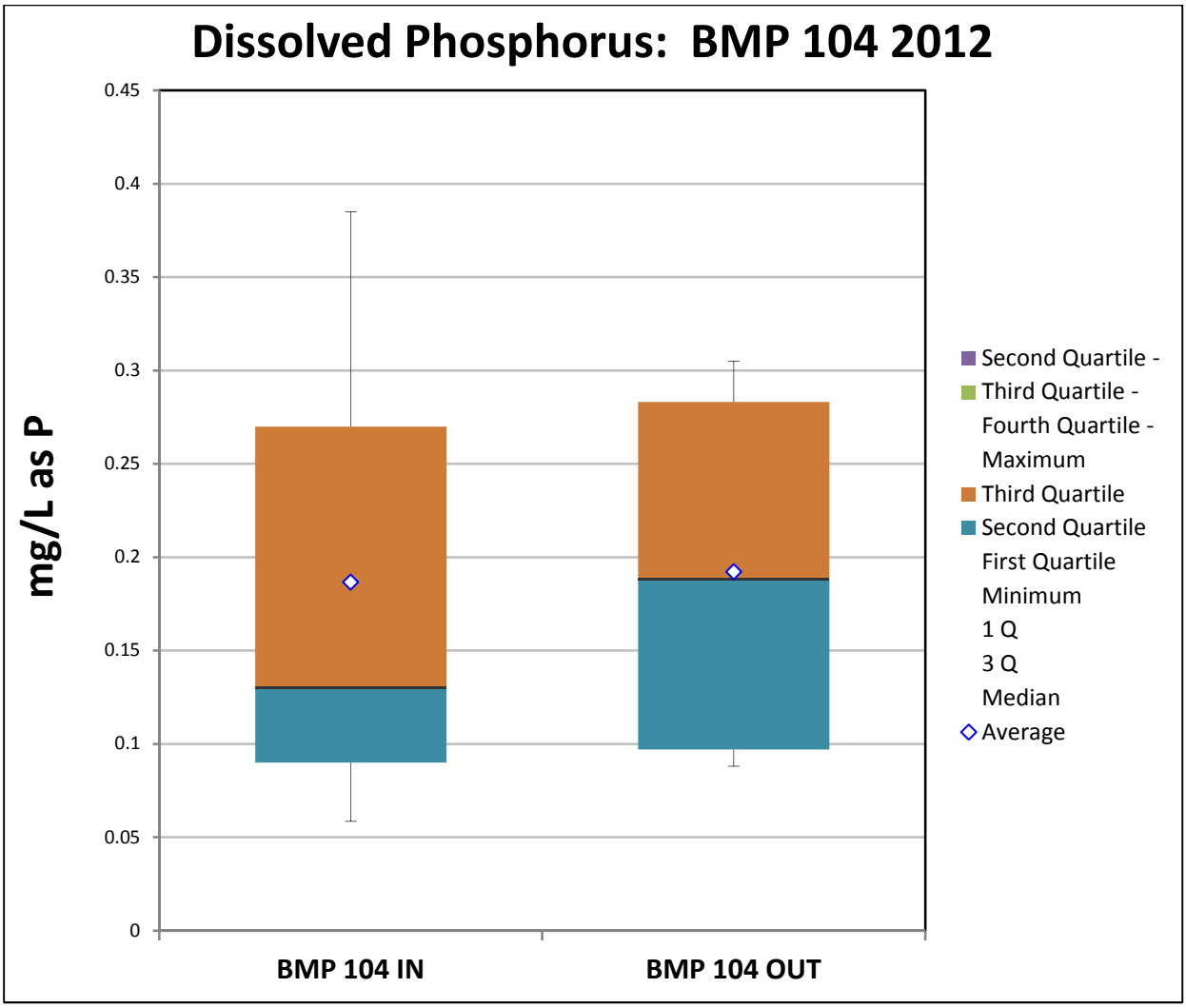
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	0.68	**0.025**	0.612	**0.025**	**0.025**
BMP 104 OUT	0.41	**0.025**	**0.025**	**0.025**	**0.025**

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	BMP 104 IN	BMP 104 OUT
Count	5	5
Min	0.187	0.169
1 Q	0.21	0.24
Median	0.272	0.25
3 Q	0.42	0.328
Max	0.751	0.479
Mean	0.368	0.2932
SD	0.232558595	0.118168101

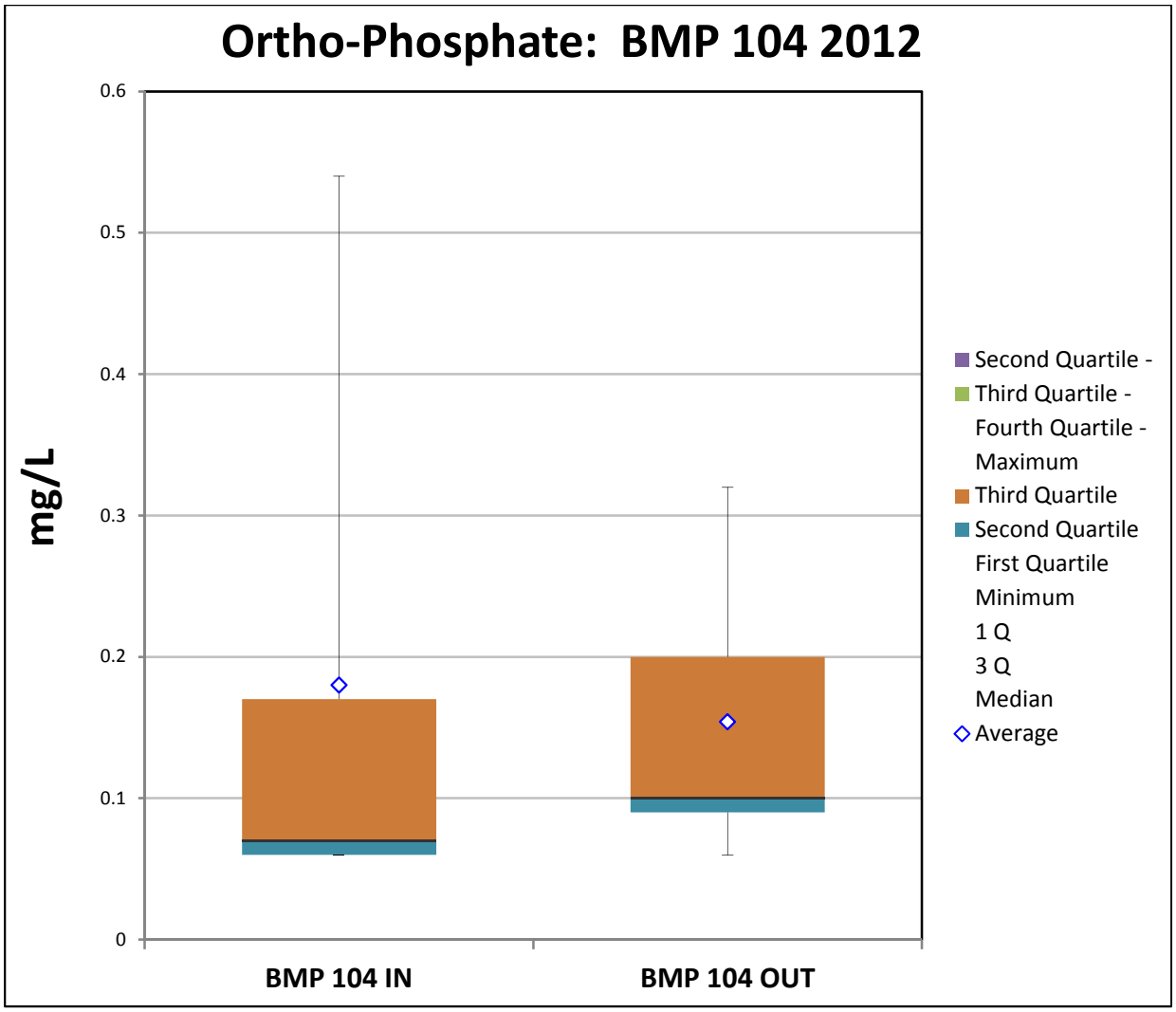
Laboratory Data					
	1/11/2012	5/9/2012	7/15/2012	10/19/2012	12/20/2012
	mg/L	mg/L	mg/L	mg/L	mg/L
BMP 104 IN	0.42	0.21	0.751	0.272	0.187
BMP 104 OUT	0.24	0.25	0.479	0.328	0.169



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	4
Min	0.0586	0.088
1 Q	0.09	0.097
Median	0.13	0.188
3 Q	0.27	0.28325
Max	0.385	0.305
Mean	0.18672	0.19225
SD	0.137146972	0.11417056

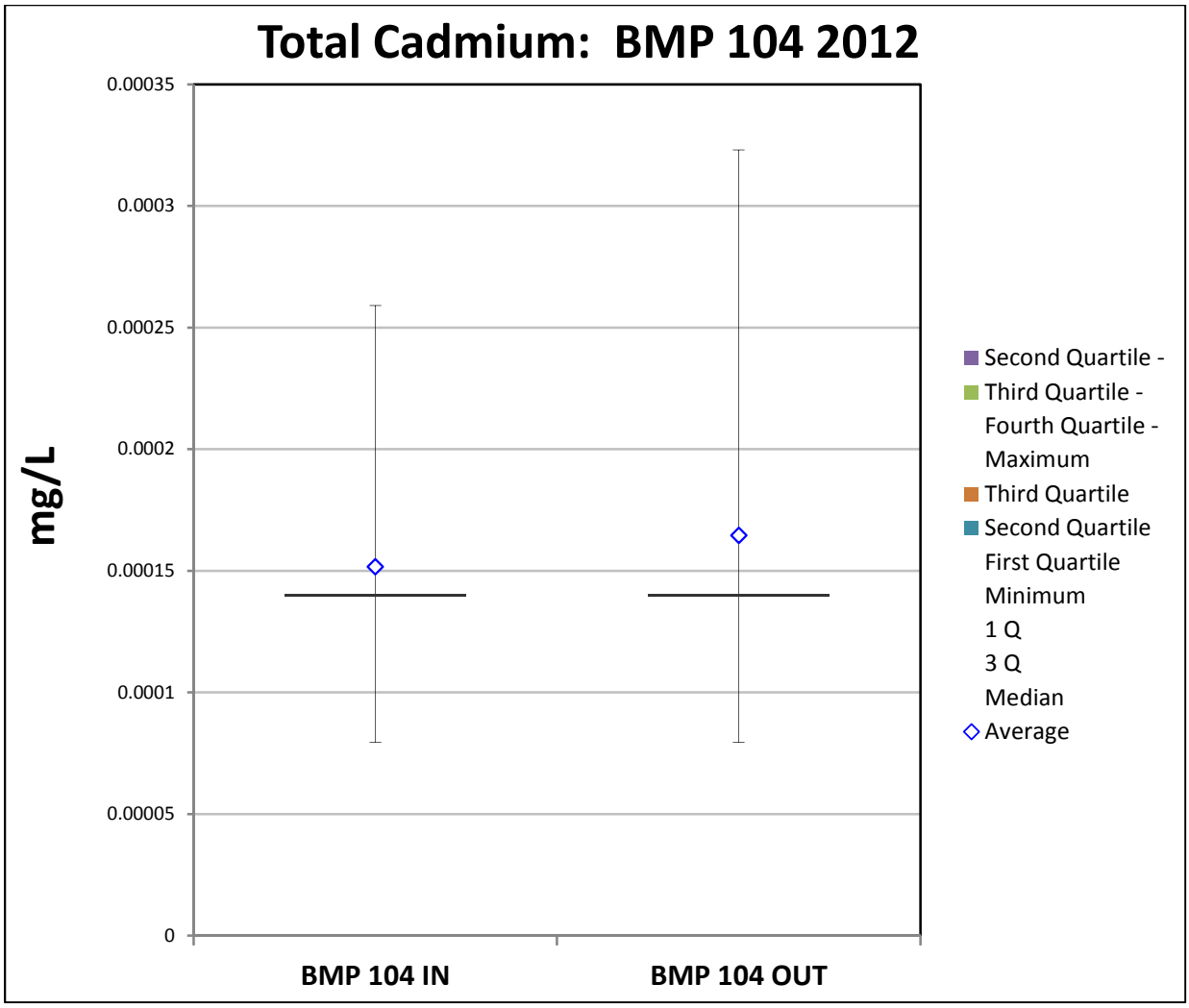
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	0.09	0.13	0.385	0.27	0.0586
BMP 104 OUT	0.1	**N/A**	0.305	0.276	0.088

Laboratory Error Occurred on 5/9/2012



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	0.06	0.06
1 Q	0.06	0.09
Median	0.07	0.1
3 Q	0.17	0.2
Max	0.54	0.32
Mean	0.18	0.154
SD	0.206518764	0.106677083

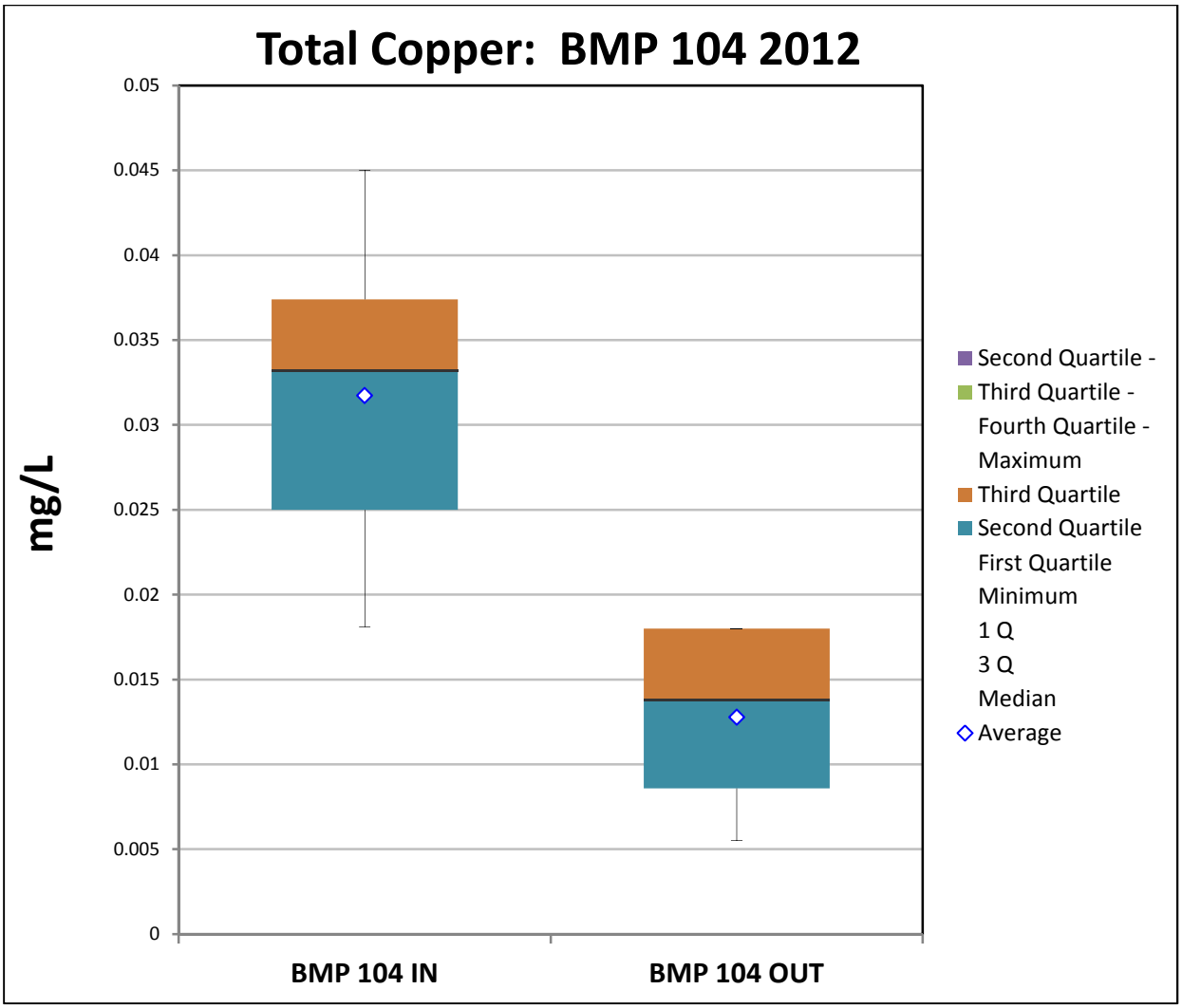
Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	0.06	0.06	0.54	0.17	0.07
BMP 104 OUT	0.09	0.06	0.32	0.2	0.1



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	0.0000795	5
Min	0.00014	0.0000795
1 Q	0.00014	0.00014
Median	0.00014	0.00014
3 Q	0.000259	0.00014
Max	0.0001517	0.000323
Mean	6.54538E-05	0.0001645
SD	0.000747005	9.23959E-05

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	**0.00014**	**0.00014**	0.000259	**0.00014**	**0.0000795**
BMP 104 OUT	**0.00014**	**0.00014**	0.000323	**0.00014**	**0.0000795**

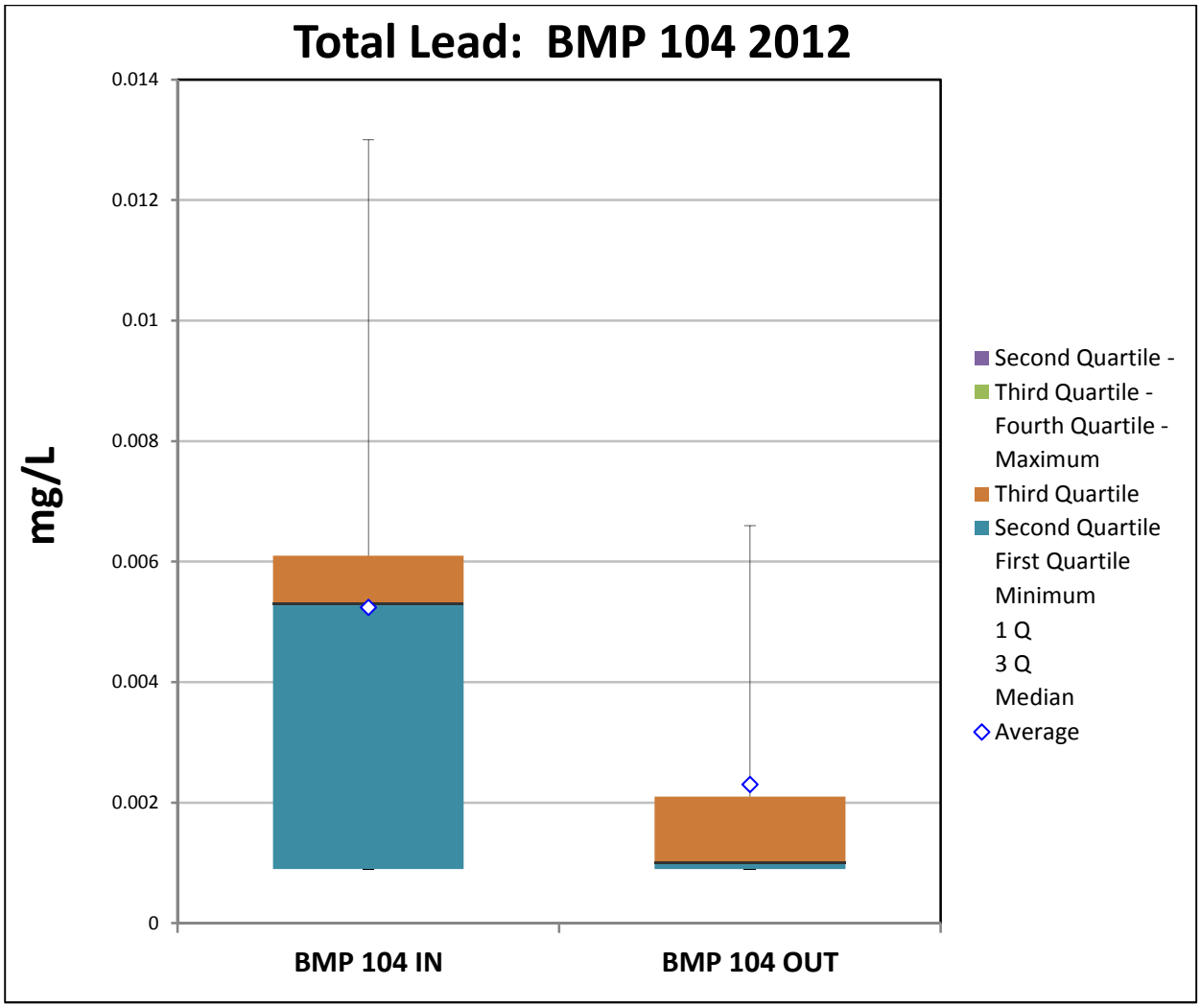
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	4
Min	0.0181	0.0055
1 Q	0.025	0.008575
Median	0.0332	0.0138
3 Q	0.0374	0.018
Max	0.045	0.018
Mean	0.03174	0.012775
SD	0.010505618	0.00626119

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	0.045	0.025	0.0374	0.0181	0.0332
BMP 104 OUT	0.018	0.018	**N/A**	0.0096	0.0055

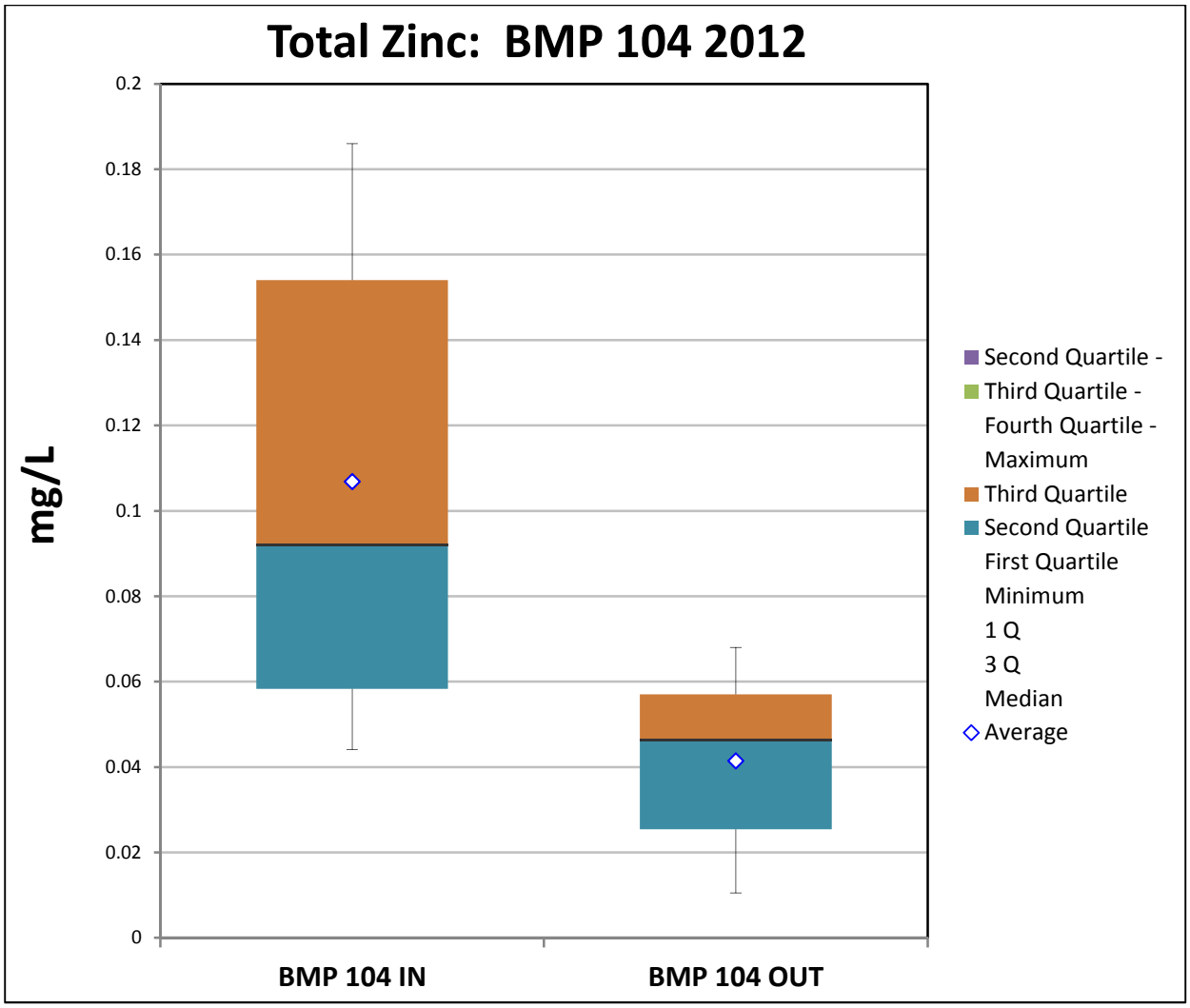
Laboratory Error Occurred on 7/15/2012



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	0.0009	0.0009
1 Q	0.0009	0.0009
Median	0.0053	0.001
3 Q	0.0061	0.0021
Max	0.013	0.0066
Mean	0.00524	0.0023
SD	0.004965682	0.002456624

Laboratory Data					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	**0.0009**	**0.0009**	0.0061	0.013	0.0053
BMP 104 OUT	**0.0009**	**0.0009**	0.0021	0.0066	**0.001**

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	BMP 104 IN	**BMP 104 OUT**
Count	5	5
Min	0.0441	0.0105
1 Q	0.0583	0.0254
Median	0.092	0.0464
3 Q	0.154	0.057
Max	0.186	0.068
Mean	0.10688	0.04146
SD	0.061243424	0.023381146

Total Zinc					
	1/11/2012	**5/9/2012**	**7/15/2012**	**10/19/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**
BMP 104 IN	0.186	0.092	0.154	0.0441	0.0583
BMP 104 OUT	0.057	0.068	0.0464	0.0105	0.0254

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APPENDIX C

ROUTE 299 STUDY

WWM LABORATORY DATA, STATISTICAL SUMMARY & BMP EFFICIENCY EVALUATION

- **Table 6A** RT 299 IN WWM Laboratory Data
- **Table 6B** RT 299 OUT WWM Laboratory Data
- **Table 7** RT 299 WWM Mean and Standard Deviation
- **Table 8** RT 299 Individual Storm Event Storm Loads/Event Mean Concentrations
- **Table 9** RT 299 Pollutant Removal Efficiency Ratios
- **Table 10** RT 299 Sum of Loads Efficiency

PARAMETER	Units	TABLE 6A WWM LABORATORY RESULTS ROUTE 299 IN			TABLE 6B WWM LABORATORY RESULTS ROUTE 299 OUT		
		04/22/12	09/18/12	12/20/12	04/22/12	09/18/12	12/20/12
		COMP	COMP	COMP	COMP	COMP	COMP
TOTAL SUSPENDED SOLIDS	mg/L	30	138.0	8.8	13.2	32.0	12.0
TOTAL DISSOLVED SOLIDS	mg/L	<11	37.0	21	99	62.0	63.0
CHEMICAL OXYGEN DEMAND	mg/L	19	50.7	36.9	84	80.0	47.3
BIOLOGICAL OXYGEN DEMAND	mg/L	<4	<4	<4.00	<4	12.0	<4.00
CHLORIDE	mg/L	8.30	2.90	<10.0	38.40	6.15	10.50
OIL & GREASE	mg/L	<5	<5	<5.00	<5	<5	<5.00
pH	units	7.07	6.71	6.95	7.12	6.53	6.85
TOTAL KJELDAHL NITROGEN	mg/L as N	0.52	<0.200	0.490	1.36	2.47	0.968
AMMONIA	mg/L as N	<0.2	<0.200	<0.200	<0.2	<0.2	<0.200
TOTAL PHOSPHORUS	mg/L as P	<0.05	<0.0500	<0.0500	0.38	0.950	0.223
DISSOLVED PHOSPHORUS	mg/L as P	<0.05	<0.0500	<0.0500	0.27	0.788	0.175
ORTHO-PHOSPHATE	mg/L	<0.05	<0.0100	<0.0100	0.25	0.610	0.130
TOTAL CADMIUM	mg/L	<0.004	<0.00200	<0.00200	<0.004	0.00490	<0.00200
TOTAL COPPER	mg/L	0.031	<0.00500	<0.00500	0.007	0.00640	<0.00500
TOTAL LEAD	mg/L	<0.01	<0.00200	<0.00500	<0.01	<0.00200	<0.00500
TOTAL ZINC	mg/L	0.049	0.0393	0.023	0.018	0.0506	0.018
FIELD TURBIDITY	NTU	69.23	41.66	6.43	20.35	44.78	31.600

ROUTE 299 STUDY
WET WEATHER MONITORING
Mean & Standard Deviation

TABLE 7

PARAMETERS	BMP 104 IN		BMP 104 OUT	
	Composite		Composite	
	Mean	SD	Mean	SD
Total Suspended Solids	59.07	69.210	19.07	11.220
Total Dissolved Solids	21.17	15.750	74.67	21.080
Chemical Oxygen Demand	35.53	15.890	70.43	20.130
Biological Oxygen Demand	ND	ND	ND	ND
Chloride	5.40	2.72	18.35	17.500
Oil & Grease	ND	ND	ND	ND
pH	6.91	0.180	6.83	0.30
Total Kjeldahl Nitrogen	0.37	0.230	1.60	0.780
Ammonia	ND	ND	ND	ND
Total Phosphorus	ND	ND	0.52	0.380
Dissolved Phosphorus	ND	ND	0.41	0.330
Ortho-Phosphate	ND	ND	0.33	0.250
Total Cadmium	ND	ND	0.003	0.0020
Total Copper	0.012	0.0200	0.005	0.0024
Total Lead	ND	ND	ND	ND
Total Zinc	0.037	0.0100	0.029	0.0188
Field Turbidity	39.11	31.480	32.24	12.228
	n = 3		n = 3	

n = number of samples collected

SD = Standard Deviation

ND = Not Detected: Parameter levels were less than laboratory equipment detection limit for all WWM Events

Mean calculation: For those parameters with levels less than and greater than the detection limit, the ND data were assumed to be one half of the limit of detection

TABLE 8

ROUTE 299 INDIVIDUAL STORM EVENT LOADS / EVENT MEAN CONCENTRATIONS

RT 299 INPUT

Note: Ammonia, Cadmium, Lead, Oil & Grease not included because all samples below MDL

Storm No.	Date	Storm Flow Volume (cf)	Storm Flow Volume (L)	TSS			TDS			Chloride			TKN			Total P			Dissolved P			Ortho-P			Copper			Zinc		
				EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)
1	4/22/12 (COMP)	139.0	3936	30.0	0.12	0.26	5.5	0.02	0.05	8.3	0.03	0.07	0.52	0.002	0.005	0.005	0.000	0.000	0.005	0.000	0.000	0.005	0.000	0.000	0.031	0.0001	0.0003	0.049	0.0002	0.0004
2	9/18/12 (COMP)	118.0	3341	138.0	0.46	1.02	37.0	0.12	0.27	2.9	0.01	0.02	0.10	0.000	0.001	0.005	0.000	0.000	0.005	0.000	0.000	0.005	0.000	0.000	0.000175	0.0000	0.0000	0.0393	0.0001	0.0003
3	12/20/12 (COMP)	712.6	20179	8.8	0.18	0.39	21.0	0.42	0.93	1.0	0.02	0.04	0.49	0.010	0.022	0.005	0.000	0.000	0.005	0.000	0.000	0.005	0.000	0.000	0.000175	0.0000	0.0000	0.0227	0.0005	0.0010
Average EMC In				**58.9**			**21.2**			**4.1**			**0.37**			**0.01**			**0.01**			**0.01**			**0.010**			**0.037**		
Sum of Loads In					**0.64**	**1.41**		**0.55**	**1.21**		**0.03**	**0.07**		**0.010**	**0.023**		**0.000**	**0.000**		**0.000**	**0.000**		**0.000**	**0.000**		**0.000**	**0.000**		**0.001**	**0.001**

RT 299 OUTPUT

Note: Ammonia, Cadmium, Lead, Oil & Grease not included because all samples below MDL

Storm No.	Date	Storm Flow Volume (cf)	Storm Flow Volume (L)	TSS			TDS			Chloride			TKN			Total P			Dissolved P			Ortho-P			Copper			Zinc		
				EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)	EMC (mg/L)	Load (kg)	Load (lbs)
1	4/22/12 (COMP)	187.00	5295	13.2	0.07	0.15	99.0	0.52	1.16	38.4	0.20	0.45	1.36	0.007	0.016	0.38	0.002	0.004	0.27	0.001	0.003	0.25	0.001	0.003	0.007	0.0000	0.0001	0.018	0.0001	0.0002
2	9/18/12 (COMP)	509.00	14413	32.0	0.46	1.02	62.0	0.89	1.97	6.15	0.09	0.20	2.47	0.036	0.078	0.95	0.014	0.030	0.788	0.011	0.025	0.61	0.009	0.019	0.000174	0.0000	0.0000	0.0506	0.0007	0.0016
3	12/20/12 (COMP)	889.10	25176	12.0	0.30	0.67	63.0	1.59	3.50	10.5	0.26	0.58	0.968	0.024	0.054	0.22	0.006	0.012	0.09	0.002	0.005	0.13	0.003	0.007	0.000174	0.0000	0.0000	0.018	0.0005	0.0010
Average EMC In				**19.1**			**74.7**			**18.4**			**1.60**			**0.57**			**0.38**			**0.33**			**0.002**			**0.029**		
Sum of Loads In					**0.83**	**1.84**		**3.00**	**6.62**		**0.56**	**1.23**		**0.067**	**0.148**		**0.021**	**0.047**		**0.015**	**0.033**		**0.013**	**0.030**		**0.000**	**0.000**		**0.001**	**0.003**

Storm No.	Date	TSS			TDS			Chloride			TKN			Total P			Dissolved P			Ortho-P			Copper			Zinc		
		Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)	Eff. Ratio (%)	Reduction (kg)	Reduction (lbs)
1	4/22/12 (COMP)	56.0	N/A	N/A	-1700.0	N/A	N/A	-362.7	N/A	N/A	-161.5	N/A	N/A	-7500.0	N/A	N/A	-5300.0	N/A	N/A	-4900.0	N/A	N/A	77.4	N/A	N/A	63.3	N/A	N/A
2	9/18/12 (COMP)	76.8	0.00	0.00	-67.6	-0.77	-1.70	-112.1	-0.08	-0.17	-2370.0	-0.04	-0.08	-18900.0	-0.01	-0.03	-15660.0	-0.01	-0.03	-12100.0	-0.01	-0.02	0.6	0.00	0.00	-28.8	0.00	0.00
3	12/20/12 (COMP)	-36.4	-0.12	-0.27	-200.0	-1.16	-2.56	-950.0	-0.24	-0.54	-97.6	-0.01	-0.03	-4360.0	-0.01	-0.01	-1660.0	0.00	0.00	-2500.0	0.00	-0.01	0.6	0.00	0.00	20.7	0.00	0.00
Efficiency Ratio		**67.6**			**-252.8**			**-351.2**			**-332.3**			**-10253.3**			**-7540.0**			**-6500.0**			**76.6**			**22.0**		
SOL Efficiency				**-30.5**			**-448.8**			**-1762.6**			**-557.1**			**-18028.1**			**-12657.3**			**-11284.8**			**-967.9**			**-116.8**

Indicates values were below reporting limits therefore half the DL was used for analysis

TABLE 9

RT 299 Pollutant Removal Efficiency Ratios

Parameter	Average Inlet EMC (mg/L)	Average Outlet EMC (mg/L)	Efficiency Ratio
TSS	58.93	19.07	68%
TDS	19.33	74.67	-286%
Chloride	5.40	18.35	-240%
TKN	0.37	1.60	-332%
Total P	0.01	0.52	-1971%
Dissolved P	0.005	0.382	-1428%
Ortho-P	0.005	0.330	-2729%
Copper	0.010	0.002	77%
Zinc	0.037	0.029	22%

Note: Oil & Grease, Ammonia, Cadmium & Lead not included because all samples below MDL

TABLE 10

RT 299 Sum of Loads Efficiency

Parameter	Sum of Inlet Loads (lbs)	Sum of Outlet Loads (lbs)	SOL Efficiency
TSS	1.41	1.84	-30%
TDS	1.21	6.62	-449%
Chloride	0.24	1.23	-403%
TKN	0.02	0.15	-557%
Total P	0.00	0.05	-3526%
Dissolved P	0.000	0.033	-2451%
Ortho-P	0.000	0.030	-11285%
Copper	0.000	0.000	-968%
Zinc	0.001	0.003	-117%

Note: Oil & Grease, Ammonia, Cadmium & Lead not included because all samples below MDL

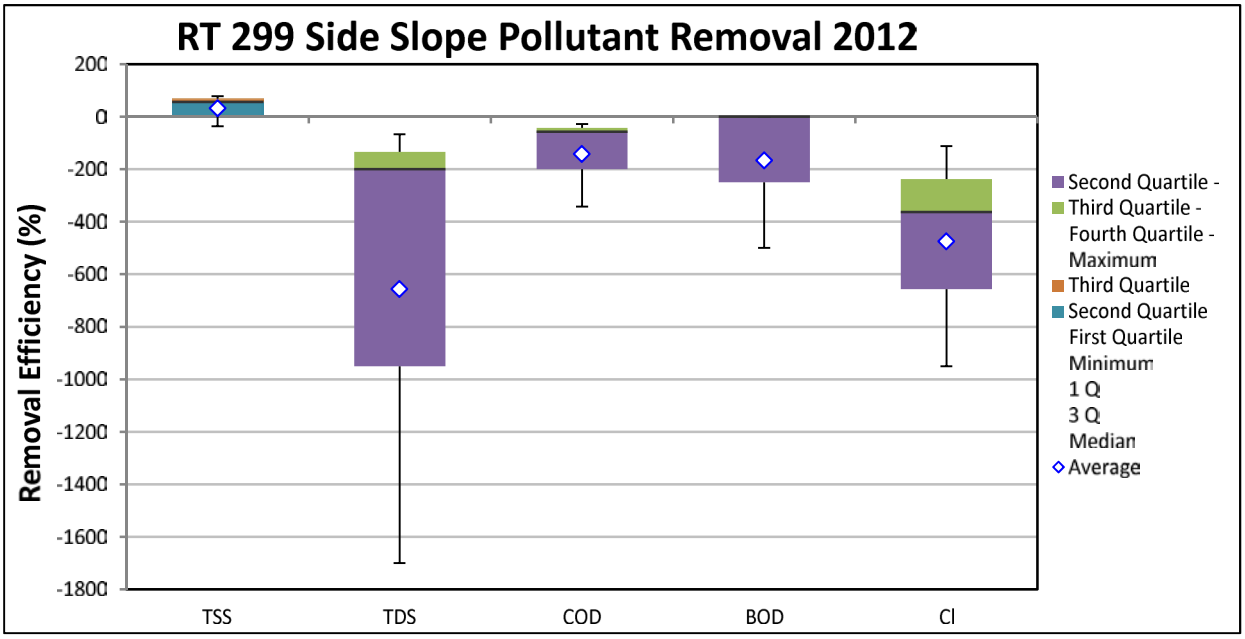
GREEN TECHNOLOGY
2012 ANNUAL REPORT

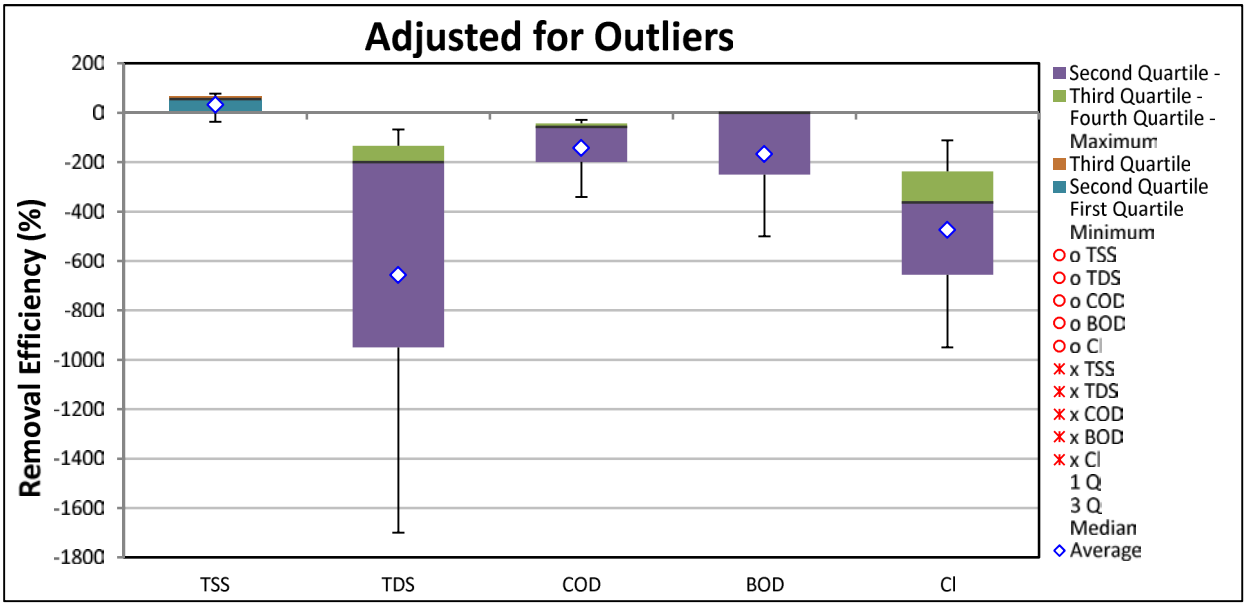
APPENDIX D

ROUTE 299 STUDY

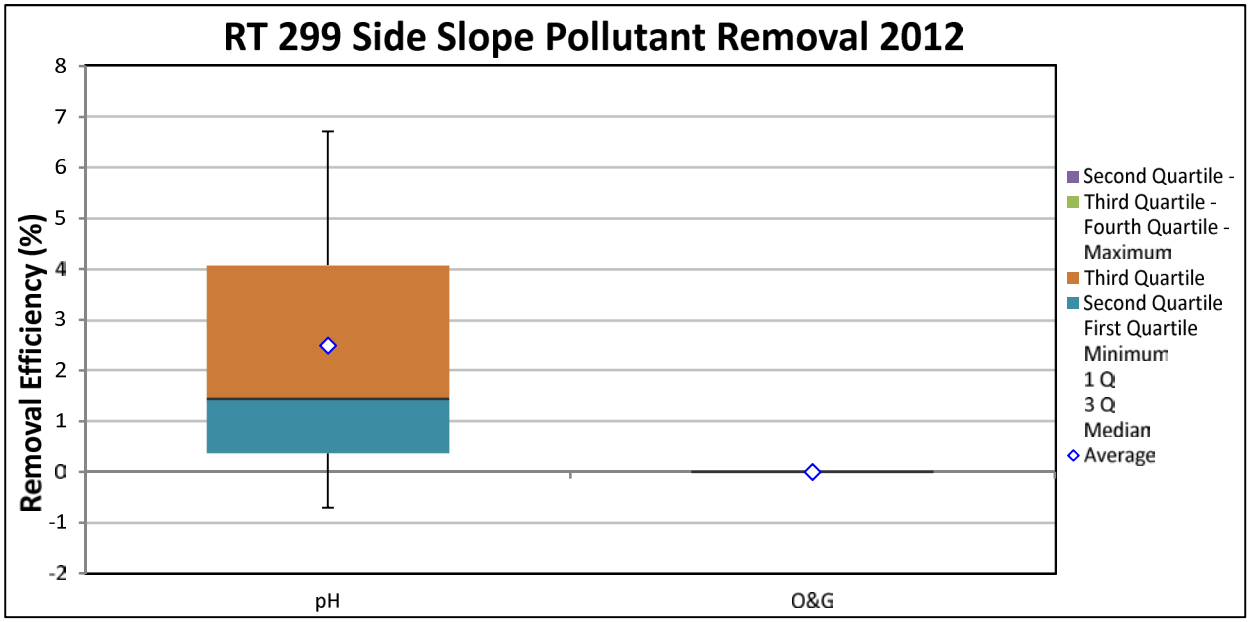
BOX AND WHISKER PLOTS

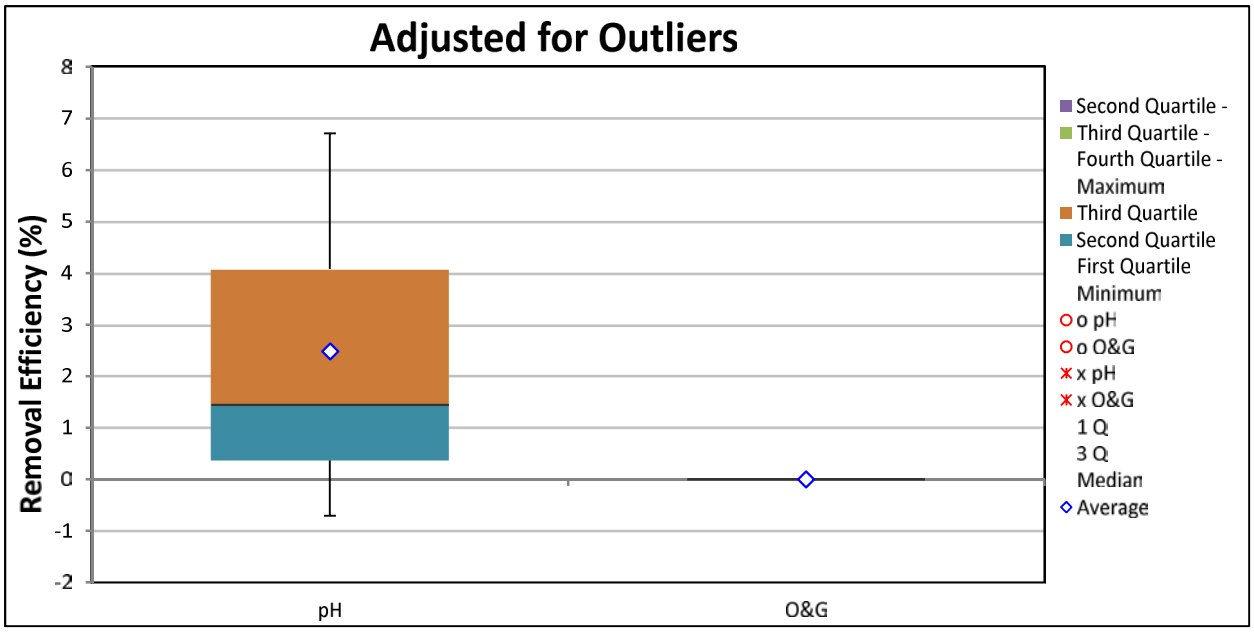
- **POLLUTANT REMOVAL EFFICIENCY: 2012**
- **EVENT MEAN CONCENTRATIONS: 2012**





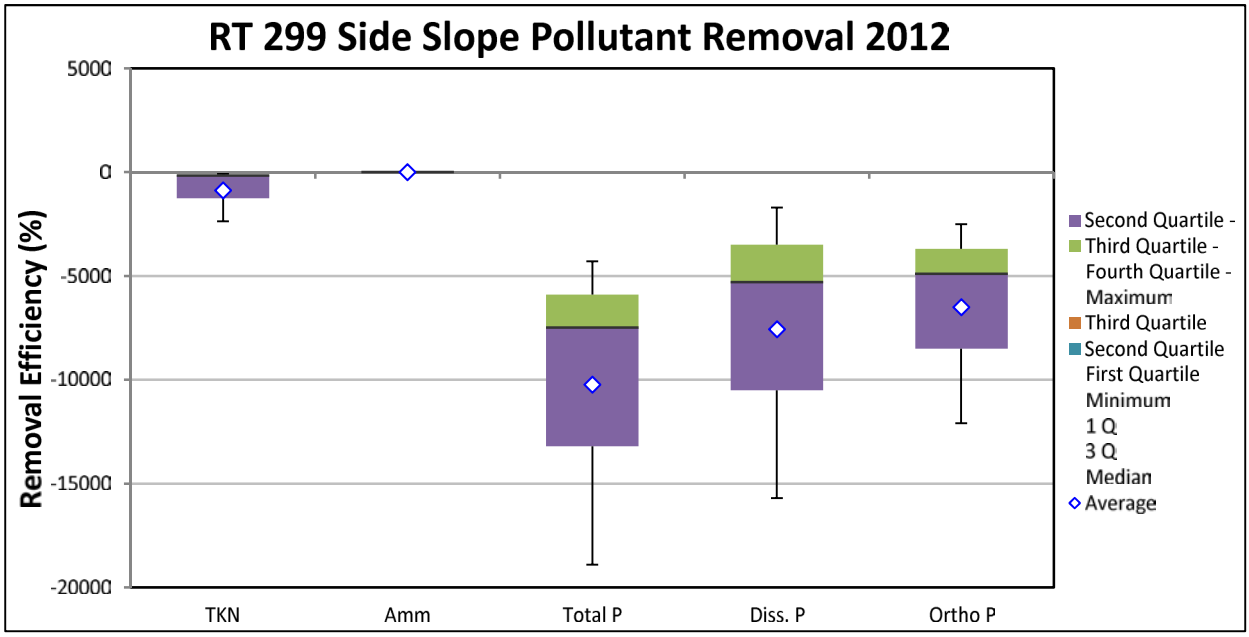
Removal Efficiency Statistical Data					
	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Chemical Oxygen Demand (COD)	Biological Oxygen Demand (BOD)	Chloride (Cl)
Count	3	3	3	3	3
Min	-36.36	-1700.00	-342.11	-500.00	-950.00
1 Q	9.82	-950.00	-199.48	-250.00	-656.33
Median	56.00	-200.00	-56.86	0.00	-362.65
3 Q	66.41	-133.78	-42.52	0.00	-237.36
Max	76.81	-67.57	-28.18	0.00	-112.07
Mean	32.15	-655.86	-142.38	-166.67	-474.91
SD	60.24	906.68	173.56	288.68	430.10

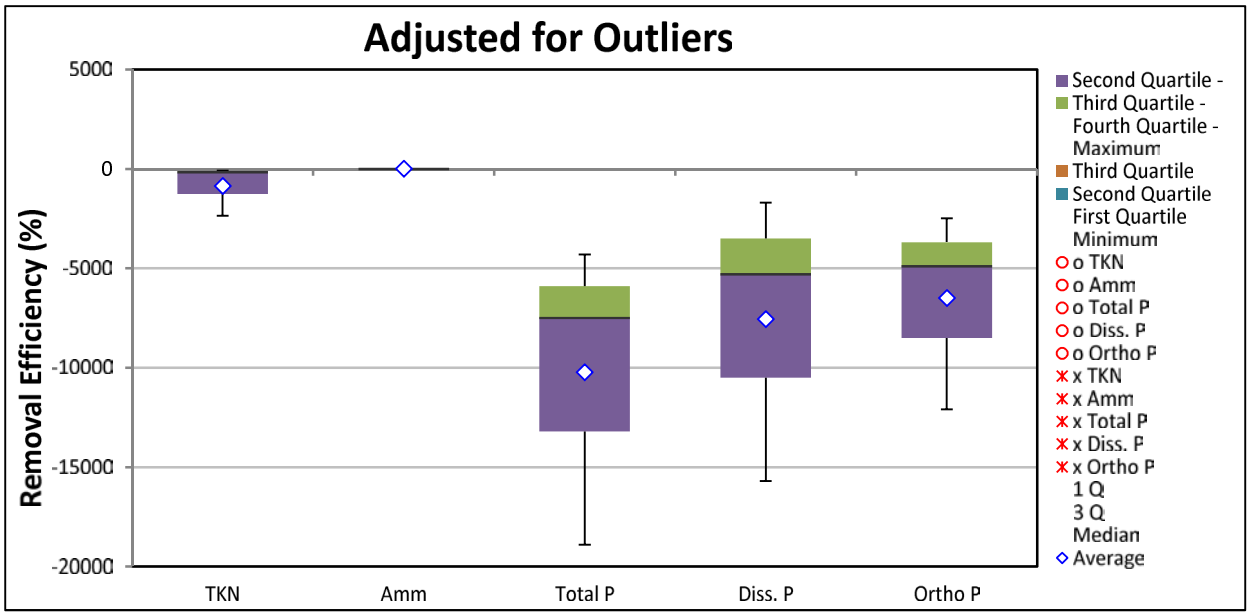




Removal Efficiency Statistical Data		
	pH	**Oil & Grease (O&G)**
Count	3	3
Min	-0.71	**ND**
1 Q	0.37	**ND**
Median	1.44	**ND**
3 Q	4.08	**ND**
Max	6.71	**ND**
Mean	2.48	**ND**
SD	3.82	**ND**

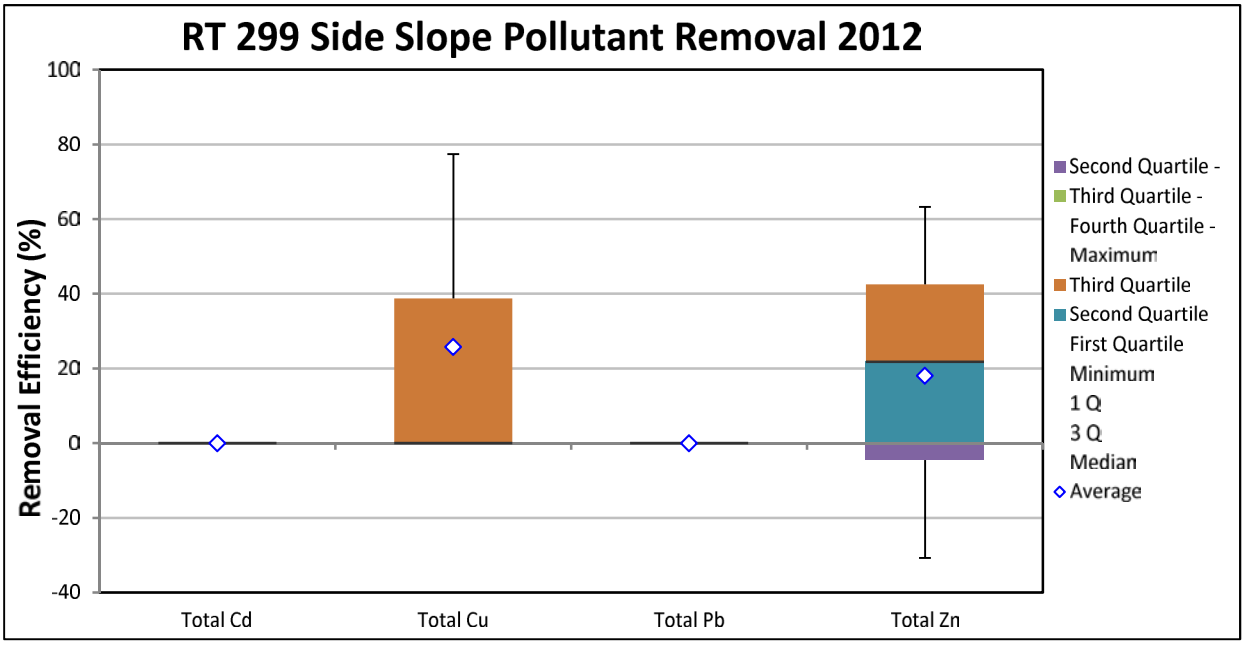
ND = Not Detected

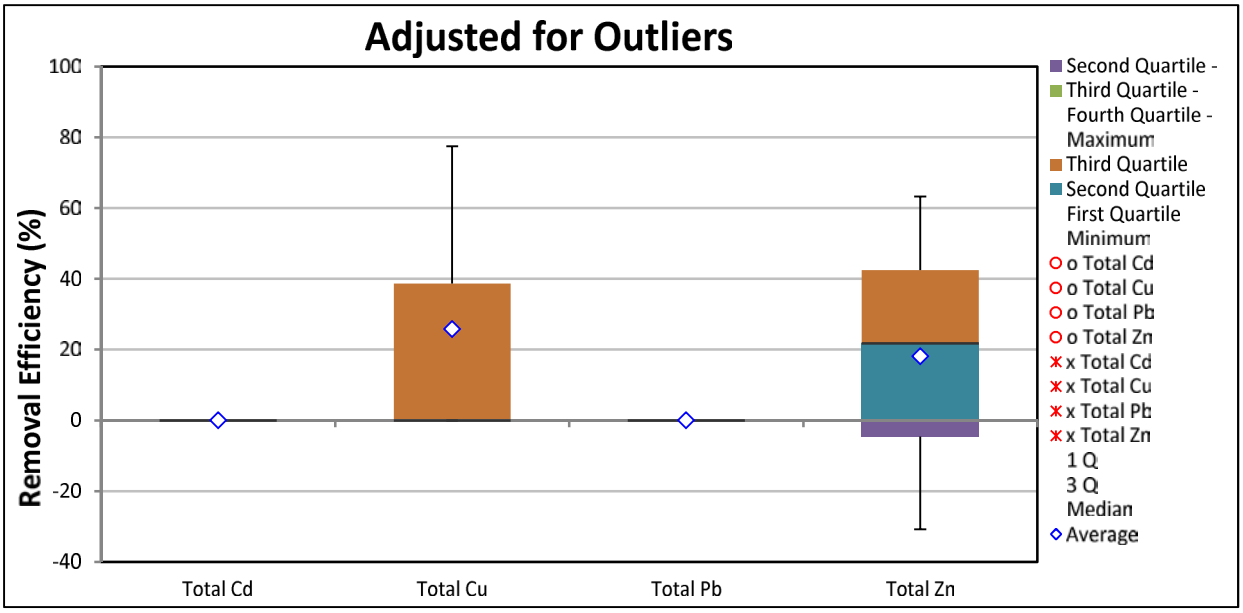




Removal Efficiency Statistical Data					
	Total Kjeldahl Nitrogen (TKN)	**Ammonia (Amm)**	**Total Phosphorus (Total P)**	**Dissolved Phosphorus (Diss. P)**	**Ortho-Phosphate (Ortho P)**
Count	3	3	3	3	3
Min	-2370.00	**ND**	-18900.00	-15700.00	-12100.00
1 Q	-1265.77	**ND**	-13200.00	-10500.00	-8500.00
Median	-161.54	**ND**	-7500.00	-5300.00	-4900.00
3 Q	-127.77	**ND**	-5900.00	-3500.00	-3700.00
Max	-94.00	**ND**	-4300.00	-1700.00	-2500.00
Mean	-875.18	**ND**	-10233.33	-7566.67	-6500.00
SD	1294.99	**ND**	7674.20	7270.03	4996.00

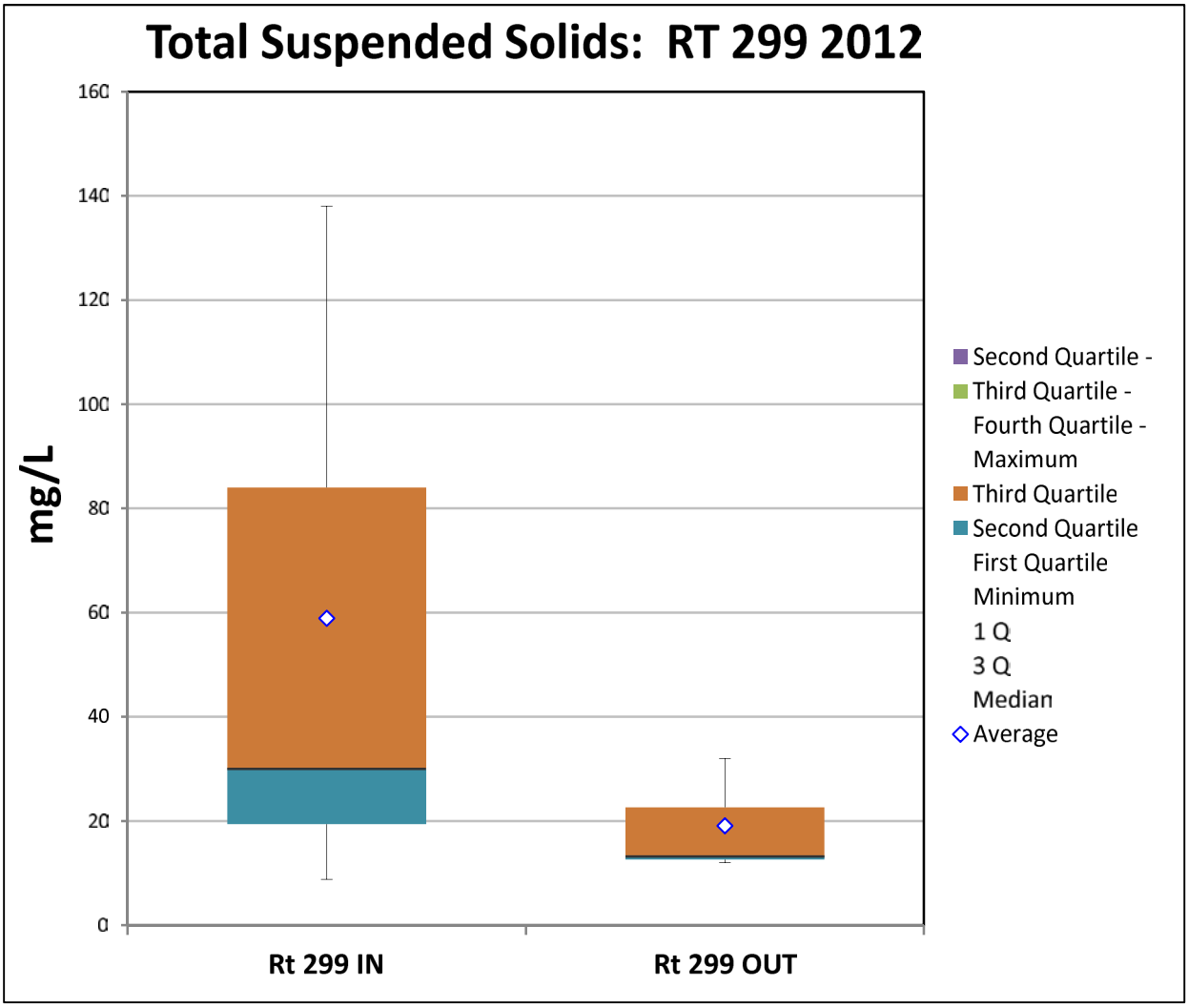
ND = Not Detected





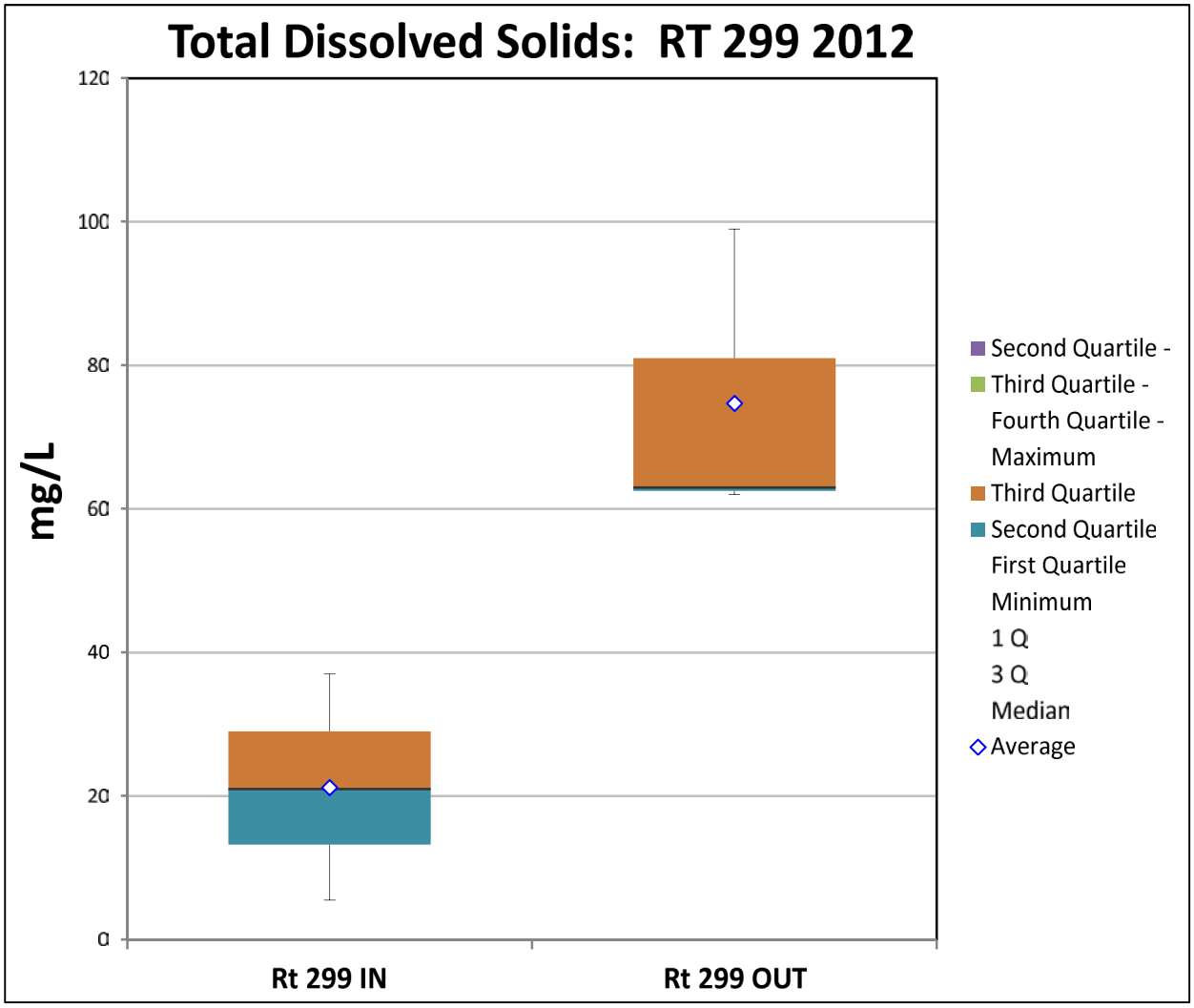
Removal Efficiency Statistical Data				
	Total Cadmium (Total Cd)	**Total Copper (Total Cu)**	**Total Lead (Total Pb)**	**Total Zinc (Total Zn)**
Count	3	3	3	3
Min	**ND**	0.00	**ND**	-30.77
1 Q	**ND**	0.00	**ND**	-4.52
Median	**ND**	0.00	**ND**	21.74
3 Q	**ND**	38.71	**ND**	42.50
Max	**ND**	77.42	**ND**	63.27
Mean	**ND**	25.81	**ND**	18.08
SD	**ND**	44.70	**ND**	47.12

ND = Not Detected



Statistical Data		
	Rt 299 IN	Rt 299 OUT
Count	3	3
Min	8.8	12
1 Q	19.4	12.6
Median	30	13.2
3 Q	84	22.6
Max	138	32
Mean	58.93333333	19.06666667
SD	69.28934502	11.21665428

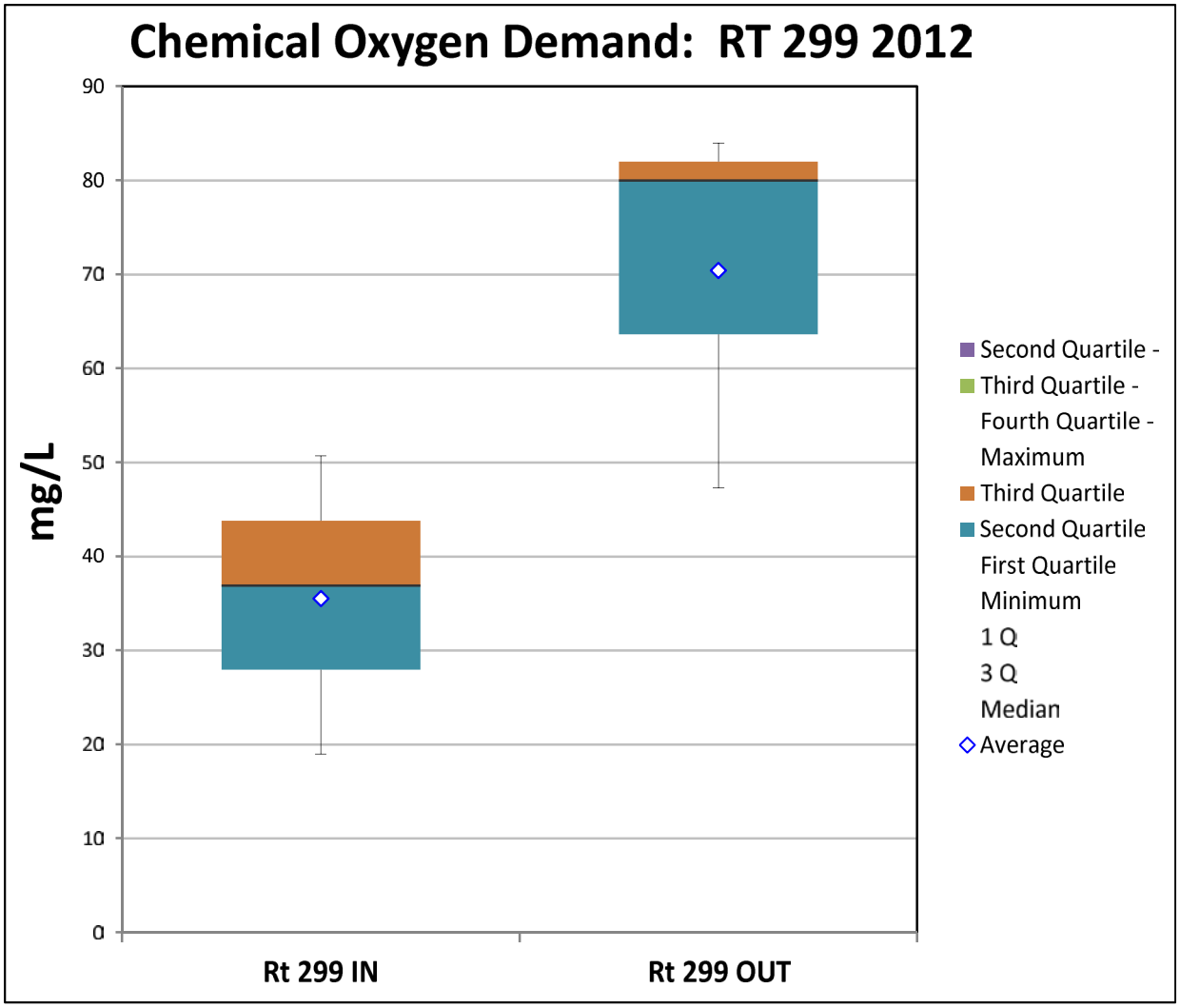
Laboratory Data			
	4/22/2012	9/18/2012	12/20/2012
	mg/L	mg/L	mg/L
Rt 299 IN	30	138	8.8
Rt 299 OUT	13.2	32	12



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	5.5	62
1 Q	13.25	62.5
Median	21	63
3 Q	29	81
Max	37	99
Mean	21.16666667	74.66666667
SD	15.75066136	21.07921567

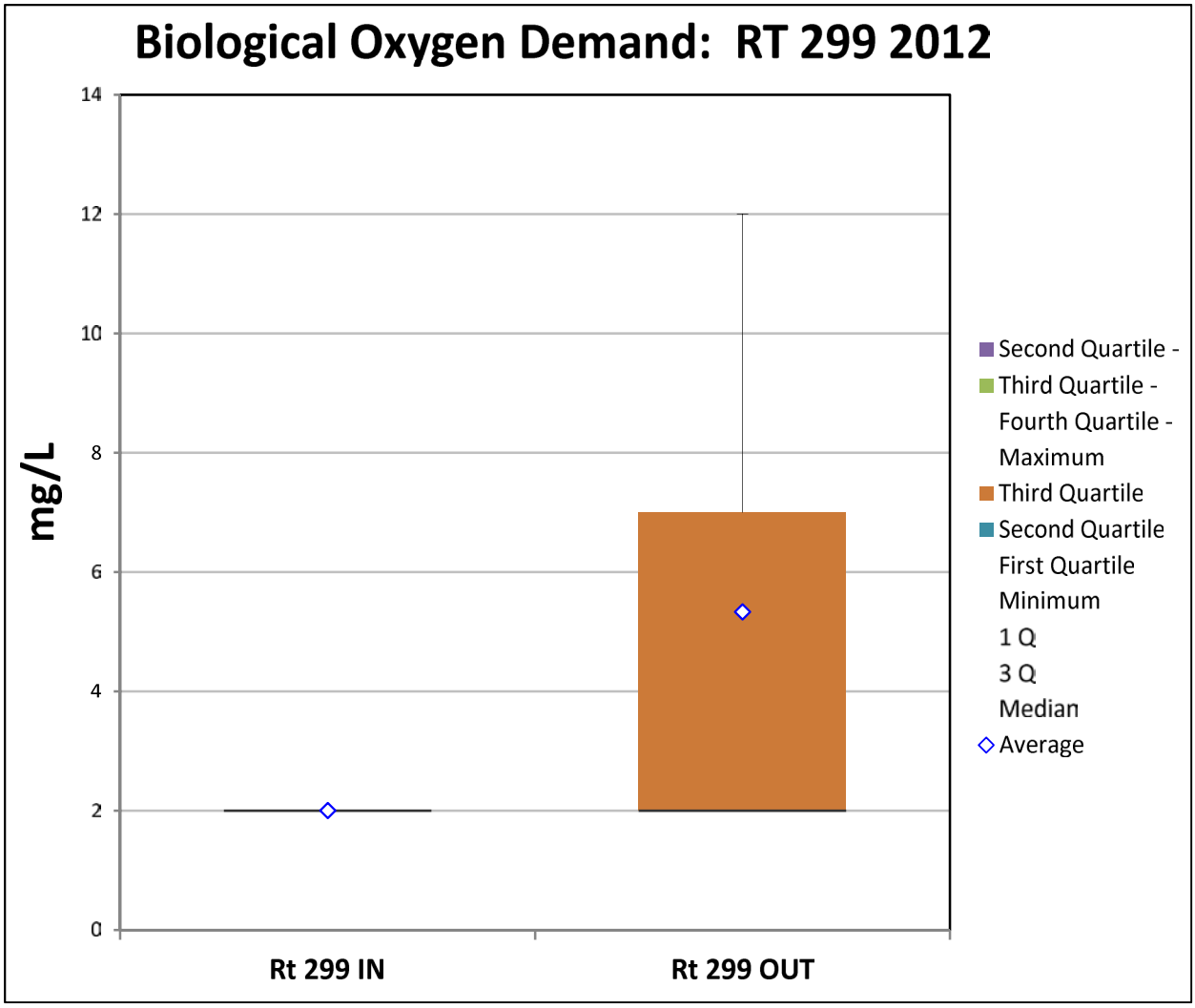
Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	**5.5**	37	21
Rt 299 OUT	99	62	63

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	19	47.3
1 Q	27.95	63.65
Median	36.9	80
3 Q	43.8	82
Max	50.7	84
Mean	35.53333333	70.43333333
SD	15.8941289	20.13363686

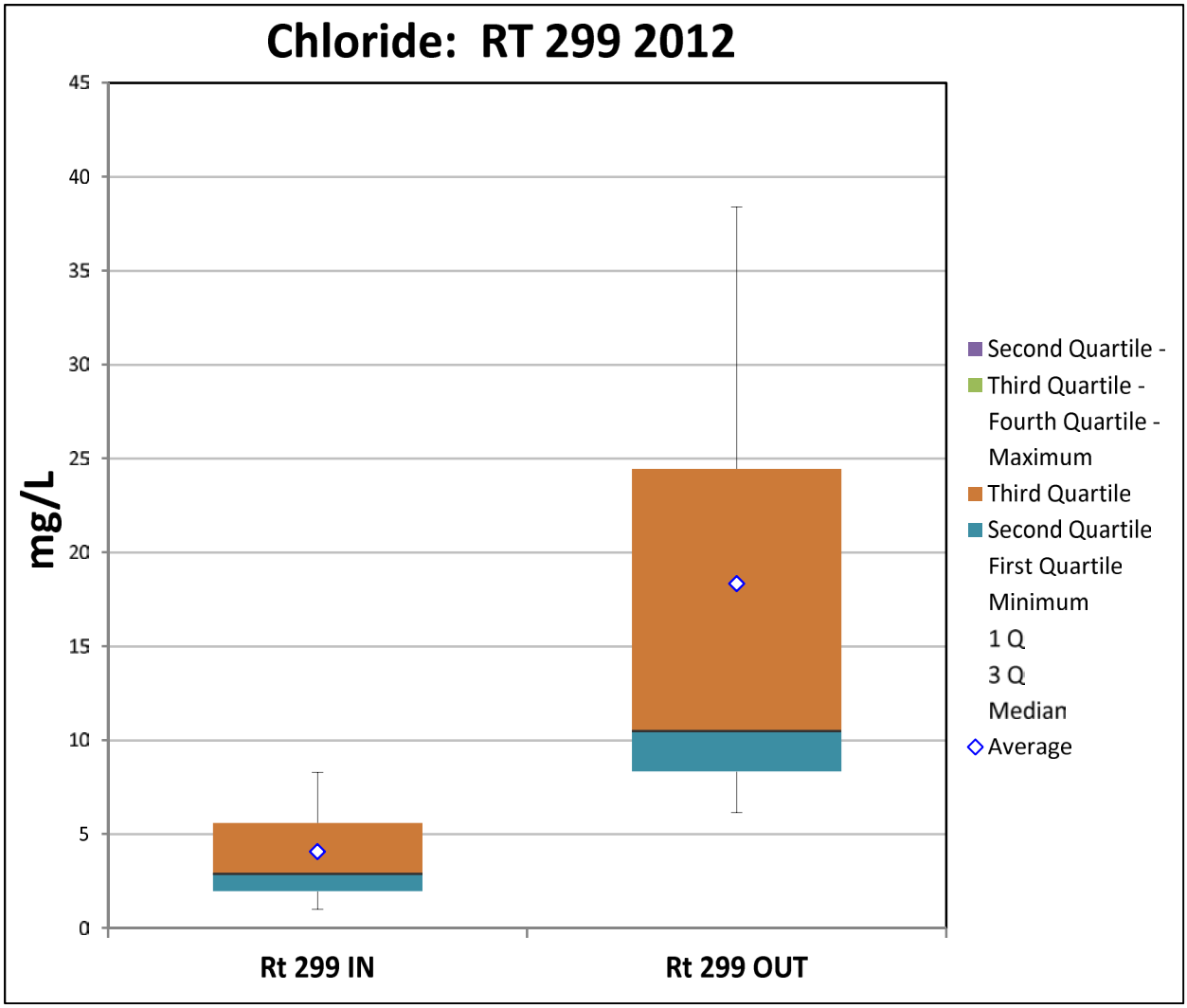
Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	19	50.7	36.9
Rt 299 OUT	84	80	47.3



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	2	2
1 Q	2	2
Median	2	2
3 Q	2	7
Max	2	12
Mean	2	5.333333333
SD	0	5.773502692

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	**2**	**2**	**2**
Rt 299 OUT	**2**	12	**2**

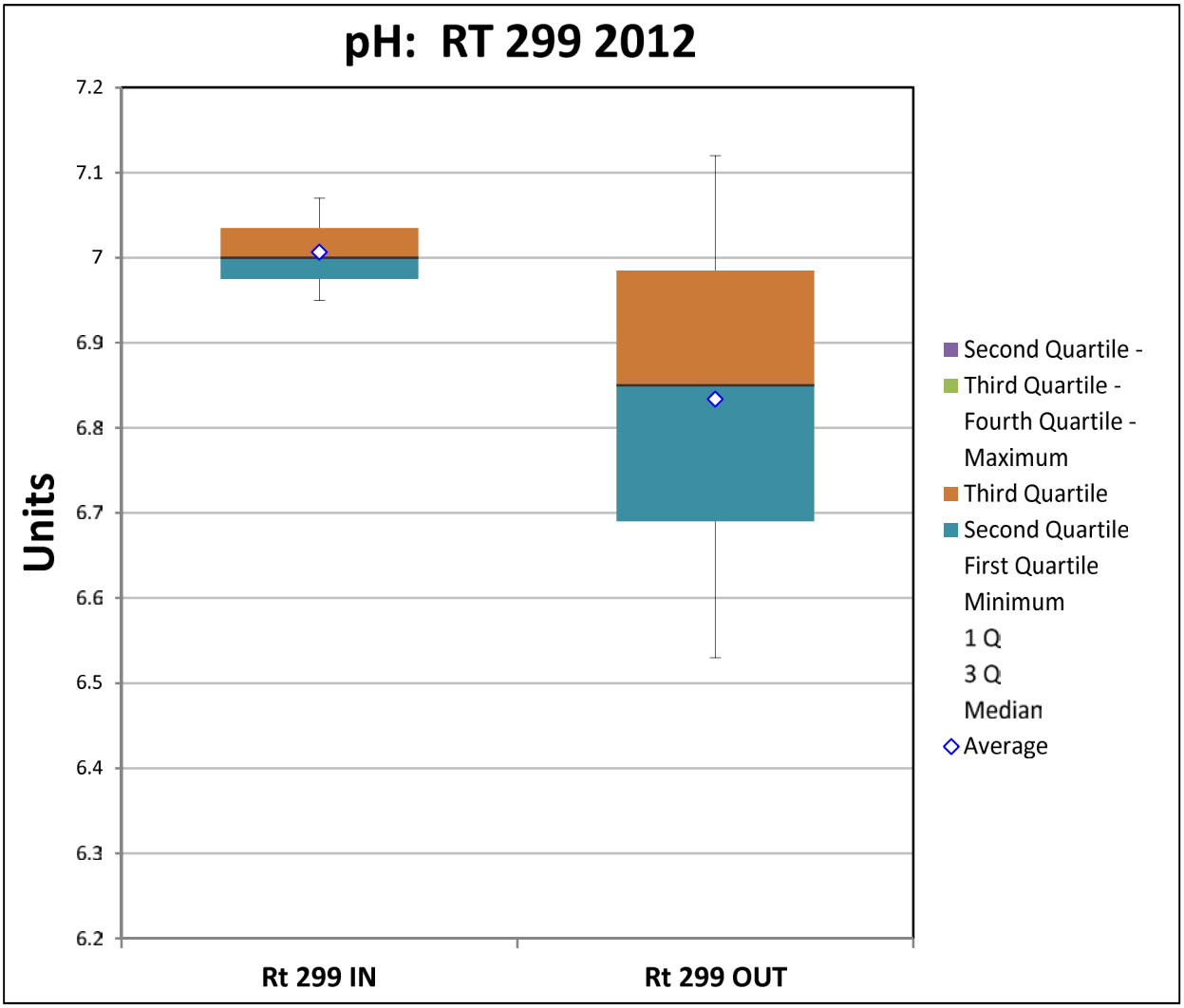
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	1	6.15
1 Q	1.95	8.325
Median	2.9	10.5
3 Q	5.6	24.45
Max	8.3	38.4
Mean	4.066666667	18.35
SD	3.787259343	17.49949999

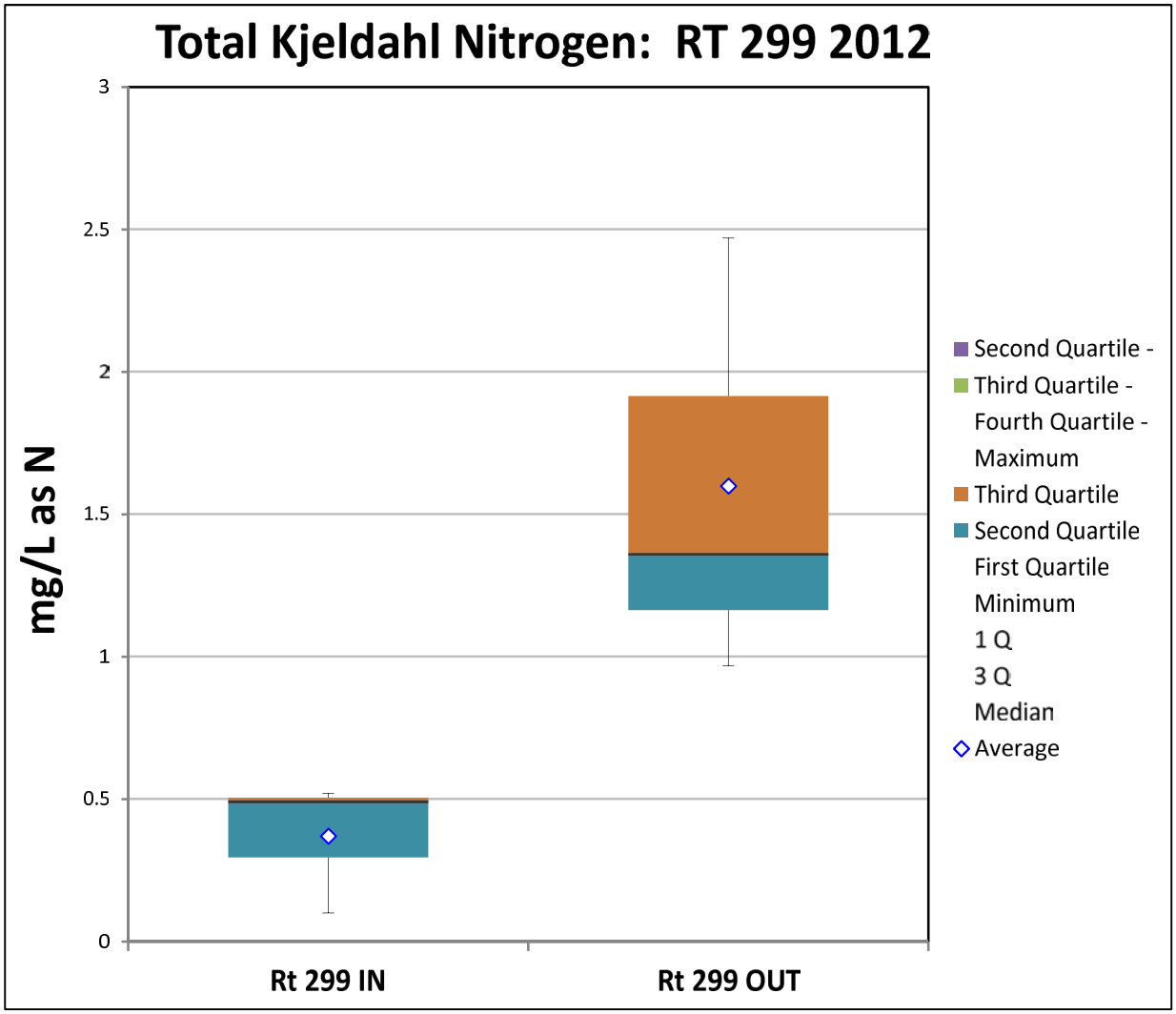
Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	8.3	2.9	**1**
Rt 299 OUT	38.4	6.15	10.5

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	6.95	6.53
1 Q	6.975	6.69
Median	7	6.85
3 Q	7.035	6.985
Max	7.07	7.12
Mean	7.006666667	6.833333333
SD	0.060277138	0.295352896

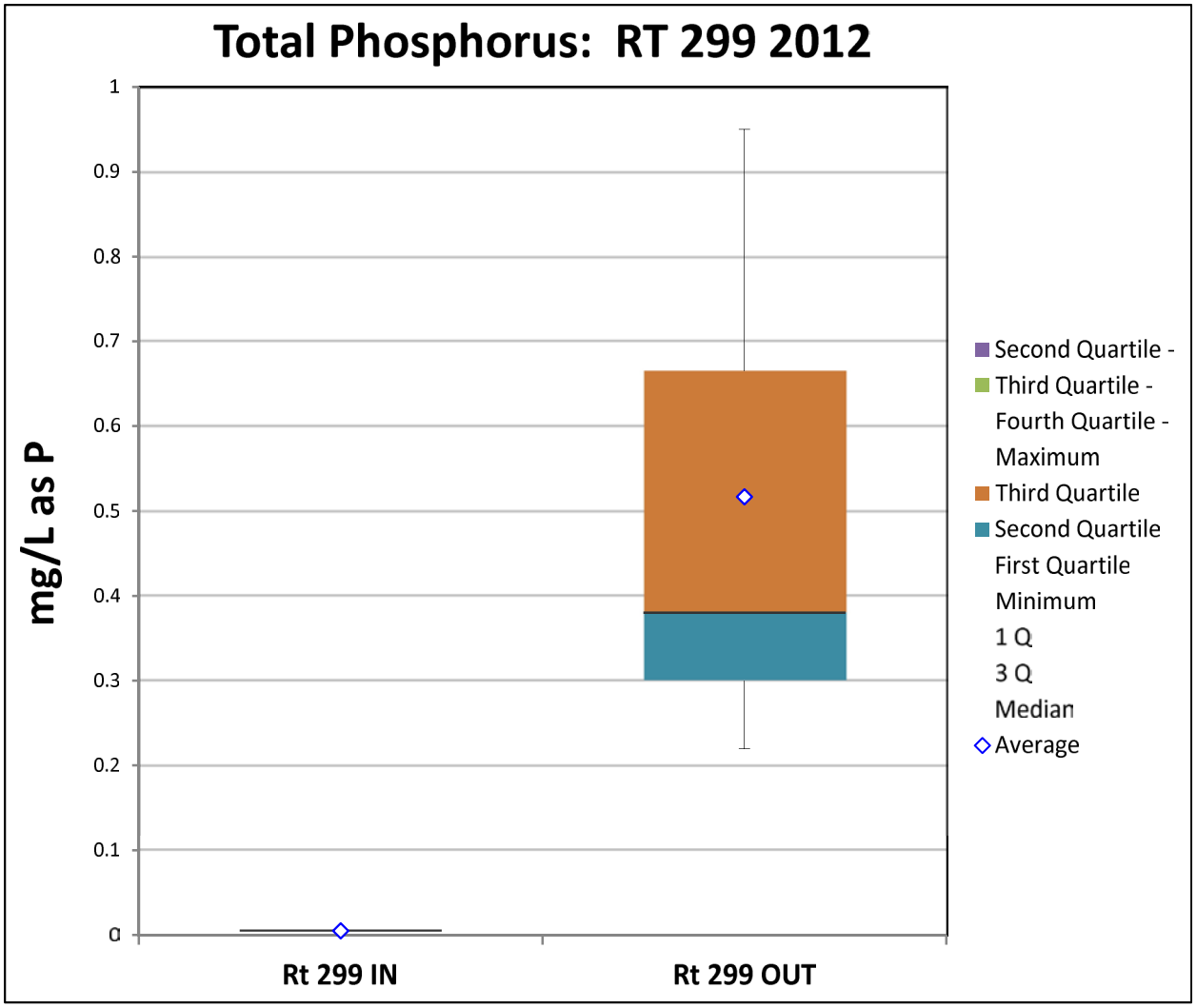
Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	Units	**Units**	**Units**
Rt 299 IN	7.07	7	6.95
Rt 299 OUT	7.12	6.53	6.85



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	0.1	0.968
1 Q	0.295	1.164
Median	0.49	1.36
3 Q	0.505	1.915
Max	0.52	2.47
Mean	0.37	1.599333333
SD	0.23430749	0.779077232

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	0.52	**0.1**	0.49
Rt 299 OUT	1.36	2.47	0.968

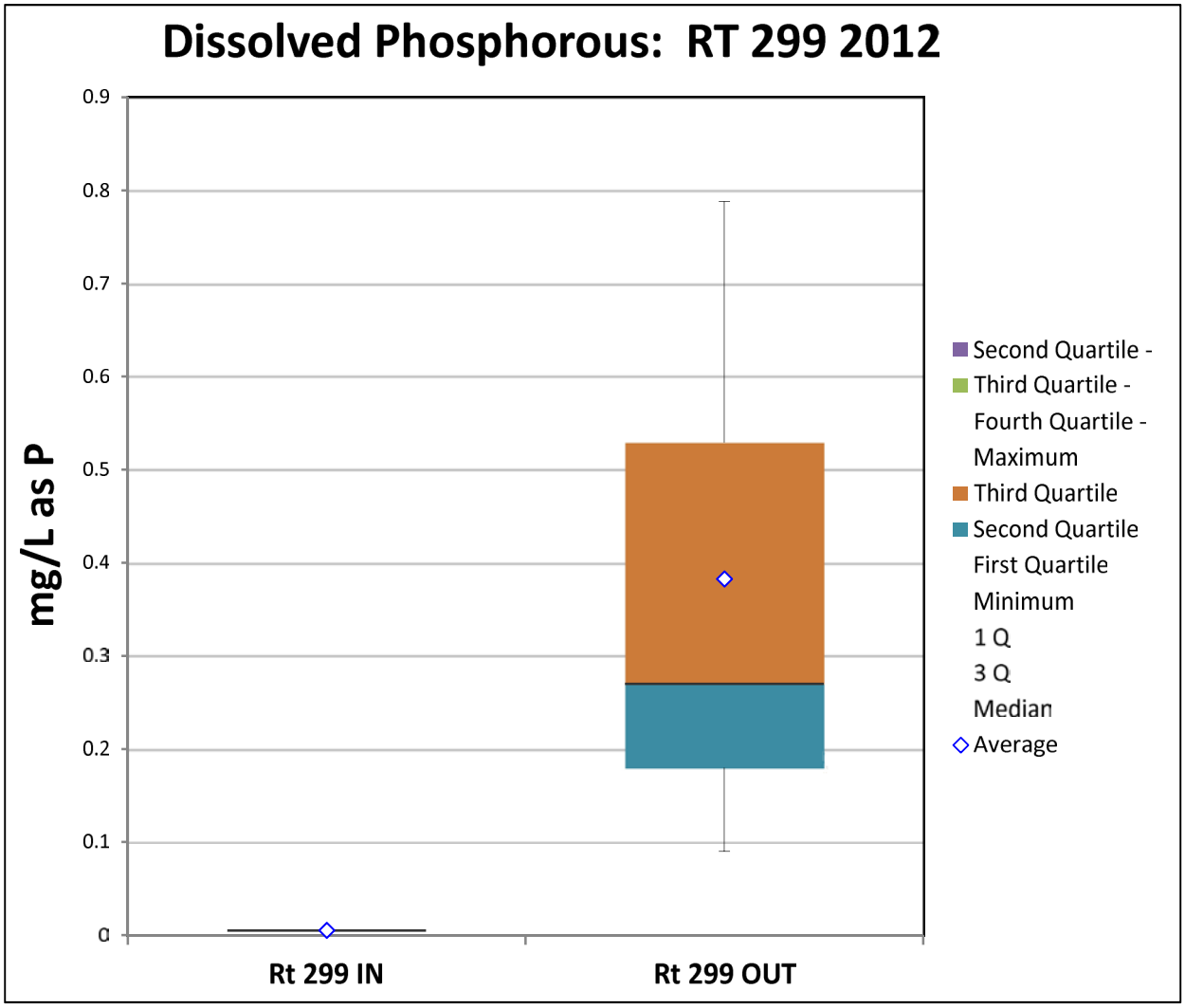
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	0.005	0.22
1 Q	0.005	0.3
Median	0.005	0.38
3 Q	0.005	0.665
Max	0.005	0.95
Mean	0.005	0.516666667
SD	0	0.38370996

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	**0.005**	**0.005**	**0.005**
Rt 299 OUT	0.38	0.95	0.22

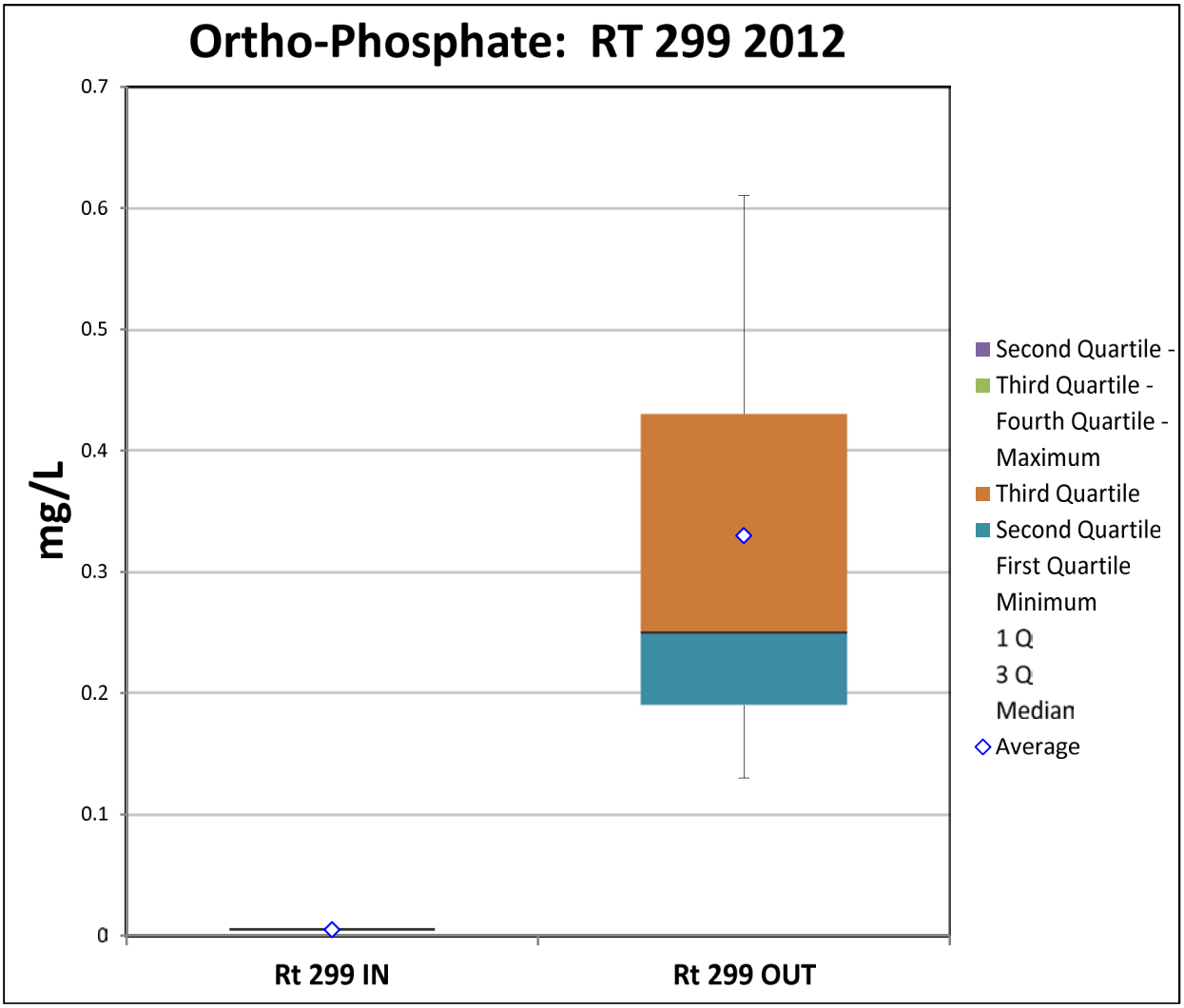
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	Rt 299 OUT
Count	3	3
Min	0.005	0.09
1 Q	0.005	0.18
Median	0.005	0.27
3 Q	0.005	0.529
Max	0.005	0.788
Mean	0.005	0.382666667
SD	0	0.362382855

Laboratory Data			
	4/22/2012	9/18/2012	12/20/2012
	mg/L	mg/L	mg/L
Rt 299 IN	**0.005**	**0.005**	**0.005**
Rt 299 OUT	0.27	0.788	0.09

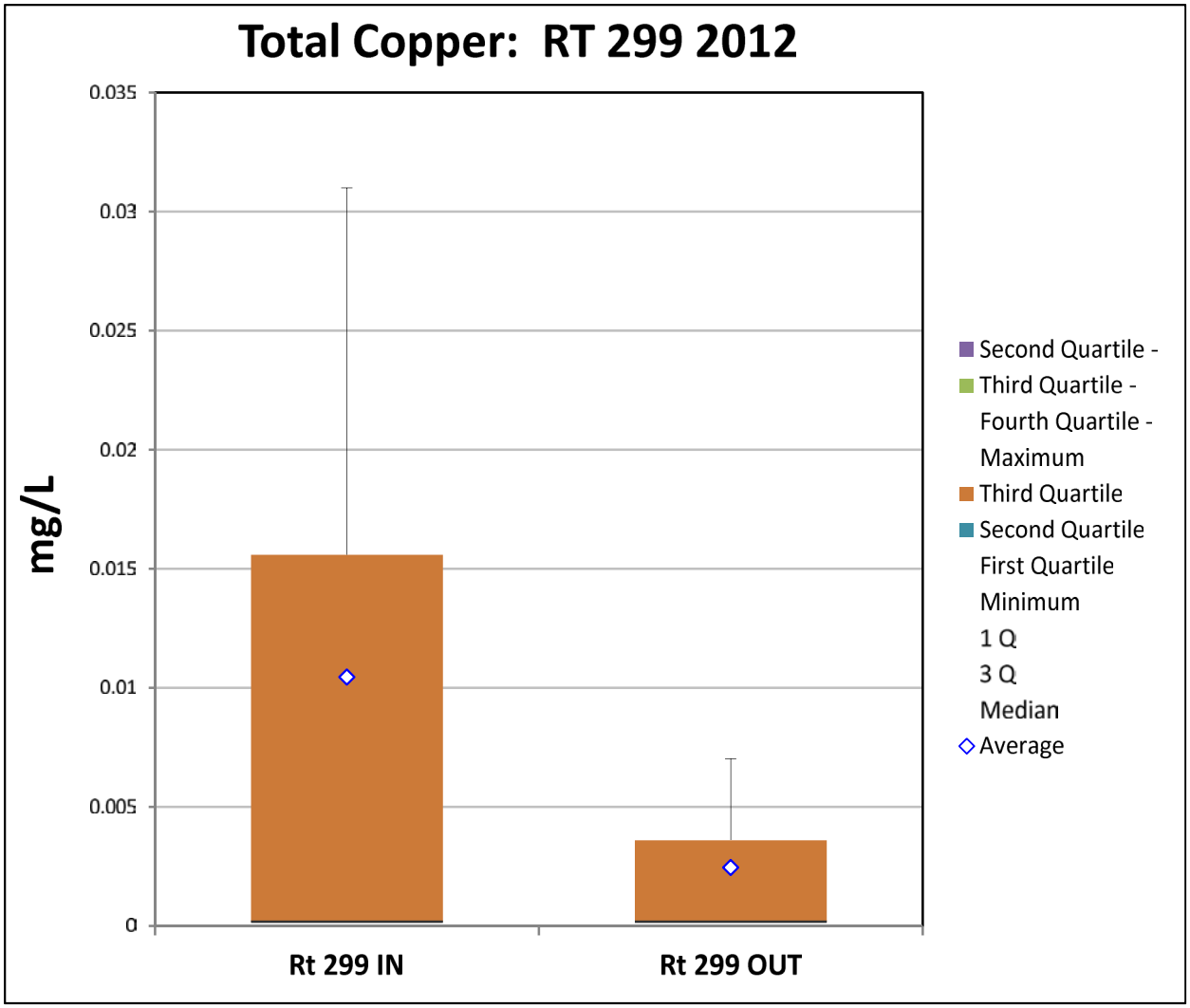
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	0.005	0.13
1 Q	0.005	0.19
Median	0.005	0.25
3 Q	0.005	0.43
Max	0.005	0.61
Mean	0.005	0.33
SD	0	0.24979992

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	**0.005**	**0.005**	**0.005**
Rt 299 OUT	0.25	0.61	0.13

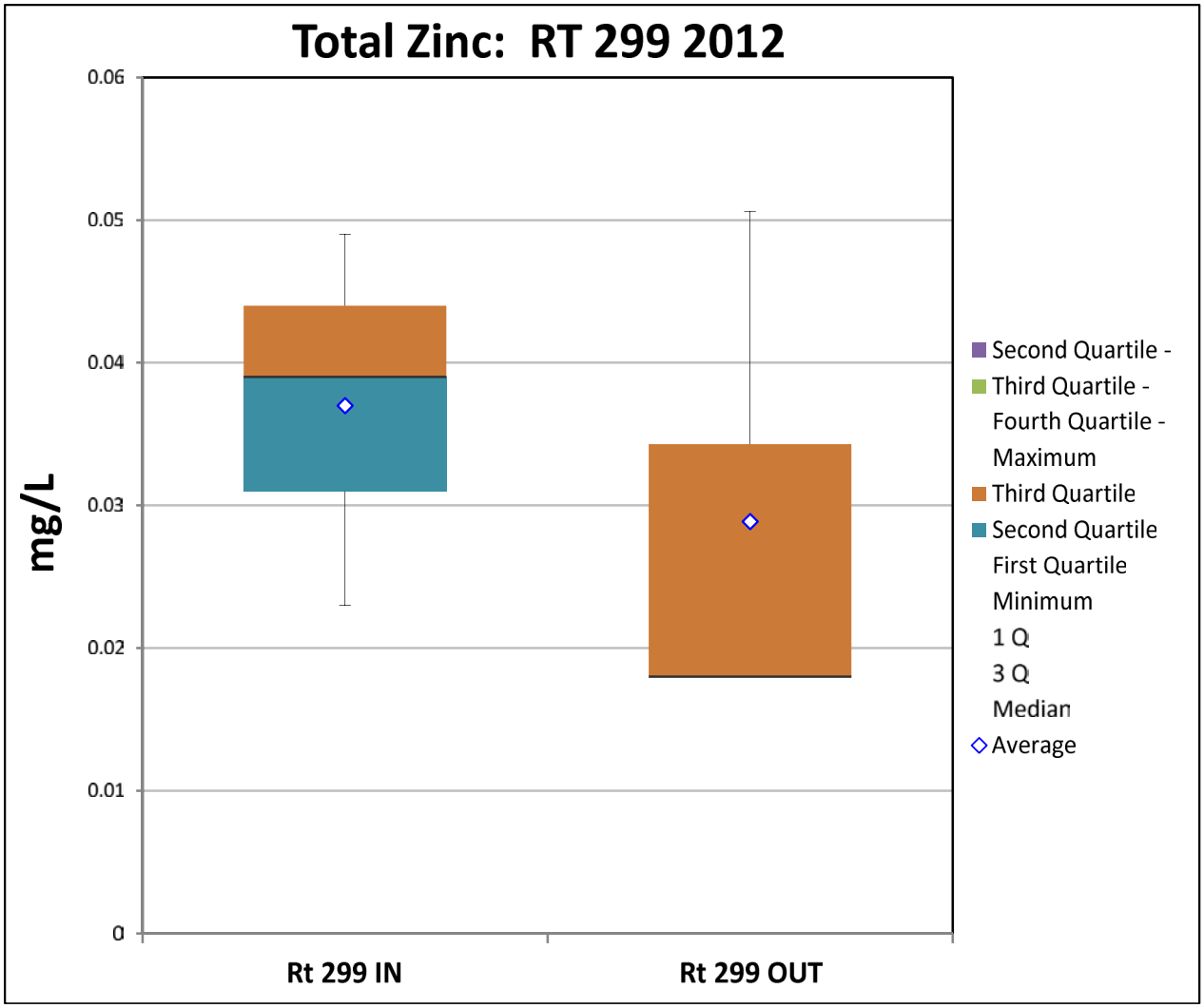
BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	0.000175	0.000175
1 Q	0.000175	0.000175
Median	0.000175	0.000175
3 Q	0.0155875	0.0035875
Max	0.031	0.007
Mean	0.01045	0.00245
SD	0.017796822	0.003940416

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	0.031	**0.000175**	**0.000175**
Rt 299 OUT	0.007	**0.000175**	**0.000175**

BOLD = Not Detected (ND), Value Shown is ½ the Detection Limit



Statistical Data		
	Rt 299 IN	**Rt 299 OUT**
Count	3	3
Min	0.023	0.018
1 Q	0.031	0.018
Median	0.039	0.018
3 Q	0.044	0.0343
Max	0.049	0.0506
Mean	0.037	0.028866667
SD	0.013114877	0.018821619

Laboratory Data			
	4/22/2012	**9/18/2012**	**12/20/2012**
	mg/L	**mg/L**	**mg/L**
Rt 299 IN	0.049	0.039	0.023
Rt 299 OUT	0.018	0.0506	0.018

Appendix I. Delaware Solid Waste Authority (DSWA) 2012 approval to deliver New Castle County street sweeper wastes to landfill. Includes chemical analyses of representative samples collected from waste stockpiles.

DELAWARE SOLID WASTE AUTHORITY

Board of Directors
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Chief Executive Officer

Richard P. Watson, P.E., BCEE
Chief Operating Officer

August 3, 2012

Ref: CIL-12.46

RECEIVED
AUG 07 2012
M&O SUPPORT SERVICES

Ms. Marianne Walch, PhD
State of Delaware
Department of Transportation
800 Bay Road
P.O. Box 778
Dover, Delaware 19903

Re: Special Waste Approval for Street Sweeper Waste
Special Waste Approval Number: **CIL-12.46**

Dear Ms. Walch:

I have received your special waste application and associated analytical testing dated July 30, 2012. Delaware Solid Waste Authority (DSWA) approves your request to dispose of approximately 2,000 tons of street sweeper waste generated as a result of ditch cleaning activities. The material will be accepted at the Cherry Island Landfill (CIL). This material must be delivered in segregated loads and not mixed with other waste. Wastes not accurately represented by the information submitted in the special waste application or as stipulated in the DSWA Special Waste Policy may be rejected.

You are requested to contact DSWA at least 24 hours in advance to schedule the waste disposal.

The rate charged for the material will be at our current tipping rate at time of disposal. A copy of this approval letter must accompany each load of waste delivered to CIL. This approval expires on July 31, 2013.

If you have any questions, please feel free to contact me at 764-5385.

Sincerely,

Robin M. Roddy, P.E., BCEE
Senior Facility Manager

RMR:ur

c: L. V. Miller, P.E., BCEE
F. W. Oehler (Compliance Supervisor)
NSWMC Compliance Officers
J. E. Haley, MPA
J. W. Wagner, E.I.
NSWMC Weighmasters
T. A. Casarino (CILLC)
M. Lyon (DNREC)

FOR DSWA USE ONLY
WM initials:_____
delivery date: _____
expiration date:_____
tonnage: _____
ticket #:_____
acct/truck #_____

1128 S. Bradford Street, P.O. Box 455, Dover, Delaware 19903-0455
Phone: (302) 739-5361 Fax: (302) 739-4287

CITIZENS' RESPONSE LINE: 1-800-404-7080 www.dswa.com

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STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

July 30, 2012

Robin M. Roddy, P.E., BCEE
Senior Facility Manager
Cherry Island Landfill
1706 E. 12th Street
Wilmington, DE 19809

Dear Ms. Roddy:

DelDOT is seeking to renew its special waste disposal approval from the Delaware Solid Waste Authority to deliver street sweeper wastes to the Cherry Island landfill. The current approval expires on July 31, 2012.

In compliance with the DSWA Policy on Special Solid Wastes, we are providing the required information about these wastes as follows:

a) The wastes in question are generated by street sweeping activities conducted by DelDOT throughout the year in New Castle County. The materials collected by the sweepers are staged in piles at six DelDOT maintenance yards (Talley, Kiamensi, Chapman Road, Bear, Odessa and Middletown).

b) The composition of these waste materials is relatively consistent over time, consisting primarily of soil particles, road dust, litter, and some organic matter such as leaves and grass.

c) None of the material is collected from Federal Superfund sites or from any areas that have had known spills of hazardous substances.

d) This material is not hazardous waste.

e) We conducted a new set of analytical tests on the street sweeper wastes on June 21, 2012. Composite samples of the wastes – one from the Chapman Road yard, and one from the Cheswold yard (in Kent County) were collected by KCI Technologies, Inc. Each composite sample contained a mixture of three to five subsamples taken from representative sections of a pile of sweepings held at the maintenance yard.

f) Copies of the test results are enclosed.

g) The laboratory analyses were performed by QC Laboratories, Inc. (QCL), in Newark. QCL is a Delaware-certified, full-service environmental analytical company. The laboratory uses EPA-approved protocols for solid and hazardous waste and groundwater testing (EPA SW-846 methods).

h) We estimate that DelDOT will deliver a total of approximately 2,000 tons of sweeper wastes to the landfill per year.

i) Maintenance staff from each of the six staging yards typically will need to transport these piles to the landfill on approximately once per month basis. Thus, each month approximately 20 to 40 tons of material will be delivered to the landfill from each of the yards.

If you need any additional information from us, please contact me at 302.760.2195, or marianne.walch@state.de.us.

Sincerely,

Marianne Walch, Ph.D.
Environmental Scientist
DelDOT NPDES Program

MW:mw
Enclosure

cc: Randy Cole, NPDES Program Manager
LaTonya Gilliam, NPDES Engineer
Andy Bowman, North District Engineer
Mark Alexander, Canal District Engineer

QC Laboratories

Analytical Report

ACCREDITED IN ACCORDANCE WITH nelac

Printed: 07/30/12 10:18

BRUCE THOMPSON
KCI TECHNOLOGIES, INC.
1352 MARROWS ROAD
SUITE 100
NEWARK, DE 19711

Regarding:
BRUCE THOMPSON
KCI TECHNOLOGIES, INC.
1352 MARROWS ROAD
SUITE 100
NEWARK, DE 19711

Account No: AL0120, KCI TECHNOLOGIES, INC. **P.O. No:** **Inv. No:** 1429905
Project No: AL0120, KCI TECHNOLOGIES, INC. **PWSID No:**

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L4213617-1	CHAPMAN MY	06/21/12 01:30pm NA F	Customer

Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
SULFATE	EPA 9056 WO/COMB	86.7 mg/kg DRY	54.2 mg/kg	06/23/12 04:43AM XJY
CYANIDE REACTIVE	EPA 7.3.3.2	ND mg/kg	25.0 mg/kg	06/22/12 09:00AM MJP
CORROSIVITY (PH)	EPA 9045C	NEG		06/22/12 10:30AM KR
TCLP EXTRACTION	EPA 1311	COMPLETE		06/25/12 12:30PM KR
TCLP-O HEADSPACE EXTRACTION	EPA 1311	COMPLETE		06/25/12 12:30PM KR
IGNITABILITY	EPA 1030	NEG		06/26/12 06:00PM JG
REACTIVE HYDROGEN SULFIDE	EPA 7.3.4.2	ND mg/kg	50.0 mg/kg	06/22/12 09:00AM MJP
TOTAL SOLIDS PERCENT	SM 2540G	92.27 %	0.01000 %	06/22/12 12:45PM P P
METALS				
MERCURY-TCLP	EPA 7470A	ND mg/l	0.0000560 mg/l*	06/26/12 03:59PM RMP
SILVER-TCLP	EPA 6010C	0.0138 mg/l	0.000580 mg/l*	06/28/12 07:10AM B B
ARSENIC-TCLP	EPA 6010C	ND mg/l	0.00360 mg/l*	06/28/12 07:10AM B B
BARIUM-TCLP	EPA 6010C	0.810 mg/l	0.000180 mg/l*	06/28/12 07:10AM B B
CADMIUM-TCLP	EPA 6010C	0.00570 B mg/l	0.000230 mg/l*	06/28/12 07:10AM B B
CHROMIUM-TCLP	EPA 6010C	ND mg/l	0.000450 mg/l*	06/28/12 07:10AM B B
LEAD-TCLP	EPA 6010C	0.00850 B mg/l	0.00210 mg/l*	06/28/12 07:10AM B B
SELENIUM-TCLP	EPA 6010C	ND mg/l	0.00520 mg/l*	06/28/12 07:10AM B B
GAS CHROMATOGRAPHY MASS SPECTROMETRY; SEMI-VOLATILES				
PYRIDINE-TCLP	EPA 8270C	ND mg/l	0.00580 mg/l*	06/28/12 05:19PM J-M
1,4-DICHLOROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00450 mg/l*	06/28/12 05:19PM J-M
2-METHYLPHENOL-TCLP	EPA 8270C	ND mg/l	0.00280 mg/l*	06/28/12 05:19PM J-M
HEXACHLOROETHANE-TCLP	EPA 8270C	ND mg/l	0.00450 mg/l*	06/28/12 05:19PM J-M
3&4-METHYLPHENOL-TCLP	EPA 8270C	ND mg/l	0.00540 mg/l*	06/28/12 05:19PM J-M
NITROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00430 mg/l*	06/28/12 05:19PM J-M
HEXACHLOROBUTADIENE-TCLP	EPA 8270C	ND mg/l	0.00390 mg/l*	06/28/12 05:19PM J-M
2,4,6-TRICHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00330 mg/l*	06/28/12 05:19PM J-M
2,4,5-TRICHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00240 mg/l*	06/28/12 05:19PM J-M
2,4-DINITROTOLUENE-TCLP	EPA 8270C	ND mg/l	0.00320 mg/l*	06/28/12 05:19PM J-M
HEXACHLOROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00340 mg/l*	06/28/12 05:19PM J-M

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Authorized by: Oommen V. Kappil, QA Director

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

QC Laboratories Analytical Report

Account No: AL0120, KCI TECHNOLOGIES, INC. **P.O. No:** **Inv. No:** 1429905
Project No: AL0120, KCI TECHNOLOGIES, INC. **PWSID No:**

Sample Number **Sample Description** **Samp. Date/Time/Temp** **Sampled by**
L4213617-1 CHAPMAN MY 06/21/12 01:30pm NA F Customer
Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst	
GAS CHROMATOGRAPHY MASS SPECTROMETRY; SEMI-VOLATILES continued					
PENTACHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00370 mg/l*	06/28/12 05:19PM	J-M
TOTAL CRESOL-TCLP	EPA 8270C	ND mg/l	0.00540 mg/l*	06/28/12 05:19PM	J-M
GAS CHROMATOGRAPHY MASS SPECTROMETRY; VOLATILES					
BENZENE	EPA 8260B	ND ug/kg DRY	0.990 ug/kg*	06/22/12 09:23PM	MHA
TOLUENE	EPA 8260B	ND ug/kg DRY	1.21 ug/kg*	06/22/12 09:23PM	MHA
ETHYL BENZENE	EPA 8260B	ND ug/kg DRY	1.20 ug/kg*	06/22/12 09:23PM	MHA
M&P-XYLENES	EPA 8260B	ND ug/kg DRY	2.44 ug/kg*	06/22/12 09:23PM	MHA
O-XYLENE	EPA 8260B	ND ug/kg DRY	0.980 ug/kg*	06/22/12 09:23PM	MHA
VINYL CHLORIDE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 05:30PM	JSH
1,1-DICHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00160 mg/l*	06/27/12 05:30PM	JSH
2-BUTANONE-TCLP	EPA 8260B	ND mg/l	0.00720 mg/l*	06/27/12 05:30PM	JSH
CARBON TETRACHLORIDE-TCLP	EPA 8260B	ND mg/l	0.00140 mg/l*	06/27/12 05:30PM	JSH
CHLOROFORM-TCLP	EPA 8260B	0.00140 J mg/l	0.00120 mg/l*	06/27/12 05:30PM	JSH
BENZENE-TCLP	EPA 8260B	ND mg/l	0.00110 mg/l*	06/27/12 05:30PM	JSH
1,2-DICHLOROETHANE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 05:30PM	JSH
TRICHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00130 mg/l*	06/27/12 05:30PM	JSH
TETRACHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00190 mg/l*	06/27/12 05:30PM	JSH
CHLOROBENZENE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 05:30PM	JSH
GAS CHROMATOGRAPHY					
GAMMA-BHC (LINDANE) TCLP	EPA 8081A	ND ug/l	0.0000201 ug/l*	06/28/12 10:31PM	AJG
HEPTACHLOR TCLP	EPA 8081A	ND ug/l	0.0000215 ug/l*	06/28/12 10:31PM	AJG
HEPTACHLOR EPOXIDE TCLP	EPA 8081A	ND ug/l	0.0000641 ug/l*	06/28/12 10:31PM	AJG
ENDRIN TCLP	EPA 8081A	ND ug/l	0.0000243 ug/l*	06/28/12 10:31PM	AJG
METHOXYCHLOR TCLP	EPA 8081A	ND ug/l	0.0000391 ug/l*	06/28/12 10:31PM	AJG
TOXAPHENE TCLP	EPA 8081A	ND ug/l	0.000972 ug/l*	06/28/12 10:31PM	AJG
CHLORDANE TCLP	EPA 8081A	ND ug/l	0.00267 ug/l*	06/28/12 10:31PM	AJG
AROCLOR-1016	EPA 8082	ND ug/kg DRY	1.89 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1221	EPA 8082	ND ug/kg DRY	5.96 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1232	EPA 8082	ND ug/kg DRY	3.97 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1242	EPA 8082	ND ug/kg DRY	1.91 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1248	EPA 8082	ND ug/kg DRY	2.17 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1254	EPA 8082	ND ug/kg DRY	2.02 ug/kg*	06/29/12 01:13PM	AJG
AROCLOR-1260	EPA 8082	196 ug/kg DRY	2.00 ug/kg*	06/29/12 01:13PM	AJG
2,4-D TCLP	EPA 8151A	ND mg/l	0.00170 mg/l*	06/28/12 04:23AM	AKP
2,4,5-TP (SILVEX) TCLP	EPA 8151A	ND mg/l	0.000114 mg/l*	06/28/12 04:23AM	AKP

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Authorized by: Oommen V. Kappil, QA Director

QC Laboratories

Analytical Report

Account No: AL0120, KCI TECHNOLOGIES, INC. **P.O. No:** **Inv. No:** 1429905
Project No: AL0120, KCI TECHNOLOGIES, INC. **PWSID No:**

Sample Number **Sample Description** **Samp. Date/Time/Temp** **Sampled by**
L4213617-2 CHESWOLD MY 06/21/12 09:45am NA F Customer
Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
SULFATE	EPA 9056 WO/COMB	128 mg/kg DRY	67.1 mg/kg	06/23/12 04:58AM XJY
CYANIDE REACTIVE	EPA 7.3.3.2	ND mg/kg	25.0 mg/kg	06/22/12 09:00AM MJP
CORROSIVITY (PH)	EPA 9045C	NEG		06/22/12 10:30AM KR
TCLP EXTRACTION	EPA 1311	COMPLETE		06/25/12 12:30PM KR
TCLP-O HEADSPACE EXTRACTION	EPA 1311	COMPLETE		06/25/12 12:30PM KR
IGNITABILITY	EPA 1030	NEG		06/26/12 06:00PM JG
REACTIVE HYDROGEN SULFIDE	EPA 7.3.4.2	ND mg/kg	50.0 mg/kg	06/22/12 09:00AM MJP
TOTAL SOLIDS PERCENT	SM 2540G	74.50 %	0.01000 %	06/22/12 12:45PM P P
METALS				
MERCURY-TCLP	EPA 7470A	ND mg/l	0.0000560 mg/l*	06/26/12 04:00PM RMP
SILVER-TCLP	EPA 6010C	0.00760 B mg/l	0.000580 mg/l*	06/28/12 07:26AM B B
ARSENIC-TCLP	EPA 6010C	0.00560 B mg/l	0.00360 mg/l*	06/28/12 07:26AM B B
BARIUM-TCLP	EPA 6010C	0.698 mg/l	0.000180 mg/l*	06/28/12 07:26AM B B
CADMIUM-TCLP	EPA 6010C	0.00140 B mg/l	0.000230 mg/l*	06/28/12 07:26AM B B
CHROMIUM-TCLP	EPA 6010C	ND mg/l	0.000450 mg/l*	06/28/12 07:26AM B B
LEAD-TCLP	EPA 6010C	0.00680 B mg/l	0.00210 mg/l*	06/28/12 07:26AM B B
SELENIUM-TCLP	EPA 6010C	ND mg/l	0.00520 mg/l*	06/28/12 07:26AM B B
GAS CHROMATOGRAPHY MASS SPECTROMETRY; SEMI-VOLATILES				
PYRIDINE-TCLP	EPA 8270C	ND mg/l	0.00580 mg/l*	06/28/12 05:43PM J-M
1,4-DICHLOROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00450 mg/l*	06/28/12 05:43PM J-M
2-METHYLPHENOL-TCLP	EPA 8270C	ND mg/l	0.00280 mg/l*	06/28/12 05:43PM J-M
HEXACHLOROETHANE-TCLP	EPA 8270C	ND mg/l	0.00450 mg/l*	06/28/12 05:43PM J-M
3&4-METHYLPHENOL-TCLP	EPA 8270C	ND mg/l	0.00540 mg/l*	06/28/12 05:43PM J-M
NITROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00430 mg/l*	06/28/12 05:43PM J-M
HEXACHLOROBUTADIENE-TCLP	EPA 8270C	ND mg/l	0.00390 mg/l*	06/28/12 05:43PM J-M
2,4,6-TRICHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00330 mg/l*	06/28/12 05:43PM J-M
2,4,5-TRICHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00240 mg/l*	06/28/12 05:43PM J-M
2,4-DINITROTOLUENE-TCLP	EPA 8270C	ND mg/l	0.00320 mg/l*	06/28/12 05:43PM J-M
HEXACHLOROBENZENE-TCLP	EPA 8270C	ND mg/l	0.00340 mg/l*	06/28/12 05:43PM J-M
PENTACHLOROPHENOL-TCLP	EPA 8270C	ND mg/l	0.00370 mg/l*	06/28/12 05:43PM J-M
TOTAL CRESOL-TCLP	EPA 8270C	ND mg/l	0.00540 mg/l*	06/28/12 05:43PM J-M
GAS CHROMATOGRAPHY MASS SPECTROMETRY; VOLATILES				
BENZENE	EPA 8260B	ND ug/kg DRY	1.24 ug/kg*	06/22/12 09:57PM MHA
TOLUENE	EPA 8260B	ND ug/kg DRY	1.52 ug/kg*	06/22/12 09:57PM MHA
ETHYL BENZENE	EPA 8260B	ND ug/kg DRY	1.51 ug/kg*	06/22/12 09:57PM MHA
M&P-XYLENES	EPA 8260B	ND ug/kg DRY	3.06 ug/kg*	06/22/12 09:57PM MHA
O-XYLENE	EPA 8260B	ND ug/kg DRY	1.23 ug/kg*	06/22/12 09:57PM MHA
VINYL CHLORIDE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 04:56PM JSH
1,1-DICHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00160 mg/l*	06/27/12 04:56PM JSH
2-BUTANONE-TCLP	EPA 8260B	ND mg/l	0.00720 mg/l*	06/27/12 04:56PM JSH
CARBON TETRACHLORIDE-TCLP	EPA 8260B	ND mg/l	0.00140 mg/l*	06/27/12 04:56PM JSH
CHLOROFORM-TCLP	EPA 8260B	0.00160 J mg/l	0.00120 mg/l*	06/27/12 04:56PM JSH

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QC Laboratories Analytical Report

Account No: AL0120, KCI TECHNOLOGIES, INC. **P.O. No:** **Inv. No:** 1429905
Project No: AL0120, KCI TECHNOLOGIES, INC. **PWSID No:**

Sample Number **Sample Description** **Samp. Date/Time/Temp** **Sampled by**
L4213617-2 CHESWOLD MY 06/21/12 09:45am NA F Customer
Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GAS CHROMATOGRAPHY MASS SPECTROMETRY; VOLATILES continued				
BENZENE-TCLP	EPA 8260B	ND mg/l	0.00110 mg/l*	06/27/12 04:56PM JSH
1,2-DICHLOROETHANE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 04:56PM JSH
TRICHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00130 mg/l*	06/27/12 04:56PM JSH
TETRACHLOROETHENE-TCLP	EPA 8260B	ND mg/l	0.00190 mg/l*	06/27/12 04:56PM JSH
CHLOROBENZENE-TCLP	EPA 8260B	ND mg/l	0.00120 mg/l*	06/27/12 04:56PM JSH
GAS CHROMATOGRAPHY				
GAMMA-BHC (LINDANE) TCLP	EPA 8081A	ND ug/l	0.0000201 ug/l*	06/28/12 10:55PM AJG
HEPTACHLOR TCLP	EPA 8081A	ND ug/l	0.0000215 ug/l*	06/28/12 10:55PM AJG
HEPTACHLOR EPOXIDE TCLP	EPA 8081A	ND ug/l	0.0000641 ug/l*	06/28/12 10:55PM AJG
ENDRIN TCLP	EPA 8081A	ND ug/l	0.0000243 ug/l*	06/28/12 10:55PM AJG
METHOXYCHLOR TCLP	EPA 8081A	ND ug/l	0.0000391 ug/l*	06/28/12 10:55PM AJG
TOXAPHENE TCLP	EPA 8081A	ND ug/l	0.000972 ug/l*	06/28/12 10:55PM AJG
CHLORDANE TCLP	EPA 8081A	ND ug/l	0.00267 ug/l*	06/28/12 10:55PM AJG
AROCLOR-1016	EPA 8082	ND ug/kg DRY	2.34 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1221	EPA 8082	ND ug/kg DRY	7.38 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1232	EPA 8082	ND ug/kg DRY	4.91 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1242	EPA 8082	ND ug/kg DRY	2.36 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1248	EPA 8082	ND ug/kg DRY	2.68 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1254	EPA 8082	ND ug/kg DRY	2.50 ug/kg*	06/29/12 01:50PM AJG
AROCLOR-1260	EPA 8082	ND ug/kg DRY	2.48 ug/kg*	06/29/12 01:50PM AJG
2,4-D TCLP	EPA 8151A	ND mg/l	0.00170 mg/l*	06/28/12 04:56AM AKP
2,4,5-TP (SILVEX) TCLP	EPA 8151A	ND mg/l	0.000114 mg/l*	06/28/12 04:56AM AKP

L4213617-1 :
The Leachate Fluid Blank associated with the TCLP Volatiles sample contained 0.0015mg/L of Chloroform.

QUALIFIERS: For metals parameters;"B" indicates a value that is > than the MDL but < than the laboratory quantitation limit. For Organics parameters; "B"is when the compound is found in the blank as well as in the sample;"J"indicates a value that is > than the MDL but < than the lowest standard, it is also used to indicate that a compound is tentatively identified in a library search;"E"(estimated) is when a compound exceeded the calibration range;"N" presumptive evidence of a compound; "D" is when a dilution was required.

L4213617-2 :

The TCLP extraction was performed in accordance with 40 CFR parts 261.24 and 268.7.
The Leachate Fluid Blank associated with the TCLP Volatiles sample contained 0.0015mg/L of Chloroform.

QUALIFIERS: For metals parameters;"B" indicates a value that is > than the MDL but < than the laboratory quantitation limit. For Organics parameters; "B"is when the compound is found in the blank as well as in the sample;"J"indicates a value that is > than the MDL but < than the lowest standard, it is also used to indicate that a compound is tentatively identified in a library search;"E"(estimated) is when a compound exceeded the calibration range;"N" presumptive evidence of a compound; "D" is when a dilution was required.

Notes:
- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too

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numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The reported results relate only to the samples.
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89021001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.
- The test results meet all requirements of NELAC unless otherwise specified.
- The report shall not be reproduced except in full without the written consent of the laboratory.

Regulatory authorities are assessing substantial fines for testing omissions. Please track your sample collections and results on a weekly, monthly, or quarterly basis to ensure compliance. QC's internet program 'LIVE ACCESS' will provide you with real-time access to collection dates and results. Please contact Customer Service for further information on acquiring LIVE ACCESS.
* - The "RLs" represents a reporting/quantitation limit. When an "*" is present in the column identified as the "RLs", it is being reported as a Method Detection Limit (MDL).

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QC Laboratories

Analytical Report

ACCREDITED IN ACCORDANCE WITH nelac

Printed: 07/23/12 17:07

BRUCE THOMPSON
KCI TECHNOLOGIES, INC.
1352 MARROWS ROAD
SUITE 100
NEWARK, DE 19711

Regarding:
BRUCE THOMPSON
KCI TECHNOLOGIES, INC.
1352 MARROWS ROAD
SUITE 100
NEWARK, DE 19711

Account No: AL0120, KCI TECHNOLOGIES, INC. **P.O. No:** **Inv. No:** 1433918
Project No: AL0120, KCI TECHNOLOGIES, INC. **PWSID No:**

Sample Number **Sample Description** **Samp. Date/Time/Temp** **Sampled by**
L4253200-1 CHAPMAN MY 06/21/12 01:30pm NA F Customer
Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
PAINT FILTER TEST	EPA 9095	NEG		07/23/12 06:45AM KR
TOTAL SOLIDS PERCENT	SM 2540G	92.27 %	0.01000 %	06/22/12 12:45PM P P

Sample Number **Sample Description** **Samp. Date/Time/Temp** **Sampled by**
L4253200-2 CHESWOLD MY 06/21/12 09:45am NA F Customer
Received Date/Time/Temp 06/21/12 08:40pm 39.5 F **Iced (Y/N):** Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
PAINT FILTER TEST	EPA 9095	NEG		07/23/12 06:45AM KR
TOTAL SOLIDS PERCENT	SM 2540G	74.50 %	0.01000 %	06/22/12 12:45PM P P

Notes:
- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The reported results relate only to the samples.
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89021001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.
- The test results meet all requirements of NELAC unless otherwise specified.
- The report shall not be reproduced except in full without the written consent of the laboratory.

Serial Number: 2278187

Authorized by: Oommen V. Kappil, QA Director

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

ACL — A10120 L4253200

QC Laboratories

1205 Industrial Blvd.
Southampton, PA 18966-0514
Phone: 215-355-3900
Fax: 215-355-7231

CHAIN OF CUSTODY

Page _____ of _____

Lab LIMS No: ~~L4213017.~~

Client/Acct. No. KCI Technologies

Address

City/State/Zip

Phone/Fax

Client Contact

Bill to/Report to: (if different)

Sampling Site Address: (if different)

P.O. No.

QC Contact

LAB USE ONLY: KD 7/20/12

___ Ascorbic/HCl Vials # ___ HCl Vials
___ $Na_2S_2O_3$
___ Na OH/Zn acetate pH
___ HNO_3 pH
___ H_2SO_4 pH
___ NaOH pH
#6 Unpreserved 2-g LCB, 4-split VOA
___ Hcl pH
#39 Temp controls ID# SE 100 Microlined

MATRIX CODES

DW: DRINKING WATER
GW: GROUND WATER
WW: WASTEWATER
SO: SOIL
SL: SLUDGE
OIL: OIL
SOL: NON SOIL SOLID
MI: MISCELLANEOUS
X: OTHER

LAB USE ONLY

PROJECT / FIELD ID	Collection Date	Collection Military Time	GRAB	COMP	Matrix Code	Number of Containers Total	H_2SO_4	HCl	Vials	HNO_3	NaOH	ZnAc	Unpre	Bact	ANALYSIS REQUESTED	Field pH, Temp (C or F), DO, Cl_2, S. Cond. etc.
Chapman MY	6/21/12	13:30 ~~14:05~~													Full TCLP/RCRA Chor/Sulfate/Percent	
Cheswold MY	6/21/12	~~14:05~~ 9:45													Solid/PCBs/BTEX	
															Paint filter added gh Rech 7/20/12	

SAMPLED BY: (Name/Company)

Verbal/fax data due: ___/___/___

Hardcopy due: ___/___/___

Report Format: ☐ Standard ☐ Forms ☐ Standard + QC ☐ NJ Reduced ☐ Disk

Please call for pricing and availability on rush (<14-21 day) turnaround and on all but standard format.

Field Parameters Analyzed By: Sig: Date/Time:

SAMPLE CUSTODY EXCHANGES MUST BE DOCUMENTED BELOW. USE FULL LEGAL SIGNATURE, DATE AND MILITARY TIME (24 HOUR CLOCK, I.E. 8AM IS 0800, 4 PM IS 1600)

	DATE	TIME		DATE	TIME
RELINQUISHED BY SAMPLER 1	6/21/12	14:10	RECEIVED BY 1	6/21/12	14:07
RELINQUISHED BY 2	6/21/12	14:45	RECEIVED BY 2	6/21/12	14:45
RELINQUISHED BY 3	6/21/12	2040	RECEIVED BY 3	6/21/12	2040
RELINQUISHED BY 4			RECEIVED BY 4		
RELINQUISHED BY 5			RECEIVED BY 5		

DELIVERY METHOD: ☐ QC COURIER ☐ CLIENT ☐ UPS ☐ FEDEX ☐ OTHER_____

Custody Seal Number

COMMENTS: 32.0°

Hazardous: yes / no

For example to aid completion, see reverse side.

FINAL REPORT

QC Laboratories

1205 Industrial Highway, Southampton, PA 18966

ATLANTIC COAST LABS

Inter-Laboratory Transport Form: AC062112

Coolers for Transport

To be completed by person sealing coolers					Complete Section Upon Delivery	
Cooler ID No.	Custody Seal No.	Date	Time	Initials	Temp °F	Iced Y/N
62	062112-1	6/21/12	15:10	PSL	39.5	Yes
A1	-2	↓	15:10	↓	36.5	Yes
container 1	-3	↓	15:10	↓	38.5	No
16	062112-4	6/21/12	1615	M.M.	50.0	Yes

Cooler 16 - All ice melted upon receipt. CM 6/21/12

CM 6/21/12

Please Note the Following:

Individual sample chains of custody must accompany this form.

Once a cooler is sealed, custody seals may not be broken until samples are received at the designated QCL laboratory.

Laboratory use only

Custody Seals intact upon receipt? (Y) N Initials: TB

List ID of any seal found broken upon receipt below:

A full legal signature is required. Record all times in military time (24-HR Clock, 4:00 PM=1600)

Relinquished by:	Date:	Time:		Received by:	Date:	Time:
RK	6/21/12	15:30		Secure Office		
Secure Office	6-21-12	19:20		[illegible]	6-21-12	1920
[illegible]	6-21-12	~~20:35~~	2040	[illegible]	6/21/12	2040
Relinquished by:	Date:	Time:		Received by:	Date:	Time:
		TB 6/21/12				

Appendix J. Article published in April 2013 issue of *Roads and Bridges Magazine*, summarizing results of the study of alternative guardrail vegetation management strategies.

By Susan Barton
Contributing Author

Guards lose cover

Study finds most effective way to treat guardrails

For the past 50 years or more, mowing and herbicides have been the predominant methods used to manage nationwide roadside vegetation.

New environmental laws, reduced budgets and increased public interests necessitate finding more environmentally sensitive methods, incorporating new technologies, incurring lower maintenance costs and finding cost-effective alternatives to today's methods of management of roadside vegetation. The Delaware Department of Transportation (DelDOT) is committed to reducing pesticide use in their transportation rights-of-way and therefore funded a study to look at various options for controlling vegetation under guardrails while maintaining functionality.

A variety of ways

The area adjacent to the guardrail must be kept clear of vegetation to allow clear visibility of the barrier. Robert Moosmann of Maine DOT explained that control of vegetation under and behind guardrails would restrict the buildup of debris, which includes sand and sediment that prevent proper sheet flow of water off the road surface. With unmanaged vegetation, rills develop behind the guardrail as water channels to points of least resistance and results in erosion. But low-growing grasses planted under guardrails can increase biofiltration of storm-water runoff.

Some states use mowing and hand trimming (mechanical control) as their primary management tool. Mowing, while evaluated as the most cost efficient currently available option in a California study, is often not

Left to right: U-Teck WeedEnder standard cut, U-Teck WeedEnder custom cut, Universal Weed Cover, TrafFix. All are guardrail treatments studied in Delaware.

feasible because of mower size and the inability to maneuver the mowing head around and under the guardrails. Hand trimming is time consuming and labor intensive as well as dangerous because of operator exposure working between traffic and the barriers.

With cultural control, a plant species is established that will compete with and suppress growth of the unwanted brush. A dense stand of low-growing plants is referred to as living mulch. White clover was tested as living mulch but did not establish successfully enough to compete with weeds. Where maintenance with residual herbicides has been practiced over a number of years, the lingering presence of residual herbicides may limit desirable plant growth, favoring the most aggressive and often undesirable species. Creating and encouraging stable, low-maintenance vegetation is a more permanent vegetation-management strategy and should be the goal for all rights-of-way. Weed-control mats (fiber and rubber) have been tested in some states, and concerns about joint sealing and molding around guardrail posts providing an opportunity for weed growth have been identified. Washington state tested several weed barriers and found a need for annual cleaning to remove accumulation of organic and inorganic debris. Without this debris removal, the organic buildup starts to grow grass and weeds. Although prohibitively expensive for normal guardrail locations, on sites where herbicide use is restricted, weed barriers may provide a viable option.

Herbicides are considered to be the cheapest and most efficient method of vegetation control. Two applications of herbicide are often sufficient to effectively treat weeds for a season. There also are many environmental, health and logistical problems with herbicide use. Herbicide spray trucks hamper traffic flow, often requiring a lane closure and causing traffic delays. Herbicide application is sensitive to weather conditions—herbicides cannot be applied on rainy or windy days. Human health risk is a concern, and protective equipment must be used

> **In Delaware, zoysiagrass** appears to be competitive enough to prevent weed incursion, at least in the first year of establishment.

Table 1. DelDOT Treatments Under Guardrails

Three herbicide formulations
Formulation 1 - standard DelDOT New Castle County formulation comprised of DuPont Karmex DF Herbicide (diuron), BASF Plateau (imazapic ammonium salt), Dow AgroSciences Accord XRT (glyphosate), BASF Pendulum (pendimethalin)
Formulation 2 - sensitive areas formulation comprised of BASF Plateau (imazapic ammonium salt), Dow AgroSciences Accord XRT (glyphosate), BASF Pendulum (pendimethalin)
Formulation 3 - Dow AgroSciences Accord XRT (glyphosate)
Four weed-control barriers
U-Teck WeedEnder standard installation (a permeable recycled fiber material)
U-Teck WeedEnder custom installation (a product designed to reach the road edge and accommodate variances in post width)
Universal Weed Cover (a semi-rigid panel made of 100% recycled plastic)
TrafFix (a rubber mat with three punched guardrail cutouts for flexible installation)
Competitive vegetation
Low fescue
Zoysia seed
Zoysia sod
Hand trimming
Pavement under guardrail

Irregular edge between herbicide-treated guardrail zone and median vegetation.

Table 2. DelDOT Suitability Rating and Weeds Rating Summarized by Treatments for 2011

Treatment	DelDOT suitability	Weeds
U-Teck WeedEnder standard cut	3.38	2.75
U-Teck WeedEnder custom cut	4.87	4.58
TrafFix	4.20	3.93
Low fescue	4.20	3.45
Zoysiagrass sod	4.93	4.47
Zoysiagrass seed	4.00	2.27
Hand trim	3.73	2.78

by applicators. Dead vegetation after the use of herbicides can be unsightly. Bare-ground herbicides can increase the risk of erosion and usually results in an uneven line between bare ground and living vegetation, which is unsightly. Herbicides are a tool in integrated vegetation management, but high ecological costs, high sociological costs and short-term, temporary benefits are prompting vegetation managers to look for alternatives.

Plotting for improvement

Most states use a mixture of vegetation-control methodologies. Site-specific procedures are selected rather than policy that applies to the entire state. The department of transportation can then utilize a geographic information system (GIS) to map populations and preserve desirable roadsides while managing undesirable vegetation. The first step is to decide if vegetation control is required based on surface-drainage issues; subsurface drainage issues; storm-water management; pavement breakup; visibility for safety; worker safety; fire starts; landscape design; wildlife road kill; and structural deterioration of guardrails. If control is required, feasibility of alternatives (mechanical, cultural, biological and chemical) is considered. Finally, criteria can be developed to identify highly sensitive areas that warrant finding workable alternatives to conventional maintenance even if costs increase.

In April 2008, 24 guardrail plots were selected on Delaware roadsides based on the presence of guardrail with low-growing existing vegetation, as well as accessibility for treatment and data collection. Treatments included three formulations of herbicide, four weed barriers, hand trimming, pavement, low fescue turf, zoysiagrass and a control (Table 1). There were three replications of each treatment located at different sections of guardrail and split between the two sites.

Low fescue plots were established using a low fescue blend (Silverlawn Creeping Red Fescue [34.46%]), Discovery Hard Fescue (27.34%), Rescue 911 Hard Fescue (27.32%) and Annual Ryegrass (9.98%), and were

hand trimmed as needed to meet DelDOT's safety requirements. Low fescue plots were spot-treated with herbicides as needed in order to reduce competition during the establishment period. Zoysiagrass plots were seeded with Compadre zoysiagrass. Zoysiagrass sod plots were prepped by raking out debris and digging out the soil so the sod could be installed level with the road surface and surrounding median turf. Hand-trimmed plots were trimmed as needed to maintain vegetation below the top of the guardrail. Hand trimming varied from year to year based primarily on rainfall. There was no vegetation-management strategy employed on the control treatment.

Plots were observed monthly during the growing season, and were assessed for compliance with DelDOT guardrail standards and the weed level present. A DelDOT acceptability rating was taken as an assessment of how well the plot conformed to DelDOT's requirement of a clear guardrail on a scale of 1-5 (1 = guardrail completely obscured; 2 = vegetation covering most of guardrail; 3 = vegetation taller than guardrail in spots; 4 = vegetation starting to grow taller than guardrail in spots; 5 = no vegetation near guardrail). A weeds rating was assigned on a scale of 1-5 (1 = completely overgrown with weeds; 2 = a high level of weeds present; 3 = moderate weeds present; 4 = a few weeds present; 5 = no weeds present).

FACT FINDER

When you consider amortization over a 10-year lifespan, weed-control barriers are still the most expensive vegetation-control option under guardrail.

Optimal options

Vegetation management of some kind is necessary to keep guardrails from being obstructed. Guardrails were still visible for the first year with no treatment, but early in the growing season of the second year they were obstructed.

Herbicides have been the traditional method of vegetation control in Delaware. The standard DelDOT guardrail formulation (DuPont Karmex DF Herbicide [diuron]), BASF Plateau (imazapic ammonium salt), Dow AgroSciences Accord XRT (glyphosate) and BASF Pendulum (pendimethalin) is used in most places, and an alternative formulation of BASF Plateau (imazapic ammonium salt), Dow AgroSciences Accord XRT (glyphosate) and BASF Pendulum (pendimethalin) is used in sensitive areas. Both provided adequate vegetation control when applied once a year. A third formulation (Dow AgroSciences Accord XRT [glyphosate]) did not adequately control vegetation. Herbicide treatments result in bare ground for most of the year. Erosion can be a problem when bare ground is maintained. After treatment, a brown zone of vegetation exists below the guardrail and can be unsightly, especially when spray drift or misapplication results in an uneven treatment edge.

We know that herbicides will prevent roadside vegetation from interfering with the guardrail and provide an inexpensive control option (Table 3). The goal of this project was to find a more environmentally satisfactory alternative to herbicide

Table 3. Cost Comparison of Guardrail Treatments in Delaware (per 100 linear ft of guardrail)

Treatment	Installation cost	Yearly maintenance cost	Installation cost (amortized over 10 years)	Total yearly cost (incl. amortized installation cost)
Standard herbicide formulation (1)	0	$44.92	0	$44.92
Sensitive site herbicide formulation (2)	0	$44.20	0	$44.20
Accord (glyphosate)-only formulation (3)	0	$38.58	0	$38.58
U-Teck WeedEnder standard cut	$1789.52	$24.00[1]	$178.95	$202.95
U-Teck WeedEnder custom cut	$2197.54	$8.00[2]	$219.75	$227.75
Universal Weed Cover	$2607.00	0	$260.70	$260.70
TrafFix	$2537.17	$24.00[1]	$253.72	$277.72
Low fescue	$444.33	$47.02[3]	$44.43	$75.34
Hand trimming	0	$24.00[1]	0	$24.00
Zoysia sod	$1,582.28	0	$158.23	$158.23
Zoysia seed	$345.28	$16.00[4]	$34.53	$50.53
FlightTurf	$541.93	TBD	$54.19	$54.19
Control	0	0	0	0

[1] Includes 1.5 hand trims/100 linear ft, no herbicide treatment.
[2] Includes .5 hand trims/100 linear ft, no herbicide treatment.
[3] Includes 1.5 hand trims/100 linear ft, and 1.25 herbicide treatments/100 linear ft. (The herbicide treatment for low fescue is assumed to be required for three years until the low fescue stand becomes thick enough to outcompete other vegetation.)
[4] Includes 1 hand trim/100 linear ft. (This is based on only one year of data and assumed to be at least 1.5x in future years.)

Strip between weed barrier and pavement allowing weed growth.

use, so alternative control measures must compare favorably with herbicide use in terms of effectiveness, cost, environmental impact and aesthetics.

Weed-control barriers are difficult to retrofit in existing sites where the weed barrier cannot be laid true to the side of the road and on a perfectly flat surface. They are more appropriate in new road situations where grading and consistent distance between guardrail and road surface can be controlled. Vegetation growing over the surface of the barrier is not a problem, since the plants that grow over the surface are low. Deposition of organic material on the barrier surface that supports weed growth may result in taller weed growth and is more likely to happen the longer the barrier stays in place on the roadside. Caulk is the weakest portion of the barrier and may degrade faster than the barrier fabric, resulting in breakthrough vegetation. Installation error also is a cause of barrier breakthrough. Expertise (possibly by vendors themselves) is required for installation.

Vegetation grows in open soil between the road surface and barrier when the barrier cannot abut the road surface. The U-Teck WeedEnder custom cut product was designed to address this issue. In some guardrail situations this product can abut or overlap the road surface, but in some cases the guardrail is located too far away from the road surface to make this feasible.

Low fescue turf is used under guardrail to provide a solid low-growing ground cover that competes with other weedy plants that will grow taller and disturb the integrity of the guardrail. In 2009 and 2011, selective herbicides were used to reduce the broadleaved weed and annual grass competition. Low fescue did not establish a dense enough cover to outcompete weeds during the course of this study. Plots required hand trimming, but the low fescue plots were superior in appearance to the hand-trimmed plots, because they contained a larger percentage of desirable turf.

Zoysiagrass did not establish from seed in 2012, but zoysiagrass sod established within one month and provided a competitive cover under the guardrail. Zoysiagrass sod was competitive enough to prevent significant weed incursion during the first year after planting. It did not require mowing during the first year. Since zoysiagrass is a warm-season grass, it went dormant and turned brown in Delaware after the first frost.

Hand-trimmed plots required trimming twice a year for the first two years

The picture above shows Bermuda grass growing around guardrail beam where caulk malfunctioned.

The study revealed that zoysiagrass sod provided a competitive, low maintenance vegetative cover under guardrail.

of the study, when they were trimmed in May and September. By waiting until mid-June for the first trimming, most plots were maintained at an appropriate height for guardrail function with one hand trimming per year. On average over the four years of data collection these plots were trimmed 1.5 times a year. Hand trimming results in relatively solid vegetation under the guardrail, which reduces erosion potential and is more attractive than bare-ground treatment.

When you consider amortization over a 10-year life span, weed-control barriers are still the most expensive vegetation-control option under guardrail. They may be warranted in highly sensitive areas where herbicide use is unacceptable or other conditions warrant the complete lack of vegetation under guardrail.

Low fescue, if it is established within three years, provided a competitive enough mat of vegetation such that selective herbicides were no longer needed and competes favorably in cost per 100 linear ft with herbicide treatments. Herbicide use has not been eliminated for the first three years, but the herbicide use is selective rather than a nonselective burn-back of all existing vegetation. So, erosion is not a problem and the guardrail treatment is more aesthetically pleasing than bare ground, especially compared with an uneven treatment edge that often exists between the guardrail zone and the median vegetation with bare-ground herbicide treatment.

Hand trimming is the least expensive control method employed in this study (other than the control). This was true when DelDOT crews performed the hand trimming. If outside contractors were hired to hand trim, the cost per year would be approximately double the herbicide and low fescue treatments.

Since zoysiagrass did not establish from seed during the first year, this does not appear to be a viable establishment protocol on the roadside. Zoysiagrass sod appears to be an effective vegetative cover. North Carolina has reported that centipedegrass and zoysiagrass can provide a stable competitive vegetation under guardrail.

In Delaware, zoysiagrass appears to be competitive enough to prevent weed incursion, at least in the first year after establishment. It will be interesting to continue observation of zoysiagrass sod plots to see how frequently hand trimming is required and if it remains competitive under the guardrail. Based on the performance of zoysiagrass in lawns in Delaware, it is expected to start to grow into the adjacent median. R&B

Barton is an associate professor and extension specialist at the University of Delaware.

For more information about this topic, check out the Maintenance Channel at www.roadsbridges.com.

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Appendix K. University of Delaware mowing study final report.

Mowing Study on Delaware Roadsides

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DelDOT Mowing Study

Maintaining roadsides for safety and aesthetics is important to DelDOT, Delaware government and Delaware residents. A healthy roadside environment reduces maintenance needs and costs, preserves the road surface, provides safety for vehicles and travelers, maintains good public relations, and improves the overall driving experience (Johnson, 2000). The most significant component of roadside vegetation maintenance is mowing the vegetation in the right-of-way adjacent to the road.

While recommendations for management of fine turf dictate a 2-3 inch mowing height, it has been found that utility turf, such as roadsides, can be mowed to 6 inches and provide an appropriate cover that is safe and aesthetically pleasing. Mowing increases the competitiveness of desirable grasses over undesirable plants if mowed high (6 inches) and infrequently (twice a year) (Gover et al., 2000 and Gover, 2003).

Researchers at Penn State conducted a mowing demonstration study in cooperation with PennDOT in the late 90's. In an area of limited access highway that was predominately vegetated with K31 tall fescue, they mowed once in early June and once in the fall. They compared the quality of cut using a flail mower and a rotary mowed in different sections of the demonstration plot. Both mowers performed well and provided a 6-inch cut. The only differences between the mowers were that the flail mowed left more clippings than the rotary mower; however neither produced enough grass clippings to smother the existing turf. The demonstration area had better turf color during the summer months than the surrounding routinely maintained turf because it was not mowed as often or as short, causing less stress to the turf (Gover et al., 1997).

The DelDOT mowing specifications are to maintain routinely mowed roadside turf to a height of six inches. In fact, roadside turf is mowed in all four districts to a height of approximately 2 inches. Turf is mowed infrequently enough that long clippings often lay on the mowed turf, excluding light and causing turf grass injury. This injury often results in dead patches that allow weed incursion and the final result is a degraded turf grass condition.

The objective of this study was to compare roadside turf mowed to a height of 6 inches and to a height of 2 inches, evaluating turf quality and weed presence with the two different mowing regimes.

Materials and Methods:

Plots were maintained in two locations—Milford bypass (6 plots) and I95 medians (6 plots). Each plot was approximately 200 feet. At each location, three plots were mowed to a height of 6 inches and three plots were mowed to a height of 2 inches.

In 2010, plots were mowed six times during the growing season. The mowing sites were visited three times to collect data. Each treatment was documented with photographs. Notations were made on weeds present, clippings and level of turf decline. Photographs were taken of each plot with each data collection visit.

In 2011, I95 plots were mowed 7 times and Milford plots were mowed six times during the growing season. The mowing sites were visited three or four times (I95 – 3 and Milford -4) to collect data. Each treatment was documented with photographs. Notations were made on weeds present, clippings and level of turf decline.

Results and Discussion:

The following weeds were observed throughout the plots—broad-leaved plantain, narrow-leaved plantain, crabgrass, foxtail, clover, weeping lovergrass, dandelion, oxalis, black medic, buttercup, wild lettuce, chickweed, spotted knapweed; thistle and nightshade. Photographs were taken documenting that matted clippings often lay on the closely mowed treatment plots, excluding light and causing turf grass injury. This injury often results in dead patches that allow weed incursion. The final result is a degraded turf grass condition.

Clippings laying on the surface of a 2" mowed plot along I95.

Matted clippings excluding light and killing grass below the clippings

During October 2011 under drought conditions, the 2-inch plots turned brown first. The 6-inch plots stayed green longer although they went dormant eventually. Gover et al (1997) also reported greener turf in plots maintained at 6 inches in the Penn State demonstration study.

6" mowing height plot in Milford on 10/31/11.

2" mowing height plot in Milford on 10/31/11.

Conclusions:

It was difficult to see species composition changes in the amount of time the turf was managed with 2-inch mowing and 6-inch mowing. There was already a significant weed population in the turf at the start of the experiment so it was hard to document increased weeds with the 2" mowing. It would be better to start with newly planted turf and monitor the effects of close cropping and 6" mowing.

These results do support the recommendation to maintain roadside turf at a height of 6 inches, reducing the unsightly clippings that lay on the turf after mowing; preventing matting of clippings that kill vegetation below and provide an opportunity for weed incursion; and reducing stress on vegetation so it stays green longer under drought conditions.

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