Upper Raccoon Creek
Watershed Based Implementation Plan
October 2008

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The Camden and Gloucester County Soil Conservation Districts with Rowan University and the Gloucester County Department of Public Works –Division of Planning prepared this Watershed Based Implementation Plan for the Upper Raccoon Creek Watershed. The project is funded by a 319h NPS Pollution Control and Management Implementation Grant from the New Jersey Department of Environmental Protection.

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Raccoon Creek Watershed

Recommended Management Strategies

The Raccoon Creek Watershed Characterization and Assessment Report defines the current condition of the watershed and many of the stormwater related features. Further investigations, data collection, research and analysis since the reports publication have provided more information on some of these features or issues. This information, combined with input from the watershed stakeholders, has resulted in this list of recommended management strategies.

These strategies are grouped into four categories: General Provisions, Priority Projects, Design Standards and Proposed Municipal Ordinances. Each strategy is directly supported by work included in either the C&A report or one of the supporting reports completed by project staff and partners. Where appropriate, the supporting report or section is referenced.

It should be noted that land preservation, especially forested land, will provide the greatest benefits to the Raccoon Creek in terms of maintaining stormwater quantity and quality and enhancement of groundwater recharge. Farmland preservation, open space preservation, deed restriction, conservation easements, greenways and all other methods of land preservation should be actively promoted, funded and endorsed.

The Raccoon Creek Watershed stakeholders, especially county and municipal planners, local planning boards, engineers and regulatory reviewing agencies should carefully review this information for inclusion into their procedures, policies and requirements.

General Provisions

1. Maintain a Raccoon Creek Watershed Stakeholder Committee to monitor conditions and progress and to coordinate activities at a watershed level. The County Planning Division could facilitate this committee.

2. Monitor Sentinel Cross-Sections for evidence of stream degradation and develop a response plan if degradation is confirmed. *See Sentinel Cross-Section Repor*t

3. Planning boards should carefully investigate the impact of development on headwater /wetland type streams and ravine tributaries. Avoid changes to the peak rate, volume and duration of runoff to limit the potential of stream degradation. *See C&A Report, Section 2.2.1*

4. Monitor all stormwater basins for effectiveness and efficiency. Failures or maintenance should be addressed immediately. *See C&A Report, Section 2.2.3*

5. Ensure that all basins are owned and maintained by an entity with sufficient expertise and financial resources. Private ownership of stormwater basins is discouraged. *See C&A Report, Section 2.2.3*

6. For all roadway improvement projects provide adequate stormwater management facilities and avoid direct connection of impervious cover to the stream network. *See C&A Report, Section 2.2.5*

7. Monitor lakes and ponds for degradation. Provide adequate protections for any lake currently swimmable to ensure the continued high level of water quality. *See C&A Report Section 2.2.8*

8. Promote through existing Federal, State and local programs agricultural Best Management Practices to control erosion, reduce surface runoff and enhance water quality of any runoff. Support efforts through cost share and other sources of funding. *See C&A Report, Section 2.2 6*

9. Implement recommendations of the Princeton Hydro, LLC report *Mullica Hill Pond Characterization and Restoration Plan*, August 2008. Major components of this plan include:
    - Use algaecide, biomanipulation and/or mechanical harvesting to reduce excessive algal biomass
    - Enhance circulation with aeration to reduce internal phosphorus load
    - Implement effective Canada goose controls
    - Consider dredging to improve aesthetic and recreational value
    - Implement watershed wide management strategies to reduce Non-point Source Pollution loads, including a low/no phosphorus fertilizer ordinance

Priority Projects

1. Complete stormwater basin, stream restoration and stormwater outfall repairs as specified in the *Priority Restoration Projects*. These projects include basin retrofit at five locations, seven stormwater outfall repairs and three stream restorations. The highest priority is Stream Reach 3001R03.

2. Address high E. coli levels in the South Branch headwaters by:
    a. Positively identifying the source(s) of bacteria. Additional sampling locations to narrow the source and/or source tracking using a method such as Quantitative Polymerase Chain Reaction (qPCR) to positively identify to source of this impairment. Once identified remedial action must be taken.
    b. Develop and implement repair, retrofit or replacement of any identified point or non-point sources

    See the Raccoon Creek Bacteria Monitoring Report

Design Standards

1. Natural Stream Restoration projects require a reference reach to determine stream geometry dimensions and ratios. Use Cartwheel Branch (Reach 1006R02a) as a Reference Reach for Natural Stream Restoration Project. *See C&A Report, Section 2.2.1 and contact the SCD for reference reach data.*

2. Ensure that culverts, cross-drains and bridge repairs meet all design requirements and avoid to greatest extent possible increasing discharge rates or volumes through these structures. Ideally, all culverts should be replaced with a similar size structure while maintaining the same inverts. *See C&A Report, Section 2.2.2*

3. All hydrologic analysis must address existing depression storage through appropriate use of ponding factors or other hydrologic methods. *See C&A Report, Section 2.2.9*

4. Adopt through ordinance or as a Special Area Standard in the New Jersey Residential Site Improvement Standards the recommendations and optimized Curve Number Table proposed by Schnabel Engineering in their report *Hydrologic Parameters for Upper Raccoon Creek Watershed Regional Stormwater Management Plan*, September 17, 2008

Municipal Ordinance

1. Adopt a Low/ No Phosphorus Fertilizer Ordinance

2. Adopt a Riparian Buffer Conservation Ordinance. *See C&A Report, Section 2.2.7 and Draft Ordinances*

3. Adopt through ordinance the recommendations and optimized Curve Number Table proposed by Schnabel Engineering in their report *Hydrologic Parameters for Upper Raccoon Creek Watershed Regional Stormwater Management Plan*, September 17, 2008

Raccoon Creek Watershed
Priority Restoration Projects

Introduction

The Raccoon Creek Watershed Characterization and Assessment (C&A) report recommends several management strategies. These strategies are grouped into four categories: General Provisions, Priority Projects, Design Standards and Proposed Municipal Ordinances. Each strategy is directly supported by work included in either the C&A report or one of the supporting reports completed by project staff and partners. Three of these strategies address the retrofit, restoration or repair of existing stormwater structures or stream segments.

In each case, the priority projects were evaluated and selected based on the data collected during the initial characterization and assessment completed during the RSMP project. Impaired and inadequate features were evaluated and ranked based on the potential water quantity and quality benefit to the watershed. The priority list includes the feature name, location (provided in a watershed map), a brief description of the problems and several potential solutions. The projects are listed in random order and there has been no effort to prioritize project areas within these lists.

Stormwater Basins

The Raccoon Creek Watershed Characterization and Assessment Report identified 5 basins where renovations, retrofit or modifications would improve their performance in mitigating runoff. In many cases these basin were designed for flood control and provided little if any mitigation of high frequency storms.

The following basins were selected for retrofit based on the following criteria:

- Size of the basin,
- Size of the lowest orifice or weir on the basin outlet structure,
- Presence of a concrete low flow channel,
- Suitability to promote recharge (soils conditions, depth to groundwater, etc),
- Land use of the drainage area,
- Proximity of basin inflow to basin outlet.

Each basin was reviewed objectively based on these criteria and subjectively based on the experience of the project staff regarding basin retrofit issues.

Basin retrofit projects will fall into three general categories:

- Outlet structure modification,
- Renovations to increase infiltration potential and pollutant removal, (i.e. low flow channel removal, lengthened flow path, soil remediation, vegetation enhancement),
- Installation of additional treatment devices.

Stormwater Outfalls

The C&A report identified 7 outfalls that are either degraded or discharge to a degraded area. These failures are most often the result of either a poorly sited outfall, where a gully has formed down slope from the outfall or an outfall that discharged directly to a stream corridor that has undergone channel erosion. Often failing outfalls become public safety concerns when erosion resulting from the failure endangers buildings or roadways.

This priority list of stormwater outfalls in need of repair, maintenance, or reconstruction is based on the following criteria:

- Causing erosion or other damage to public or private structures or property,
- Severity of the erosion at the outfall,
- Contribution to downstream siltation.

Although a specific design for the repair or renovation of the prioritized outfalls, most will fit into one of the following categories:

- Installation of riprap or other suitable protection,
- Removal and replacement,
- Removal and relocation, with drop structures as necessary,
- End of pipe or inline treatment

Stream Corridor Restoration

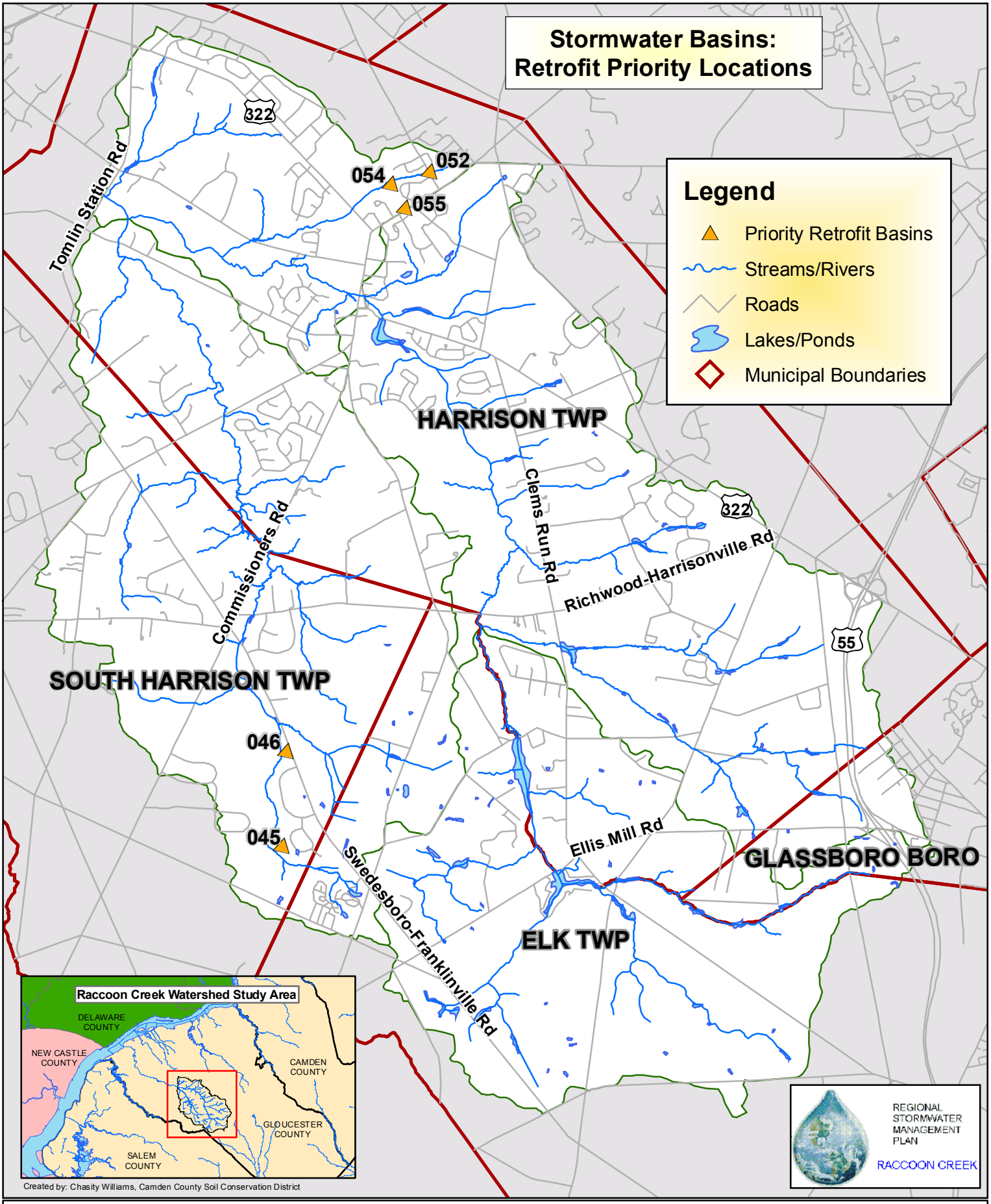
The C&A report characterizes much of the Raccoon Creek stream corridor as good. Only a handful of reaches were ranked as impaired during the assessment. The impaired reaches are characterized by eroded stream banks, incised stream channels, silted streambeds and sometimes limited riparian buffer.

The priority list of stream corridor restoration projects is based on the following criteria:

- Extent of streambank erosion
- Extent of channel erosion or incision
- Streambed substrate, siltation and presence or absence of pools
- Presence and quality of riparian buffer

Stream corridor renovations will require extensive planning and design, unique to every reach. The identified reaches typically will include at least one of the following measures:

- Grade Control
- Bank Stabilization
- Sediment Removal
- Buffer enhancement
- Hard armor or streambank stabilization
- Bio-engineered solutions
- Vegetative enhancements



Created by: Chasity Williams, Camden County Soil Conservation District

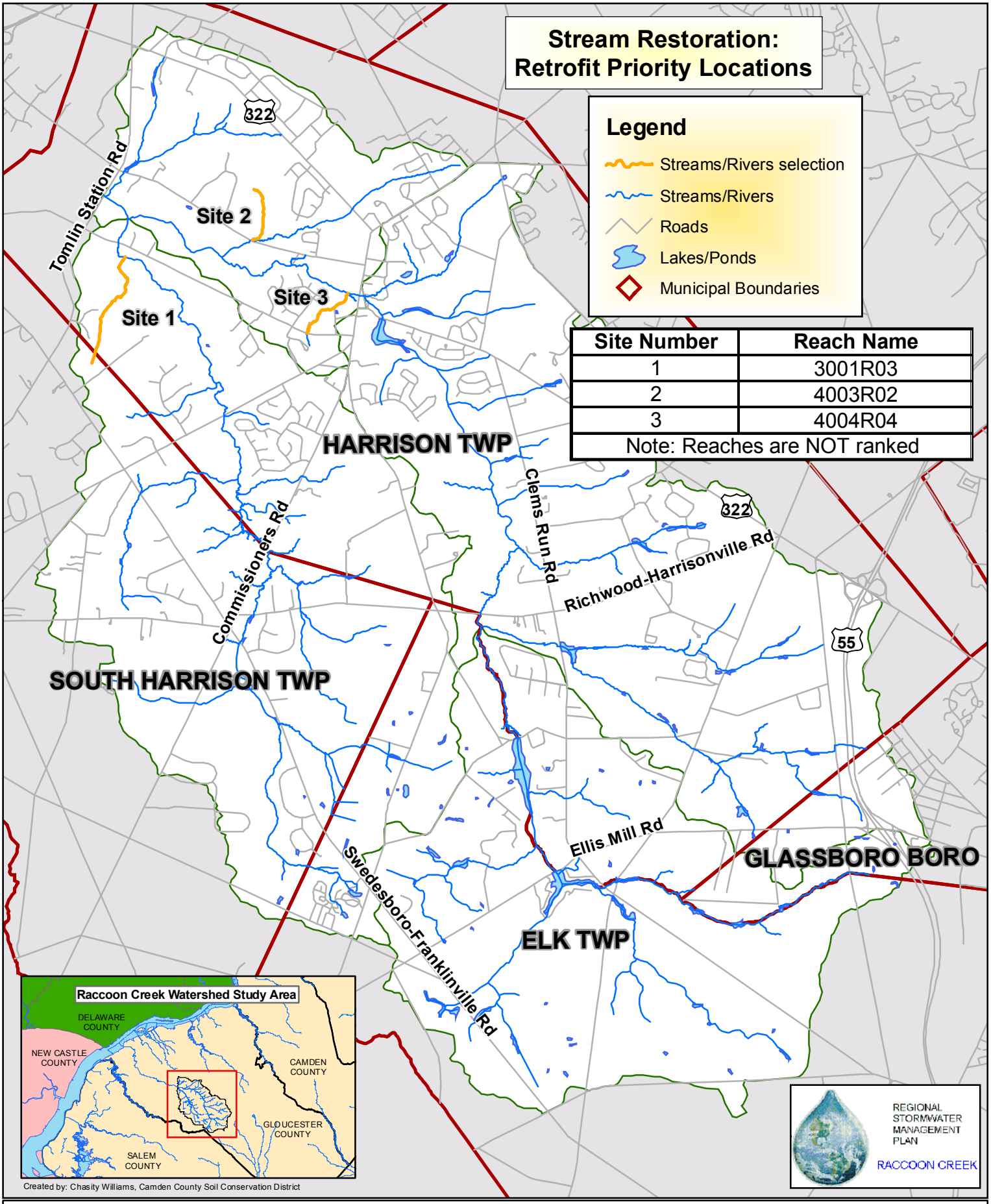
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

Priority Retrofit Stormwater Basins

Basin ID#	Location of Stormwater Basin	Impairments	Potential Solution(s)	Ownership
045	Basin located on Greenbriar Road off of Hollybrook and Shadybrook Roads in South Harrison Township within the Hollybrook Estates Development	Concrete lowflow channel, limited infiltration, excessive siltation	Remove lowflow channel, restore infiltration, regrade to add meanders, plant vegetation	Individual
046	Basin located at the corner of Swedesboro-Franklinville Road and Hollybrook Road in South Harrison Township within the Hollybrook Estates Development	Concrete lowflow channel, limited infiltration, excessive siltation	Remove lowflow channel, restore infiltration, regrade to add meanders, plant vegetation	Individual
052	Basin located on Wolfert Station Road southeast of Briarwood Road and Meadowview Court in the Mullica Hill Section of Harrison Township within the High Meadows Development	Outlet oversized, excessive siltation, limited infiltration	Outlet modification, restore infiltration, regrade to add meanders, plant vegetation	Home Owners Association
054	Basin located on the bend on Colson Lane in the Mullica Hill Section of Harrison Township within the High Meadows Development	Concrete lowflow channel, limited infiltration, excessive siltation	Remove lowflow channel, restore infiltration, regrade to add meanders, plant vegetation	Business
055	Basin located at the corner of Main Street and Colson Lane in the Mullica Hill Section of Harrison Township	Concrete lowflow channel, limited infiltration, excessive siltation	Remove lowflow channel, restore infiltration, regrade to add meanders, plant vegetation	Business

Stream Restoration: Retrofit Priority Locations



Site Number	Reach Name
1	3001R03
2	4003R02
3	4004R04
Note: Reaches are NOT ranked	

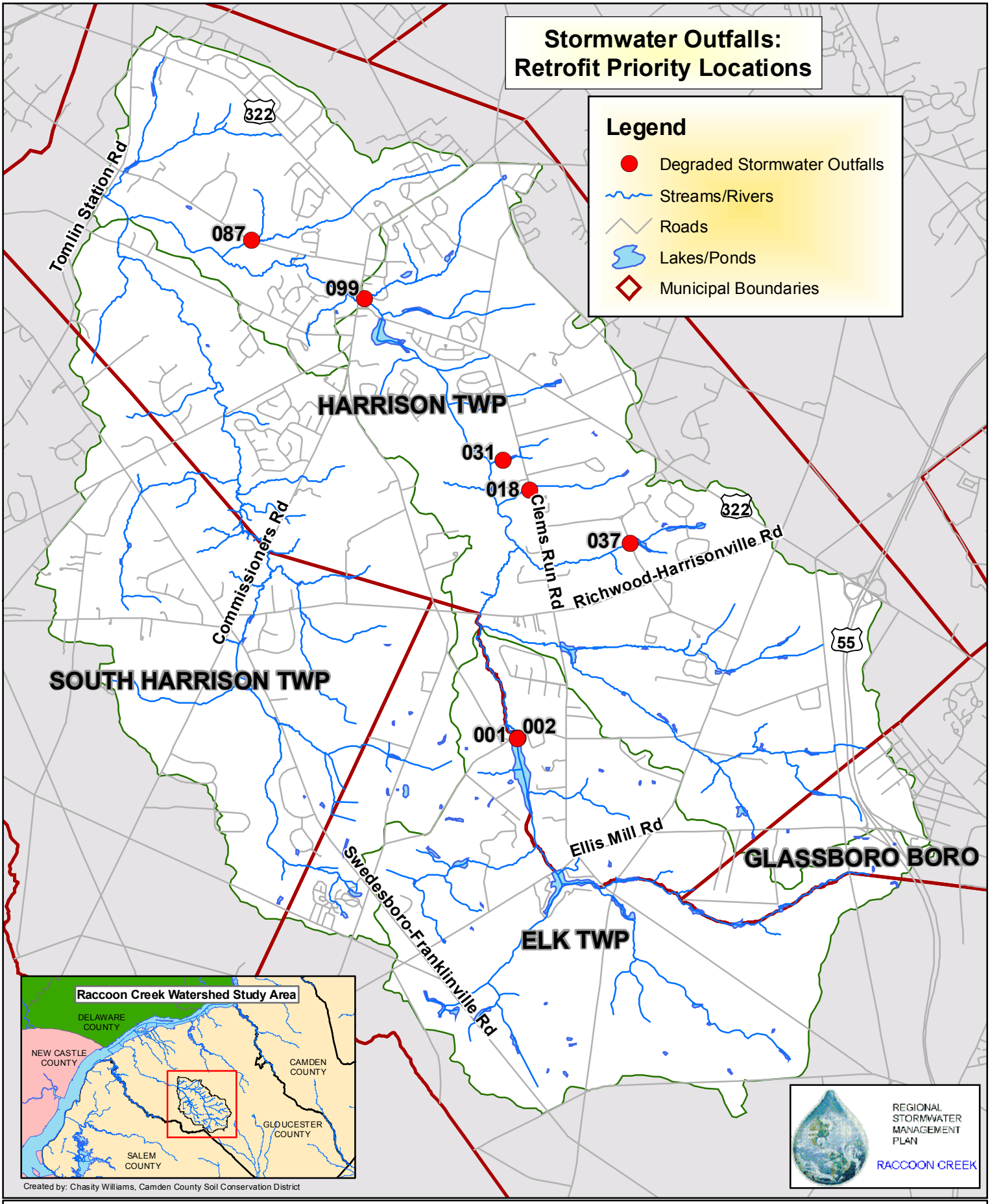
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Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

Stream Restoration Priority Projects

Reach Name	Stream Name	Location of Stream Restoration	Impairments	Potential Solution(s)	Comments
3001R03	Tributary #16 - South Branch Raccoon Creek	Stream located between Swedesboro-Franklinville Road (downstream) and Confluenc with South Branch Raccoon Creek in South Harrison Township	Severe streambank erosion, excessive siltation, severe erosion of side slopes	Streambank stablization, sediment removal, side slope protection	Excessive cutting of streambanks and side slopes
4003R02	Tributary #21 - Raccoon Creek	Stream originates at a culvert/cross-drain on Woodland Avenue (upstream) in the Mullica Hill Section of Harrison Township	Excessive siltation	Sediment removal	
4004R04	Tributary #19 - Raccoon Creek	Stream originates at a culvert/cross-drain on High Street (downstream) north of Eric Road and Confluence Raccoon Creek in the Mullica Hill Section of Harrison Township	Severe streambank erosion, excessive debris and siltation	Streambank stabilization, removal of debris and sediment	
Note: Reaches are not listed in any particular order.					


Stormwater Outfalls:
Retrofit Priority Locations
Legend
Degraded Stormwater Outfalls
Streams/Rivers
Roads
Lakes/Ponds
Municipal Boundaries
322
Tomlin Station Rd
087
099
HARRISON TWP
031
018
Clems Run Rd
322
037
Richwood-Harrisonville Rd
Commissioners Rd
55
SOUTH HARRISON TWP
001
002
Ellis Mill Rd
GLASSBORO BORO
Swedesboro-Franklinville Rd
ELK TWP
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
0
0.5
1
2
Miles

Stormwater Outfalls: Retrofit Priority List

GCSCD Label ID	SWO ID	Outfall Area	Condition of Outlet	Outlet Discharge	Potential Solution(s)
001	1001SWO01	Eroded embankments	Suspended	Stream or River	Drop Manhole, Replace Outfall with headwall, Restore Riprap
002	1001SWO02	Eroded embankments	Suspended	Stream or River	Drop Manhole, Replace Outfall with headwall, Restore Riprap
018	2002SWO03	Eroded embankments	Suspended	Stream or River	Replace outfall, Restore Riprap, Replace Fill around outfall pipe
031	2002SWO16	Eroded embankments	Suspended	Stream or River	Drop Manhole, Replace Outfall with headwall, Restore Riprap
037	2004SWO06	Eroded embankments	Suspended	Stream or River	Replace outfall, Restore Riprap, Replace Fill around outfall pipe
087	4003SWO01	Eroded embankments	Suspended	Stream or River	Drop Manhole, Replace Outfall with headwall, Restore Riprap
099	4004SWO08	Eroded embankments	Suspended	Stream or River	Drop Manhole, Replace Outfall with headwall, Restore Riprap

Potential Retrofit to Stormwater Outfalls






2002SWQ03


2002SWQ16


2004SWQ06


4003SWQ01


4004SWQ08

Raccoon Creek Watershed

Characterization and Assessment Report

February 2006
Revised October 2008

Prepared for: The Raccoon Creek Regional Stormwater Management Committee for the purpose of preparing a Raccoon Creek Regional Stormwater Management Plan

Prepared by: Gloucester and Camden County Soil Conservation Districts
Rowan University
Gloucester County Department of Public Works –Division of Planning

The information contained in this report is for planning and evaluation purposes only and is presented to assist in the development of a Regional Stormwater Management Plan. A Professional Engineer must make all design determinations and no structure or engineering design should be based on this information without detailed analysis by the proper professionals.

The Camden and Gloucester County Soil Conservation Districts with Rowan University and the Gloucester County Department of Public Works –Division of Planning prepared this Characterization and Assessment Report of the Raccoon Creek Watershed. The project is funded by a 319h NPS Pollution Control and Management Implementation Grant from the New Jersey Department of Environmental Protection. The watershed stakeholders, organized as a Regional Stormwater Management Committee, will use the information contained in this report to prepare and implement a Regional Stormwater Management Plan.

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Executive Summary

The Gloucester and Camden Soil Conservation Districts and Rowan University, with the cooperation of the Gloucester County Public Works Department – Division of Planning, have prepared this Draft Characterization and Assessment (C&A) of the Raccoon Creek Watershed. The Characterization and Assessment Report will support the development of a Regional Stormwater Management Plan for the Raccoon Creek Watershed. The project is funded by a Nonpoint Source Pollution Control – Section 319(h) grant and is administered by The New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management.

This Characterization and Assessment Report provides the stakeholders of the Raccoon Creek Watershed with a detailed understanding of the current condition of the surface water resources of this watershed and the information and tools to prepare and adopt an implementable Regional Stormwater Management Plan (RSMP). A Regional Stormwater Management Committee (RSMC) comprised of the watershed stakeholders and project partners, and organized by the Lead Planning Agency (the Gloucester County Planning Division) will be responsible for taking the recommendations of this report and preparing an implementable RSMP.

Located in Watershed Management Area 18, the Raccoon Creek flows from east to west in Gloucester County toward the Delaware River. The study area focuses on the upper portions of the Raccoon Creek, its streams and tributaries and all the lands draining to these streams. The watershed encompasses a total area of 25.67 square miles with 63 linear miles of watercourse. The main stem drains approximately two-thirds of this area with the remainder draining to the South Branch Raccoon Creek. The downstream terminus of the project area is just below the confluence of the main stem and the south branch at Tomlin Station Road (County Route (CR) #607). Four municipalities: Elk Township, Glassboro Borough, Harrison Township and South Harrison Township, contain lands within the watershed.

The Raccoon Creek Watershed is currently experiencing booming development and includes some of the fastest growing municipalities in the county. Despite this recent growth, the watershed remains predominantly agricultural land and the stream corridor

remains largely intact without significant degradation. However, land use changes in the watershed are likely to impact both surface water quality and quantity.

The Characterization and Assessment Report reviews many of the features impacting, or impacted by, surface water in the Raccoon Creek Watershed. It identifies impairments, issues and concerns, and recommends strategies, solutions and ideas to be adopted in a Regional Stormwater Management Plan.

The stream corridor was inspected and assessed to establish a baseline of current conditions and determine the need for stream rehabilitation or restoration. The stream channels and valleys exhibited a wide range of geometry, profile and forms, but nearly all fit into one of three broad categories: the flat headwater/ wetland streams, the ravine tributaries and the channel and valley streams. Although only a few reaches exhibit significant impairment, the headwater/wetland and ravine tributaries are vulnerable. The regional plan should carefully investigate the impact of development on headwater /wetland type streams and ravine tributaries. Management strategies, land use decisions and design criteria should all be considered to further protect these resources. Management strategies could include stream protection ordinances, enhanced recharge requirements, limitations on acceptable discharge locations, low impact design requirements or other suitable measures.

Bridges, culverts, cross drains and stormwater outfalls were mapped and assessed. In general, these structures are in satisfactory conditions and do not require specific management measures beyond that required for standard maintenance, repair or replacement. However, in all cases, replacement of any culvert should be with a similarly sized structure, unless careful analysis indicates stream stability will not be impacted. Further, the few degraded structures should be listed and prioritized for repair or maintenance.

The watershed has a growing number of stormwater management basins. All basins completed at the time of the fieldwork, were mapped, inspected and assessed. Most are in good condition and appear to be maintained frequently, but several appear to have been abandoned. As development continues to occur within the Raccoon Creek Watershed, monitoring and maintenance of the existing and new stormwater basins will remain a critical aspect in managing stormwater in this watershed. Stakeholders should

consider a basin inspection schedule and specific triggers for maintenance and more extensive restoration. Management and maintenance of stormwater basins should be the responsibility of a municipality, agency or entity, but not a private homeowner. Private homeowners typically lack the expertise and financial resources to properly maintain stormwater management facilities.

The Characterization and Assessment report also recommends that care be taken to manage stormwater runoff from roadway improvement projects, adopt riparian buffer conservation ordinances and consider options to support and maintain the many existing ponds and lakes.

After completing the characterization and assessment of the physical features of the watershed, a detailed hydrologic analysis was completed. The hydrology of the Raccoon Creek is being changed by development. The conversion of agricultural and wooded land to suburban developments has the potential to impact the stream corridor, stream stability and in-stream habitat, the existing lakes and ponds, and the downstream receiving waters.

Four main areas of concern were noted: First, is the apparent over estimation of existing condition runoff, leading to improperly designed stormwater facilities and unnecessary costs. Second, the stormwater and surface water infrastructure is aging, leading to potential failures and watershed impacts. Third, are structures, built to now obsolete standards, that fail to provide the necessary mitigation. Finally, as road improvements keep pace with development, the increase in connected impervious cover must be properly mitigated.

To support the C&A report and the evaluation of the stormwater issues, the overall watershed was modeled with the HEC-HMS computer program. After calibration, the modeling data suggests that revised procedures should be implemented to manage stormwater discharges from development projects. The following recommendations are made:

- Use the DelMarVa dimensionless unit hydrograph for all hydrologic analyses in the Raccoon Creek Watershed when the NRCS runoff methods are used,

- Use field indicators to verify the existing condition calculations, including evidence of overland flow where channel flow is said to occur, in order to improve accuracy of Time of Concentration calculations and drainage area delineation,
- Design bridges, dams, culverts and other similar structures using Curve Numbers calculated following standard engineering practices,
- Develop a regional table of Curve Numbers to reflect seasonally low runoff conditions and use these Curve Numbers to describe the existing hydrologic condition for all site development work.

The final component of the Characterization and Assessment report is a review of existing water quality data. The Raccoon Creek Watershed is known to have several documented water quality issues. Specific segments are listed as impaired for a variety of parameters, including fecal coliform, phosphorus, silver and benthic marcroinvertebrates. In response to these impairments, the NJDEP has proposed a Total Maximum Daily Load (TMDL) for fecal coliform and has listed the other parameters in the 2004 303(d) list of impaired waters. The fecal coliform TMDL requires the reduction of 88% to meet the fecal coliform Surface Water Quality Standards. Neither the TMDL document nor the sampling programs have narrowed the source(s) of fecal coliform contamination. The RSMC should consider their response to this TMDL and if additional sampling or source tracking is necessary. Further stakeholders should provide guidance and recommendations regarding how water quality should be addressed in the RSMP.

This Draft Characterization and Assessment Report suggests land use changes have begun, and will continue, to impact the surface water resources of the Raccoon Creek Watershed. As rural land is developed, runoff patterns will change, aging stormwater infrastructure will be stressed, stream corridors will be impacted, groundwater recharge patterns will change, and water quality will be affected.

These stormwater issues can most effectively and appropriately be addressed through a regional stormwater management plan. The stakeholders of the Raccoon Creek Watershed, together with the project partners, must address these issues over the next six to nine months to develop a functional and implementable RSMP.

Section 1.0 – Introduction

1.1 Authority and Background

The Gloucester and Camden Soil Conservation Districts (districts) and Rowan University with the cooperation of the Gloucester County Public Works Department – Division of Planning have prepared this Characterization and Assessment (C&A) of the Raccoon Creek Watershed. The C&A report will support the development of a Regional Stormwater Management Plan for the Raccoon Creek Watershed.

The project is funded by a Nonpoint Source Pollution Control – Section 319(h) grant and is administered by The New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management.

The scope of work for this project is based on Chapter 3 of the New Jersey Stormwater Best Management Practices Manual and on guidance provided in the NJ State 319 RfP for FY 2003. The scope of work defines overall project milestones and required specific administrative activities. The districts, Rowan University and the NJDEP Project Manager finalized specific details and tasks.

1.2 Objective and Purpose

This characterization and assessment report provides the stakeholders of the Raccoon Creek Watershed with a detailed understanding of the current condition of the surface water resources of this watershed and the information and tools to prepare and adopt an implementable Regional Stormwater Management Plan (RSMP).

This document is intended to provide planners, regulators, developers, landowners and other stakeholders with a current assessment of the Raccoon Creek Watershed, with the information necessary to determine the desired condition, and with the tools to prepare a plan for achieving the desired condition. The report includes a detailed assessment, an evaluation of the watershed and a discussion of management strategies to continue to protect the watershed from degradation and impairments.

1.3 Scope of Study

The physical area covered by this report is limited to an approximately 26 square-mile area drained by the Raccoon Creek and its tributaries from the headwaters to the USGS Stream gage located at Tomlin Station Road near Swedesboro. In order to compile this report, the staff:

- Collected and reviewed existing data, including any previous regional or local hydrologic or hydraulic studies,
- Collected data on many of the stormwater structures and watershed features,
- Prepared an extensive photographic record of the assessed features,

- Mapped newly created data and existing data available from other public agencies and private entities,
- Developed baseline hydrologic modeling for the watershed study area,
- Detailed stream assessments of most stream reaches, including a quantitative ranking,
- Identified impairments within the watershed,
- Conducted water quality monitoring within the watershed.

1.4 Stakeholder Involvement

Developing a regional stormwater management plan is logically and legally a public process. Input from the stakeholders of the watershed, especially the affected municipalities and counties, is critical to developing an effective and implementable plan. Management strategies adopted in the RSMP often fall to the municipalities to enforce or implement, so their input into the process is essential.

The Regional Stormwater Management Committee (RSMC) for the Raccoon Creek RSMP formed in May 2004 and elected the Gloucester County Planning Division the Lead Planning Agency for this RSMP project. The committee met several times during the characterization process to receive updates on the project status, provide direction and re-direction of the C&A process and to review preliminary information. The RSMC discussed stormwater quantity, quality and recharge issues and priorities for this watershed.

This characterization and assessment plan will provide the RSMC with the information necessary to proceed with the preparation and adoption of the RSMP. It is recommended that the RSMC meet regularly over the next nine to twelve months to prepare the final Characterization and Assessment Report and the Management Plan.

Section 2.0 – Assessment Report

2.1 General Characterization

2.1.1 Location and Description

Located in Watershed Management Area 18, the Raccoon Creek flows from east to west in Gloucester County toward the Delaware River. The study area focuses on the upper portions of the Raccoon Creek, its streams and tributaries and all the lands draining to these streams. The downstream terminus of the project area is just below the confluence of the main stem and the south branch at Tomlin Station Road (County Route (CR) #607). The USGS stream gage 01477120, described as near Swedesboro, New Jersey, is located at the limit of the study area.

Four municipalities; Elk Township, Glassboro Borough, Harrison Township and South Harrison Township, contain lands within the watershed. Table 1 indicates the approximate area of each municipality within the project watershed. A detailed map of the watershed and the municipal boundaries is shown in Figure 1. For the purposes of this report, the Raccoon Creek Watershed refers only to the described study area.

Table 1: Municipalities within Raccoon Creek Watershed Study Area

Municipality	Area within Watershed (miles^2)
Elk Township	5.75
Glassboro Borough	0.94
Harrison Township	14.58
South Harrison Township	4.43

The watershed encompasses a total area of 25.67 square miles with 63 linear miles of watercourse. The main stem drains approximately two-thirds of this area with the remainder draining to the South Branch Raccoon Creek. Tributaries of varying sizes support both the main stem and South Branch.

The Raccoon Creek Watershed consists of four sub-watersheds defined by the United States Geological Survey (USGS) 14-digit Hydrologic Unit Codes (HUC14). Table 2 lists the project name and code of each sub-watershed name and the USGS HUC 14 identifier.

Table 2: Sub Watersheds and HUC 14 IDs

Sub Watershed (Name & Code)	HUC 14
Upper Raccoon Creek - 010	02040202150010
Lower Raccoon Creek - 020	02040202150020
South Branch Raccoon Creek - 030	0204020215030
Raccoon Creek - 040	Part of 02040202150040

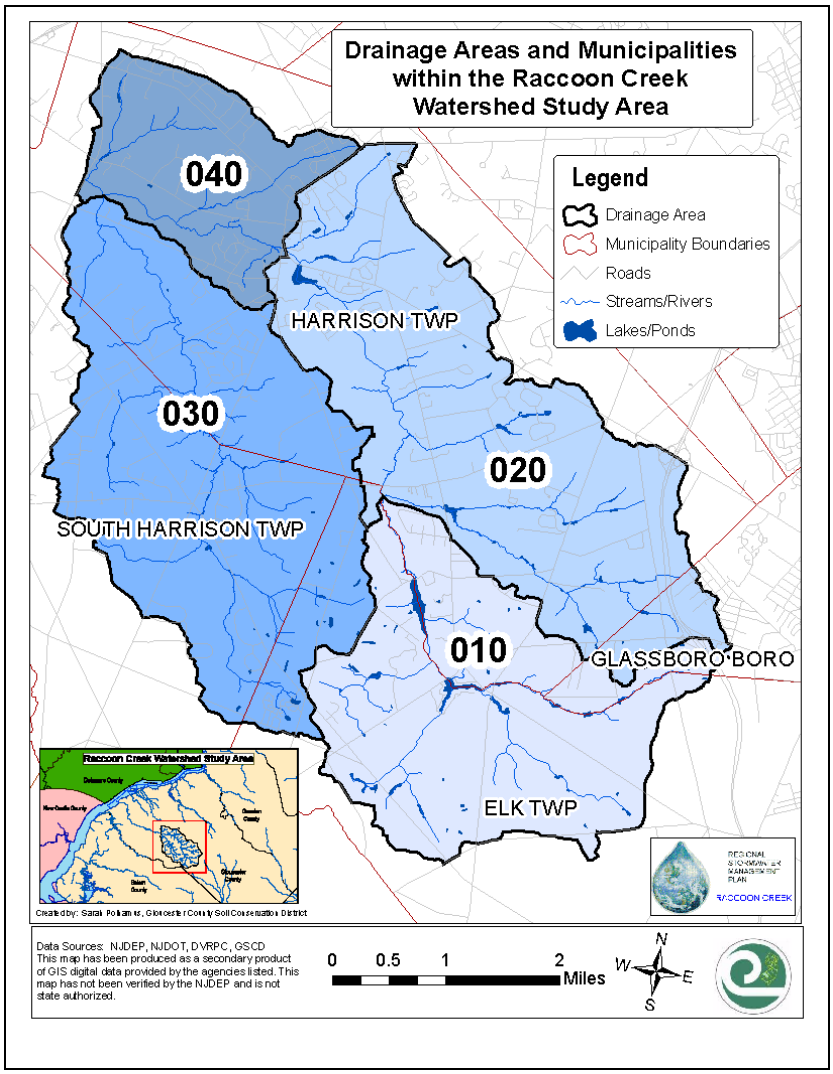


Figure 1: Raccoon Creek Watershed Project Area

The Upper Raccoon Creek originates within Elk and Glassboro Townships and encompasses 6.37 square miles. The primary land use throughout this sub-watershed is agricultural with scattered residential development. The stream corridor is usually within wide riparian forest. The total main channel length is 4.92 miles. The downstream terminus of this sub-watershed is located 555 feet upstream of Richwood-Harrisonville Road (CR #618) in Harrison Township.

The Lower Raccoon Creek originates at the outlet of the Upper Raccoon Creek and encompasses 8.08 square miles. The primary land use is a mix of agricultural and scattered residential developments. The stream corridor has a very well protected forested riparian buffer. The total stream channel length is 3.00 miles. The downstream terminus of this sub-watershed is located on Main Road (Route 45) in Harrison Township.

The South Branch Raccoon Creek originates within Elk Township and encompasses 8.36 square miles. The headwaters originate in a high density residential development. The stream corridor has a very well protected forested riparian buffer. This sub-watershed is a mix of agricultural and residential development. The total main channel length is 6.47 miles. The downstream terminus of this sub-watershed is the

confluence of the South Branch with the main stem of the Raccoon Creek 920 feet downstream of High Street.

The final section of the Raccoon Creek is located downstream of Main Road (Route 45) in Harrison Township, and includes the confluence of the South Branch. It encompasses 2.88 square miles. This sub-watershed is heavily developed with residential and small areas of agricultural land. The total stream channel length is 2.23 miles. The downstream terminus is located on Tomlin Station Road (CR #607) in Harrison Township.

The watershed includes several major lakes and ponds, including Winarski Lake, Gilman Lake, Ewan Lake, Kincaid Lake and Mullica Hill Pond. These lakes and ponds are all within the run of the river and were constructed as millponds during the 19th or early 20th century. These lakes and ponds serve as regional stormwater management facilities, leveling the watershed, providing storm flow storage and collecting sediment.

2.1.2 Topography

The study area includes a variety of topography. Uplands are typically flat or gently rolling, especially in the headwater regions. Slightly hillier terrain occurs from the lower end to the mid-section of the watershed. Land slopes range from less then 0.5% to 25 % or more on ravine embankments.

The steepest slopes are located along the valley scarp where uplands drop to the main channel floodplain. In many sections of the watershed, slopes exceeding 25% with elevation changes of 25 to 50 feet mark the boundary between these two landforms. Nearly all tributaries in the lower end of the watershed are ravines and gullies extending from the floodplain into the uplands. The stream slope of these tributaries is the steepest in the watershed, typically about 2%. This topography is most evident in and around Mullica Hill.

The high point in the watershed, approximately150 feet (NGVD 1929), is located off Richwood Aura Road near the Elk Township - Glassboro border. At the USGS stream gage at Tomlin Station Road the channel invert is about 7 feet. This represents an average watershed slope of about 20 feet per mile.

Along the main stem, at least seven lakes and ponds significantly affect stream slope. The larger lakes have spillways ranging from only a few feet to over 12 feet. The average stream slope of the main stem is 13 feet per mile. By contrast, the slope of the South Branch of the Raccoon is not flattened by any lakes, and as such the stream slope is steeper at 22 feet per mile.

Table 3 below shows the average slope of the streambed for each drainage area. Overall, the stream corridor profile has an average slope of about 0.2%. The topography of the watershed is illustrated in Appendix A, Figure 1.

Table 3: Average Slope of Streambed

HUC 14	Average Slope
010	0.35%
020	0.19%
030	0.34%
040	0.13%

2.1.3 Geology and Soils

Gloucester County is in the southwestern part of New Jersey and lies within the Coastal Plain Physiographic Province of New Jersey. All the soils have formed on unconsolidated beds of either sand or clay mixed with silt or gravel (SCS, 1962). These beds were laid down in a succession of ocean or river deposits and then tilted to the southeast. Glacial waters brought deposits of rounded quartzes gravel. During periods of low water, wind and water erosion reworked the original deposits. Climate and topography contributed significantly to the formation of the soils. More recently, human activities have begun to affect the soil, as large areas have been drained, stripped of topsoil, re-graded, filled, borrowed from and otherwise altered.

The Soil Survey of Gloucester County indicates there are eight soil associations within the watershed (Table 4). According to the Soil Survey, a "soil association" is a landscape that has a distinctive proportional pattern of soils. A SSURGO soils series map and descriptions are included in Appendix A, Figure 2 and Table 1.

Table 4: Gloucester County Soil Associations

Soil Associations	Area (Square Miles)
Aura-Downer	2.13
Downer-Woodstown-Sassafrass	10.34
Freehold-Colts Neck-Collington	1.89
Keyport-Lenori-Elkton	1.54
Lakeland	0.65
Marlton-Kresson-Colemantown	1.56
Muck-Alluvial Land-Fallsingotn-Pocomoke	3.47
Westphalia-Nixonton-Barclay	3.78
*Other	0.34
*Other Associations: Bayboro, Made Land, Pasquotank, (Pits, Sand, Gravel), Water	
Source: Gloucester County Soil Survey, 1962, NRCS SSURGO data	

The Natural Resources Conservation Services (NRCS) classifies most soils into one of four Hydrologic Soil Groups (HSG) based on their minimum infiltration (transmission) rates when thoroughly wetted. Table 5 shows the percentage of each HSG within the watershed and the average transmission rate of each. This transmission rate is often used to estimate recharge potential. The Annual Groundwater Recharge Analysis calculator (based on GSR–32) found in the NJDEP BMP, estimates recharge potential based on HSG and land cover. The recharge calculator indicates Type A soils recharge up to 14 inches of rainfall per year, while HSG D soils recharge none. The predominate HSG in the Raccoon Creek, HSG B recharges 9 to 12 inches per year. Maps depicting the extent of each hydrologic soil group and the average annual ground water recharge are provided in Appendix A, Figures 3 and 4.

Table 5: Distribution of Hydrologic Soil Groups in Raccoon Creek Watershed

HSG	Percent of Watershed	Average Transmission Rate
A	2.7	>0.3 in/hr
B	60.1	0.15-0.30 in/hr
B/D*	4.4	
C	28.0	0.05-0.15 in/hr
C/D*	3.2	
D	1.3	0-0.05 in/hr
* HSG characteristics differ on whether the soil is drained or un-drained.		

The Raccoon Creek Watershed is underlain by two major aquifers. These are the Mt. Laurel-Wenonah aquifer and the Kirkwood-Cohansey aquifer (Figure 2). The Kirkwood-Cohansey is unconfined. The Mt. Laurel-Wenonah aquifer is confined except where it reaches the surface or is overlain by permeable surface material.

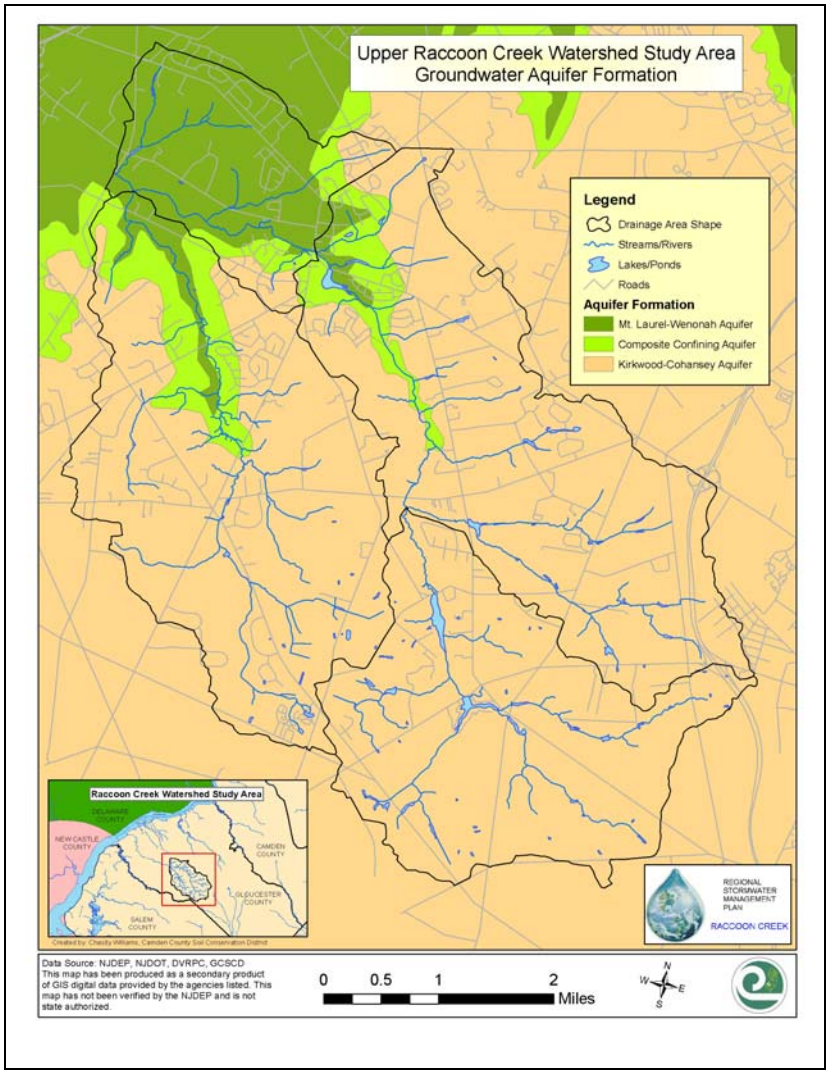


Figure 2: Groundwater Aquifer Formation

2.1.4 Climate

The climate of Gloucester County is considered humid and temperate. The impact of the Delaware River and Atlantic Ocean on temperature and precipitation are considerable. Summer temperatures rarely exceed 100ºF, but heat waves of temperatures in the middle to upper 90s occur most summers. The average summer high temperatures are about 86 degrees. Winter temperatures are generally not below 10ºF for long, with average winter lows in the low to mid 20s. Winter temperatures rarely keep the ground frozen throughout winter. Rainfall during the winter can be very erosive and produces potentially high rates of runoff.

Precipitation averages 44 inches/year and is well distributed throughout the year. Rainfall is often heaviest during March, July and August with the precipitation in the later two months coming in thunderstorms. Downpours may produce rainfall approaching 3.5 inches/hour. The National Resources Conservation Services (NRCS) 24-Hour Type III design storms for Gloucester County are shown in Table 6.

Table 6: NRCS 24-Hour Type III Rainfall Totals for Gloucester County, NJ

Recurrence Interval	24-Hour Rainfall (inches)
1 yr.	2.8
2 yr.	3.3
10 yr.	5.0
25 yr.	6.2
100 yr.	8.5

Rainfall and rainfall intensity data are now frequently updated and the data is available online at http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nj_pfds.htm

Additional rainfall data was acquired from the South Jersey Resource Conservation and Development Council (SJRCD) and their RISE weather network. There are two RISE weather stations located near the Raccoon Creek Watershed, one at Gloucester County Solid Waste Complex in South Harrison Township and the other at Bethel Mill Park in Mantua Township. Both stations record 6-minute incremental rainfall as well as other weather data. Rainfall data from the RISE weather stations was used in model calibration procedures.

2.1.5 Historical Land Uses and Development

As early as 12,000 years ago, Raccoon Creek area was home to the Narraticons tribe, of the Lenni-Lenape Indians, who lived along the Delaware River. Swedish settlers moved into the area in the early 1700's and built a town known as "Raccoon" (present day Swedesboro). As more settlers moved into the area, some settled in a town know as Molica's Hill (present day Mullica Hill).

By the 1800's many water powered sawmills and gristmills had been built throughout this area. The mills allowed for production of lumber, farm goods and other products. The Raccoon Creek was used to transport these goods by sailing vessels to the Philadelphia market. Much of the land was cleared to harvest the lumber and prepare land for farming.

In the early part of the 20th century, several lakes in the Raccoon Creek Watershed were converted to summer recreational or private uses. Until recently, the watershed had

changed little from its historic roots with only scattered home sites and commercial development along the major roadways and community centers. Only within the past 20 years has large-scale residential development begun.

2.1.6 Current Land Uses

The Raccoon Creek Watershed is currently experiencing booming development and includes some of the fastest growing municipalities in the county. The region is under intense development pressure and there are many current agricultural parcels already slated for development. Despite this recent growth, the watershed remains predominantly agricultural land. Figure 3 depicts the overall percentage of general land use categories as of 2002.

Land use analysis utilized the NJDEP 1995/97 Landuse/ landcover database. However, the rapid development in this watershed suggests this data is obsolete. Project staff completed a re-mapping of land use based on the NJ-OIT 2002 aerial orthoimages and the Gloucester County 2003 parcel data. This dataset is mapping grade only and provides only basic land use information. This data set does not include the many development projects underway or planned for this watershed and should not be considered an accurate representation of current conditions. Figure 4 depicts the distribution of the general land use categories within the watershed, while Figure 5 shows the change over time.

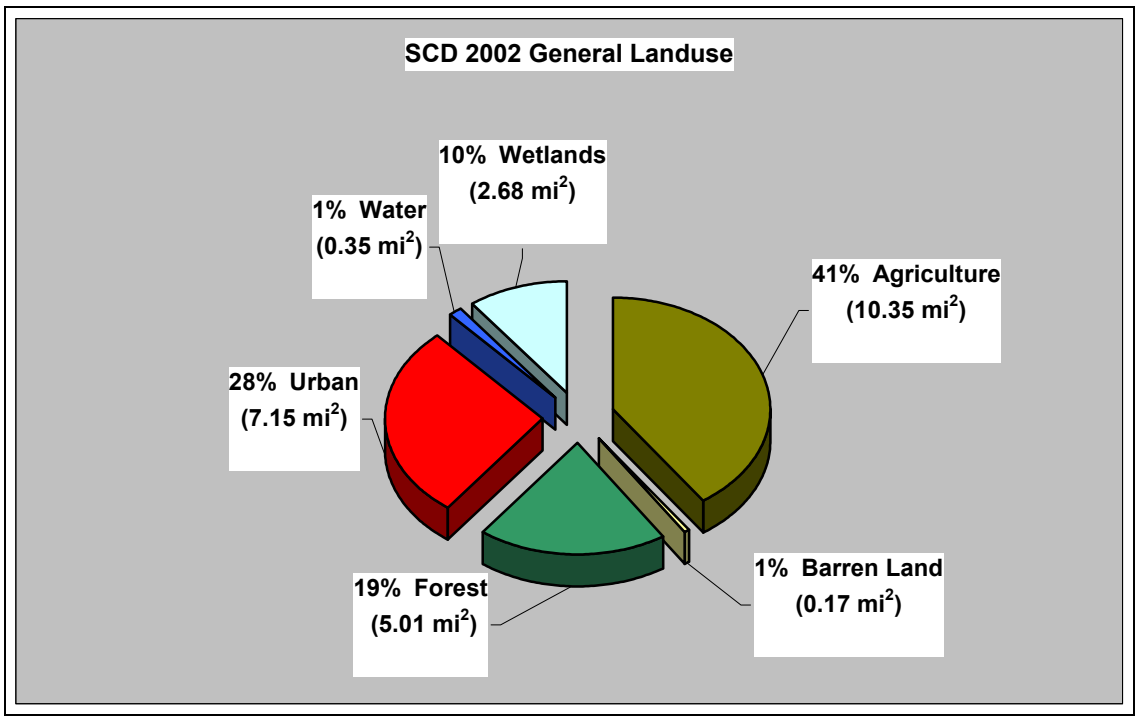


Figure 3: SCD 2002 General Land Use

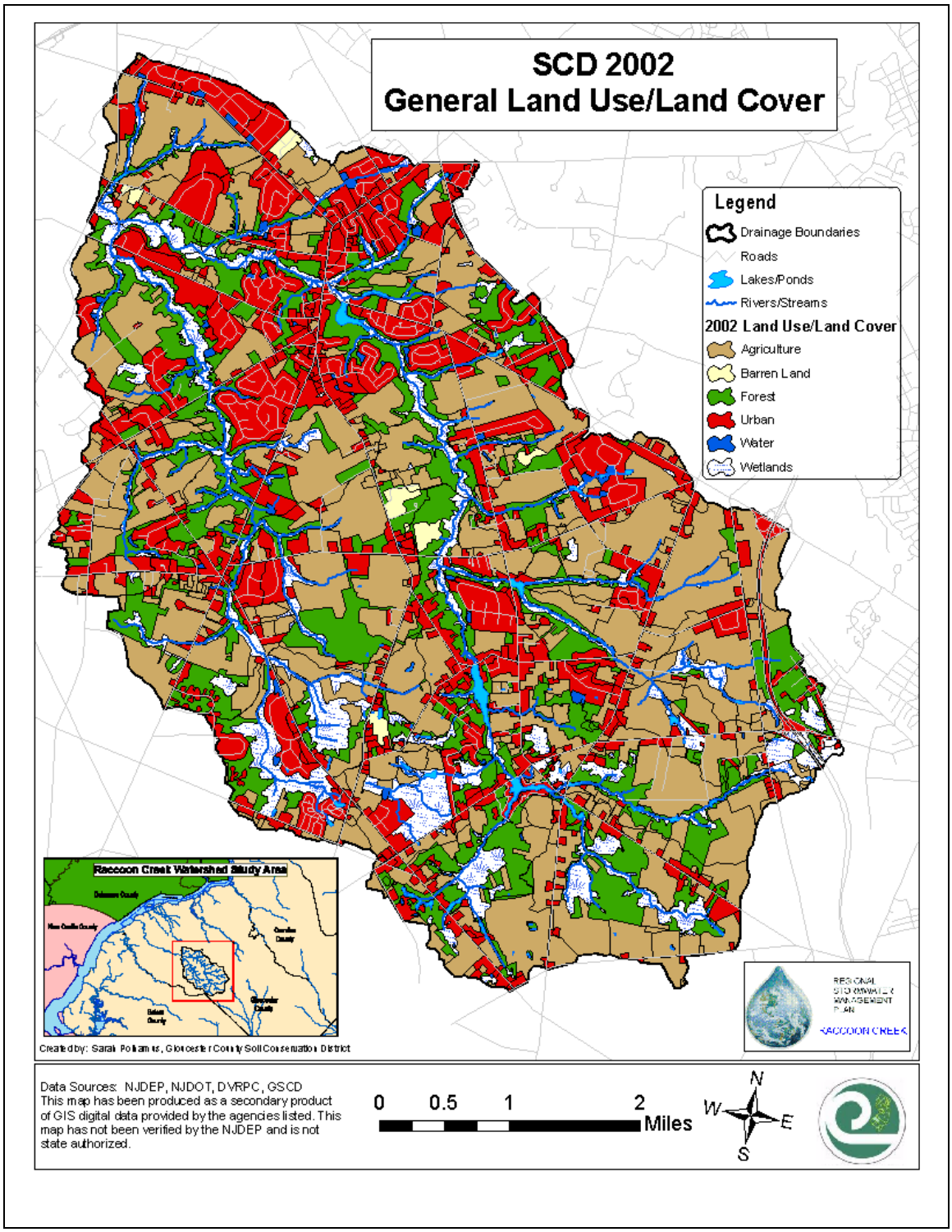


Figure 4: SCD 2002 General Land Use Land Cover

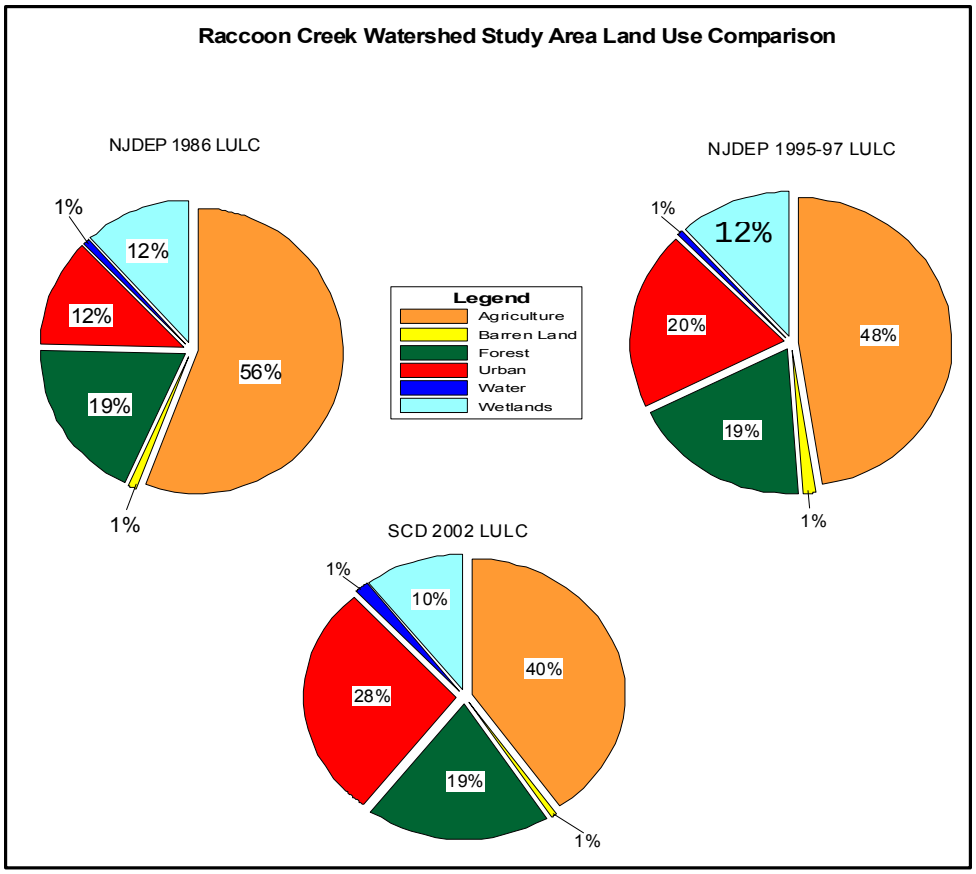


Figure 5: Comparison of Land Use Land Cover

Impervious cover in the Raccoon Watershed as of 2002 is estimated at about 5 percent of the total land area. As noted above, significant development since 2002 has occurred and the current impervious cover is higher. Impervious cover is frequently related to watershed impairment. The Center for Watershed Protection suggests that impervious cover exceeding 10% results in impairments to the receiving watershed.

The NJDEP estimates impervious cover based on land use categories. The above estimate was obtained by data prepared by Civil Solutions for the Gloucester County Improvement Authority and is based on aerial photo interpretation. The estimated 5 percent is slightly less then an estimate derived from the NJDEP land use data and is likely more accurate.

The data does not differentiate between connected and disconnected impervious cover. Disconnected impervious areas frequently discharge to pervious areas where at least some of the runoff is mitigated. Where feasible maintaining this disconnect is highly favorable.

2.2 Watershed Characterization and Assessment

In order to develop an implementable Regional Stormwater Management Plan, it is necessary to have a complete understanding of the features and issues affecting the watershed. The characterization and assessment included a review of existing documents, maps and data and an extensive field program where streams and stormwater features were mapped, described and assessed. The data collected during the assessment and the conclusions drawn will greatly assist all stakeholders in determining the final goals and management strategies for the Raccoon Creek Watershed.

In the sections that follow, specific watershed features will be discussed and the data collection process described. The discussion will include a description and assessment of the observed condition.

2.2.1 Overall Stream Assessment

To determine the overall condition of the watershed the stream corridor was carefully evaluated. To conduct this assessment the stream reaches were delineated based on natural divisions, such as the confluence of two tributaries, and at every stream obstruction. The NJDEP GIS stream hydrography data was edited to depict each stream reach and in some cases relocated to better reflect actual conditions. Field crews evaluated each stream reach and completed a reach evaluation form (Appendix B, Table 1) describing the average conditions of the channel and the immediate riparian area. The reach was then assessed and graded to determine a total reach score. The resulting score ranks each reach as Optimal, Sub-Optimal, Marginal, or Poor, allowing individual reaches to be described and compared. Figure 6 shows the overall stream assessment of the watershed reaches.

This characterization and assessment of the stream corridor not only establishes a baseline of current conditions but also will help to determine the need for stream rehabilitation or restoration. When considering the need for restoration, a wide variety of issues must be considered. Stream corridors form and evolve, over time, in response to various geomorphic and hydrologic processes. When all conditions remain stable, a stream achieves equilibrium. Changes in the watershed hydrology will cause changes to occur within the stream corridor. The goal of a stream assessment and management plan should include an assessment of the current conditions and recommendations to avoid unnecessary changes in the contributing watershed.

Project staff assessed 151 of the 267 delineated reaches in the Raccoon Creek Watershed, representing 60% of the linear feet of stream. The un-assessed reaches included lake reaches, wetland areas, farm ditches and middle sections of headwater tributaries. Thus, the assessment and ranking is considered representative of the entire watershed.

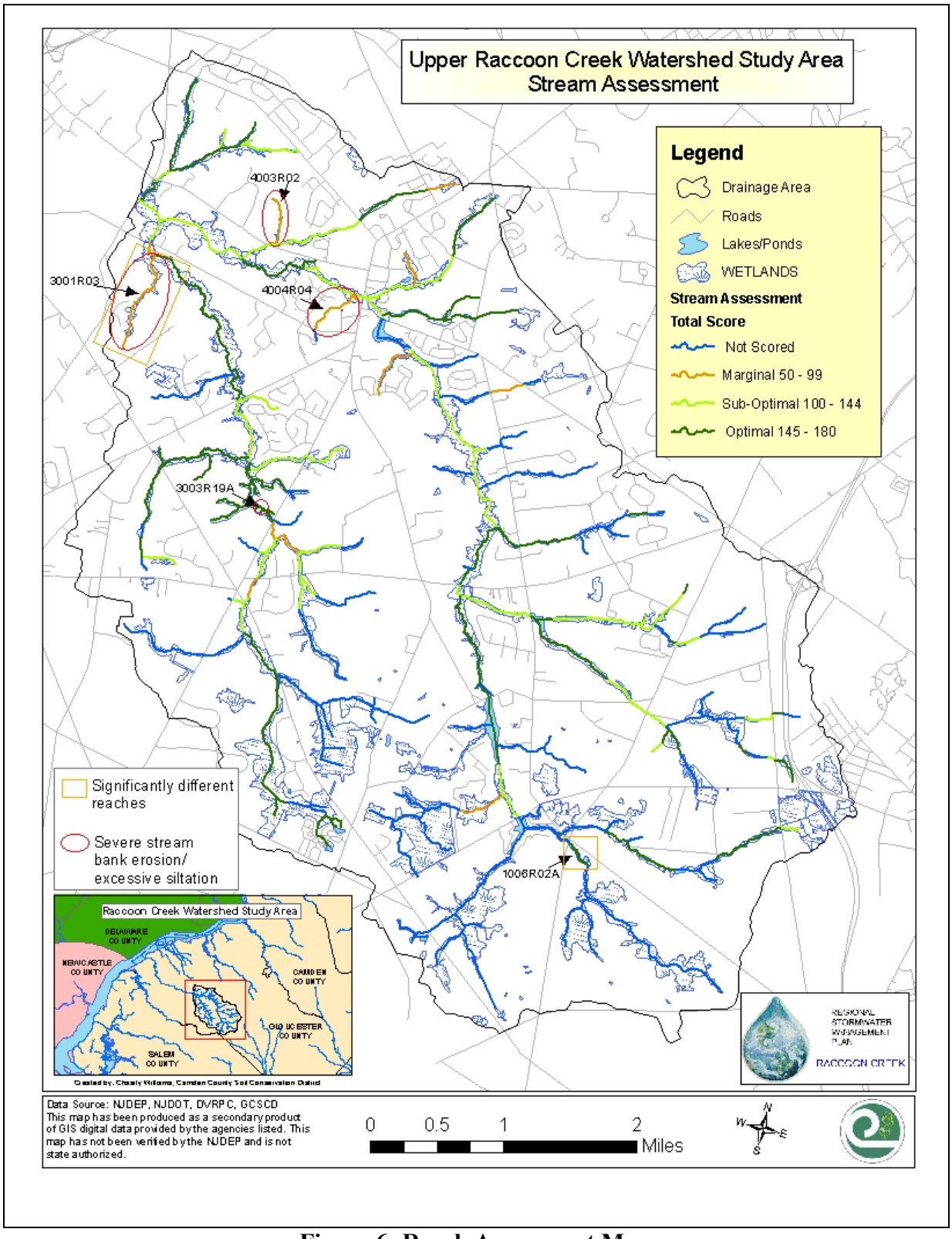


Figure 6: Reach Assessment Map

Each assessment is based on the average condition of the entire reach and as such some reaches scored higher or lower then certain segments would suggest. Nearly all reaches were ranked as either optimal or sub-optimal. Only 5% of the streams were considered to be in marginal condition and none were deemed to be poor condition, although two reaches (Reach 3001R03 and 4004R04) both scored near the bottom of the marginal category. A typical stream reach had a natural (unaltered) cross-section, with bed material comprised of a mix of sand, gravel and mud. Most stream channels were completely shaded and within a wooded riparian buffer that exceeded 20 feet and in many cases exceeded 200 feet. Severe stream bank erosion or excessive siltation was only noted on 4 reaches: 3001R03, 3003R19A, 4003R02, 4004R04.

The stream channels and valleys exhibited a wide range of geometry, profile and forms, but nearly all fit into one of three broad categories: the flat headwater wetland streams, the ravine tributaries and the channel and valley streams.

Headwater Wetland Streams:

The southern most headwaters of the Raccoon Creek form in wooded wetlands and along agricultural fields. As such, these streams flow slowly in narrow, shallow channels. The adjacent wetlands become inundated during wet periods with a combination of exposed groundwater and overland flow. These wetlands provide most of the stream flow in the form of baseflow and mitigate surface runoff. Typically these streams are in very good condition, have very wide riparian buffers, natural bed materials, no erosion or siltation and have scored highly in the assessment. The topography prevents the formation of the typical run, riffle and pool system and this should not be considered indicative of impairment. These headwater streams are highly sensitive to changes in hydrology and sediment characteristics and supply. Figure 7 shows a typical flat headwater wetland stream.

Ravine Tributaries:

The ravine tributaries are located along both the South Branch and main stem of the Raccoon Creek, predominantly near the Mullica Hill Area. These tributaries form in the rolling uplands of the watershed and flow toward the main stream corridor. As noted in the topographic discussion (Section 2.1.2) the valley scarp is often steep. The ravine tributaries transition from the upland areas to the floodplain by crossing these valley scarps, through deeply incised, often triangular, stream corridors. Channel slopes are typically about 2 percent, but can reach nearly 5 percent. Although many of these tributaries are ephemeral, most support only minor baseflow and some are dry unless it has recently rained. Figure 8 shows typical conditions of ravine tributary.

The ravine tributaries extend dendritically into the farmland and development of the region. The ravines are not acceptable for agricultural production and most are wooded with large, old trees. It is likely that the historic conversion of these lands from virgin forests to agricultural uses increased the runoff received by the ravines and likely caused the ravines to grow. Most of the ravines appeared stable, without massive erosion, headcutting or bank failure. Notable exceptions are where stormwater outfalls from developed areas have increased flow, Figure 9.

Changes to the land draining to these tributaries could have significant impacts. The ravines have evolved over many years to the relative stable condition. Changes in

the rate, volume or duration of runoff will impact the channel stability. In their current condition, the ravine tributaries are an important source of sediment for the main stream corridor. Without this sediment (or with excess sediment resulting from increased erosion) the channel evolution of the receiving waterways will be impacted.



Figure 7: Typical Wetland Stream



Figure 8: Typical Ravine Condition



Figure 9: Condition from Stormwater Outfall

Channel and Valley Streams:

The final stream type is the typical channel and valley arrangement. These streams are the most common in the watershed. A typical channel meanders through a wide flat valley/floodplain. The largest channels in the Raccoon Creek are nearly 30 feet wide and at least 4 feet deep. At the USGS stream gage this channel carries an average baseflow of about 20 cubic feet per second (cfs). This fills the channel only a foot or so deep.

The valleys are often very wide, exceeding 200 feet, and the embankments to the uplands are often steep. This ample floodplain is available to store and transport high flows without impacting upland areas. Figures 10 and 11 depict typical conditions of these channel/valley streams.

These larger streams are not nearly as sensitive to hydrologic changes as those streams previously discussed. The significant baseflow and transport capacity, coupled with mild stream slopes indicate minor changes in runoff should have negligible impacts of the stream corridor. However, the cumulative effect of many changes in the contributing watersheds remains a concern. The impact of many stormwater basins discharging reduced rates of runoff over long periods of time, may have unintended consequences of increased flows or longer duration of channel forming flows.



Figure 10: Typical Channel Condition



Figure 11: Typical Valley Stream Condition



Figure 12: Reach 1006R02A



Figure 13: Reach 3001R03

Several stream segments are significantly different enough to be individually addressed. Reach 1006R02A (Figure 12) has only recently formed in the drained lakebed of Wrights Mill Pond. The stream geometry is comprised of cross-section, profile and form that have all developed naturally since the lake was drained late in 2001 when the outlet structure was modified to pass baseflow and provide some detention of higher flows. The newly formed meadow provides habitat for wetland and emergent species. Thus far the watershed draining to this reach remains unchanged by development. ***Reach 1006R02A should serve as a reference reach for this watershed and should be monitored carefully***.

Reach 3001R03 (Figure 13), a small tributary discharging to the South Branch near High Street, exhibits some of worst erosion in the watershed. The stream loosely fits in the ravine tributaries category but exhibits significantly more erosion then the typical ravine reach. Here steep embankments immediately adjacent to the stream are failing and runoff from adjoining agricultural lands is contributing to the erosion and excess sediment in the system. Excess sediment, in the form of sediment bars have developed and continue to shift in the South Branch Raccoon Creek below the mouth of this tributary. The upper segments and at least one minor tributary are in significantly worse conditions then the balance of the stream. ***Reach 3001R03 should be investigated for restoration or source control projects.***

Details of the stream reach assessment are included in Appendix B, Figures 1-4. This characterization and assessment provides a preliminary view of the 2003/ 2004 conditions, indicates potential areas of concern and areas where the stream corridor might warrant extra protections to ensure certain segments retain their optimal conditions. Further work to classify representative reaches with the Rosgen's stream classification system would be beneficial. A reference reach of each stream type would be beneficial for future potential restoration projects.

Overall most stream reaches of the Raccoon Creek scored as optimal or sub-optimal. Despite these high scores, it seems likely that many of these same reaches are stressed by changing hydrologic conditions. Streambank erosion, channel incision and the resulting siltation may begin to degrade the channel, filling pools and covering the gravel streambed. Siltation has already significantly impacted Mullica Hill Pond and is likely to impact other lakes within the watershed. Although it is unlikely that flood damage will increase as a result of development, the impacts of development on peak flows and duration of these peaks will likely have impacts on the stream corridor.

This regional plan should carefully investigate the impact of development on headwater /wetland type streams and ravine tributaries. One of the most important issues of the Raccoon Creek Watershed is stream protection. Management strategies, land use decisions and design criteria should all be considered to further protect these resources. Management strategies could include stream protection ordinances, enhanced recharge requirements, limitations on acceptable discharge locations, low impact design requirements or other suitable measures.

Further stream restoration, stabilization or rehabilitation efforts should include as part of the planning and design an evaluation of the probable sources of impairment, a determination of the channel evolution status (Schumm's Channel Evolution Model) and a classification existing conditions (Rosgen Stream Classification).

2.2.2 Culverts, Cross Drains, Bridges ands Stream Obstructions

This features includes culverts, cross-drains, bridges and stream obstructions, such as beaver dams or debris jams and includes all manmade or naturally occurring structures or features that have the potential of impacting stormwater flows. In the Raccoon Creek Watershed, these are primarily roadway culverts and bridges. A detailed map and table of stream obstructions is provided in Appendix B, Figure 5 and Table 2.

In general, these structures are in satisfactory condition. Although project staff made no effort to determine the structural integrity of any bridge or culvert, a few structures are obviously very old and may require inspection by the appropriate authorities. Our assessment focused on the comparative size (or capacity) of the culvert and the presence of excessive siltation or erosion nearby. Signs of increased erosion, such as scour of the stream channel and erosion of the upstream and downstream embankments is common at many culverts and may be indicative of the need for maintenance or restoration. Several culverts discharge to ravine type streams and erosion below these culverts is occasionally severe. At most locations, the capacity of the culverts or bridges appears adequate to pass stream flows generated by high frequency storms. Care should be taken to individually assess and evaluate any culvert or bridge prior to repair, reconstruction or replacement.

Although project staff did not observe any beaver activity, stakeholders reported the presence of beaver in several tributaries above Mullica Hill. Beaver dams can significantly impact the watershed and should be monitored for potential negative impacts.

Overall these features do not appear to require specific management measures or attention beyond that required for standard maintenance, repair or replacement. However, in all cases, replacement of any culvert should be with a similarly sized structure, unless careful analysis indicates stream stability will not be impacted.

2.2.3 Stormwater Basins/ BMPs

Stormwater basins have been constructed since the early 1970s in an attempt to reduce the impact of development on the receiving waterway. Initially, stormwater basins were designed to provide only flood control and attenuated peak flows from large design storms. Currently stormwater basins are often designed and constructed to meet runoff water quality standards, recharge stormwater and provide mitigation of high frequency runoff events. The stormwater basin data for the Raccoon Creek Watershed is provided in Appendix B, Table 3 along with a map (Appendix B, Figure 6) indicating the locations of assessed basins.

In general, most of the stormwater basins assessed are functioning as designed. The most frequent deficiency stems either from the clogging of the outlet structure with debris, or from sediment preventing the complete drainage of the basin. Although this condition may result in standing water and the negative conditions associated with this, it may also provide a benefit to the watershed by providing increased detention times, potentially greater infiltration and treatment of high frequency runoff. An efficient system, which completely and quickly empties a stormwater basin, does not necessarily provide the most benefit to the receiving waterbody. The longer the detention time, the greater the opportunity for infiltration to occur and the greater the effectiveness of the pollutant removal.

As part of this project, the apparent frequency of stormwater basin maintenance was estimated. The responsibility for stormwater basin maintenance typically falls to the owner and although this is often the municipality in residential areas, in this watershed it may also be an individual homeowner. Maintenance duties range from maintaining the basin vegetation to removal of sediment and structure repairs. Twenty nine of the 60 basins assessed were maintained regularly, with frequent (weekly to monthly) mowing and occasional sediment removal. However, at least seven basins appear to have never been maintained in any way.

As noted above, this lack of maintenance may provide improved water quality "treatment". Basins that have been neglected for extended periods frequently take on characteristics of a wooded wetland. Permanent pools, dense and woody vegetation and an indirect flow path extend the detention, increase uptake of pollutants and decrease the direct discharge for high frequency events. A careful evaluation should be made before attempting to restore an abandoned basin to its design condition. This evaluation should consider if the dense vegetation affects to overall storage capacity of the basin.

It should be noted that the assessment of stormwater basins was completed during the fall and winter of 2004-05. Since that time is it presumed that additional stormwater structures were completed. Although the SCD plans to add these basins to the database and a procedure for ensuring future basins are added should be adopted as part of the RSMP.

As development continues to occur within the Raccoon Creek Watershed, monitoring and maintenance of the existing and new stormwater basins will remain a critical aspect in managing stormwater in this watershed. Stakeholders should consider a basin inspection schedule and specific triggers for maintenance and more extensive restoration. Management and maintenance of stormwater basins should be the responsibility of a municipality, agency or entity, but not a private homeowner. Private homeowners lack the expertise and financial resources to properly maintain stormwater management facilities.

2.2.4 Stormwater Outfall

Stormwater outfalls (SWOs) are defined as any point discharge of stormwater via a pipe, swale or other manmade conveyance. As part of the assessment of the Raccoon Creek, stormwater outfalls were located in the field and mapped with GPS. Although an effort was made to find as many SWOs as possible, this mapping should not be considered complete. Many of the mapped outfalls were found during the stream assessments or the mapping of the stormwater management basins. At each outfall, information was collected on the size of the discharge pipe, the condition of the structure and the condition of the outfall area. In addition, the location of the outfall, for example a discharge directly to a stream or to a wetland area was noted. The data for stormwater outfalls is provided in Appendix B, Table 4 along with a detailed map (Appendix B, Figure 7).

Forty one (41) outfalls out of 103 are either degraded or discharge to a degraded area. Typically, this is the result of scour at the outfall or channel erosion, leaving the outlet structure suspended above the bottom of the stream. These are typically the older outfalls. Most of the outfalls associated with detention basins are in good condition with riprap protection. Nearly 73% the outfalls in the watershed discharge directly to the

stream or other surface waters. This "direct connection" eliminates any potential for infiltration or water quality benefit as compared to areas where discharged stormwater flows through a riparian buffer. The erosion caused by a degraded outfall is usually self-limiting, however, it can be severe and a significant source of sediment.

The management plan should list and prioritize outfalls where restoration, reconstruction or maintenance is required. When feasible future outfalls should be sited to take advantage of pervious area before discharging to open water. The Standards for Soil Erosion and Sediment Control in New Jersey provide guidance for siting outfalls and ensuring off-site stability.

2.2.5 Roadways and Roadway Drainage

Many secondary and rural roads exist within the watershed boundary. Many of these roads are narrow, without curbs, gutters or stormwater runoff collection systems. Much of the stormwater runoff from these roadways is disconnected from the stream network. As development takes place within the watershed, many of these roads will be upgraded, including the construction of stormwater systems.

Care must be taken to avoid the direct connection of this impervious cover to the stream network. Stormwater BMPs for rate, volume and quality should be required for all roadway improvements in the watershed.

2.2.6 Agriculture

See page 46 for information on agriculture

2.2.7 Riparian Buffers

Over 86 percent of the stream length in this watershed has a riparian buffer exceeding 50 feet. These buffers are mostly wooded or wooded wetlands and in many cases exceed several hundred feet. The remaining stream reaches, are typically headwater tributaries originating in agricultural fields. In some cases there is no buffer at all, but it is about equally likely to have a narrow buffer.

These buffers appear to be adequately protecting the stream corridor from agricultural runoff. At most locations runoff from farm fields discharged to buffer areas before draining to the stream. In a few cases, lanes or paths through the buffer to the streams served as a conduit for runoff and perhaps sediment.

In nearly all cases riparian buffers provide valuable benefits to waterways. From filtering overland runoff, to absorbing excess rainfall and shading the stream corridor riparian buffers should be maintained and enhanced at every opportunity.

A watershed wide Riparian Buffer Conservation Ordinance should be adopted. The Harrison Township Riparian Buffer Conservation Zone ordinance (Article X, § 225-72 et al) is typical of an appropriate ordinance.

2.2.8 Lakes and Ponds

The watershed includes several major lakes and ponds, the most significant are Winarski Lake, Gilman Lake, Ewan Lake, Kincaid Lake and Mullica Hill Pond. These lakes and ponds are all within the run of the river and were constructed as millponds during the 19th or early 20th century. The mills are long gone and the lakes now serve as passive open space, except for Gilman Lake, which remains open as a private swimming lake. Some of the spillway structures are old and may need repair or maintenance. All regulated dams must comply with the requirements and standards of the NJDEP Dam Safety Section.

In general, the lakes are effective at reducing peak flow, slowing stream velocity, storing sediment, thereby reducing suspended sediments, as well as providing aesthetic and recreational value to the community. However, lakes may also have negative impacts on the watershed, such as habitat for geese, increased thermal pollution and a source of nutrients (excessive algae growth).

Mullica Hill Pond is stocked annually with trout and is a popular fishing lake, but shows signs of extreme stress. The lake is very shallow, at most 3 feet (except immediately adjacent to the spillway) and filled with silt and mud. During the spring and summer the lake surface is covered with floating algae. Water quality data from downstream of Mullica Hill Pond indicate elevated levels of phosphate.

Changes in watershed hydrology will likely have a negative impact on most of these lakes and their dams. Increased runoff will likely increase sediment loads and additional volume will stress the dams. Lake owners and managers are under increasing pressure to ensure the safety of the dam and associated structures. The costs associated with these responsibilities are onerous for private owners.

This management plan should consider the overall impact of these facilities, determine their value to the watershed and the community and provide management strategies to meet these goals.

2.2.9 Significant Features

During the course of the watershed assessment, the field crews encountered many interesting, unique or significant features. This section discusses these features and their impact on the watershed.

Depression Storage

Throughout the watershed, ample depression and surface storage was observed in open fields and within wooded areas. Most are natural features, although a few appear to be long abandoned farmer borrow pits. These storage areas effectively retain or detain rainfall, increasing infiltration and delaying overland runoff. Depression storage is often very shallow, perhaps only a few inches, and isn't often accurately mapped in development surveys. Yet these features may have a significant impact in determining pre-developed runoff patterns.

The management plan should require a detailed analysis of any depression storage for any new proposed development. This analysis should consider the impacts of the depression storage on existing runoff and recharge capacity.

2.3 Hydrologic Analysis

2.3.1 Introduction

The hydrology of the Raccoon Creek is being changed by development. The conversion of agricultural and wooded land to suburban developments has the potential to impact the stream corridor, stream stability and in-stream habitat, the existing lakes and ponds and the downstream receiving waters. As noted in the stream assessment segment, many of the general stream types found in this watershed are especially susceptible to changes in surface runoff and groundwater recharge. Analysis associated with this report suggests that current management strategies and regulations may not provide adequate protections.

This section of the Characterization and Assessment Report will address existing conditions, suggest deficiencies and provide potential solutions.

To support this assessment project staff studied data from the USGS monitoring station, monitored stream flow at six additional sites, developed and calibrated detailed hydrologic models of the entire watershed and several sub-basins, reviewed historic rainfall/ runoff records and calculated event Curve Numbers based on this data and made detailed observations of the watershed.

It is important to note that all models prepared as part of this project are for planning and assessment only. The hydrologic models are not design models. A Professional Engineer must make all design determinations and no structure or engineering design should be based on these models without detailed analysis by the proper professionals.

2.3.2 Existing Conditions

Existing conditions were evaluated by reviewing USGS gage records of the monitoring station at Tomlin Station Road, Station ID 01477120. This gage has recorded stream flow and stage since May 1966. To supplement this gage station, project staff installed water level loggers at six locations to monitor stream stage. This data, when combined with direct flow measurements at these sites, provides an estimate of flows over time at these locations. Further, project staff spent many hours observing watershed characteristics and stormwater runoff patterns.

Stormwater runoff in this watershed is typical of a coastal plain watershed in the humid northeast. The soils generally support high infiltration rates, while evaporation, interception and recharge are a significant component of the annual hydrologic budget. The average annual runoff at USGS gage is 19.88 inches, less then half of the average annual rainfall (44 inches). Analysis of this runoff data with the iSep[1] hydrograph separation utility indicates that only about 32% or 6.3 inches is direct overland runoff, the remainder, over 68% of the total annual runoff is baseflow. Note, the ponds and lakes in this watershed will tend to dampen the direct runoff and increase the apparent percentage of baseflow.

Baseflow in coastal plain watersheds is mostly comprised of shallow ground water flow, or interflow, that moves through the upper layers of the soil profile and re-enters the stream flow as exfiltration either at a connected wetlands or directly to the stream channel. It is this baseflow that is most at risk as the watershed undergoes

[1] http://pasture.ecn.purdue.edu/~kjlim/iSep/main.html

hydrologic modification associated with development. The increase of impervious cover, disturbance of the natural soil profiles and efforts to mitigate stormwater runoff in large facilities, all impact the effectiveness of natural infiltration and shallow groundwater movement.

It seems likely that as the percentage of developed land increases so will the percentage of direct runoff. This is borne out by an analysis of the nearby Cooper River Watershed. The Cooper River Watershed has similar rainfall patterns, soils and topography, but has been extensively developed. In this watershed the average annual runoff is nearly 60% at 26.36 inches and over 58% (15.3 inches) of that runoff is direct overland runoff. Baseflow in the Cooper River represents only 42% of the average annual discharge as compared to the current 68% in the Raccoon Creek Watershed. Obviously, development increases both the overall runoff and percentage of direct runoff. Not surprisingly, the stream corridor of the Cooper River has been significantly degraded.

Flooding in the Raccoon Creek Watershed does not seem to be a significant problem. Flood stage at the USGS gage is estimated at 13 feet, with a peak discharge of about 1000 cfs. This discharge is likely to occur every few years on average and seems unlikely to cause significant problems. The USGS estimates the 100-year flood at 3590 cfs. The gage record indicates this rate was only approached once since 1966 (August 1967 – max discharge 3530 cfs). Overall, riverine flooding along the Raccoon Creek appears to have only a minor impact on infrastructure or structures, as the streams have wide floodplains, often in deep valleys. However, localized flooding may occur at some locations where existing stormwater infrastructure is inadequate to transmit high volumes of runoff.

2.3.3 Stormwater Issues

The ongoing and rapid development of this watershed may impact the stream corridor. Although stormwater basins or other mitigation structures have been part of most new developments, the effectiveness of these structures remains a concern. There are several areas of concern:

1. First, is the apparent over estimation of existing condition runoff. This issue has been documented by SCD staff during development plan reviews and field inspections and appears to reflect the limitations of the modeling methods or the misapplication of the standard practices in calculating runoff from an undeveloped landform. Accurate estimates of the existing runoff conditions are necessary to properly size stormwater facilities, insure downstream stability and prevent unintended consequences of development. Improperly designed structures can also cause unnecessary costs to the municipality and developer.
2. The second issue involves the age, original design or maintenance of existing stormwater facilities. Stormwater basins and other structures have been built over the years to evolving requirements. Older structures or poorly maintained structures may not be providing adequate stormwater management. When, for whatever reason, stormwater structures fail to properly or adequately mitigate runoff from development, the impacts will be seen in the stream corridor. These impacts include increased peak discharges, increased runoff volume, increased frequency and duration of channel forming discharges and result in channel and

stream bank erosion, siltation of lakes, ponds and downstream waters, dam safety issues and habitat protection issues.

3. Aging or inadequate stormwater infrastructure presents another issue. Mullica Hill Pond dam is currently being studied by NJDOT for repair or replacement, while other small dams may soon require repair as well. The failure of an aging culvert on Woodland Avenue has recently caused the collapse of the roadway. Although the physical characteristics of these structures are the primary cause for concern, it is likely that the changing hydrology of the watershed is exacerbating the issues.
4. Road improvements are likely to further impact the watershed hydrology. Many of the existing roads lack stormwater collection systems helping to disconnect this impervious cover. As roads are reconstructed, curbs, gutters and storm sewer systems will likely be added and the impacts of the reconstruction will need to be mitigated.

As development continues to occur within the Raccoon Creek Watershed, effective and cost effective management of the stormwater resources will have a long and lasting impact to society and the natural resources of the watershed. Ineffective management of stormwater may result in significantly degraded stream corridors, lakes and water quality. The costs to restore these features to ideal or even current conditions would likely place a tremendous burden on taxpayers and business. Sound practices, good planning and careful consideration can help to avoid much of the degradation that typically results from development. At the same time, appropriate stormwater management must be cost effective and not unduly burdensome. Careful analysis of the watershed hydrology can help to provide the solutions and guidance of meeting these challenges.

2.3.4 Stormwater Modeling

To support the C&A report and the evaluation of the stormwater issues, a hydrologic modeling effort was undertaken. The overall watershed was modeled with the HEC-HMS computer program. HEC-HMS developed by the U. S. Army Corps of Engineers includes a variety of methods to simulate the rainfall runoff process of a watershed and provide peak flows and distribution hydrographs at all model elements for a variety of design and actual storm events. HMS has the added benefit of supporting comparisons of gage records to model results and optimization routines to calibrate the model.

Process

The HMS model was chosen for the overall modeling effort due the flexibility of the model and the ability to support large and complex watersheds. To conform to the vast majority of stormwater reports prepared by engineers working in southern New Jersey and to be in compliance with the regulatory requirements of the RSIS, Stormwater Rule 7:8 and most municipal requirements, the NRCS methods were used. The NRCS curve number and unit hydrograph methods are described in the National Resource Conservation Service, Engineering Handbook, Part 630– Hydrology and in a wide variety of text books and user manuals.

A GIS of the Raccoon Creek Watershed was used extensively to develop the input data for the models. The following methods and procedures were followed in all modeling.

Subareas were delineated from the USGS 10m DEM using the HEC GeoHMS Extension of ArcView 3.3. The total area of each subarea was calculated in ArcGIS. Curve Numbers (CN) were calculated with the ArcGIS CN generator tool, which combines soil types and 2002 land use to calculate a composite CN. In several subareas the CN was calculated by hand to compare to the GIS generated data. In all cases the results were favorable and the GIS generated CNs were accepted. Both the NRCS and User Specified S-graph methods were used to *Transform* excess rainfall to runoff. The NRCS lag equation was used to determine watershed lag for each subarea and is consistent for both *Transform* methods. Finally *Baseflow* was estimated with the Recession method where the initial Q, Recession Constant and Threshold Q variables were initially estimated as Q=1cfs, Rc=0.07 and Qt=0.5.

Each *stream reach* was routed through a Muskingum Cunge 8-point cross-section. To generate the 8-point cross sections stream channel were surveyed in a several locations along each reach. The HEC GeoRAS Extension was used to provide a coarse valley cross-sections based on the 10m DEM. To prepare the 8-point cross-section for the HMS model, the surveyed channel was "hung" below the generated valley cross-section and the coordinates were selected to define the reach. A typical cross-section was used to represent the entire reach. Manning's n values were calculated using the procedures defined in Appendix A8, Supplement A of the New Jersey Standards for Soil Erosion and Sediment Control. Reach length was determined from the SCD edited streams in GIS and based on field surveys and recent aerial imaging, while slope was based on field surveys of the channel invert at each end of the stream reaches.

Lakes and ponds are included in the, *Reservoir* elements of the model. Where available, rating tables describing the stage –storage -discharge relationships at each dam were included in the model. This data is from dam studies on file at the NJDEP Dam Safety Section or from previous watershed modeling projects. Where data was unavailable the spillway geometry was used to develop rating tables and stage storage was estimated by aerial imagery and field surveys. Stormwater basins were not included in the model.

The completed HMS model utilized commonly used engineering practices in determining input parameters and data. Figure 14 shows a schematic of the overall Raccoon Creek Watershed model. Original model input data is provided in Appendix C, Table 1.

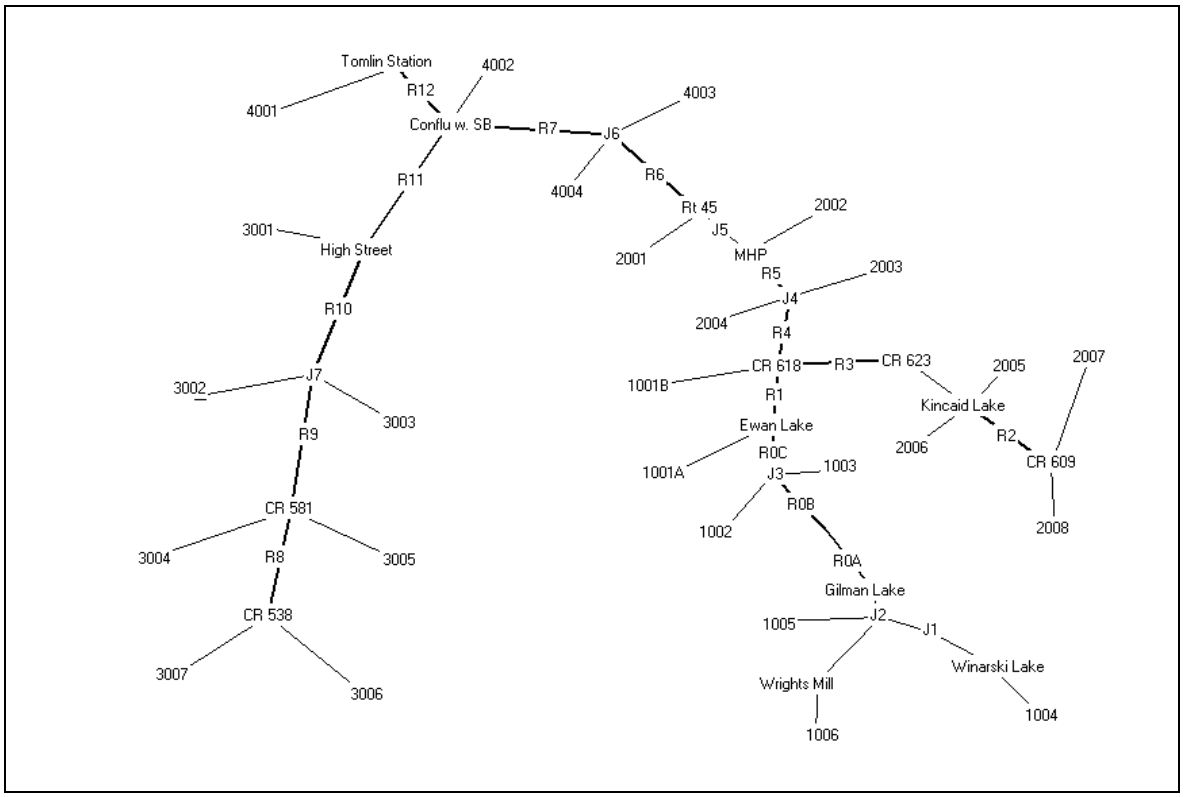


Figure 14: Overall HEC-HMS Model

Model Results and Calibration

The HMS model was initially run with all calculated parameters for the 2, 10 and 100 year Type III NRCS design storms. The results were compared to the USGS Log Pearson Type III Flood Frequency Analysis discharges (available from the NJ USGS). Table 7 shows the model results compared poorly to the flood frequency estimates. The modeled discharges also appeared high when compared to a regional study performed as part of the Mullica Hill Pond dam reconstruction. The project staff considered the model results unsatisfactory. It is important to note, these unsatisfactory results were obtained after following the standard methods, using the standard values, associated with typical hydrologic analyses, the same techniques used by most practicing professionals today.

In an effort to improve the accuracy of the overall HMS model and to test the sensitivity of the results to adjustments of input parameter data, a variety of calibration scenarios were developed. Calibration efforts focused on the dimensionless unit hydrograph, Curve Number (CN), Subarea Lag, and initial abstraction. Model calibration efforts utilized the optimization routines in the HEC-HMS software and event data including stream flow from USGS Station ID 01477120 and six minute incremental rainfall data from two R.I. S.E weathers stations. Rainfall from the two weather stations was averaged for the calibration effort.

Table 7: USGS Flood vs. Design Storm Discharges

Stream Reach Location	*Data Source*	Peak Discharge (cfs)		
		2 yr	*10 yr*	*100 yr*
Tomlin Station Road	**USGS Flood[1]**	701	1680	3590
	SCD-HMS[2]	1214	3089	8566
Note: Peak Discharges are rounded and values are in Cubic Feet per Second				
Source: [1]USGS Log Pearson Type III Flood Frequency Analysis Gage Station No. 01477120 Raccoon Creek near Swedesboro, NJ [2] Project staff used the Hydrologic Engineering Center Hydrologic Modeling System, (HEC-HMS) Version 2.2.2. Revised: May 28, 2003, by US Army Corp of Engineers.				

Several events were selected for calibration trials. Table 8 list the storm date, the rainfall recorded at both weather stations, the average rainfall used in the calibration runs and the peak stream flow and volume as recorded by the USGS gage station. Although the USGS gage has a nearly 40 year record, the weather stations have only been in place since the mid 1990s, limiting the number of large events available for calibration. In addition to the larger storms, the model calibration runs also included a few recent, smaller events monitored by the data loggers installed as part of this project.

Table 8: Storm Data and Recorded Runoff

Storm Event	*South Harrison Precipitation (inches)*	*Bethel Mill Park Precipitation (inches)*	*Averaged Precipitation (inches)*	*Peak Runoff Discharge (cfs)*	*Total Runoff Volume (acre-ft)*
9/15/1999	7.17	5.29	6.23	1720	2634
3/21/2000	3.78	3.37	3.58	1290	2515
4/12/2004	3.27	2.69	2.98	600	1895
9/28/2004	2.38	3.2	2.79	222	424
10/7/2005	5.39	4.08	4.74	755	1179

The optimization trials with the parameter constraints are shown in Table 9. Parameter constraints were selected to achieve the best results without grossly changing the calculated parameter value. The limits set seemed reasonable and within the range of error for the calculation. Each trial was run for each event and the discharge hydrographs were compared to the observed hydrograph at the USGS gage station.

Assumptions: Prior to completing the calibration runs a variety test runs were completed. The first goal was to check the reasonableness of the baseflow parameters. Once these numbers were selected they were maintained for all events. Manning's n for the stream reaches was also carefully reviewed. Calibration runs with a reasonable variation in n-values produced only limited changes in the model results, so the initially calculated n-values were accepted.

Table 9: Calibration Trials and Parameter Constraints

Calibration Trials	*Parameter Constraints*
1	Decreasing Curve Number by 15 points
2	Curve Number plus/minus 10 points
3	Initial Abstraction with minimum/maximum values set at 0.05-3 inches
4	Decreasing Curve Number by 15 points and Initial Abstraction with minimum/maximum values set at 0.05-3 inches
5	Increase SCS Lag by 1.5 times longer
6	Increase SCS Lag by 2 times longer
Note: All calibration trials were optimized with Averaged Rainfall, Baseflow (Initial 1 cfs, Constant 0.07, Threshold 0.5), DelMarVa S-graph with SCS Lag, Modified Cross-section data and Channel N-values.	

DelMarVa Dimensionless Unit Hydrograph

Although not strictly a calibration parameter the appropriateness of the DelMarVa unit hydrograph was investigated. The DelMarVa unit hydrograph appears to better represent runoff then the standard unit hydrograph. After determining the DelMarVa is appropriate in the Raccoon Creek Watershed all further calibration trials utilized the DelMarVa unit hydrograph.

The DelMarVa unit hydrograph is represented by the Peak Rate Factor of 285 and is currently required for most of the Outer Coastal Plain of NJ. The NJDEP has adopted the use of the DelMarVa where appropriate as of September 8, 2005 and pursuant to the USDA-NRCS, Technical Bulletin NJ210-3-1. The Raccoon Creek Watershed is located in a zone where the DelMarVa unit hydrograph applies in some cases. The calibration effort suggests the DelMarVa is appropriate in this watershed. Figure 15 shows the impact of the DelMarVa unit hydrograph in a typical modeled event.

Appendix C, Report 1 includes additional information on the DelMarVa Unit Hydrograph. The report includes the hydrograph ordinates, the mass curve (as calculated by SCD staff), and discussion on how the DelMarVa was used in the HMS model

Note, the DelMarVa unit hydrograph typically reduces the peak discharge from any single subbasin by about 40%, however the overall reduction at the watershed outlet is somewhat less. As hydrographs from contributing subareas are combined, the timing of the discharges mutes some of the reduction at the watershed outlet.

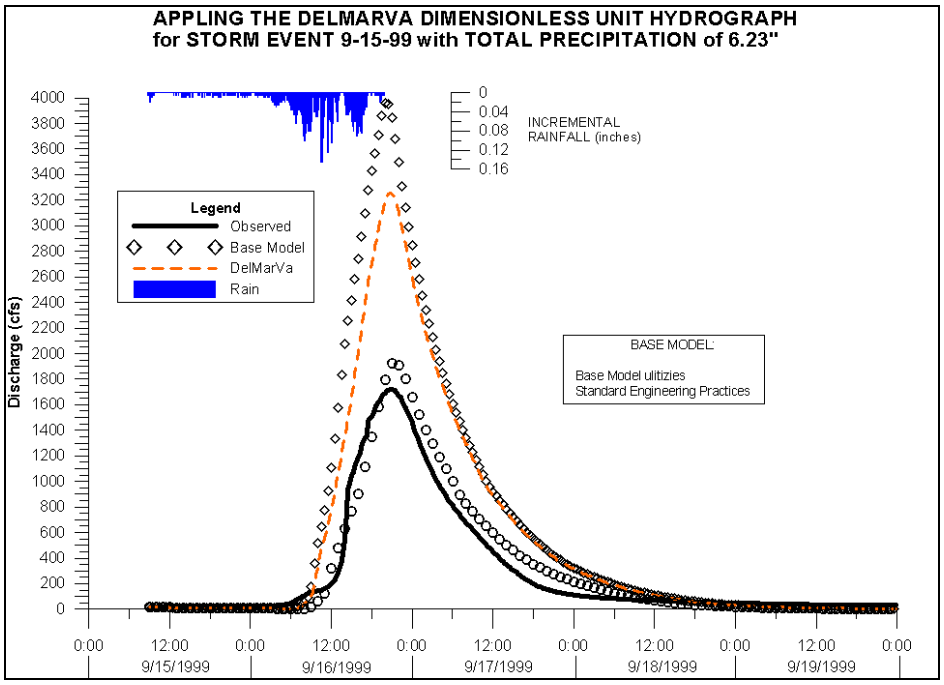
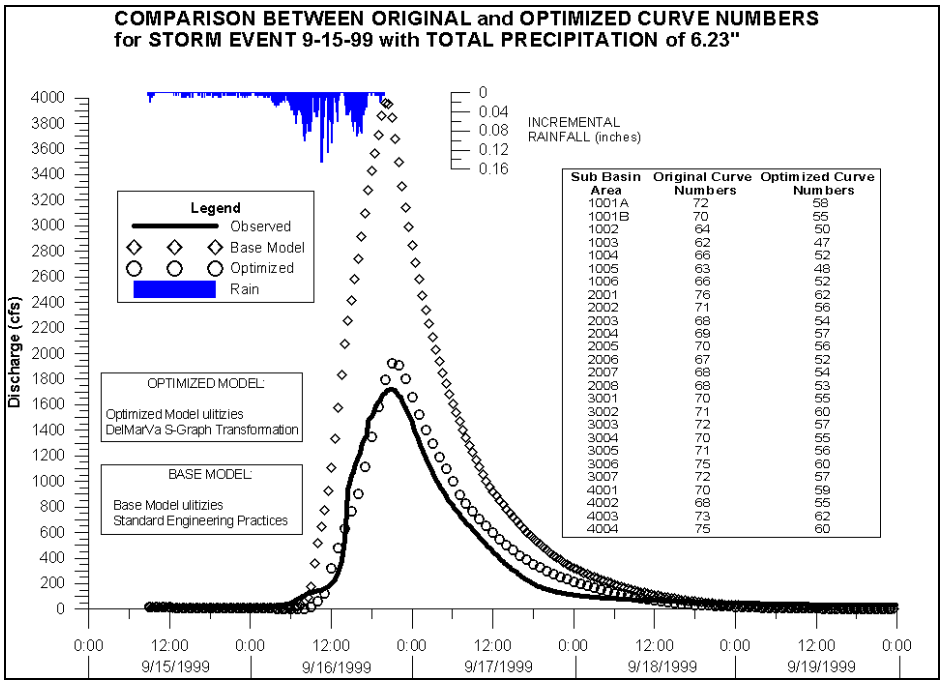


Figure 15: Comparison between NRCS and DelMarVa

Composite Curve Number

The modeling and calibration effort show the Curve Number appears to be highly dependent on season. In both the calibration runs and while calculating the CN directly from event data, the CN was significantly lower during summer and fall events. Standard practices appear to reasonably calculate the CN for winter / spring events. These "worst case" conditions are characterized by saturated soils, no leaf cover, reduced ground cover, high groundwater levels and limited evaporation. By contrast the actual CN appears to be at least 15 units lower during summer and fall months. In all the summer and fall calibration runs, including Hurricane Floyd allowing the CN to reduce up to 15 units produce a significantly better result then the standard CN value. Figure 16 shows a comparison between the calculated CN and the optimized value.



Sub Basin Area	Original Curve Numbers	Optimized Curve Numbers
1001A	72	58
1001B	70	55
1002	64	50
1003	62	47
1004	66	52
1005	63	48
1006	66	52
2001	76	62
2002	71	56
2003	68	54
2004	69	57
2005	70	56
2006	67	52
2007	68	54
2008	68	53
3001	70	55
3002	71	60
3003	72	57
3004	70	55
3005	71	56
3006	75	60
3007	72	57
4001	70	59
4002	68	55
4003	73	62
4004	75	60

Figure 16: Results of CN Calibration

The seasonality of the CN is not unexpected, however, the extent of the difference may be surprising. Dealing with this issue will most likely be the greatest challenge of this RSMP. If indeed the CN is lower then traditionally calculated during summer and fall, this would help explain to apparent overestimation of existing condition runoff. At a hypothetical 25 acre site, the discharge from the 2, 10 and 100 yr storms is reduced by 80, 60 and 40 percent, respectively, when the CN is reduced by 15 units. A stormwater basin designed to meet RSIS requires reductions to 50, 75 and 80 percent of the existing condition runoff. In our example, the discharge from a stormwater basin at this site would represent an increase in peak discharge over the reduced CN discharge.

To further investigate the seasonality of the CN, staff calculated the "observed" CN for a variety of runoff events. Using equations from the NRCS the actual CN for each modeled storm and runoff event was calculated. Table 10 shows the results of this calculation. The fall event CNs ranged from 14 to 23 units below the estimated overall CN of 70. The data also indicate the CN for spring storms may be higher then estimated using the standard NRCS CN method. Staff performed this calculation on all runoff events where rainfall exceeded 3 inches for the period of record for the USGS gage. This data is provided in Appendix C, Table 2. Note that during the period 1966 to 1997 rainfall data from the NWS weather station in nearby Glassboro was used and may not reflect the actual rainfall in the Raccoon Creek watershed. The data from this calculation indicates the average CN for the watershed above the USGS gage is 61, nine units below the originally estimated value.

Table 10: Calculated CN for calibration events

Storm Event	Direct Runoff (in)	Calculated CN
9/15/1999	1.77	56
3/21/2000	1.70	80
4/12/2004	1.24	80
9/28/2004	0.20	57
10/7/2005	0.69	47

Lag times

Subarea lag times were calculated using the NRCS lag equation. Optimizing for lag time within reasonable constraints (up to 2x calculated value) affected the peak rate discharge only slightly. Although it is possible (likely) the lag equation underestimates the actual travel time, a reasonable method for estimating this parameter is beyond the scope of this project. Figure 17 shows the results of an optimization run where the SCS lag was permitted to vary by up to 2x the calculated value.

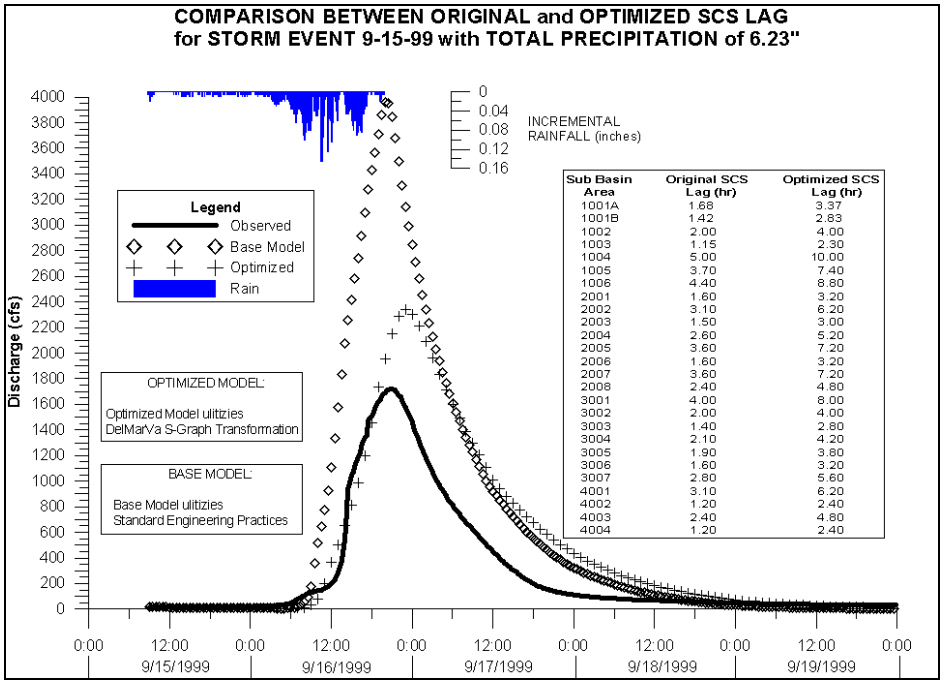
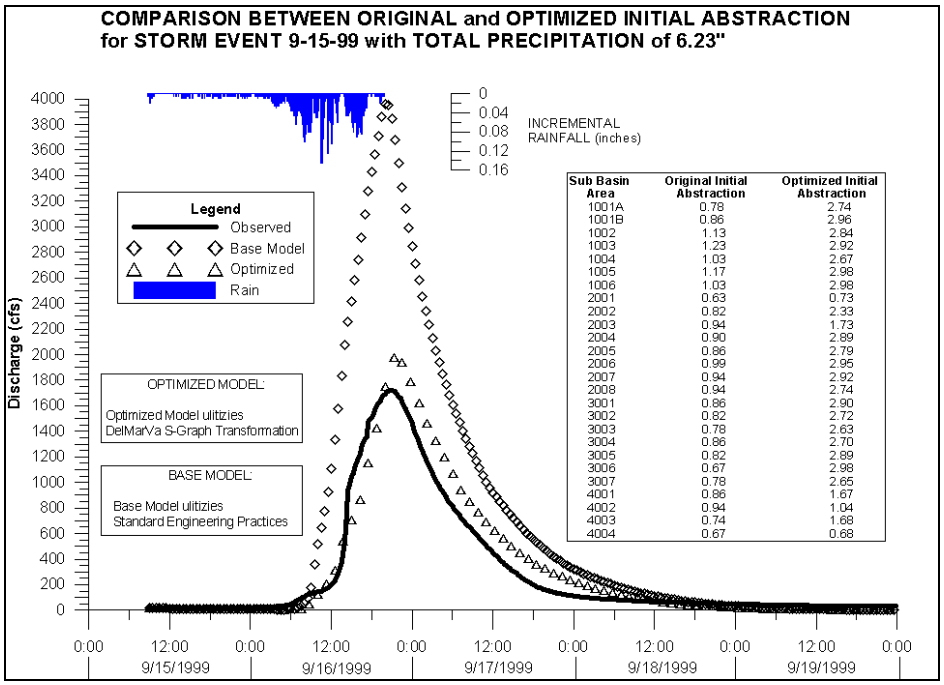


Figure 17: Results of SCS Lag Calibration

Estimating travel time (lag or time of concentration) has been the focus of much scientific research. Whether using the segmental method or lag equation, the designer must rely on sound engineering judgment to confirm the accuracy of the estimate. Field investigation and observation of the hydrologic point of interest will be the best resource in ensuring an accurate calculation of this parameter.

Initial Abstraction

The HMS model allows the user to vary the initial abstraction (loss). The HMS software will automatically adjust the CN used in the model, based on the entered initial loss according to the NRCS equation Ia= 0.2S, where S=(1000/CN)-10. Research on the CN method suggest that the initial abstraction value is closer to Ia = 0.05S. In the optimization trials the initial loss constraints were set between 0.05 inches and 3.0 inches (Figure 18). Calibration runs indicated that, as in the CN calibration, that loss is greatly impacted by seasonality and antecedent conditions. Although peak discharges and volumes could be reasonably impacted by adjusting this parameter, project staff felt the judgment of initial conditions was too arbitrary to be effective as a management tool.



Sub Basin Area	Original Initial Abstraction	Optimized Initial Abstraction
1001A	0.78	2.74
1001B	0.86	2.96
1002	1.13	2.84
1003	1.23	2.92
1004	1.03	2.67
1005	1.17	2.98
1006	1.03	2.98
2001	0.63	0.73
2002	0.82	2.33
2003	0.94	1.73
2004	0.90	2.89
2005	0.86	2.79
2006	0.99	2.95
2007	0.94	2.92
2008	0.94	2.74
3001	0.86	2.90
3002	0.82	2.72
3003	0.78	2.63
3004	0.86	2.70
3005	0.82	2.89
3006	0.67	2.98
3007	0.78	2.65
4001	0.86	1.67
4002	0.94	1.04
4003	0.74	1.68
4004	0.67	0.68

Figure 18: Results of Initial Abstraction Calibration

The overall best fit for each storm event was calibrated by allowing several parameters to be adjusted. Figure 19 shows the best fit for the 9-15-99 event, where CN was decreased by up to 15 units and the Ia was allowed to vary. This large rainfall event produced significantly less runoff then would have been predicted by an un-calibrated NRCS runoff model. The calibrated model includes reasonable adjustments to runoff parameters and produces a result that nearly matches peak discharge, volume and hydrograph shape.

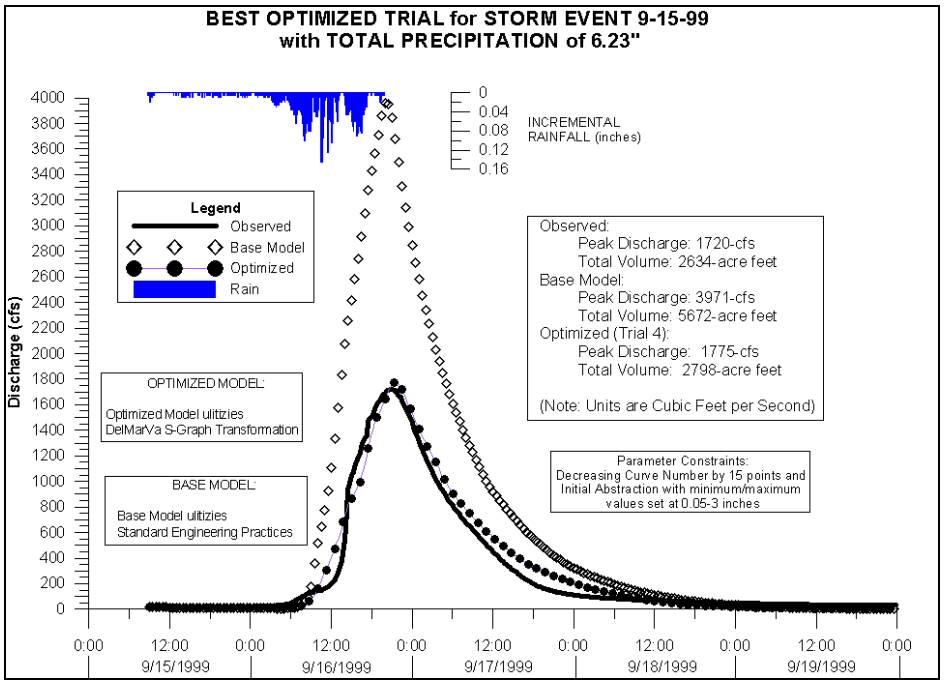


Figure 19: Results from Best-Fit Calibration

Calibration summary

The calibration effort focused on CN, initial abstraction and watershed lag. Each parameter was allowed to optimize within reasonable constraints in individual calibration runs. Figure 20 shows all the calibration plots of the 9-15-99 storm in relation to the observed hydrograph and the original model. Again it is important to note that all calibration trials were run with the DelMarVa mass curve in the HMS User Specified Unit Hydrograph transform method. The calibration clearly indicates the accuracy of this model can be improved by adjusting the input parameters within reasonable constraints. Although the text of this report shows only the results of one storm, the same results (depending on the season) were observed in all calibration trials. The complete results of this calibration are provided in Appendix C, Figures 1-24.

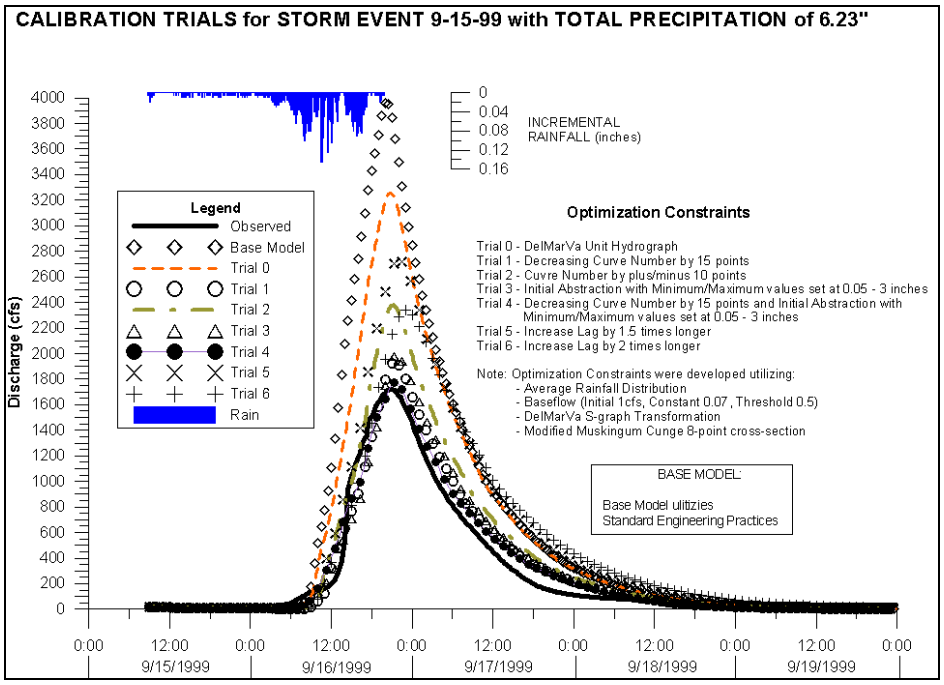


Figure 20: Results from All Calibration Trials

2.3.5 Conclusions and Recommendations

The hydrologic modeling and calibration process is useful to determine trends and sensitivity of the model input parameters. Further, the modeling and calibration process has provided some guidance in establishing appropriate input parameters.

The overall results suggest the following:

- Standard engineering practices dramatically over predict runoff from design storms when compared to USGS Flood Frequency Analysis,
- The DelMarVa dimensionless Unit Hydrograph, already approved for use in the Outer Coastal Plain, appears to be appropriate for the Raccoon Creek Watershed,
- Curve Numbers are strongly affected by seasonal conditions,
- Standard engineering practices to calculate CN work reasonably well during the late winter and spring seasons, but not during the remainder of the year,
- CN values calculated using standard engineering practices are about 15 units high during typical summer and fall conditions,
- Reasonable changes in Time of Concentration (utilizing standard NRCS techniques) do not significantly improve the accuracy of the hydrologic model,
- Varying the Initial Abstraction can help account for the effects of the CN, but is difficult to develop guidance for practical application.

Overall the model calibration process suggests that standard practice works reasonably well for modeling the worst-case scenarios. This is appropriate for designing roads, dams and other public structures where failure is unacceptable and a suitable

margin of safety is required. During normal conditions, standard practices modeling tends to over predict the peak discharge and volume of runoff by at least a factor of two. This is especially true of smaller, more frequent events.

The modeling data suggests that revised procedures should be implemented to manage stormwater discharges from development projects. Based on these conclusions, the following recommendations are made:

- **Use the DelMarVa dimensionless unit hydrograph for all hydrologic analyses in the Raccoon Creek Watershed when the NRCS runoff methods are used,**
- **Use field indicators to verify the existing condition calculations, including evidence of overland flow where channel flow is said to occur, in order to improve accuracy of Time of Concentration calculations and drainage area delineation,**
- **Design bridges, dams, culverts and other similar structures using Curve Numbers calculated following standard engineering practices,**
- **Develop a regional table of Curve Numbers to reflect seasonally low runoff conditions,**
- **Use regional Curve Numbers to generate existing condition runoff hydrographs of development parcels. Standard Curve Numbers should be used in determining developed condition runoff and follow existing stormwater management requirements.**

Adopting these recommendations will provide several benefits to the community and watershed features. The current factor of safety of stormwater infrastructure will be maintained. However, by better mimicking the existing runoff conditions during low runoff periods, the impact of development on the receiving waterways will likely be substantially reduced. This recommendations will require additional effort by the design and reviewing engineers and professionals, but this more careful look at the watershed hydrology will only further the effectiveness of proposed stormwater management facilities. A sample case study is provided in Appendix C 1.

2.4 Water Quality Assessment

The Raccoon Creek Watershed is known to have several documented water quality issues. Specific segments are listed as impaired for a variety of parameters, including fecal coliform, phosphorus, silver and benthic marcroinvertebrates. In response to these impairments, the NJDEP has proposed a TMDL for fecal coliform and has listed the other parameters in the 2004 303(d) list of impaired waters in varying sublists.

2.4.1 General Water Quality Assessment from Published Data

The NJDEP and the U.S. Geological Survey (USGS) collect and analyze water quality samples from the USGS Station 01477120 at Tomlin Station Road. Sampling is conducted at various times during the year and samples are analyzed for a variety of nutrients, bacteria, chemical and in-situ parameters. The data are published in the annual report *Water Resources Data for New Jersey*. The data for the Station 01477120 Raccoon Creek near Swedesboro, New Jersey, from Water Year 2004 are included in Appendix D, Report 1.

To complement the chemical water quality data, the NJDEP maintains five Ambient Biological Network (AMNET) monitoring sites within the watershed (shown in Appendix D, Figure 1). At these AMNET sites the NJDEP conducts biological assessments of in-stream benthic macroinvertebrate communities. Benthic macroinvertebrates include aquatic insects, worms, snails, crayfish and clams. Utilizing the USEPA Rapid Bioassessment Protocols, the NJDEP monitors these sites every five years and analyzes the data to provide an overall evaluation of the stream's ability to support aquatic life.

The AMNET sampling can help to identify a trend in aquatic life support. This serves as an indicator of the overall health of the watershed, but the assessments do not always provide information on the causes for this impairment. The Raccoon Creek sites were first sampled during the 1995/96 season and again during the 2000/01 season. The New Jersey Impairment Scores as published in the *New Jersey AMNET Study – 2001 Lower Delaware Region* are shown in Table 2 of that report and are included in this report in Appendix D, Table 1. Four of the five sites are trending down, indicating increasing impairment. The fifth site is unchanged.

The NJDEP has published the water quality impairments of Raccoon Creek in the *New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report*. The report lists river segments and water bodies that are impaired and in sub-list 5 ranks the relative priority of resolving the impairment. Four river segments or sites within the watershed are listed for impairments. These include parameters such as fecal coliform, phosphorus, benthic macroinvertebrates and chemicals; arsenic, cadmium, mercury and silver. Table 11 is excerpted from the integrated report. Appendix D, Table 2 includes a section of sub-list 5 from the referenced report. The complete report is available from the NJDEP Water Monitoring and Standards website at:
http://www.state.nj.us/dep/wmm/sgwqt/wat/index.html

Table 11: List of Impairments within Raccoon Creek Watershed

Station Name/Waterbody	Site ID	Parameters
Raccoon Creek at Ellis Mill Road in Elk Township	AN0679	Benthic Macroinvertebrates
Raccoon Creek at Tomlin Station Road in Harrison Township	AN0683 01477120	Arsenic, Benthic Macroinvertebrates, Cadmium, Chromium, Copper, Dissolved Oxygen, Dissolved Solids, Fecal Coliform, Lead, Mercury, Nickel, Nitrate, pH, Phosphorus, Selenium, Silver, Temperature, Total Suspended Solids, Unionized Ammonia, Zinc
Raccoon Creek South Branch at High Street in Harrison Township	AN0682	Benthic Macroinvertebrates
Raccoon Creek South Branch at Swedesboro Road in South Harrison Township	AN0681	Benthic Macroinvertebrates

2.4.2 Volunteer Water Quality Monitoring

In order to support the formal water quality data collected by NJDEP and USGS, Rowan University students collected and analyzed data from seven sites from Summer 2004 through Winter 2005. The samples were analyzed for in-situ parameters (temperature, pH, dissolved oxygen and percent dissolved oxygen), nutrients (total phosphorus and nitrogen) and bacteria (total and fecal coliform). Their procedures, the sampling locations and generalized results are provided below.

This data should be used to characterize the water quality and spot trends or changes over time. The following procedures and results are supplied by Rowan University under-graduate students.

Procedure

Surface water samples have been collected bi-monthly for the Raccoon Creek Watershed. When possible, samples were collected directly into the sampling container; otherwise a collection dipper was used. The collection dipper was triple rinsed at each site and discarded downstream of the sampling location.

Parameters measured in the field include dissolved oxygen (in mg/L & %), pH, and temperature. Dissolved oxygen and temperature is measured using YSI Model 550A and field pH is measured using Orion Model 290A. If the steam depth is greater than 1 foot deep, multiple dissolved oxygen samples will be taken at 0.5 foot intervals. General field notes include: location, date, time, physical appearance, staff gauge measurement (if available), depth of measurement, and field parameters listed above.

Laboratory analysis of the surface water samples includes testing for nutrients and bacteria. The Phosphate test is performed using PhosVer3 Soluble Reactive Phosphorus Test-N-Tube Reagent Set, HACH Method 8048. This method uses a spectrophotometer to produce the amount, in mg/L, of Phosphate (PO_4^{3-}) in the sample. The Nitrate test is performed using NitraVer 5 Reagent Powder Pillow, HACH Method 8039. This method uses a spectrophotometer to produce the amount, in mg/L, of Nitrate Nitrogen (NO_3^--N) in the sample. The bacteria test is for Total and Fecal Coliform. The Coliform test is performed using the Presumptive Test for Total Coliforms (m-Endo), HACH Method 8074. This method is a membrane filtering method that produces a Fecal Coliform

Count, as well as a Total Coliform Count (cfu/100 mL) from the sample. Surface water samples used in this method include 1 mL, and 5 mL samples.

Locations

Sampling will be conducted at seven (7) locations including: Winarski Lake, Gilman Lake, Kincaid Lake, Ewan Lake, Mullica Hill Pond, High Street, and Swedesboro Road. Surface water samples will be collected at a single point at each location and all are downstream of the spillway except for High Street, and Swedesboro Road. Figure 21 depicts the sample locations.

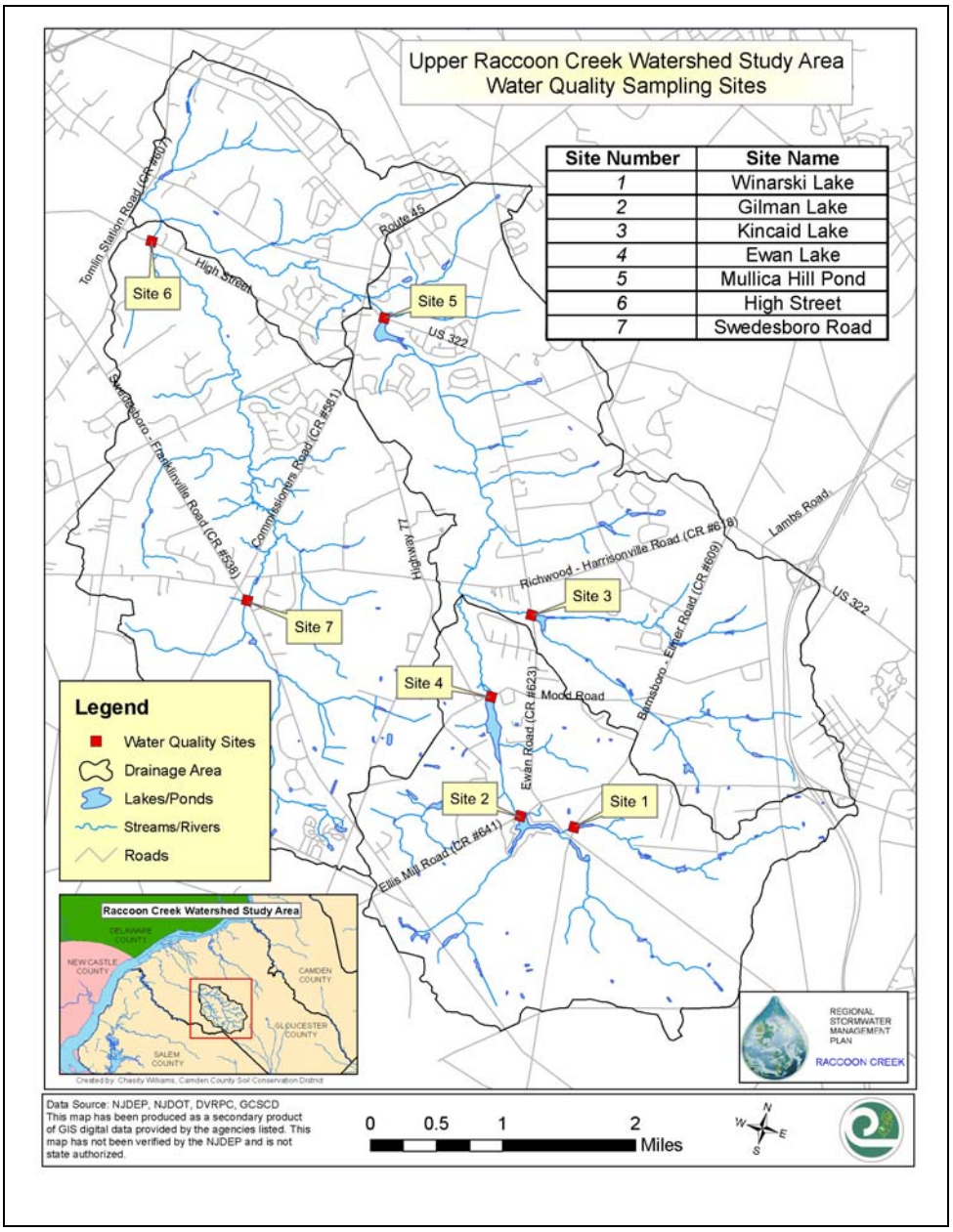


Figure 21: Water Quality Sampling Locations

Results

The results for the field and laboratory parameters have been analyzed for seasonal and monthly results. The Nitrate-Nitrogen NJDEP limit is set at 10 mg/L, and for all seven sites the maximum concentration during the peak season (Spring-Summer) was 6 mg/L. The Phosphate NJDEP limit is set at 0.1 mg/L (for TP), and for all seven sites the seasonal averages were at or above the limit with the peak season being Summer-Autumn. For the individual, bi-monthly results, all locations except for Gilman Lake and Ewan Lake were above the NJDEP limit. Gilman Lake and Ewan Lake were within 0.05 mg/L of the NJDEP limit for most samples. Appendix E includes all plots and scatter plots of the data collected from several sites.

The insitu parameters analyzed included pH, dissolved oxygen (mg/L), and temperature. For pH all seven locations were within 6.5-7.5, which is within the NJDEP limit of 6.5-8.5 for aquatic life. Temperature results were as expected with lower values in the winter and higher values in the summer. For dissolved oxygen the NJDEP requires a minimum of 4 mg/L for aquatic life to not be harmed. All seven sites were above the limit for the entire year with winter being the peak period for dissolved oxygen. During the winter months several locations had dissolved oxygen readings above 12 mg/L which is above the optimum range for aquatic life (5.0-10.0 mg/L).

2.4.3 Water Quality Discussion

As noted, the 2004 Integrated List of Waterbodies list several impairments in this watershed. Although not a requirement of the scope of work for this project, adopting strategies to address these impairments would be a valuable asset to this management plan. The established TMDL for fecal coliform bacteria indicates the NJDEP has already taken steps to address this impairment. The TMDL requires the reduction of 88% to meet the fecal coliform Surface Water Quality Standards.

Neither the TMDL document nor the sampling programs have narrowed the source(s) of fecal coliform contamination. The RSMC should consider their response to this TMDL and if additional sampling or source tracking is necessary. Further stakeholders should provide guidance and recommendations regarding how water quality should be addressed in the RSMP.

Section 2.2.6 Agriculture

Agricultural land remains the single largest land use within the Raccoon Creek Watershed. Grain crops, corn and soybeans, comprise large percentage of the farms, but there are also, truck crops, orchard, nursery stock, small animal agriculture and some specialty agriculture.

Overall agricultural practices appear sound. Our project staff did not find any evidence of severe erosion or excessive overland runoff. Most farms had adequate riparian buffers along mapped streams, although there were several open drainage ditches without vegetated buffers. Farming practices appear typical for southern New Jersey and many farmers are NRCS cooperators.

Gloucester County and the State of New Jersey have already permanently preserved several farms within the watershed. Farmland preservation can have a significant impact on maintaining and meeting the water quantity, quality and recharge goals.

Farmers and agricultural landowners should be encouraged to participate in existing Federal, State and local agricultural Best Management Practices programs to control erosion, reduce surface runoff and enhance water quality with funding through cost share and other sources of funding.

Section 3.0 – Characterization and Assessment Conclusions

This Characterization and Assessment suggests land use changes have begun, and will continue, to impact the surface water resources of the Raccoon Creek Watershed. As rural land is developed, runoff patterns will change, aging stormwater infrastructure will be stressed, stream corridors will be impacted, groundwater recharge patterns will change, and water quality will be affected. Not all of these changes will produce negative results, however an increase of impervious cover nearly always results in an increased potential for impairments.

The C&A report suggests several stormwater issues that can be most effectively and appropriately addressed through a regional stormwater management plan. The stakeholders of the Raccoon Creek watershed, together with the project partners must address these issues to develop a functional and implementable RSMP.

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APPENDIX A:
GENERAL CHARACTERIZATION

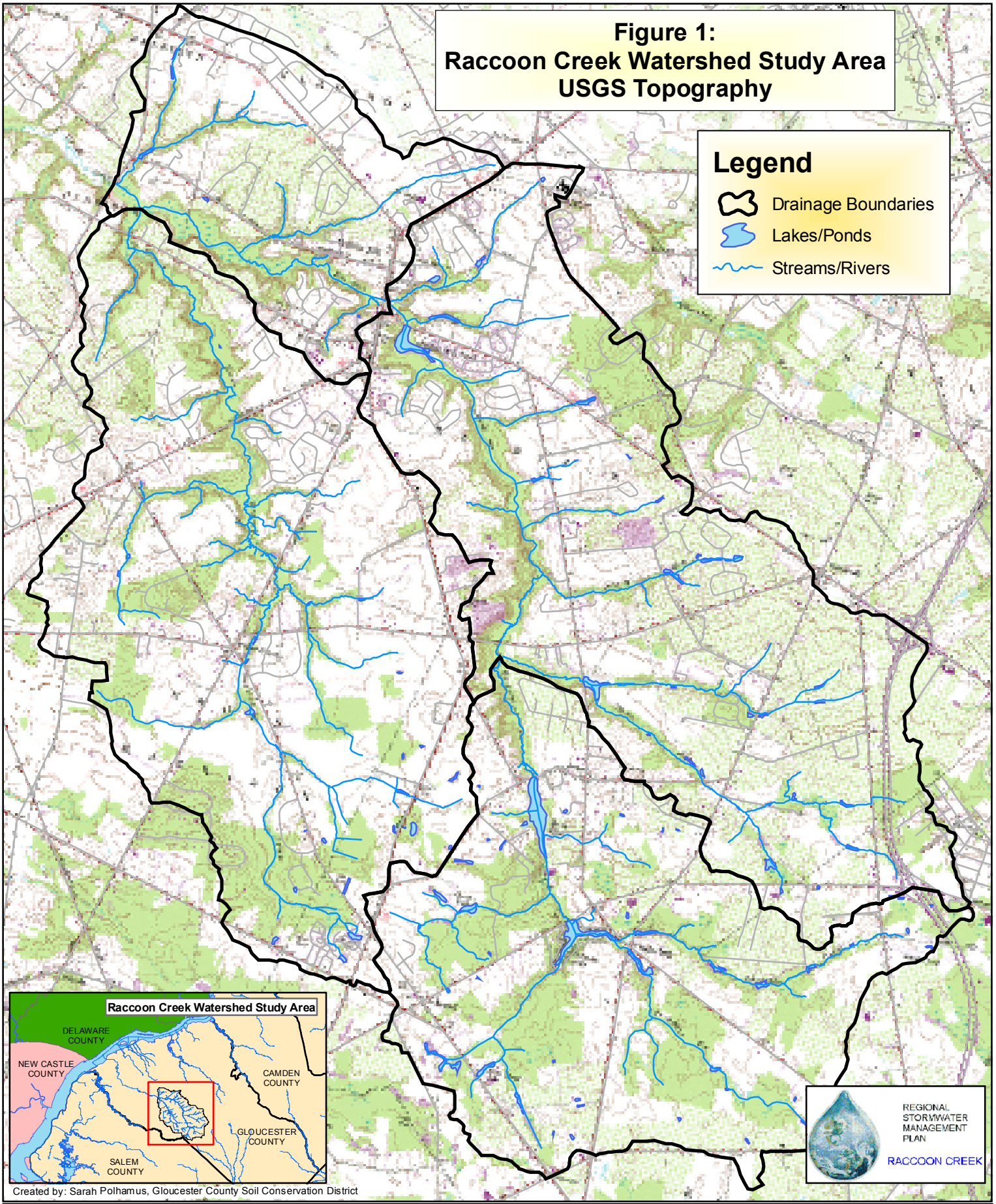
Figure 1: Raccoon Creek Watershed Study Area Topography 55

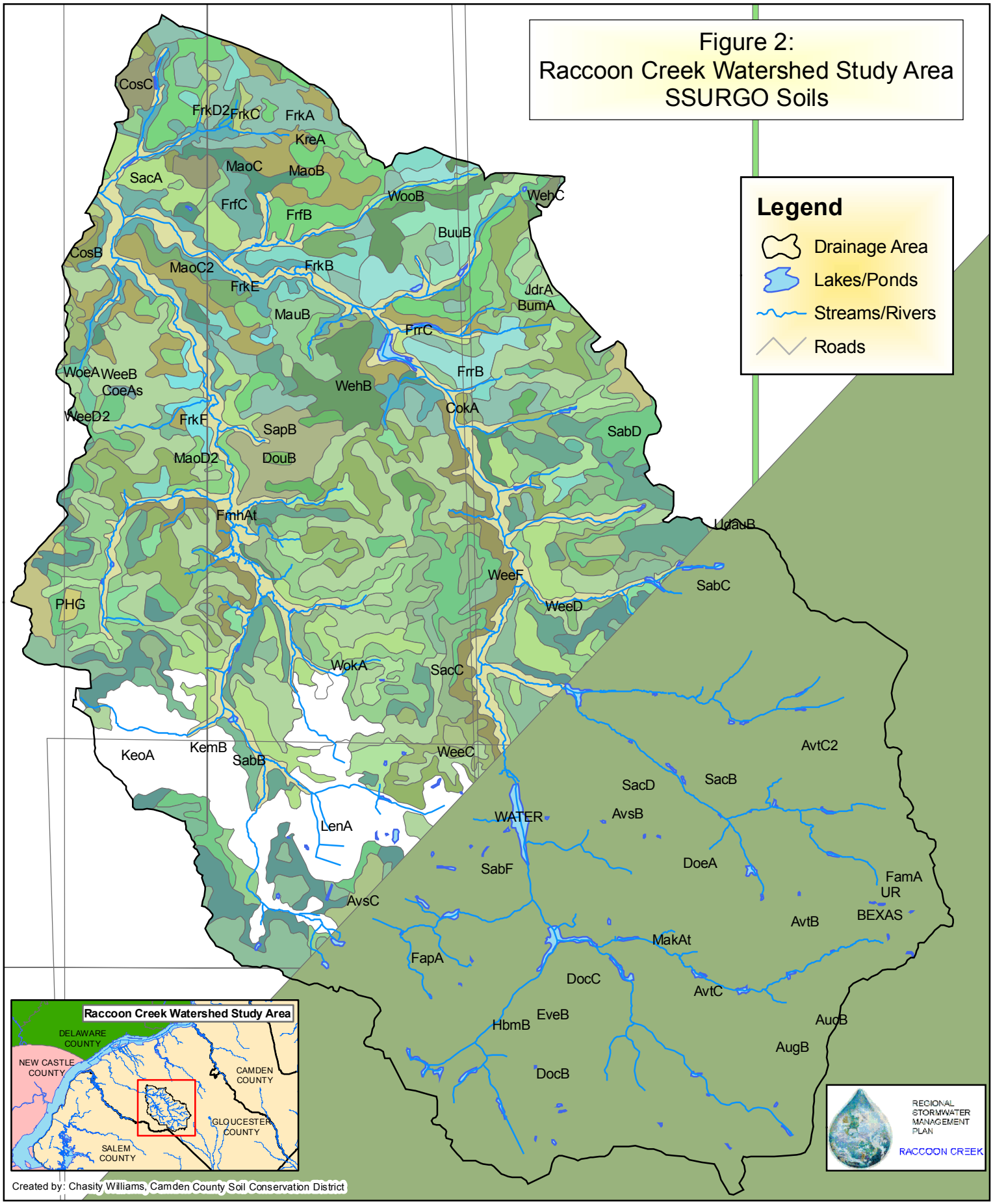
Figure 2: Raccoon Creek Watershed Study Area SSURGO Soils 57

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Figure 1:
Raccoon Creek Watershed Study Area
USGS Topography
Legend
Drainage Boundaries
Lakes/Ponds
Streams/Rivers
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Sarah Polhamus, Gloucester County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
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Figure 2:
Raccoon Creek Watershed Study Area
SSURGO Soils
Legend
Drainage Area
Lakes/Ponds
Streams/Rivers
Roads
CosC
FrkD2
FrkC
FrkA
KreA
MaoC
MaoB
SacA
FrfC
FrfB
WooB
WehC
BuuB
CosB
MaoC2
FrkB
FrkE
JdrA
BumA
MauB
FrrC
WoeA
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FrkF
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SabD
MaoD2
DouB
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UdaB
WeeF
SabC
PHG
WeeD
WokA
SacC
KeoA
KemB
SabB
WeeC
AvtC2
SacD
SacB
WATER
AvsB
LenA
SabF
DoeA
FamA
UR
AvsC
BEXAS
AvtB
MakAt
FapA
DocC
AvtC
EveB
HbmB
AucB
AugB
DocB
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
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GLOUCESTER COUNTY
SOIL CONSERVATION DISTRICT

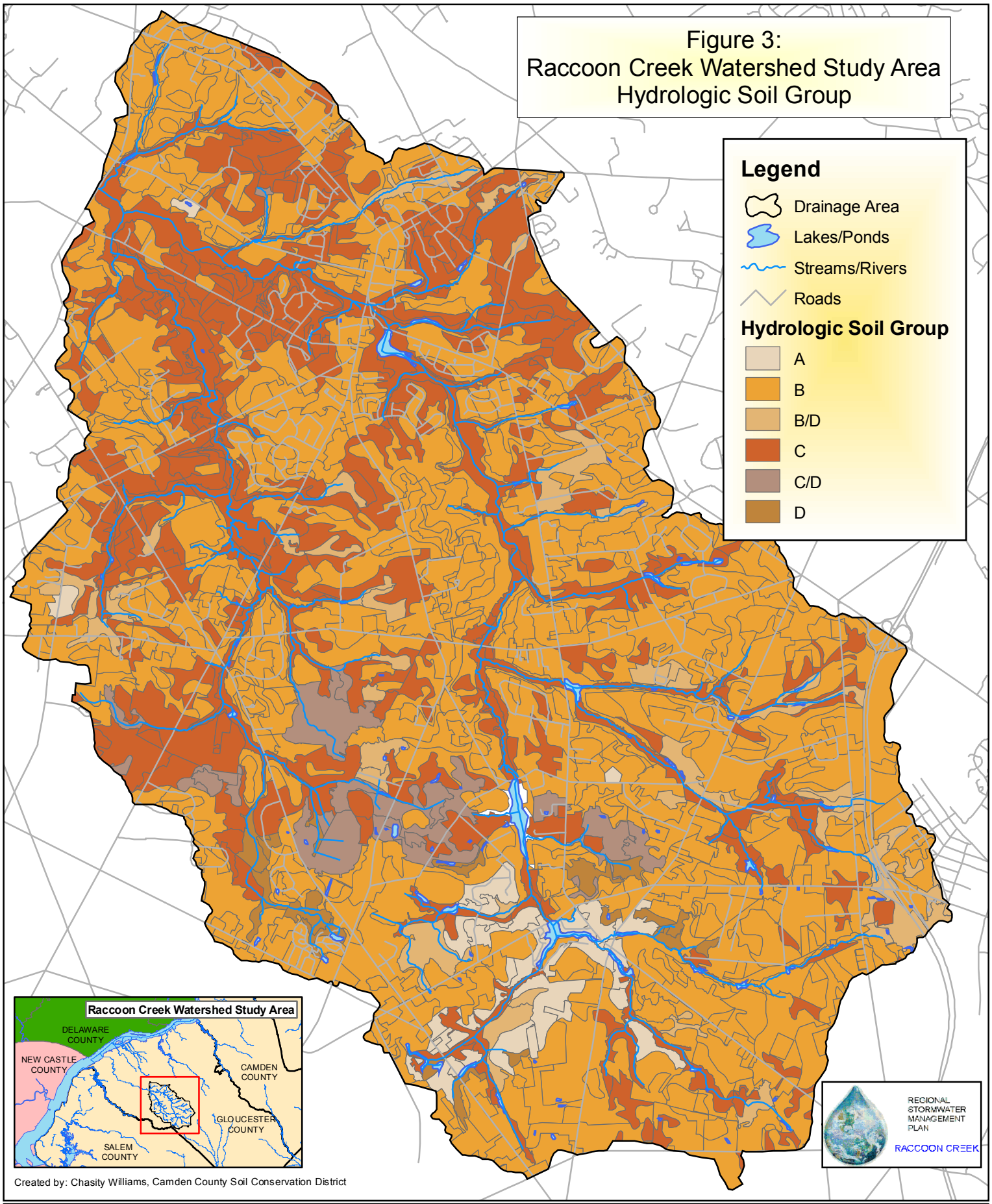
RACCOON CREEK WATERSHED
REGIONAL STORMWATER MANAGEMENT PLAN

TABLE 1: GLOUCESTER COUNTY SSURGO SOILS

SSURGO Symbol	SSURGO Name
AucB	Aura loamy sand, 0 to 5% slopes
AugB	Aura sandy loam, 2 to 5% slopes
AvsB	Aura-Sassafras loamy sands, 0 to 5% slopes
AvsC	Aura-Sassafras loamy sands 5 to 10% slopes
AvtB	Aura-Sassafras sandy loams, 2 to 5% slopes
AvtC	Aura-Sassafras sandy loams, 5 to 10% slopes
AvtC2	Aura-Sassafras sandy loams 5 to 10 % slopes eroded
BEXAS	Berryland and Mullica soils, 0 to 2% slopes
BumA	Buddtown-Deptford complex, 0 to 2% slopes
BuuB	Buddtown-Urban land complex, 0 to 5% slopes
CoeAs	Colemantown loam, 0 to 2% slopes
CokA	Collington sandy loam, 0 to 2% slopes
CosB	Colts Neck sandy loam, 2 to 5% slpoes
CosC	Colts Neck sandy loam, 5 to 10% slopes
DocB	Downer loamy sand, 0 to 5% slopes
DocC	Downer loamy sand, 0 to 5% slopes
DoeA	Downer sandy loam, 0 to 2% slopes
DouB	Downer-Urban land complex, 0 to 5% slopes
EveB	Evesboro sand, 0 to 5% slopes
FamA	Fallsington sandy loam, 0 to 2% slopes
FapA	Fallsington loam, 0 to 2% slopes
FmhAt	Fluvaquents, loamy, 0 to 3% slopes
FrfB	Freehold loamy sand, 0 to 5% slopes
FrfC	Freehold loamy sand, 5 to 10% slopes
FrkA	Freehold sandy loam, 0 to 2% slopes
FrkB	Freehold sandy loam, 2 to 5% slopes
FrkC	Freehold sandy loam, 5 to 10% slopes
FrkD2	Freehold sandy loam, 10 to 15% slopes
FrkE	Freehold sandy loam, 15 to 25% slopes
FrkF	Freehold sandy loam, 25 to 40% slopes

TABLE 1: GLOUCESTER COUNTY SSURGO SOILS (con't)

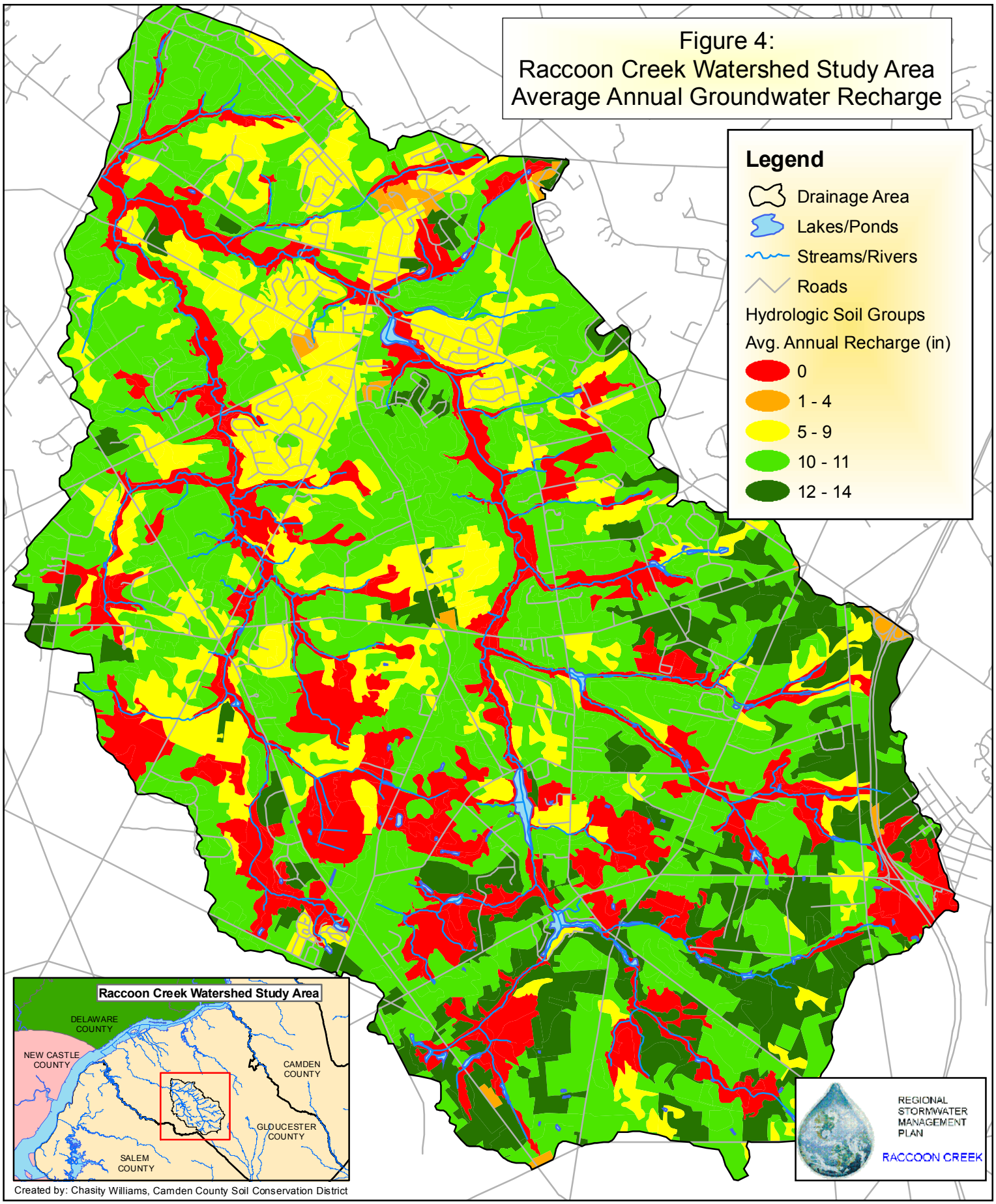
	FrrB	Freehold-Urban land complex, 0 to 5% slopes
	FrrC	Freehold-Urban land complex, 5 to 10% slopes
	HbmB	Hammonton loamy sand, 0 to 5% slopes
	JdrA	Jade Run fine sandy loam, 0 to 2% slopes
	KemB	Keyport sandy loam, 2 to 5% slopes
	KeoA	Keyport loam, 0 to 2% slopes
	KreA	Kresson fine sandy loam, 0 to 2% slopes
	LenA	Lenni loam, 0 to 2% slopes
	MakAt	Manahawkin muck, 0 to 2% slopes
	MaoB	Marlton sandy loam, 2 to 5% slopes
	MaoC	Marlton sandy loam, 5 to 10% slopes
	MaoC2	Marlton sandy loam, 5 to 10% slopes
	MaoD2	Marlton sandy loam, 10 to 15% slopes
	MauB	Marlton-Urban land complex, 0 to 5% slopes
	PHG	Pits, sand and gravel
	SabB	Sassafras loamy sand, 0 to 5% slopes
	SabC	Sassafras loamy sand, 5 to 10% slopes
	SabD	Sassafras loamy sand, 10 to 15% slopes
	SabF	Sassafras loamy sand, 15 to 40% slopes
	SacA	Sassafras sandy loam, 0 to 2% slopes
	SacB	Sassafras sandy loam, 2 to 5% slopes
	SacC	Sassafras sandy loam, 5 to 10% slopes
	SacD	Sassafras sandy loam, 10 to 15% slopes
	SapB	Sassafras-Urban land complex, 0 to 5% slopes
	UR	Urban land
	UdauB	Udorthents-Urban land complex, 0 to 8% slopes
	WATER	Water
	WeeB	Westphalia fine sandy loam, 2 to 5% slopes
	WeeC	Westphalia fine sandy loam, 5 to 10% slopes
	WeeD	Westphalia fine sandy loam, 10 to 15% slopes
	WeeD2	Westphalia fine sandy loam, 10 to 15% slopes
	WeeF	Westphalia fine sandy loam, 15 to 40% slopes
	WehB	Westphalia-Urban land complex, 0 to 5% slopes
	WehC	Westphalia-Urban land complex, 5 to 10% slopes
	WoeA	Woodstown sandy loam, 0 to 2% slopes
	WokA	Woodstown-Glassboro complex, 0 to 2% slopes
	WooB	Woodstown-Urban land complex, 0 to 5% slopes



Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

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N W E S


Figure 4:
Raccoon Creek Watershed Study Area
Average Annual Groundwater Recharge
Legend
Drainage Area
Lakes/Ponds
Streams/Rivers
Roads
Hydrologic Soil Groups
Avg. Annual Recharge (in)
0
1 - 4
5 - 9
10 - 11
12 - 14
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
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APPENDIX B:
WATERSHED CHARACTERIZATION AND ASSESSMENT

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Figure 2: Raccoon Creek Watershed Study Area Stream Assessment – 020 71

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Table 4: Stormwater Outfall Data 87

GLOUCESTER COUNTY
SOIL CONSERVATION DISTRICT

RACCOON CREEK WATERSHED
REGIONAL STORMWATER MANAGEMENT PLAN

Table 1: Stream Assessment Data Collection Sheet

All Assessments must be taken looking upstream of reach assessment point

Subwatershed ID	_____
Reach ID	_____
Inventoried By:	(R.Bergeman, C. McGee, C. Williams, S. Polhamus, G.Hyunh-Ba)
Date	_____
Time	_____
Weather Conditions	(Clear, Overcast, Rain, Snow)
Temperature (F)	_____
Precipitation Date	_____ (within 7 days)
Precipitation (in)	_____
Channel Width (ft)	_____ (from top of bank to top of bank)
Flow Width (ft)	_____
Channel Depth (ft)	_____ (from top of bank to channel bed)
Flow Depth (ft)	_____
Right Buffer Width (ft)	_____
Left Buffer Width (ft)	_____
Right Bank Slope	(Flat, Gentle, Moderate, Steep)
Left Bank Slope	(Flat, Gentle, Moderate, Steep)
Right Bank Disturbance	(Natural, Manmade, None)
Left Bank Disturbance	(Natural, Manmade, None)
Right Bank Erosion	(Severe, Moderate, Minimal, None)
Left Bank Erosion	(Severe, Moderate, Minimal, None)
Right Bank Land Use	(Forest, Orchard, Farmland, Industrial, Residential, Wetlands)
Left Bank Land Use	(Forest, Orchard, Farmland, Industrial, Residential, Wetlands)
Stream Movement	(Stagnant, Sluggish, Slow, Swift)
Water Clarity	(Clear, Cloudy, Opaque, Eutrophic)
Bed Material	(Mud, Sand, Gravel, Rip-Rap)
Indicator Plants	(Algae, Mosses, Herbaceous, None)
Aquatic Plants	(Purple Loosestrife, Phragmities, Cattails, Tussock Sedge, None)
Bank Symmetry	(Symmetric, Non-Symmetric)
Stream Shading	(75-100% 50-74% 25-49% 0-24%)
Debris	(Natural, Garbage, Natural & Garbage, None)
Stream Alterations	(None, Around Structures, 40-80% Channelized, >80% Channellized)

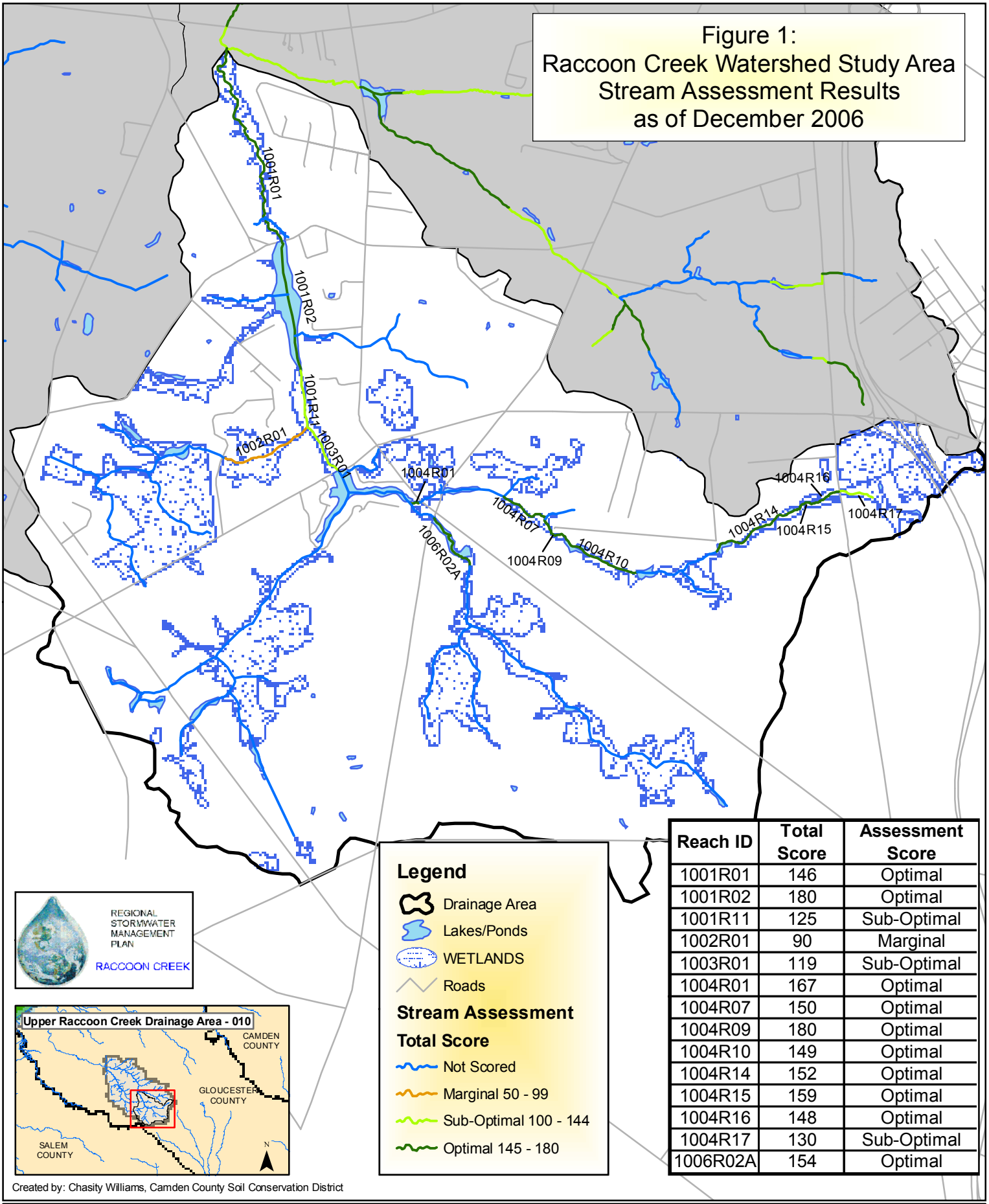
Comments_____
_____
_____
_____
_____
_____

Table 1: Stream Assessment Data Collection Sheet (Con't)

	Condition Category			
	Optimal	**SubOptimal**	**Marginal**	**Poor**
1. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent, root mats and submerged vegetation common.	Mixture of soft sand, mud or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat, no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Sediment Depostion	Little or no enlargement of islands or point bars and less than 5% (20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increases in bar formation mostly from gravel, sand or fine sediment; 5-30% (20-50% for low gradient streams) of the bottom affected; slight depositions in pools.	Moderate depositions of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low gradient streams) of the bottom affected; sediment deposits is at obstructions, bends and constrictions.	Heavy deposits of fine material, increase bar development; more than 50% (80% for low gradient streams) of the bottom changing frequently; pools almost absent due to substantial sediment depositions.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel or <25% of channel substrate is exposed.	Water fills 25-75% of the available, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Alteration	Channelization or dredging absent or minimal; stream width normal pattern.	Some channelization present, usually areas of bridge abutments; evidence of past channelization (ie dredging) (greater than past 20 years) may be present, but recent channelization not present	Channelization may be extensive; embankments and 40 to 80% of stream reach channelized and disrupted.	Banks shored with Gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it was a straight line. (Note-channel braiding is considered normal in coastal plains and other low-laying areas. This parameter is not easily read in these areas).	The bends in the stream increase the stream length 2 to 3 times longer than if it was a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was a straight line.	Channel straight; waterway has been channelized for a long time.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Bank Stability	Banks stable; evidence of erosion or bank failure absent or minimal; little protential for future problems. <5% of bank affected/	Moderatley stable; infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion	Moderatley unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% bank has erosional scars.
Score (Left Bank)	10 9	8 7 6	5 4 3	2 1 0
Score (Right Bank)	10 9	8 7 6	5 4 3	2 1 0
8. Bank Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation; including trees, under story shrubs, or nonwoody macrophytes vegetative distruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation but one class of plants is not well represented. Disruption evident but not affecting full plant growth potential to any great extent; more than 1/2 of the potential plant stubble height remaining	50-70% of the streambank surfaces covered by vegetation; distruption obvious; patches of bare soil or closely cropped vegetation common; less than 1/2 of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
Score (Left Bank)	10 9	8 7 6	5 4 3	2 1 0
Score (Right Bank)	10 9	8 7 6	5 4 3	2 1 0
9. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; Human activities (ie. Parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; Human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; Human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
Score (Left Bank)	10 9	8 7 6	5 4 3	2 1 0
Score (Right Bank)	10 9	8 7 6	5 4 3	2 1 0

Note: Determine Left Bank by facing upstream

STREAM ASSESSMENT SCORE	VALUE
Optimal	145 - 180
Sub-Optimal	100 - 144
Marginal	50 - 99
Poor	< 50



Reach ID	Total Score	Assessment Score
1001R01	146	Optimal
1001R02	180	Optimal
1001R11	125	Sub-Optimal
1002R01	90	Marginal
1003R01	119	Sub-Optimal
1004R01	167	Optimal
1004R07	150	Optimal
1004R09	180	Optimal
1004R10	149	Optimal
1004R14	152	Optimal
1004R15	159	Optimal
1004R16	148	Optimal
1004R17	130	Sub-Optimal
1006R02A	154	Optimal

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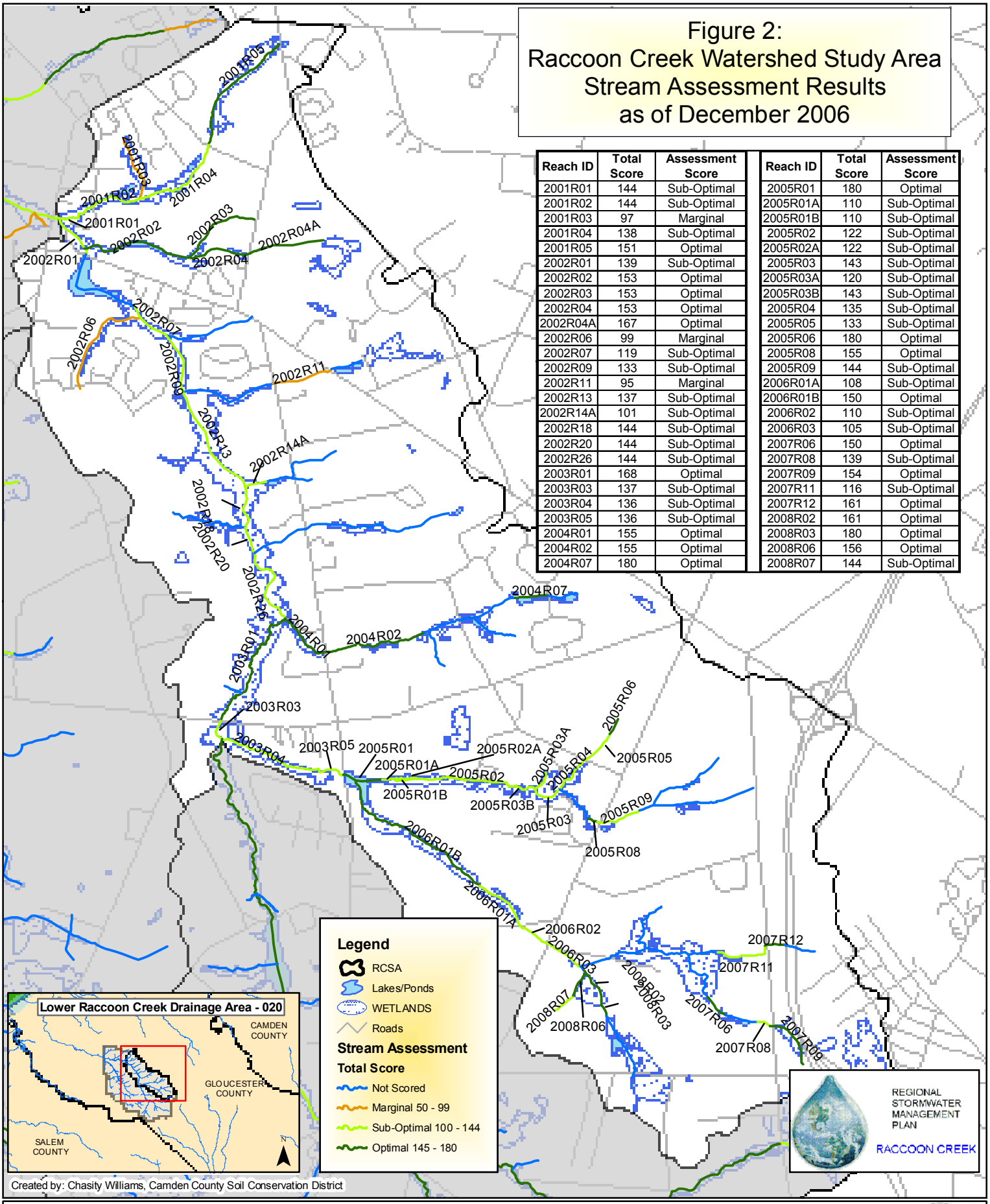
0 0.3 0.6 1.2 Miles

N W E S

Figure 2:
Raccoon Creek Watershed Study Area
Stream Assessment Results
as of December 2006

Reach ID	Total Score	Assessment Score
2001R01	144	Sub-Optimal
2001R02	144	Sub-Optimal
2001R03	97	Marginal
2001R04	138	Sub-Optimal
2001R05	151	Optimal
2002R01	139	Sub-Optimal
2002R02	153	Optimal
2002R03	153	Optimal
2002R04	153	Optimal
2002R04A	167	Optimal
2002R06	99	Marginal
2002R07	119	Sub-Optimal
2002R09	133	Sub-Optimal
2002R11	95	Marginal
2002R13	137	Sub-Optimal
2002R14A	101	Sub-Optimal
2002R18	144	Sub-Optimal
2002R20	144	Sub-Optimal
2002R26	144	Sub-Optimal
2003R01	168	Optimal
2003R03	137	Sub-Optimal
2003R04	136	Sub-Optimal
2003R05	136	Sub-Optimal
2004R01	155	Optimal
2004R02	155	Optimal
2004R07	180	Optimal

Reach ID	Total Score	Assessment Score
2005R01	180	Optimal
2005R01A	110	Sub-Optimal
2005R01B	110	Sub-Optimal
2005R02	122	Sub-Optimal
2005R02A	122	Sub-Optimal
2005R03	143	Sub-Optimal
2005R03A	120	Sub-Optimal
2005R03B	143	Sub-Optimal
2005R04	135	Sub-Optimal
2005R05	133	Sub-Optimal
2005R06	180	Optimal
2005R08	155	Optimal
2005R09	144	Sub-Optimal
2006R01A	108	Sub-Optimal
2006R01B	150	Optimal
2006R02	110	Sub-Optimal
2006R03	105	Sub-Optimal
2007R06	150	Optimal
2007R08	139	Sub-Optimal
2007R09	154	Optimal
2007R11	116	Sub-Optimal
2007R12	161	Optimal
2008R02	161	Optimal
2008R03	180	Optimal
2008R06	156	Optimal
2008R07	144	Sub-Optimal



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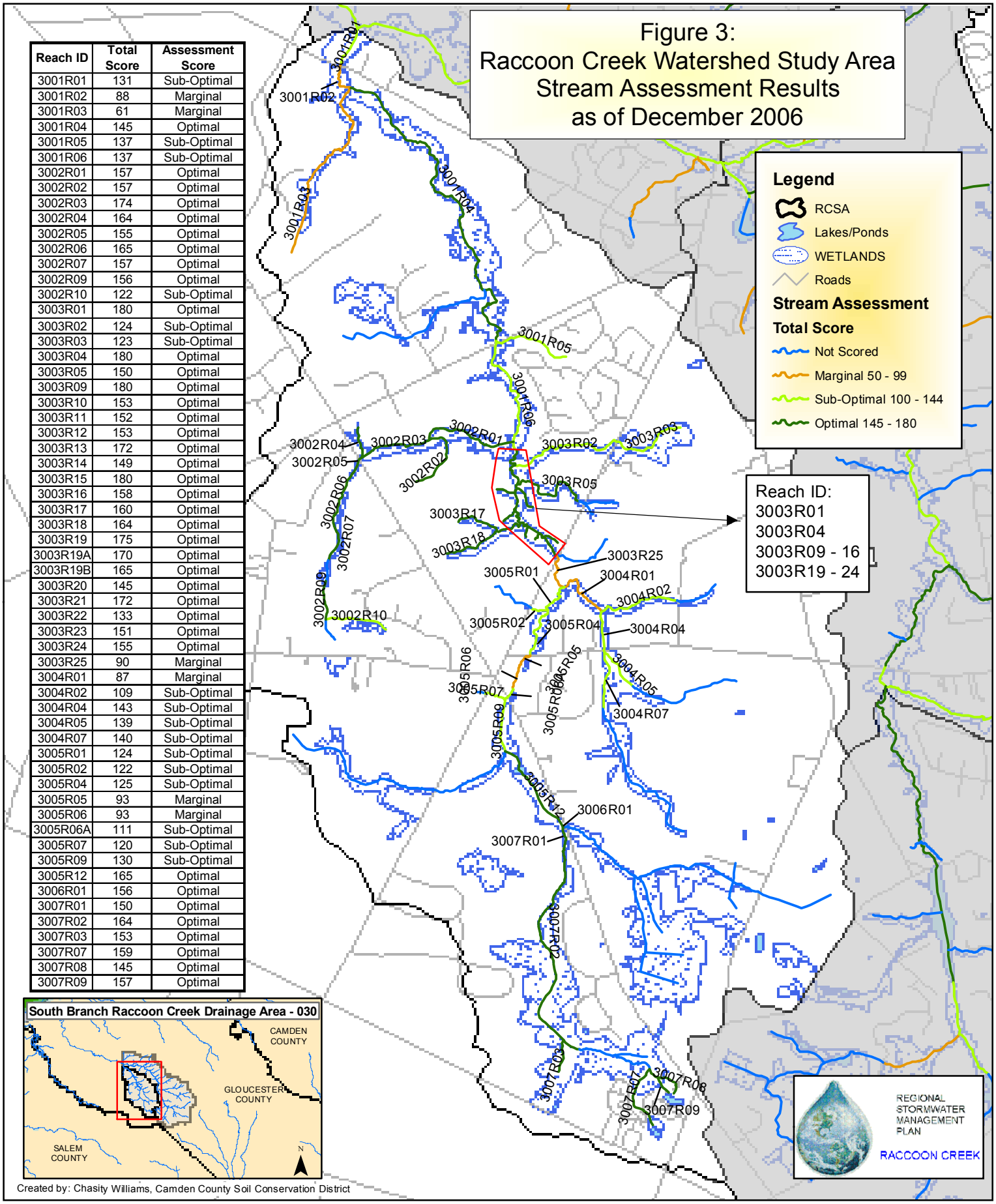
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
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0 0.35 0.7 1.4 Miles

N W E S

Figure 3:
Raccoon Creek Watershed Study Area
Stream Assessment Results
as of December 2006

Reach ID	Total Score	Assessment Score
3001R01	131	Sub-Optimal
3001R02	88	Marginal
3001R03	61	Marginal
3001R04	145	Optimal
3001R05	137	Sub-Optimal
3001R06	137	Sub-Optimal
3002R01	157	Optimal
3002R02	157	Optimal
3002R03	174	Optimal
3002R04	164	Optimal
3002R05	155	Optimal
3002R06	165	Optimal
3002R07	157	Optimal
3002R09	156	Optimal
3002R10	122	Sub-Optimal
3003R01	180	Optimal
3003R02	124	Sub-Optimal
3003R03	123	Sub-Optimal
3003R04	180	Optimal
3003R05	150	Optimal
3003R09	180	Optimal
3003R10	153	Optimal
3003R11	152	Optimal
3003R12	153	Optimal
3003R13	172	Optimal
3003R14	149	Optimal
3003R15	180	Optimal
3003R16	158	Optimal
3003R17	160	Optimal
3003R18	164	Optimal
3003R19	175	Optimal
3003R19A	170	Optimal
3003R19B	165	Optimal
3003R20	145	Optimal
3003R21	172	Optimal
3003R22	133	Optimal
3003R23	151	Optimal
3003R24	155	Optimal
3003R25	90	Marginal
3004R01	87	Marginal
3004R02	109	Sub-Optimal
3004R04	143	Sub-Optimal
3004R05	139	Sub-Optimal
3004R07	140	Sub-Optimal
3005R01	124	Sub-Optimal
3005R02	122	Sub-Optimal
3005R04	125	Sub-Optimal
3005R05	93	Marginal
3005R06	93	Marginal
3005R06A	111	Sub-Optimal
3005R07	120	Sub-Optimal
3005R09	130	Sub-Optimal
3005R12	165	Optimal
3006R01	156	Optimal
3007R01	150	Optimal
3007R02	164	Optimal
3007R03	153	Optimal
3007R07	159	Optimal
3007R08	145	Optimal
3007R09	157	Optimal



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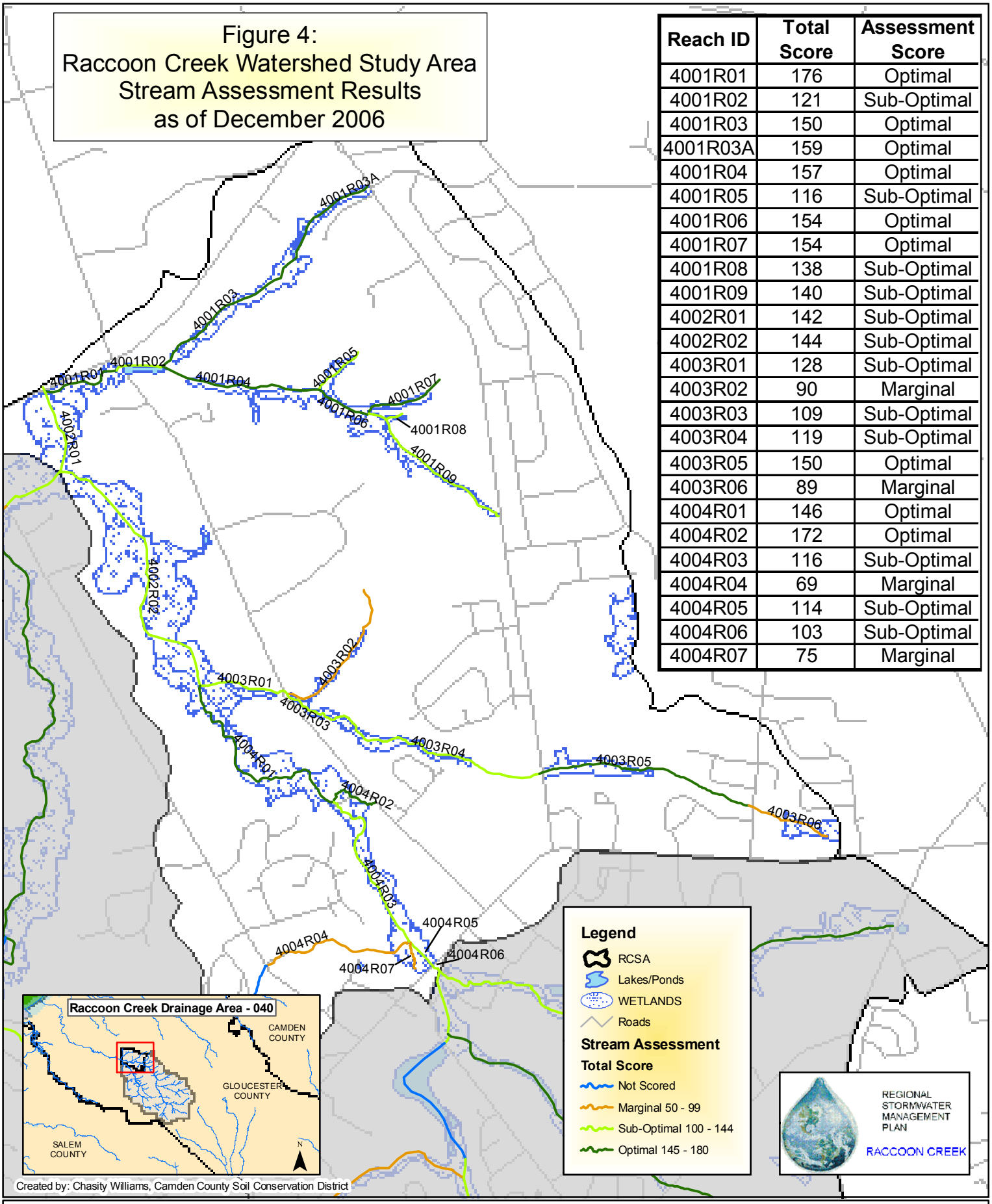
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
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0 0.35 0.7 1.4 Miles

N W E S

Figure 4:
Raccoon Creek Watershed Study Area
Stream Assessment Results
as of December 2006

Reach ID	Total Score	Assessment Score
4001R01	176	Optimal
4001R02	121	Sub-Optimal
4001R03	150	Optimal
4001R03A	159	Optimal
4001R04	157	Optimal
4001R05	116	Sub-Optimal
4001R06	154	Optimal
4001R07	154	Optimal
4001R08	138	Sub-Optimal
4001R09	140	Sub-Optimal
4002R01	142	Sub-Optimal
4002R02	144	Sub-Optimal
4003R01	128	Sub-Optimal
4003R02	90	Marginal
4003R03	109	Sub-Optimal
4003R04	119	Sub-Optimal
4003R05	150	Optimal
4003R06	89	Marginal
4004R01	146	Optimal
4004R02	172	Optimal
4004R03	116	Sub-Optimal
4004R04	69	Marginal
4004R05	114	Sub-Optimal
4004R06	103	Sub-Optimal
4004R07	75	Marginal



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0 0.25 0.5 1 Miles

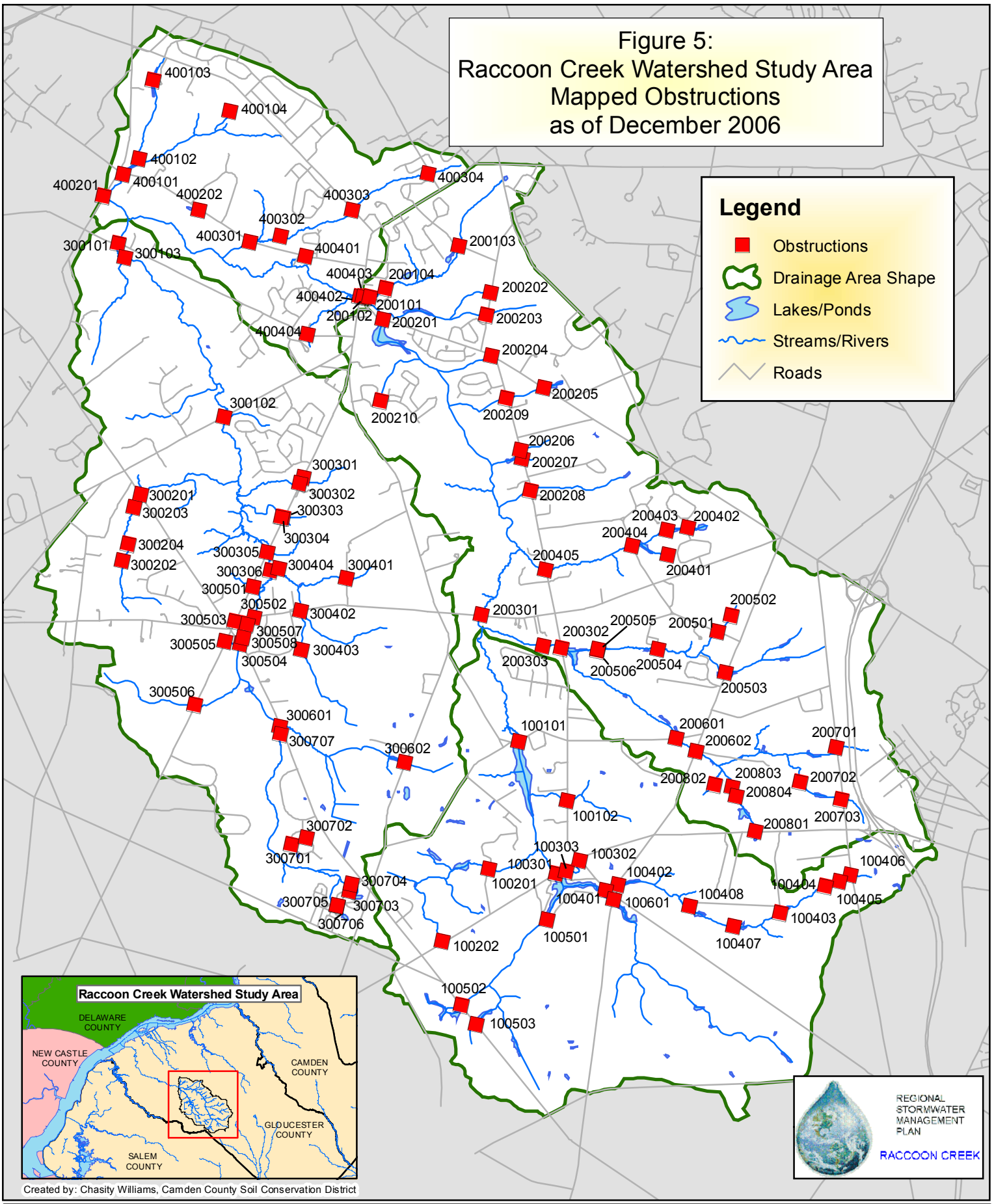

Figure 5:
Raccoon Creek Watershed Study Area
Mapped Obstructions
as of December 2006
Legend
Obstructions
Drainage Area Shape
Lakes/Ponds
Streams/Rivers
Roads
400103
400104
400102
400101
400201
400202
400303
400304
400301
400302
400401
300101
300103
200103
400403
200104
400402
200101
200102
200201
200202
200203
400404
200204
200205
300102
200210
200209
200206
200207
300301
200208
300201
300302
300203
300303
300304
200403
200402
200404
300204
300305
200405
300202
300306
300404
300401
200401
300501
300502
200502
300503
300402
200301
200505
200501
300507
200302
300505
300508
300403
200504
300504
200506
200503
300506
300601
100101
200601
300707
300602
200602
200701
200802
200803
200702
200804
100102
200703
300702
200801
100303
100302
100406
300701
100301
100402
100404
300704
100201
100401
100408
100405
300705
300703
100601
100403
300706
100501
100407
100202
100502
100503
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
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0
0.5
1
2
Miles
N
W
E
S

Table 2: Stream Obstructions Data

GCSCD Label ID	Obstruction ID	Description of Obstruction	Type of Material	Upstream Condition	Downstream Condition	Number of Barrels	Height (Feet)	Width (Feet)
100101	1001OBS01	Arch Culvert	Concrete	Good	Good	1	15	20
100102	1001OBS02	Circular Culvert	Corrugated Metal	Good	Good	2*	3	3
100201	1002OBS01	Arch Culvert	Corrugated Metal	Good	Good	2*	7	16
100202	1002OBS02	--	--	Good	Good	1	--	--
100301	1003OBS01	Bridge	Concrete	Good	Good	1	10	20
100302	1003OBS02	Circular Culvert	Corrugated Metal	Good	Good	1	1	1
100303	1003OBS03	Circular Culvert	Corrugated Plastic	Good	Good	1	2	2
100401	1004OBS01	Circular Culvert	Concrete	Good	Good	1	4	4
100402	1004OBS02	Circular Culvert	Other	Good	Eroded	1	3	3
100403	1004OBS03	Circular Culvert	Concrete	Good	Good	1	2.5	2.5
100404	1004OBS04	Circular Culvert	Corrugated Metal	Good	Good	3*	1	1
100405	1004OBS05	Circular Culvert	Steel	Good	Good	1	3	3
100406	1004OBS06	Circular Culvert	Concrete	Good	Good	1	2	2
100407	1004OBS07	Circular Culvert	Corrugated Metal	Good	Good	1	4	4
100408	1004OBS08	Circular Culvert	Corrugated Plastic	Good	Eroded	1	2.5	2.5
100501	1005OBS01	Circular Culvert	Concrete	Good	Good	3*	1.5	1.5
100502	1005OBS02	Circular Culvert	Corrugated Metal	Good	Good	1	1.5	1.5
100503	1005OBS03	Elliptical Culvert	Corrugated Metal	Good	Good	1	1.5	2.5
100601	1006OBS01	Arch Culvert	Concrete	Good	Good	1	10.5	10
200101	2001OBS01	Bridge	Steel	Silted	Silted	1	4	15
200102	2001OBS02	Circular Culvert	Steel	Good	Eroded	1	1.5	1.5
200103	2001OBS03	Circular Culvert	Corrugated Metal	Eroded	Eroded	1	5	5
200104	2001OBS04	Circular Culvert	Steel	Silted	Silted	2*	1.5	1.5
200201	2002OBS01	Arch Culvert	Concrete	Good	Good	1	6	12
200202	2002OBS02	Circular Culvert	Corrugated Metal	Silted	Silted	1	3	3
200203	2002OBS03	Circular Culvert	Concrete	Silted	Good	1	3	3
200204	2002OBS04	Circular Culvert	Corrugated Metal	Good	Good	1	2	2
200205	2002OBS05	Pipe Arch	Concrete	Good	Good	1	4	5
200206	2002OBS06	Circular Culvert	Corrugated Metal	Silted	Eroded	1	3	3
200207	2002OBS07	Circular Culvert	Corrugated Metal	Silted	Eroded	1	3	3
200208	2002OBS08	Circular Culvert	Corrugated Metal	Good	Silted	1	4	4
200209	2002OBS09	Circular Culvert	Corrugated Metal	Good	Silted	1	5	5
200210	2002OBS10	Circular Culvert	Concrete	Erosion	Good	1	2.5	2.5
200301	2003OBS01	Bridge	Concrete	Good	Good	1	10	60.5
200302	2003OBS02	Arch Culvert	Concrete	Good	Good	1	15	25
200303	2003OBS03	Bridge	Other	Good	Good	1	4	10
200401	2004OBS01	Circular Culvert	Steel	Good	Good	1	3	3
200402	2004OBS02	Box Culvert	Concrete	Good	Good	1	--	--
200403	2004OBS03	Circular Culvert	Corrugated Metal	Good	Good	1	3	3
200404	2004OBS04	Circular Culvert	Corrugated Metal	Good	Eroded	1	5	5
200405	2004OBS05	Bridge	Concrete	Good	Good	1	7.5	15
200501	2005OBS01	Circular Culvert	Corrugated Metal	Good	Good	1	4	4
200502	2005OBS02	Circular Culvert	Corrugated Metal	Good	Good	1	4	4
200503	2005OBS03	Circular Culvert	Corrugated Metal	Good	Good	1	4	4
200504	2005OBS04	Bridge	Other	Good	Good	--	--	--
200505	2005OBS05	Circular Culvert	Corrugated Metal	Silted	Silted	1	3	3
200506	2005OBS06	Circular Culvert	Corrugated Metal	Silted	Silted	1	3	3
200601	2006OBS01	Circular Culvert	Corrugated Metal	Silted	Eroded	2*	5.5	5.5
200602	2006OBS02	Circular Culvert	Corrugated Metal	Good	Silted	2*	5	5
200701	2007OBS01	Circular Culvert	Other	Good	Silted	1	2	2

Table 2: Stream Obstructions Data (Con't)

GCSCD Label ID	Obstruction ID	Description of Obstruction	Type of Material	Upstream Condition	Downstream Condition	Number of Barrels	Height (Feet)	Width (Feet)
200702	2007OBS02	Circular Culvert	Corrugated Metal	Good	Good	1	2	2
200703	2007OBS03	Circular Culvert	Concrete	Good	Good	2*	2.5	2.5
200801	2008OBS01	Circular Culvert	Corrugated Metal	Good	Good	1	1.5	1.5
200802	2008OBS02	Circular Culvert	Steel	Good	Good	1	2	2
200803	2008OBS03	Circular Culvert	Steel	Good	Good	1	1	1
200804	2008OBS04	Circular Culvert	PVC	Good	Good	1	1	1
300101	3001OBS01	Bridge	Concrete	Eroded	Silted	1	12	24
300102	3001OBS02	Bridge	Concrete	Silted	Silted	1	7	28
300103	3001OBS03	Bridge	Other	Silted	Silted	1	5	20
300201	3002OBS01	Circular Culvert	Corrugated Metal	Good	Eroded	1	6	6
300202	3002OBS02	Circular Culvert	Corrugated Plastic	Silted	Eroded	1	2	2
300203	3002OBS03	--	--	Good	Eroded	--	--	--
300204	3002OBS04	Debris Veg Other	--	--	--	--	--	--
300301	3003OBS01	Circular Culvert	Corrugated Metal	Good	Eroded	1	5	5
300302	3003OBS02	Circular Culvert	Concrete	Good	Good	1	0.7	0.7
300303	3003OBS03	Circular Culvert	Corrugated Metal	Good	Eroded	1	5	5
300304	3003OBS04	Circular Culvert	Corrugated Metal	Eroded	Eroded	1	5	5
300305	3003OBS05	Circular Culvert	Corrugated Metal	Good	Good	2*	10	10
300306	3003OBS06	Debris Veg Other	--	--	--	--	--	--
300401	3004OBS01	Circular Culvert	Corrugated Metal	Good	Eroded	1	3	3
300402	3004OBS02	Arch Culvert	Concrete	Good	Good	1	6	12
300403	3004OBS03	Circular Culvert	Concrete	Good	Good	1	4	4
300404	3004OBS04	Debris Veg Other	--	--	--	--	--	--
300501	3005OBS01	Circular Culvert	Concrete	Good	Good	1	4	4
300502	3005OBS02	Arch Culvert	Concrete	Good	Good	1	15	15
300503	3005OBS03	Circular Culvert	Corrugated Metal	Good	Good	1	2.5	2.5
300504	3005OBS04	Arch Culvert	Concrete	Good	Good	1	7	12
300505	3005OBS05	Circular Culvert	Concrete	Good	Good	1	2	2
300506	3005OBS06	Circular Culvert	--	Good	Good	1	3	3
300507	3005OBS07	Bridge	Other	Good	Good	--	--	--
300508	3005OBS08	Bridge	Other	Silted	Good	1	10	20
300601	3006OBS01	Circular Culvert	Concrete	Good	Good	2*	3	3
300602	3006OBS02	Circular Culvert	--	Good	Good	1	3	3
300701	3007OBS01	Circular Culvert	Concrete	Good	Silted	1	2	2
300702	3007OBS02	Circular Culvert	Concrete	Good	Good	1	2	2
300703	3007OBS03	Circular Culvert	Concrete	Good	Good	1	3	3
300704	3007OBS04	Circular Culvert	Corrugated Plastic	Good	Silted	1	2.5	2.5
300705	3007OBS05	Circular Culvert	Concrete	Good	Good	2*	1.5	1.5
300706	3007OBS06	Circular Culvert	Concrete	--	Good	1	3	3
300707	3007OBS07	Circular Culvert	Corrugated Metal	Good	Good	1	4	4
400101	4001OBS01	Circular Culvert	Corrugated Metal	Good	Good	1	6	6
400102	4001OBS02	--	Other	Good	Good	1	--	--
400103	4001OBS03	Circular Culvert	Corrugated Metal	Good	Good	1	36	36
400104	4001OBS04	Circular Culvert	Corrugated Metal	Good	Good	1	2	2
400201	4002OBS01	Bridge	Concrete	Good	Good	1	6.5	49
400202	4002OBS02	Arch Culvert	Concrete	Silted	Silted	1	5	10.5
400301	4003OBS01	Circular Culvert	Corrugated Metal	Good	Good	2*	4	4
400302	4003OBS02	Arch Culvert	Concrete	Silted	Good	1	7	10
400303	4003OBS03	Circular Culvert	Corrugated Metal	Silted	Eroded	2*	3	3
400304	4003OBS04	Circular Culvert	Corrugated Metal	Good	Good	1	2.5	2.5
400401	4004OBS01	Circular Culvert	Corrugated Metal	Good	Eroded	1	4	4
400402	4004OBS02	Bridge	Concrete	Good	Good	1	24	40
400403	4004OBS03	Arch Culvert	Concrete	Good	Good	1	8	24
400404	4004OBS04	Circular Culvert	Concrete	Good	Silted	1	2	2

Note: *2nd and 3rd Barrels have same dimensions as reported.
Any (--) indicates that no data was available or collected at time of assessment.

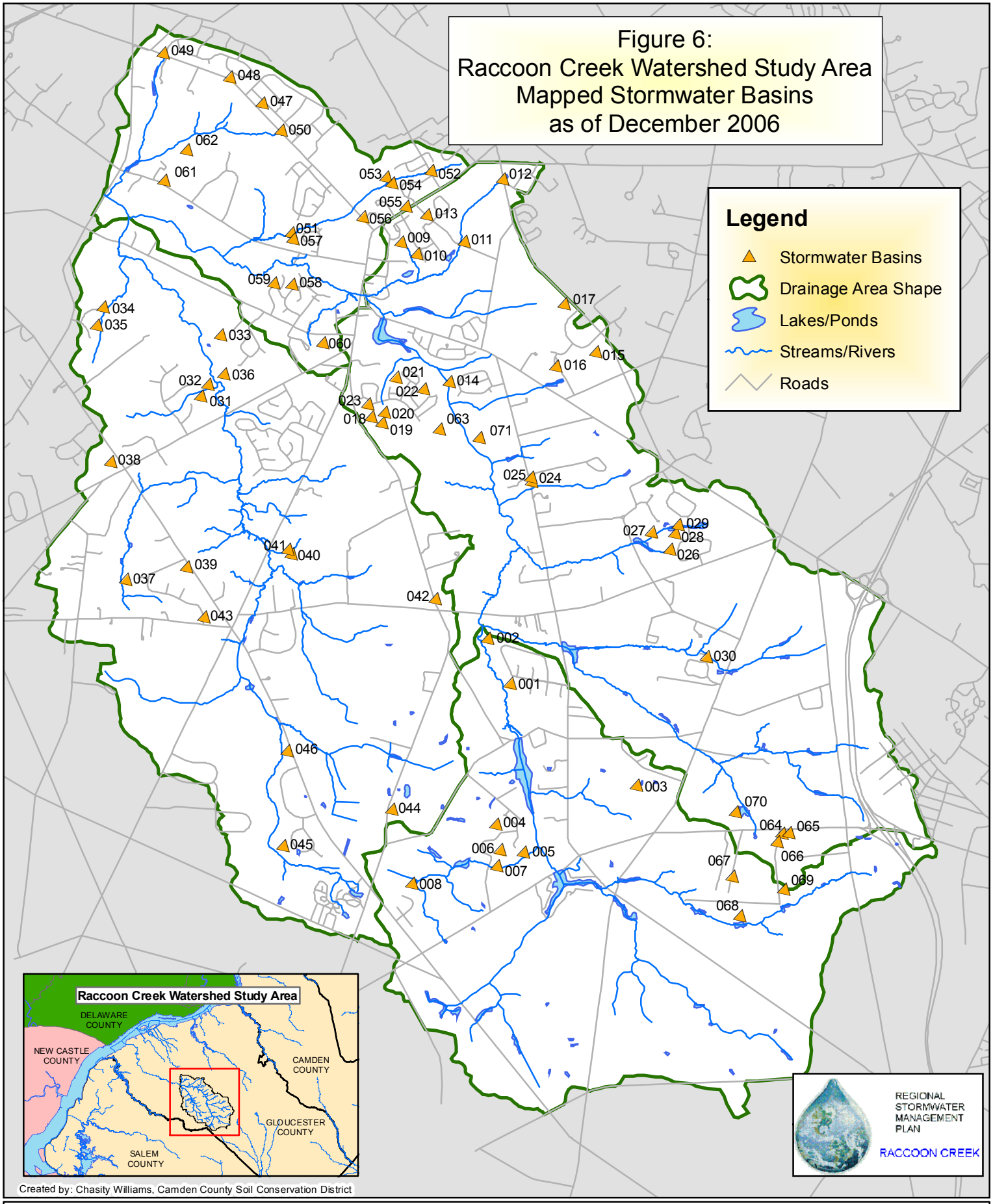

Figure 6:
Raccoon Creek Watershed Study Area
Mapped Stormwater Basins
as of December 2006
Legend
Stormwater Basins
Drainage Area Shape
Lakes/Ponds
Streams/Rivers
Roads
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Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
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Table 3: Stormwater Basins Data

GCSCD Label ID	Basin ID	Contributing Drainage Area	Basin Type	Description of Initial Outlet	Outlet Structure Condition	Discharge Location	Type of Lowflow Channel	Height (Feet)	Width (Feet)
001	1001BSN01	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	Vegetated	0.40	0.40
002	1001BSN02	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	None	0.35	0.35
003	1001BSN03	Residential (SF)	Detention W/PP	Orifice	Good	Lake or Pond	None	1.00	1.00
004	1001BSN04	Residential (SF)	Detention W/WQ	Orifice	Good	Open Space	None	0.30	0.30
005	1002BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	None	0.30	0.30
006	1002BSN02	Residential (SF)	Detention W/PP	Orifice	Good	Open Space	None	0.30	0.30
007	1002BSN03	Residential (SF)	Detention W/PP	Orifice	Good	Open Space	None	0.30	0.30
008	1002BSN04	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	Vegetated	0.30	0.30
009	2001BSN01	Residential (MF)	Detention W/WQ	Orifice	Good	Open Space	None	0.30	0.30
010	2001BSN02	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	Concrete	0.30	0.30
011	2001BSN03	Other	Detention W/WQ	Orifice	Good	Open Space	None	--	--
012	2001BSN04	Other	Detention	Inaccessible	Clogged W/ Debris	Storm System	None	--	--
013	2001BSN05	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Storm System	Concrete	0.30	0.30
014	2002BSN01	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.40	0.40
015	2002BSN02	Residential (SF)	Detention W/WQ	Inaccessible	Good	Open Space	None	--	--
016	2002BSN03	Residential (SF)	Detention W/WQ	Inaccessible	Clogged W/ Debris	Open Space	None	--	--
017	2002BSN04	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	Concrete	0.30	0.30
018	2002BSN05	Commercial / Retail	Detention W/WQ	Orifice	Good	Open Space	Pavers	0.30	0.30
019	2002BSN06	Commercial / Retail	Detention W/WQ	Orifice	Good	Open Space	Stone / Riprap	0.30	0.30
020	2002BSN07	Residential (SF)	Detention W/WQ	Orifice	Good	Wetlands	None	--	--
021	2002BSN08	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.30	0.30
022	2002BSN09	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	Pavers	0.30	0.30
023	2002BSN10	Commercial / Retail	Detention W/WQ	Orifice	Good	Storm System	None	0.40	0.40
024	2002BSN11	Residential (SF)	Detention W/WQ	Orifice	Good	Storm System	None	0.40	0.40
025	2002BSN12	Residential (SF)	Detention W/WQ	Inaccessible	Good	Storm System	None	--	--
026	2004BSN01	Residential (SF)	Detention W/WQ	Orifice	Good	Ditch (Dry)	None	0.30	0.30
027	2004BSN02	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.30	0.30
028	2004BSN03	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.30	0.30
029	2004BSN04	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	None	0.30	0.30
030	2005BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	Concrete	0.30	0.30
031	3001BSN01	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.30	0.30
032	3001BSN02	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.30	0.30
033	3001BSN03	Residential (SF)	Detention W/WQ	Inaccessible	Inaccessible	Open Water	None	--	--
034	3001BSN04	Residential (SF)	Detention W/WQ	Orifice	Silted	Open Water	Concrete	0.30	0.30
035	3001BSN05	Residential (SF)	Detention W/WQ	Inaccessible	Inaccessible	Open Water	None	--	--
036	3001BSN06	Residential (SF)	Detention W/WQ	Orifice	Good	Open Space	None	0.30	0.30
037	3002BSN01	Residential (SF)	Detention W/WQ	Inaccessible	Clogged W/ Debris	Open Water	None	--	--
038	3002BSN02	Residential (SF)	Detention W/WQ	Orifice	Good	Storm System	Stone / Riprap	0.60	0.60
039	3003BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	None	0.80	0.80
040	3003BSN02	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	Pavers	0.30	0.30
041	3003BSN03	Residential (SF)	Detention W/WQ	V Notch (Weir)	Clogged W/ Debris	Open Water	Pavers	0.80	0.80
042	3004BSN01	Commercial / Retail	Infiltration (Dry)	Not Applicable	Inaccessible	None	Concrete	--	--
043	3005BSN01	Residential (SF)	Detention W/WQ	Inaccessible	Good	Storm System	None	--	--
044	3006BSN01	Commercial / Retail	Detention	Orifice	Good	Open Space	Stone / Riprap	0.35	0.35
045	3007BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	Concrete	0.60	0.60
046	3007BSN02	Residential (SF)	Detention W/WQ	Orifice	Good	Open Space	Concrete	0.60	0.60
047	4001BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Storm System	Pavers	0.40	0.40
048	4001BSN02	Residential (SF)	Detention W/WQ	Inaccessible	Good	Ditch (Dry)	None	0.40	0.40
049	4001BSN03	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Water	None	0.30	0.30
050	4001BSN04	Residential (SF)	Detention W/WQ	Inaccessible	Good	Storm System	None	--	--
051	4003BSN01	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.50	0.50
052	4003BSN02	Residential (SF)	Detention	Weir	Needs Repair	Open Water	None	2.50	5.00
053	4003BSN03	Residential (SF)	Detention W/WQ	Orifice	Not Applicable	Open Water	None	--	--
054	4003BSN04	Residential (SF)	Detention W/WQ	Orifice	Good	Ditch (Wet)	Concrete	0.40	0.40
055	4003BSN05	Commercial / Retail	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	Concrete	0.30	0.30
056	4003BSN06	Commercial / Retail	Detention W/WQ	Orifice	Clogged W/ Debris	Storm System	Concrete	0.30	0.30
057	4003BSN07	Residential (SF)	Detention	Inaccessible	Inaccessible	Open Water	None	--	--
058	4004BSN01	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	None	0.30	0.30
059	4004BSN02	Residential (SF)	Detention W/WQ	Orifice	Clogged W/ Debris	Open Space	Vegetated	0.40	0.40
060	4004BSN03	Commercial / Retail	Detention W/WQ	Orifice	Good	Open Space	Stone / Riprap	0.30	0.30
061	4002BSN01	Residential (SF)	Detention W/PP	Weir	Good	Open Space	None	6.00	6.00
062	4001BSN05	Residential (SF)	Detention W/PP	Weir	Good	Open Space	None	3.00	6.00
063	2002BSN13	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.60	0.60
064	2008BSN01	Residential (SF)	Detention W/PP	Orifice	Good	Ditch (Wet)	None	0.30	0.30
065	2008BSN02	Residential (SF)	Detention W/PP	Orifice	Good	Ditch (Wet)	None	--	--
066	2008BSN03	Residential (SF)	Detention W/PP	Weir	Good	Wetlands	None	--	--
067	1004BSN01	Residential (SF)	Detention W/PP	Orifice	Good	Ditch (Dry)	None	0.30	0.30
068	1004BSN02	Residential (SF)	Detention W/PP	Weir	Good	Open Water	None	--	--
069	1004BSN03	Residential (SF)	Detention W/PP	Weir	Good	Open Water	None	--	--
070	2008BSN04	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	--	--
071	2002BSN14	Residential (SF)	Detention W/WQ	Orifice	Good	Open Water	None	0.60	0.60

Any (--) indicates that no data was available or collected at time of assessment.

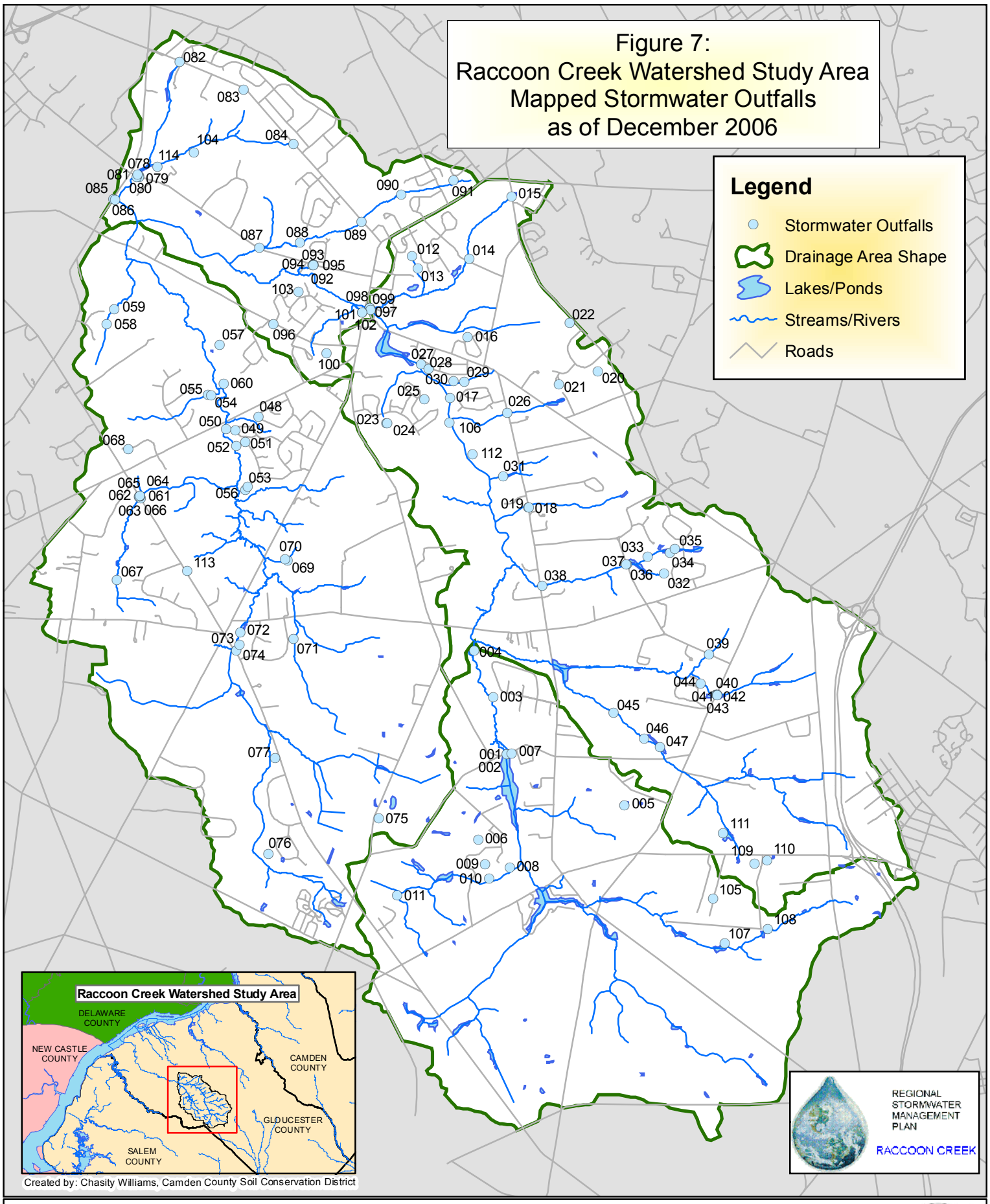

Figure 7:
Raccoon Creek Watershed Study Area
Mapped Stormwater Outfalls
as of December 2006
Legend
Stormwater Outfalls
Drainage Area Shape
Lakes/Ponds
Streams/Rivers
Roads
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
Created by: Chasity Williams, Camden County Soil Conservation District
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
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Table 4: Stormwater Outfalls Data

GCSCD Label ID	SWO ID	Description of SWO	Type of Material	Description of Outfall Area	Suspended Outfall	Discharge Location	Height (Feet)	Width (Feet)
001	1001SWO01	Circular	Corrugated Metal	None	Yes	Stream or River	1.0	1.0
002	1001SWO02	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	2.0	2.0
003	1001SWO03	Circular	Concrete	Minimal Erosion	No	Stream or River	2.0	2.0
004	1001SWO04	Circular	Concrete	None	No	Stream or River	2.0	2.0
005	1001SWO05	Circular	Concrete	None	No	Lake or Pond	1.5	1.5
006	1001SWO06	Circular	Concrete	None	No	Woods	1.5	1.5
007	1001SWO07	Circular	Corrugated Metal	Silted	No	Forest	2.0	2.0
008	1002SWO01	Circular	Concrete	Minimal Erosion	No	Woods	1.5	1.5
009	1002SWO02	Circular	Concrete	None	No	Woods	1.5	1.5
010	1002SWO03	Circular	Concrete	None	No	Stream or River	1.5	1.5
011	1002SWO04	Circular	Concrete	None	No	Lake or Pond	3.0	3.0
012	2001SWO01	Circular	Concrete	Minimal Erosion	No	Ditch	3.0	3.0
013	2001SWO02	Circular	Concrete	None	No	Stream or River	2.0	2.0
014	2001SWO03	Circular	Concrete	None	No	Woods	2.5	2.5
015	2001SWO04	Elliptical	Corrugated Metal	Eroded	Yes	Stream or River	3.0	4.0
016	2002SWO01	Circular	Concrete	None	No	Ditch	3.0	3.0
017	2002SWO02	Circular	Concrete	None	No	Stream or River	2.0	2.0
018	2002SWO03	Circular	Corrugated Metal	Moderate Erosion	Yes	Stream or River	1.0	1.0
019	2002SWO04	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	1.0	1.0
020	2002SWO05	Circular	Concrete	None	No	Woods	1.5	1.5
021	2002SWO06	Circular	Concrete	None	No	Woods	1.5	1.5
022	2002SWO07	Circular	Concrete	None	No	Woods	1.5	1.5
023	2002SWO08	Circular	Concrete	None	No	Wetlands	2.5	2.5
024	2002SWO09	Elliptical	Concrete	None	No	Wetlands	2.0	3.0
025	2002SWO10	Circular	Concrete	None	No	Stream or River	3.0	3.0
026	2002SWO11	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	2.0	2.0
027	2002SWO12	Circular	Concrete	Minimal Erosion	No	Lake or Pond	2.0	2.0
028	2002SWO13	Circular	Concrete	Moderate Erosion	No	Stream or River	1.5	1.5
029	2002SWO14	Circular	Concrete	Minimal Erosion	No	Stream or River	1.0	1.0
030	2002SWO15	Circular	Concrete	Heavy Erosion	No	Stream or River	1.0	1.0
031	2002SWO16	Circular	Corrugated Metal	Moderate Erosion	Yes	Stream or River	3.5	3.5
032	2004SWO01	Circular	Concrete	None	No	Wetlands	2.5	2.5
033	2004SWO02	Circular	Concrete	None	No	Stream or River	2.0	2.0
034	2004SWO03	Circular	Concrete	None	No	Lake or Pond	2.5	2.5
035	2004SWO04	Circular	Concrete	None	No	Lake or Pond	3.0	3.0
036	2004SWO05	Circular	Corrugated Metal	Minimal Erosion	No	Lake or Pond	1.0	1.0
037	2004SWO06	Circular	Corrugated Metal	Moderate Erosion	Yes	Stream or River	1.5	1.5
038	2004SWO07	Circular	Corrugated Metal	None	Yes	Stream or River	1.0	1.0
039	2005SWO01	Other	Other	Heavy Erosion	Yes	Stream or River	--	1.0
040	2005SWO02	Other	Steel	None	No	Stream or River	2.0	6.0
041	2005SWO03	Other	Steel	None	No	Stream or River	2.0	6.0
042	2005SWO04	Other	Steel	None	No	Stream or River	2.0	6.0
043	2005SWO05	Other	Steel	None	No	Stream or River	2.0	6.0
044	2005SWO06	Circular	Concrete	None	No	Stream or River	3.0	3.0
045	2006SWO01	Circular	PVC	None	No	Stream or River	1.0	1.0
046	2006SWO02	Circular	Concrete	None	No	Stream or River	1.3	1.3
047	2006SWO03	Circular	Corrugated Metal	None	Yes	Stream or River	2.0	2.0
048	3001SWO01	Circular	Concrete	None	No	Stream or River	5.0	5.0
049	3001SWO02	Circular	Concrete	Minimal Erosion	No	Stream or River	2.0	2.0
050	3001SWO03	Circular	Concrete	None	No	Stream or River	2.0	2.0
051	3001SWO04	Elliptical	Concrete	Minimal Erosion	No	Ditch	4.0	6.0
052	3001SWO05	Elliptical	Concrete	Minimal Erosion	No	Stream or River	4.0	6.0
053	3001SWO06	Circular	Concrete	Minimal Erosion	No	Ditch	4.0	4.0
054	3001SWO07	Circular	Concrete	Minimal Erosion	No	Stream or River	2.0	2.0
055	3001SWO08	Circular	Concrete	None	No	Stream or River	1.8	1.8
056	3001SWO09	Circular	Concrete	None	No	Stream or River	3.0	3.0
057	3001SWO10	Circular	Concrete	None	No	Wetlands	3.0	3.0
058	3001SWO11	Circular	Concrete	Silted	No	Stream or River	2.0	2.0

Table 4: Stormwater Outfalls Data (Con't)

GCSCD Label ID	SWO ID	Description of SWO	Type of Material	Description of Outfall Area	Suspended Outfall	Discharge Location	Height (Feet)	Width (Feet)
059	3001SWO12	Circular	Concrete	Minimal Erosion	No	Stream or River	2.0	2.0
060	3001SWO13	Circular	Concrete	None	No	Woods	2.0	2.0
061	3002SWO01	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	1.5	1.5
062	3002SWO02	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	1.5	1.5
063	3002SWO03	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	1.5	1.5
064	3002SWO04	Other	Steel	Minimal Erosion	Yes	Stream or River	0.3	3.0
065	3002SWO05	Other	Steel	Minimal Erosion	No	Stream or River	0.3	3.0
066	3002SWO06	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	1.5	1.5
067	3002SWO07	Circular	Concrete	Minimal Erosion	No	Stream or River	1.0	1.0
068	3002SWO08	Circular	Concrete	None	No	Field	3.0	3.0
069	3003SWO01	Circular	Concrete	None	No	Stream or River	2.0	2.0
070	3003SWO02	Circular	Concrete	None	No	Stream or River	2.0	2.0
071	3004SWO01	Circular	Concrete	None	No	Stream or River	2.0	2.0
072	3005SWO01	Circular	PVC	Minimal Erosion	Yes	Stream or River	0.8	0.0
073	3005SWO02	Circular	Concrete	Minimal Erosion	No	Lake or Pond	3.0	3.0
074	3005SWO03	Circular	Concrete	Minimal Erosion	No	Lake or Pond	1.6	1.6
075	3006SWO01	Circular	Steel	None	No	Field	1.0	1.0
076	3007SWO01	Circular	Concrete	None	No	Woods	2.5	2.5
077	3007SWO02	Circular	Concrete	None	No	Stream or River	2.0	2.0
078	4001SWO01	Circular	Corrugated Metal	Silted	No	Lake or Pond	3.0	3.0
079	4001SWO02	Circular	Corrugated Metal	Moderate Erosion	No	Ditch	2.0	2.0
080	4001SWO03	Circular	Corrugated Metal	Moderate Erosion	Yes	Woods	2.5	2.5
081	4001SWO04	Circular	Corrugated Metal	None	No	--	2.5	2.5
082	4001SWO05	Circular	Corrugated Metal	Silted	No	Stream or River	3.0	3.0
083	4001SWO06	Circular	Corrugated Metal	Minimal Erosion	No	Field	2.0	2.0
084	4001SWO07	Box	Concrete	None	No	Stream or River	2.5	2.5
085	4002SWO01	Circular	Concrete	None	Yes	Stream or River	1.5	1.5
086	4002SWO02	Circular	Concrete	None	No	Stream or River	1.5	1.5
087	4003SWO01	Circular	Corrugated Metal	Silted	Yes	Stream or River	1.5	1.5
088	4003SWO02	Circular	Concrete	None	No	Stream or River	2.5	2.5
089	4003SWO03	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	3.0	3.0
090	4003SWO04	Circular	Concrete	None	No	Stream or River	2.5	2.5
091	4003SWO05	Circular	Concrete	Minimal Erosion	No	Ditch	2.0	2.0
092	4004SWO01	Circular	Corrugated Metal	None	No	Stream or River	1.0	1.0
093	4004SWO02	Circular	Concrete	Silted	No	Stream or River	2.0	2.0
094	4004SWO03	Circular	Corrugated Metal	Heavy Erosion	Yes	Stream or River	2.0	2.0
095	4004SWO04	Circular	Corrugated Metal	Heavy Erosion	Yes	Stream or River	2.0	2.0
096	4004SWO05	Circular	Corrugated Metal	None	No	Wetlands	1.5	1.5
097	4004SWO06	Circular	Corrugated Metal	None	No	Stream or River	1.0	1.0
098	4004SWO07	Circular	Corrugated Metal	None	No	Stream or River	1.0	1.0
099	4004SWO08	Circular	Corrugated Metal	None	Yes	Stream or River	2.0	2.0
100	4004SWO09	Circular	Corrugated Plastic	None	No	Field	1.5	1.5
101	4004SWO10	Circular	Corrugated Metal	Minimal Erosion	No	Stream or River	2.0	2.0
102	4004SWO11	Circular	Corrugated Metal	Minimal Erosion	Yes	Stream or River	2.5	2.5
103	4004SWO12	Circular	Concrete	None	No	Woods	2.5	2.5
104	4001SWO08	Circular	Concrete	Silted	No	Lake or Pond	2.0	2.0
105	1004SWO01	Circular	Concrete	None	No	Ditch	2.0	2.0
106	2002SWO17	Circular	Concrete	Silted	Yes	Stream or River	2.5	2.5
107	1004SWO02	Circular	Concrete	None	No	Lake or Pond	2.5	2.5
108	1004SWO03	Circular	Concrete	None	No	Lake or Pond	2.5	2.5
109	2008SWO02	Circular	Concrete	None	No	Woods	3.0	3.0
110	2008SWO01	Circular	Concrete	None	No	Wetlands	1.5	1.5
111	2008SWO03	Circular	Concrete	--	--	Lake or Pond	3.0	3.0
112	2002SWO18	Circular	Concrete	Minimal Erosion	No	Wetlands	2.5	2.5
113	3003SWO03	Circular	Concrete	Silted	No	Woods	1.0	1.0
114	4001SWO09	Circular	Concrete	None	No	Stream or River	3.0	3.0

Any (--) indicates that no data was available or collected at time of assessment.

APPENDIX C:
WATERSHED HYDROLOGY AND HYDRAULICS OF RACCOON CREEK

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GLOUCESTER COUNTY
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RACCOON CREEK WATERSHED
REGIONAL STORMWATER MANAGEMENT PLAN

TABLE 1: RACCOON CREEK WATERSHED HMS MODEL PARAMETERS

Sub-basin	Area ($Mile^2$)	CN	T_c (hours)
1001A	0.92	72	1.70
1001B	0.53	70	1.40
1002	0.73	64	2.00
1003	0.22	62	1.10
1004	1.20	66	5.00
1005	1.28	63	3.70
1006	1.50	66	4.40
2001	0.63	76	1.60
2002	2.75	71	3.10
2003	0.52	68	1.50
2004	0.86	69	2.60
2005	1.34	70	3.60
2006	0.59	67	1.60
2007	0.91	68	3.60
2008	0.48	68	2.40
3001	1.97	70	4.00
3002	1.13	71	2.00
3003	0.88	72	1.40
3004	1.43	70	2.10
3005	1.35	71	1.90
3006	0.80	75	1.60
3007	0.81	72	2.80
4001	1.15	70	3.10
4002	0.40	68	1.20
4003	0.67	73	2.40
4004	0.66	75	1.20

Report 1: Using the DelMarVa Unit Hydrograph in HMS

Caution: This report provides information and data on how to simulate the DelMarVa dimensionless unit hydrograph within the HEC-HMS software. This method includes an un-approved version of the DelMarVa mass curve and techniques within HMS that have not been formally approved by HEC nor NRCS. The end user bears all responsibility for the suitability of these methods. This report assumes a familiarity with the HMS software.

Background

The New Jersey National Resource Conservation Service issued guidance via New Jersey Bulletin No. NJ210-3-1 dated September 8, 2003, indicating the DelMarVa dimensionless unit hydrograph was appropriate to apply the Outer Coastal Plain region of New Jersey. Further, the bullentin indicated that the DelMarVa may apply in portions of the Inner Coastal Plain. Since then, the NJ State Soil Conservation Committee has issued Technical Bulletin 2004-2.0, effective July 12, 2004, requiring the use of the DelMarVa unit hydrograph in appropriate locations in the preparation of Chapter 251 applications. In addition, effective September 1, 2005, the NJ Department of Environmental Protection adopted language to require the use of the DelMarVa unit hydrograph, where appropriate, in the preparation of plans for Land Use Regulation review. See- http://www.njstormwater.org/rainfalldata.htm

Many hydrologic analysis programs have the DelMarVa unit hydrograph included or allow a straightforward method for selecting a user specified Peak Rate Factor. For example, the NRCS WinTR-55 allows the user to select the DelMarVa unit graph or enter the ordinates of any appropriate unit graph, while the proprietary Intellisolve Hydraflow software allows the user to select a peak rate factor.

Software prepared by the Army Corps of Engineers, Hydrologic Engineering Center, the Hydrologic Modeling System (HEC-HMS) is frequently used to model watersheds and provide hydrologic data for further river analysis. Soil District staff has used the HMS software extensively in developing hydrologic models of various watersheds, including the Raccoon Creek watershed. Unfortunately, the HEC-HMS software does not include options to directly enter the DelMarVa (or any other user specified unit hydrograph) or adjust the peak rate factor.

The HMS software allows the user to select a variety of options to transform excess rainfall into runoff. The NRCS transform utilizes the standard dimensionless unit hydrograph. Among the other options is the User Specified S-Graph transform method. On the recommendation of a HEC staff member, project staff investigated the potential of the User Specified S-Graph transform mimicking the NRCS transform.

Procedure and Analysis
On the HMS main screen the user navigates to the S-Graph editor under the data tab on the main menu. One or more s-graphs can be entered in this editor. Once a Basin Model has been developed, the User Specified S-Graph Transform is selected and the appropriate s-graph is selected from the list. Watershed lag is calculated the same as with the NRCS transform.

To test the effectiveness of this option several small watersheds were analyzed. Identical basins were modeled using either the NRCS transform or the User Specified S-Graph Transform with the published ordinates of the standard NRCS hydrograph as the referenced S-Graph. As shown in Figure 1 results are nearly identical, but it appears critical that a significantly small time step is used. The appropriate time step will vary depending on the size of the watershed, but in most small watershed (less then 200 Acres) a time step of 5 minutes or less seems appropriate.

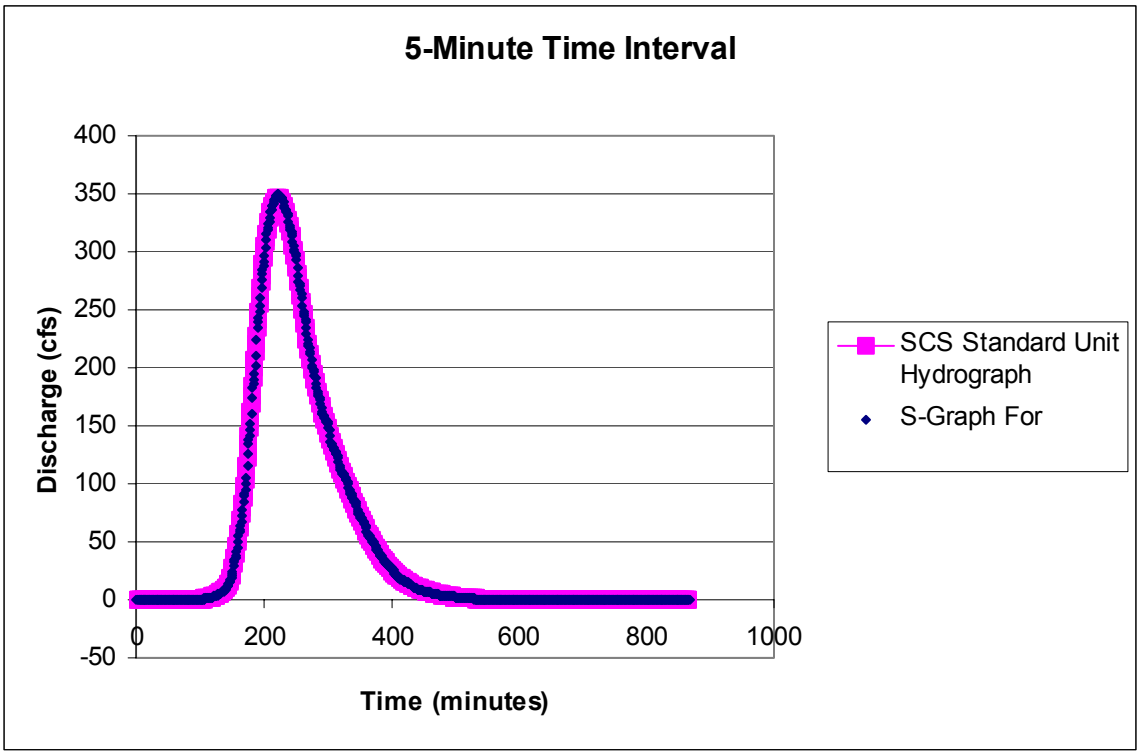


Figure 1. HEC-HMS Results: Comparison between the NRCS Transform and User Specified S-Graph Transform.

The next step was to develop an S-Graph of the DelMarVa unit hydrograph. Since the NRCS has not yet published the mass curve of the DelMarVa, project staff and associates calculated a DelMarVa mass curve (S-Graph) from the unit hydrograph ordinates. This was done by computing the average q/qp for each time interval, then multiplying that by delta(t), and summing the cumulative (q/qp)avg * delta(t). This method produces a mass curve that preserves the same mass under the rising limb of the hydrograph as the unit hydrograph. A graph showing the unit hydrograph and mass curve are shown in Figure

2. The ordinates of the mass curve and the values for the HMS S-Graph are shown in Table 3. The attached S-Graph has not yet been approved by NRCS, but the same calculation method produces the published mass curve of the standard DUH.

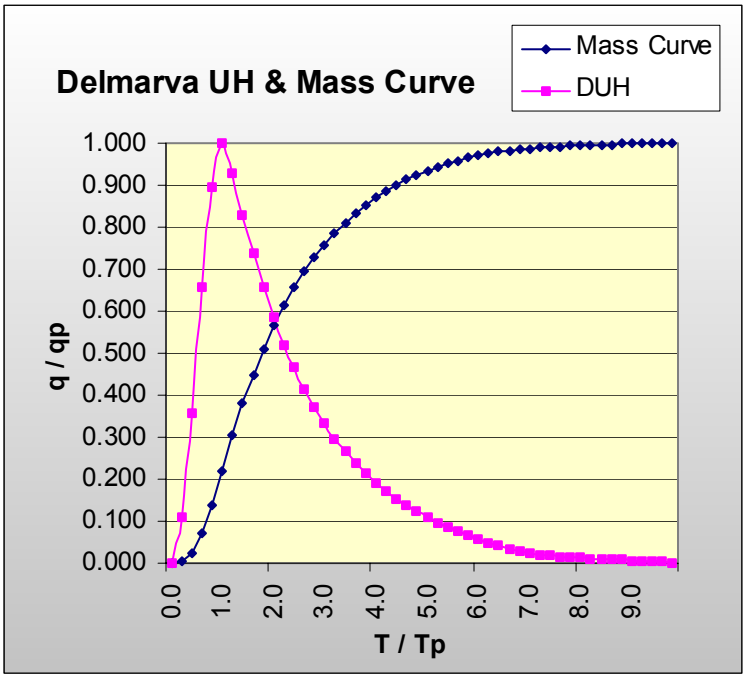


Figure 2: DelMarVa Unit Hydrograph and Mass Curve

The DelMarVa S-Graph was entered into HMS and selected in the transform section of each subbasin. The model was again run and the results compared to the Standard NRCS transform. As expected the S-Graph transform with the DelMarVa mass curve reduced the peak discharge between 34 and 40%, while preserving the total volume of runoff.

Finally the HMS results were compared to the WinTR55 results. Once again the results of each model compared favorably. A summary of the results from a single subarea are shown in Tables 1 and 2.

Table 1: Results of Different Methods using the Standard DUH or Mass Curve

Event – Drainage Area (sq mi)/ CN/ Lag – 10 Yr storm	Peak Discharge, Calculated Using:		
	WinTR55: Standard NRCS DUH	HEC-HMS: Built-in NRCS Transform	HEC-HMS: User Specified S-Graph Transform – Std DUH Mass Curve
0.1906/85/3.0	67.2 cfs	69.3 cfs	69.7 cfs

Table 2: Results of Different Methods using the DelMarVa DUH and Mass Curve

Event – Drainage Area (sq mi)/ CN/ Lag – 10 Yr storm	Peak Discharge Calculated Using:		
	WinTR55: DelMarVa DUH	HEC-HMS: Built-in DelMarVa Transform	HEC-HMS: User Specified S-Graph Transform – DelMarVa Mass Curve
0.1906/85/3.0	38.8 cfs	(does not exist in HEC-HMS)	41.5 cfs

This same test method was repeated for a variety of hypothetical watersheds, with varying characteristics. The results of other trial runs produce similar results. In all cases the NRCS Transform and the User Specified S-Graph transform (with the standard NRCS DUH mass curve) within HMS calculated nearly equal peak discharges and volumes. The results vary slightly when compared to the WinTR55 method, but this is likely due to the inability to vary the time increment in WinTR55.

A comparison between the WinTR55 with the DelMarVa unit hydrograph selected and the HMS model with the User Specified S-Graph with the DelMarVa S-Graph produced similar results.

Conclusion

This information suggests that the User Specified S-Graph transform method within the HMS software sufficiently mimics the NRCS transform when an appropriate time increment is used. When an S-Graph (mass curve) of the DelMarVa dimensionless unit hydrograph is used in the User Specified S-Graph transform, the HMS model calculates a reasonably accurate peak discharge and runoff volume when compared to the WinTR55 model.

Again it is important to note that this method includes an un-approved version of the DelMarVa mass curve and techniques within HMS that have not been formally approved by HEC nor NRCS. The end user bears all responsibility for the suitability of these methods.

Table 3: The ordinates of the DelMarVa mass curve as calculated by SCD staff. Again, note that this table has not been approved by the NRCS or HEC

.

T/Tp	Mass Curve		% T/Tp	% Mass Curve
0.000	0.000000		0	0
0.200	0.004851		20	0.485097457
0.400	0.025260		40	2.526002972
0.600	0.069443		60	6.944323049
0.800	0.137226		80	13.7225767
1.000	0.220086		100	22.00856568
1.200	0.304388		120	30.43877283
1.400	0.381173		140	38.11729744
1.600	0.449567		160	44.95673455
1.800	0.510445		180	51.04448912
2.000	0.564636		200	56.46359584
2.200	0.612927		220	61.29271917
2.400	0.656018		240	65.60178306
2.600	0.694476		260	69.44760073
2.800	0.728826		280	72.88261516
3.000	0.759505		300	75.9505288
3.200	0.786907		320	78.69067389
3.400	0.811424		340	81.14238266
3.600	0.833362		360	83.33624683
3.800	0.852985		380	85.29848789
4.000	0.870553		400	87.05532733
4.200	0.886286		420	88.62861638
4.400	0.900402		440	90.04020628
4.600	0.913119		460	91.31194826
4.800	0.924526		480	92.45258282
5.000	0.934665		500	93.4664802
5.200	0.943668		520	94.36675116
5.400	0.951665		540	95.16650642
5.600	0.958745		560	95.8744865
5.800	0.964951		580	96.49506162
6.000	0.970326		600	97.03260205
6.200	0.974958		620	97.49584827
6.400	0.978892		640	97.88917053
6.600	0.982126		660	98.21256883
6.800	0.984748		680	98.47478367
7.000	0.986977		700	98.69766629
7.200	0.988943		720	98.89432742
7.400	0.990648		740	99.06476707
7.600	0.992090		760	99.20898523
7.800	0.993314		780	99.33135215
8.000	0.994406		800	99.44060834
8.200	0.995411		820	99.54112403
8.400	0.996285		840	99.62852897
8.600	0.997028		860	99.70282318
8.800	0.997727		880	99.77274714
9.000	0.998339		900	99.8339306
9.200	0.998864		920	99.88637357
9.400	0.999344		940	99.93444629
9.600	0.999781		960	99.97814876
9.800	1.000000		980	100

GLOUCESTER COUNTY
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Rainfall from NWS-Glassboro (until 1998 then avg. RISE gage data)

CN=(1000)/(10+5*(p+2*q-(4*q^2+5*p*q)^(1/2)))

Table 2: Calculated Curve Number for Historic Events

Rainfall Date	Precipitation (inches)	Inches of Runoff	Calculated CN
10/19/1966	3.64	0.67	62
3/5/1967	3.03	0.65	68
8/3/1967	5.02	0.69	50
8/10/1967	4.99	1.97	69
8/24/1967	3.81	0.98	66
6/13/1968	4.17	0.47	52
7/21/1969	3.93	0.08	41
7/28/1969	4.49	1.43	67
9/3/1969	3.94	0.70	59
10/20/1970	4.39	0.36	47
9/11/1971	6.27	1.40	52
10/24/1971	3.44	0.17	49
7/10/1975	7.87	2.54	54
8/16/1975	3.02	0.93	74
9/23/1975	6.44	1.56	52
11/7/1977	3.65	0.79	64
2/24/1979	3.30	2.73	95
9/29/1979	3.53	0.47	58
4/27/1982	3.82	0.55	57
6/20/1983	3.55	1.04	70
5/29/1984	3.77	1.20	70
7/7/1984	3.01	0.58	67
9/27/1985	5.37	1.00	52
4/16/1986	3.33	0.34	57
9/19/1989	3.01	1.22	79
10/18/1989	3.84	1.08	68
8/6/1990	5.38	0.19	37
7/13/1991	3.32	0.25	54
12/11/1996	3.55	1.64	79
3/30/1997	3.06	0.32	59
9/16/1999	6.23	1.77	56
3/21/2000	3.57	1.70	80
4/12/2004	2.98	1.24	80
9/20/2004	2.79	0.20	57
10/7/2005	5.39	0.69	47
		Average	**61**

This table shows storms in excess of 3 inches since 1966 as recorded by the NWS Weather Station in Glassboro, NJ until 1988, then the Average RISE Weather Station data.

Inches of runoff were estimated from daily runoff measurements at the USGS Stream Gage # 01477120 The iSep baseflow hydrograph seperation utility was used to determin direct runoff

CN was calculated with the formula noted above.

The Composite CN calculated for the Raccoon Creek using Standard Engineering Practices is 70

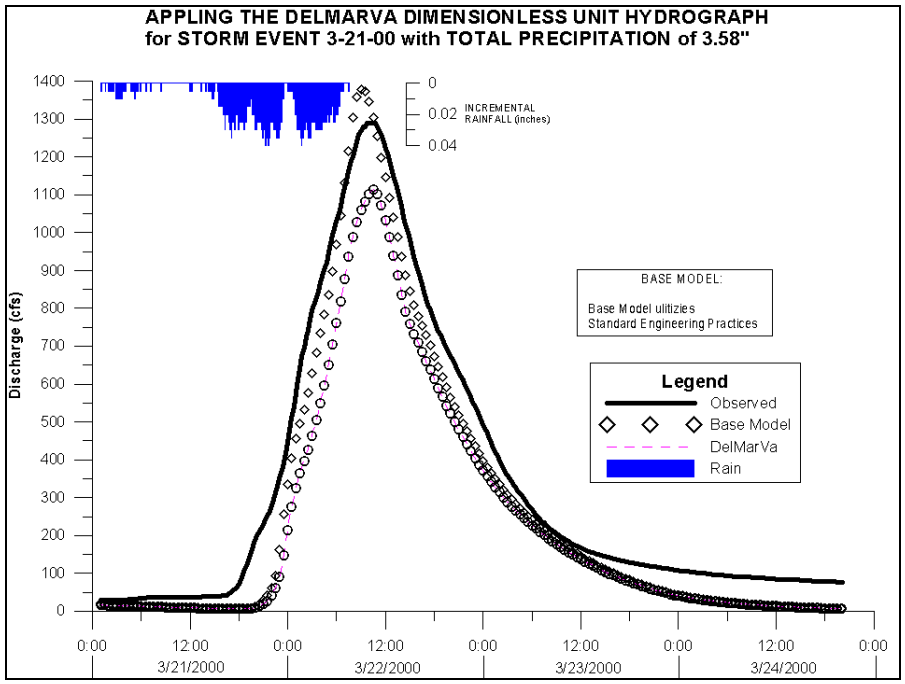


Figure 1: Comparison between NRCS and DelMarVa

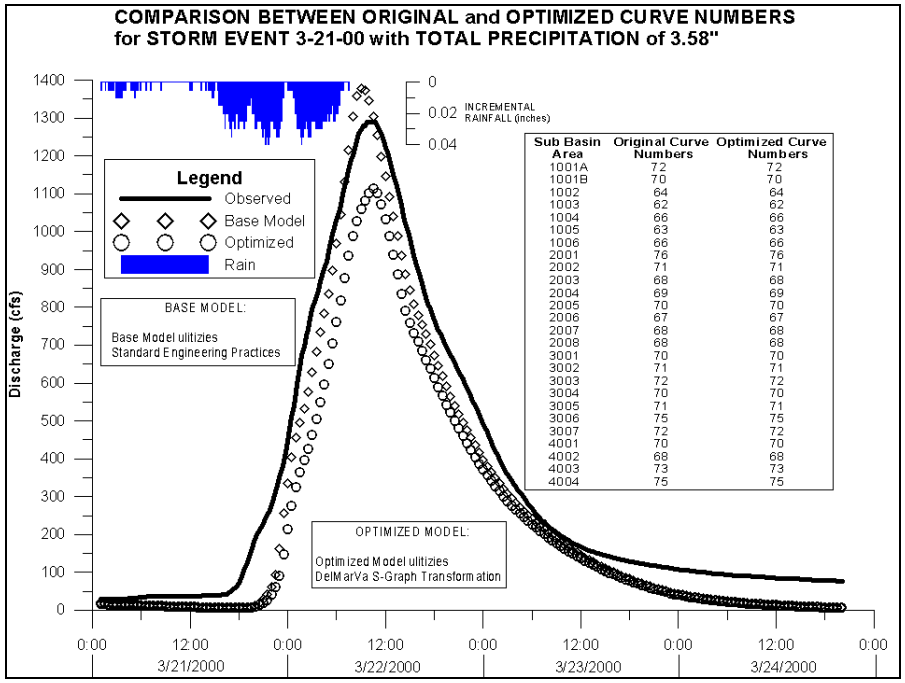
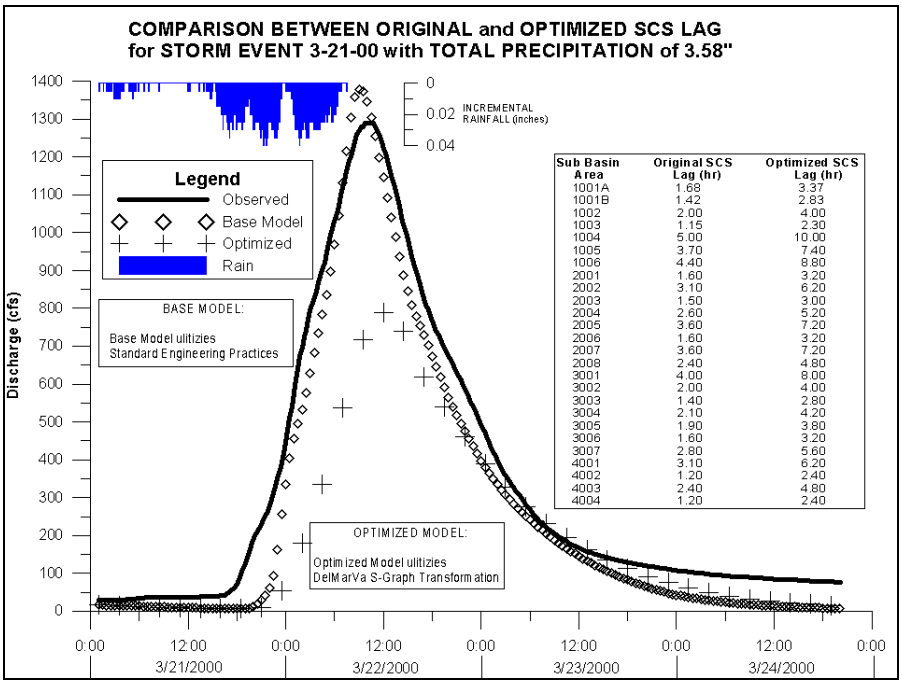
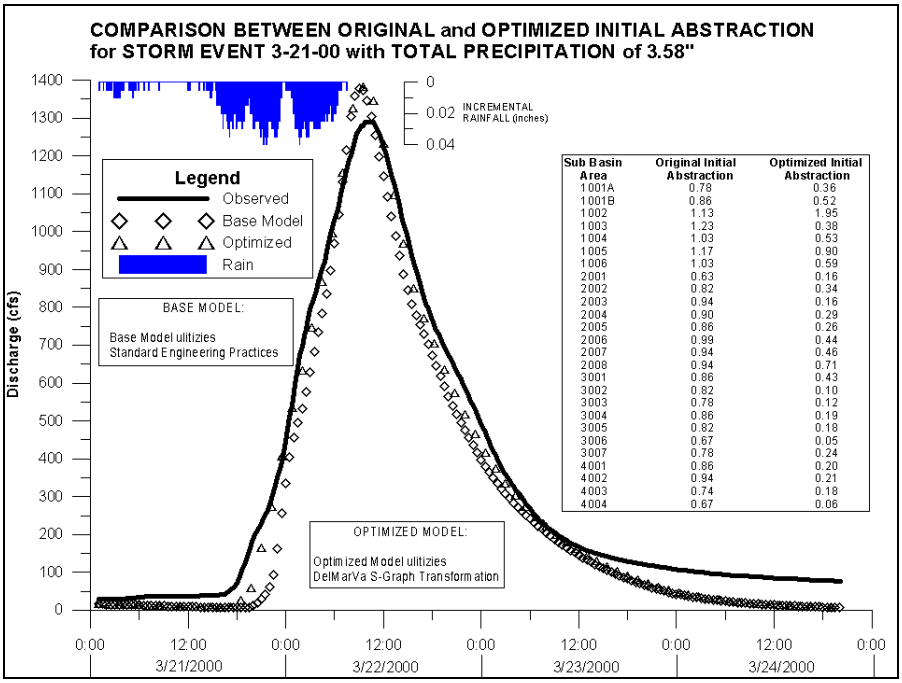


Figure 2: Results of CN Calibration



Sub Basin Area	Original SCS Lag (hr)	Optimized SCS Lag (hr)
1001A	1.68	3.37
1001B	1.42	2.83
1002	2.00	4.00
1003	1.15	2.30
1004	5.00	10.00
1005	3.70	7.40
1006	4.40	8.80
2001	1.60	3.20
2002	3.10	6.20
2003	1.50	3.00
2004	2.60	5.20
2005	3.60	7.20
2006	1.60	3.20
2007	3.60	7.20
2008	2.40	4.80
3001	4.00	8.00
3002	2.00	4.00
3003	1.40	2.80
3004	2.10	4.20
3005	1.90	3.80
3006	1.60	3.20
3007	2.80	5.60
4001	3.10	6.20
4002	1.20	2.40
4003	2.40	4.80
4004	1.20	2.40

Figure 3: Results of SCS Lag Calibration



Sub Basin Area	Original Initial Abstraction	Optimized Initial Abstraction
1001A	0.78	0.36
1001B	0.86	0.52
1002	1.13	1.95
1003	1.23	0.38
1004	1.03	0.53
1005	1.17	0.90
1006	1.03	0.59
2001	0.63	0.16
2002	0.82	0.34
2003	0.94	0.16
2004	0.90	0.29
2005	0.86	0.26
2006	0.99	0.44
2007	0.94	0.46
2008	0.94	0.71
3001	0.86	0.43
3002	0.82	0.10
3003	0.78	0.12
3004	0.86	0.19
3005	0.82	0.18
3006	0.67	0.05
3007	0.78	0.24
4001	0.86	0.20
4002	0.94	0.21
4003	0.74	0.18
4004	0.67	0.06

Figure 4: Results of Initial Abstraction Calibration

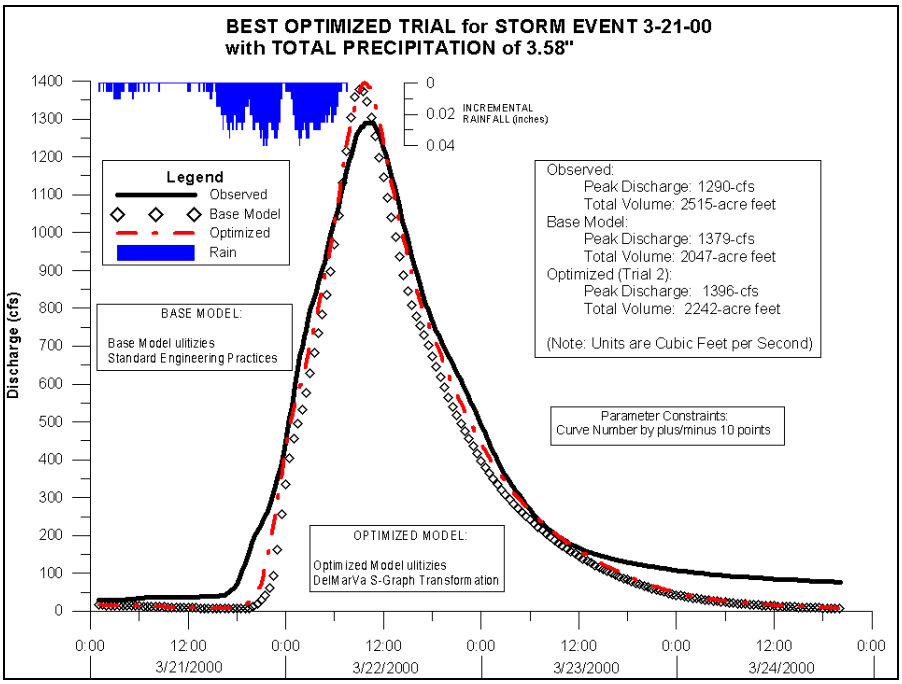


Figure 5: Results from Best-Fit Calibration

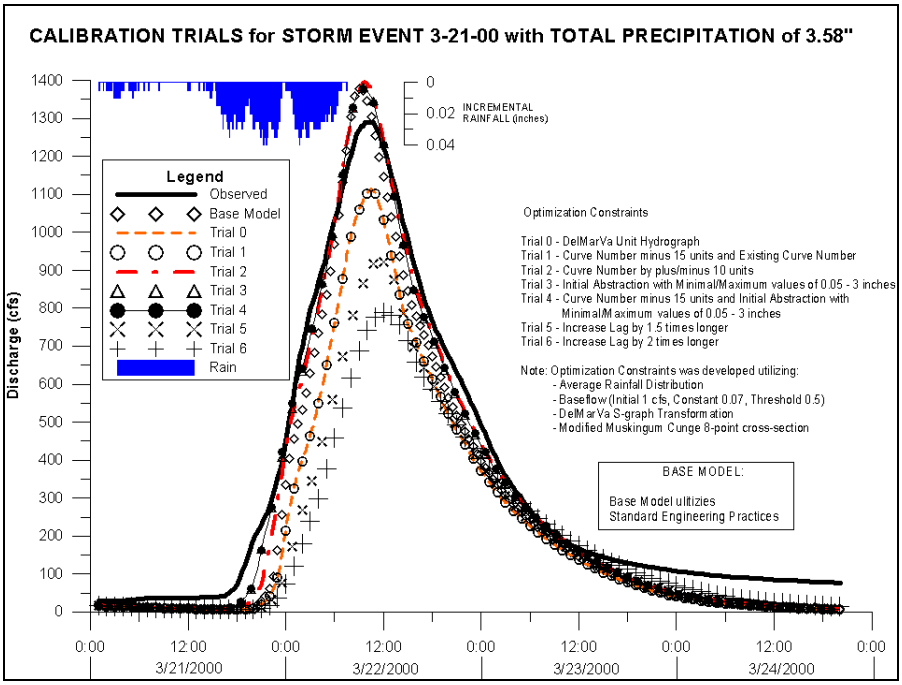


Figure 6: Results from All Calibrated Trials

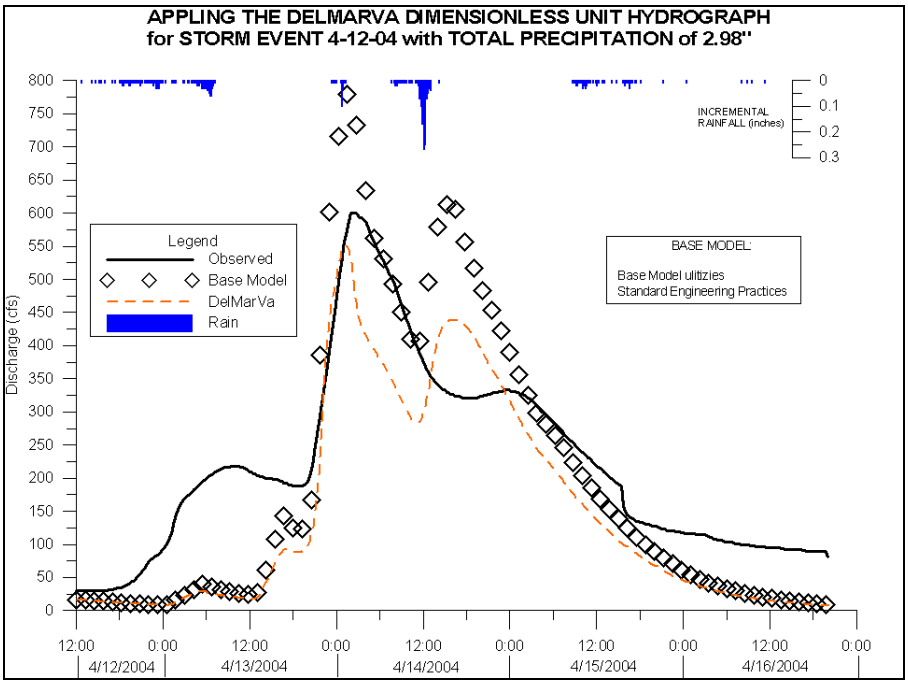


Figure 7: Comparison between NRCS and DelMarVa

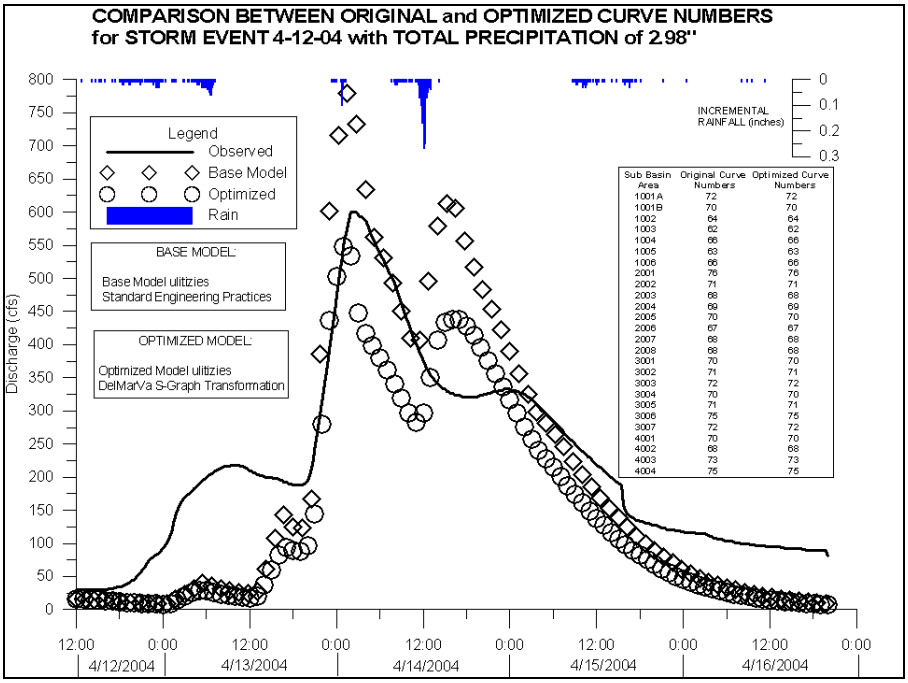


Figure 8: Results of CN Calibration

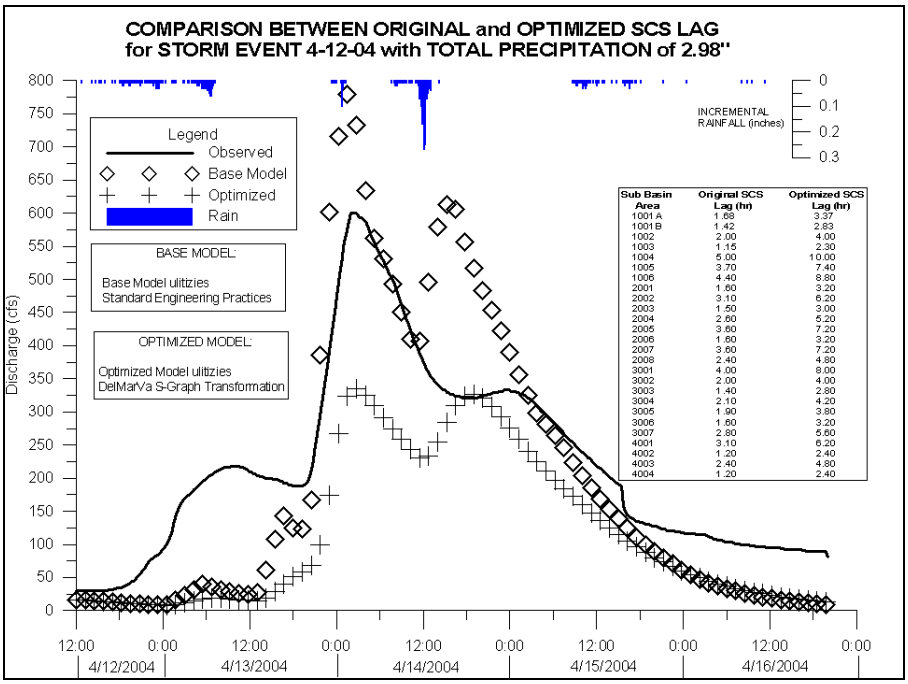


Figure 9: Results of SCS Lag Calibration

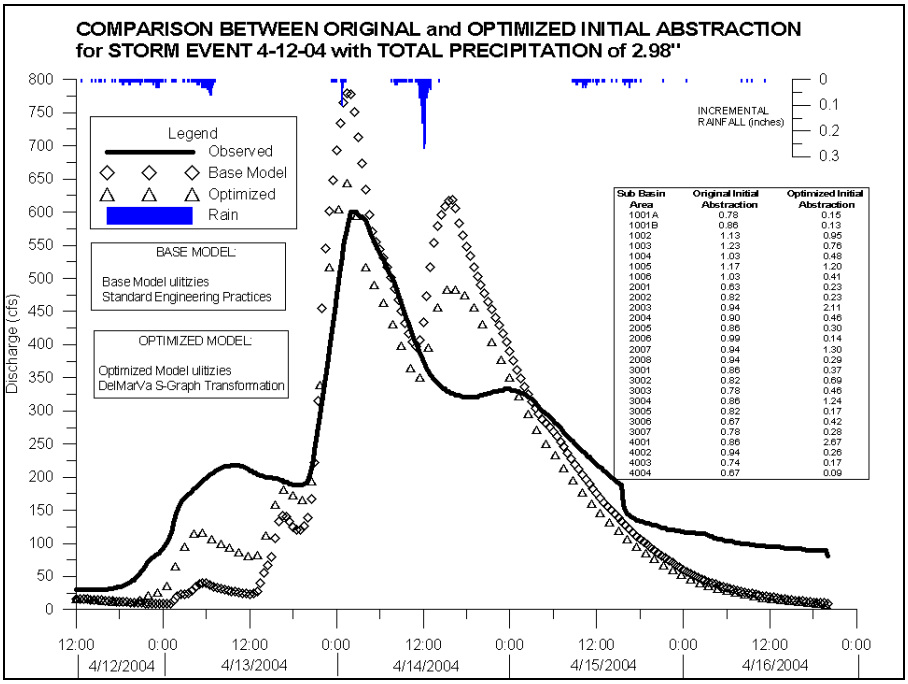


Figure 10: Results of Initial Abstraction Calibration

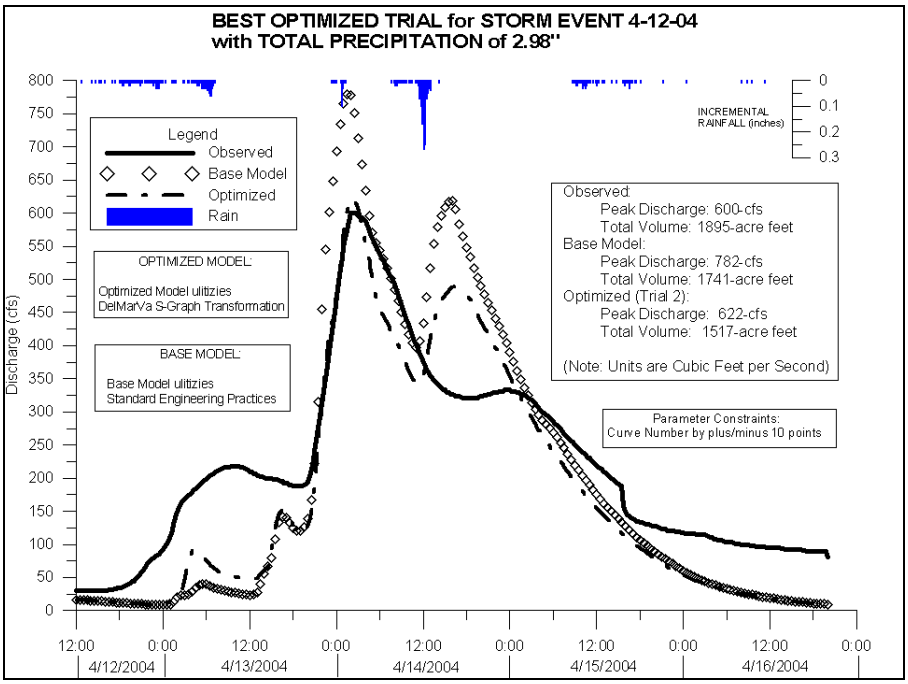


Figure 11: Results from Best-Fit Calibration

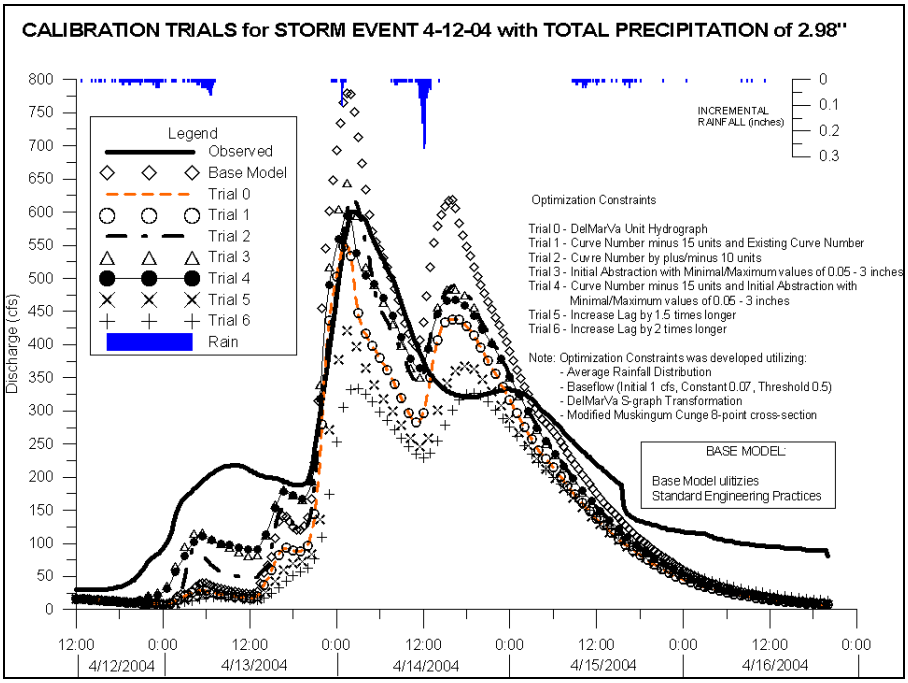


Figure 12: Results from All Calibration Trials

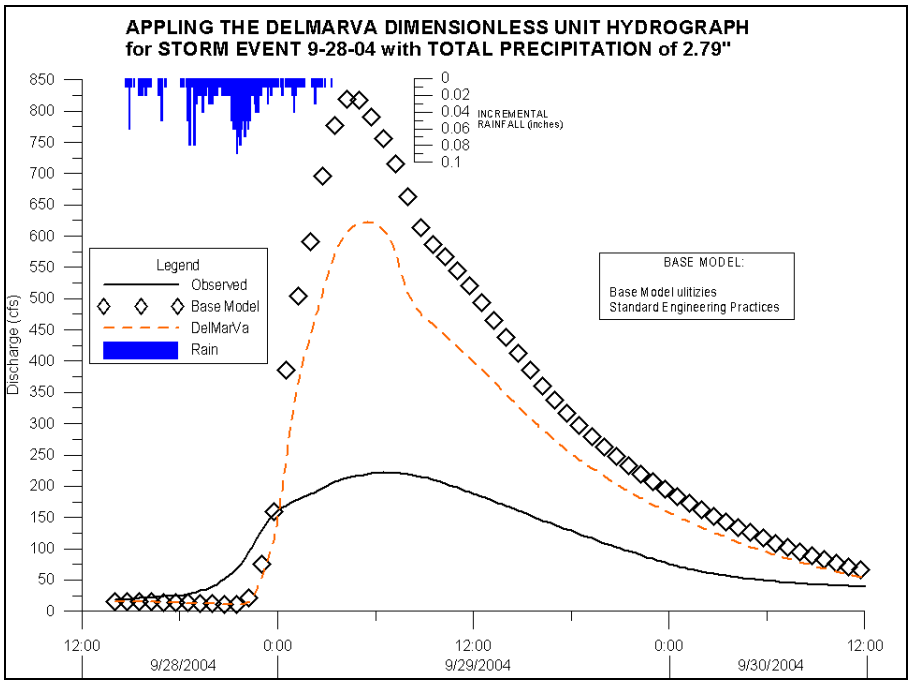


Figure 13: Comparison between NRCS and DelMarVa

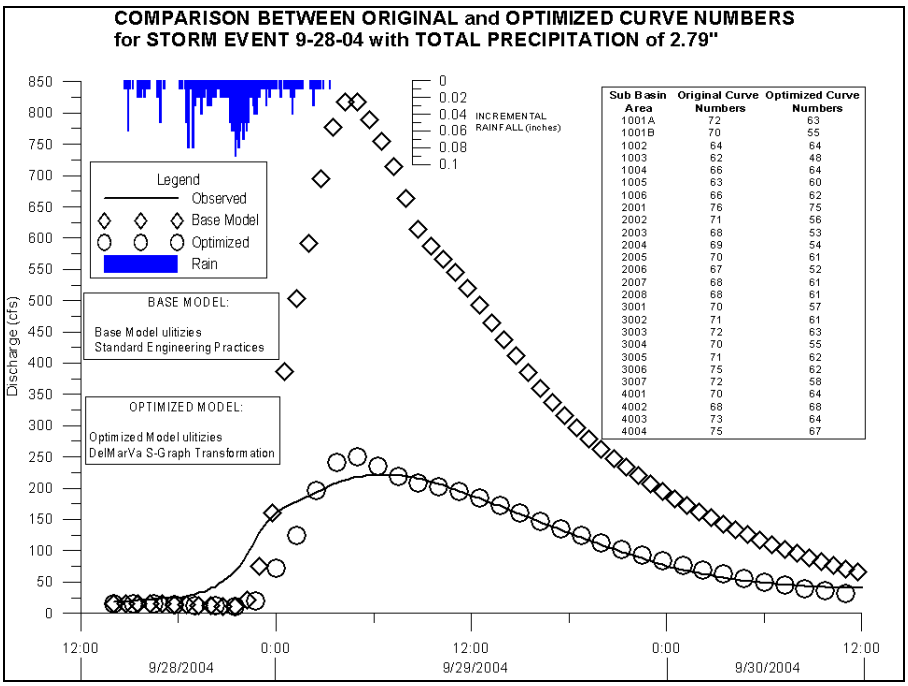
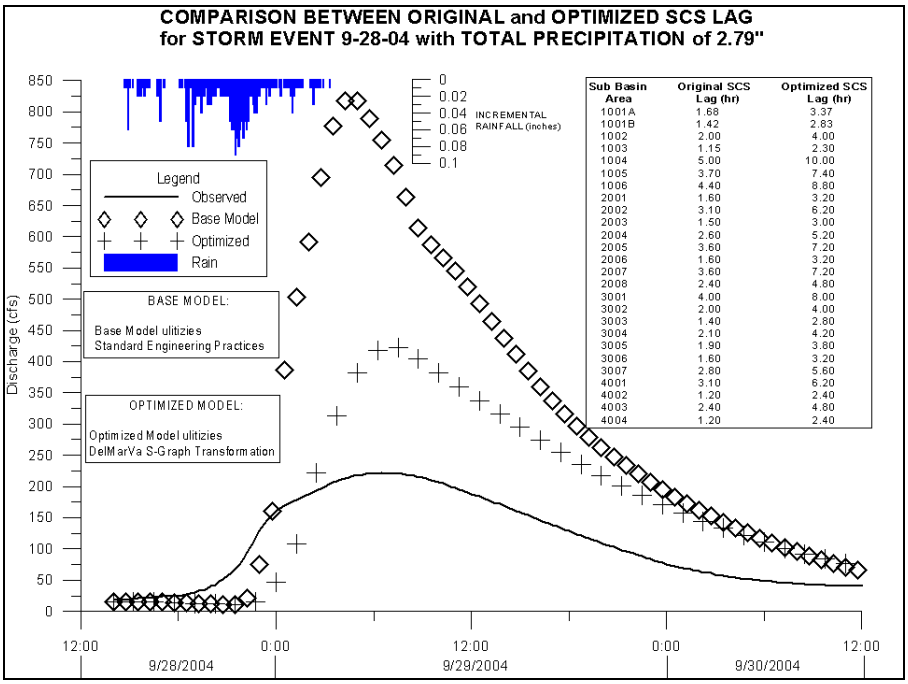
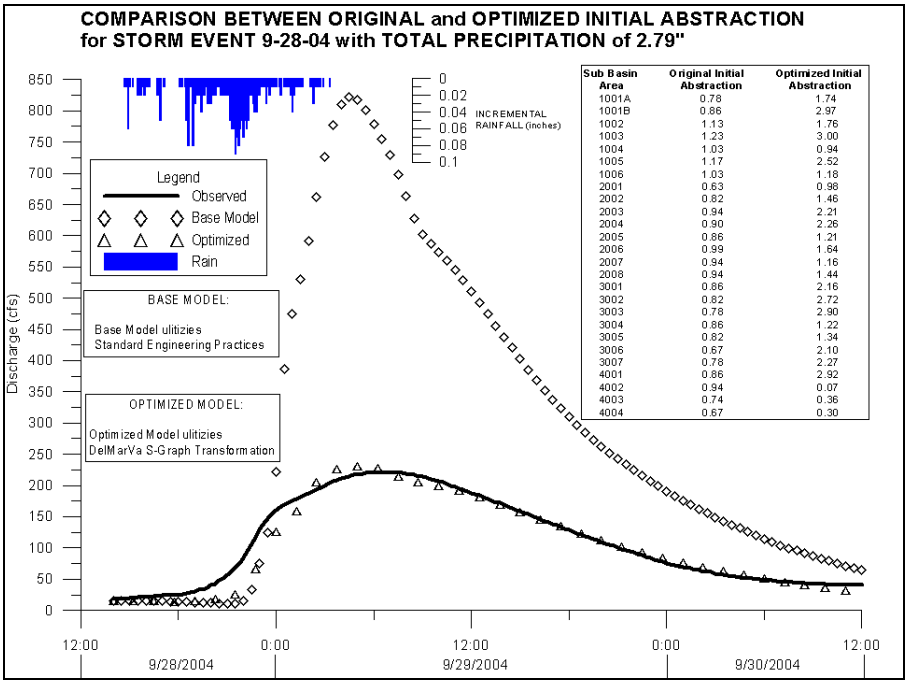


Figure 14: Results of CN Calibration



Sub Basin Area	Original SCS Lag (hr)	Optimized SCS Lag (hr)
1001A	1.68	3.37
1001B	1.42	2.83
1002	2.00	4.00
1003	1.15	2.30
1004	5.00	10.00
1005	3.70	7.40
1006	4.40	8.80
2001	1.60	3.20
2002	3.10	6.20
2003	1.50	3.00
2004	2.60	5.20
2005	3.60	7.20
2006	1.60	3.20
2007	3.60	7.20
2008	2.40	4.80
3001	4.00	8.00
3002	2.00	4.00
3003	1.40	2.80
3004	2.10	4.20
3005	1.90	3.80
3006	1.60	3.20
3007	2.80	5.60
4001	3.10	6.20
4002	1.20	2.40
4003	2.40	4.80
4004	1.20	2.40

Figure 15: Results of SCS Lag Calibration



Sub Basin Area	Original Initial Abstraction	Optimized Initial Abstraction
1001A	0.78	1.74
1001B	0.86	2.97
1002	1.13	1.76
1003	1.23	3.00
1004	1.03	0.94
1005	1.17	2.52
1006	1.03	1.18
2001	0.63	0.98
2002	0.82	1.46
2003	0.94	2.21
2004	0.90	2.26
2005	0.86	1.21
2006	0.99	1.64
2007	0.94	1.16
2008	0.94	1.44
3001	0.86	2.16
3002	0.82	2.72
3003	0.78	2.90
3004	0.86	1.22
3005	0.82	1.34
3006	0.67	2.10
3007	0.78	2.27
4001	0.86	2.92
4002	0.94	0.07
4003	0.74	0.36
4004	0.67	0.30

Figure 16: Results of Initial Abstraction Calibration

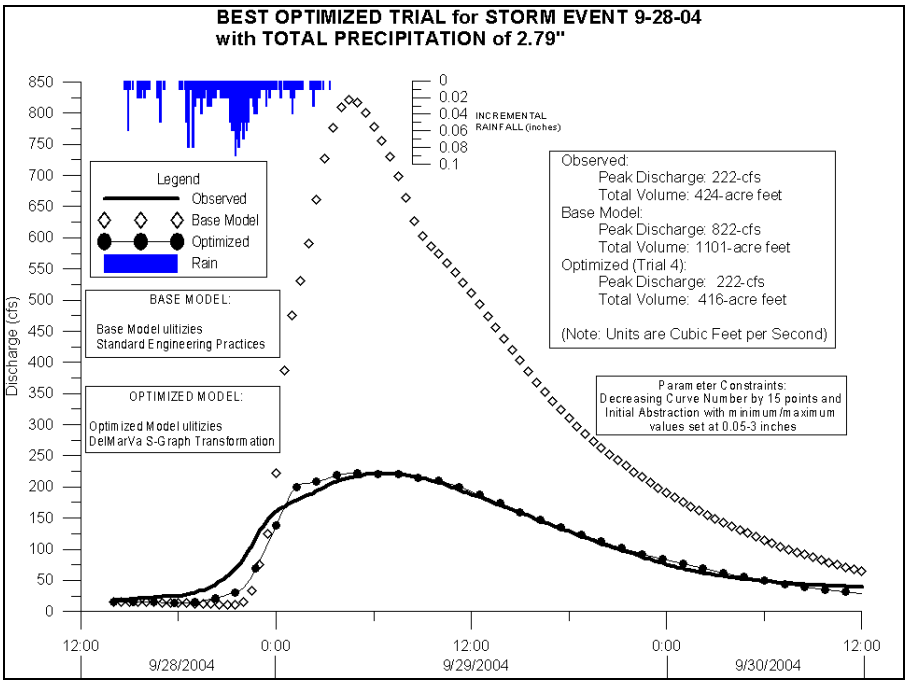


Figure 17: Results from Best-Fit Calibration

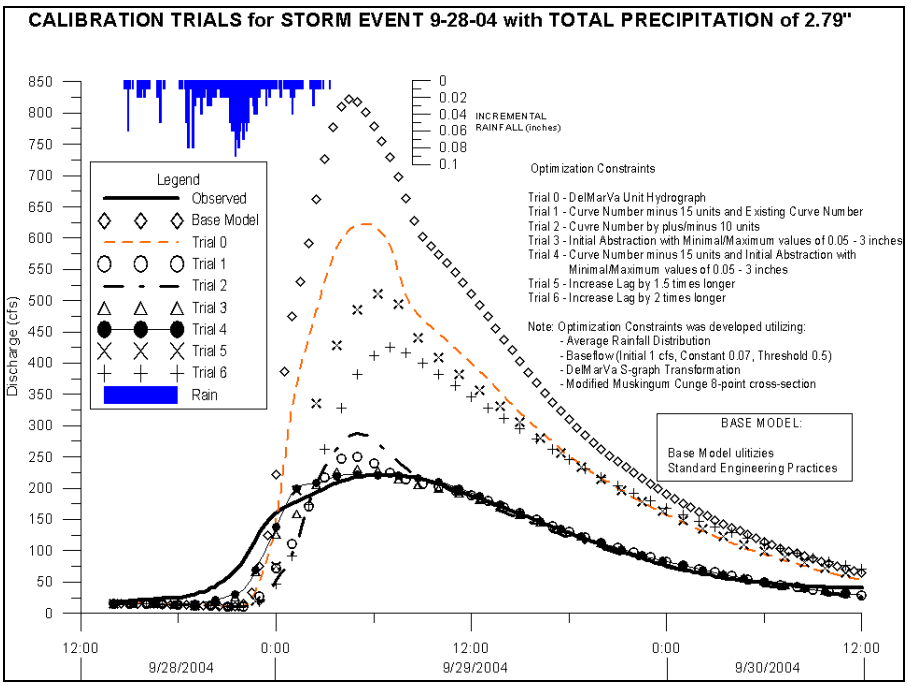


Figure 18: Results from All Calibration Trials

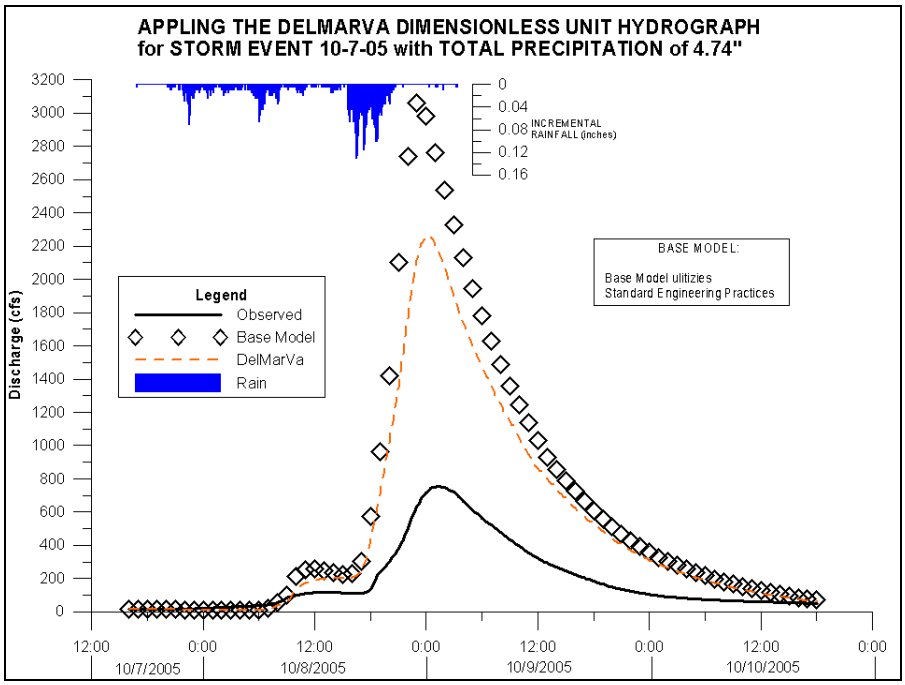


Figure 19: Comparison between NRCS and DelMarVa

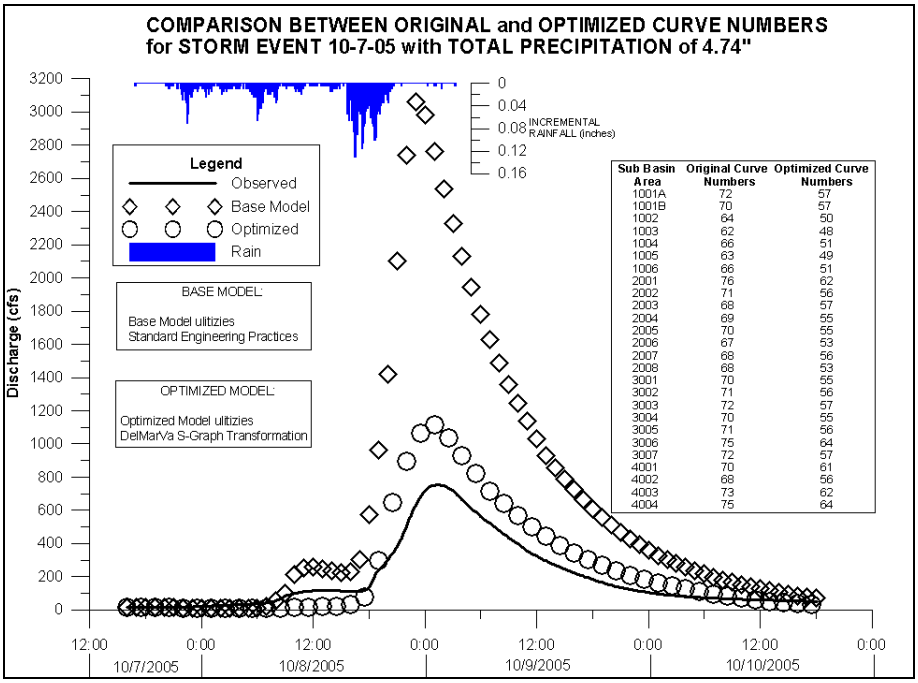
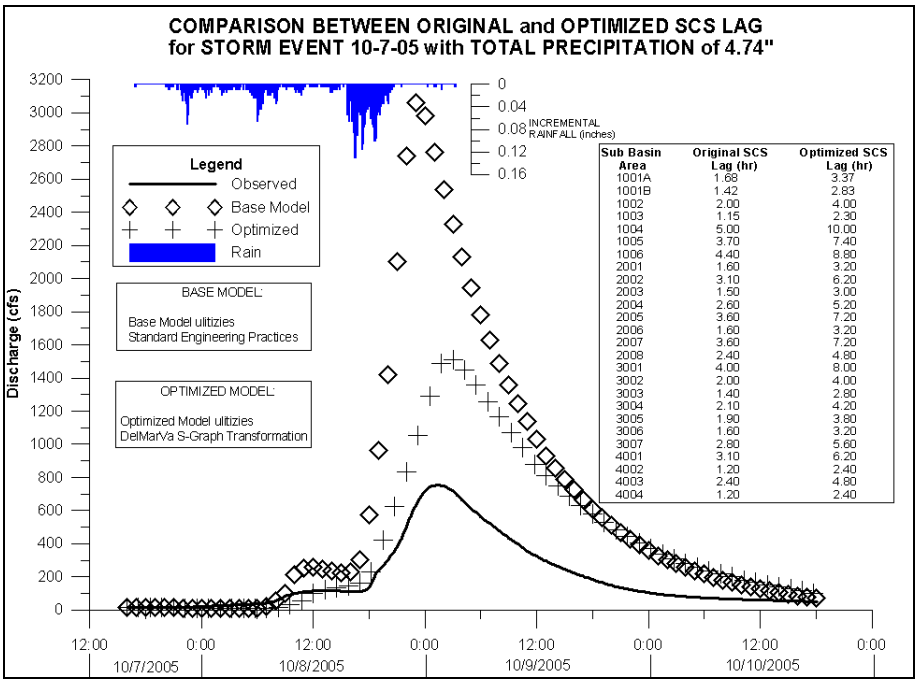
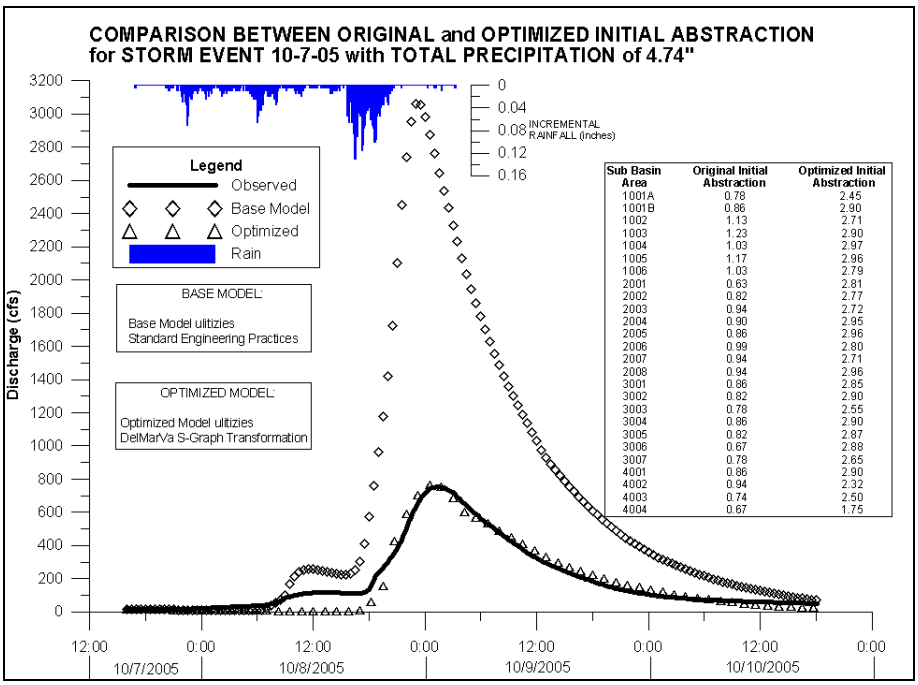


Figure 20: Results of CN Calibration



Sub Basin Area	Original SCS Lag (hr)	Optimized SCS Lag (hr)
1001A	1.68	3.37
1001B	1.42	2.83
1002	2.00	4.00
1003	1.15	2.30
1004	5.00	10.00
1005	3.70	7.40
1006	4.40	8.80
2001	1.60	3.20
2002	3.10	6.20
2003	1.50	3.00
2004	2.60	5.20
2005	3.60	7.20
2006	1.60	3.20
2007	3.60	7.20
2008	2.40	4.80
3001	4.00	8.00
3002	2.00	4.00
3003	1.40	2.80
3004	2.10	4.20
3005	1.90	3.80
3006	1.60	3.20
3007	2.80	5.60
4001	3.10	6.20
4002	1.20	2.40
4003	2.40	4.80
4004	1.20	2.40

Figure 21: Results of SCS Lag Calibration



Sub Basin Area	Original Initial Abstraction	Optimized Initial Abstraction
1001A	0.78	2.45
1001B	0.86	2.90
1002	1.13	2.71
1003	1.23	2.90
1004	1.03	2.97
1005	1.17	2.96
1006	1.03	2.79
2001	0.63	2.81
2002	0.82	2.77
2003	0.94	2.72
2004	0.90	2.95
2005	0.86	2.96
2006	0.99	2.80
2007	0.94	2.71
2008	0.94	2.96
3001	0.86	2.85
3002	0.82	2.90
3003	0.78	2.55
3004	0.86	2.90
3005	0.82	2.87
3006	0.67	2.88
3007	0.78	2.65
4001	0.86	2.90
4002	0.94	2.32
4003	0.74	2.50
4004	0.67	1.75

Figure 22: Results of Initial Abstraction Calibration

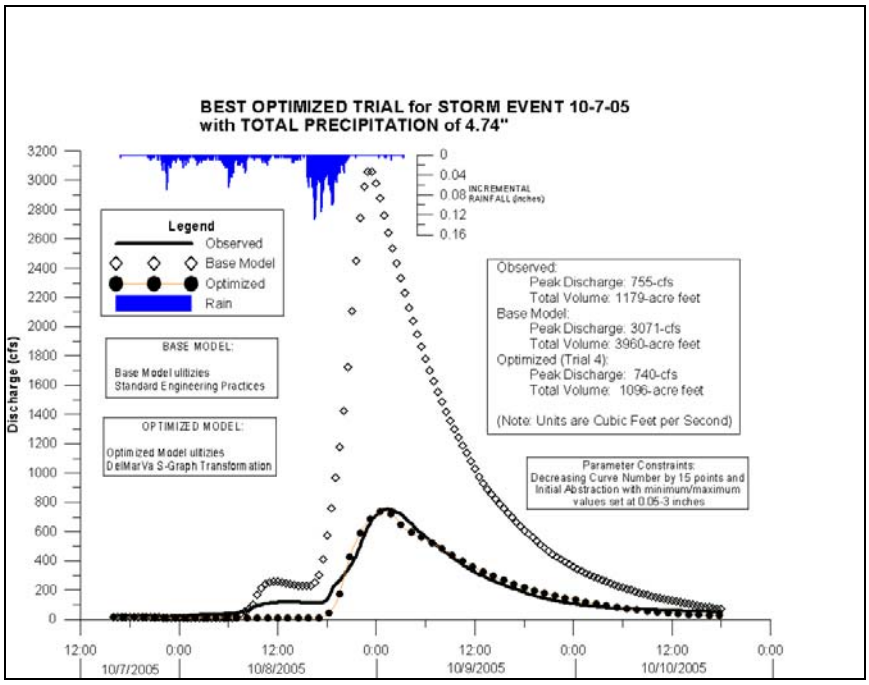


Figure 23: Results from Best-Fit Calibration

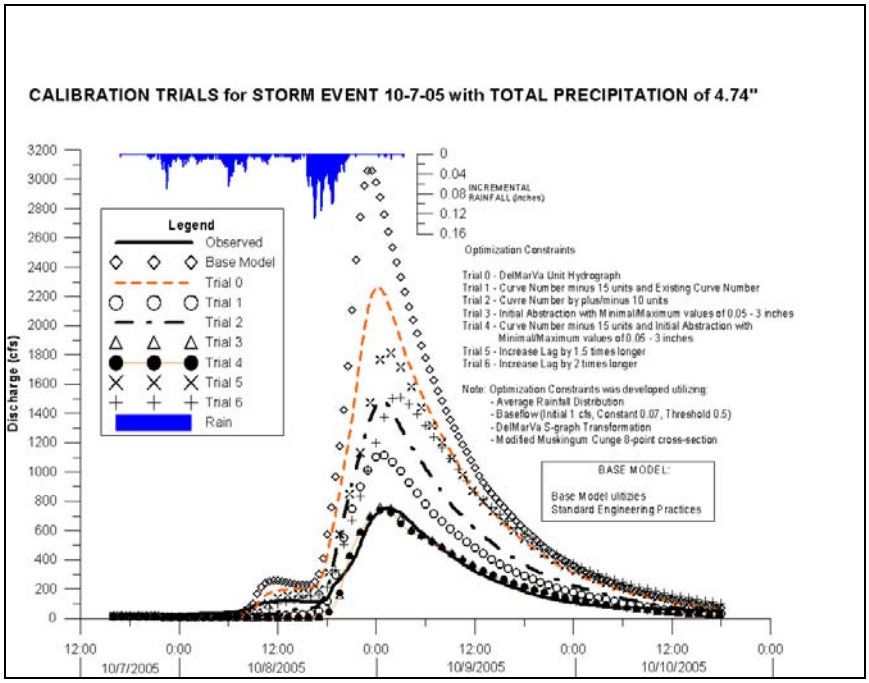


Figure 24: Results from All Calibration Trials

APPENDIX C1:
HYPOTHETICAL CASE STUDY

Report 1: Impact of Proposed Conditions 115

Report 1

Impact of Proposed Changes

Introduction

In the Raccoon Creek Characterization and Assessment Report, the project staff recommends the Regional Stormwater Management Committee adopted several changes to protect the stream corridor. These changes include a revised CN table for describing existing conditions and utilizing the DelMarVa unit hydrograph for all hydrologic calculations.

To estimate the impacts of these changes on both the receiving waterway and on a typical development site, a simple hypothetical site and an actual project from the Raccoon Creek were modeled using both the current regulations and the proposed regulations.

Procedure and Assumptions

All modeling was completed with the Hydraflow Hydrographs 2004 by Intellisolve software package. Composite Curve numbers (CN) and Time of Concentration (Tc) were estimated from the TR 55 worksheets. A six minute time step was selected for all modeling. The standard NRCS unit hydrograph is represent by PRF 484, while the DelMarVa unit hydrograph is represented by PRF 285. For clarity, stormwater recharge requirements were not included in this calcualation.

Hypothetical Site

Site Description and Proposed Improvements

The existing 15-acre site is assumed to have a composite CN of 57 and represents a mix of woods and meadow in good condition on HSG B soils. The Tc was set at 22.3 minutes. The proposed site consists of single-family homes on ½ acre lots, with a composite CN of 70. The Tc was set at 15 minutes.

A stormwater basin was designed to provide a reduction of peak discharge to 50, 75 and 80 percent of the existing condition 2, 10 and 100-year storm. NRCS 24 Hour, Type III rainfall of 3.3, 5.1 and 8.5 inches for the 2, 10 and 100-year storms were used.

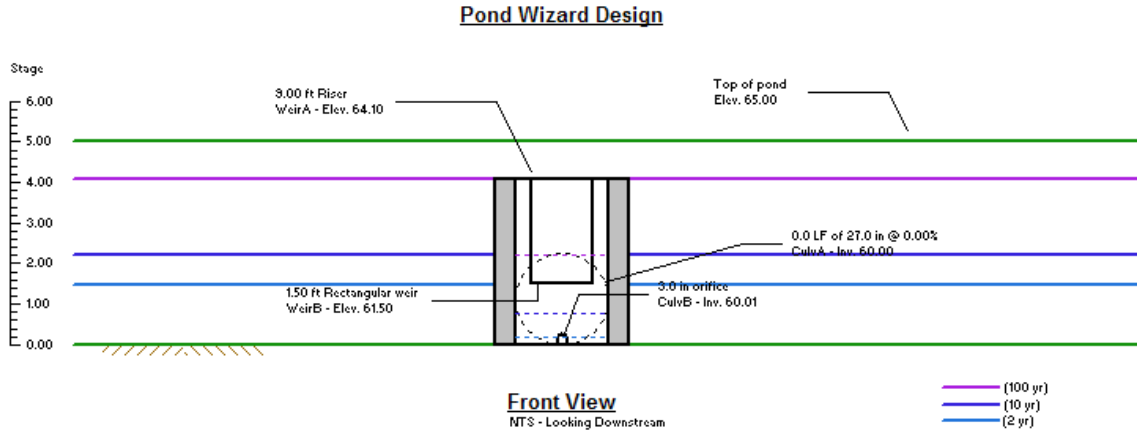
The stormwater basins were designed with the Hydraflow Pond Design Wizard. The outlet structure geometry was edited to ensure the basin would meet water quality requirements, detain the 100-year storm and provide at least one foot of freeboard.

Design Based on Current Requirements

Runoff Summary

	2- Year Peak Discharge (cfs)	**10- Year Peak Discharge (cfs)**	**100- Year Peak Discharge (cfs)**
Existing Condition	2.02	10.44	34.27
Proposed Condition	9.67	24.94	58.52

The stormwater basin necessary to meet the required reductions has the following characteristics: A bottom surface area of 0.5 Acres, 3:1 side slopes and a total depth of 5.0 feet. A multi-stage outlet structure includes a three-inch orifice set at the basin bottom, a 1.5 foot wide weir 1.5 feet above the basin bottom and a 9 foot weir set 4.1 feet above the bottom.



Discharge Summary

Storm	Basin Inflow (cfs)	Allowable Discharge (cfs)	Basin Discharge (cfs)	Maximum Storage (acft)
2- Year	9.67	1.01	0.27	0.792
10- Year	24.94	7.83	3.39	1.230
100- Year	58.52	27.4	20.0	2.438

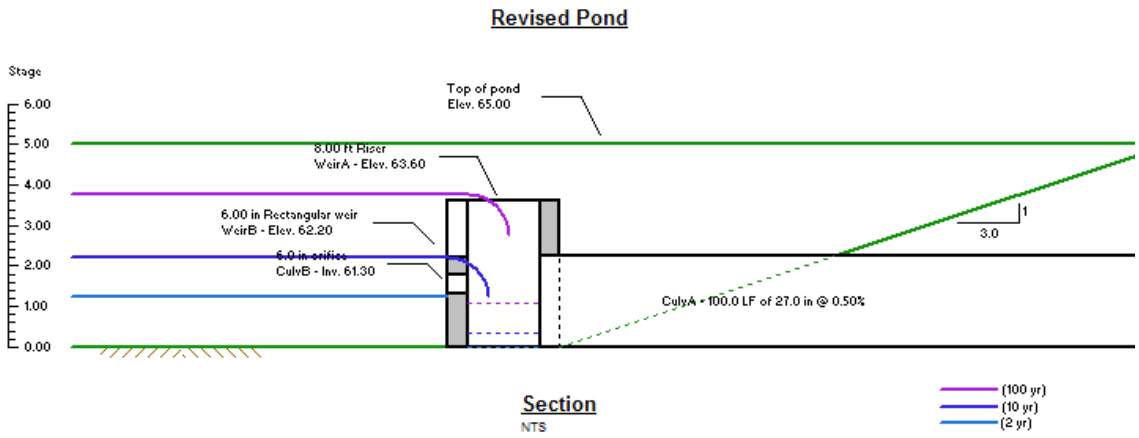
Design Based on Revised Practices

The suggested revisions for the Upper Raccoon Creek Watershed include using the DelMarVa unit hydrograph for all calculations and decreasing existing condition CN by 15 units. This yields an existing condition CN of 42

Runoff Summary

	2- Year Peak Discharge (cfs)	10- Year Peak Discharge (cfs)	100- Year Peak Discharge (cfs)
Existing Condition	0.04	1.06	10.52
Proposed Condition	9.67	24.94	58.52

The same design criteria, reducing the peak runoff to 50, 75 and 80 percent of the existing condition, was used to design the stormwater basin. The new basin has the following characteristics: A bottom surface area of 0.8 Acres, 3:1 side slopes and a total depth of 5.0 feet. A multi-stage outlet structure includes a six-inch orifice set 1.3 feet above the basin bottom, a 0.5 foot wide weir 2.2 feet above the basin bottom and a 8 foot weir set 3.6 feet above the bottom.



Discharge Summary

Storm	Basin Inflow (cfs)	Allowable Discharge (cfs)	Basin Discharge (cfs)	Maximum Storage (acft)
2- Year	9.67	0.0	0.0	1.102
10- Year	24.94	0.8	0.78	2.009
100- Year	58.52	8.4	6.51	3.582

Summary

By implementing the proposed changes the allowable discharges from the site are dramatically reduced. In this example, the stormwater basin designed to meet these reductions requires about 45% more storage capacity during the 100-year storm.

APPENDIX D:
WATER QUALITY ASSESSMENT

Report 1: Water Resources Data, New Jersey Water Year 2004, Volume 3 121

Figure 1: NJDEP Ambient Biomonitoring Sites within Raccoon Creek Watershed Study Area 123

Table 1: New Jersey AMNET Study – 2001 Lower Delaware Region 125

Table 2: New Jersey Integrated List of Waterbodies (Sublists 1 – 5) 126

01477120 RACCOON CREEK NEAR SWEDESBORO, NJ

LOCATION.--Lat 39°44'26", long 75°15'33", Gloucester County, Hydrologic Unit 02040202, at bridge on County Route 607 on Gibbstown-Harrisonville Road (Tomlin Station Road), 1.8 mi west of Mullica Hill, and 2.8 mi east of Swedesboro.

DRAINAGE AREA.--26.9 mi^2.

PERIOD OF RECORD.--Water years 1965 to current year.

PERIOD OF DAILY RECORD.--
SUSPENDED-SEDIMENT DISCHARGE: June 1966 to September 1969.
WATER TEMPERATURE: May 1966 to September 1973, daily maximum-minimum; October 1998 to October 2001, recorded hourly.

REMARKS.--Total nitrogen (00600) equals the sum of dissolved ammonia plus organic nitrogen (00623), dissolved nitrite plus nitrate nitrogen (00631), and total particulate nitrogen (49570). Additional trace-element data for this and other stations are presented in "Trace-Elements Collected During High-Flows in Selected Streams in New Jersey (303d)" in the Water-Quality at Special-Study Sites section of this report.

COOPERATION.--Field data and samples for laboratory analyses were provided by the New Jersey Department of Environmental Protection. Determination of dissolved ammonia, total ammonia, dissolved nitrite, dissolved orthophosphate, biochemical oxygen demand, total suspended solids, fecal coliform, E.coli, and enterococcus bacteria was performed by the New Jersey Department of Health and Senior Services, Public Health and Environmental Laboratories, Environmental and Chemical Laboratory Services.

COOPERATIVE NETWORK SITE DESCRIPTOR.--Watershed Integrator, New Jersey Department of Environmental Protection Watershed Management Area 18.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004

Date	Time	Instantaneous discharge, cfs (00061)	Turbidity, water, unfltrd field, NTU (61028)	UV absorbance, 254 nm, wat flt units /cm (50624)	UV absorbance, 280 nm, wat flt units /cm (61726)	Barometric pressure, mm Hg (00025)	Dissolved oxygen, mg/L (00300)	Dissolved oxygen, percent of saturation (00301)	pH, water, unfltrd field, std units (00400)	Specif. conductance, wat unf uS/cm 25 degC (00095)	Temperature, air, deg C (00020)	Temperature, water, deg C (00010)	Hardness, water, mg/L as CaCO3 (00900)
NOV													
06...	0930	40	6.3	.184	.142	761	7.3	75	7.1	223	17.5	16.4	65
FEB													
19...	1000	39	4.9	.087	.068	756	12.1	91	7.2	207	12.0	3.3	65
MAY													
05...	1000	50	6.5	.191	.150	757	9.7	--	7.0	--	18.0	13.1	60
AUG													
05...	0900	26	9.9	.263	.208	747	6.8	79	7.1	195	23.0	22.4	67

Date	Calcium water, fltrd, mg/L (00915)	Magnesium, water, fltrd, mg/L (00925)	Potassium, water, fltrd, mg/L (00935)	Sodium, water, fltrd, mg/L (00930)	ANC, wat unf fixed end pt, lab, mg/L as CaCO3 (90410)	Chloride, water, fltrd, mg/L (00940)	Fluoride, water, fltrd, mg/L (00950)	Silica, water, fltrd, mg/L (00955)	Sulfate water, fltrd, mg/L (00945)	Residue water, fltrd, sum of constituents mg/L (70301)	Residue on evap. at 180degC wat flt mg/L (70300)	Residue total at 105 deg. C, suspended, mg/L (00530)	Ammonia + org-N, water, fltrd, mg/L as N (00623)
NOV													
06...	19.5	4.07	5.02	10.5	36	22.0	<.2	10.6	24.6	123	138	6	.80
FEB													
19...	19.7	3.88	3.55	11.1	22	20.6	<.2	9.2	28.8	118	138	4	.90
MAY													
05...	17.4	4.07	3.86	10.3	24	19.7	<.2	8.0	24.1	110	127	5	.50
AUG													
05...	20.3	3.87	4.42	8.70	34	18.9	.2	10.3	22.7	115	136	22	.38

Date	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)	Particulate nitrogen, susp, water, mg/L (49570)	Orthophosphate, water, fltrd, mg/L as P (00671)	Phosphorus, water, fltrd, mg/L (00666)	Phosphorus, water, unfltrd mg/L (00665)	Total nitrogen, water, fltrd, mg/L (00602)	Total nitrogen, water, unfltrd mg/L (00600)	Total carbon, suspnd sedimnt total, mg/L (00694)	Inorganic carbon, suspnd sedimnt total, mg/L (00688)	Organic carbon, suspnd sedimnt total, mg/L (00689)
NOV													
06...	.310	.310	1.10	.031	.10	.038	.030	.029	1.9	2.0	.9	<.1	.9
FEB													
19...	.400	--	1.80	.024	.08	.026	--	.018	2.7	2.8	.7	<.1	.7
MAY													
05...	.227	--	1.60	.032	.10	.028	.026	.090	2.1	2.2	.9	<.1	.9
AUG													
05...	.066	--	1.07	.014	.08	.043	.044	.175	1.4	1.5	.8	<.1	.7

01477120 RACCOON CREEK NEAR SWEDESBORO, NJ—Continued

WATER-QUALITY DATA, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004—CONTINUED

Date	Organic carbon, water, fltrd, mg/L (00681)	BOD, water, unfltrd 5 day, 20 degC mg/L (00310)	Boron, water, fltrd, ug/L (01020)
NOV			
06...	5.3	E1.6	37
FEB			
19...	2.3	<1.0	29
MAY			
05...	4.3	E1.5	35
AUG			
05...	5.0	E1.1	35

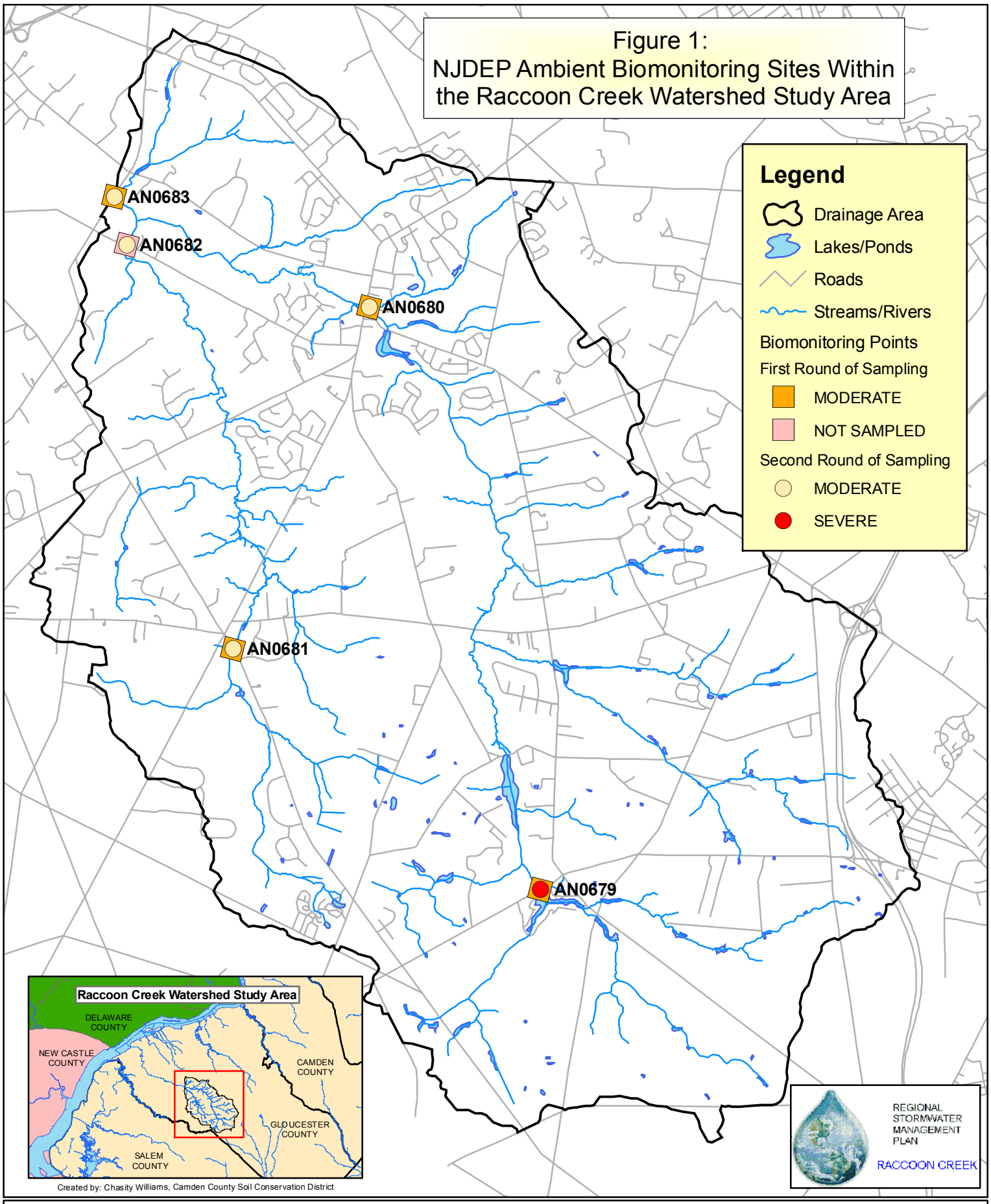
Remark codes used in this table:
< -- Less than
E -- Estimated value

WATER-COLUMN BACTERIA ANALYSES

Samples were collected synoptically over a 30-day period during the summer.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004

Date	Time	Instantaneous discharge, cfs (00061)	Enterococci, m-E MF, water, col/ 100 mL (31649)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coliform, ECbroth water, MPN/ 100 mL (31615)
JUN					
02...	1000	37	380	100	130
09...	0955	32	120	300	500
16...	1020	56	2,000	1,700	3,000
23...	1020	27	540	300	230
30...	1015	22	360	500	1,400


Figure 1:
NJDEP Ambient Biomonitoring Sites Within the Raccoon Creek Watershed Study Area
Legend
Drainage Area
Lakes/Ponds
Roads
Streams/Rivers
Biomonitoring Points
First Round of Sampling
MODERATE
NOT SAMPLED
Second Round of Sampling
MODERATE
SEVERE
AN0683
AN0682
AN0680
AN0681
AN0679
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
0 0.5 1 2 Miles
N
W
E
S

GLOUCESTER COUNTY
SOIL CONSERVATION DISTRICT

RACCOON CREEK WATERSHED
REGIONAL STORMWATER MANAGEMENT PLAN

Table 1: NJ AMNET Study 2001 - Lower Delaware Region

Station	NJ Impairment Score		Change in Rating	Habitat Score
	95 / 96	00 / 01		
679	9	6	----	167
680	21	21	/	150
681	21	18	/-	159
682	27	12	----	146
683	15	12	/-	161

NOTES:
Comparison of NJ impairment score with earlier study results:
+ indicates positive change in rating
---- indicates negative change in rating
/ indicates no change in rating
/+ or /- indicates change in score, but not in rating (see Table 1)

NJ Impairment Score	*Value*
Non-Impaired	24 - 30
Moderately Impaired	9 - 21
Severely Impaired	0 - 6

Habitat Score	*Value*
Optimal	160 - 200
Sub-optimal	110 - 159
Marginal	60 - 109
Poor	<60

Table 2: 2004 Intergrated Water Quality Monitoring and Assessment Report Sublists 1 - 5

NJDEP Sublist	Region	WMA	Station Name/ Waterbody	Site ID#	Impairment	Data Source	Priority Ranking
1	Lower Delaware	18	Gilman Lake-18	Lake Gilman	Fecal Coliform	Gloucester Co HD	
1	Lower Delaware	18	Raccoon Creek near Swedesboro	01477120, 18-RAC-1	Temperature, pH, Dissolved Oxygen, Nitrate, Dissolved Solids, Total Suspended Solids, Unionized Ammonia, Chromium, Copper, Lead, Nickel, Selenium, Zinc	NJDEP/USGS Data, Metal Recon	
3	Lower Delaware	18	Raccoon Creek near Swedesboro	01477120, 18-RAC-1	Arsenic, Cadmium, Mercury	NJDEP/USGS Data, Metal Recon	
3	Lower Delaware	18	Raccoon Creek South Branch at Swedesboro Rd in South Harrison	AN0681	Benthic Macroinvertebrates	NJDEP AMNET	
4	Lower Delaware	18	Raccoon Creek near Swedesboro	01477120, 18-RAC-1	Fecal Coliform	NJDEP/USGS Data, Metal Recon	
5	Lower Delaware	18	Raccoon Creek at Ellis Mill Rd in Elk	AN0679	Benthic Macroinvertebrates	NJDEP AMNET	Low
5	Lower Delaware	18	Raccoon Creek at Tomlin Sta Rd in Harrison	AN0683	Benthic Macroinvertebrates	NJDEP AMNET	Low
5	Lower Delaware	18	Raccoon Creek near Swedesboro	01477120, 18-RAC-1	Phosphorus, Silver	NJDEP/USGS Data, Metal Recon	Medium, High (respectfully)
5	Lower Delaware	18	Raccoon Creek S Br at High St in Harrison	AN0682	Benthic Macroinvertebrates	NJDEP AMNET	Low
Data Source: http://www.state.nj.us/dep/wmm/sgwqt/wat/index.html							

APPENDIX E:
VOLUNTEER WATER QUALITY MONITORING
AS OF DECEMBER 2006

Figure 1: Raccoon Creek Watershed Study Area Water Quality Sampling Sites 129

Figures 2 - 4: Raccoon Creek Watershed Study Area Results for ALL Sites 131
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 5 - 8: Raccoon Creek Watershed Study Area Results for Site 1 (Winarski Lake) 135
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 9 - 12: Raccoon Creek Watershed Study Area Results for Site 2 (Gilman Lake) 141
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

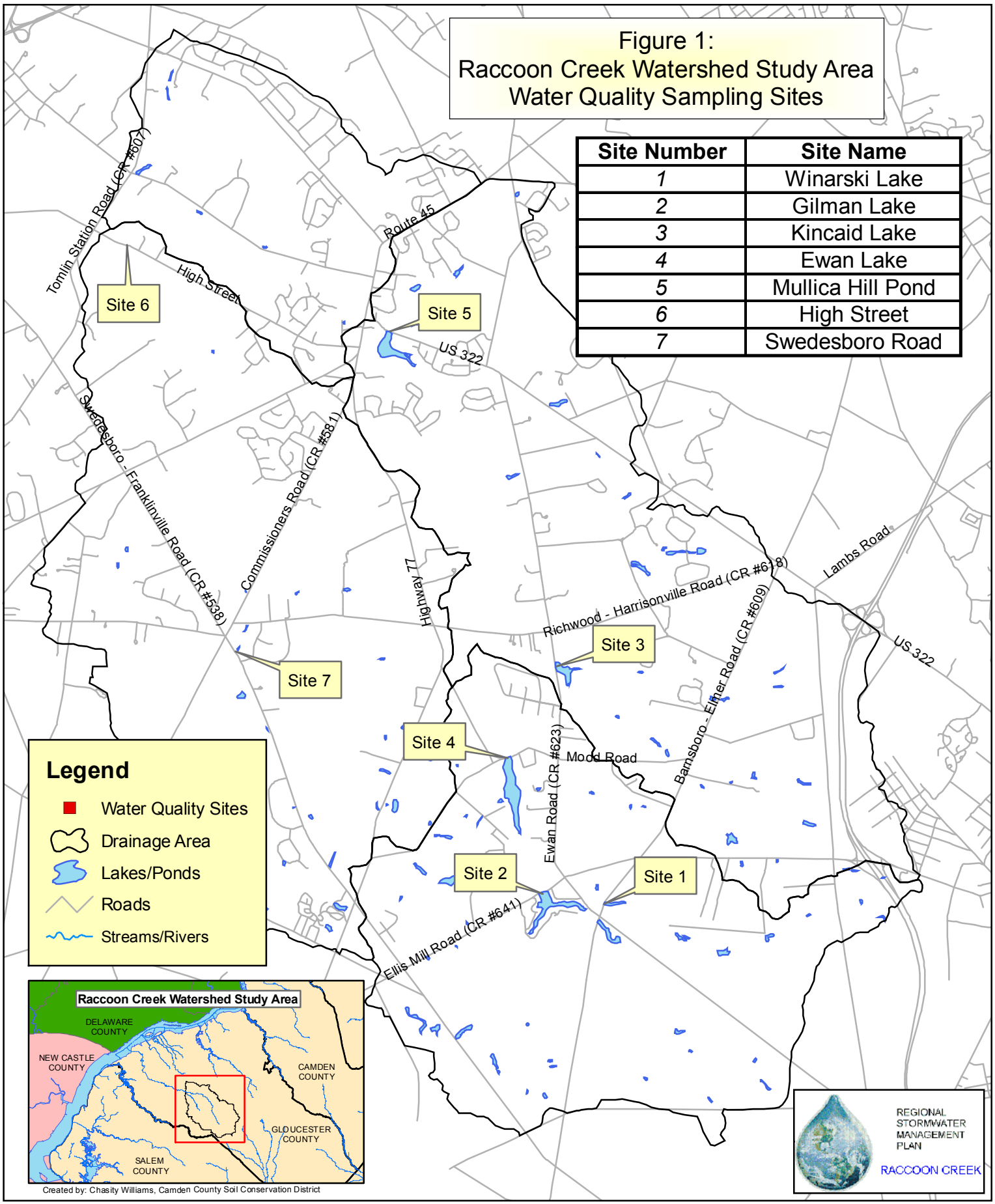
Figures 13 - 16: Raccoon Creek Watershed Study Area Results for Site 3 (Kincaid Lake) 147
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 17 - 20: Raccoon Creek Watershed Study Area Results for Site 4 (Ewan Lake) 153
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 21 - 24: Raccoon Creek Watershed Study Area Results for Site 5 (Mullica Hill Pond) 159
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 25 - 28: Raccoon Creek Watershed Study Area Results for Site 6 (High Street) 165
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*

Figures 29 - 32: Raccoon Creek Watershed Study Area Results for Site 7 (Swedesboro Road) 171
- *INSITU Parameters*
- *Phosphate & Nitrate*
- *Fecal Coliform*
- *Total Coliform*



Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

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N W E S

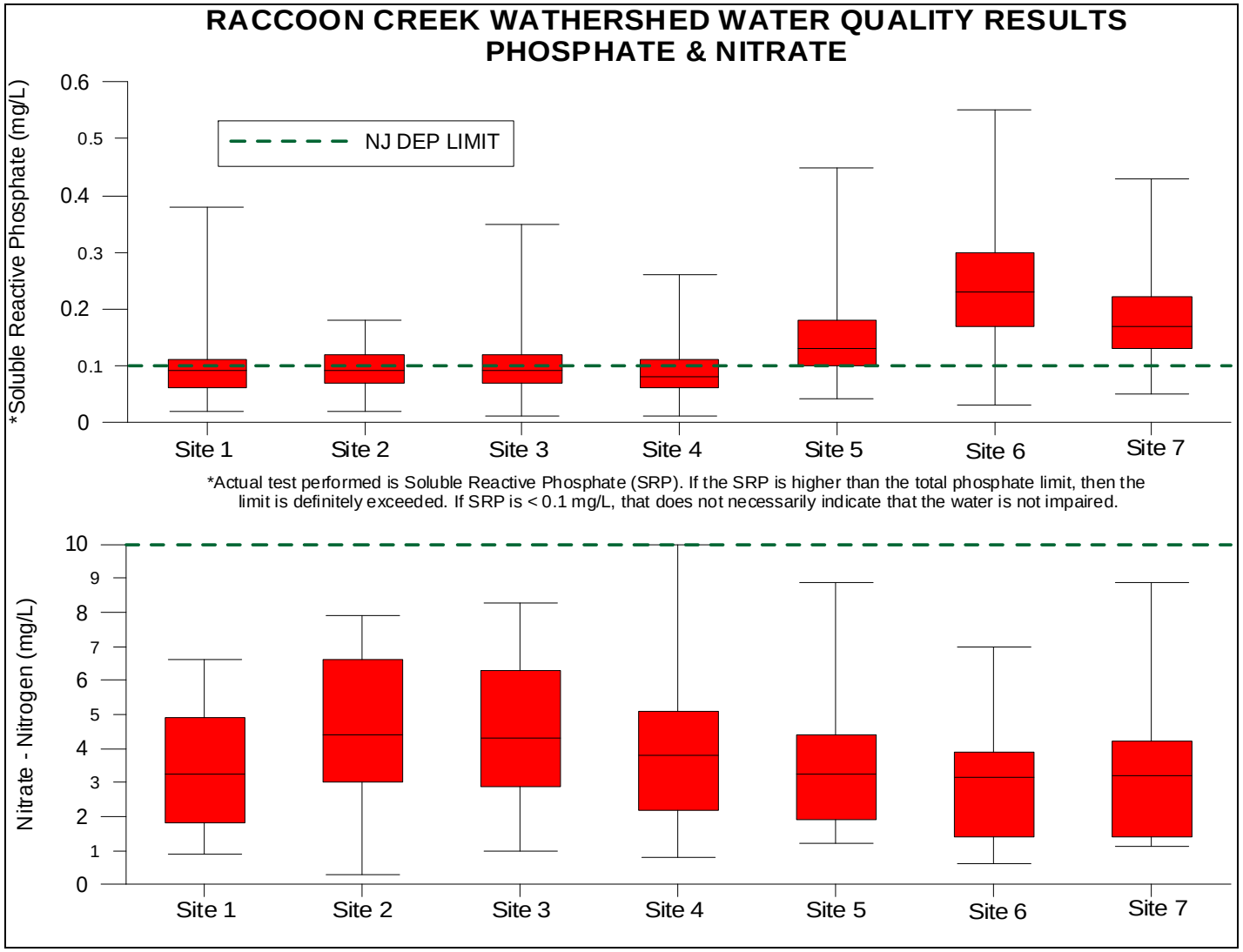


Figure 2: Seasonal Phosphate & Nitrate Results for ALL Sites

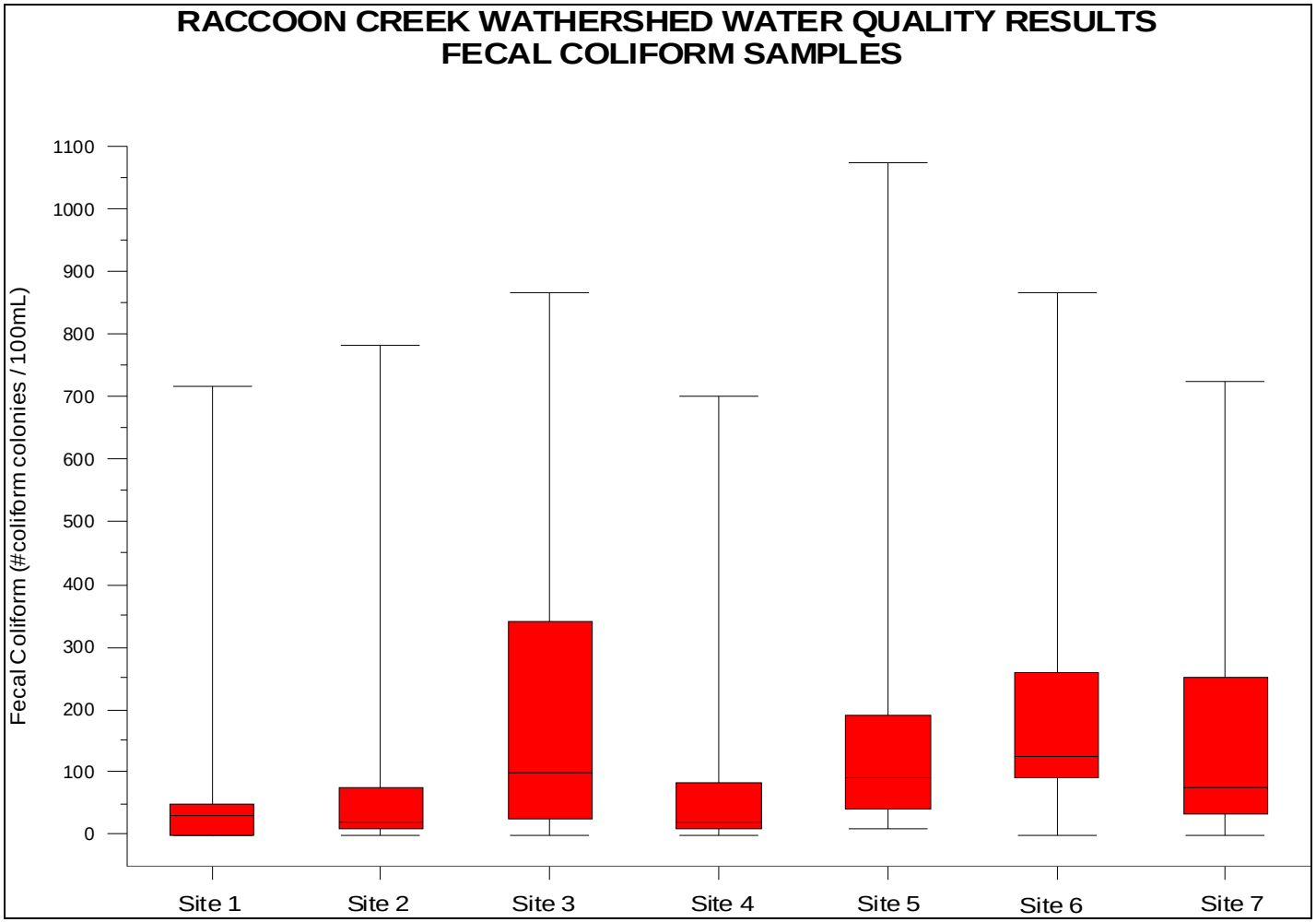


Figure 3: Fecal Coliform Results for ALL Sites

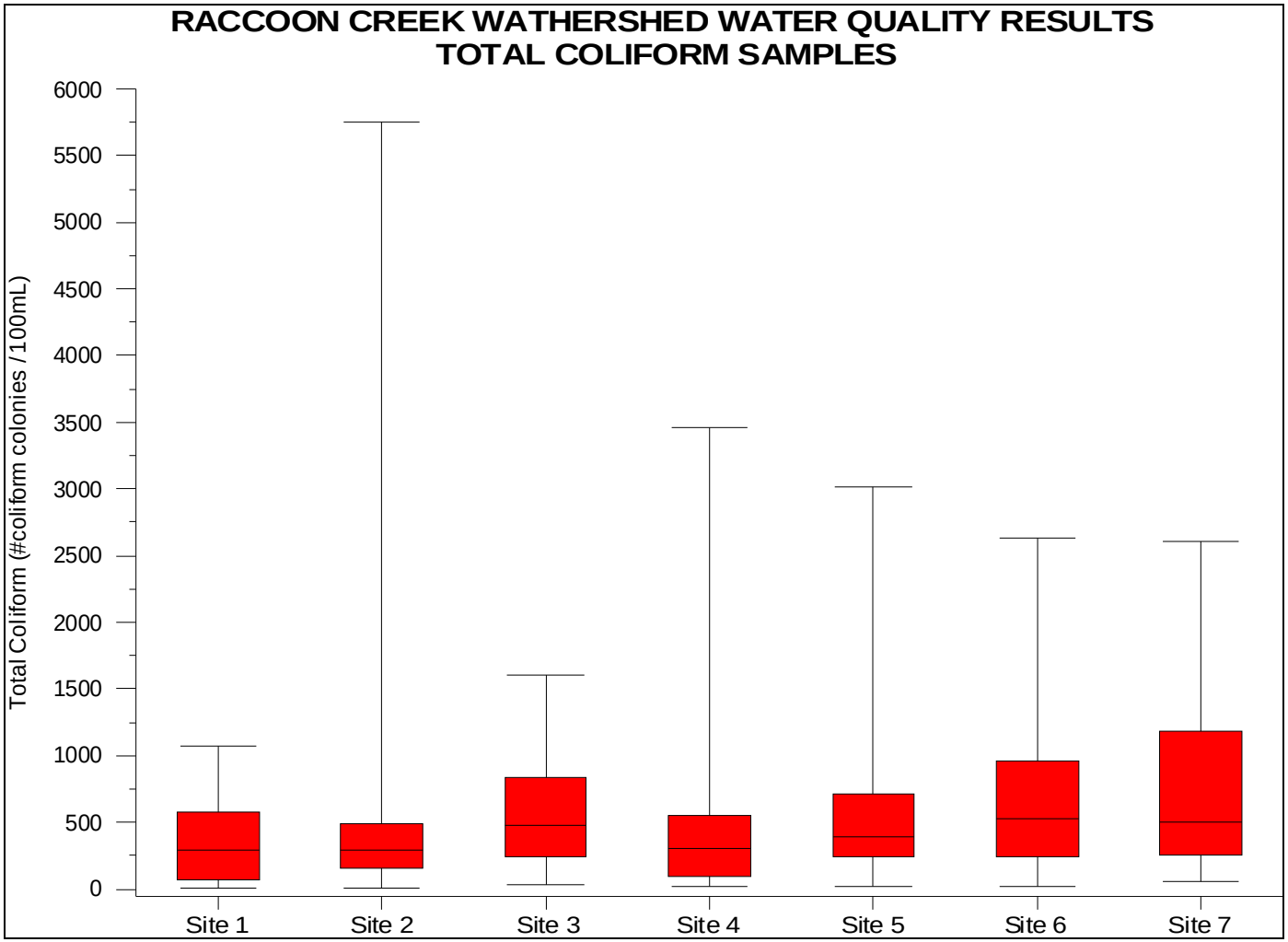


Figure 4: Total Coliform Results for ALL Sites

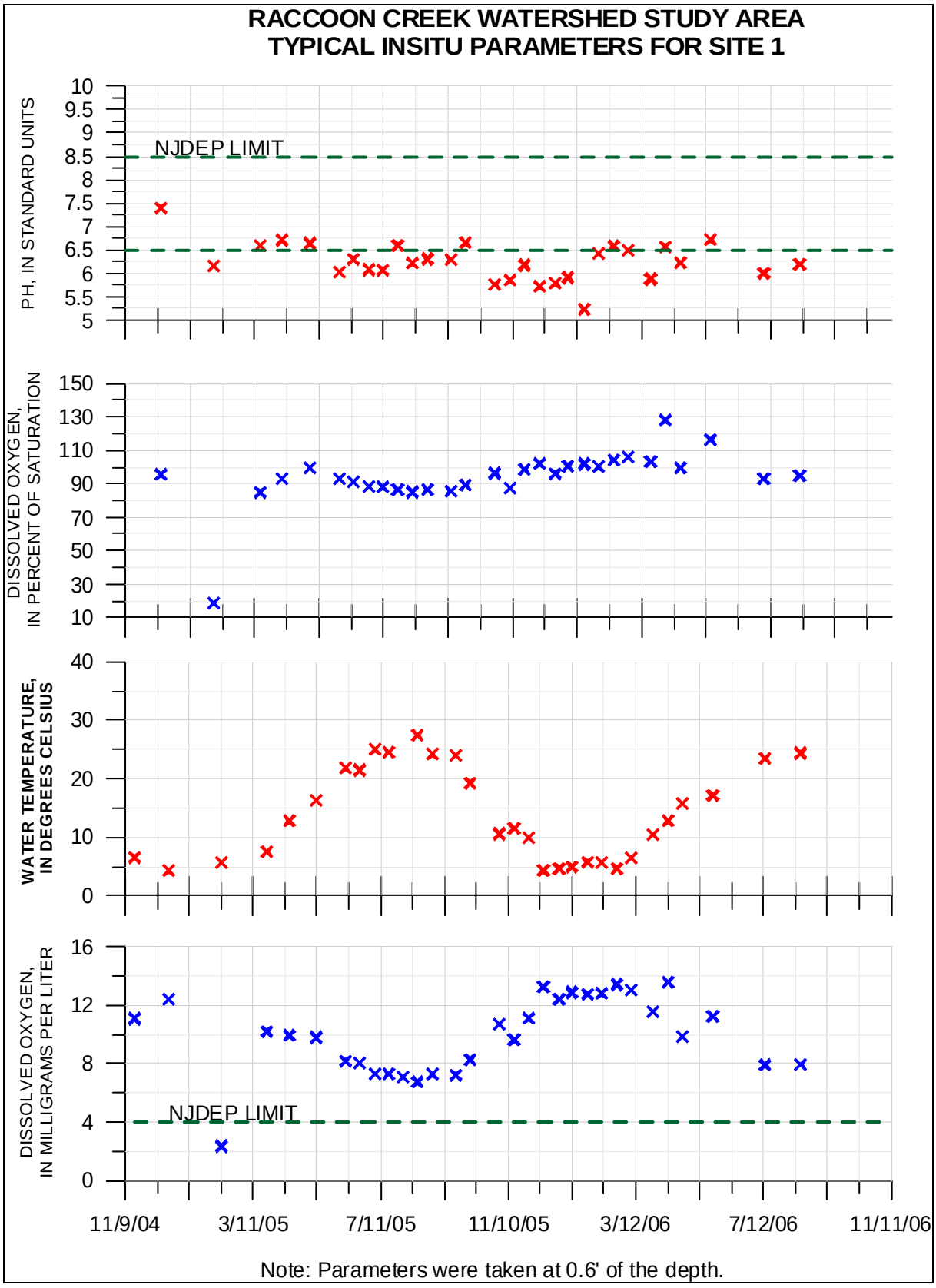


Figure 5: INSITU Parameters for Site 1

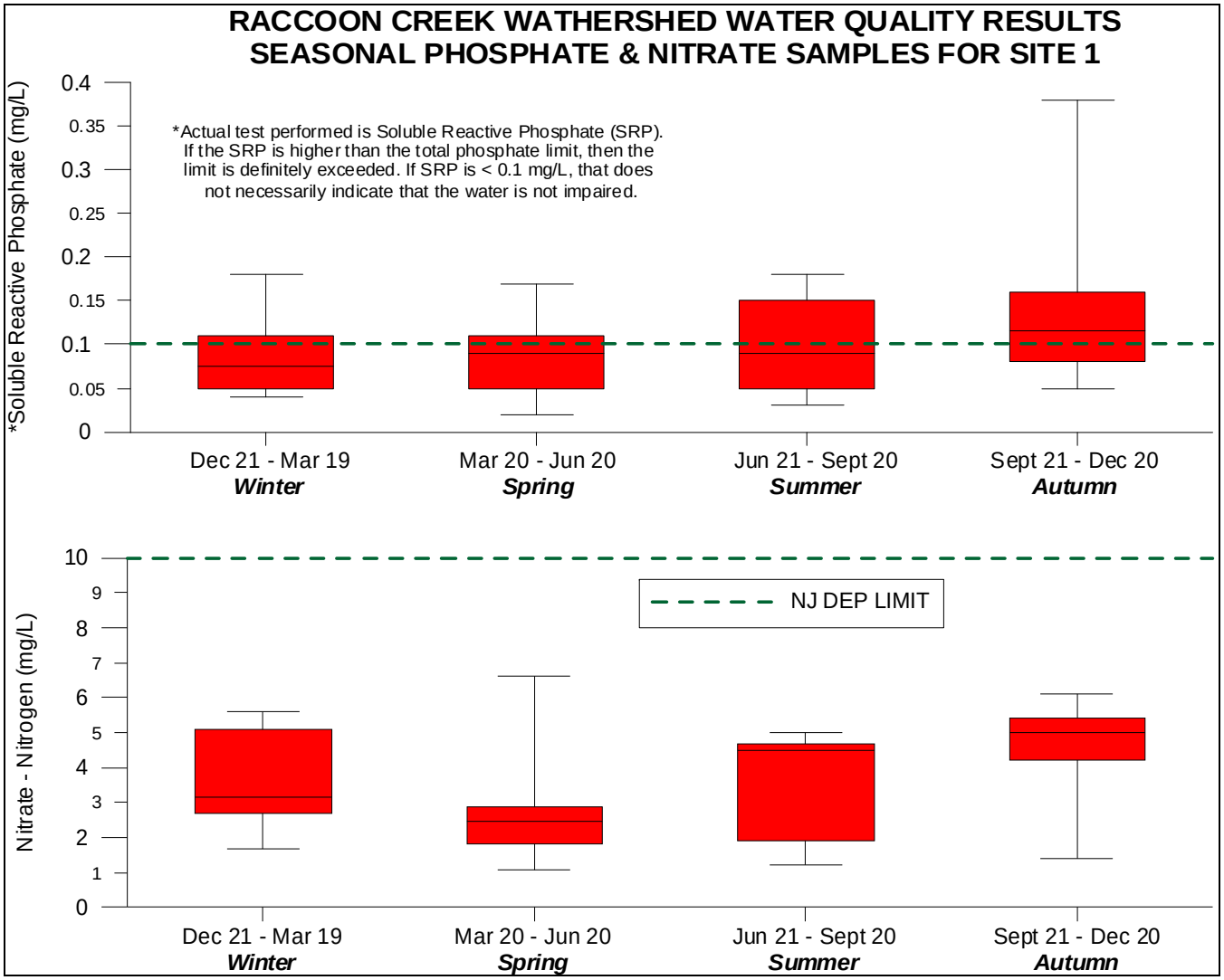


Figure 6: Seasonal Phosphate & Nitrate Results for Site 1

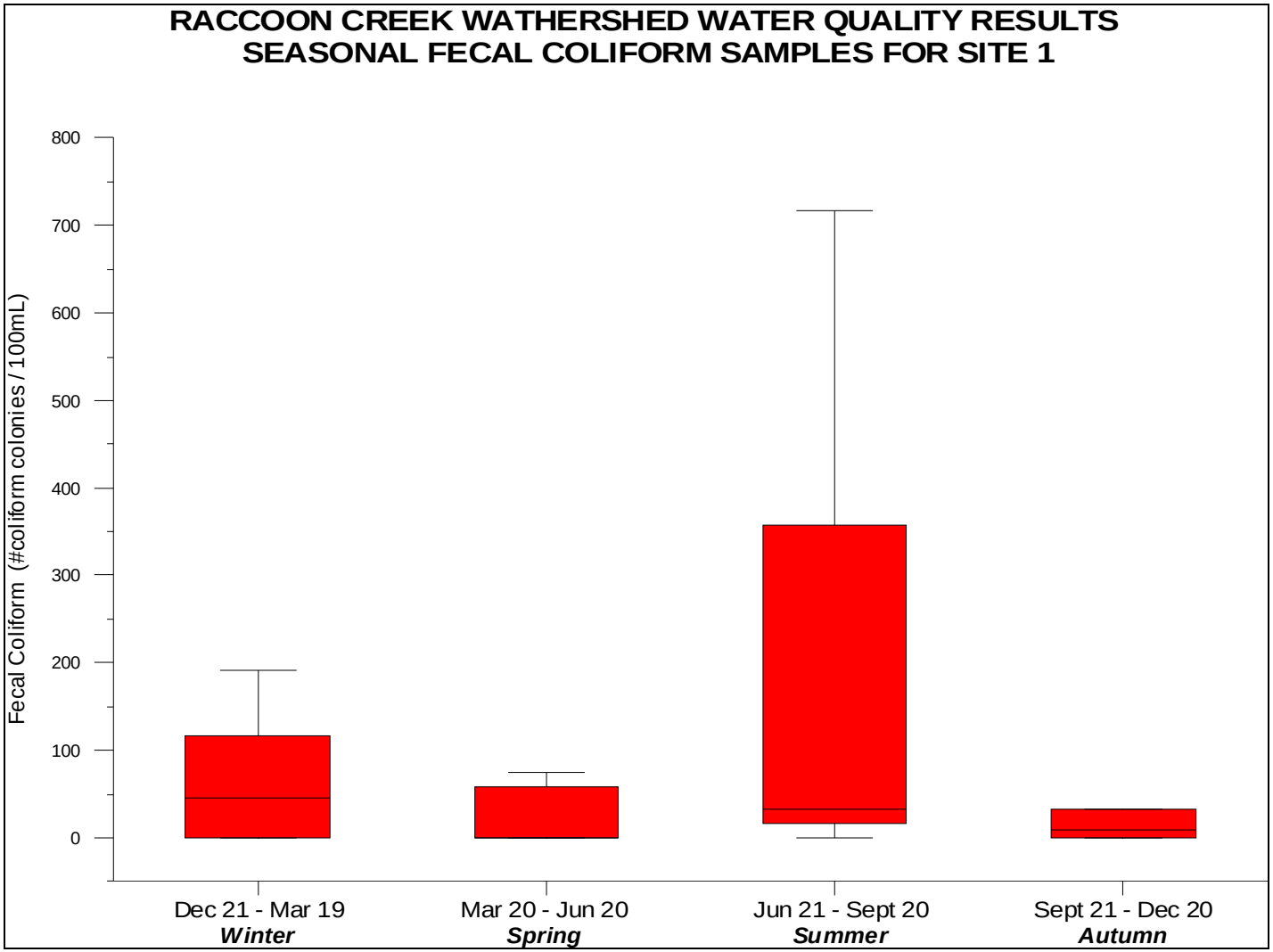


Figure 7: Seasonal Fecal Coliform Results for Site 1

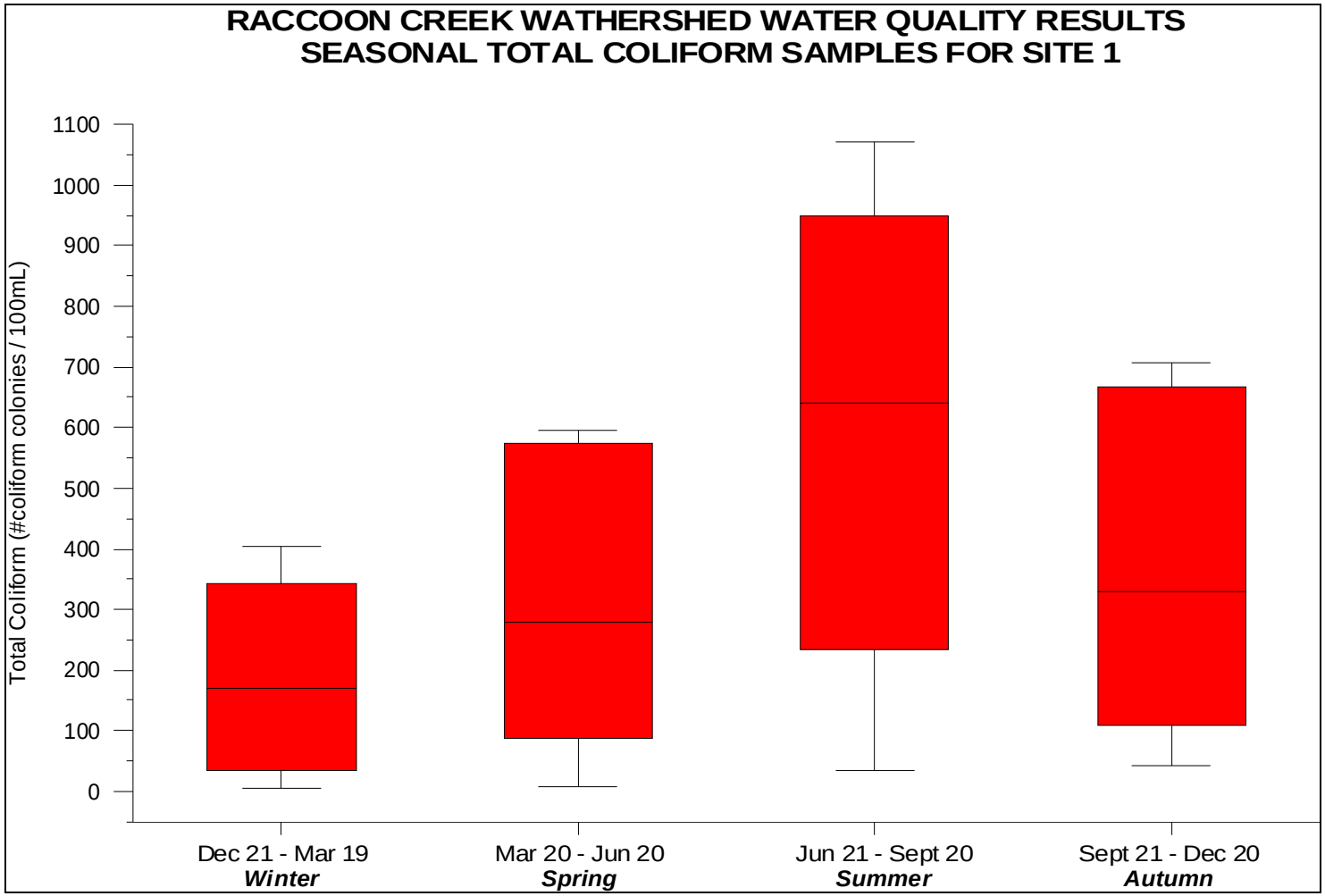


Figure 8: Seasonal Total Coliform Results for Site 1

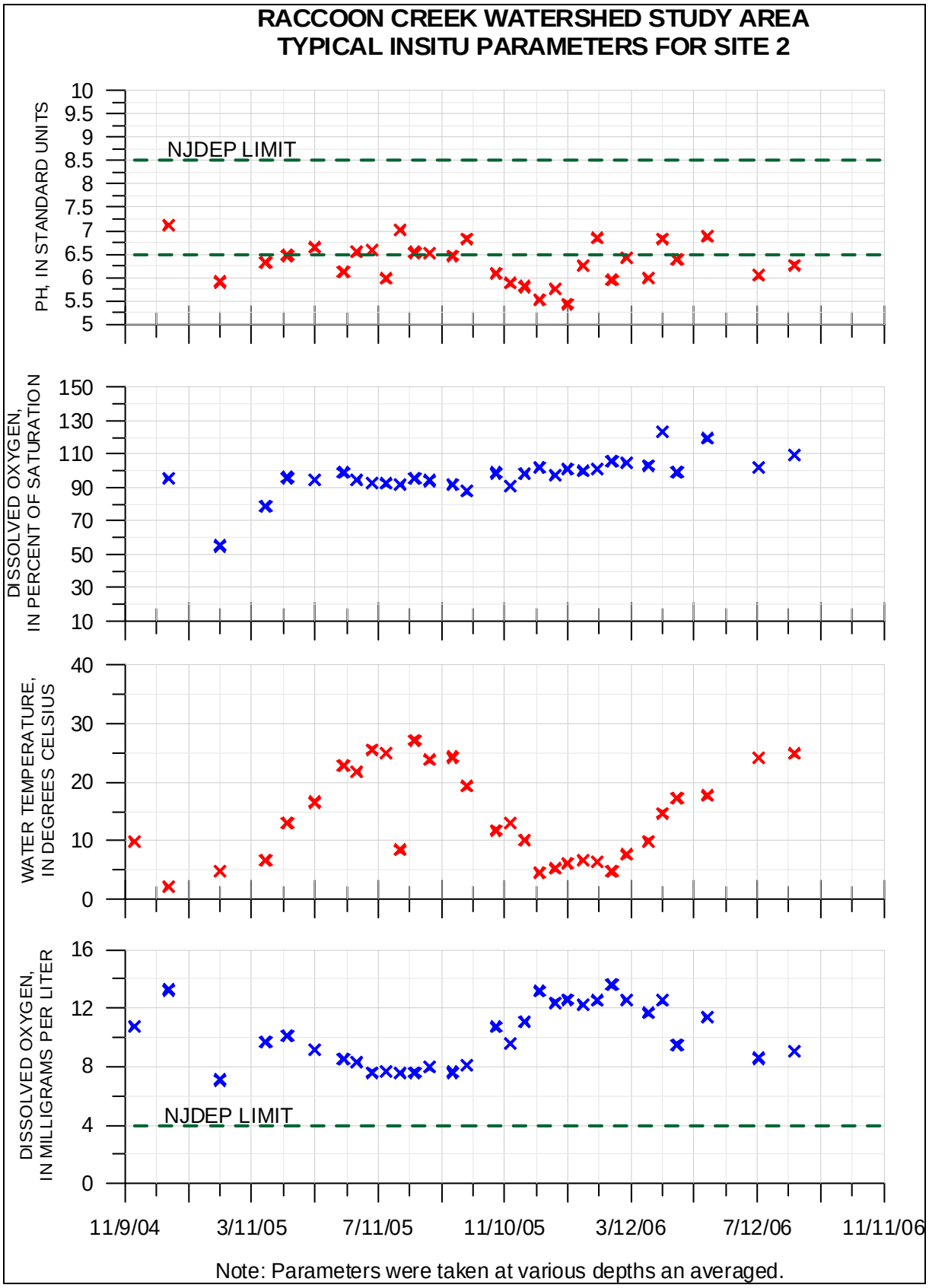


Figure 9: INSITU Parameters for Site 2

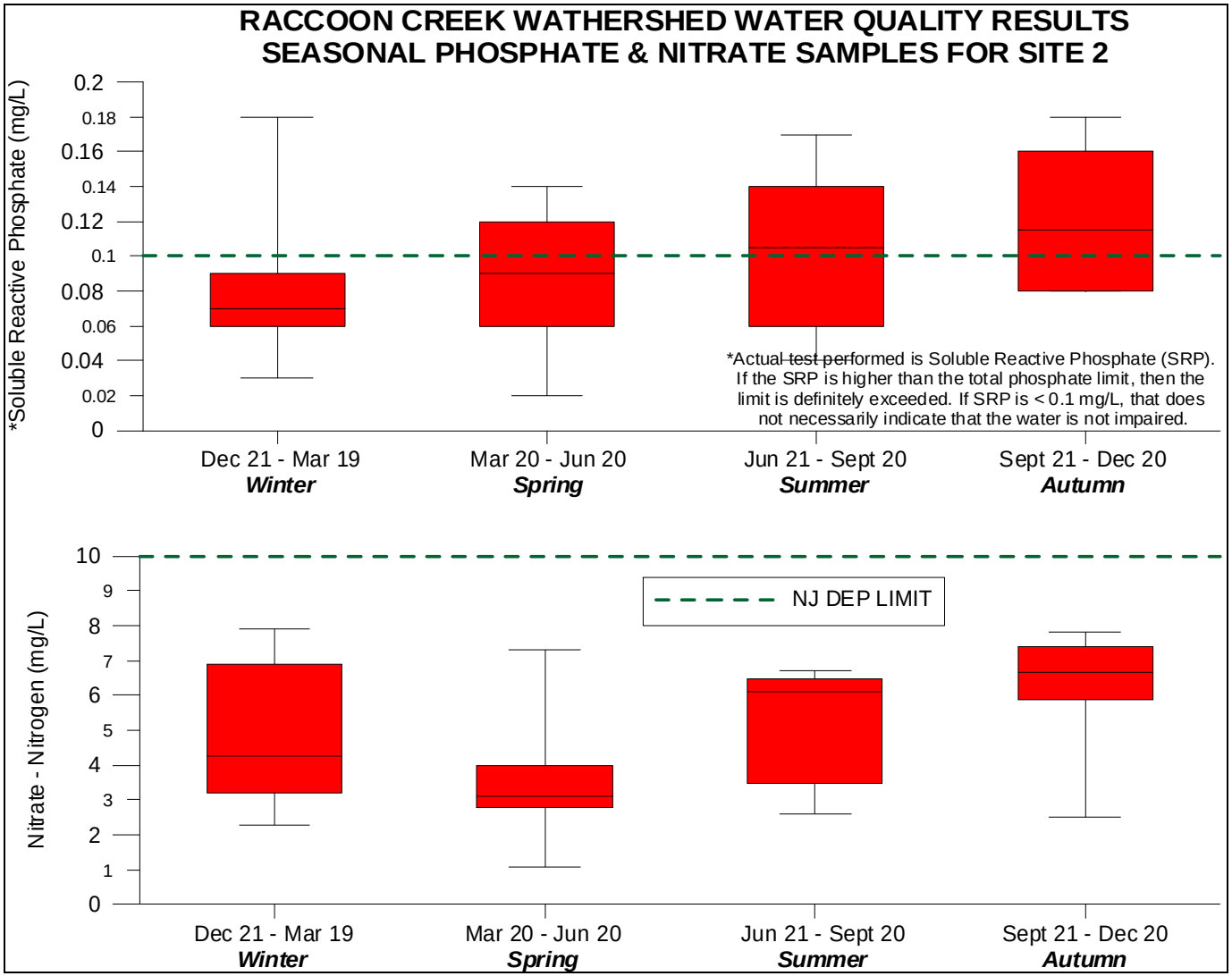


Figure 10: Seasonal Phosphate & Nitrate Results for Site 2

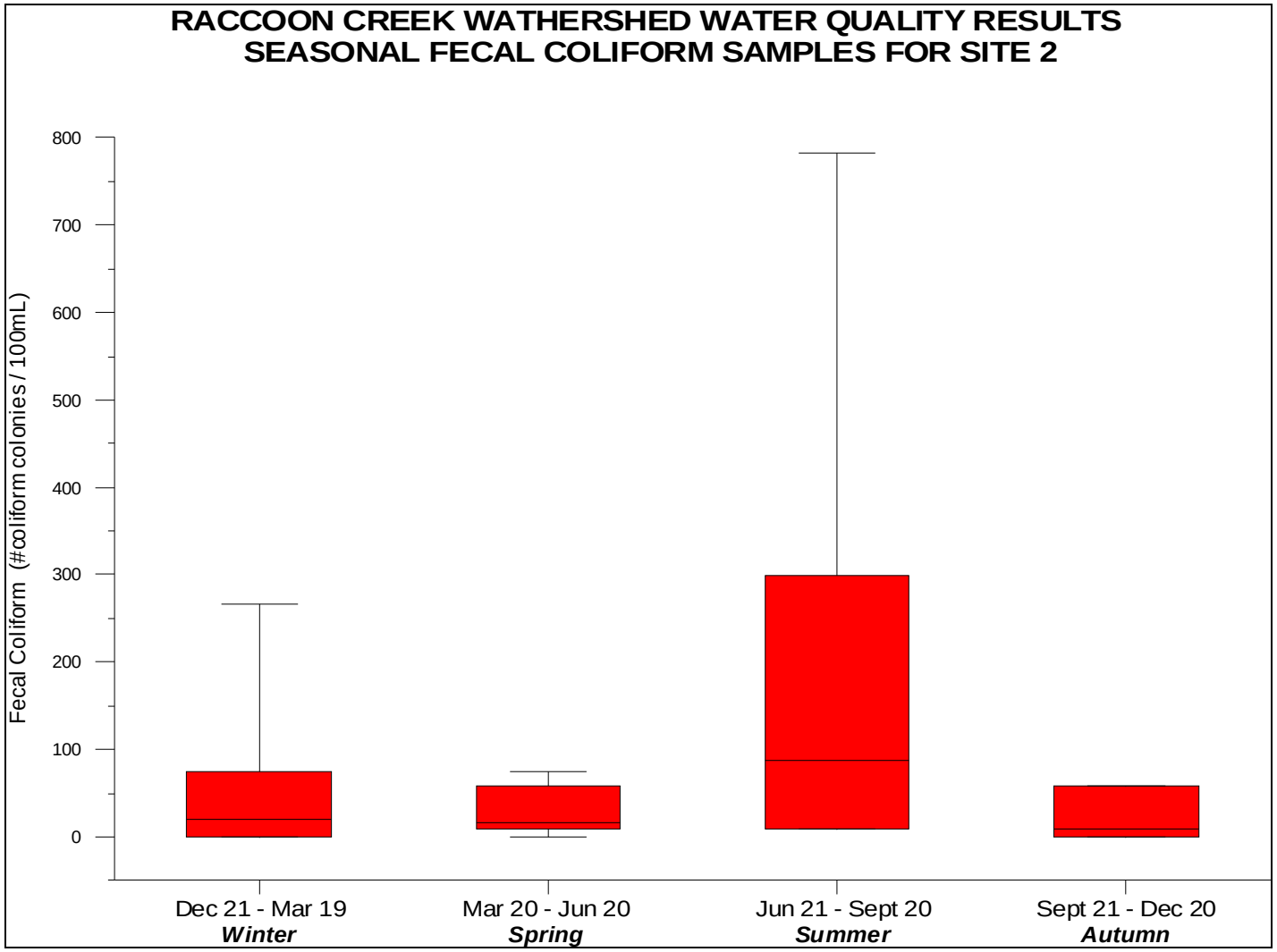


Figure 11: Seasonal Fecal Coliform Results for Site 2

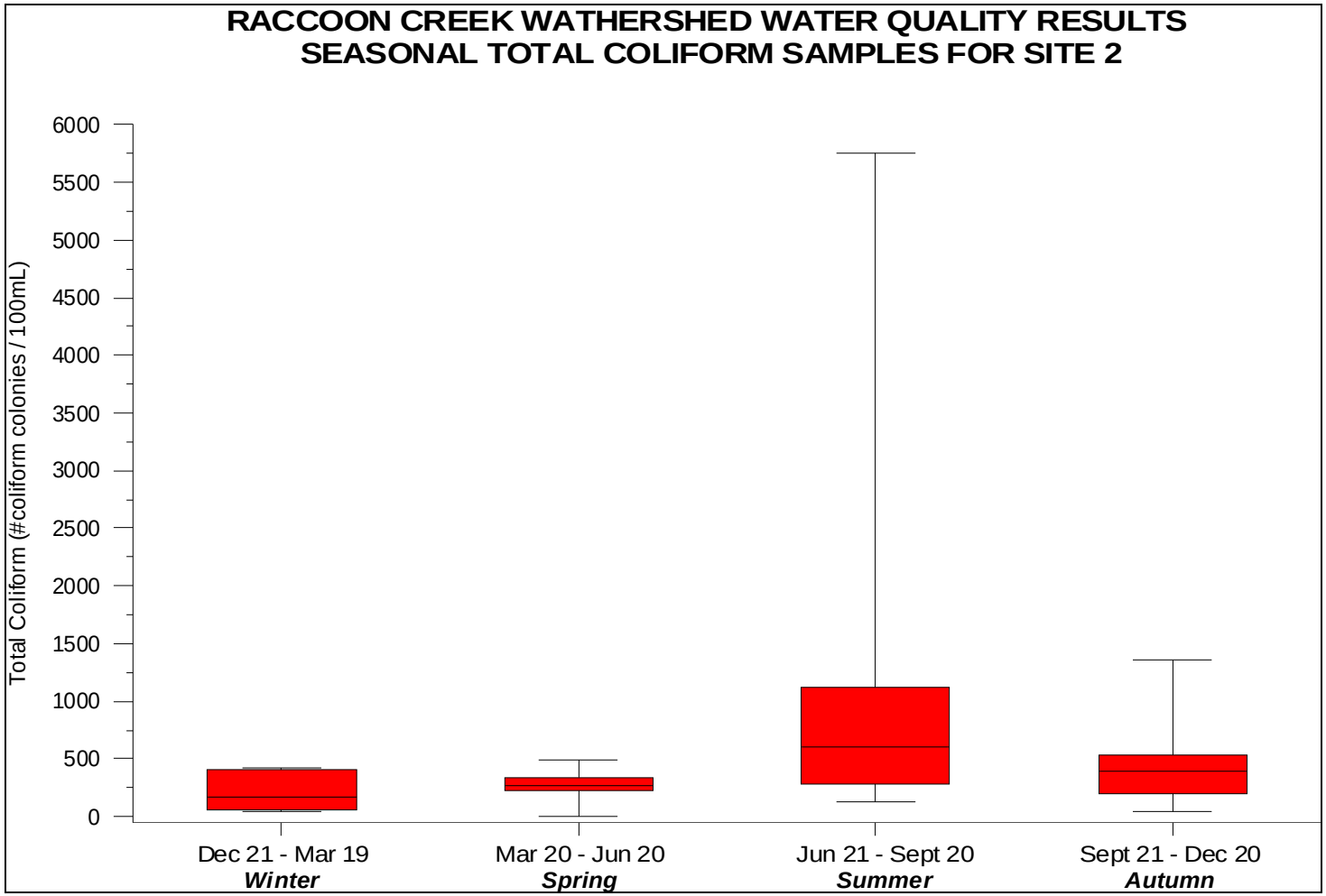


Figure 12: Seasonal Total Coliform Results for Site 2

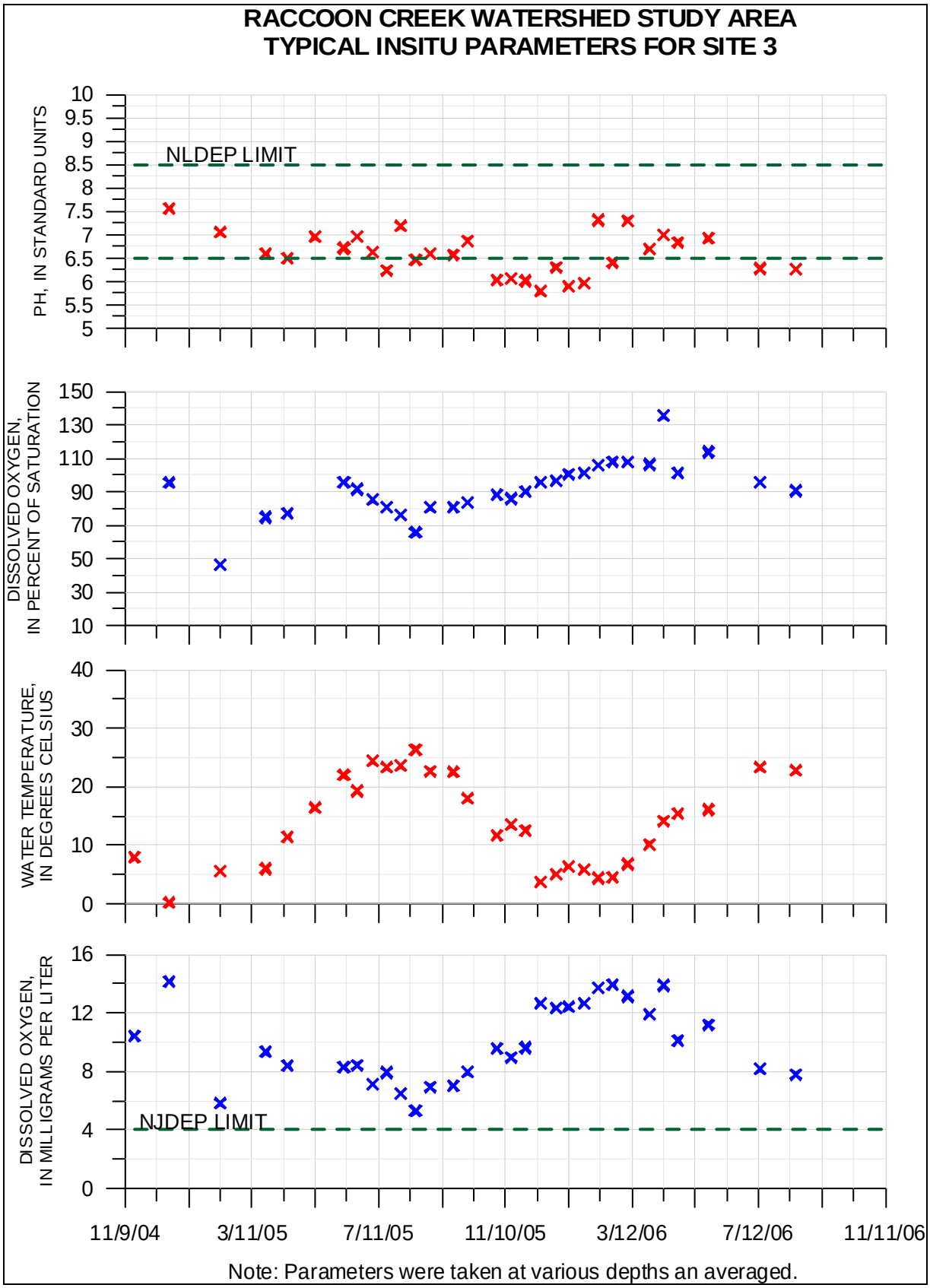


Figure 13: INSITU Parameters for Site 3

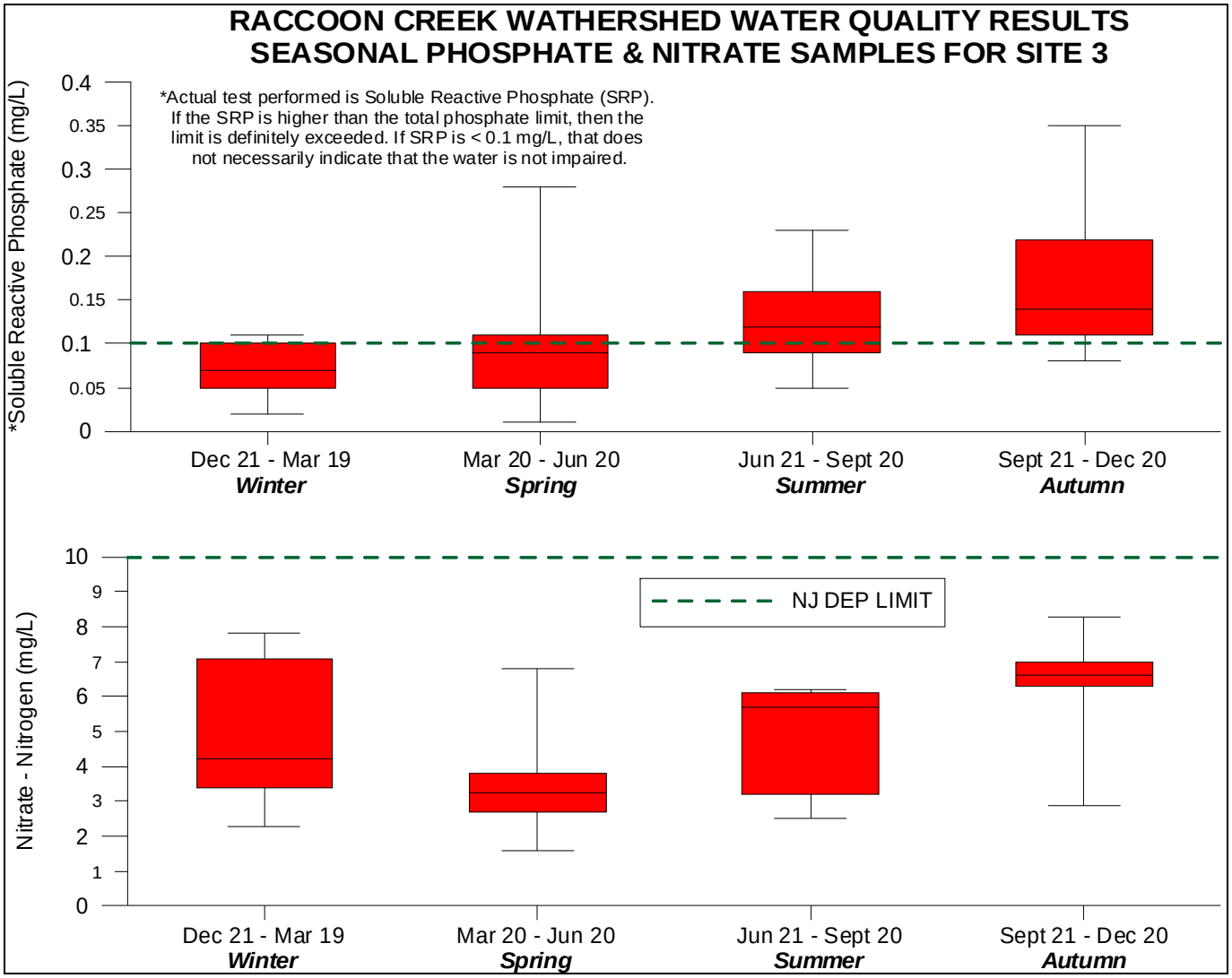


Figure 14: Seasonal Phosphate & Nitrate Results for Site 3

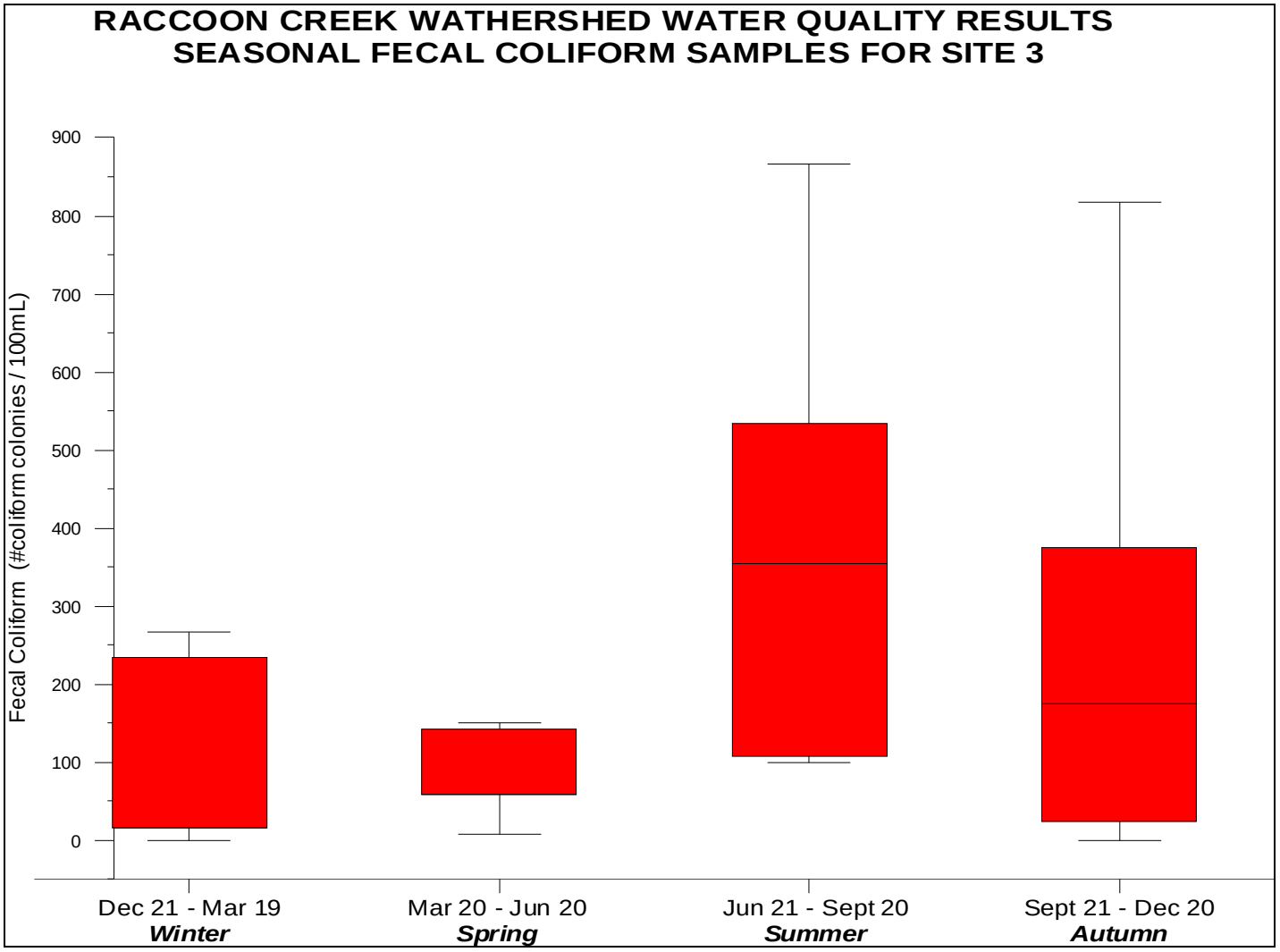


Figure 15: Seasonal Fecal Coliform Results for Site 3

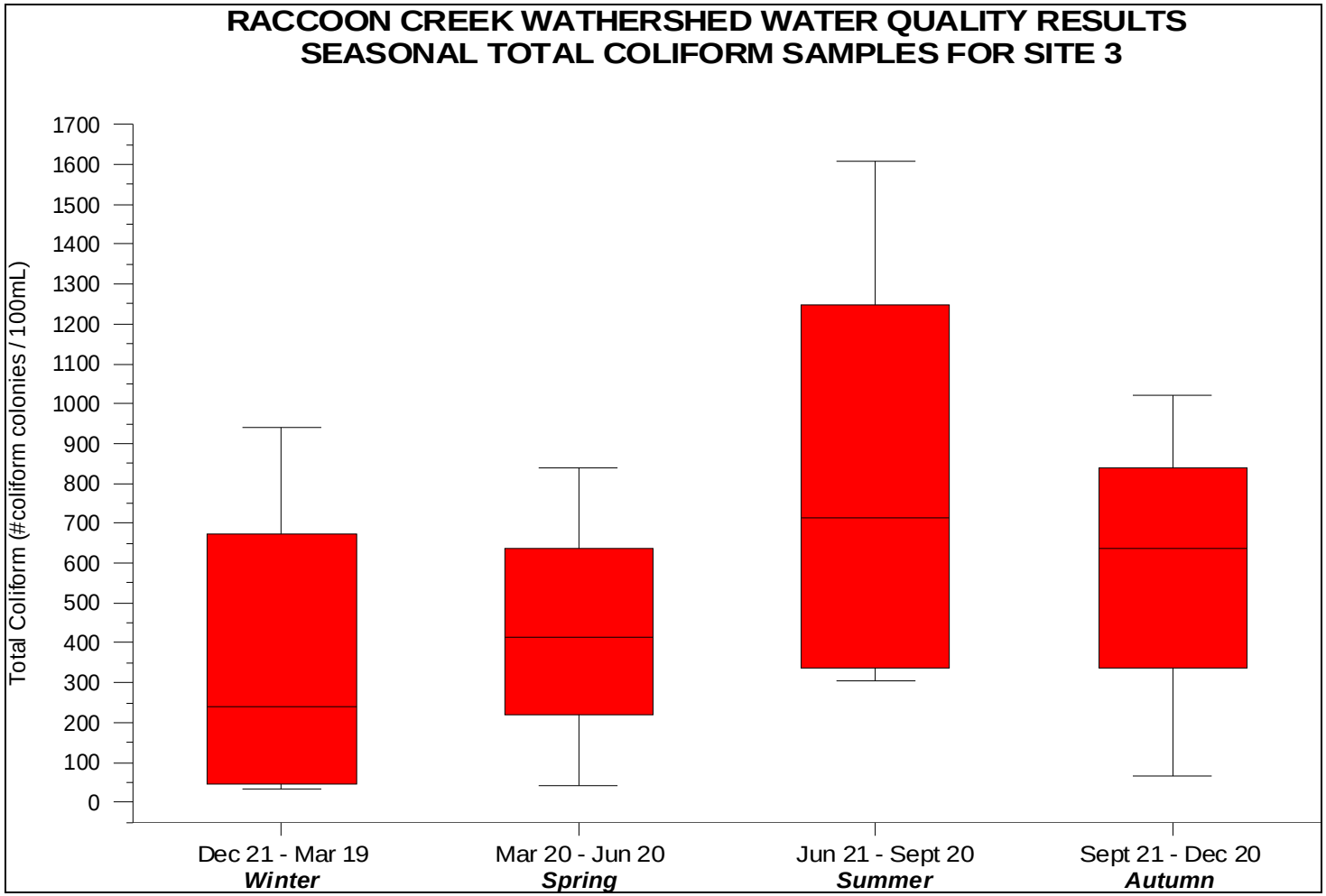


Figure 16: Seasonal Total Coliform Results for Site 3

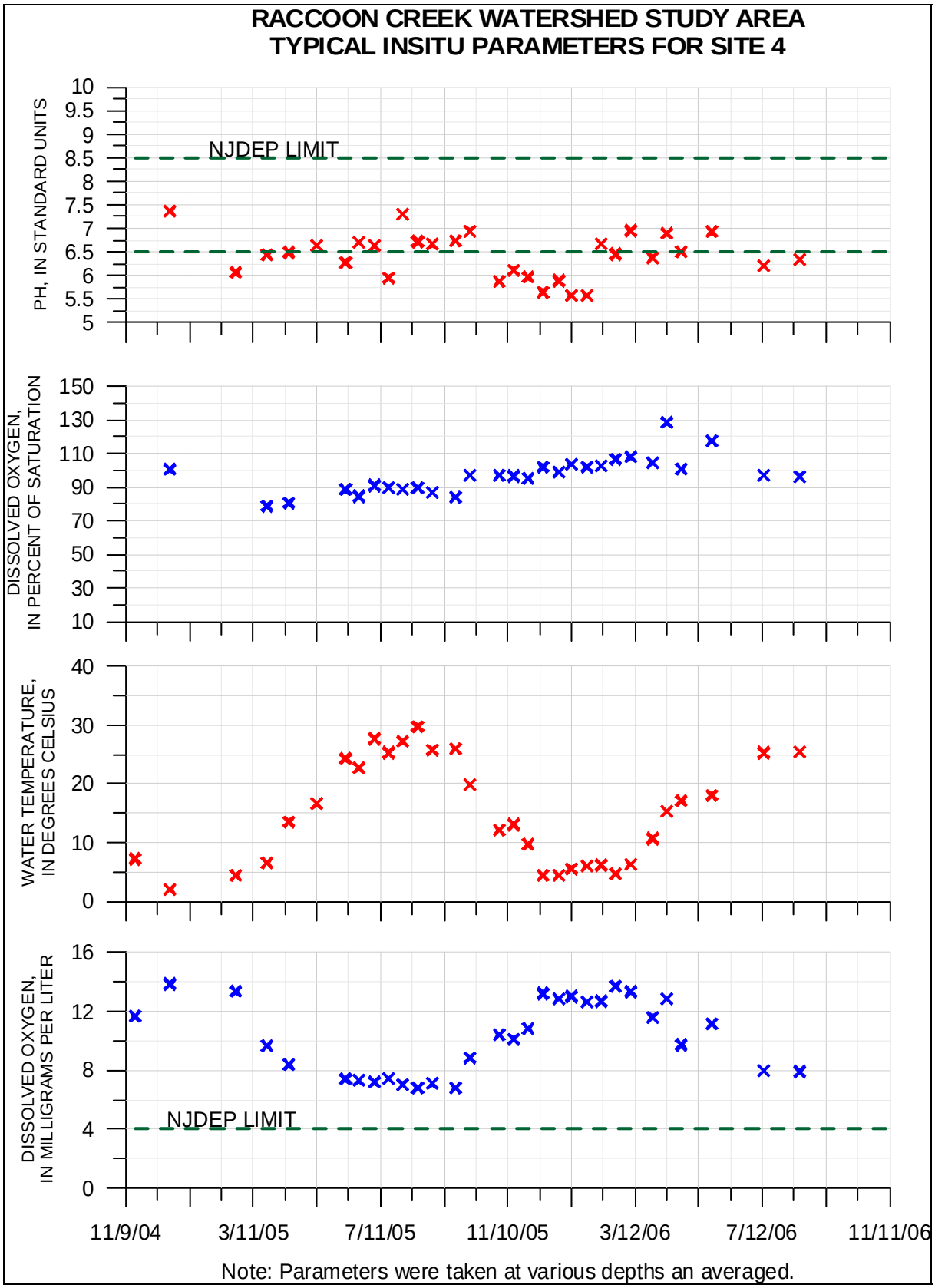


Figure 17: INSITU Parameters for Site 4

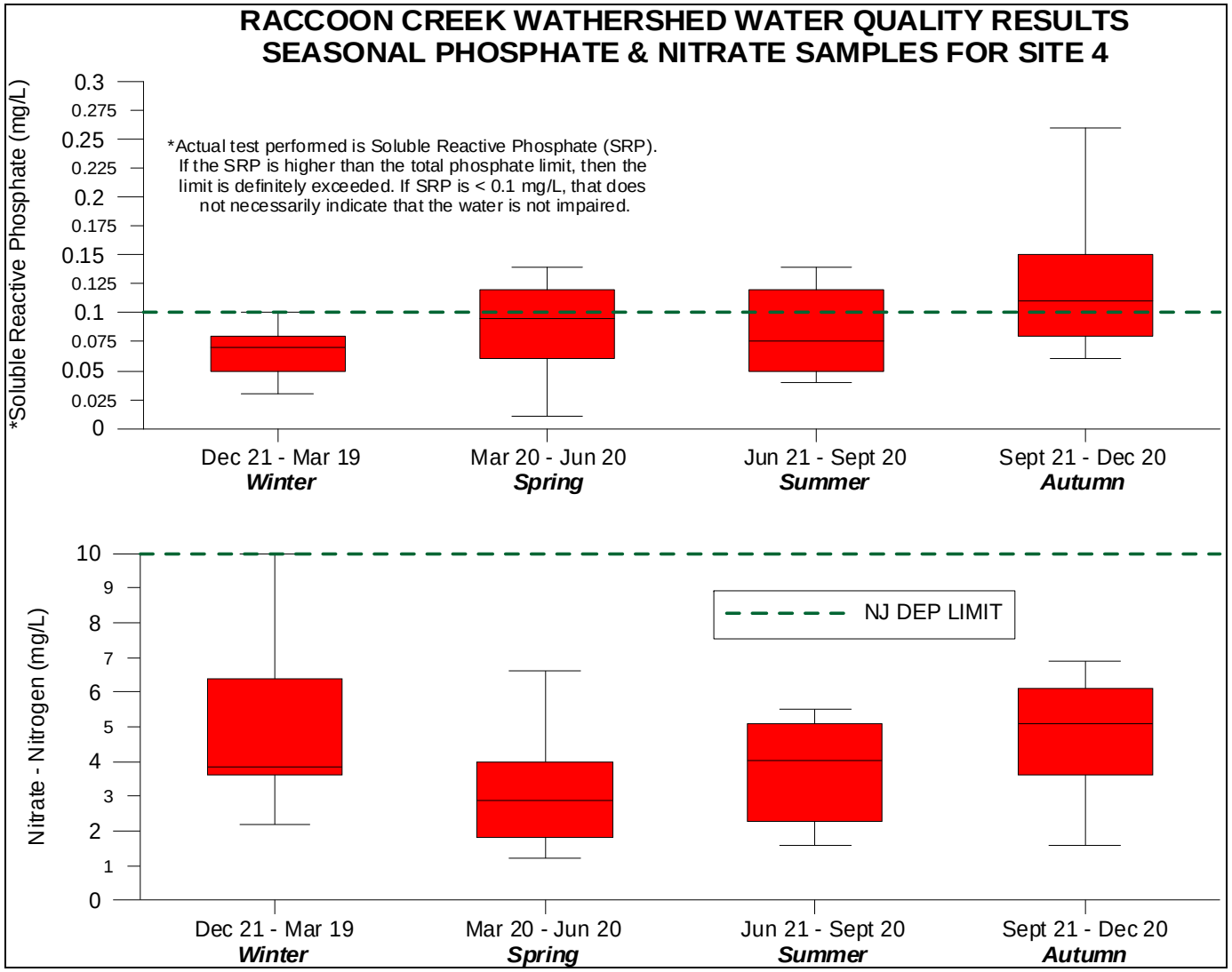


Figure 18: Seasonal Phosphate & Nitrate Results for Site 4

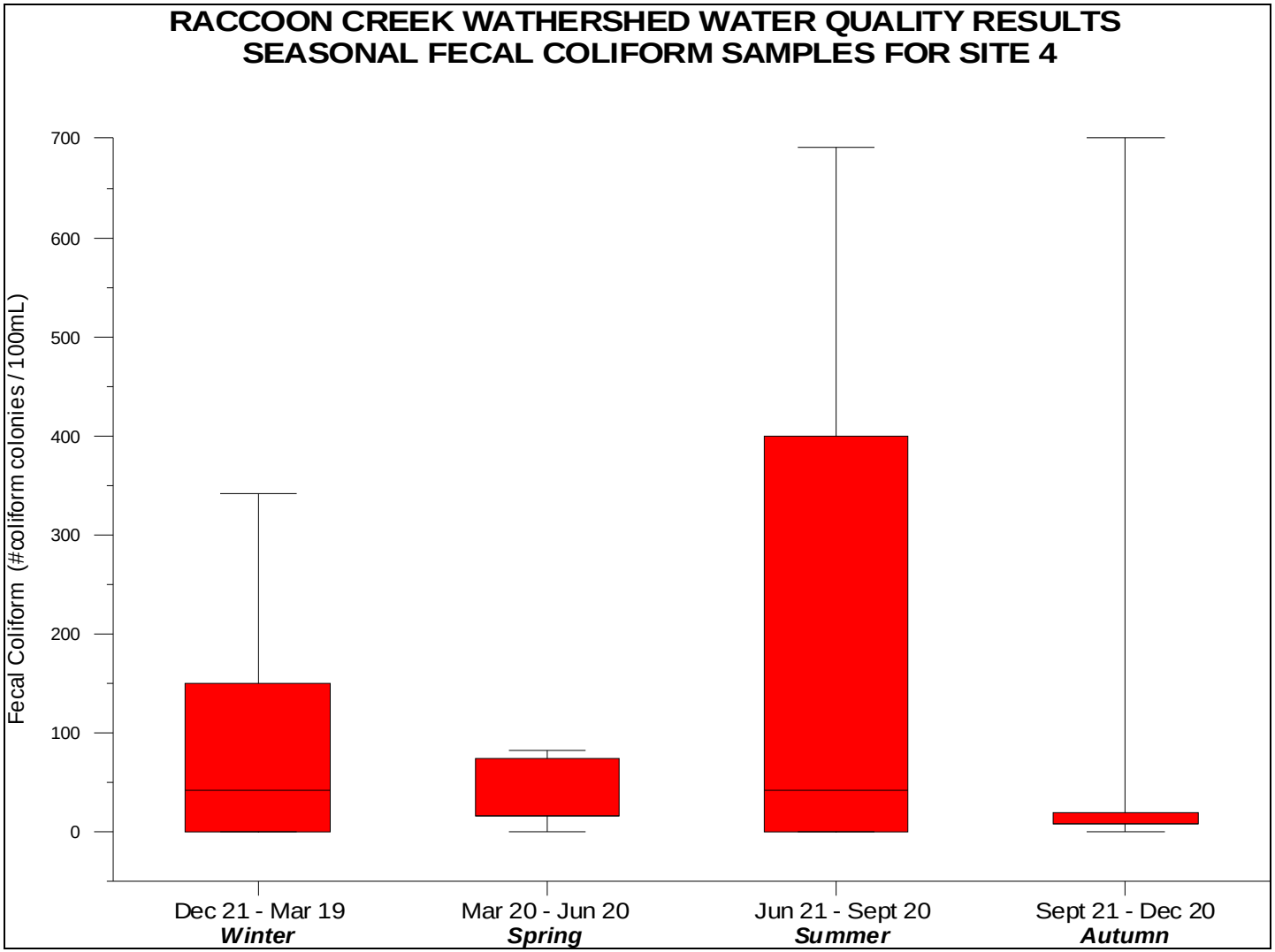


Figure 19: Seasonal Fecal Coliform Results for Site 4

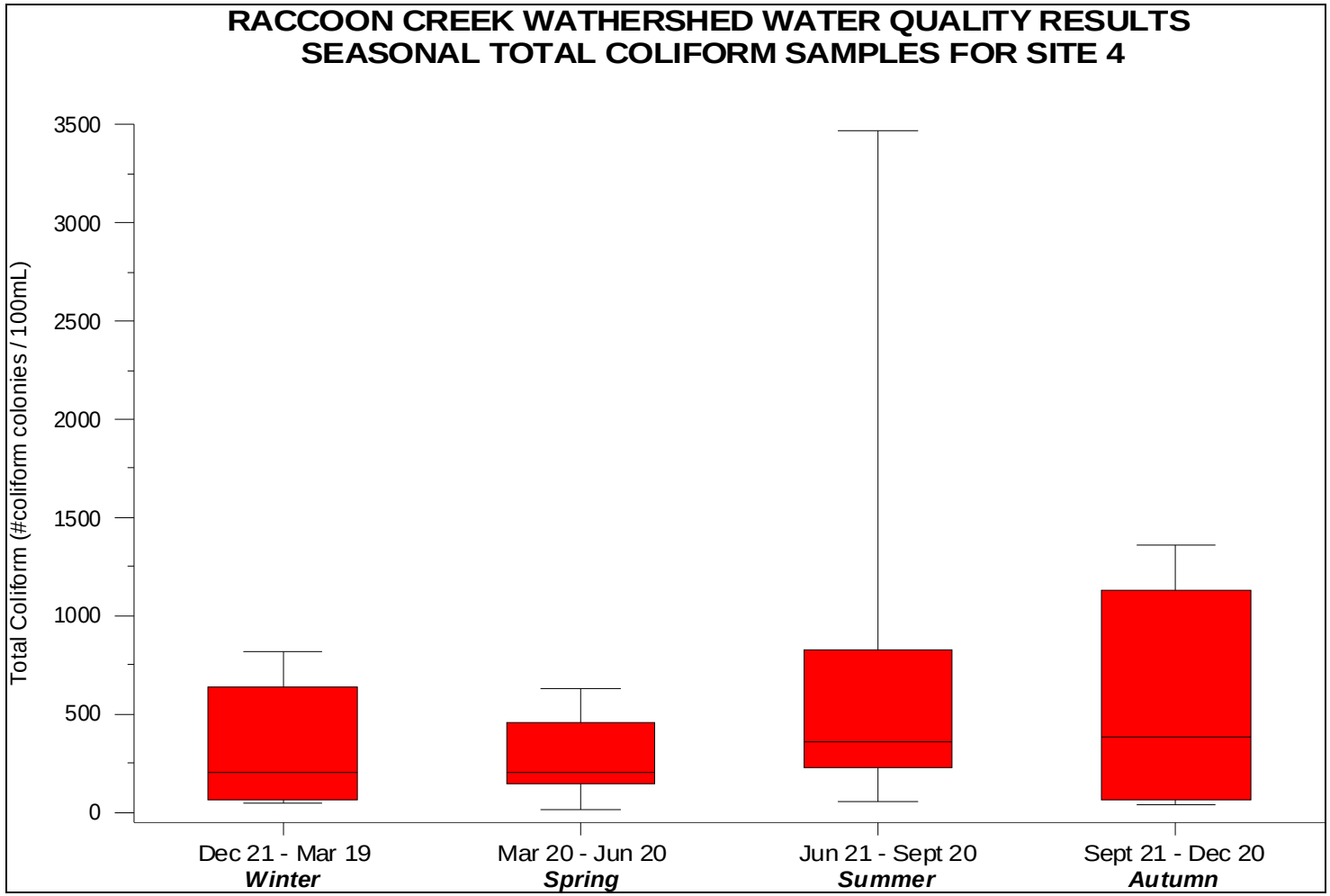


Figure 20: Seasonal Total Coliform Results for Site 4

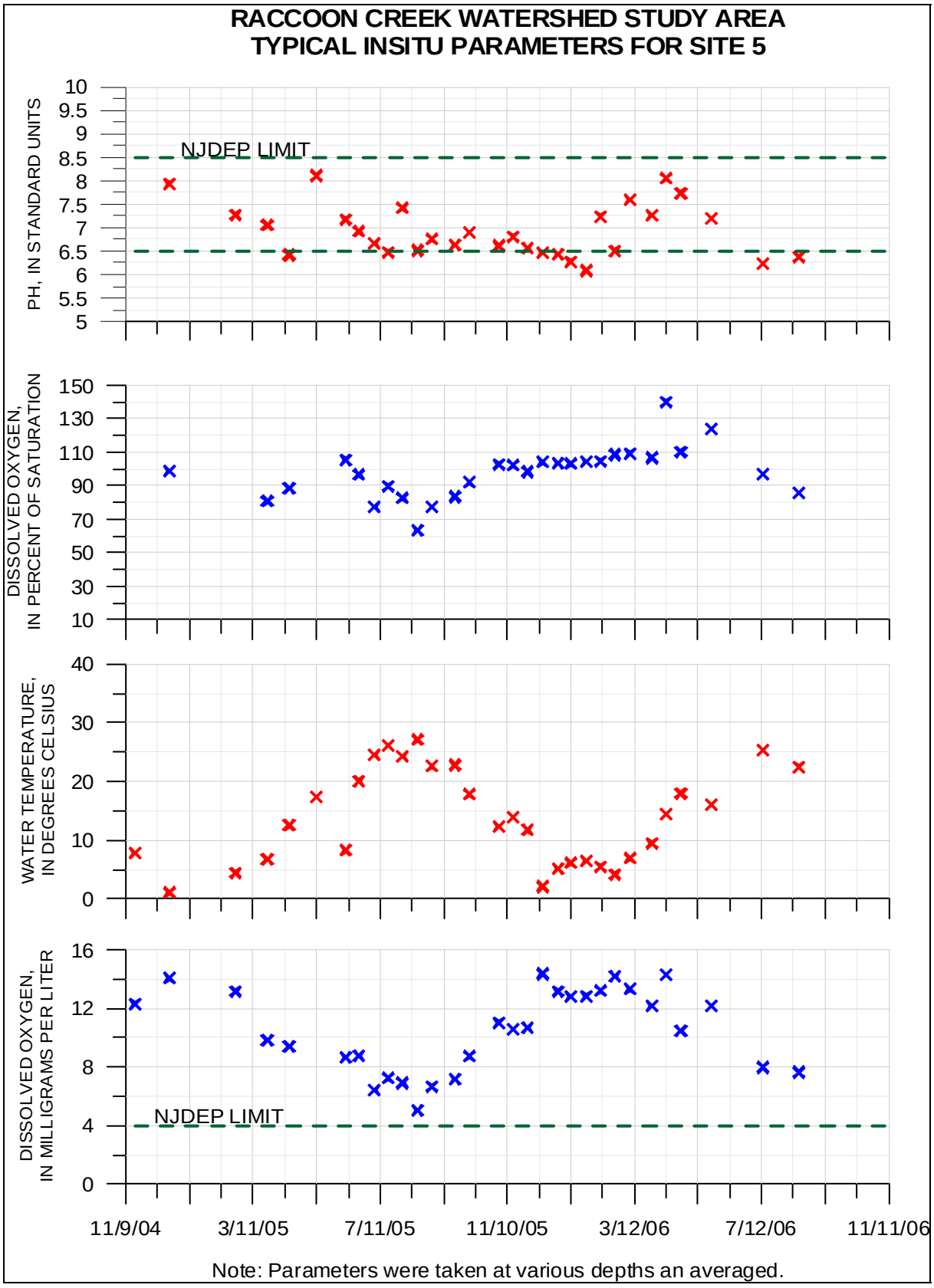


Figure 21: INSITU Parameters for Site 5

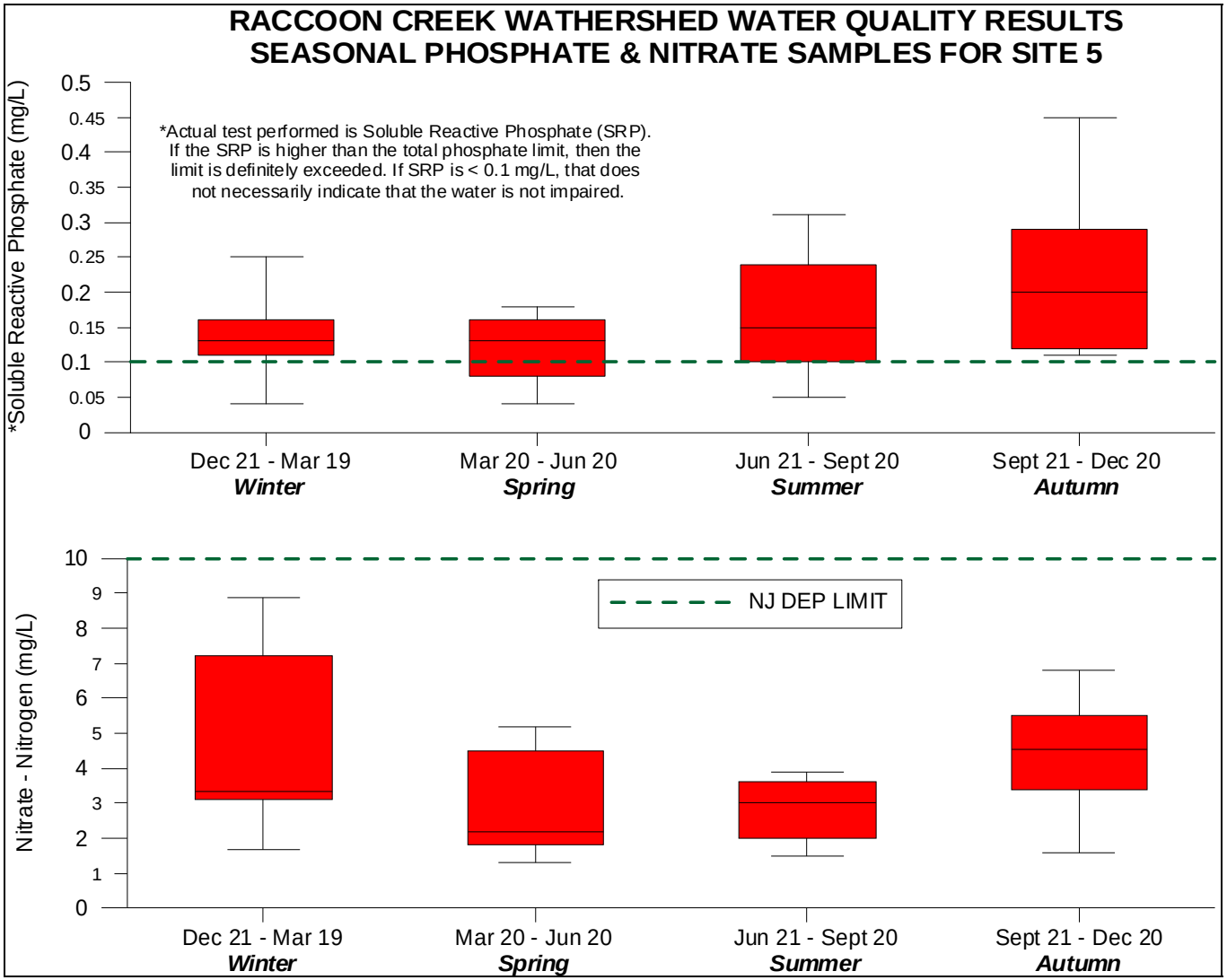


Figure 22: Seasonal Phosphate & Nitrate Results for Site 5

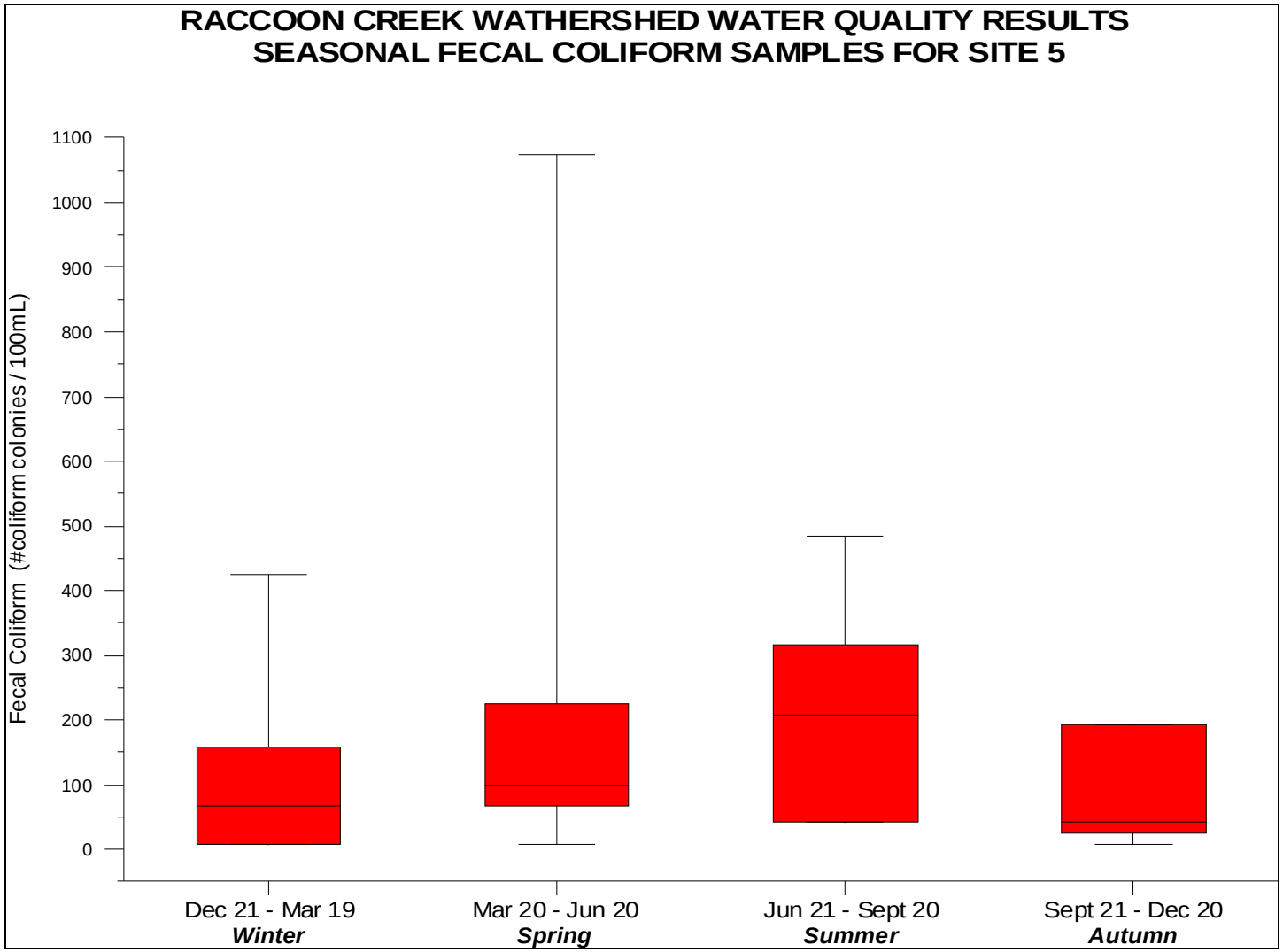


Figure 23: Seasonal Fecal Coliform Results for Site 5

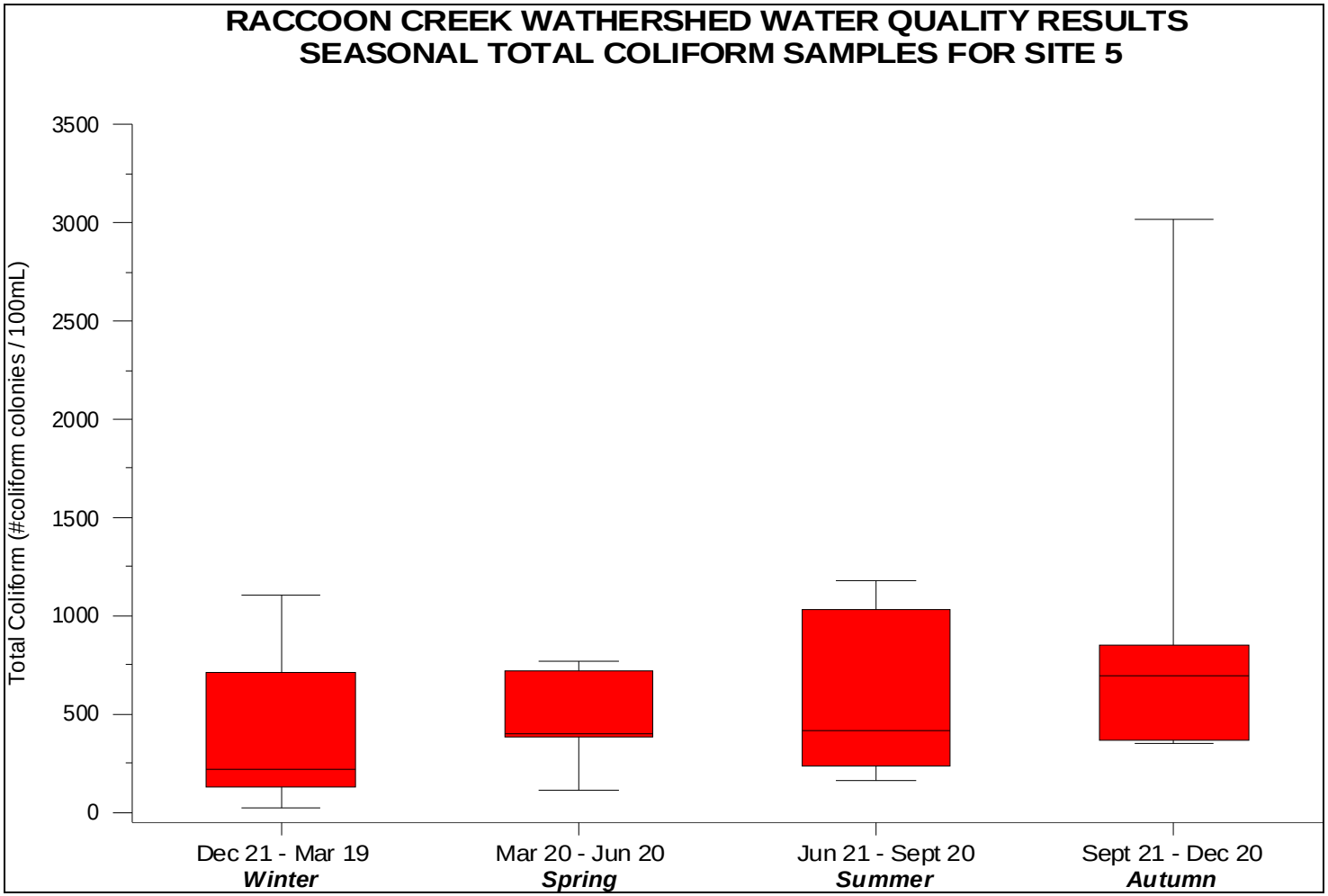


Figure 24: Seasonal Total Coliform Results for Site 5

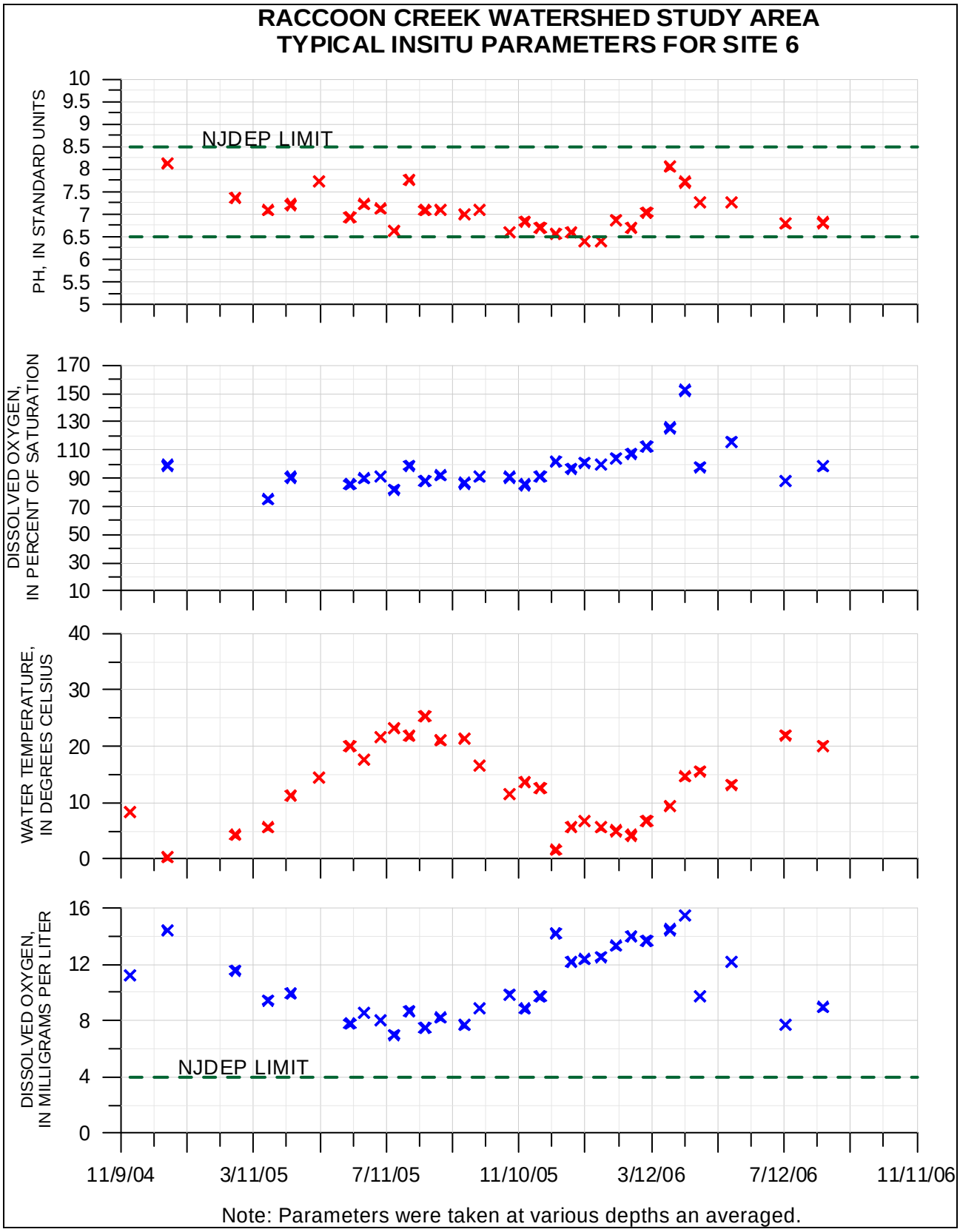


Figure 25: INSITU Parameters for Site 6

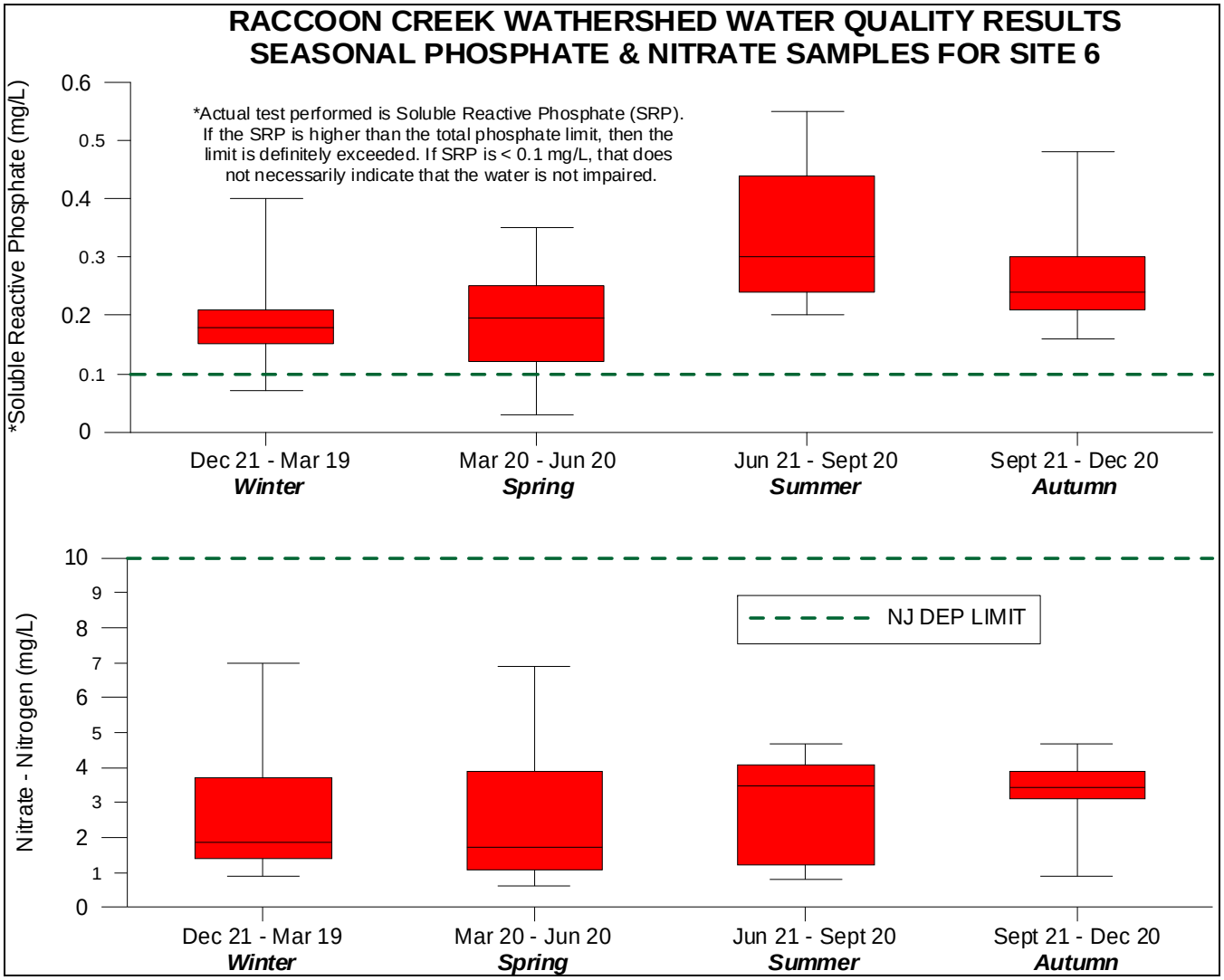


Figure 26: Seasonal Phosphate & Nitrate Results for Site 6

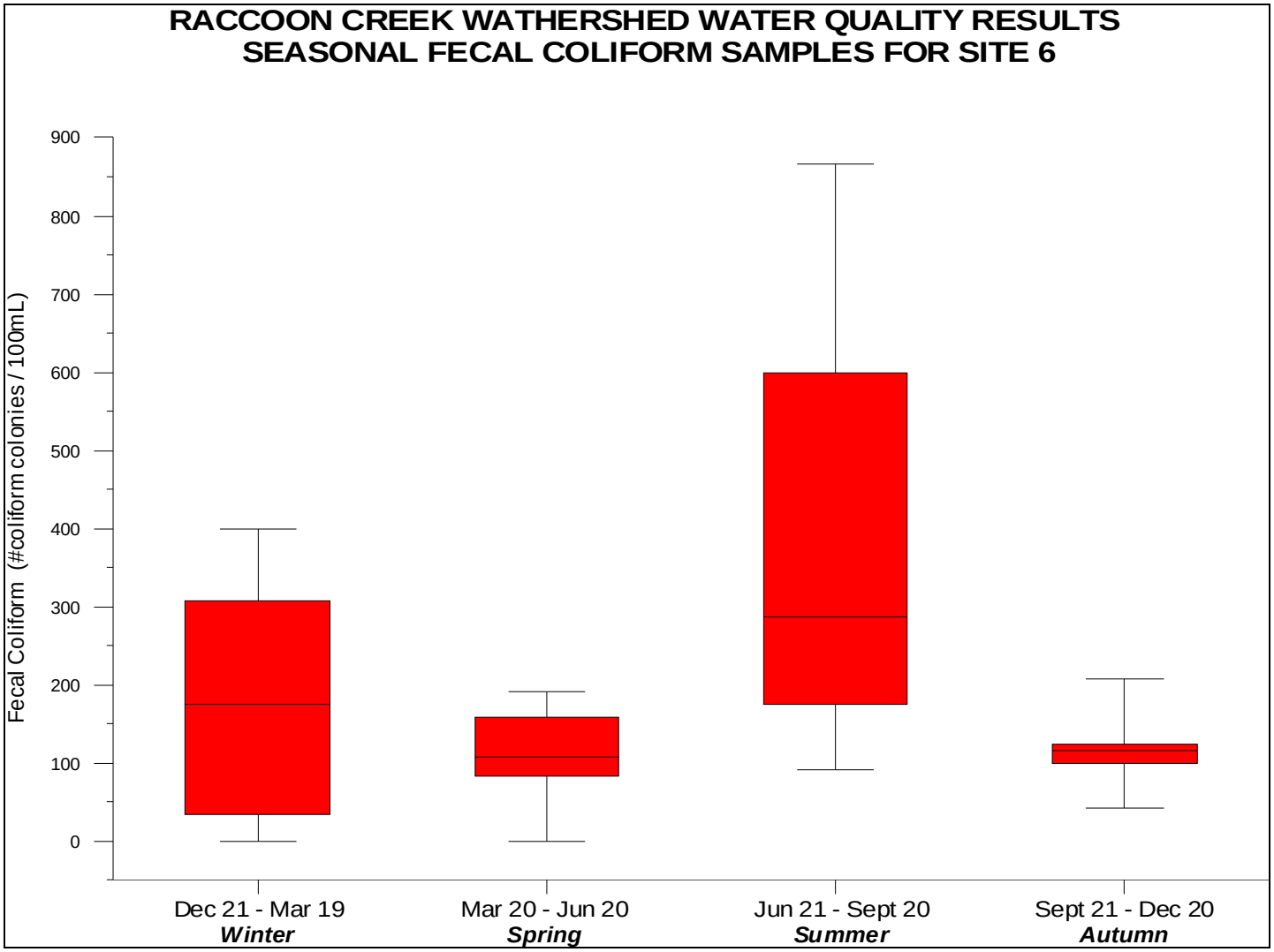


Figure 27: Seasonal Fecal Coliform Results for Site 6

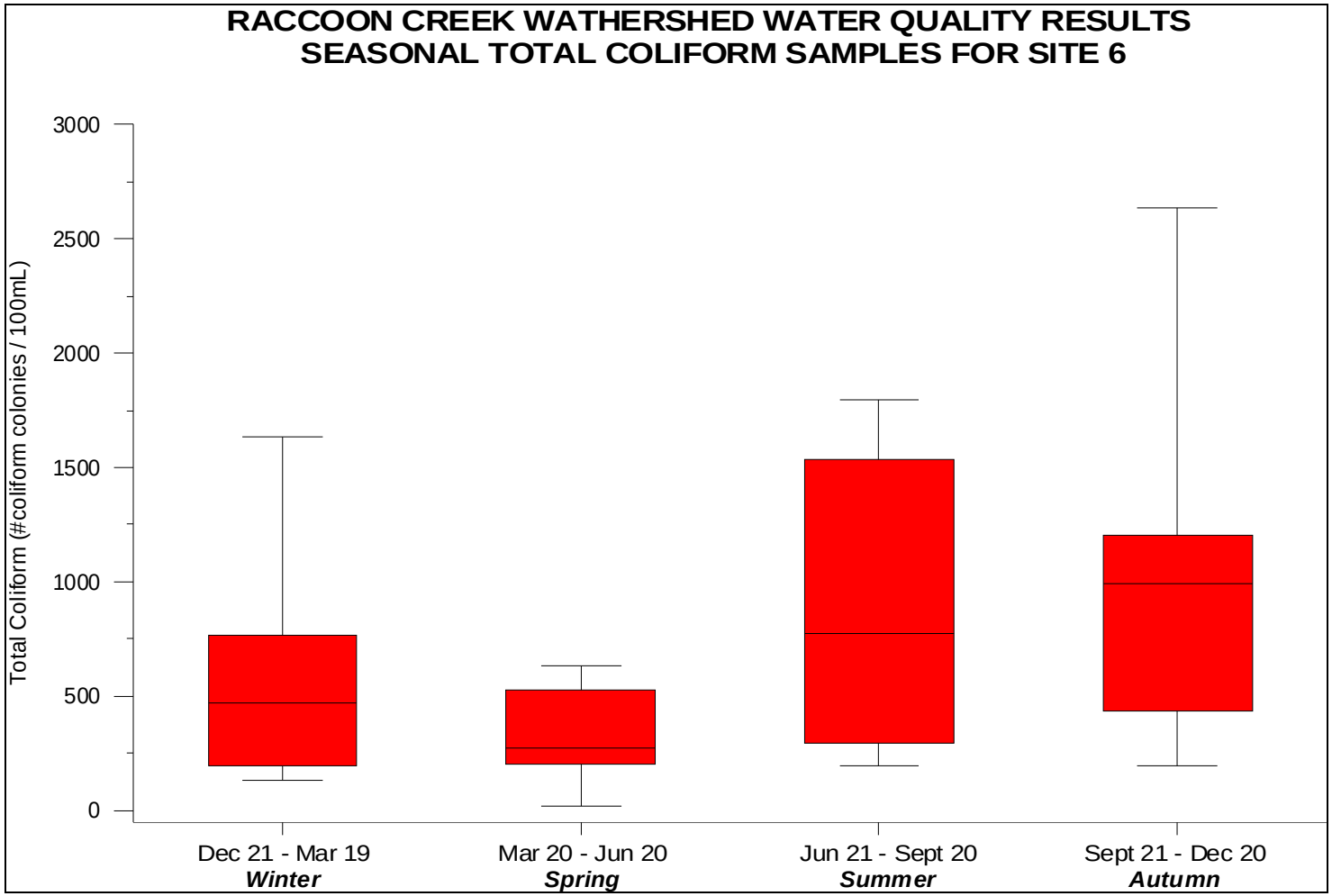


Figure 28: Seasonal Total Coliform Results for Site 6

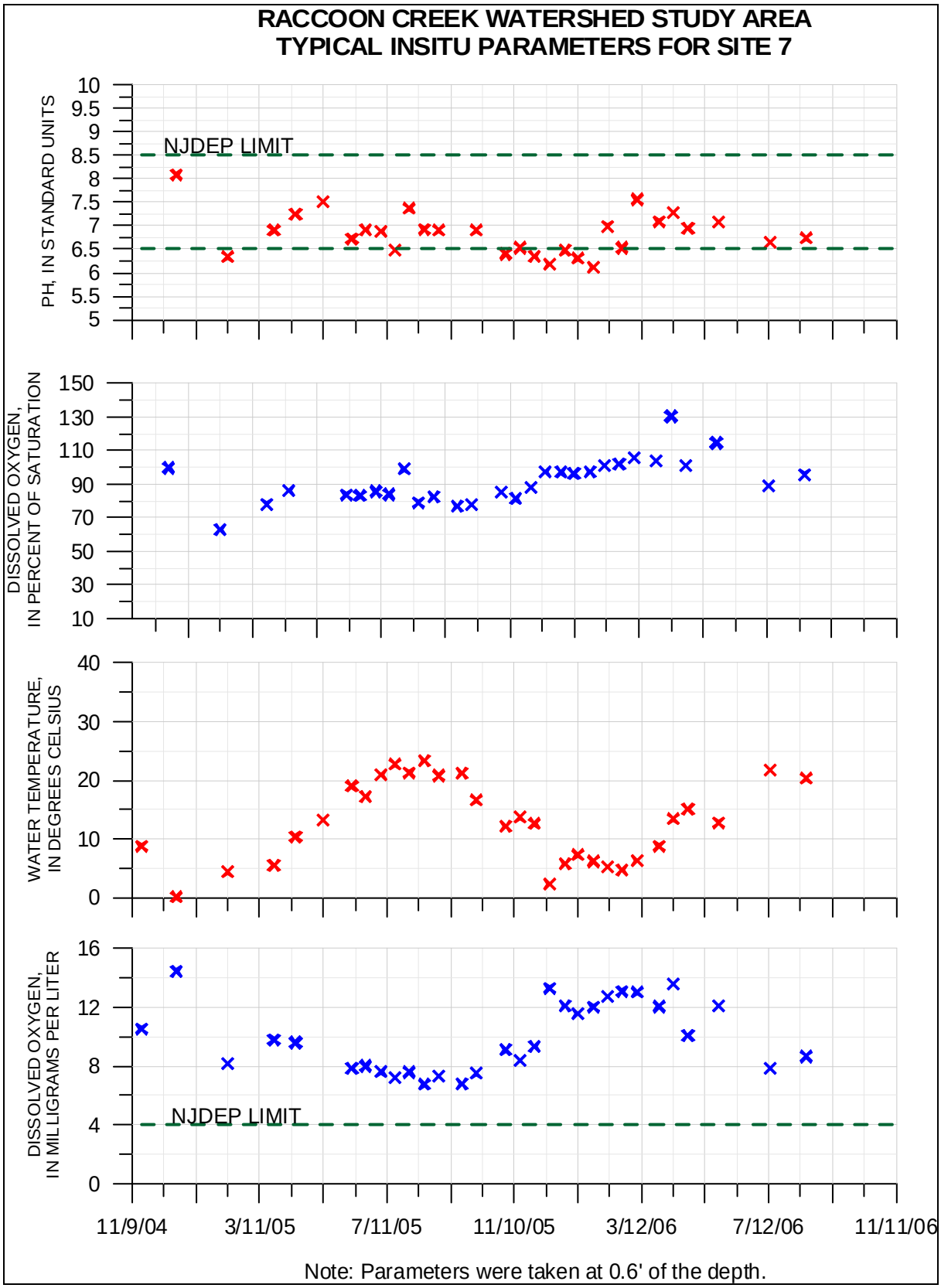


Figure 29: INSITU Parameters for Site 7

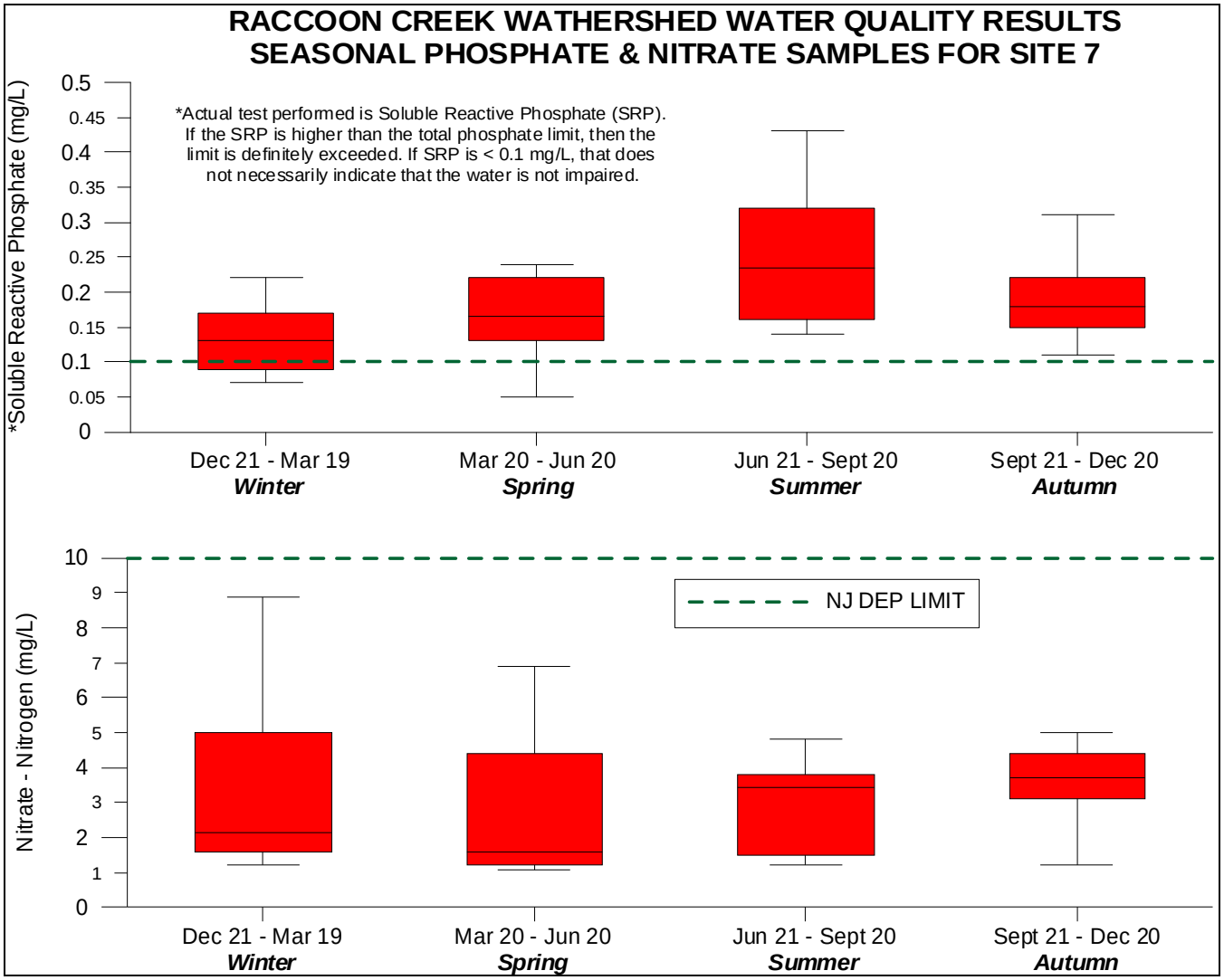


Figure 30: Seasonal Phosphate & Nitrate Results for Site 7

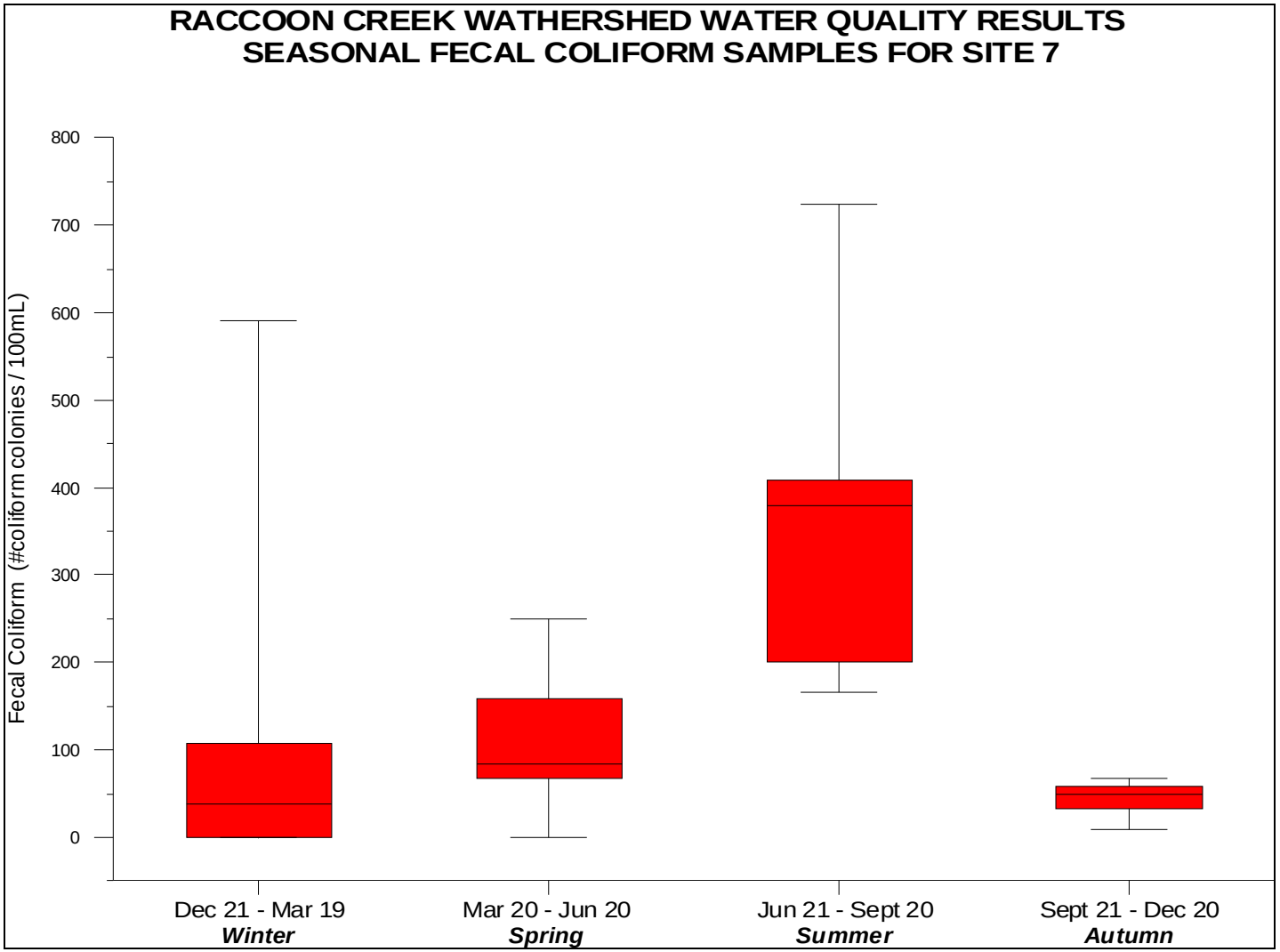


Figure 31: Seasonal Fecal Coliform Results for Site 7

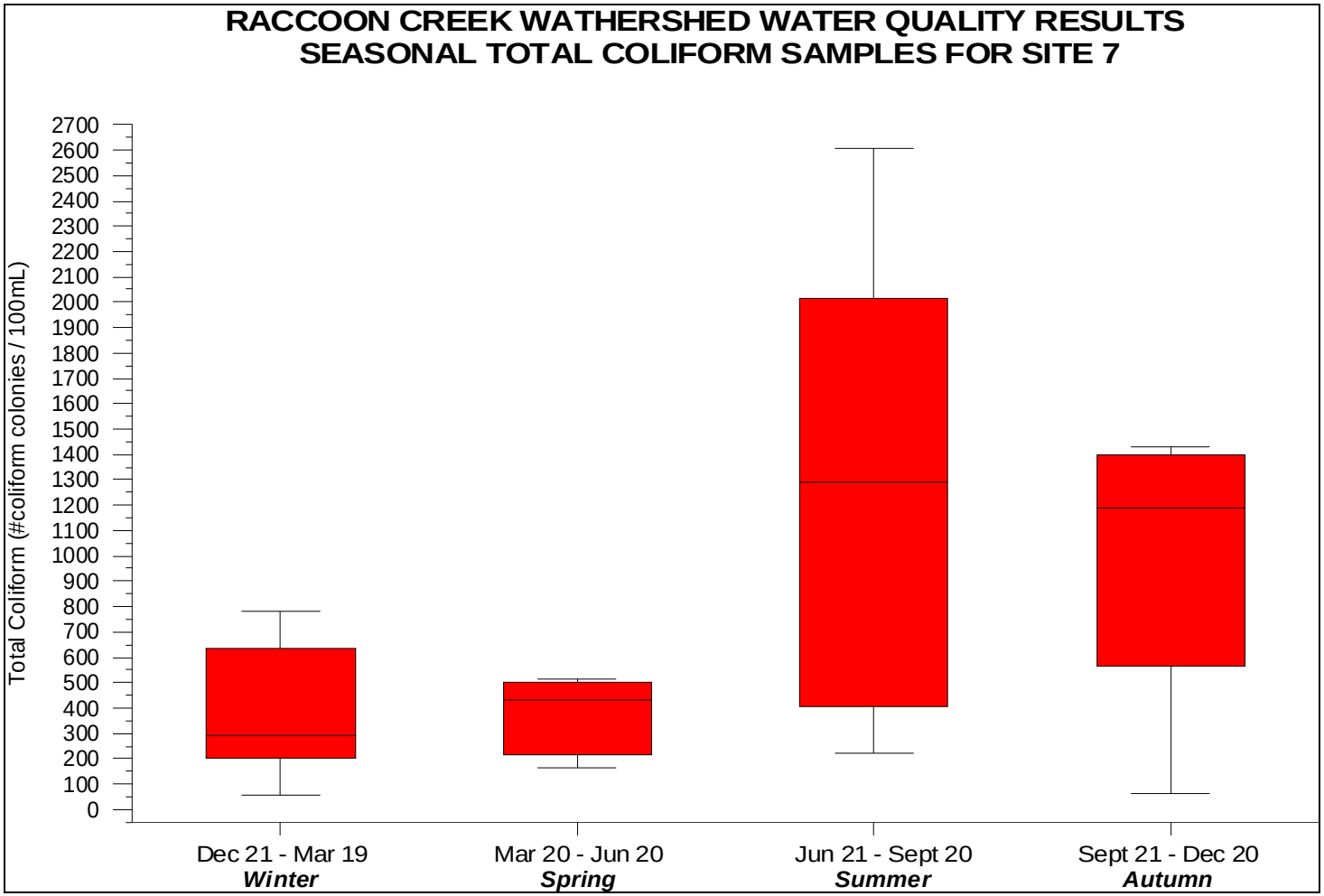


Figure 32: Seasonal Total Coliform Results for Site 7

APPENDIX F:
ADDITIONAL MAPS

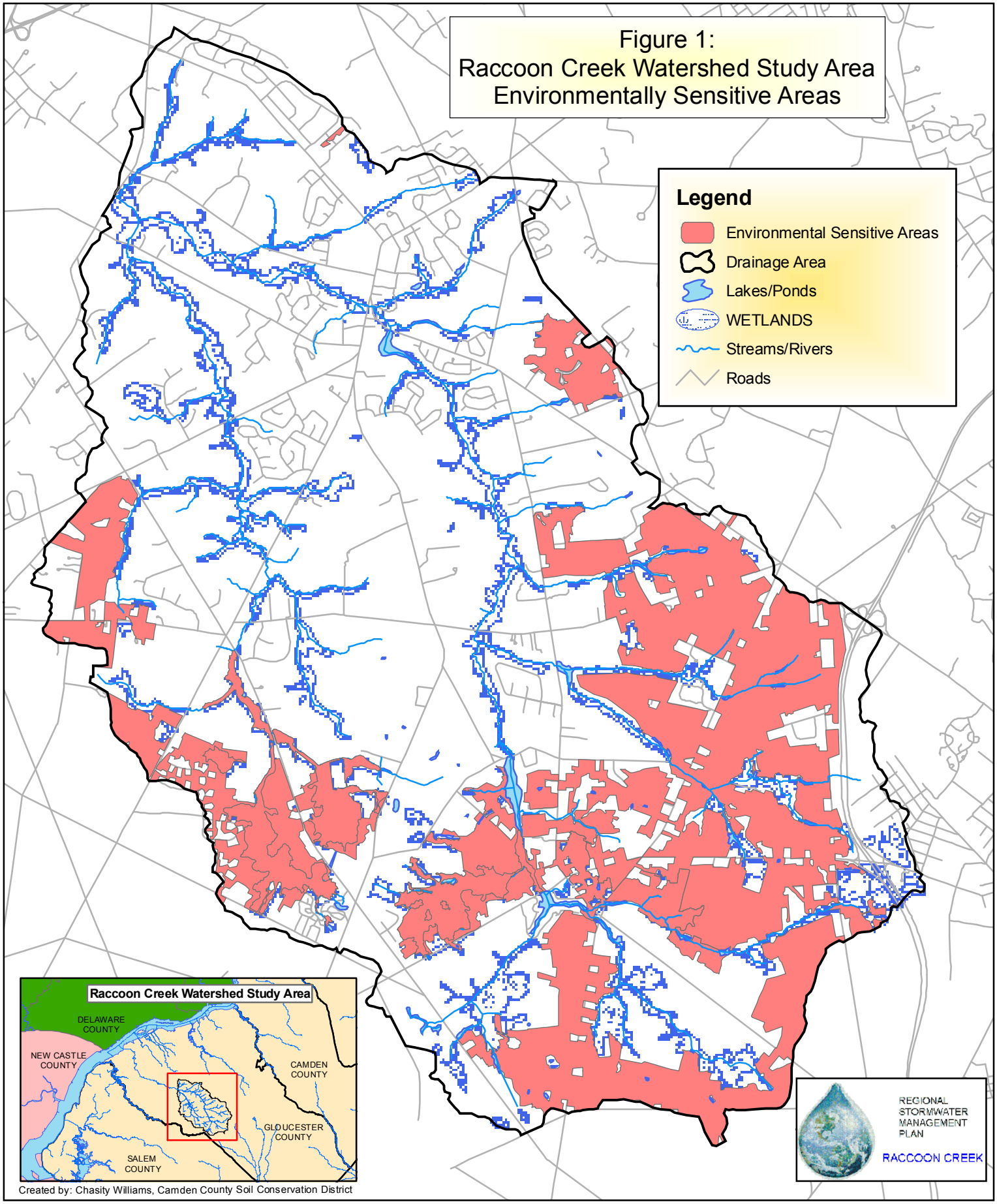
Figure 1: Raccoon Creek Watershed Study Area Environmentally Sensitive Areas 179

Figure 2: Raccoon Creek Watershed Study Area Flood Hazard Areas 181

Table 1: Flood Hazard Area Descriptions 183

Figure 3: Raccoon Creek Watershed Study Area Geologic Formation 185

Figure 1:
Raccoon Creek Watershed Study Area
Environmentally Sensitive Areas



Created by: Chasity Williams, Camden County Soil Conservation District

Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

N W E S

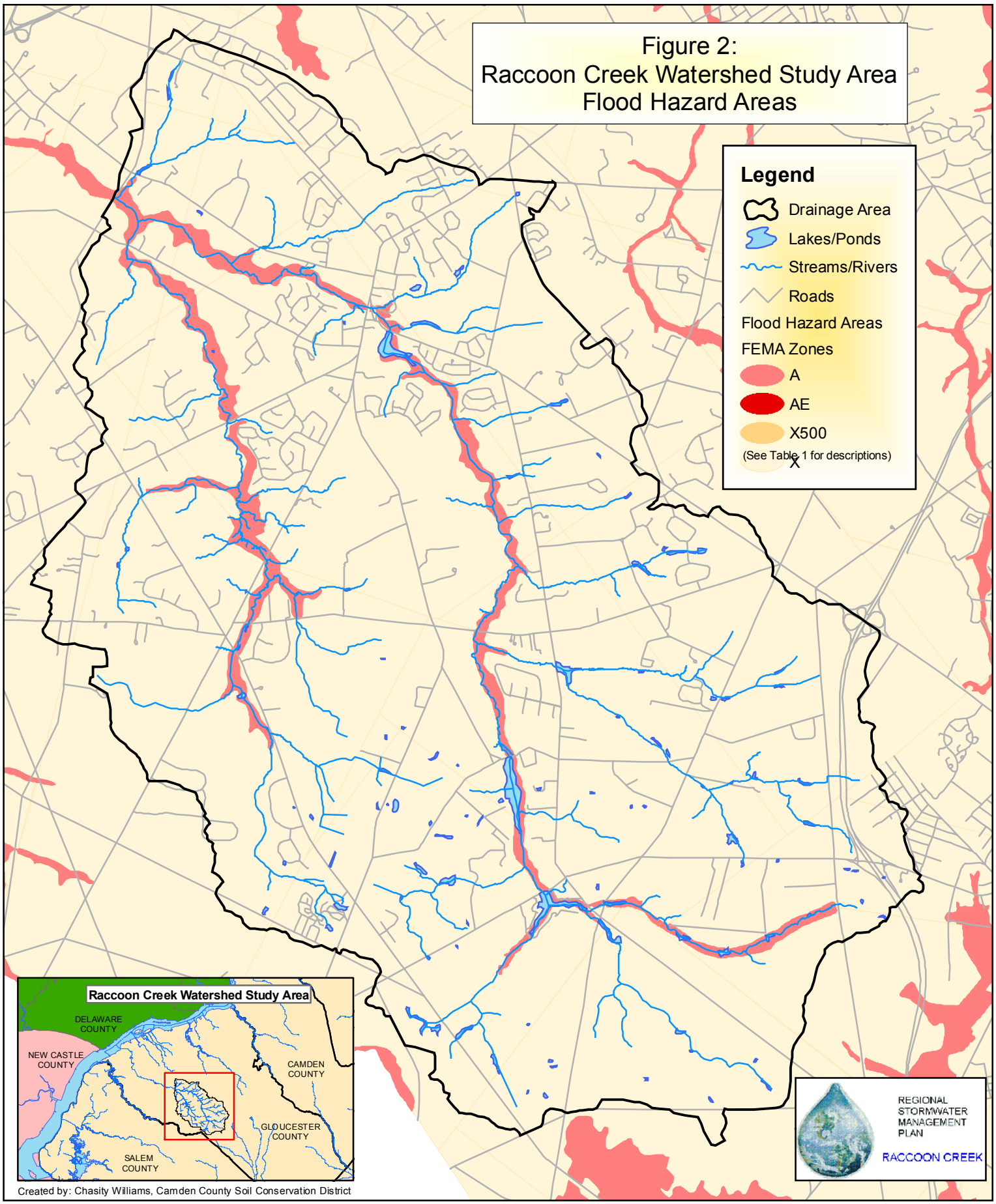
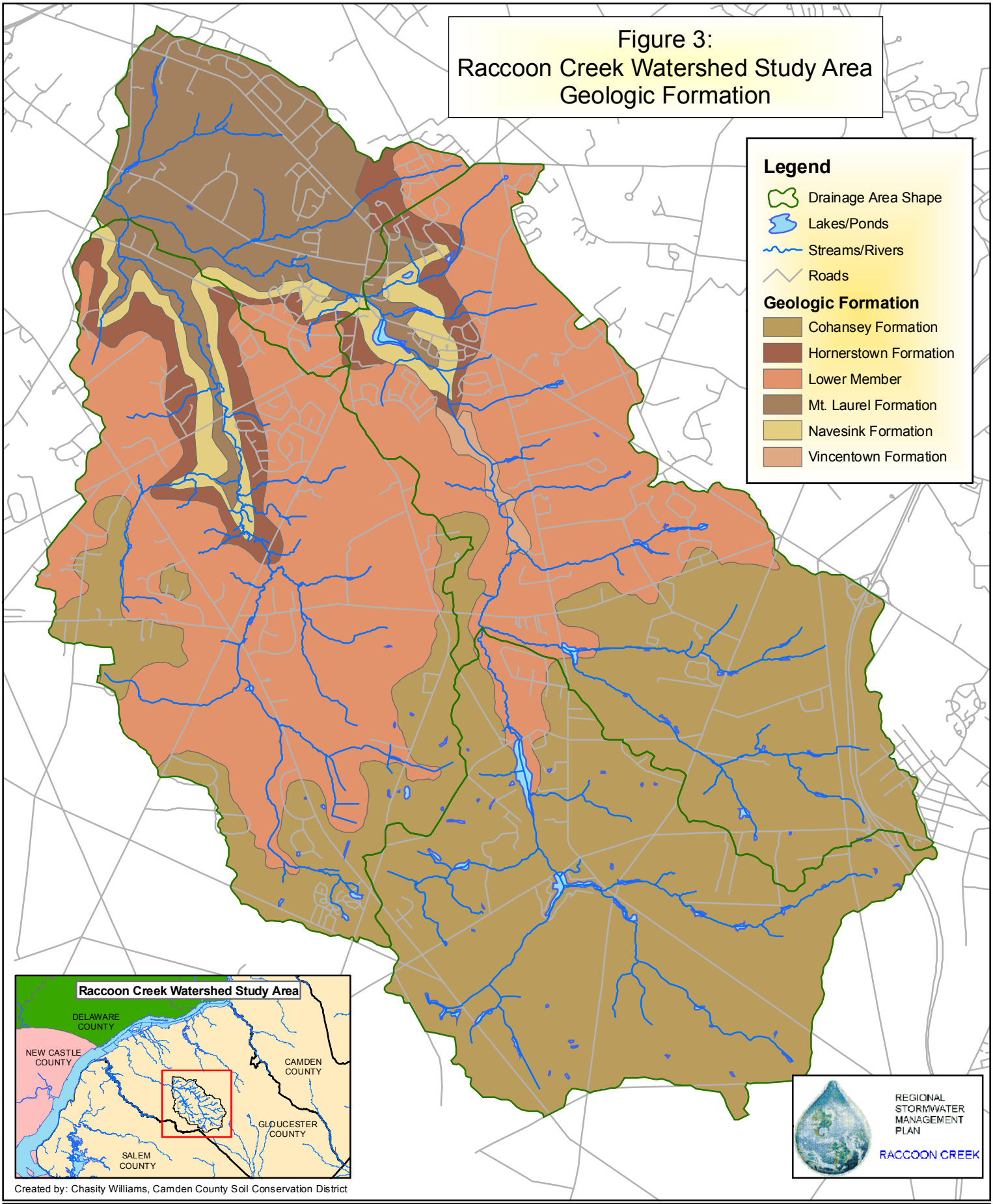

Figure 2:
Raccoon Creek Watershed Study Area
Flood Hazard Areas
Legend
Drainage Area
Lakes/Ponds
Streams/Rivers
Roads
Flood Hazard Areas
FEMA Zones
A
AE
X500
(See Table 1 for descriptions)
X
Raccoon Creek Watershed Study Area
DELAWARE COUNTY
NEW CASTLE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK
Created by: Chasity Williams, Camden County Soil Conservation District
Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.
0 0.5 1 2
Miles
N
W
E
S

Table 1: Flood Hazard Area Descriptions

FEMA Zone	Description
A	Flood insurance rate zone that corresponds to the 100-year floodplains. No Base Flood Elevations (BFE) determined.
AE	Flood insurance rate zones that correspond to the 100-year floodplains that are determined by detailed methods. In most instances, BFE derived from the detailed hydraulic analyses.
X 500	Areas of 500-year floodplains; the flood insurance rate zones that correspond to areas outside the 100-year floodplains, areas of 100-year sheet flow flooding where average depths are less than 1 foot, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile. No BFE or depths are shown within this zone.
X	Areas determined to be outside the 500-year floodplain.
ANI	Area Not Included

Figure 3:
Raccoon Creek Watershed Study Area
Geologic Formation



Created by: Chasity Williams, Camden County Soil Conservation District

Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

N W E S

Raccoon Creek
Sentinel Cross-Sections

Introduction

Development and changes in land use can have a direct impact on the receiving stream corridor. However, these changes may occur over a long period of time and may be difficult to quantify to the casual observer. The Raccoon Creek Watershed is experiencing very rapid development and despite the use of current stormwater management practices, the ultimate impact to the stream corridor is unknown. The Camden and Gloucester Soil Conservation Districts (the Districts) have created a series of sentinel cross-sections at key locations within the watershed to monitor changes within these stream corridors.

The Raccoon Creek Watershed encompasses about 25 square miles in central Gloucester County. In 1986, less then 12% of the watershed was considered developed. In 2006, that figure has at least doubled with even more proposed development already been approved. The Characterization and Assessment report (drafted February 2006) prepared by the Districts in support of a Regional Stormwater Management Plan indicated that, with few exceptions, the stream corridor was in good condition. Stream channels exhibited very little streambank erosion, channel substrate remained in good condition and the channels were still well connected to their wide and undisturbed floodplains.

As development takes place it is likely that the stream corridor will evolve to accommodate the new runoff patterns of the developed watershed. These sentinel cross-sections were designed and located to provide a quantifiable method of measuring change in the stream corridor.

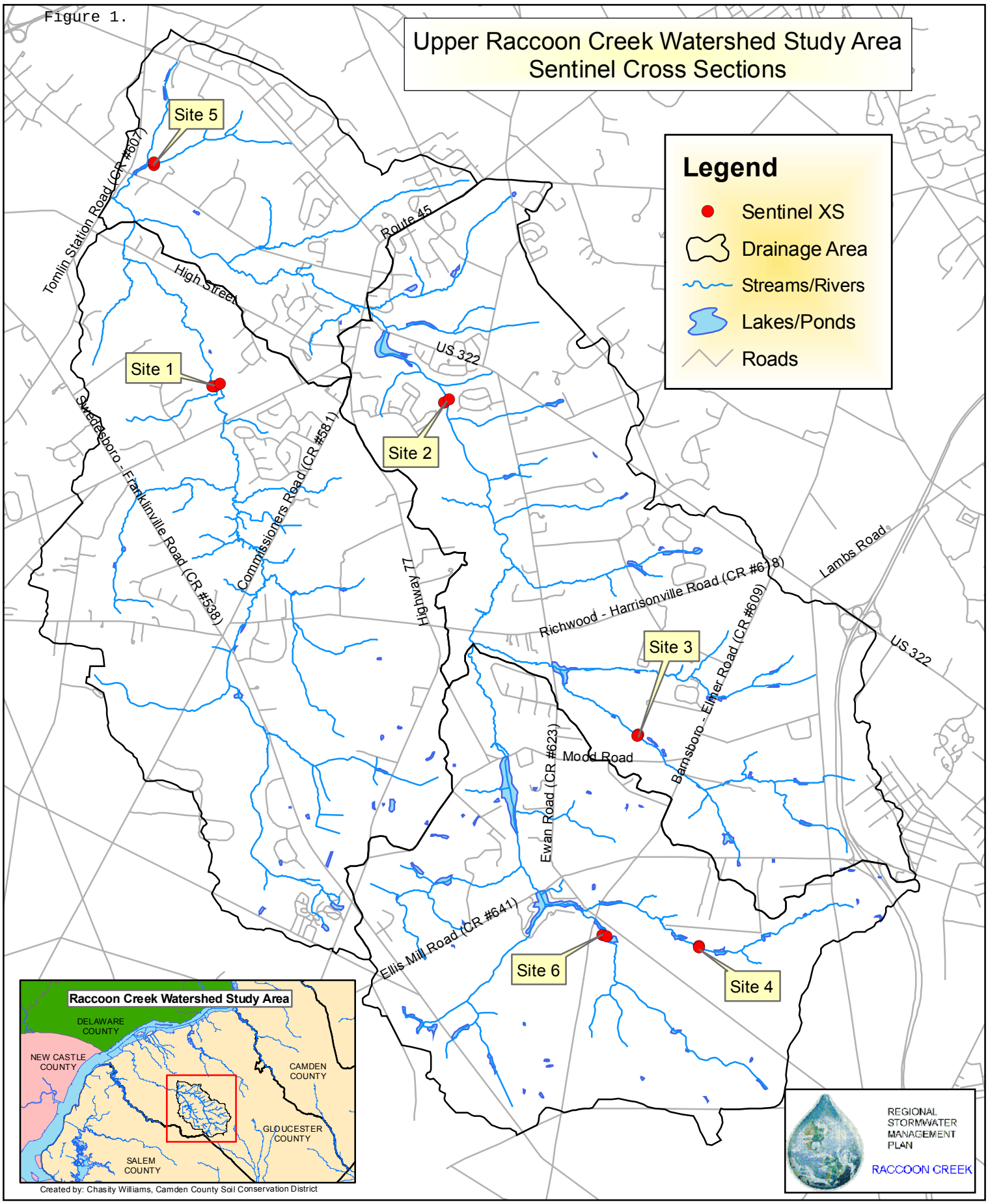
Cross-section Measurements

Permanent monuments were installed by the Districts in the winter/spring of 2006 & 2007 to establish six (6) sentinel cross-sections. Each cross-section was located downstream of areas where development is proposed to or has recently occurred. The locations of each cross-section are shown in Figure 1. All sites are in Gloucester County.

At each site standard stream cross-section measurements were completed, plotting distance and elevation from a starting point. All elevations are based on an assumed datum. The end points of each cross-section were marked, mapped with GPS and described in relationship to nearby features. At some sites a basic stream profile was created. Bankfull stage was estimated and the elevation recorded. And each site was photographed. All the information was recorded in field books and then summarized on a Cross-Section Detail Card (Appendix A).

Figure 1.

Upper Raccoon Creek Watershed Study Area
Sentinel Cross Sections



Created by: Chasity Williams, Camden County Soil Conservation District

Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

N W E S

Cross-Section Details

Cross-section 1 is located on the south branch Raccoon Creek near Hickory Court in Harrison Township. The western bank has very steep slope while the east bank is very flat with heavy sediment deposition. The stream bottom is composed of organic matter, small gravel and sand.

Cross-section 2 is located on the main stem Raccoon Creek near Darwin Court in Harrison Township. The west bank has a wide flat floodplain with several ponded areas. The stream bottom has several sand/mud bars near both banks.

Cross-section 3 is located on Clems Run off of Ewan Road in Harrison Township. The land use to the east is currently a peach orchard, but a new residential development is proposed on this parcel. The stream corridor has wide flat floodplains and the stream bottom is mostly small gravel with only minor silt deposition.

Cross-section 4 is located on the main stem Raccoon Creek off of Ellis Mill Road and on the border of Glassboro Borough and Elk Township. This site is downstream of The Village Grande at Camelot a new housing development in Glassboro. The east bank is currently a peach orchard, while the west bank is forested. The stream corridor has wide flat floodplains and the stream bottom is a mix of organic material and fine sand.

Cross-section 5 is located on northeast side of Woodland Avenue on an un-named tributary to the main stem Raccoon Creek in Harrison Township. The stream corridor meanders within a wide flat floodplain. The floodplain appears to be the deposited sediment of upstream erosion. The stream has incised a channel into the floodplain and the stream bed is mostly fine sediment.

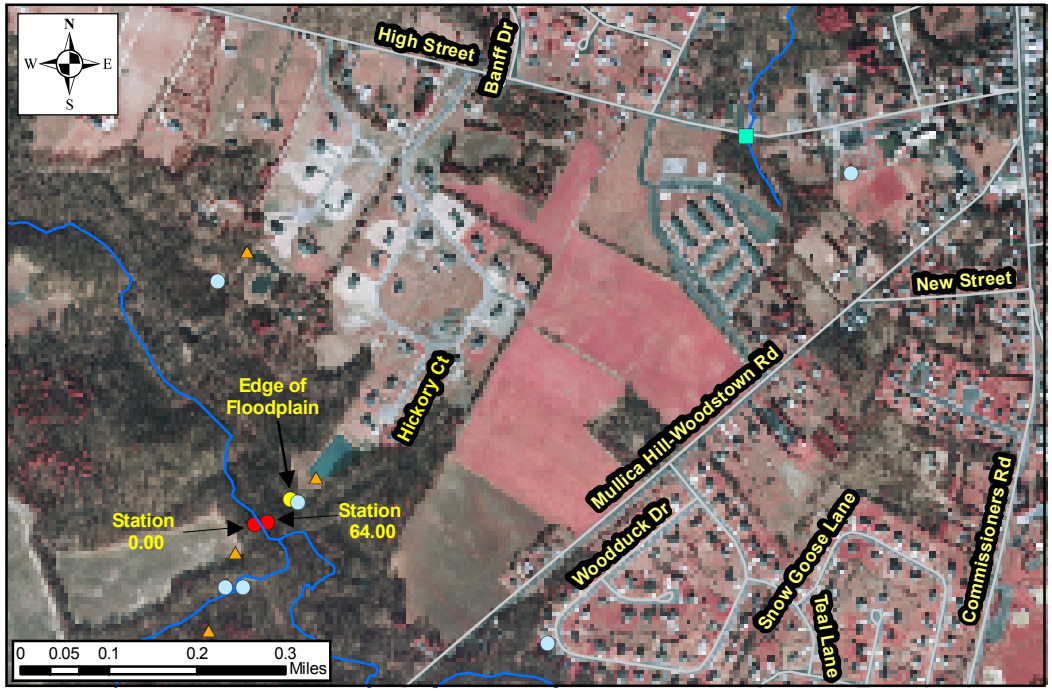
Cross-section 6 is located within the former mill pond at Wrights Mill, near the corner of Barnsboro-Elmer and Aura-Mullica Hill Roads Elk Township. The stream meanders within a wide flat floodplain formed when the pond was drained in 2003. In some areas the stream has eroded away the organic sediments that filled the former pond, but in other areas several feet of muck still exist in the stream bed.

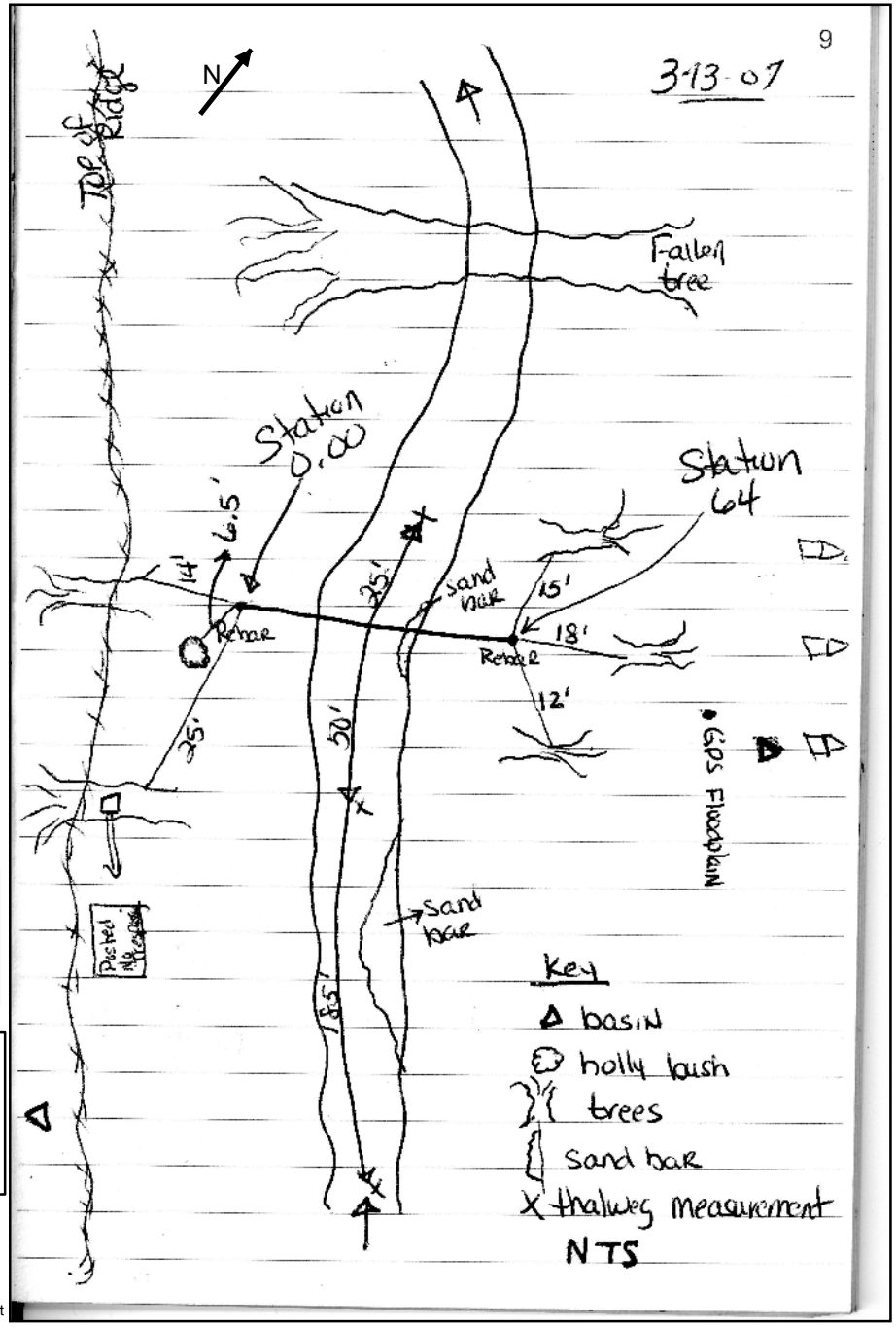
Recommendations

The cross-sections should be visited and re-measured every few years and perhaps after major storm events. The results should be compared to the initial survey. Changes to the cross-section must be analyzed to determine if they are representative of natural channel evolution or related to human activities. If excessive erosion or siltation is noted and can be linked to development or other changes in the land use, the municipality should consider the need for corrective actions in the contributing watershed.

The Districts recommend working with Rowan University Water Resources faculty and students to provide the labor and analysis of the updated stream measurements.

SENTINEL CROSS - SECTION #1

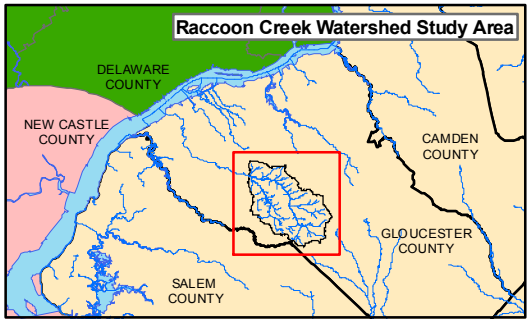




Location Description:
Enter the Country Lane Development off High Street follow Country Lane then turn onto Hickory Court. Follow easement along side of stormwater facility then down the path into the woods. Approximately 300-feet downstream from the confluence of South Branch and small tributary is the cross-section.

	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.240656	39.725265	75° 14' 26.363"W	39° 43' 30.953"N
64.00	75.240188	39.725298	75° 14' 24.676"W	39° 43' 31.073"N
Edge of Floodplain	75.239801	39.725662	75° 14' 23.284"W	39° 43' 32.385"N

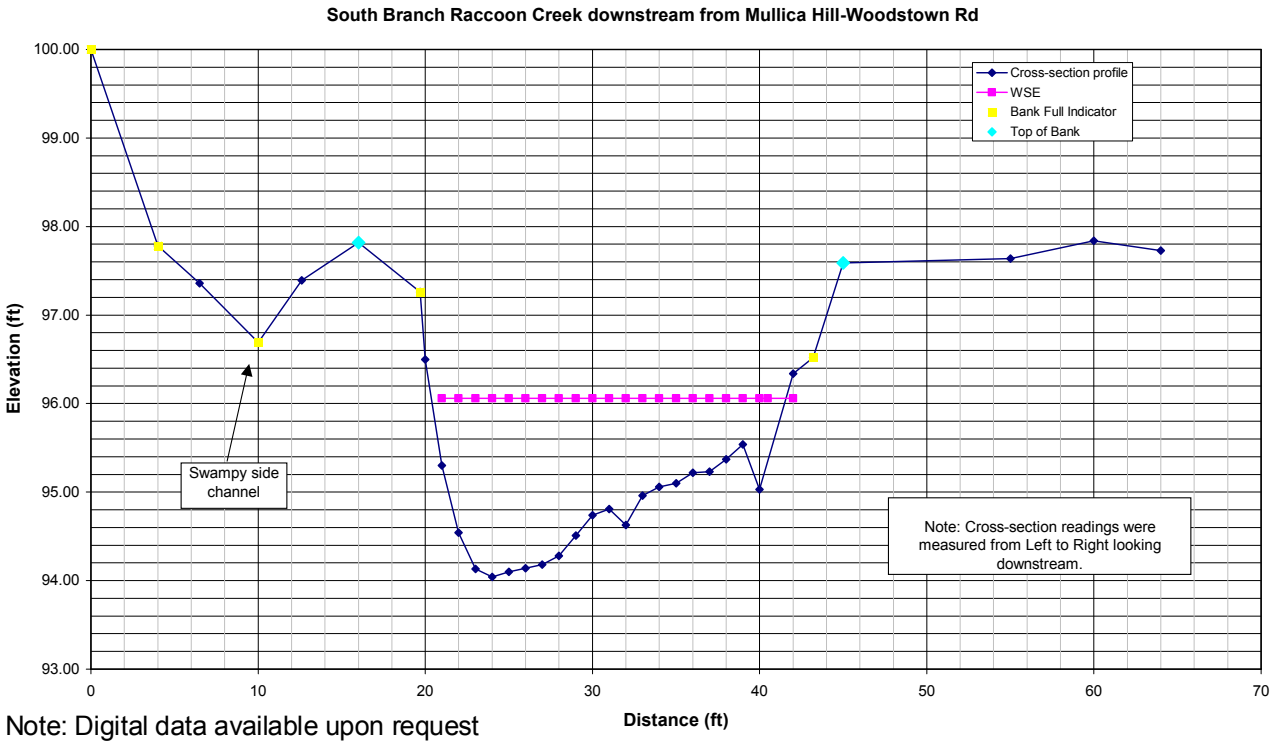
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK



Legend
- Sentinel XS
- Edge of Floodplain
- Stormwater Basins
- Stormwater Outfalls
- Obstructions
- Roads
- Streams/Rivers

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

Created by: Chasity Williams, Camden County Soil Conservation District



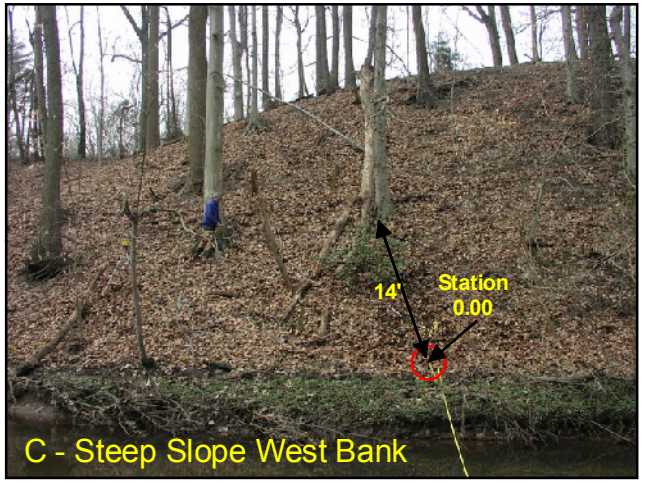
Note: Digital data available upon request

Cross-sectional Data (Left - Right looking downstream)

Station	BS	HI	FS	Elevation	Comments
				100.00	BM (assumed)
0	6.93	106.93	6.93	100.00	BF, Toe of slope
4			9.15	97.78	BF, side channel
6.5			9.57	97.36	Swampy side channel
10			10.24	96.69	BF
12.6			9.54	97.39	
16			9.11	97.82	EOB, looking d/s
19.7			9.67	97.26	BF
20			10.43	96.50	EOW
21			11.63	95.30	
22			12.39	94.54	
23			12.8	94.13	
24			12.89	94.04	
25			12.83	94.10	
26			12.79	94.14	
27			12.75	94.18	
28			12.65	94.28	
29			12.42	94.51	
30			12.19	94.74	
31			12.12	94.81	
32			12.3	94.63	
33			11.97	94.96	
34			11.87	95.06	
35			11.83	95.10	
36			11.71	95.22	
37			11.7	95.23	
38			11.56	95.37	
39			11.39	95.54	
40			11.9	95.03	
40.5			10.87	96.06	WSEL
42			10.59	96.34	Deposition of sand bar
43.2			10.41	96.52	BF
45			9.34	97.59	TOB
55			9.29	97.64	
60			9.09	97.84	
64			9.2	97.73	End point, rebar


A - Upstream Condition


B - Downstream Condition



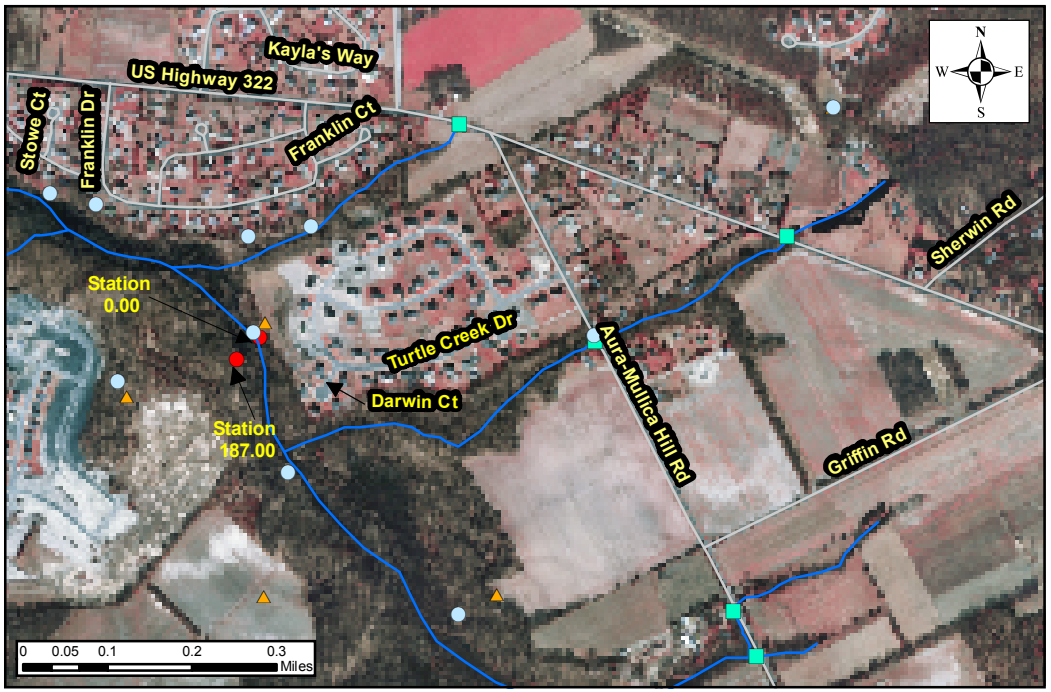
C - Steep Slope West Bank

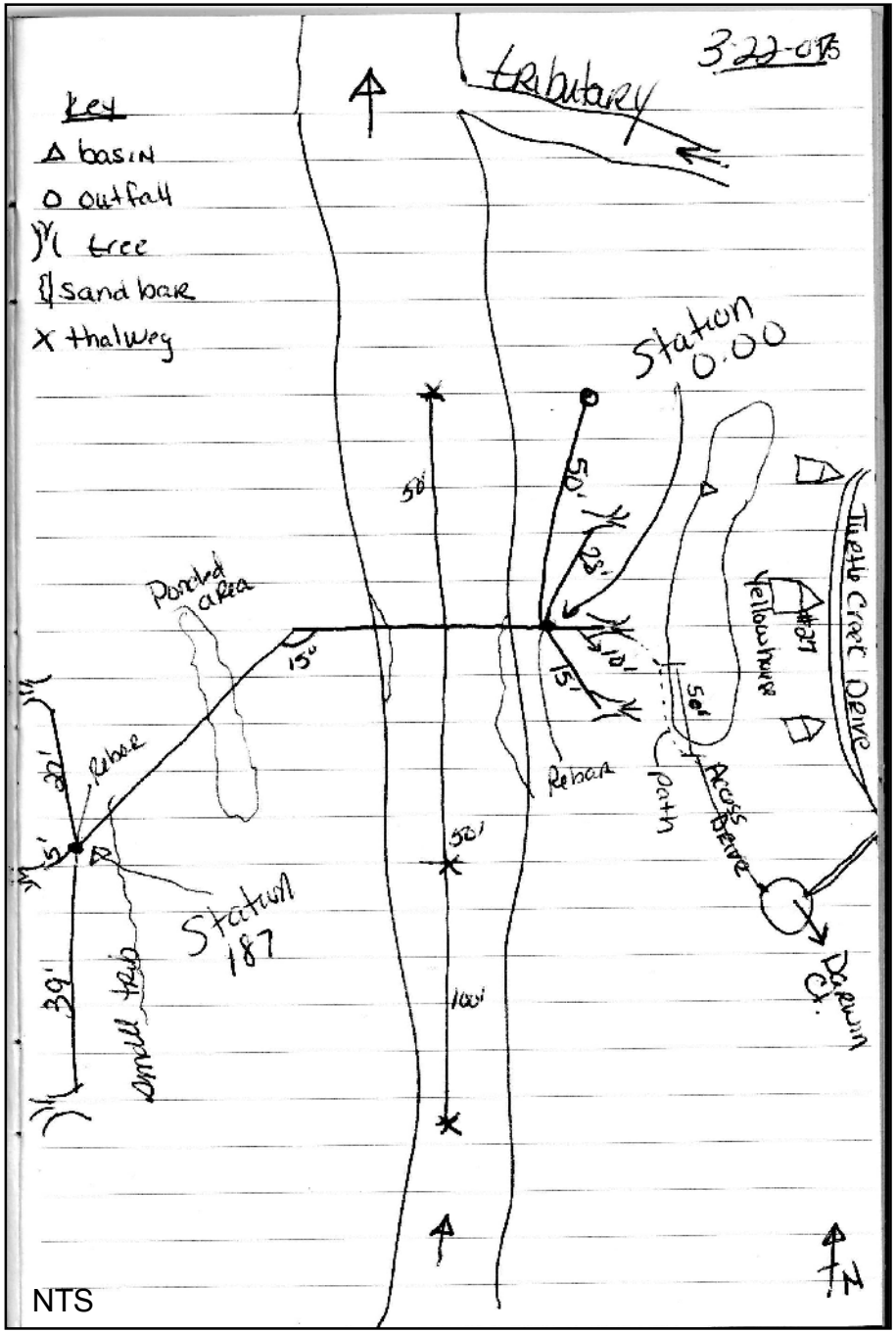
Cross-section Description:
Ends of cross-section were staked with rebar and capped. West bank has a very steep slope while the East bank has a very flat slope with a flat wide floodplain and sediment deposition. The stream bottom had a mix of small gravel and sand.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

SENTINEL CROSS - SECTION #2



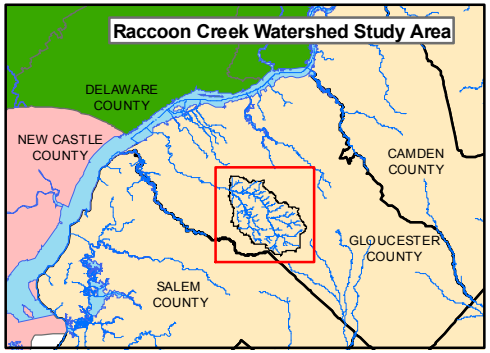


Location Description:
Enter the Turtle Creek Development off Aura-Mullica Hill Road. Follow Turtle Creek Drive then turn onto Darwin Court. Follow the access drive to the stormwater facility. Walk along side of facility and then turn into the woods. The cross-section is approximately 50' upstream from stormwater outfall.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

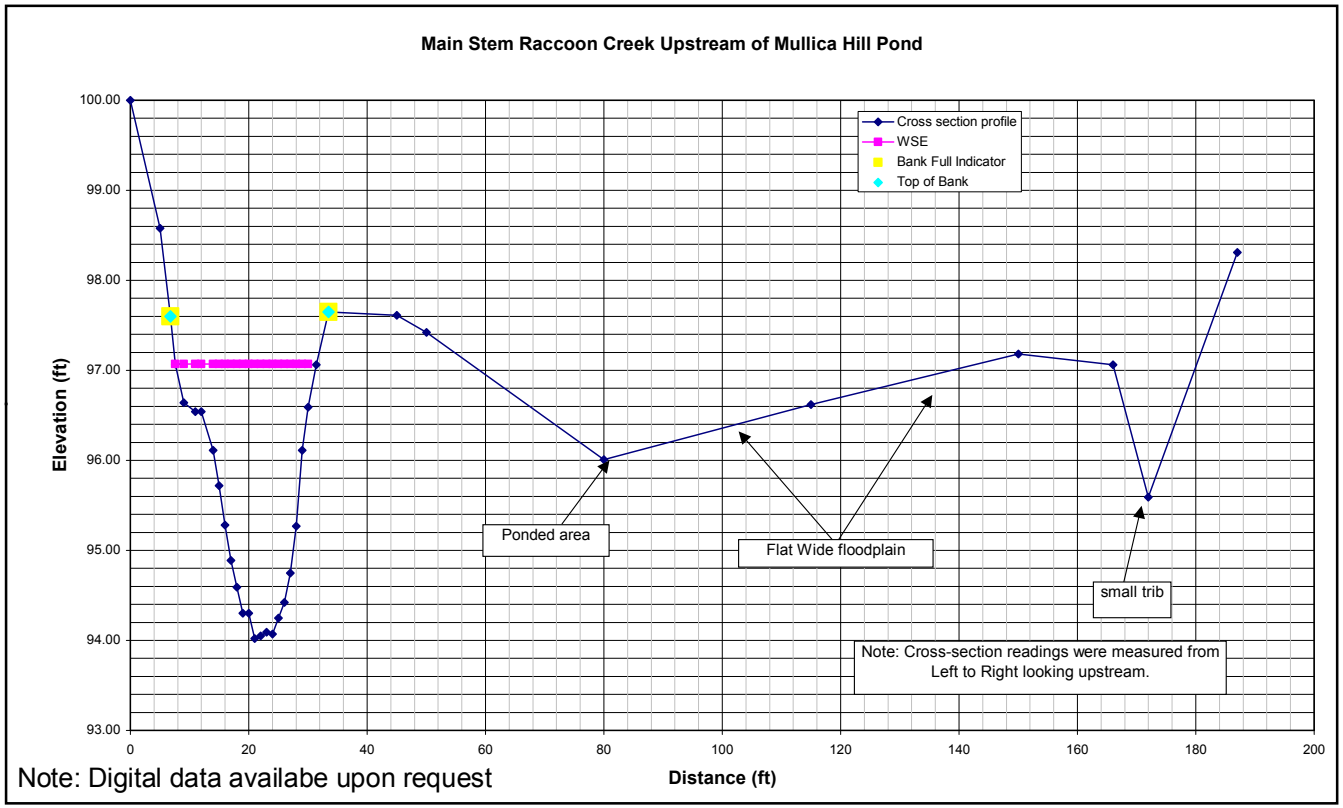
	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.211230	39.729837	75° 12' 40.429"W	39° 43' 47.413"N
187.00	75.211819	39.729580	75° 12' 42.55"W	39° 43' 46.486"N



Legend

- Sentinel XS
- Stormwater Basins
- Stormwater Outfalls
- Obstructions
- Roads
- Streams/Rivers

Created by: Chasity Williams, Camden County Soil Conservation District



Note: Digital data availabe upon request

Cross-sectional Data (Left - Right looking upstream)					
Station	BS	HI	FS	Elevation	Comments
0	7.14	107.14		100.00	BM (assumed)
5			8.56	98.58	
6.8			9.54	97.60	BF, TOB, beginning of sand
7.6			10.07	97.07	WSEL
9			10.5	96.64	Soft mud/sand bar
11			10.6	96.54	Soft mud/sand bar
12			10.6	96.54	Soft mud/sand bar
14			11.03	96.11	Soft mud/sand bar
15			11.42	95.72	downslope of sand bar
16			11.86	95.28	
17			12.25	94.89	
18			12.55	94.59	
19			12.84	94.30	Thalweg, beg.of finer sand
20			12.84	94.30	
21			13.12	94.02	
22			13.09	94.05	
23			13.05	94.09	
24			13.07	94.07	
25			12.89	94.25	
26			12.72	94.42	
27			12.39	94.75	
28			11.87	95.27	
29			11.03	96.11	downslope of sand bar
30			10.55	96.59	
31.4			10.08	97.06	EOW
33.5			9.49	97.65	BF, TOB, beginning of sand
45			9.53	97.61	
50			9.72	97.42	bend in tape goes left on a 15^0
80			11.13	96.01	low area, mud puddle
115			10.52	96.62	
150			9.96	97.18	
166			10.08	97.06	small trib, EOW
172			11.55	95.59	
187			8.83	98.31	end point







Cross-section Description:
Ends of cross-section were staked with rebar and capped. West bank has flat wide floodplain. The channel bottom as very sandy with underwater sandbars on both banks. The channel center became very deep with very fine sand.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
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SENTINEL CROSS - SECTION #3

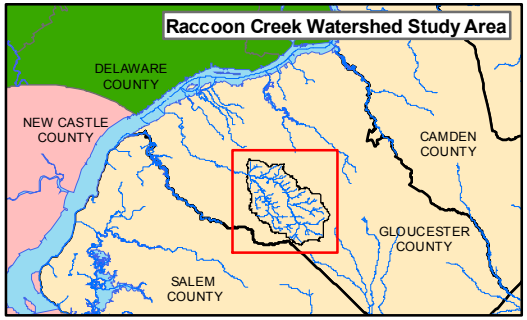


Location Description:
From Barnsboro-Elmer Road turn onto Ewan Road. Turn into orchard field approximately (870-feet from culvert) under Ewan Road. Follow old famers lane along the woods until the second irrigation pond (left side of lane). Cross-section is located approximately 300-feet downstream from stormwater outfall associated with the second irrigation pond.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

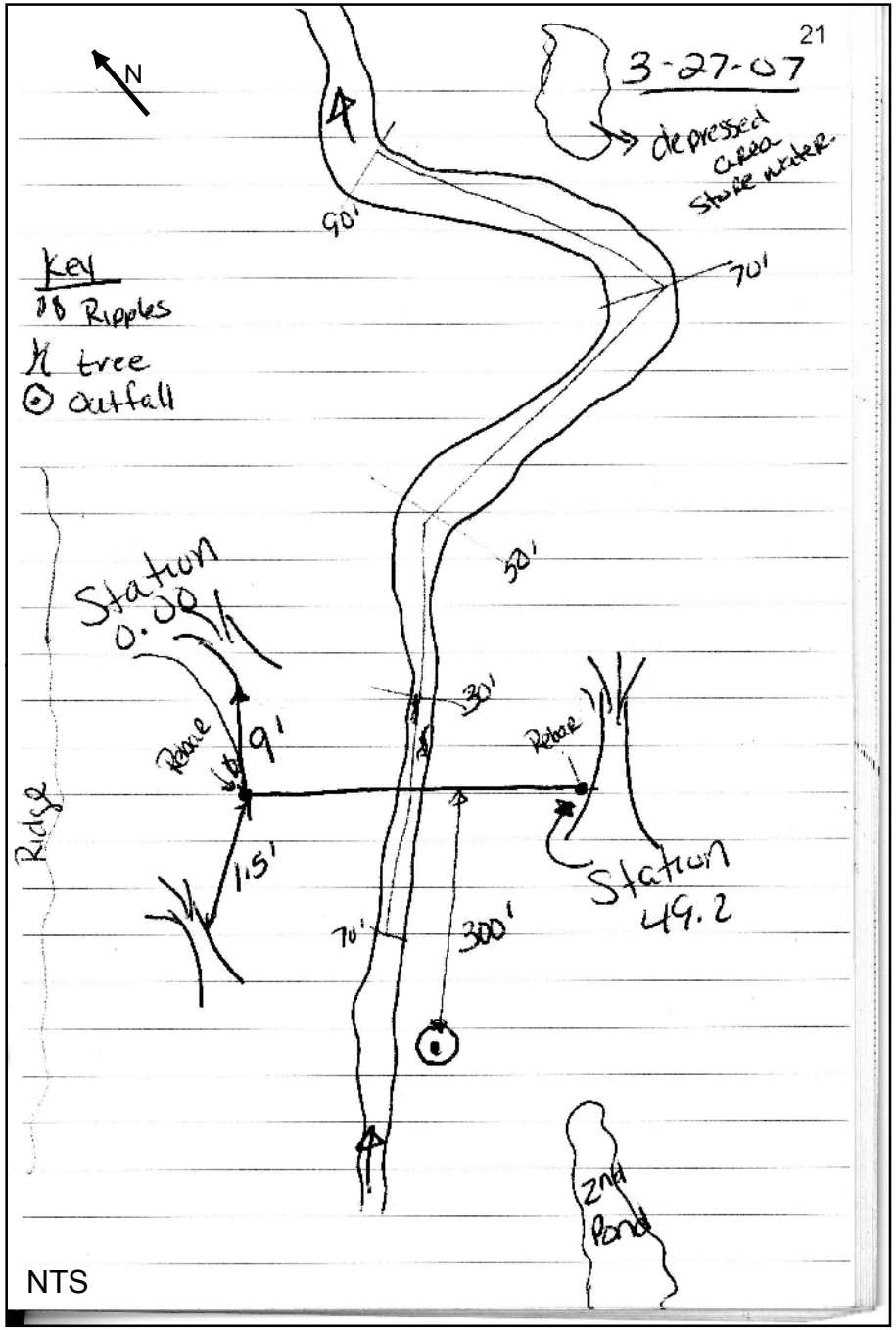
	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.177637	39.702936	75° 10' 39.623"W	39° 42' 10.569"N
49.20	75.177580	39.703160	75° 10' 39.287"W	39° 42' 11.375"N

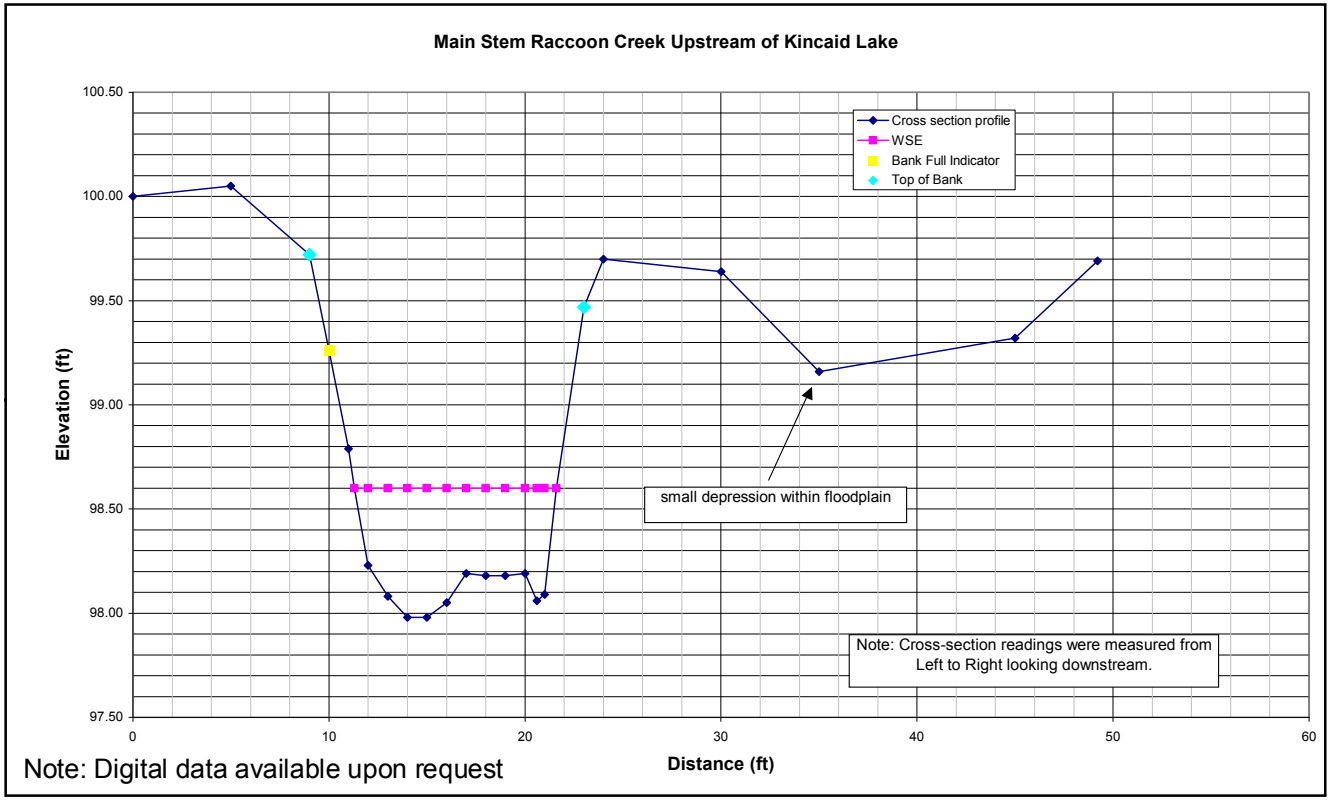
Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.



Legend
- Sentinel XS
- Stormwater Basins
- Stormwater Outfalls
- Obstructions
- Roads
- Streams/Rivers

Created by: Chasity Williams, Camden County Soil Conservation District





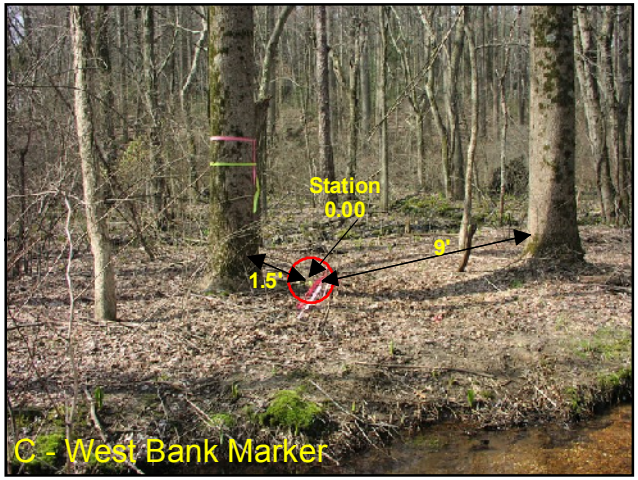
Note: Digital data available upon request

Cross-sectional Data (Left - Right looking upstream)

Station	BS	HI	FS	Elevation	Comments
0	6.88	106.88		100.00	BM (assumed), rebar
5			6.83	100.05	
9			7.16	99.72	TOB
10			7.62	99.26	BF, TOB, beginning of sand bar
11			8.09	98.79	
11.3			8.28	98.60	WSEL, EOW
12			8.65	98.23	
13			8.8	98.08	
14			8.9	97.98	
15			8.9	97.98	
16			8.83	98.05	
17			8.69	98.19	
18			8.7	98.18	
19			8.7	98.18	
20			8.69	98.19	
20.6			8.82	98.06	
21			8.79	98.09	
21.6			8.28	98.60	EOW
23			7.41	99.47	TOB
24			7.18	99.70	Top of depositional
30			7.24	99.64	
35			7.72	99.16	depression
45			7.56	99.32	
49.2			7.19	99.69	rebar





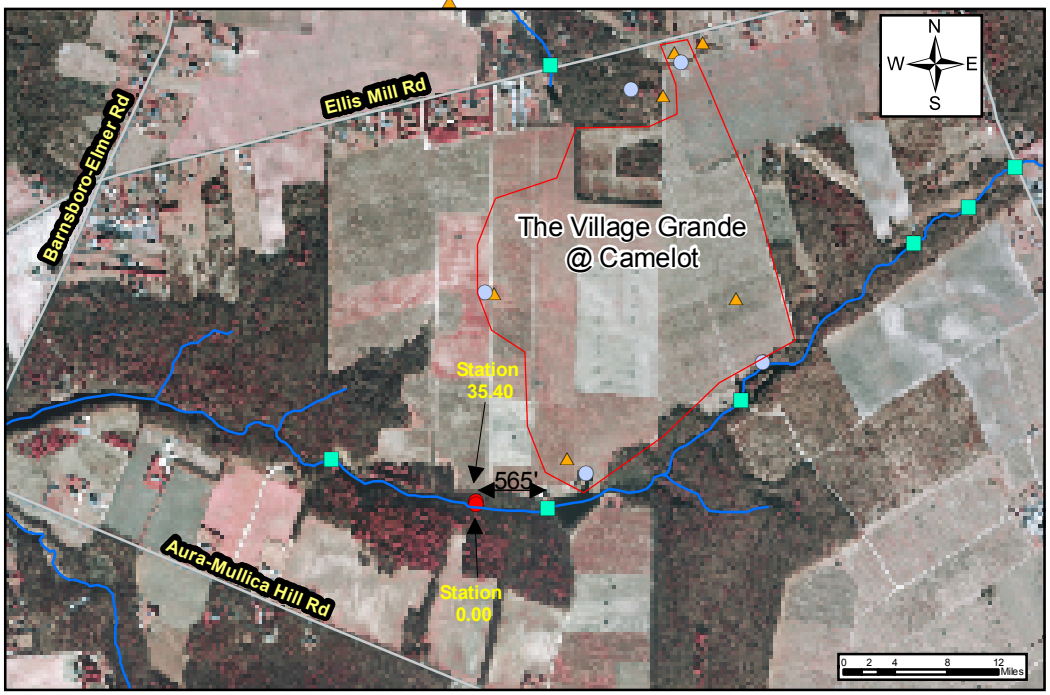


Cross-section Description:
Ends of cross-section were staked with rebar and capped. Both banks have wide flat floodplains. Channel bottom is mostly gravel with few small areas of siltation.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
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SENTINEL CROSS - SECTION #4

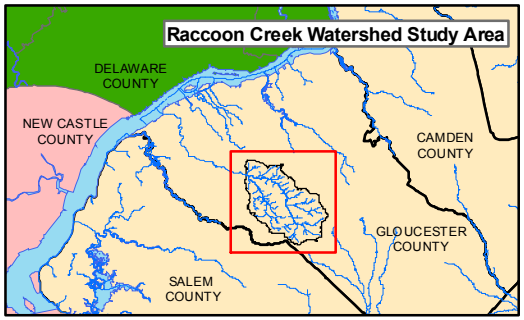


Location Description:
From Ellis Mill Road turn into The Village Grande @ Camelot Development. Travel towards the furtherest most southern portion of site past stormwater facility. Cross-section is approximately 565-feet downstream from irrigation pond.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

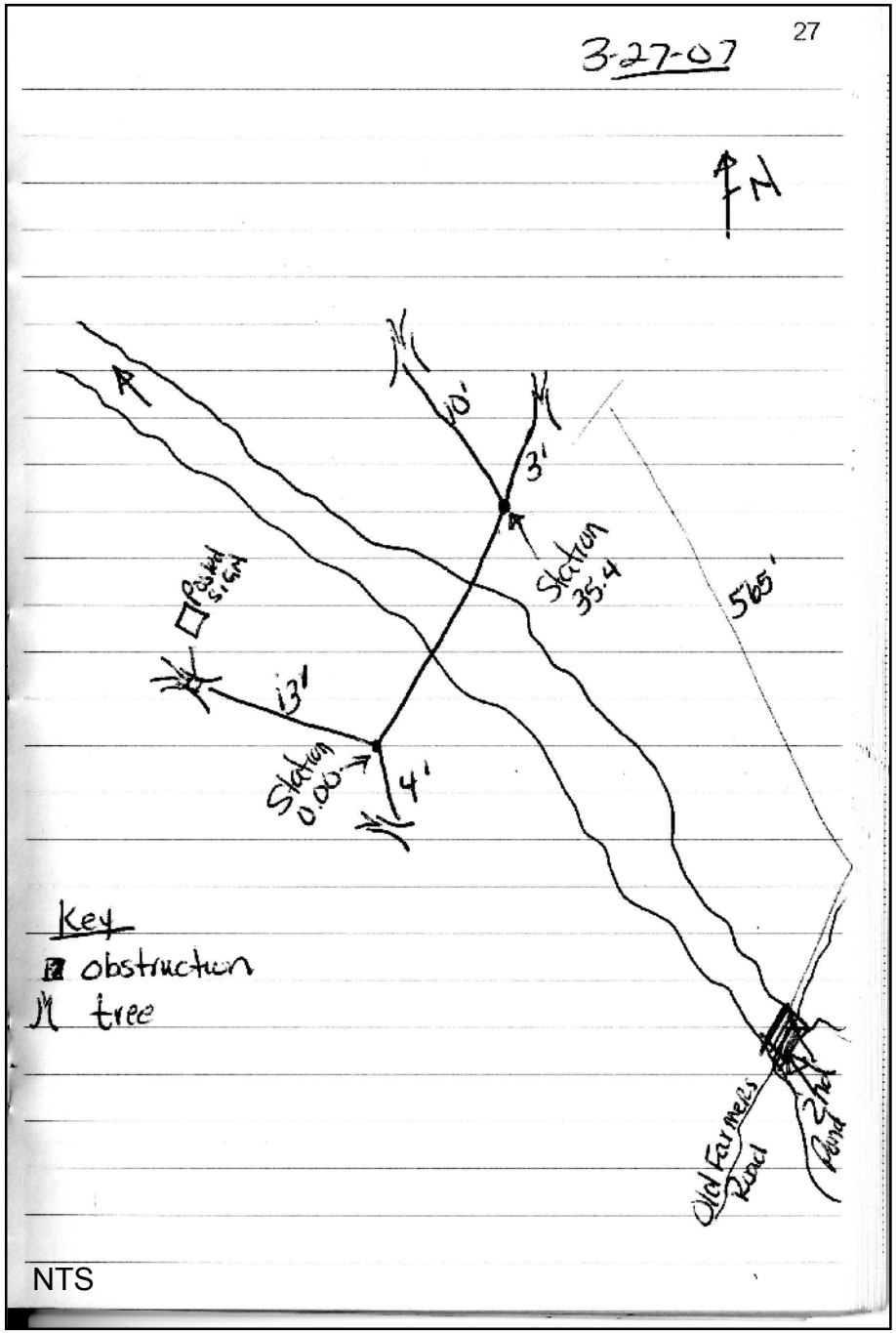
	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.163414	39.684665	75° 9' 48.292"W	39° 41' 4.794"N
35.40	75.163354	39.684743	75° 9' 48.074"W	39° 41' 5.073"N

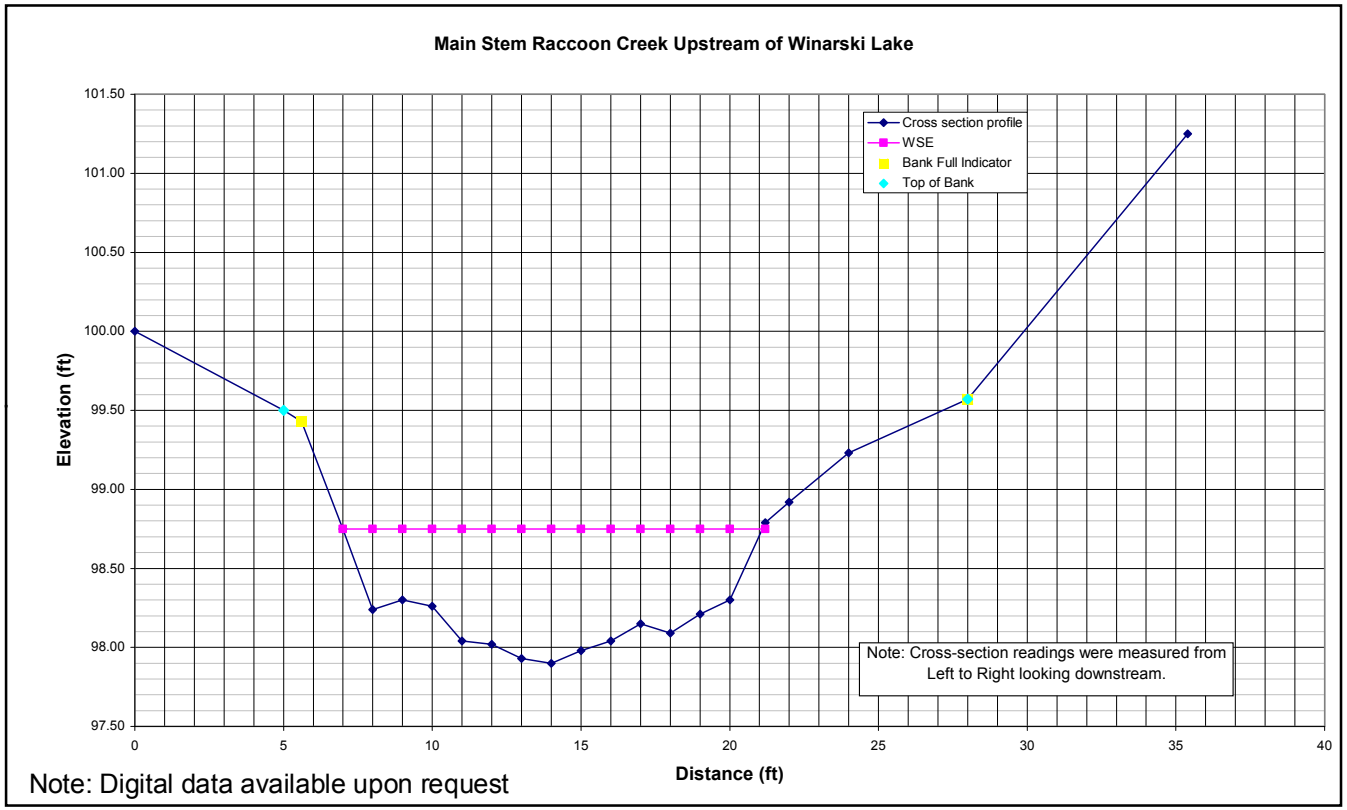
Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.



Legend
- Sentinel XS
- Obstructions
- Stormwater Outfalls
- Stormwater Basins
- Roads
- Streams/Rivers

Created by: Chasity Williams, Camden County Soil Conservation District





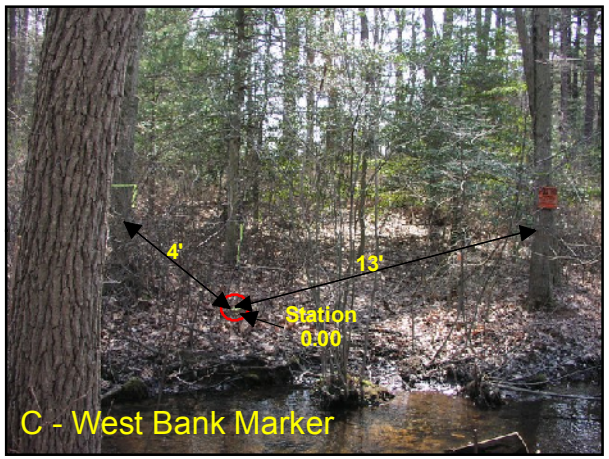
Note: Digital data available upon request

Cross-sectional Data (Left - Right looking downstream)

Station	BS	HI	FS	Elevation	Comments
0	6.4	106.4		100.00	BM (assumed), rebar
5			6.9	99.50	TOB
5.6			6.97	99.43	BF
7			7.65	98.75	EOW,
8			8.16	98.24	
9			8.1	98.30	
10			8.14	98.26	
11			8.36	98.04	
12			8.38	98.02	
13			8.47	97.93	
14			8.5	97.90	
15			8.42	97.98	
16			8.36	98.04	
17			8.25	98.15	
18			8.31	98.09	
19			8.19	98.21	
20			8.1	98.30	
21.2			7.61	98.79	EOW,
22			7.48	98.92	
24			7.17	99.23	
28			6.83	99.57	TOB, BF
35.4			5.15	101.25	end survey, rebar





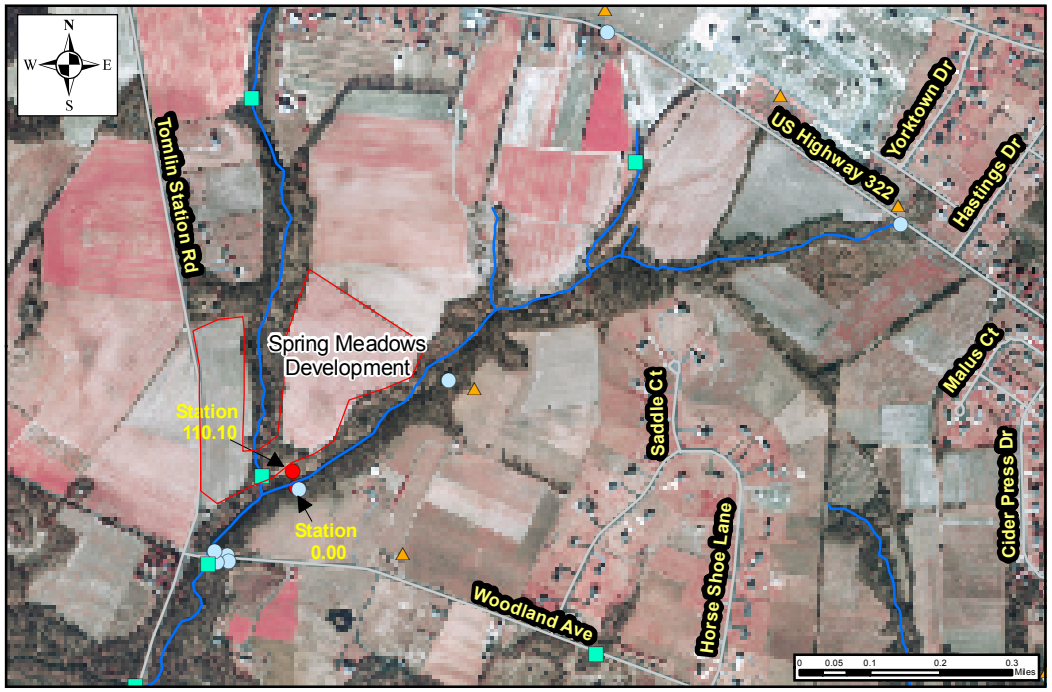


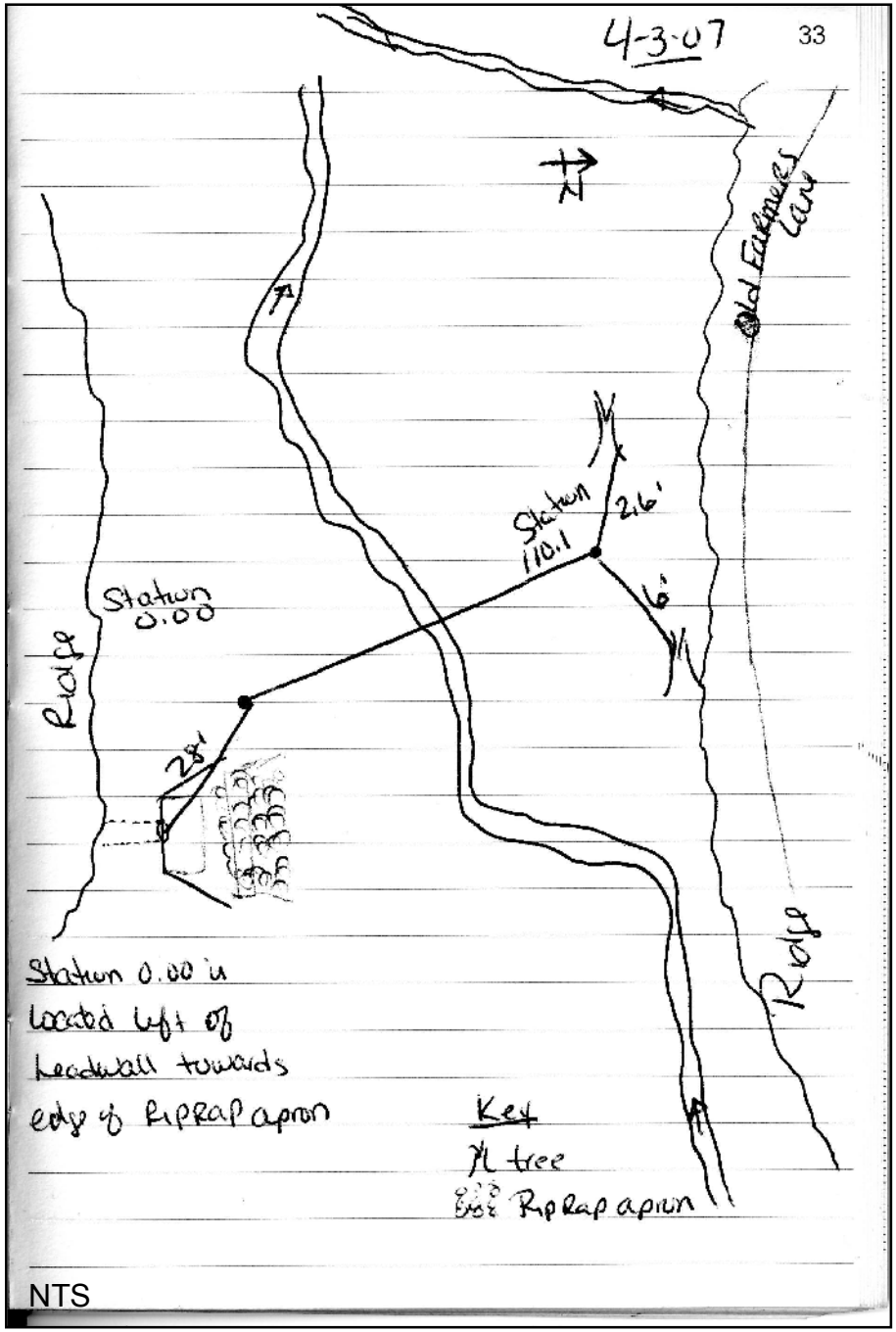
Cross-section Description:
Ends of cross-section were staked with rebar and capped.
Channel bottom has organic matter with very fine sand material.
East bank has orchards of peaches
with few small areas of woods. West bank (downstream) is forest.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

SENTINEL CROSS - SECTION #5

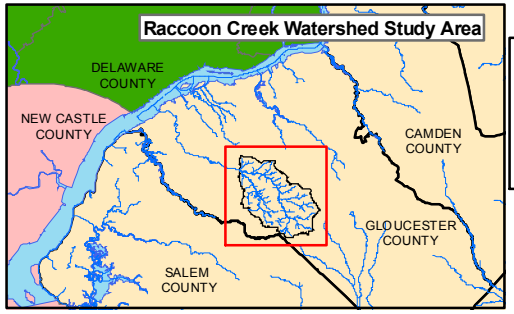




Location Description:
Enter Spring Meadows Development off Tomlin Station Road. Cross over newly constructed road bridge and make immediate right onto path. Follow the path, cross-section is located approximately 28-feet downstream of stormwater outfall. Note: Outfall is located across the stream, left bank looking downstream.

	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.254630	39.744479	75° 15' 16.668"W	39° 44' 40.124"N
110.10	75.254772	39.744746	75° 15' 17.178"W	39° 44' 41.086"N

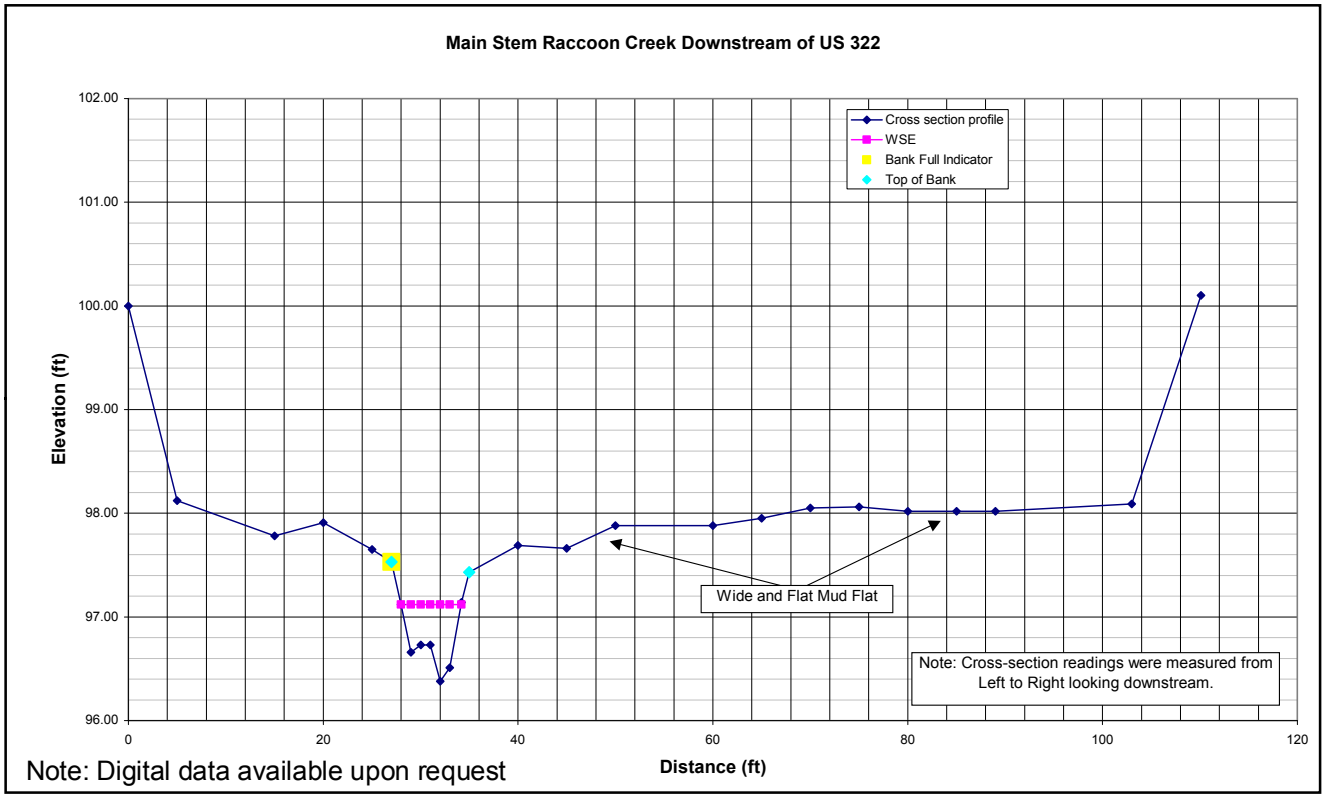
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK



Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

Legend
- Sentinel XS
- Stormwater Basins
- Stormwater Outfalls
- Obstructions
- Roads
- Streams/Rivers

Created by: Chasity Williams, Camden County Soil Conservation District



Note: Digital data available upon request

Cross-sectional Data (Left - Right looking downstream)					
Station	BS	HI	FS	Elevation	Comments
0	6.85	106.85		100.00	BM (assumed)
5			8.73	98.12	Edge of Rip-rap apron
15			9.07	97.78	End of Rip-rap apron
20			8.94	97.91	Muddy area d/s of apron
25			9.2	97.65	
27			9.32	97.53	BF, TOB
28			9.73	97.12	Edge of Water, WSEL
29			10.19	96.66	Muddy botton
30			10.12	96.73	
31			10.12	96.73	
32			10.47	96.38	Thalweg, sand bottom
33			10.34	96.51	Relatively firm sand bottom
34.2			9.71	97.14	Edge of Water
35			9.42	97.43	TOB
40			9.16	97.69	Flat n wide mud flat
45			9.19	97.66	Flat n wide mud flat
50			8.97	97.88	Flat n wide mud flat
60			8.97	97.88	Flat n wide mud flat
65			8.9	97.95	Flat n wide mud flat
70			8.8	98.05	Flat n wide mud flat
75			8.79	98.06	Flat n wide mud flat
80			8.83	98.02	Flat n wide mud flat
85			8.83	98.02	
89			8.83	98.02	ponding area
103			8.76	98.09	Edge of mud flat
110.1			6.75	100.10	end point







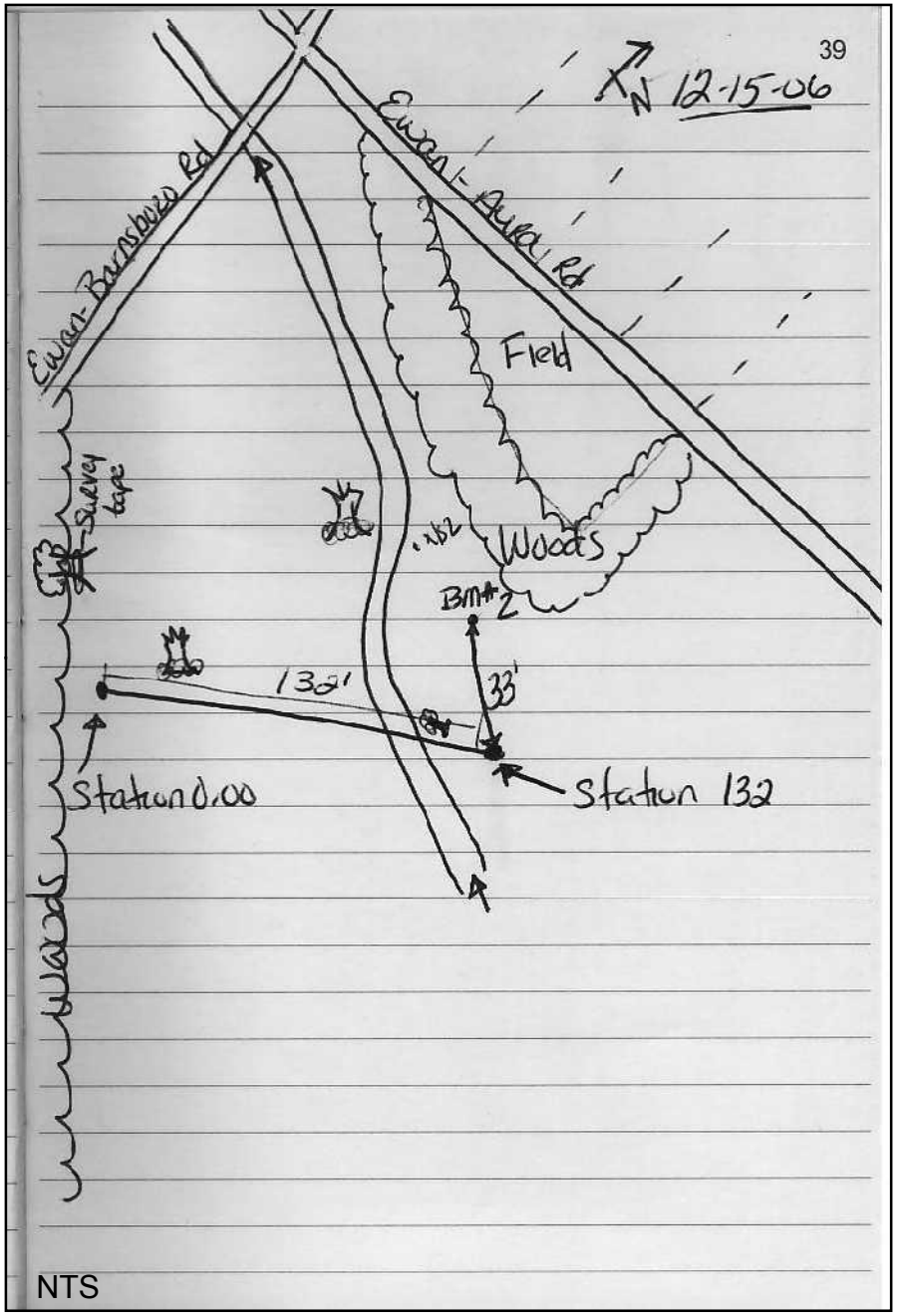
Cross-section Description:
Ends of cross-section were staked with rebar and capped. Channel bottom is very silty and muddy. Both banks have very gentle slopes with soft mud. Channel meanders with wide flat ponding area . Approximately 100-feet downstream of cross-section the channel bottom is about 2-feet below the organic muck.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
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SENTINEL CROSS - SECTION #6

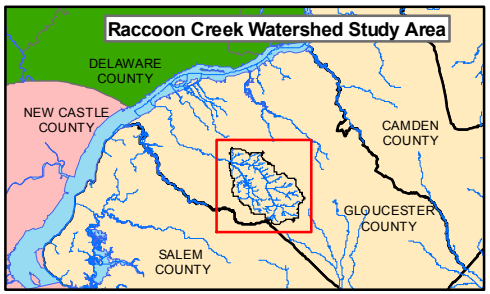




Location Description:
Travel about 825-feet east on Aura-Mullica Hill Road from intersection with Barnsboro-Elmer Road. Walk along the edge of field and into woods. Find bench mark or Station 132 at flagged stakes. Cross-section is located approximately 33-feet southeat of bench mark within Cartwheel Branch (formely Wrights Mill Pond).

	Decimal Degrees		Degrees Minutes Seconds	
Station	Longitude	Latitude	Longitude	Latitude
0.00	75.175522	39.683402	75° 10' 31.878"W	39° 41' 0.246"N
132.00	75.175030	39.683403	75° 10' 30.135"W	39° 41' 0.249"N
Bench Mark	75.174953	39.683456	75° 10' 29.832"W	39° 41' 0.443"N

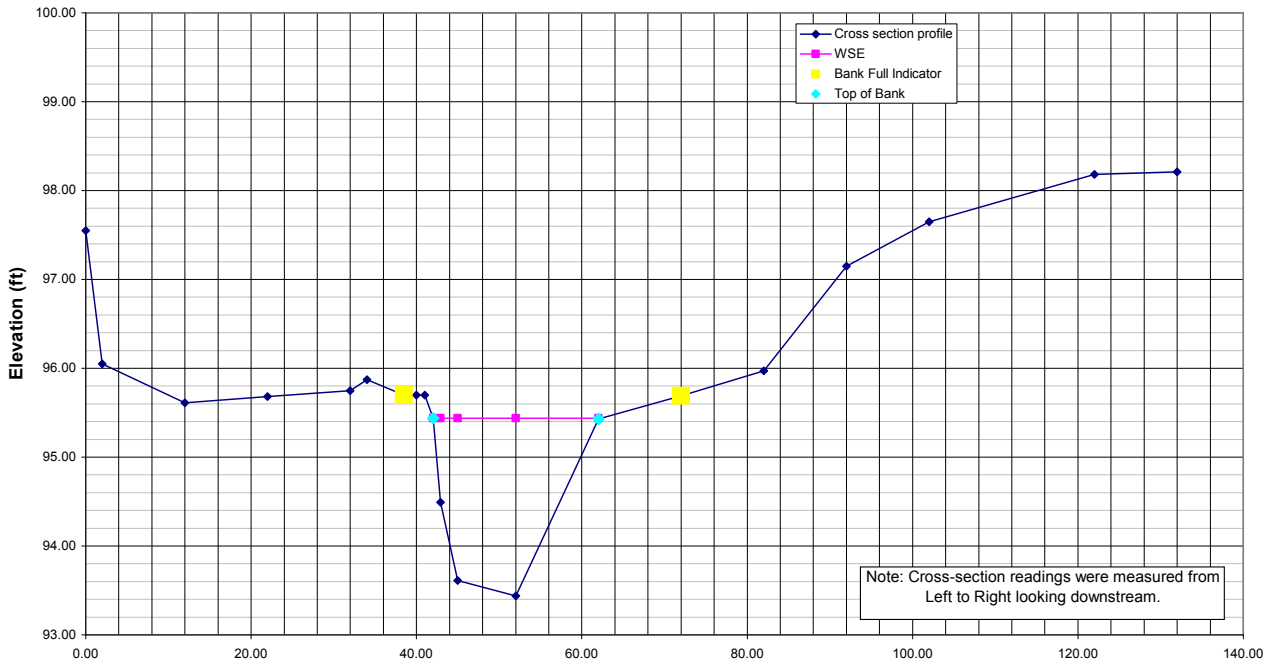
REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK



Legend
- Sentinel XS
- Bench Marks
- Stormwater Basins
- Stormwater Outfalls
- Obstructions
- Roads
- Streams/Rivers

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD. This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

Created by: Chasity Williams, Camden County Soil Conservation District



Note: Digital data available upon request

Cross-sectional Data (Left - Right looking downstream)					
Station	**BS**	**HI**	**FS**	**Elevation**	**Comments**
				98.17	BM (KNOWN)
	5.23	103.40			
0.00			5.85	97.55	Start
2.00			7.35	96.05	
12.00			7.79	95.61	
22.00			7.72	95.68	
32.00			7.65	95.75	
34.00			7.53	95.87	
38.50			7.70	95.70	Bank Full
40.00			7.70	95.70	
41.00			7.70	95.70	
42.00			7.96	95.44	EOW & TOB
42.90			8.91	94.49	
45.00			9.79	93.61	
52.00			9.96	93.44	Thalweg
62.00			7.97	95.43	EOW & TOB
72.00			7.71	95.69	Bank Full
82.00			7.43	95.97	
92.00			6.25	97.15	
102.00			5.75	97.65	
122.00			5.22	98.18	
132.00			5.19	98.21	End point


A - Condition at Cross-section


B - Downstream Condition o


C - Upstream Condition

Cross-section Description:
Ends of cross-section were staked with rebar and capped. Channel bottom is silty and muddy. Both banks have very gentle slopes with soft mud. Cross-section is within the former Wrights Mill Pond. Bench mark was established and is located approximately 1000-feet from breached spillway on East bank looking downstream.

REGIONAL STORMWATER MANAGEMENT PLAN
RACCOON CREEK

Data Source: NJDEP, NJDOT, DVRPC, GCSCD, CCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

Raccoon Creek Water Quality and Bacteria Monitoring
Raccoon Creek, WMA 18

Introduction:

During the summer of 2008 the Camden County Soil Conservation District (CCSCD) completed a water quality and bacteria monitoring project within the Raccoon Creek Watershed. This project involved sampling at seven locations five times during a 30 day period. All project work was done in compliance with an approved Quality Assurance Project Plan (QAPP). Samples from each site were analyzed for Escherichia coli, total phosphorus, orthophosphate phosphorus, total dissolved phosphorus and Total Suspended Sediment by a NJ certified laboratory.

Samples were collected during a variety of flow conditions, including one sample collected during a significant runoff event. Estimated flows at each station for each event are included in this report.

Locations:

Samples were collected at seven sites located through out the non-tidal portion of the Raccoon Creek. Table 1 lists the site name and GPS coordinates. A map showing these locations is provided in Attachment A. The GIS shapefile of all sample locations is included on the data CD.

Table 1: Sample Locations

Site Number	Site Name	Latitude (decimal degrees North)	Longitude (decimal degrees West)
1	Downstream of Kincaid Lake	39.707320	75.190294
2	Upstream of Richwood Road	39.706350	75.200522
3	Swedesboro- Road	39.70869	75.229750
4	Turtle Creek Subdivision	39.729464	75.211486
5	Downstream of Mullica Hill Pond	39.734644	75.221208
6	High Street	39.736230	75.255769
7	Tomlin Station Road	39.740359	75.258830
Note: Samples will be taken at designated locations downstream of lakes			

Site 7- Tomlin Station Road, is existing USGS Sta. ID 01477120. All the other sites were established by the CCSCD.

At each site a staff gage marks the sampling location (at Mullica Hill Pond the staff gage is upstream of the dam and samples are collected about 150 feet below the spillway).

Parameters:

Single grab samples were collected at each site and were analyzed for E. coli, total phosphorus, orthophosphate phosphorus, total dissolved phosphorus and TSS. E. coli was analyzed by QC Laboratories in Vineland, NJ (Lab ID 06005). All other parameters were analyzed by QC Laboratories in Southampton, PA (Lab ID PA166). In-situ measurements of DO (mg/L), Temp and pH were conducted in the field by CCSCD (Lab ID 04019).

A quality table depicting methods, detection limits and accuracy is provided in Attachment B

Sampling Period:

As per the requirements of NJDEP, each site was sampled five times within a 30 day period between Memorial Day and Labor Day. Specifically samples were collected on: June 4, 11, 18, 25 and July 2, 2008

Flow Measurements:

At each site except Tomlin Station Road, the CCSCD establish a monitoring station by installing a staff gage, surveying the cross-section and conducting several direct flow measurements. These flow measurements and the corresponding staff gage reading were used to develop a basic rating table for each cross-section. At the time of each sample the water level was read from the staff gage and the flow was calculated from the rating curve. Sufficient data was collected to estimate flow at all sites. A USGS stream gage is maintained at the Tomlin Station site and the flow during each sampling event was read from the USGS Station Record.

Results:

The laboratory results are provided in Attachment C. Table 1 shows the results of each analysis by sampling event date. These data were plotted by parameter for each site and this information is shown in Graph 1. In-situ results are shown in a similar set of tables and graphs (Table 2 and Graph 2).

Additional data, including direct and indirect flow measurements and rating tables are provided digitally.

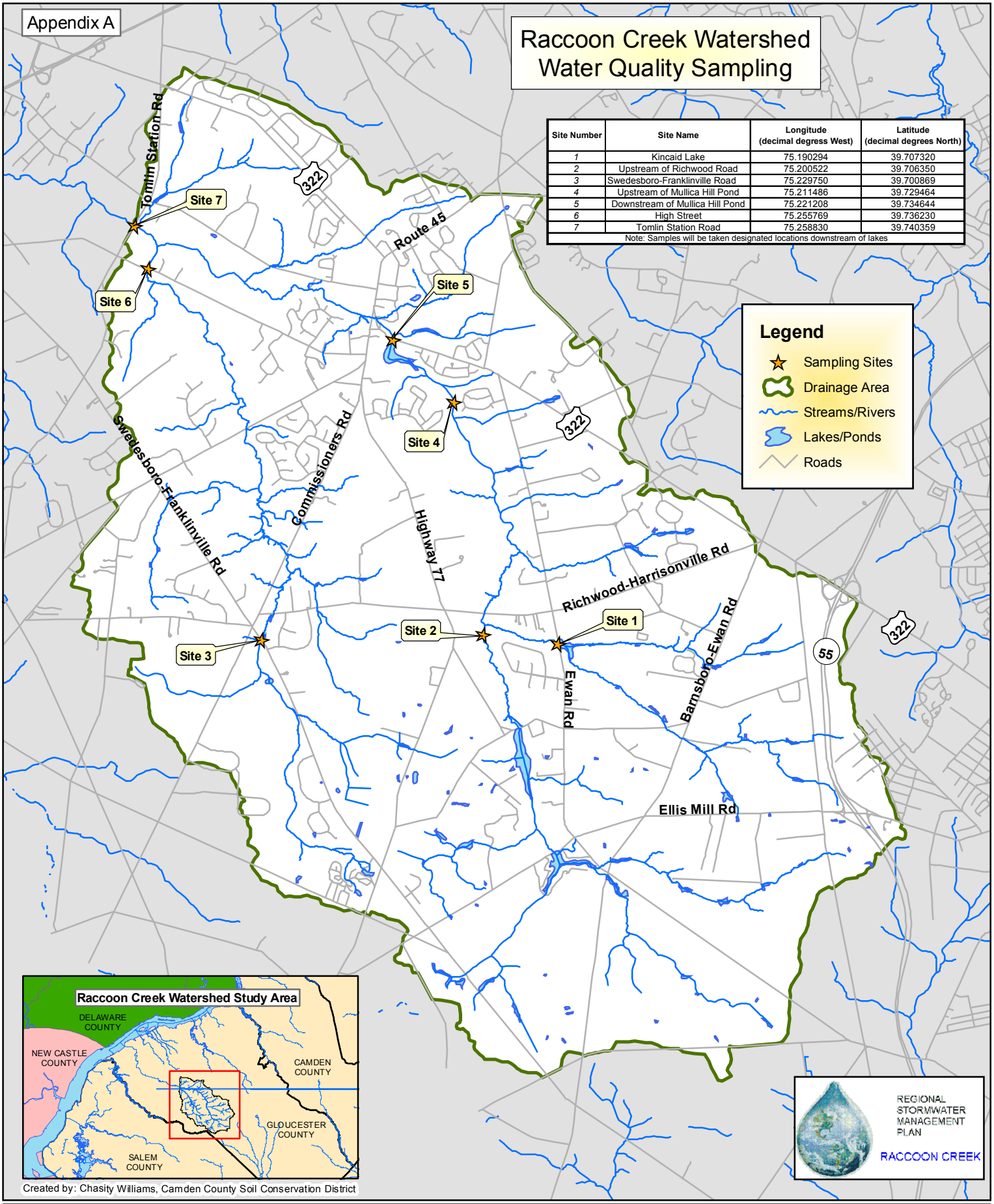
Comments:

Site #3 Swedesboro is the most upstream sample location on the South Branch Raccoon Creek. Consistently high E. coli results suggest a significant source exists upstream of this site. Further evaluation to determine the source of this impairment is recommended.

Appendix A

Raccoon Creek Watershed Water Quality Sampling

Site Number	Site Name	Longitude (decimal degress West)	Latitude (decimal degrees North)
1	Kincaid Lake	75.190294	39.707320
2	Upstream of Richwood Road	75.200522	39.706350
3	Swedesboro-Franklinville Road	75.229750	39.700869
4	Upstream of Mullica Hill Pond	75.211486	39.729464
5	Downstream of Mullica Hill Pond	75.221208	39.734644
6	High Street	75.255769	39.736230
7	Tomlin Station Road	75.258830	39.740359
Note: Samples will be taken designated locations downstream of lakes			



Created by: Chasity Williams, Camden County Soil Conservation District

Data Source: NJDEP, NJDOT, DVRPC, GCSCD
This map has been produced as a secondary product of GIS digital data provided by the agencies listed. This map has not been verified by the NJDEP and is not state authorized.

0 0.5 1 2 Miles

N W E S

Quality Table Raccoon Creek Water Quality Sampling

Test	Total Phosphorus as P	Ortho Phosphate as P	Dissolved Total Phosphorus as P	Total Suspended Solids	E. coli
Method	SM 4500 B.5E	SM 4500 P-E	SM 4500 B.5E	SM 2540-D	EPA 1103.1
MDL	0.009	0.005	0.009	1.8	N/A
PQL	0.05	0.01	0.05	2.0	N/A
PDL	0.05	0.05	0.05	2.0	N/A
Accuracy Mean % Rec	95.72	97.75	95.72	97.0	N/A
Precision Mean % Rec	1.61	1.33	1.61	N/A	N/A
Accuracy Limits	85.3-106.1	89.2-106.3	85.3- 106.3	85-108	N/A
Precision Limit (RPD	4.49	4.01	4.49	5%	

Attachment C: Table 1

Laboratory Results w/ Flow Estimates

Sampling Event : 6-4-08

Analyses	*Site 1 - Kincaid*	*Site 2 - Richwood*	*Site 3 - Swedesboro*	*Site 4 - Turtle*	*Site 5 - DS MHP*	*Site 6 - High*	*Site 7 - Tomlin*
Orthophosphate (mg/L)	0.032	0.028	0.03	0.076	0.104	0.238	0.205
Total Phosphate (mg/L)	0.084	0.097	0.098	0.148	0.163	0.429	0.288
Dissolved Total Phosphorous (mg/L)	0.043	0.029	0.053	0.091	0.13	0.157	0.148
TSS (mg/L)	22.50	30.00	12.70	10.70	40.7	73	62
E. coli (# colonies / 100 mg/L)	3000	300	6700	1900	3300	**8000**	**8000**
Estimated Stream Flow (cfs)	14.56	**24.21**	**20.00**	56.25	58.70	43.99	147.00

E.coli values are Greater than (>8000)
(--) Denotes no sample was collected
(ND) Denotes no detection

Sampling Event : 6-11-08

Analyses	*Site 1 - Kincaid*	*Site 2 - Richwood*	*Site 3 - Swedesboro*	*Site 4 - Turtle*	*Site 5 - DS MHP*	*Site 6 - High*	*Site 7 - Tomlin*
Orthophosphate (mg/L)	0.04	0.017	0.05	0.066	0.081	0.12	0.12
Total Phosphate (mg/L)	0.078	0.038	0.069	0.092	0.151	0.148	0.18
Dissolved Total Phosphorous (mg/L)	0.037	0.021	0.049	0.073	0.079	0.116	0.116
TSS (mg/L)	40.00	6.70	4.50	2.00	9.5	6	2.7
E. coli (# colonies / 100 mg/L)	**100**	**100**	400	200	600	**100**	100
Estimated Stream Flow (cfs)	2.80	4.40	0.67	9.82	9.63	11.27	31.00

E.coli values are Less than (<100)
(--) Denotes no sample was collected
(ND) Denotes no detection

Sampling Event : 6-18-08

Analyses	*Site 1 - Kincaid*	*Site 2 - Richwood*	*Site 3 - Swedesboro*	*Site 4 - Turtle*	*Site 5 - DS MHP*	*Site 6 - High*	*Site 7 - Tomlin*
Orthophosphate (mg/L)	0.026	0.023	0.051	0.052	0.057	0.097	0.091
Total Phosphate (mg/L)	0.096	0.028	0.07	0.067	0.119	0.127	0.13
Dissolved Total Phosphorous (mg/L)	0.027	0.028	0.061	0.079	0.06	0.093	0.094
TSS (mg/L)	32.00	ND	3.30	8.00	5.3	3.3	4
E. coli (# colonies / 100 mg/L)	50	50	330	110	90	460	110
Estimated Stream Flow (cfs)	1.60	4.21	0.30	7.53	8.40	9.55	26.00

(--) Denotes no sample was collected
(ND) Denotes no detection

Sampling Event : 6-25-08

Analyses	*Site 1 - Kincaid*	*Site 2 - Richwood*	*Site 3 - Swedesboro*	*Site 4 - Turtle*	*Site 5 - DS MHP*	*Site 6 - High*	*Site 7 - Tomlin*
Orthophosphate (mg/L)	0.017	0.013	0.054	0.047	0.043	0.085	0.052
Total Phosphate (mg/L)	0.064	0.027	0.073	0.073	0.083	0.121	0.082
Dissolved Total Phosphorous (mg/L)	0.024	0.024	0.063	0.061	0.07	0.083	0.051
TSS (mg/L)	19.00	5.00	4.00	11.50	4	3.5	6
E. coli (# colonies / 100 mg/L)	30	10	190	120	20	15	80
Estimated Stream Flow (cfs)	2.00	3.47	0.23	6.81	12.40	7.71	23.00

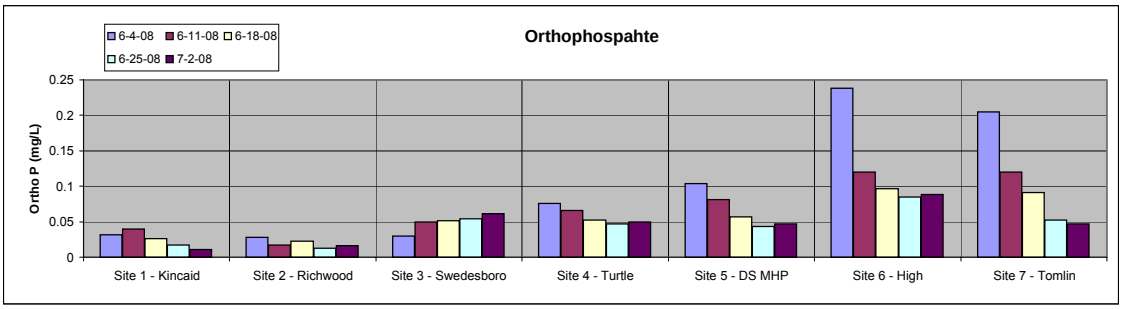
(--) Denotes no sample was collected
(ND) Denotes no detection

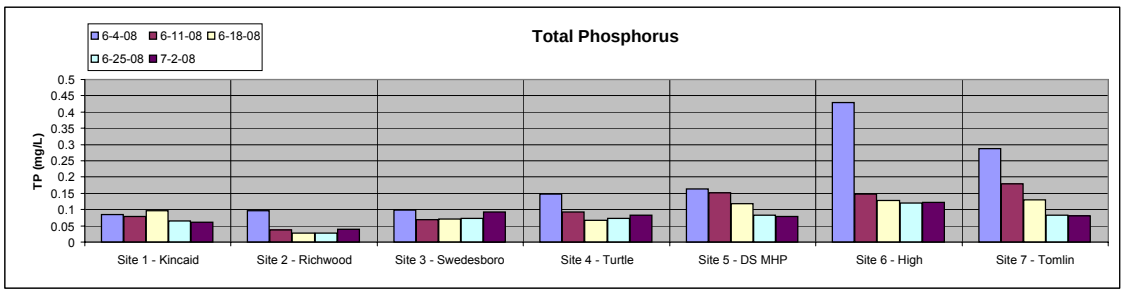
Sampling Event : 7-2-08

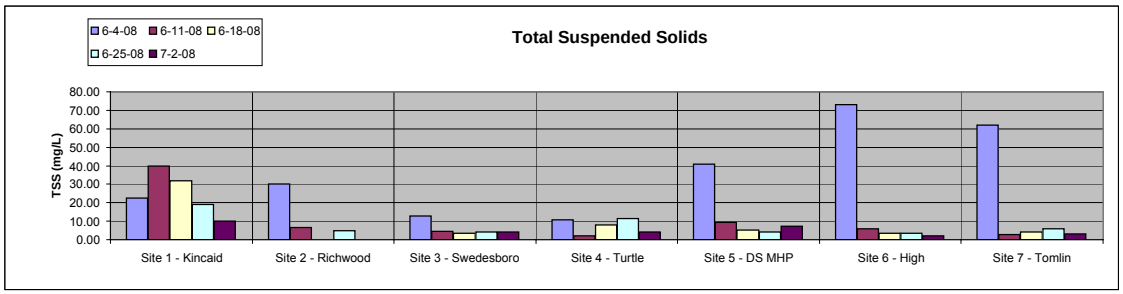
Analyses	*Site 1 - Kincaid*	*Site 2 - Richwood*	*Site 3 - Swedesboro*	*Site 4 - Turtle*	*Site 5 - DS MHP*	*Site 6 - High*	*Site 7 - Tomlin*
Orthophosphate (mg/L)	0.011	0.016	0.061	0.05	0.047	0.088	0.047
Total Phosphate (mg/L)	0.061	0.04	0.093	0.083	0.079	0.1221	0.081
Dissolved Total Phosphorous (mg/L)	0.027	0.03	0.065	0.06	0.038	0.09	0.054
TSS (mg/L)	10.00	ND	4.00	4.00	7.2	2	3.2
E. coli (# colonies / 100 mg/L)	80	60	420	290	130	220	180
Estimated Stream Flow (cfs)	1.36	2.25	0.20	5.05	7.28	7.26	21.00

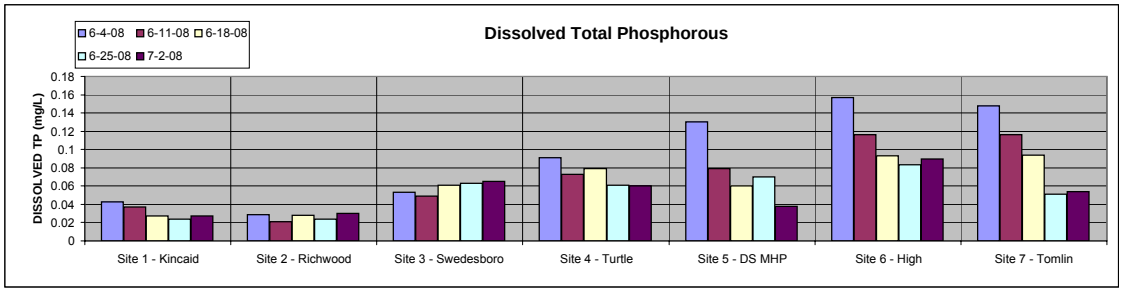
(--) Denotes no sample was collected
(ND) Denotes no detection

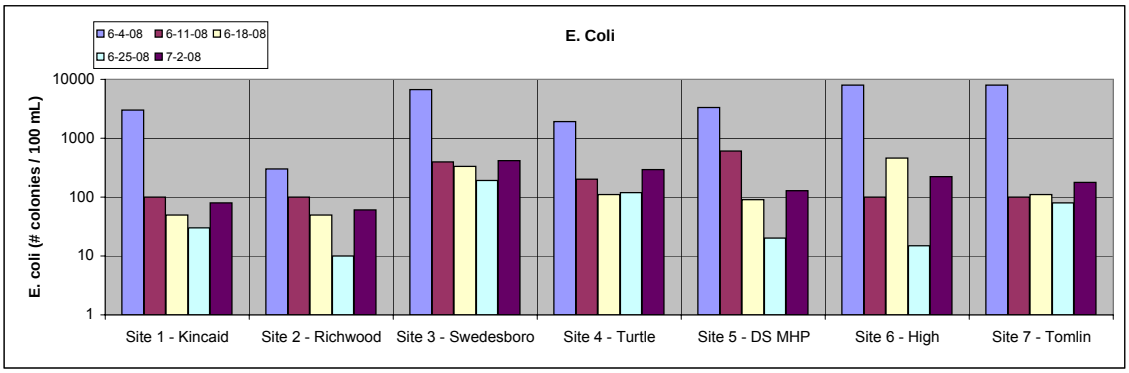
Attachment C: Graph 1











Attachment C: Table 2

Dissolved Oxygen (mg/L)

	6/4/2008	*6/11/2008*	*6/18/2008*	*6/25/2008*	7/2/2008
Site 1	8.00	6.94	6.49	7.60	6.41
Site 2	7.51	6.27	5.82	6.79	6.17
Site 3	8.12	7.71	6.89	7.78	7.17
Site 4	6.83	6.69	6.33	7.50	7.16
Site 5	7.93	7.61	6.40	7.23	5.92
Site 6	6.91	7.27	7.17	8.36	8.02
Site 7	7.57	7.15	7.03	8.17	7.91

Dissolved Oxygen (%)

	6/4/2008	*6/11/2008*	*6/18/2008*	*6/25/2008*	*7/2/2008*
Site 1	86.60	84.90	74.10	89.50	78.70
Site 2	86.80	77.60	67.70	80.10	75.20
Site 3	86.60	86.20	72.90	83.20	79.50
Site 4	76.30	81.00	71.60	85.50	83.90
Site 5	87.80	94.10	72.00	84.30	71.60
Site 6	73.40	82.90	75.60	91.50	90.70
Site 7	81.80	83.70	76.00	90.00	89.40

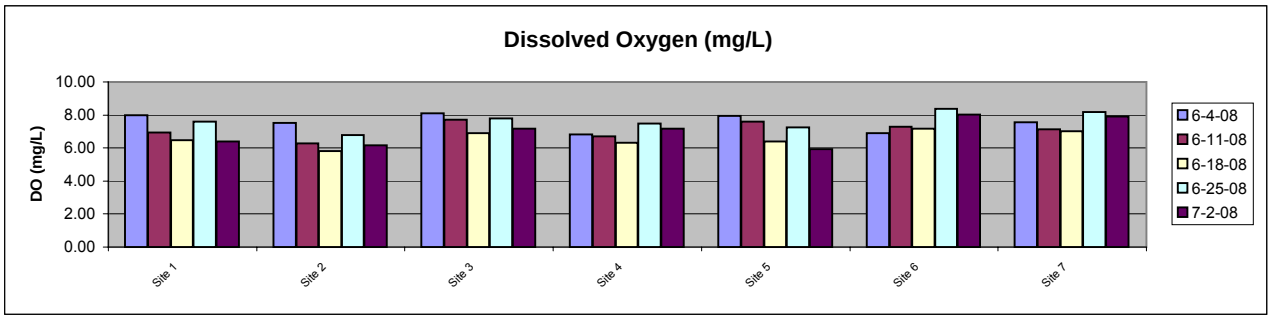
pH

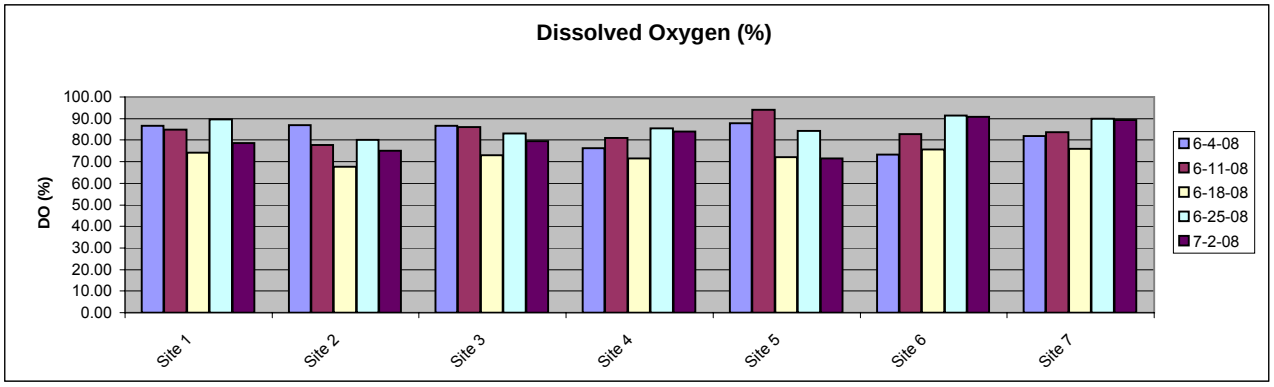
	6/4/2008	*6/11/2008*	*6/18/2008*	*6/25/2008*	*7/2/2008*
Site 1	6.80	5.54	5.74	7.41	5.81
Site 2	6.51	6.10	6.20	7.12	6.20
Site 3	6.29	6.61	6.56	7.08	6.55
Site 4	6.58	6.80	6.98	7.13	6.87
Site 5	6.53	6.88	7.02	7.06	6.74
Site 6	6.35	6.82	5.47	7.16	6.89
Site 7	6.54	6.82	7.07	7.12	6.88

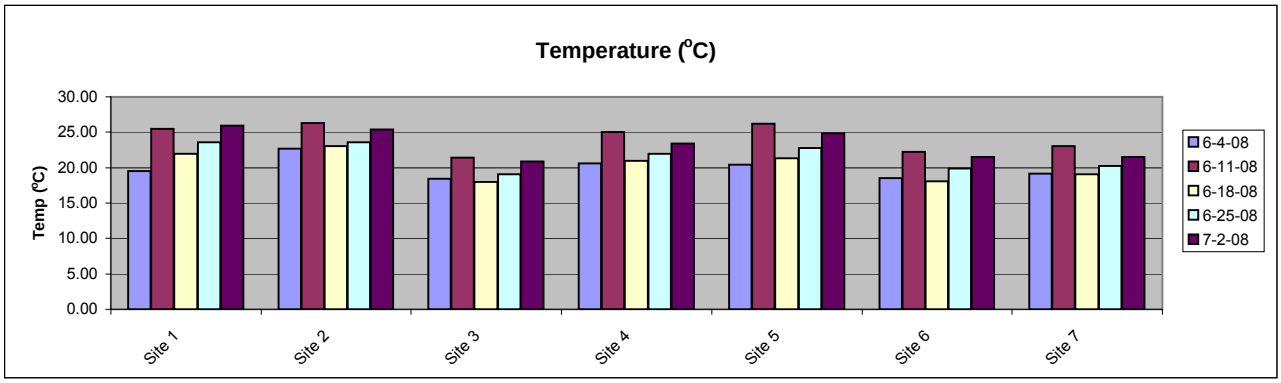
Temperature (^{o}C) - Corrected

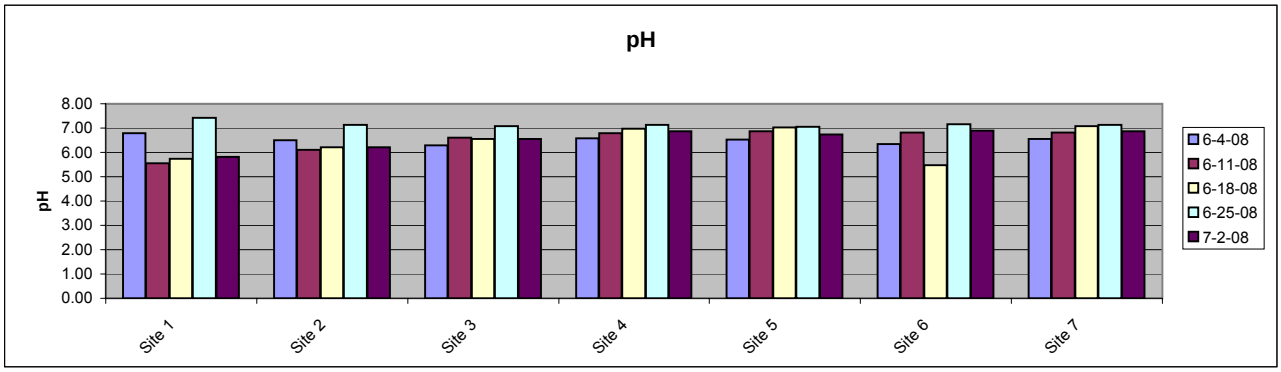
	6/4/2008	*6/11/2008*	*6/18/2008*	*6/25/2008*	*7/2/2008*
Site 1	19.53	25.45	21.92	23.55	25.97
Site 2	22.65	26.34	23.01	23.60	25.43
Site 3	18.45	21.40	18.02	19.06	20.85
Site 4	20.62	25.01	20.93	21.92	23.40
Site 5	20.39	26.16	21.31	22.80	24.87
Site 6	18.55	22.23	18.04	19.85	21.55
Site 7	19.17	23.04	19.09	20.25	21.48

Attachment C: Graph 2









Mullica Hill Pond
Characterization and Restoration Plan



Prepared For:
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August 2008

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1.0 Introduction

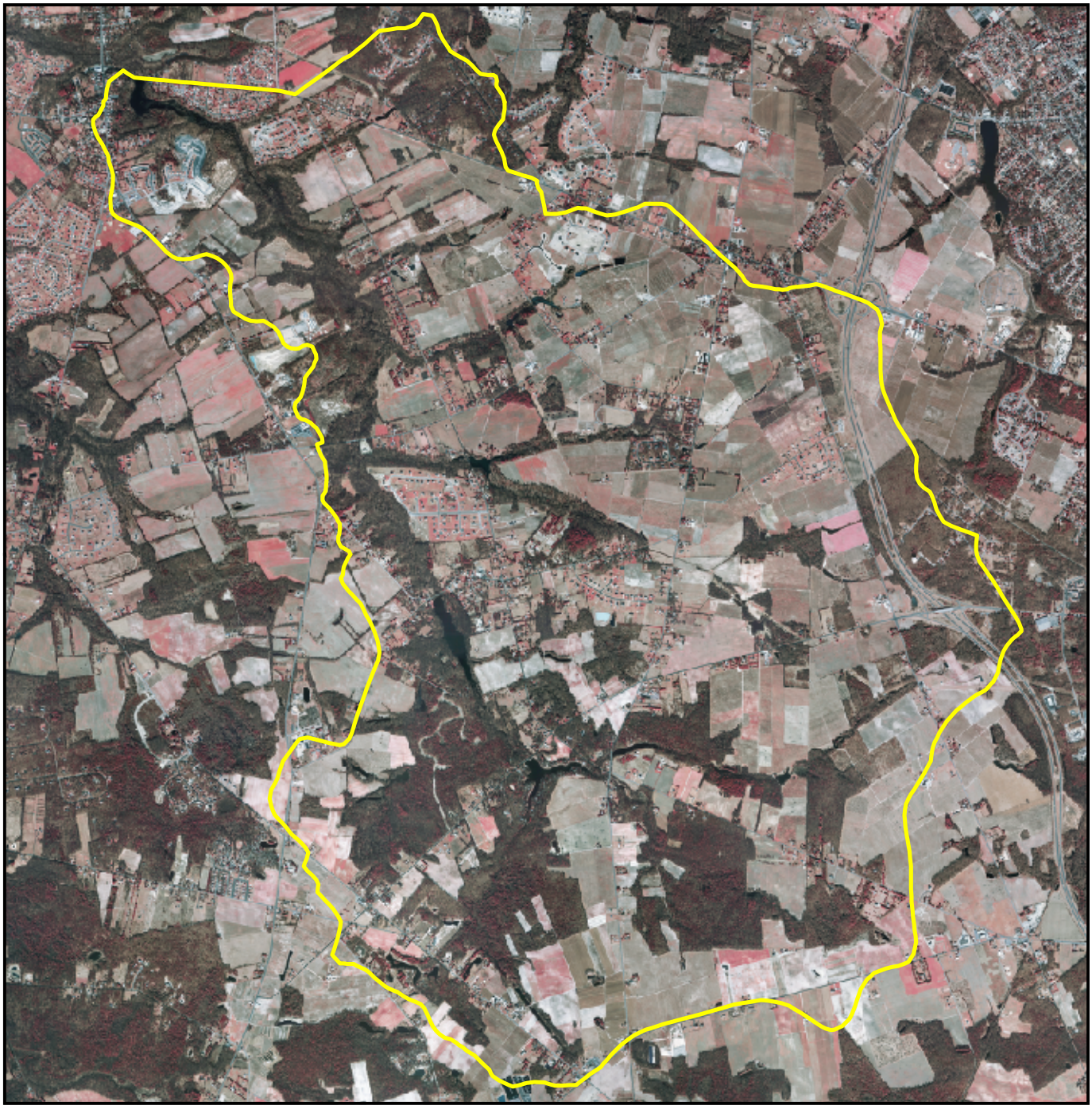
The Camden County Soil Conservation District (CCSCD) proposed to conduct a long-term Restoration and Management Plan of Mullica Hill Pond, a 13.3-acre water body located in Harrison Township, Gloucester County, New Jersey. The project work plan essentially was modeled following the guidance for lake characterizations developed by the United States Environmental Protection Agency (USEPA) and the New Jersey Department of Environmental Protection (NJDEP). The main objectives of the project is the collection of a variety of in-lake and watershed data used to assess the status of the lake, the quantification of the lake's annual hydrologic and pollutant budgets and the development of a holistic Restoration and Management Plan for the lake and the watershed.

The tasks implemented in the completion of this assessment consisted of the following:

1. In-Lake Water Quality Monitoring
2. Pollutant Budget Analysis
3. Bathymetric Survey
4. Basic Hydrologic Budgets
5. Identification of Restoration Plan Strategies (including a fishery survey)

This report presents the findings as based on the completion of the water quality monitoring effort as well as the results of the bathymetric survey and nutrient and sediment budget analyses, fishery survey and finally Management and Restoration Plan recommendations.

Although Mullica Hill Pond is a popular site for fishing and canoeing, it does experience water quality problems through the growing season. Excessive densities of algae, both planktonic and filamentous, are the primary water quality problem in Mullica Hill Pond. Thus, a substantial portion of this Lake Characterization and Restoration Plan will focus on addressing and reducing the excessive densities of this nuisance algal growth. However, the Lake Characterization will also be pro-active in nature, quantifying the lake's current pollutant loads (i.e. nitrogen, phosphorus and suspended solids) and providing recommendations on how to prevent additional declines in water quality in the future.



Princeton Hydro

FIGURE 1: 2002 AERIAL PHOTOGRAPHS

HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

LEGEND

Watershed

0 2,000 4,000 Feet

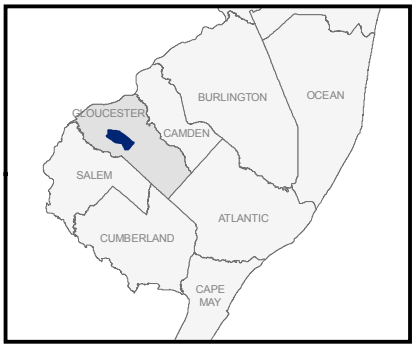
1 inch equals 4,000 feet

PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551

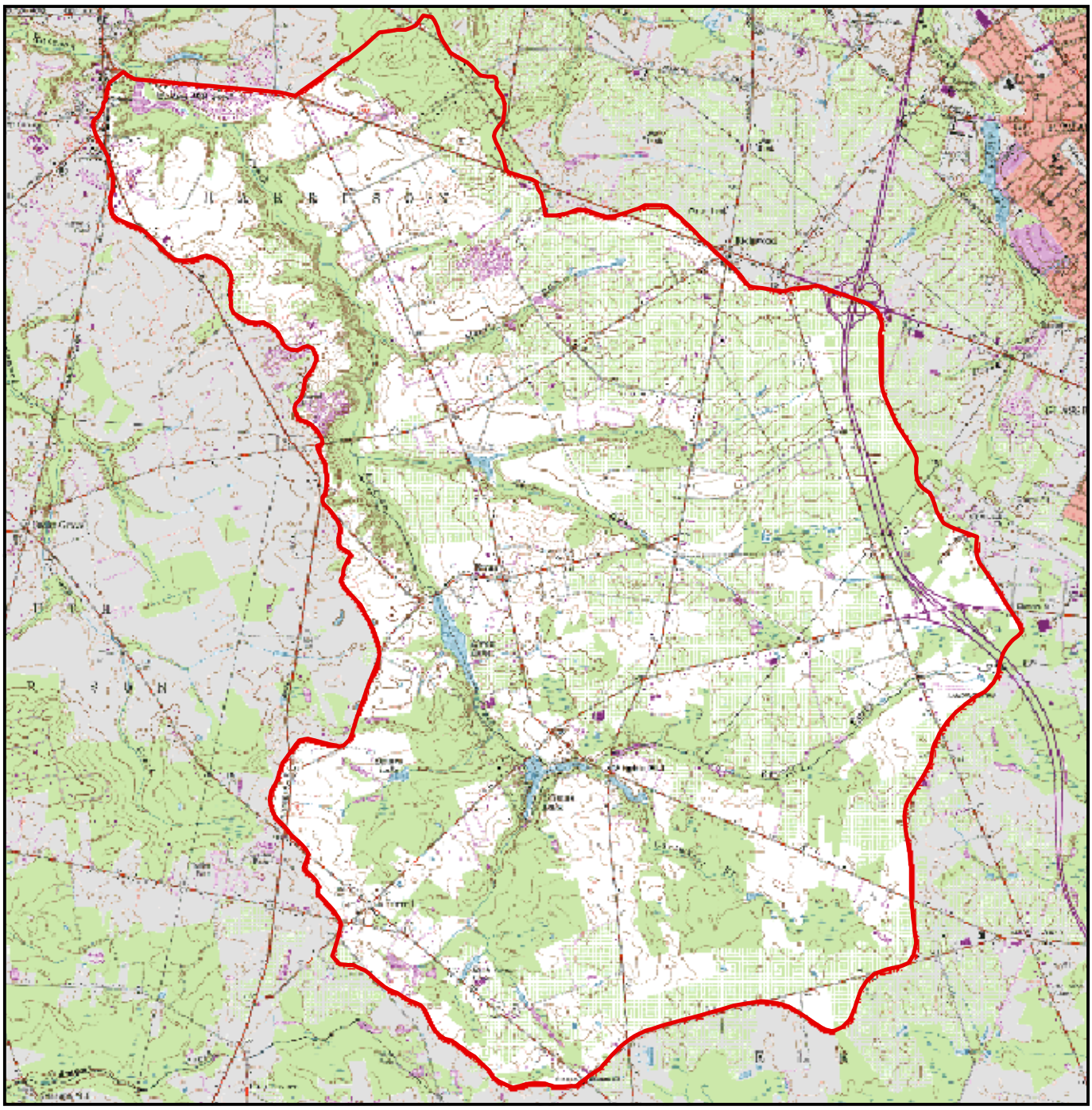
SOURCES:

1. Project watershed boundary as obtained from the NJDEP website.
2. USGS 7.5 Minute Series Topographic Map for Pitman West and Woodbury, NJ, as exported from Terrain Navigator Pro.

NEW JERSEY COUNTY MAP



File:R:\0763\Projects\07630001\GIS\MXD\revisedwatershed\rewshedUSGS.mxd. Copyright Princeton Hydro, LLC.



Princeton Hydro

FIGURE 2: USGS TOPOGRAPHIC MAP

HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

LEGEND

Watershed

0 2,000 4,000 Feet

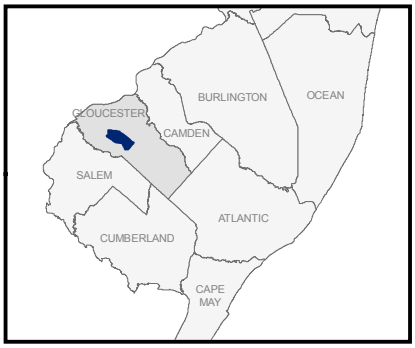
1 inch equals 4,000 feet

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SOURCES:

1. Project watershed boundary as obtained from the NJDEP website.
2. USGS 7.5 Minute Series Topographic Map for Pitman West and Woodbury, NJ, as exported from Terrain Navigator Pro.

NEW JERSEY COUNTY MAP



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2.0 Characterization of Lake Morphometry

Mullica Hill Pond has a surface area of 13.3 acres (5.4 hectares) and is similar to the letter "L" in shape (Figure 2). Water flows to the Lake via the Raccoon Creek. The damming of the Run forms Mullica Hill Pond. In turn, water from Mullica Hill Pond flows over the dam and downstream and eventually drains in an eastern direction to the Raccoon Creek, which in turns drain directly to the Delaware River.

The lake is a shallow system, with a mean depth of only 1.5 ft (0.5 m) and a maximum depth of 7.5 ft (2.3 m). The resulting volume of water within Mullica Hill Pond is 12.9 acre-ft (15,900 m^3). As will be shown in more detail later in the report, the general shape and morphometry of the lake will have a direct impact on the development of the lake's Management Plan.

A bathymetric survey of Mullica Hill Pond was conducted by Princeton Hydro on 30 October 2006. A series of transects were surveyed with a dual frequency fathometer and tied into GPS via a field laptop computer. The collected data were used to generate a bathymetric map of the lake (Figure 3). In turn, the analyzed data were used to planimetrically calculate the lake's total volume as well as generate the bathymetric contours (Table 1 and Figure 3, respectively).

In addition to water depth, data were collected on the depth or "thickness" of the unconsolidated sediments in Mullica Hill Pond. Such data are absolutely essentially in order to quantify the costs associated with potentially dredging the lake. The quantified sediment thickness data were used to calculate the total volume of unconsolidated sediments in Mullica Hill Pond (Figure 3).

Finally, the morphometric data were combined with select hydrologic data to calculate Mullica Hill Pond's hydraulic residence time and annual flushing rate, two important parameters with regard to management of a lake. The hydraulic residence time is the amount of time required to completely replace the lake's current volume with "new" water. It can also be thought of how long one molecule of water will be in the lake before it leaves via the main outflow. The annual flushing rate, which is the inverse of the hydraulic residence time, is the rate at which water enters and leaves a lake relative to its volume. As will be shown in Sections 5 through 7, these parameters aid in determining how efficiently incoming nutrients will be assimilated by algae and plants. In turn, this will dictate the observed water quality conditions through the growing season.

TABLE 1

Lake and Watershed Characteristics for Mullica Hill Pond

Parameter	Value
Lake Surface Area	13.3 acres
Watershed Area	8,616 acres
Mean Depth	1.5 feet
Maximum Depth	7.5 feet
Lake Volume	15,900 m^3
Hydraulic Residence Time	0.35 days
Flushing Rate	1,036 times per year
Watershed Area/Lake Surface Area	648:1

File: P:\0763\Projects\0763001\GIS\MXD\Water_Depth_1117.mxd

LAKE STATISTICS

Area of Lake: 13.3 Acres
Area of Survey: 8.6 Acres

Estimated Volume of Water: 562,054 cubic feet
(of Area Surveyed) (20,816.8 cubic yards)

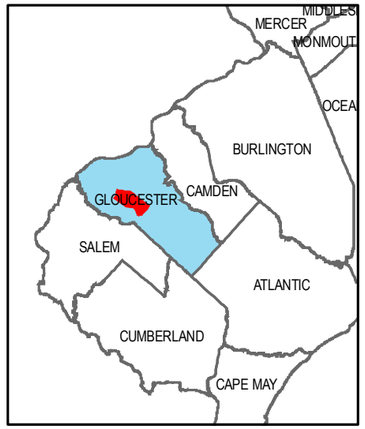
Note:

Areas noted on the map was Emergent Vegetation were inaccessable to the boat and sounder utilized in this survey. These areas were probed with a sounding rod and an average depth of 0.75' was assigned to these areas

pH

Princeton Hydro

NEW JERSEY COUNTY MAP



PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
Offices in Sicklerville, NJ and Exton, PA

N

1 inch equals 200 feet

0 200 Feet

SOURCES:

1. Bathymetry of Mullica Hill Pond performed on Oct. 30, 2006 utilizing a Knundsen EchoSounder in unison with a Trimble ProXH GPS unit.
2. Bathymetric data post-processing completed with Hypack Max software
3. All 3-D modeling and contouring completed with ESRI's ArcGIS 9.2

FIGURE 3
WATER DEPTH CONTOURS

CAMDEN COUNTY SOIL
CONSERVATION DISTRICT

MULLICA HILL POND
LONG TERM MAINTENANCE PLAN
HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

Legend

- Lake Boundary
- Limit of Survey
- Water Depth Contours
- Emergent Vegetation

File: P:\0763\Projects\0763001\GIS\MXD\Water_Depth_1117.mxd

LAKE STATISTICS

Area of Lake: 13.3 Acres
Area of Survey: 8.6 Acres

Estimated Volume of Water: 562,054 cubic feet
(of Area Surveyed) (20,816.8 cubic yards)

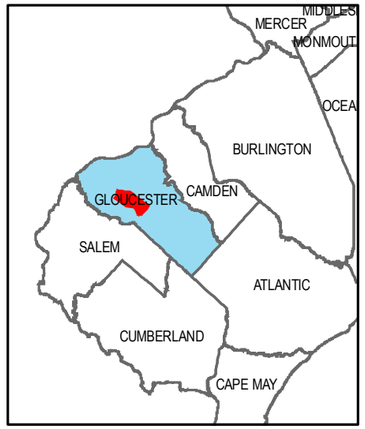
Estimated Volume of Sediment: 357,020 cubic feet
(of Area Surveyed) (13,225 cubic yards)

Note:

Areas noted on the map was Emergent Vegetation were inaccessable to the boat and sounder utilized in this survey. These areas were probed with a sounding rod and an average depth of 0.75' was assigned to these areas

Princeton Hydro

NEW JERSEY COUNTY MAP



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N

1 inch equals 200 feet

0 200 Feet

SOURCES:

1. Bathymetry of Mullica Hill Pond performed on Oct. 30, 2006 utilizing a Knundsen EchoSounder in unison with a Trimble ProXH GPS unit.
2. Bathymetric data post-processing completed with Hypack Max software
3. All 3-D modeling and contouring completed with ESRI's ArcGIS 9.2

FIGURE 4
SEDIMENT THICKNESS CONTOURS

CAMDEN COUNTY SOIL
CONSERVATION DISTRICT

MULLICA HILL POND
LONG TERM MAINTENANCE PLAN
HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

Legend

- Lake Boundary
- Limit of Survey
- Sediment Thickness Contours
- Emergent Vegetation

3.0 Water Quality Data

Mullica Hill Pond was sampled twice by Princeton Hydro during the 2007 growing season: 29 May 2007 and 16 July 2007. These sampling events were conducted to document the general "health" of the lake and aid in the quantification and refinement of its annual pollutant budgets. Both *in-situ* and discrete water quality sampling was conducted for a variety of physical, chemical and biological parameters.

3.1 In-situ Water Quality Data

During each sampling event, temperature, dissolved oxygen (DO), pH and conductivity were measured at half to one meter intervals from surface to bottom at a mid-lake sampling station. A Eureka Manta PDA meter with Amphibian multi-probe was utilized to collect the *in-situ* data. A sample location map, as well as the collected *in-situ* data can be found in Appendix A.

3.1.1 Temperature

Temperature is one of the most important water quality parameters, since it controls the rate of all chemical and biological reactions and determines the physical structure of a lake or pond. As the air temperature increases through the growing season, the temperature of the surface waters increases. This results in the surface waters being warmer than the bottom waters. Once the temperature difference between the surface and the bottom waters is large enough (i.e. a difference > 1° C per meter) a waterbody becomes thermally stratified. These conditions substantially minimize the transfer of materials and gases between the surface waters (the epilimnion) and the bottom waters (the hypolimnion). Although this process, called thermal stratification, is more common for deep lakes, it can occur to some extent in even lakes as shallow as Mullica Hill Pond. In productive waterbodies, once the deeper water is restricted, even for a short period of time, from freely mixing with the surface water, atmospheric oxygen is no longer mixed to the deeper waters. As a result of bacterial processes occurring in the lake's sediment, the deep water DO becomes quickly exhausted. This depletion of DO in the bottom waters is termed anoxia. As such thermal conditions can have a substantial impact on the overall water quality of a lake.

For the most part, water temperatures were reflective of ambient conditions. That is as air temperatures increased so did the water temperatures of the lake. However, the surface water temperatures of Mullica Hill Pond were slightly higher than those of the bottom waters. It should be noted that this difference between the surface and bottom waters was minor and not enough to create the stratification affect noted above. The relatively shallow depth of the lake prevented the establishment of strong thermal differences (Appendix A). Although the temperature differences were minor, it appears that the establishment of dense filamentous algae mats may have impeded

water column mixing enough to cause the bottom waters to reach a reduced dissolved oxygen state at points through the course of the growing season. This condition was likely exacerbated by the lake's highly organic sediments, which have a high bacterial oxygen demand. Further affecting the lake's mixing and thermal state was seasonal changes in inflow from Raccoon Creek.

3.1.2 Dissolved Oxygen (DO)

For a healthy and diverse ecosystem, DO concentrations should be equal to or greater than 4 mg/L. Although most aerobic organisms can exist at 4 mg/L, some, such as trout, require at least 4 mg/L of DO to survive. For the most part, DO concentrations were sufficient to maintain in-lake habitat for most aquatic organisms through the course of the program. However, more sensitive organisms, such as any trout that may be present, may have been stressed at points during the program when reduced concentrations of dissolved oxygen were observed.

During the 29 May sampling event, DO concentrations were greater than 4 mg/L from surface to bottom (Appendix A). In contrast, during the 16 July sampling event, DO concentrations declined within specific areas of Mullica Hill Pond. Both surface and bottom water DO concentrations were less than the 4 mg/L threshold during this time period and were substantially lower than the DO concentrations of the middle waters (Appendix A). In July it appears that the dense amount of algal mats present on the surface did not allow for surface water mixing, thus reducing the dissolved oxygen concentrations. Within the middle portions of the water column, baseline stream flow allowed enough mixing to occur for the dissolved oxygen to achieve acceptable concentrations.

Thus, Mullica Hill Pond appears to experience a seasonal decline in DO concentrations, especially through the mid-summer season. One of the direct causes of this decline can be attributed to the large density of filamentous algal mats present within the lake. The large presence of these algal mats can actually prevent wind action from mixing the water column, preventing both the top and bottom waters from being directly oxygenated.

It should be noted that the extent of mid-summer DO depletion may be greater than reflected in the data. During the day the algae will contribute DO via photosynthesis. However, at night, the algae will use DO, thus adding to the lake's overall oxygen demand. This can lead to significant nocturnal decreases in DO. This is why in general fish kills tend to occur over-night.

3.1.3 pH

The pH of Mullica Hill Pond was relatively neutral for the most part, ranging between 6.8 and 7.2 during the sampling events (Appendix A). On 29 May 2007 in-lake pH varied between 7.16 and 7.23 and on 16 July 2007 the in-lake pH ranged between 6.80 and 6.88.

The relatively neutral pH values in Mullica Hill Pond, especially during the summer months, were attributed to the general water chemistry of the lake and geology of the watershed. The southern portion of New Jersey, and in particular the Pinelands areas, typically possess neutral to slightly acidic stream and groundwater. This was specifically observed in the Mullica Hill Pond sampling events of 2007. However, it is also curious that given the amount of algal productivity observed in the lake in July that the pH was actually lower in the summer than in the spring. Typically increased levels of photosynthesis causes the pH to increase, pushing a lake further into the alkaline pH range. Just the opposite was observed. Given the fact that our analysis is based only two sampling events this discrepancy may be a function of a number of factors.

3.1.4 Conductivity

Conductivity is a measurement of the ability of water to carry an electric current. However, it can also be used as a measurement of the amount of dissolved substances (i.e. nutrients, minerals, salts) present in water. Therefore, the higher the conductivity, the more dissolved substances present in the water. Through the course of the sampling program of Mullica Hill Pond, specific conductivity varied between 0.193 mmhos/cm and 0.196 mmhos / cm (Appendix A). These conductivity values are considered low to moderate for a New Jersey lake. For example, conductivity in waterbodies within the Pine Barrens can be as low as < 0.1 mmhos / cm, while the conductivity in lakes in northern New Jersey can be as high as 0.4 to 0.5 mmhos / cm. The measured conductivities in Mullica Hill Pond are not indicative of any large-scale pollutant contamination (i.e. nutrients, heavy metals), at least during the 2007 sampling events.

3.1.5 Water Clarity (measured with a Secchi disk)

The water clarity of Mullica Hill Pond was measured with a Secchi disk, which is a weighted circular disk 20cm in diameter with four (4) alternating black and white sections painted on the surface. The disk is attached to a measured line that is marked in 0.2 meter intervals. The disk is slowly lowered into the water until it can no longer be seen. At this point the observer records the depth with the calibrated line. The disk is then slowly raised until it reappears. Once it reappears, this depth is recorded. The average of the two values is the Secchi depth. The clearer the water, the larger the Secchi depth value will be. Secchi depth was measured at the in-lake stations during each sampling event.

Water clarity, as measured with a Secchi disk, was at least 1.0 meters each of the sampling events (Appendix A). However, it should be noted that in order to obtain these Secchi depth readings, the filamentous algal mats needed to be broken apart for the measurement. The relatively shallow water depths and generally clear waters of Mullica Hill Pond result in the high rates of benthic and filamentous algal growth that currently exists.

3.2 Discrete Water Quality Data

In addition to *in -situ* monitoring, discrete samples were collected during each sampling event for a variety of chemical and biological parameters. Mid-lake samples were collected during each of the two sampling events. The discrete samples were transported to a State-certified laboratory and analyzed for alkalinity, ammonia-N (NH_4-N), nitrate-N (NO_3-N), total phosphorus (TP) and total suspended solids (TSS).

In addition to the chemical samples, biological samples were also collected from the mid-lake sample station as part of the Mullica Hill Pond water quality monitoring program. Biological monitoring included the collection of samples for chlorophyll *a*, phytoplankton and zooplankton. During each monitoring event, whole water samples were collected for chlorophyll *a* and phytoplankton, while another sample was collected with a Schindler trap for zooplankton. The phyto- and zooplankton samples were preserved with a Lugol's solution. The organisms were identified to genus and were enumerated. The resulting data were then used to identify plankton abundance in Mullica Hill Pond.

General observations on the dominant aquatic plants and benthic algae were also made and recorded during each sampling event. Finally, a fishery survey of Mullica Hill Pond was conducted with the use of a boat-based electro-fishing system and two (2) different types of nets on 18 October 2007 and 19 October 2007.

3.2.1 Alkalinity

The alkalinity of water is its capacity to resist a change or shift in pH; it is also known as the buffering capacity of a waterbody. Alkalinity is typically expressed in terms of calcium carbonate with concentrations ranging from 20 to 200 mg of $CaCO_3$ / l in most natural freshwater ecosystems. Alkalinity was measured during the Mullica Hill Pond monitoring program. The in-lake alkalinities ranged from 27.3 mg to 31.9 mg of $CaCO_3$ / l, throughout the course of the sampling program (Appendix B). Based on these results, the alkalinity Mullica Hill Pond can be considered moderately low as compared to other New Jersey lakes. This moderate alkalinity means its buffering capacity is low. This makes the lake relatively prone to pH shifts. This may in part explain the observed seasonal differences in pH.

3.2.2 Phosphorus

Phosphorus is the primary limiting nutrient in most freshwater waterbodies within the Mid-Atlantic section of the United States. In other words, it takes very little phosphorus to stimulate large amounts of algal and/or aquatic plants growth; as phosphorus concentrations increase, the amount of algal and/or aquatic plant biomass will also increase. Thus, reducing current phosphorus loads, as

well as controlling future loads, is an effective, long term strategy in improving and preserving the water quality of a lake or pond.

It has been well documented that in-lake TP concentrations greater than 0.03 mg/L can stimulate high levels of algal and/or aquatic plant growth. Under such conditions, a lake or pond is described as being eutrophic, meaning it is highly productive. Thus, such water bodies have the potential to experience algal blooms and excessive densities of aquatic plants. Based on Princeton Hydro's project experience, when in-lake TP concentrations exceed 0.06 mg/L, nuisance-level algal blooms will more than likely occur.

A single form of phosphorus was measured in Mullica Hill Pond. This form is TP, which measures all the phosphorus in the water; inorganic and organic, particulate and dissolved. Most water quality models are based on in-lake TP concentrations.

TP concentrations were somewhat elevated in Mullica Hill Pond, with a consistent concentration of 0.08 mg/L detected during the in-lake monitoring events (Appendix B). Thus, TP concentrations at Mullica Hill Pond were greater than the 0.03 mg/L threshold, and exceeded the 0.06 mg/L threshold for nuisance algal bloom conditions. The elevated concentrations of TP measured in Mullica Hill Pond is the key factor responsible for the nuisance algal blooms routinely observed during the middle of the summer.

3.2.3 Nitrogen

While phosphorus is the primary nutrient limiting algal and aquatic plant growth, nitrogen is another extremely important nutrient. Nitrogen can be found in an aquatic system in a variety of forms; particulate and dissolved, inorganic and organic. However, the two forms that are most easily utilized by algae and aquatic plants are ammonia-N and nitrate-N. Both forms are dissolved, inorganic forms of nitrogen.

Ammonia-N is a common by-product of the bacterial decomposition of organic matter. Thus, ammonia-N has the potential to accumulate in a lake or pond, however, since algae and aquatic plants easily assimilate ammonia-N for growth, concentrations tend to be low (< 0.05 mg/L) in most natural ecosystems.
In-lake ammonia-N concentrations were 0.05 mg/L (29 May 2007) and 0.08 mg/L (16 July 2007) through the course of the Mullica Hill Pond monitoring program (Appendix B). Thus, ammonia-N concentrations in Mullica Hill Pond were generally low. The observed decline in ammonia-N concentrations through the course of the 2007 growing season is most likely the result of increased assimilation of this nutrient by algae and aquatic plants while the seasonal temperatures increased.

Nitrate-N is another form of dissolved inorganic nitrogen that is readily utilized by algae and aquatic

plants for growth. Nitrate-N tends to be more mobile in surface and groundwater relative to ammonia-N and it can be generated through microbial activities, such as nitrification. However, bacterial decomposition of organic matter does not produce nitrate-N. Thus, algal and aquatic plant uptake of nitrate-N tends to keep its concentration relatively low in lakes and ponds.

For sources of potable water, the Federal and State limit for nitrate-N is 10 mg/L. In contrast, summer nitrate-N concentrations greater than 1 mg/L can generate excessive amounts of algal and aquatic plant biomass. In-lake nitrate-N concentrations in Mullica Hill Pond were 1.40 mg/L (29 May 2007) and 0.43 mg/L (16 July 2007) through the course of the monitoring program (Appendix B). Thus, in-lake nitrate-N concentrations were below the potable water nitrate-N threshold values, however were prone to be above the ecological threshold, especially in the late spring timeframe.

3.2.4 Total Suspended Solids

Total suspended solids (TSS) are a measure of the amount of particulate matter in the water column of a lake. The State limit for TSS is 25 mg/L. TSS concentrations greater than 25 mg/L, under baseline (non-storm event) conditions, can negatively impact aquatic habitats. Some of these negative impacts include in-filling of wetlands, lakes and waterways, the destruction of spawning habitat, and added physiological stress on fish through suspended sediments entering their gills. In addition, TSS concentrations greater than 25 mg/L are perceived by the layperson as being "dirty" or "muddy".

In-lake TSS concentrations were low in Mullica Hill Pond, varying between 5 mg/L and 9 mg/L during the sampling events. These low TSS concentrations correspond to the overall high degree of water clarity experienced during the same sampling events.

3.2.5 Chlorophyll a

As described above, data were also collected on the biology of Mullica Hill Pond. One such biological parameter included chlorophyll *a*, a photosynthetic pigment all plants and algal groups possess. Since all algal groups contain chlorophyll *a*, measuring its concentration in lake water is an excellent means of quantifying the relative biomass of the phytoplankton within the open water of a waterbody. Concentrations of chlorophyll *a* are also utilized in gauging the in-lake productivity associated with the phytoplankton. In turn, this information can be used to quantify the trophic state of a waterbody, as well as measure the relative effectiveness of an implemented in-lake restoration technique.

To the layperson, chlorophyll *a* concentrations greater than 30 mg/m^3 produce algal blooms / surface scums that are considered unpleasant for recreational waterbodies. Mid-lake chlorophyll *a* concentrations in Mullica Hill Pond varied between 4.6 mg/m^3 to 21.3 mg/m^3 (Appendix B). Thus,

planktonic (open water) algal blooms were not a major nuisance at Mullica Hill Pond. However, based on field observations, the more nuisance groups included filamentous mat algae and rooted aquatic plants. The productivity of neither the mat algae nor the aquatic plants is reflected in chlorophyll *a* data reported for the lake. Thus, although the measured chlorophyll a concentrations suggest low levels of algal productivity, clearly the filamentous algae attain nuisance densities in Mullica Hill Pond. As a result, the chlorophyll data need to be used somewhat selectively when assessing the lake's overall trophic state.

In addition, prevailing winds can concentrate algae, along with other floating debris, against the lake's shorelines. Thus, while the chlorophyll data indicate that portions of the open waters of Mullica Hill Pond may have be relatively algae free and aesthetically acceptable, at the same time given nearshore areas may have been impacted with high concentrations of phytoplankton, mat algae and other floating debris.

3.3 Plankton Sampling

Phytoplankton and zooplankton samples were collected at the mid-lake station during each sampling event. Samples were taken to Princeton Hydro's biological laboratory and organisms were identified to genus and/or species.

On 29 May 2007 the phytoplankton community of Mullica Hill Pond was dominated by diatoms (Bacillariophyta) in terms of abundance. In addition, green algae (Chlorophyta) and golden algae (Chrysophyta) were also observed. No nuisance cyanobacteria, also known as blue-green algae, were identified in Mullica Hill Pond at this time. The spring phytoplankton community of most temperate lakes is typically dominated by chrysophytes and diatoms.

On 16 July 2007 the bacillariophytes were again the dominant algal group in terms of abundance. In addition, green algae (Chlorophyta), golden algae (Chrysophyta) and cryptomonads (Cryptophyta) were also observed. In addition, the nuisance cyanobacteria, also known as blue-green algae, *Anabaena* was identified in Mullica Hill Pond, however at minimal densities.

It is clear that algal abundance increased from June to August. This was the result of an increase in the number of small-celled algae (i.e. chrysophytes, and some green algae and some blue-green algae) relative to large-celled algae (i.e. diatoms, filamentous green algae and colonial blue-green algae). In terms of abundance and biomass the dominant algae were chrysophytes and the green alga *Gloeocystis*, respectively, during the 14 August 2001 sampling event.

One blue-green alga, *Anabaena*, was identified in Mullica Hill Pond. This blue-green alga can produce obnoxious blooms or surface scums. The elevated phosphorus concentrations, combined with a small community of herbivorous zooplankton (for details see below), create in-lake

conditions generally favorable for the aesthetically displeasing genera of blue-greens. Therefore, in order to prevent bloom-forming blue-green algae from appearing and attaining nuisance conditions in Mullica Hill Pond, preventative efforts must be in place to ensure the phosphorus load of Mullica Hill Pond does not increase in the future.

Zooplankton are micro-animals that live in the open waters of lakes and ponds. Many zooplankton are a source of food for forage or young game fish. Some types of zooplankton are herbivorous (eat algae) and thus can provide a natural means of controlling excessive algal growth. Therefore, given the important role of zooplankton in the aquatic food web, the Mullica Hill Pond monitoring program included these organisms.

In contrast to the phytoplankton, zooplankton numbers and biomass were relatively low in Mullica Hill Pond. More notable is the low number of herbivorous (algae-eating) zooplankton identified in the lake. A larger number of herbivorous zooplankton would contribute toward limiting phytoplankton densities through grazing.

On 29 May 2007, the only zooplankton identified were herbivorous and included three genera of cladocerans (*Bosmina, Chydorus* and *Ceriodaphnia*). In turn, these same conditions resulted in the relatively higher abundance of phytoplankton observed on the same date.

Copepods were the only zooplankton group identified on 16 July 2007. Copepods typically feed on other zooplankton, bacteria and detritus. Thus, algal control through grazing by zooplankton was minimal at best during the peak of the summer season. Such conditions are not typical of temperate lakes. Normally, once algal growth rates increase after the lake ices out, and water temperatures increase, the zooplankton will become active and increase in abundance through the course of the late spring / early summer season. However, these conditions were not observed in Mullica Hill Pond. These data demonstrate the strong ecological link between the phytoplankton and zooplankton in Mullica Hill Pond. In conjunction with this copepod-dominated community, phytoplankton densities remained high. This natural ecological link may need to be explored further since it provides a natural means of controlling the development of excessive amounts of open water algae.

3.4 Aquatic Macrophytes

Excessive densities of rooted aquatic plants have the possibility to be a water quality concern associated with Mullica Hill Pond. Based on the clarity and shallow depth within Mullica Hill Pond, nuisance plants may have the potential to attain densities that can negatively impact recreational activities such as canoeing and fishing. In addition, invasive aquatic plant species can out-compete the native aquatic vegetation that provides ecological benefits for resident wildlife. Given the potential impact aquatic plants have on the water quality and recreational use of Mullica Hill Pond,

detailed field observations were made on the aquatic plant community during each monitoring event.

During the 29 May 2007 nearly 100% of Mullica Hill Pond was covered in filamentous algal mats. Little to no open water areas were observed, thus not allowing for light penetration to reach any submerged macrophyte communities. Further upstream of the lake, some aquatic macrophytes were observed within the flowing channel of Raccoon Creek. Specifically, this majority of these macrophytes were the species Parrot Feather (*Myriophyllum brasiliense*).

On 16 July 2007, the conditions of Mullica Hill Pond remained the same with nearly 100% coverage of the lake's surface by algal mats. Little to no aquatic macrophytes were observed in the main portion of the lake. However, as stated previously, the furthest upstream portion of the lake did possess submerged aquatic macrophytes. As with the May sampling event, Parrot Feather was the dominant species observed.

Based on field observations made during the Mullica Hill Pond monitoring program, the surficial algal mats clearly restrict the extent to which planktonic algae and submerged aquatic macrophyte can develop and grow. Such conditions persisted through the summer and into the fall. These high densities of algal mats negatively impact the ecological and recreational value of Mullica Hill Pond. However, based upon the shallow depth and excellent clarity of Mullica Hill Pond, the potential for the lake to transition to an aquatic macrophyte dominated ecosystem is high. If the algal mats are to be addressed in any future management plan, the potential for submerged aquatic vegetation to subsequently reach nuisance densities must be considered and addressed as well.

3.5 Fishery Survey

The fishery of a lake is an integral component of the biological community of any aquatic ecosystem. As such, the fishery is a reliable indicator of overall ecosystem health and water quality, and can also be a major factor in effecting the water quality of an aquatic ecosystem. At the same time, the fishery is also the most familiar part of aquatic ecosystems to many lake users and a primary source of lake recreation. Therefore, it is important to evaluate the fishery through a thorough fishery survey investigation as part of any restoration or lake management strategy to maximize the potential for increased water quality, fishery quality, and recreational opportunities.

In order to perform a comprehensive survey of the Mullica Hill Pond fishery, a variety of fishery survey techniques were utilized to sample different fishery populations in the lake differentiated by habitat preference and size-class. The fishery survey was conducted over a two-day period from 18 October to 19 October 2007. Prior to the initiation of the fishery survey, Princeton Hydro obtained a Scientific Collectors Permit from the NJDEP Bureau of Freshwater Fisheries to sample the fishery of Mullica Hill Pond via electrofishing and the deployments of various nets and traps. All nets and traps were deployed on 18 October and retrieved on 19 October. Electrofishing was conducted on

18 October.

Gill netting was the one of the primary sampling technique used in the collection of fisheries data in Mullica Hill Pond. The gill net was selected for use because of its high efficacy in capture and the ability to deploy this net in a variety of habitats and a variety of depths. Princeton Hydro utilized a horizontal style scientific sampling gill net. This net is 125′ long and 6′ deep and constructed of monofilament netting. The top main line on the net is a floating line while the bottom mainline is a braided lead line; this configuration allows the net to remain horizontal and fully vertically extended in the water column. This style of gill net consists of various mesh sizes in alternating 25 foot panels in each net to allow the capture of a variety of size class of fish. The net that was utilized was a large mesh net consisting of 1, 1 ½, 2, 2 ½, and 3 inch mesh sizes. The net is deployed horizontally in the water column at the selected depth by lashing each end of the net to a buoy line anchored to the bottom.

In total, one (1) gill net was deployed during the fishery study. For the purposes of this survey, the gill net was used to sample the larger fish that use the open-water, deeper parts of the lake. The net was set at the lower end of the lake, running roughly north to south, adjacent to Route 322. It was deployed for a period of approximately 24 hours before retrieval.

Trap nets were a secondary passive netting method used to sample the fish using the nearshore, littoral areas of the lake. The trap net data are intended to supplement the electrofishing data. Trap nets are designed to capture fish as they move along structures, including the lake bed, banks, or deadfall trees. Fish are guided towards the traps utilizing wing nets that basically create a funnel; the wings are each positioned at 45° to the main body of the net, or 90° to each other. As the fish move within the confines of the wings they eventually move towards the trap at which point they are captured. Trap nets (also known as fykes) consist of several metal frames and a series of more frames or rings wrapped in netting known as the body. Within the body are a series of throats and parlors which serve as the "traps" to capture fish. In front of the primary frame is a leader or a series of leaders or wings which are nets projected in front of the traps that serve to direct fish towards the traps. Princeton Hydro utilized Indiana style fykes with $^{5}/_{16}$ inch mesh net for the leader and the body of the trap.

In total, two (2) trap nets were utilized; with each trap net deployed for a period of approximately 24 hours. Trap net T-1 was placed in the southern inlet of the lake, while T-2 was deployed around deadfall on the western shoreline. Each net was deployed so that the wings were positioned around preferred habitat, in this case consisting of shoreline features and fallen trees. The front of the wings and the rear of the body were anchored in position using cinder blocks and both of these locations were marked with buoys.

An extensive electrofishing survey was also conducted in the littoral areas of the lake. In this case,

the majority of the lake can be considered a littoral zone as the maximum depth is approximately 7.5 feet. Electrofishing is a particularly effective method of capturing fish because it allows targeting of key pieces of structure likely to hold fish, and fish are immediately captured without the lag of using nets generally resulting in a much higher capture per unit effort (CPUE). Capture mortality is also much lower than other methods making this a preferred sampling technique. Electrofishing involves creating local electrical fields in the water that serve to stun fish. When fish enter the electrical fields generated around the electrofishing gear in the water column the nervous system of the fish is shocked and the fish float to the surface for capture. Larger fish often involuntarily orient themselves in the electric field and actually move towards the source of the stimulus.

Electrofishing was conducted from a 12 foot aluminum jon boat. Princeton Hydro utilized a SmithRoot Model 12 backpack electroshocker unit rated at an operational output of 300 to 600 volts. The electrofishing unit was powered by external 12 volt batteries. This system utilizes electrode probes suspended off the side of the boat. Safety protocols are outlined in Princeton Hydro's Electrofishing Safety Plan; specific requirements include the use of proper ground connections, the use of insulated gloves, positive engagement switches, and operable breakers.

Electrofishing was performed using 15 minute timed transects that covered on average approximately 100 meters of linear shoreline. In total, six (6) of these timed transects were performed around the entire perimeter of Mullica Hill Pond. During the operation of the electrofishing unit stunned fish were captured on the lake surface using long-handled dip nets. Captured fish were then transferred to a temporary holding tank for processing. Electrofishing activity was primarily focused immediately adjacent to the shoreline and other structures such as dead fall trees and exposed root masses. While electrofishing can be used effectively in open waters most electrofishing during the survey was conducted in the littoral zone to more accurately quantify the littoral fish community and because of the use of gill nets in open portions of Mullica Hill Pond.

Upon retrieval of the gill nets, trap nets, and after the completion of each timed electrofishing transect all captured fish were processed. Processing included the identification of all fish to a species level, measuring for total length (the length from the snout to the end of the caudal fin), and enumeration. Identifications were made utilizing Page and Burr, 1991 and Murdy, Birdsong, and Musick, 1997. Following their identification, measurement and enumeration, all surviving fish were returned live to the water. Any capture mortality was bagged and properly disposed off site.

A variety of population analyses were performed using standard statistical methods and population biology indices as well as simple descriptive statistics. This included size and mass distributions. Mass distribution was calculated using species specific mass-length models derived from published coefficients. Specific coefficients used were selected as median values or for regional fitness. These models are regressions that relate the length of a species to a mass and allow for calculation of biomass metrics without directly measuring mass in the field.

Total abundance of fish captured during the Fall 2007 fishery survey was 315 fish; the gill net accounted for just 45 fish or 14.3% of the total catch, while trap nets and electrofishing respectively captured 51 and 219 fish or 16.2% and 69.5% of the total catch. In total, eleven (11) species were observed. Two species dominated the fishery in terms of abundance, Creek Chubsucker (*Erimyzon oblongus*) and an unidentified Shiner of the genus *Notropis* (*Notropis* sp.). However, Creek Chubsucker clearly dominated the fishery in terms of biomass accounting for over 65% of the total fishery biomass. By comparison, the next most important species in terms of biomass, Chain Pickerel (*Esox niger*), accounted for only 17% of the fishery biomass.

The size distribution showed two distinct size classes of fish in the lake. Abundance was highest in the size range between 0 and 3 inches. This size class of fish is dominated by the several sunfishes (Family Centrarchidae) including Banded Sunfish (*Enneacanthus obesus*), Bluegill (*Lepomis macrochirus*), Pumpkinseed (*Lepomis gibbosus*), but the unrelated unidentified Shiner and the Creek Chubsucker were by far the most important species. The remainder of the specified size classes showed an incremental decrease through the final 20 to 25 inch size class. In terms of biomass distribution the 9 to 12 and 12 to 15 inch size classes dominated the biomass of the fishery and was largely driven Creek Chubsuckers, although Chain Pickerel and Largemouth Bass (*Micropterus salmoides*) were also important components.

Several patterns are immediately clear in the analysis of the fishery data. Most noticeable and most significant is that the fishery is dominated by Creek Chubsuckers in terms of both abundance and biomass. The second observed pattern is that there is a distinct lack of the number of large predators necessary in the system to effectively control the numbers of Creek Chubsuckers and Golden Shiners present in the lake. A third pattern is that the fishery was somewhat more balanced with greater species richness, abundance, species composition, and size distribution in the upper open water portions of the lake outside the influence of filamentous mat algae and macrophyte growth in the upper portion of the lake. Conversely, it was interesting that most of the larger fish were captured in the lower end of the lake where mat algae was thickest. This is likely a function of increased water depths in this area and not the presence of algae mats. Finally, the fishery is showing very high recruitment (reproduction) with the Creek Chubsuckers exhibiting the majority of the reproductive capacity as represented by the dominance in the number of fish in the 0 to 3 inch range in the lake.

The species composition and various metrics analyzed for this fishery survey show that the fishery is clearly impaired, with one of the root causes being the nuisance density of algae in the lake. Of greatest concern is relative abundance of Creek Chusuckers in the lake. While the presence of the Creek Chubsuckers is no cause for concern of itself, and in fact is normal in most healthy impoundments of this size in the Coastal Plain portion of New Jersey, the dominance in biomass relative to other species in the lake reflects a problem with the fishery. First, an abundance of Creek

Chubsuckers relative to other species can be taken as sign of negatively impacted water quality, because Creek Chubsuckers have a high tolerance for poor water quality including the ability to survive at lower dissolved oxygen concentrations. The fish also do well in lakes characterized by high turbidity and nutrient loads, as well as the presence of other contaminants. Chubsuckers are not just an indication of poor water quality, but can contribute to poor water quality through the suspension of sediments resulting from their foraging activities. Similarly, they can impact fisheries through the destruction of bass and sunfish nests, both directly and indirectly, and by competing with other fish for food resources, especially various invertebrates that are favored by the Centrarchids. Therefore, the abundance of Creek Chubsuckers in Mullica Hill Pond indicate impaired water quality, a competitive advantage to suckers created by nuisance algae density, and probable impacts on the rest of the fishery.

The impacts of the algal density are also clearly observed in the composition of the fishery. The area of the lake near the dam has a much higher density of algae and fewer species and a reduced abundance of fish in general was observed in this area. As noted above though more larger fish were observed in this area including most of the adult Chain Pickerel, Largemouth Bass, Brown Bullheads (*Ameiurus nebulosus*), Golden Shiners (*Notemigonus crysoleucas*), and a sizable portion of adult Creek Chubsuckers. Again, this difference is likely related to increased depths in this area and the use of the gill net which is biased towards the capture of larger fish. Overall, the reduced number of species and total abundance is evidence that algae growth negatively affects the fishery of Mullica Hill Pond.

The lack of large predators relative to the amount of available forage in the form of various Sunfish, Golden Shiners, Shiners, and in particular Creek Chubsuckers is some cause for concern. While the Chain Pickerel is found in moderate density and at quite large sizes (up to 25 inches) Largemouth Bass in particular seem stunted in length and exhibit low population densities. This effect again is related to inadequate depths throughout most of the lake to provide protection from predation and the inability of bass to effectively capture food items due to the overabundance of algae which creates myriad refuge habitat for small size class fish in the lake.

4.0 General Watershed Characteristics

4.1 Geology

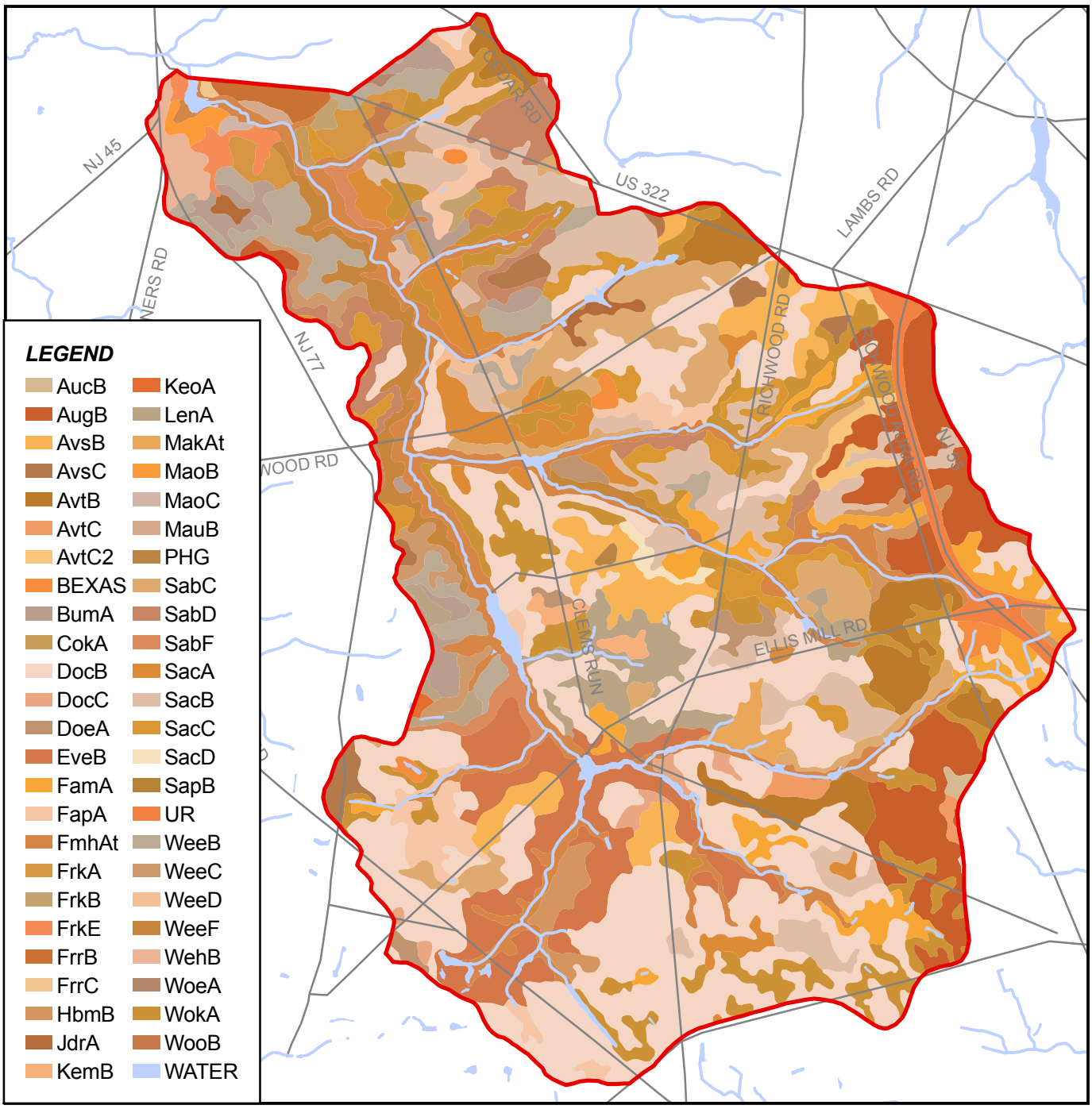
Gloucester County lies along the Delaware River encompassing approximately 329 square miles. It is part of the Atlantic Coastal Plain geologic region and is characterized by nearly all of the geologic formations of sand, clay, and marl that constitute the Atlantic Coastal Plain in the state. In some areas the geologic formations are overlain by sand and gravel that were deposited at different times. These deposits and the underlying formations vary in characteristics, and as a result, the soils that have developed over them vary considerably.

4.2 Soils

The watershed immediately adjacent to Mullica Hill Pond is dominated by soils of the Aura-Sassafras-Downer association. According to the Soil Conservation Service (USDA, 1979), soils occurring in this association are generally well-drained. This general soil area occupies the southeastern half of the county, except where other general soils areas are interspersed. In addition, isolated tracts of the general area cap the higher hills in the western part of the county. This general area constitutes the drainage divide that separates streams that flow northwestward to the Delaware River from those that flow southward and eastward. A complete list of the soils occurring within the Mullica Hill Pond watershed are listed and described in Table 2, including an overview of some of their basic properties.

TABLE 2: Dominant Soil Characteristics of the Mullica Hill Pond Watershed

Soil Name	Erodibility	Slope (%)	Depth to seasonal water table (feet)	Septic suitability
Downer loamy sand, 0 to 5 % slopes	Severe	0 - 5	5 to 10 feet	Good
Fluvaquents, loamy, 0 to 3 % slopes, Frequently flooded	N/A	0 – 3	Grade	N/A
Sassafras loamy sand, 5 to 10 % slopes	Severe	5 – 10	> 10 feet	Good
Sassafras sandy loam, 2 to 5 % slopes	Severe	2 – 5	> 10 feet	Good
Sassafras sandy loam, 5 to 10 % slopes	Severe	5 – 10	> 10 feet	Good
Sassafras sandy loam, 10 to 15 % slopes	Severe	10 - 15	> 10 feet	Good



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FIGURE 5: SSURGO SOILS

HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

LEGEND

- Watershed
- Lakes
- Streams
- Highways

0 2,000 4,000 Feet

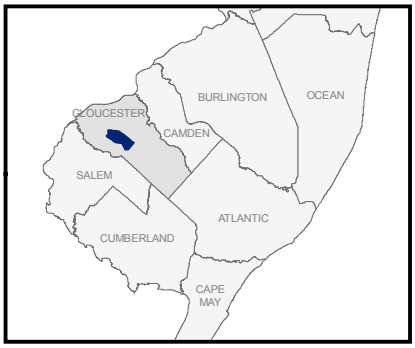
1 inch equals 4,000 feet

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RINGOES, NJ 08551

SOURCES:

1. Project watershed boundaries, streams, lakes, highways and wetlands as obtained from the NJDEP website.
2. SSURGO soils obtained from Natural Resources Conservation Service.

NEW JERSEY COUNTY MAP



File: P:\0763\Projects\07630011\GIS\MXD\revisedwatershed\Figure5_soils.mxd Jul 23, 2008 3:13:38 PM. Copyright Princeton Hydro, LLC.

5.0 Hydrologic Budget

Introduction

The hydrology of Mullica Hill Pond in its simplest sense represents the water budget associated with the lake. A complete water budget will account for all water inputs to the lake which ultimately equal all water exiting the lake and will therefore represent a "mass balance" approach to modeling the lake's hydrologic properties. This process is generally calculated on an annual basis but for the purpose of this study is defined on a monthly scale to offer more refinement due to seasonal variations in precipitation, runoff and stream flow. Understanding the hydrologic cycle for Mullica Hill Pond is crucial in its overall management as the magnitude and temporal variation of hydrologic loading directly effects watershed nutrient transport, assimilative capacity and trophic response.

Methodology

In order to calculate the total hydrologic budget of Mullica Hill Pond, Princeton Hydro utilized several empirically based models to calculate all major hydrologic components. Upon the completion of the hydrologic models the results were summed, normalized for watershed area and then compared to localized United States Geologic Service (USGS) gaging stations to further calibrate the modeled data and verify the accuracy of the modeled results.

Lake Precipitation / Evaporation

Perhaps the simplest component of the total hydrologic load to Mullica Hill Pond is that of net precipitation on the lake proper. In order to calculate this component of the load we simply multiplied average monthly precipitation values derived from the National Oceanic and Atmospheric Administration (NOAA) 30-year climate summary (Station: Glassboro 2 NE, #283291) by the total lake area. Once the calculation of the gross precipitation load to the lake proper was determined it became necessary to adjust for lake evaporation. To account for lake evaporation we again utilized empirical, site specific data by the way of pan evaporation rates taken from the Pemberton, New Jersey weather station (ID#286843). Since pan evaporation rates tend to overestimate actual lake evaporation we applied a simple correction factor taken from the scientific literature whereby 70% of the pan evaporation rates were equated to actual lake evaporation. Following the computation of lake evaporation this value was simply subtracted by the calculated gross precipitation volume to arrive at monthly net precipitation volume on the lake surface.

Tributary / Surface / Sub-surface Runoff

The Modified Rational Method is commonly used as a predictor of gross hydrologic loading to streams in a watershed based on precipitation, LU/LC, and soil hydrologic group. Specific runoff coefficients correlated to both LU/LC and soil hydrology was taken from National Resource Conservation Service (NRCS) Technical Release 55 (TR-55) Curve Numbers. Precipitation data was again derived from the National Oceanic and Atmospheric Administration (NOAA) 30-year Climate Summary for New Jersey at the Glassboro 2 NE, New Jersey station (ID#283291). The use

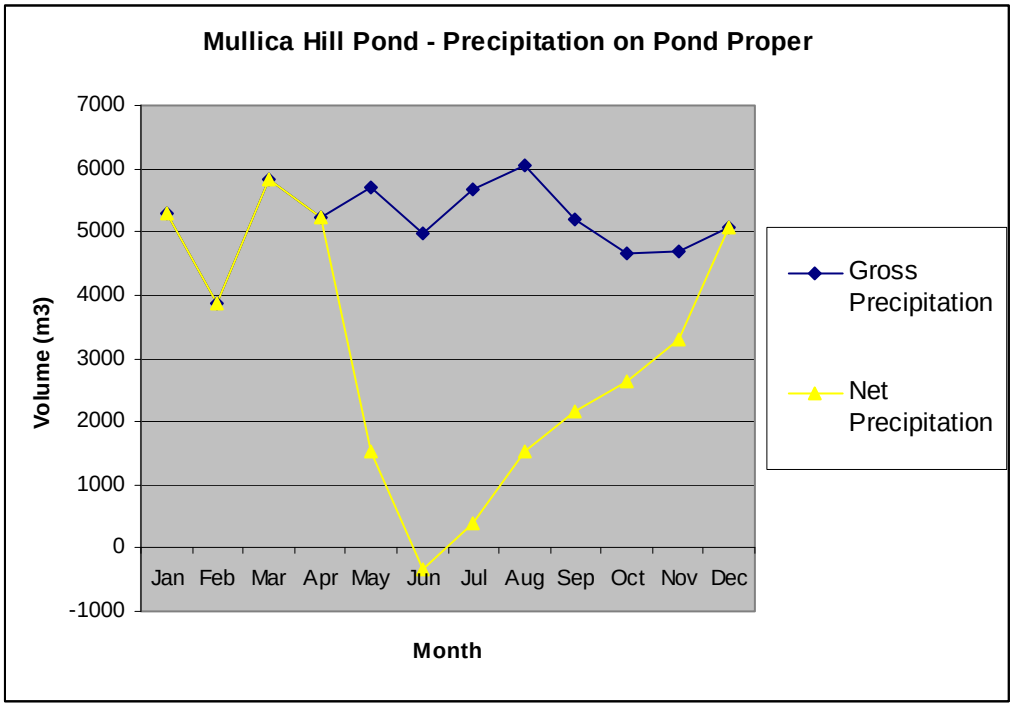
of the Modified Rational Method for calculating gross discharge is widely accepted by both the US Environmental Protection Agency (USEPA) and New Jersey Department of Environmental Protection (NJDEP). However, this method grossly overestimates annual loads because it was created for quantifying storm event surface runoff in small watersheds. Princeton Hydro has therefore developed a correction for the Modified Rational Method to more accurately predict stream hydrology in larger watersheds. The chief correction is the inclusion of an evapotranspiration and abstraction term, which is very important in growing season hydrology. Evapotranspiration is the combined loss of water to the atmosphere via evaporation and transpiration, which is the biological cycling of water that is removed from groundwater through vegetative uptake and exhausted as water vapor through the leaves. Generally, the Modified Rational is calculated by multiplying the area of a delineated land use parcel by an appropriate curve number and gross precipitation value. In the corrected model, precipitation is modified by subtracting PET (potential evapotranspiration) calculated using the Thornthwaite methodology. However, in summer months PET can be greater than precipitation, but instead of modeling a withdrawal from the system, there is an assumption that a certain percentage of precipitation, regardless of PET, is always available as runoff/groundwater to contribute to stream discharge. For the purpose of this study we chose a correction value of at least 35% of precipitation being available for runoff / groundwater flow during those periods whereby PET exceeded precipitation.

A final assumption of this use of the Modified Rational Method is that in watershed scale studies the model predicts not only surface runoff but also accounts for groundwater discharges as well. This assumption, and the applicability of the entire model, was subsequently verified and calibrated through the comparison of specific discharge (cfs / mi^2) between our modeled lake discharge data to that of the United States Geologic Survey (USGS) gaging station at Raccoon Creek (Station ID# 01477120) located approximately two (2) miles downstream of Mullica Hill Pond. The availability of a continuously gaged USGS station on the outlet side of the Mullica Hill Pond's main feeder tributary allowed for optimal refinement of our modeled hydrology and subsequently lends great confidence to the following hydrology estimates.

Results

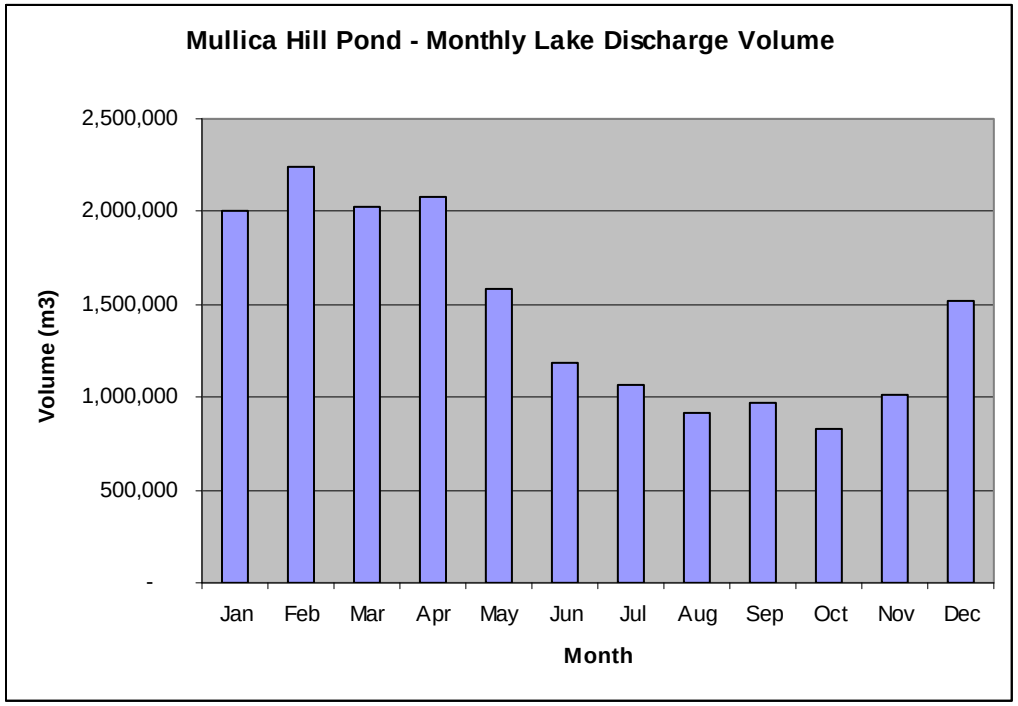
Gross precipitation on the lake proper accounted for 6.2 x 10^5 m^3 while annual evaporation accounted for 2.6 x 10^5 m^3 which resulted in 3.7 x 10^5 m^3 of net precipitation falling directly on Mullica Hill Pond on an annual basis (Table 3).

Table 3: Net Precipitation on Mullica Hill Pond Proper



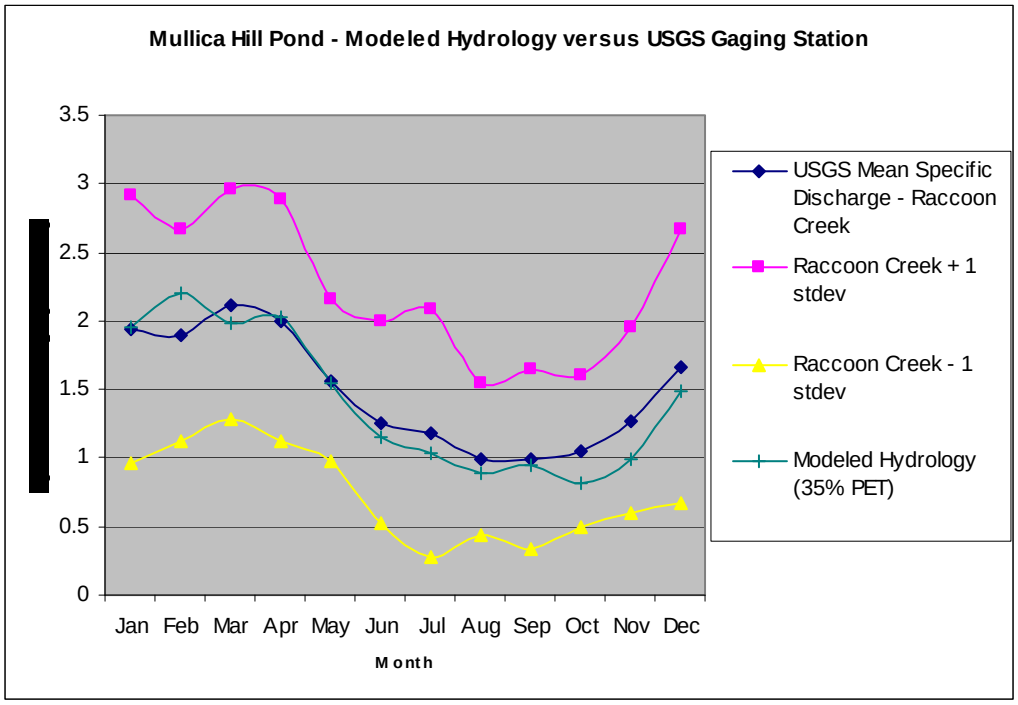
Given the extremely small area of the lake (13.3 acres) in comparison to the watershed (8,616 acres) it becomes clear that direct precipitation on the lake proper plays a diminutive role towards the overall hydrologic cycle of Mullica Hill Pond. The majority of the water load entering Mullica Hill Pond is that through watershed derived inputs, primarily through Raccoon Brook. Through the use of the Corrected Modified Rational model we were able to model that watershed derived hydrologic load transported through Raccoon Brook, and in conjunction with net precipitation on the lake proper, determine lake discharge on a monthly scale. The results of this modeling are hereby presented in Table 4.

Table 4: Mullica Hill Pond Monthly Discharge



Total tributary / groundwater load to Mullica Hill Pond, on an annual basis, is 1.7×10^7 m^3. As illustrated in Table 4, there exist rather large variations between months due to seasonal differences in precipitation rates and ambient temperature, which influences PET. Nevertheless, when the modeled lake discharge is normalized for watershed area and compared with the same metric derived from the USGS monitoring station located on Raccoon Brook the data were found to be in excellent agreement as indicated in Table 5.

Table 5: Modeled Discharge Versus Raccoon Creek (USGS Station)

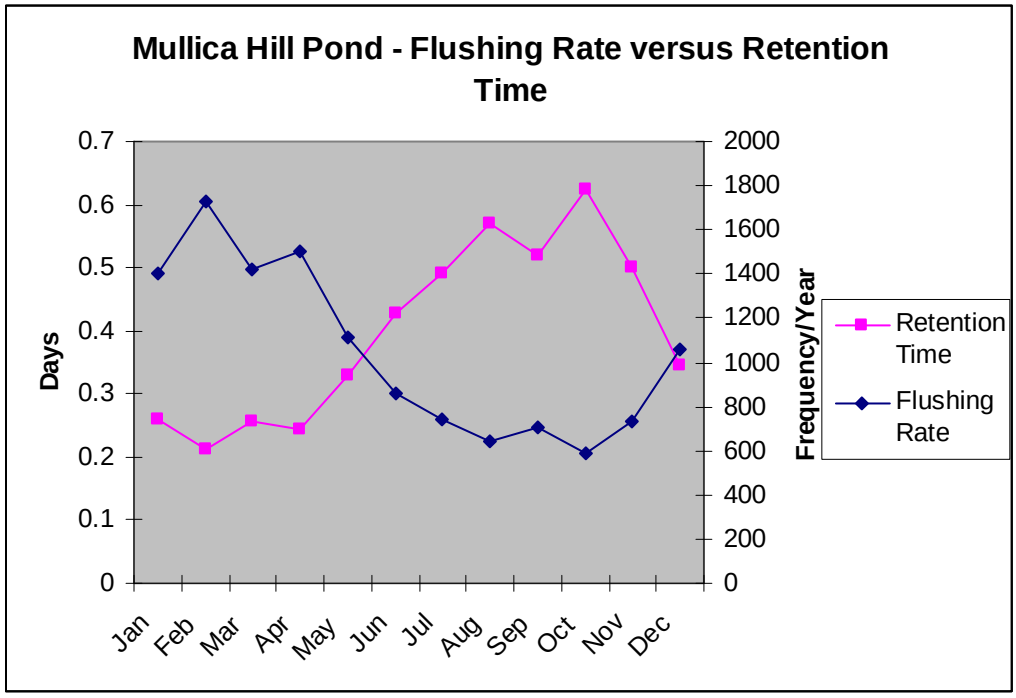


As evidenced in the above figure, the modeled hydrologic load (green line) lines up almost perfectly with measured discharge values at Raccoon Brook by the USGS (blue line) with only slight oscillation amongst the winter months (January through March) and a slight under-representation from June through December. Overall, the modeled hydrologic load fit extremely well to that of USGS measured data and therefore may be utilized with confidence in the overall ecological assessment of Mullica Hill Pond.

Upon verification of the modeled load the flushing and retention times of Mullica Hill Pond were calculated. Flushing time, which represents the number of times the lake volumetrically exchanges per year, is 1,036. The retention time, which is simply an inverse metric that determines how long a single drop of water entering the lake stays within the waterbody, is 0.35 days. The aforementioned flushing data essentially means that on an annual basis the lake will volumetrically exchange approximately three (3) times per day. Overall, this is an extremely fast flushing rate and representative of a very dynamic lake system. The elevated flushing rate of Mullica Hill Pond is primarily a factor of its extremely small lake surface area and volume in relation to its expansive watershed area (watershed : lake = 648). Of all metrics assessed throughout this study the flushing rate may prove to be one of the most diagnostically telling as the increased flushing rate of Mullica Hill Pond should logically translate to reduced nutrient assimilation time for nuisance algae therefore translating to lower productivity. This is obviously not the case given the pervasiveness of nuisance mat algae which plagues the lake throughout the summer months. It must be realized that most of this growth is sediment driven and is not directly linked with lake flushing. This skews the

trophic state indicators. While the calculated rate of flushing is rather elevated the actual flushing rate may be considerably lower due to the presence of expansive wetland areas surrounding the lake's inlet which may serve to reduce inflow velocity and increase storage capacity, therefore increasing retention time. In addition, flushing rate and retention times are not constant throughout the year but vary seasonally and even monthly due to prevailing precipitation and climatic conditions (Table 6).

Table 6: Hydraulic Flushing Versus Retention Time



The above graph highlights the role of monthly variances in precipitation and climatic conditions on resultant lake flushing. As evidenced above it is clear to see that the flushing rate of Mullica Hill Pond is at its highest during the months of February through April, coinciding with spring precipitation. Following these months is a steady decline in flushing rate, which coincides with decreased rainfall and increased evaporation and plant transpiration. While this decrease in flushing rate may serve to slightly increase nutrient assimilation time it is essential to note that, even during the summer months, Mullica Hill Pond flushes rapidly in relation to other regional waterbodies.

6.0 Watershed Characteristics – Land Use / Land Cover

Every lake system drains a distinct area of land known as a watershed. Determined by the surrounding topography Mullica Hill Pond has its own unique watershed whereby every drop of rain that falls on this area either returns to the atmosphere via evaporation or is conveyed through groundwater, tributary flow, or direct surface flow into the lake.

The size, land uses, soils, and slopes of Mullica Hill Pond's watershed are unique to that watershed and are the primary influencing factor on water quality of the lake. Of all the different variables that may be analyzed when looking at a lakes watershed the two most important ones are the watershed size and the land uses that comprise that watershed. As discussed in Section 5, watershed size relative to the receiving waterbody is crucial in determining the magnitude of loads entering the receiving lake. Simply, larger watersheds transport more water, nutrients, and sediments to receiving waterbodies than do small watersheds. As such, high watershed to lake ratios, impart a greater loading aspect to the receiving lake and are often correlated to increased rates of eutrophication.

The land uses comprising the watershed are the other critical component in determining the receiving lake's water quality. In its natural state, before the impoundment of Raccoon Creek to form Mullica Hill Pond, the watershed area was likely dominated primarily by forested lands. With the settlement of the area and subsequent formation of the lake was a concomitant change in watershed lands use from that of forested land to agricultural and residential land uses which served to alter the natural hydrology and nutrient dynamics of the study area.

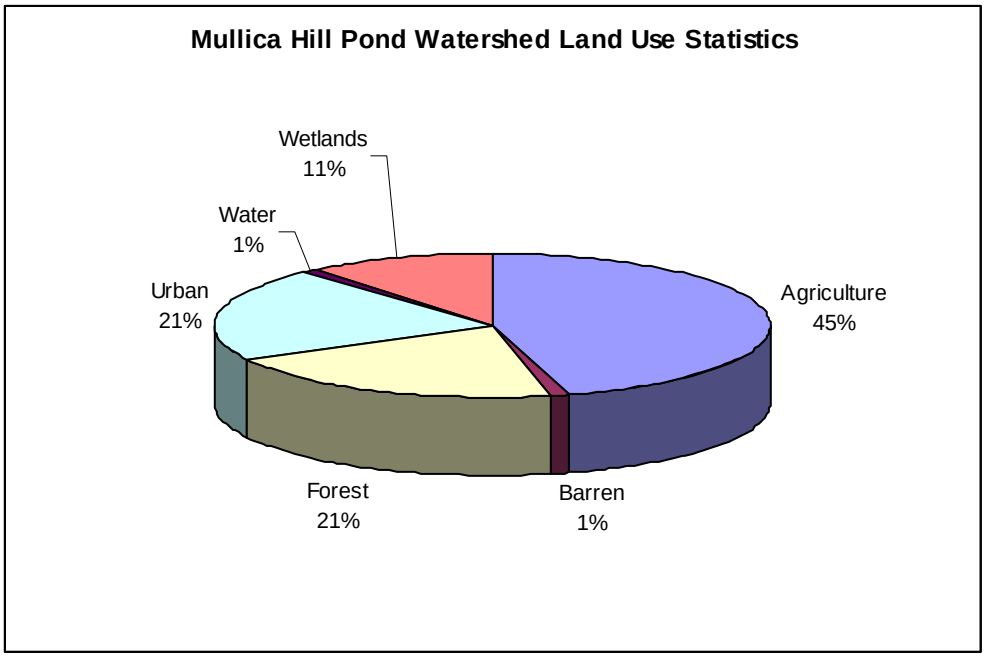
For the purpose of this study Princeton Hydro made use of spatial data manipulated through ArcGIS, a geographical information software package, to delineate Mullica Hill Pond's catchment area. Furthermore, information as to land use (2002 LU/LC), soils, and slopes were collected for the watershed. This information is a critical component not only in the general characterization of the catchment basin but is also the primary data component utilized in hydrologic and pollutant loading calculations as water and nutrient flux are inherently linked to land use characteristics.

Mullica Hill Pond's watershed encompasses 8,616 acres which translates to a watershed to lake ratio of 648:1. The expansive watershed of Mullica Hill Pond essentially consists of the majority of lands which drain the eastern branch of Raccoon Creek just above the confluence with the southern branch of Raccoon Creek. Land use within Mullica Hill Pond's watershed is dominated primarily by agriculture (45.6%) followed by urban land (20.7%) and forest (20.6%) and is hereby presented in tabular form below (Table 7 and Table 8).

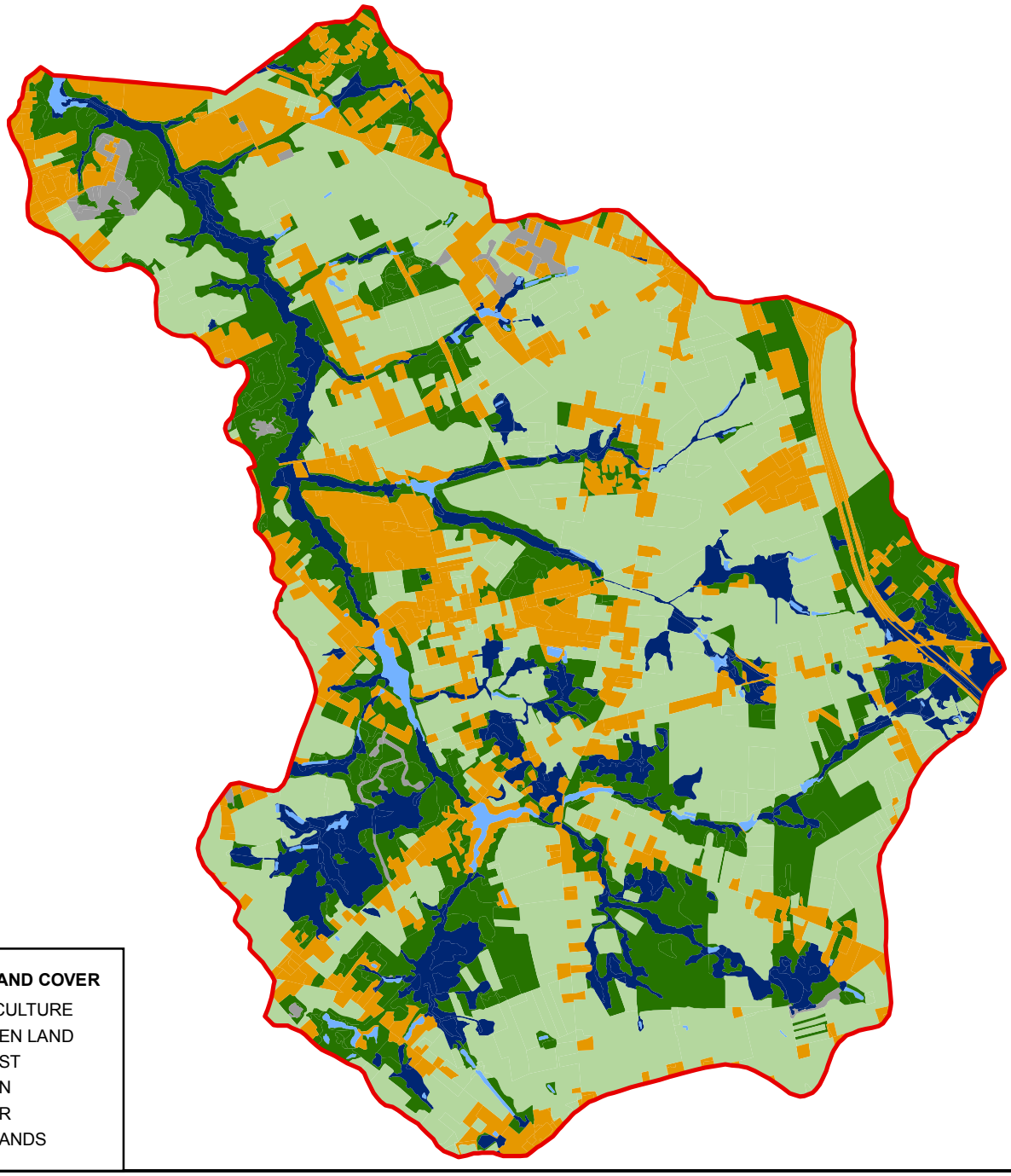
Table 7: Mullica Hill Pond Watershed Land Use Characteristics

Land Use	Area	Percent of Total Area
	(acres)	(%)
Agriculture	3,930	45.6
Barren Land	91	1.1
Forest	1,772	20.6
Urban	1,787	20.7
Water	94	1.1
Wetlands	944	11.0

Table 8: Mullica Hill Pond Watershed Land Use Characteristics



The predominance of agricultural lands within the Mullica Hill Pond watershed, in combination with the overall large watershed size, translates to elevated nutrient loading to the receiving lake. This elevated nutrient loading may be attributable to several characteristic disturbance patterns of agricultural land including land clearing and tilling, fertilizer application, and presence of livestock, each of which serves to increase sediment and nutrient transport above baseline (forested) levels during precipitation events.



Princeton Hydro

FIGURE 6: LAND USE / LAND COVER

HARRISON TOWNSHIP
GLOUCESTER COUNTY, NEW JERSEY

LEGEND

Watershed

0 2,000 4,000 Feet

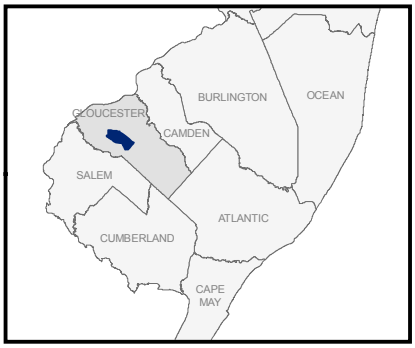
1 inch equals 4,000 feet

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SOURCES:

1. Project watershed boundaries, streams, lakes, highways and LULC as obtained from the NJDEP website.

NEW JERSEY COUNTY MAP



File:R:\0763\Projects\0763001\GIS\MXD\revisedwatershed\rewshedLULC.mxd. Copyright Princeton Hydro, LLC.

7.0 Pollutant Loading

In order to properly analyze the trophic state of Mullica Hill Pond and decide on appropriate watershed and in-lake management techniques a comprehensive nutrient budget must first be developed. In this sense all pollutant inputs must be identified and quantified in order to assess those areas which contribute a disproportional amount of that load and their relative influence on lake productivity. The pollutants of concern are total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS). Phosphorus and nitrogen are those two nutrients most critical to plant and algal growth and as such, increases in these nutrients generally lead to increased lake/pond productivity. While both nutrients are modeled the nutrient of primary concern is phosphorus. In most temperate freshwater ecosystems this is the limiting nutrient, that is, the nutrient that is least available in relation to biological demand, and as such, small increases in phosphorus loading may result in exponential increases in algal and weed growth. There are several sources, both external and internal, of phosphorus loading to freshwater systems and each of these potential sources must be evaluated to develop a proper loading estimate. Total suspended solids represent the total amount of inorganic and organic particles within the water column and are the prime determinant of water clarity. High TSS concentrations may be associated with "muddy" water clarity and are generally the result of excessive sediment loading and suspensions of algal particles. Primary sources of sediment loading to the lake are generally derived through erosion of watershed soils and stream banks. These erosional processes may be even more pronounced in those watersheds dominated by agricultural land use due to land tilling and absence of cover vegetation. This increased sediment loading generally results in the formation of sediment deltas and infilling of near shore areas thereby increasing aquatic weed habitat and providing the fertile substrate for benthic, filamentous algae. In addition, as phosphorus is often tightly bound to soil particles, increases in sediment loading are commonly correlated with increases in total phosphorus loading.

To address the issues of nutrient loading to trophic response Princeton Hydro conducted a comprehensive pollutant model which served to quantify both external and internal sources of nutrient loading. Those sources of nutrients which were quantified in this study include the following:

External

- Watershed – as based on LU/LC
- Atmospheric Sources

Internal

- Sediment phosphorus release

It is important to note that in many lakes and ponds septic systems may also play a strong role in nutrient loading and are generally quantified for a proper nutrient budget. For this quantification the general methodology consists of accounting for all residences which are on septic and located within 100 yard boundary of the lake perimeter. Upon review of GIS based spatial data pertaining to sewer

service areas it became clear that all residences located within this boundary layer were serviced by sewer systems, therefore, this component is not pertinent to this study. While there are residences relying upon septic systems further upstream along Raccoon Creek it became clear that the majority of these residences were set back further than the 100 yard boundary and are therefore negligible contributors to the overall pollutant load of Mullica Hill Pond.

Methodology and Results - Watershed Loading

Watershed based nutrient loading is often times the largest contributor of nutrients and sediments to the receiving waterbody. The watershed area and land use in conjunction with the soils and slopes which comprise the watershed are all prime determinants of the magnitude of nutrient loading to a lake system. For the purpose of calculating the watershed based nutrient load Princeton Hydro utilized the Unit Areal Loading (UAL) approach. The UAL approach is the recommended pollutant modeling technique as per 40 CFR Part 35, Appendix A, the USEPA's "Guidance for Diagnostic-Feasibility Studies". This modeling approach is widely used by both USEPA and NJDEP, and Princeton Hydro has applied it to compute the nutrient and sediment loads for well over 200 lakes and reservoirs located throughout the mid-Atlantic and New England states. The unit areal loading modeling approach is based on the premise that land use activities throughout a watershed have a direct impact on subsequent nutrient release and transport to a receiving waterbody. Essentially, those land uses which are disturbed (i.e. urban, commercial, and agricultural lands) serve to transport more pollutants to a receiving waterbody than those which are undisturbed (i.e. forest and wetlands). For the application of this model Princeton Hydro first utilized ArcGIS to delineate Mullica Hill Pond's watershed. Following the watershed delineation, Princeton Hydro made use of several data layers maintained through the NJDEP GIS database for the spatial representation of land use, soils, and slopes throughout the delineated watershed. This information was then utilized as the basis for the selection of pollutant export coefficients, in the units of (Kilogram of pollutant / Hectare / Year), which were most suitable Mullica Hill Pond's watershed given prevailing soils, slopes, geology, and climatic conditions. Sources of export coefficients chosen for the Mullica Hill Pond watershed were derived primarily from the scientific literature which included but was not limited to those published by Reckhow, 1980 and Uttomark et al, 1974.

The following table (Table 8) lists each land use category identified throughout the watershed and its contribution of phosphorus, nitrogen, and sediments to Mullica Hill Pond as based upon the chosen export coefficients.

Table 8: Watershed Pollutant Loads

Pollutant (Kg/Yr)	Agriculture	Barren	Forest	Urban	Water	Wetlands	Sum
TN	33,434	196	2,418	4,076	0.2	43	40,167
TP	1,504	29	157	323	-9	-83	1,921
TSS	2,675,597	44,578	248,799	573,526	-7,566	-58,396	3,476,537

When viewing the above summary table it must be noted that the watershed based loads are based on land area and export coefficients (Kg of pollutant / ha / yr) determined by the land use of that area. Therefore, those land use types which comprise a larger delineated area of the lake's total watershed will inherently be the potential source of more pollutants to the lake due to the total land area alone. Therefore, it is often more appropriate to normalize the pollutant loads per unit area to assess whether any particular land use types is contributing a disproportionate amount of the pollutant load. Conducting this analysis enables management efforts to be better focused and prioritized thereby optimizing nutrient reduction per unit cost. The results of this normalization are presented in Table 9 for nitrogen loading and interpreted again in Tables 10 and 11 respectively for phosphorus and sediment loading.

Table 9: Total Nitrogen Load Per Unit Area

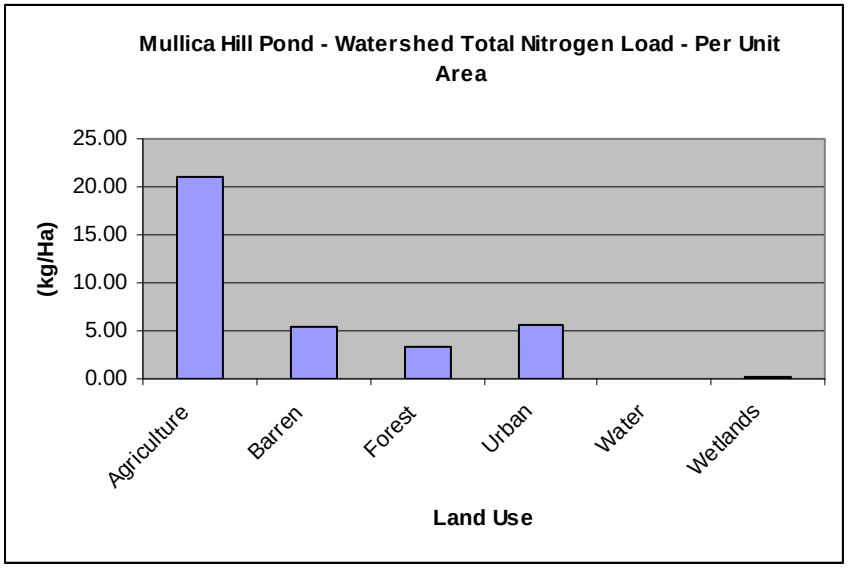


Table 10: Total Phosphorus Load Per Unit Area

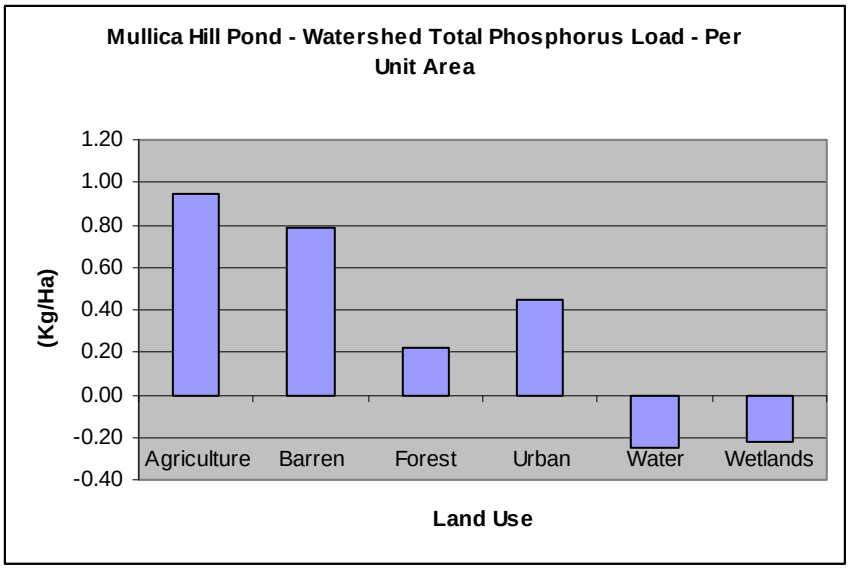
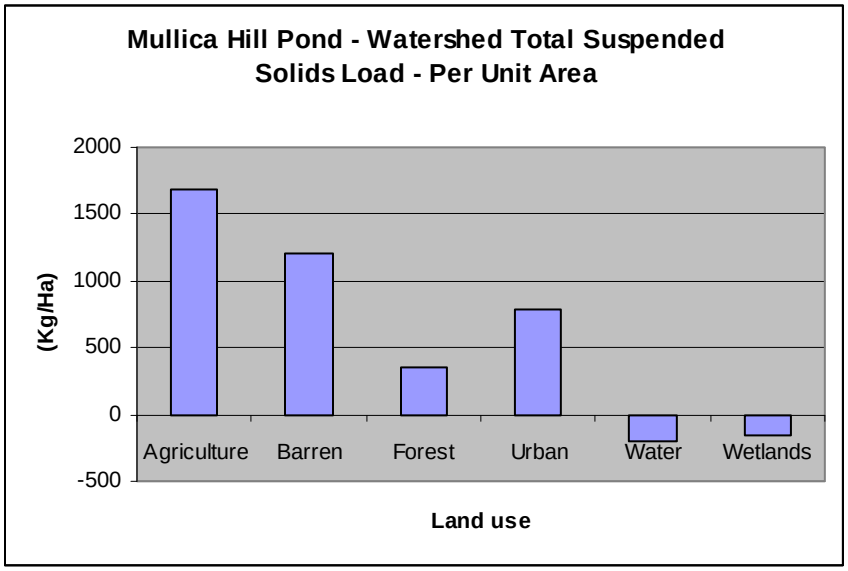


Table 11: Total Suspended Solids Load Per Unit Area



As evidenced in the tables above, agriculture not only represents the highest overall load contributor but is also the highest pollutant contributor on a per unit area basis for all three parameters modeled.

Of particular importance is the elevated phosphorus loadings derived from agricultural land, which are approximately 18% higher than the next greatest contributor, barren land. Obviously the results presented in Tables 9, 10 and 11 are a function of the ascribed loading coefficients. However, because these coefficients are derived from field data collected by various researchers, the data show that although agriculture is often considered benign as compared to other forms of land development it has the potential to generate a large amount of pollutants. For a lake such as Mullica Hill Pond where agriculture is a dominant element of the landscape, it becomes increasingly important to develop and implement pollutant load reduction strategies that specifically target the pollutant loading that originates from agricultural lands. Focus is therefore given in the overall restoration and management plan developed for Mullica Hill Pond in the mitigation and/or reduction in nutrient and sediment loads originating from agricultural lands. Such a focus will provide the most efficient route to the lake's restoration.

7.1 Atmospheric Loading

The final modeled external input of nutrients and sediments to the lake was that attributable to that originating from the atmosphere. Sediments and their bound nutrients may be precipitated as dryfall (dust) or through stripping during rainfall or snow events. While generally recognized as a small source of loading to many waterbodies, atmospheric loading may play a critical role in large lakes or in those waterbodies with small watersheds. Although neither are characteristic of Mullica Hill Pond, to make the pollutant load analysis compete the lake's atmospheric load was nonetheless computed. This load was calculated using empirically derived loading coefficients (Schueler, 1992, Uttormark, et al. 1974, USEPA 1980 and Owe, et al. 1982) of nutrient and sediment sources during dryfall and wetfall (rain / snow).

An estimated annual load of 56 Kg of total nitrogen and1.3 Kg of total phosphorus, and 38 Kg of TSS enter Mullica Hill Pond from atmospheric deposition on a yearly basis. This translates to 0.1%, 0.07%, and 0.001% of the entire TN, TP, and TSS load respectively. Overall, this source is extremely minor and unmanageable therefore rendering it negligible towards the overall nutrient budget and subsequent management plan.

7.2 Internal Sediment Load

Further refinement of the nutrient budget was accomplished through the modeling of the internal nutrient load. Specifically, internal loading is the process whereby phosphorus, which is normally bound in the sediments in an iron / phosphorus molecular complex, is released to the overlying waters. While this process naturally occurs during conditions of ample dissolved oxygen it has been scientifically proven to occur at rates up to an order of magnitude greater during periods of hypolimnetic anoxia (Cooke, 1993, Nurnberg, 1984, Lubnow and Souza, 1999, and Souza and Koppen, 1984b). During these periods of anoxic conditions (DO < 1 mg/L) the lake sediments may release a substantial portion of phosphorus to the waters overlying the sediments which may create an additional "pulse" of nutrients into the system during the summer when plants and algae are growing at their fastest rates.
Analysis of *in-situ* data collected throughout the 2007 growing season has shown that the water column of Mullica Hill Pond remains oxygenated throughout. This is again attributable primarily to

the shallow depths of the pond which negates thermal stratification therefore allowing wind driven mixing. Given the ample concentrations of dissolved oxygen throughout the water column there is no reason to believe there is any significant anoxic internal phosphorus load. Therefore, the only modeled sediment release load was that which would occur under oxic conditions. Utilizing an empirical oxic sediment release rate of 0.6 mg/m^2/day Princeton Hydro calculated an annual total phosphorus load of 11.8 Kg/Yr as attributable to oxic sediment release. Overall, this represents only 0.6% of the entire phosphorus load on an annual basis and is therefore not a cause for concern in terms of management. However, since no diurnal (day/night) DO data was collected the internal load reported herein may be on the low side. As noted previously, we did see come evidence of DO depletion and there is the possibility that at night, given the lake's organic sediments and the presence o the large wetland complex at the lake's upper end, that episodes of localized DO depletion may occur. If and when anoxic conditions occur in the lake, the potential is great that large amounts of phosphorus are released from the sediments. Dense benthic algae mats can exacerbate and facilitate sediment P release and its transfer into the water column. As such, although the results developed as part of this study suggest the internal P load is small, additional data collection may be warranted to further confirm this finding. Overall, the annual total P load can be summarized below inTable 12.

Table 12: Total Annual P Loading to Mullica Hill Pond by category/percentage

Total P Loading Category	Total P load (kg/yr)	% of overall TP load
External	1,921	99.3
Atmospheric	1.3	0.0006
Internal	11.8	0.006

7.3 Trophic State

The productivity or "trophic" state of Mullica Hill Pond is of special concern in relating the overall degree of production (algal / weed growth) in relation to ecological health and user satisfaction. The trophic status of any waterbody pertains to the productivity of that waterbody, specifically the rate or degree or algal and aquatic weed growth. When dealing with many impaired waterbodies the term "Eutrophication" is commonly encountered. Eutrophication is a natural process in lake ecosystems whereby as a result of increased sediment and nutrient loading the waterbody becomes increasingly productive and more prone to nuisance aquatic weed growth and excessive algae blooms. In ecosystems undisturbed by man this process occurs over a geologic time frame taking millions of

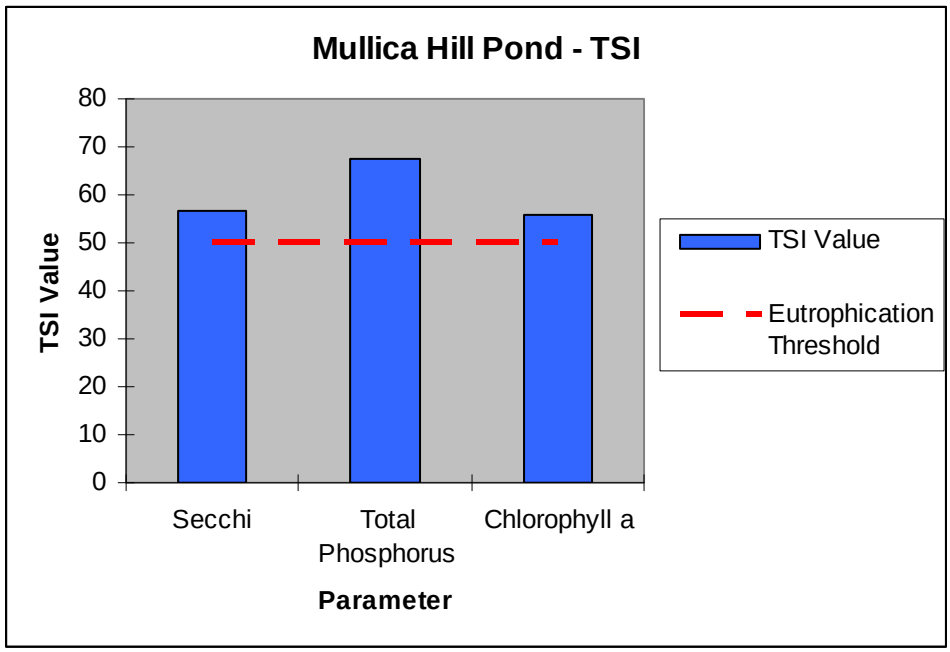
years. Problems arise when the rate of this process is exponentially increased due to unmitigated anthropogenic factors. Essentially, when land is disturbed for either farming, residential development, or any other change in cover from forested land, increased loads of sediments and nutrients enter the lake stimulating weed and algae growth.

While the trophic concept is often misunderstood it represents a continuum from a nutrient limited state (oligotrophy) to a nutrient rich state (eutrophy). What is often misunderstood is that a eutrophic lake can be a very "healthy" lake. It is simply lake that due to its nutrient state is more prone to algae and weed related problems that are a nutrient limited lake. When classifying lakes based on their eutrophic character questions frequently arise as to exactly which diagnostic parameters (chlorophyll *a*, total phosphorus, and/or light extinction) more accurately define and reflect the true trophic status of that waterbody. A simple scheme to classify lake productivity and therefore make educated decisions as to their use and management is the trophic state index (TSI) derived by Dr. Robert Carlson. Because of the flexibility and robust nature of this technique it was utilized to classify the productivity status of Mullica Hill Pond.

The TSI of Carlson (1977) uses a log-based, single variable transformation for an easy to calculate index of trophic state. The basis of this index is derived from chlorophyll *a* concentrations, which serve as a proxy indicator for algal biomass, although growing season total phosphorus concentrations and Secchi disk values may be substituted using modified regression equations derived by Carlson. The basic assumptions of this trophic state model are that suspended particulate matter is the sole contributor to water clarity problems and that algae are the sole source of this particulate matter. For lakes such as Mullica Hill Pond where planktonic algae may not be the best representative of trophic state, one can substitute TP as the basis for the ranking. Based on a scale of 0 to 100, Carlson's TSI provides an easy to understand index of lake productivity that may used by limnologists or volunteers to accurately gauge the lakes state of productivity.

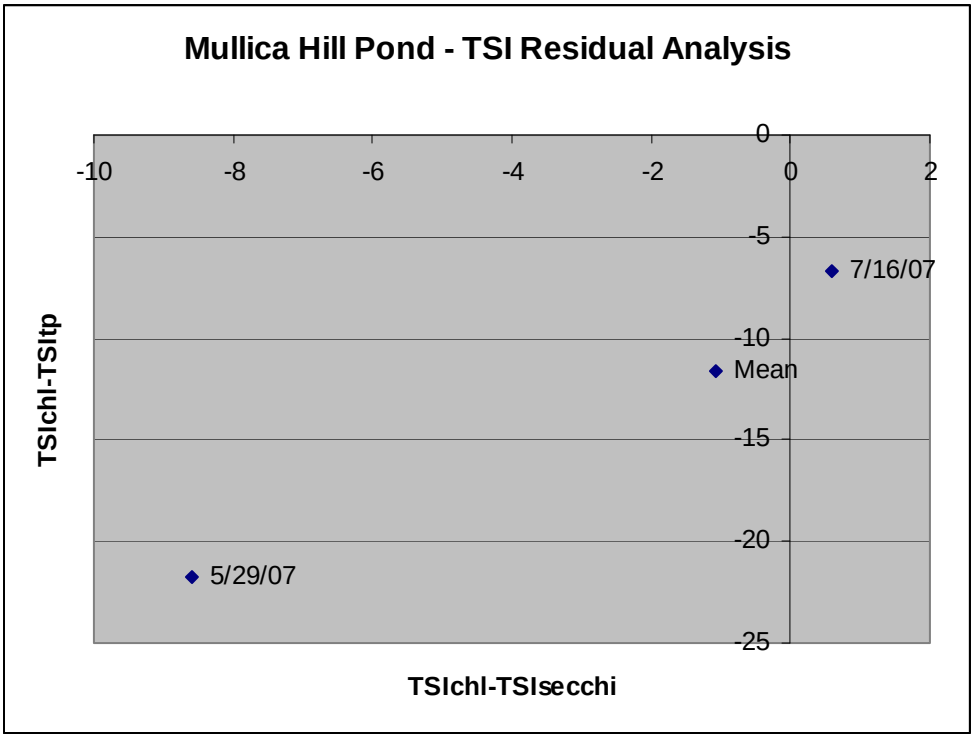
Carlson's trophic state index values for Mullica Hill Pond were hereby calculated as the average of Secchi depths and surface water chlorophyll *a* and total phosphorus concentrations. The results of which are hereby presented in Table 13.

Table 13: Mullica Hill Pond TSI



TSI values for Mullica Hill Pond, as based on the mean of all three parameters modeled, were 57, 67, and 56 for Secchi disk depth, total phosphorus, and chlorophyll *a* respectively. While all values were above the eutrophication threshold of 50 there were notable differences between those TSI values which warranted residual analysis to determine if any systematic deviations from the basic model assumptions could be discerned (Table 14).

Table 14: Mullica Hill Pond TSI Residual Analysis



As previously stated, the basic assumptions of this model are that particulate matter is the sole contributor to water clarity and that phytoplankton are the sole source of this particulate matter. Therefore, differences between the three modeled variables, as was seen to occur in the Mullica Hill Pond dataset, may infer systematic deviations from these assumptions therefore shedding additional light on other factors driving the pond's trophic state. For instance, deviations above the zero point on the x-axis infer varying rates of phosphorus limitation while deviations to the right of the y-axis may imply large particle algae growth (i.e. cyanobacteria) or elevated suspended inorganic sediments if deviations occur to the left of y-axis.

Overall, TSI values were markedly similar between chlorophyll *a* and Secchi disk depth while those based on total phosphorus were routinely elevated. Therefore, while the residual analysis seems to indicate this system is nitrogen limited this is not actually the case. The predominance of filamentous mat algae, which is not accounted for in chlorophyll *a* measures, inherently skews the chlorophyll *a* based TSI value to the low side therefore underestimating productivity. The more likely results given the primary state of productivity (filamentous mat algae and submerged aquatic vegetation growth) is that phosphorus and chlorophyll *a* are highly correlated while Secchi disk depth still remains acceptable. The general maintenance of good water clarity throughout the lake is again a direct result of mat algae growth. While the surface waters of Mullica Hill Pond may be continually covered with nuisance mats the actual measuring of the Secchi disk occurs following the

removal of a portion of the mat algae and subsequent lowering of the Secchi disk throughout the water column. The predominance of surface mat algae inherently excludes ample light from penetrating the water column which would serve to increase phytoplankton production and ultimately decreasing Secchi disk depth.

In summary, while all TSI values were above the eutrophication threshold of 50, that of chlorophyll *a* was routinely underestimated given the predominance of filamentous mat algae. The abundance of mat algae, in concert with elevated phosphorus concentrations, implies that this is a eutrophic system and warrants phosphorus reductions. While water transparency remains acceptable this is simply a factor of the type of algal growth and is not an accurate representation of the trophic state of the pond. Furthermore, and most importantly, TP is the best indicator of the lake's actual trophic state. When the TSI is computed and evaluated using TP the lake scales as a much more eutrophic waterbody than suggested by either the Secchi or chlorophyll metrics. What this means is that improvements in the lake's overall state is by far best determined by examining TP. Reductions in TP loading, via both internal and external control techniques, has the greatest impact on controlling the lake's trophic state and leading to sustainable improvements in the lake's overall condition.

8.0 Restoration Plan

The data compiled and computed in Section 2 through 7, were utilized to prepare a Restoration and Management Plan for Mullica Hill Pond. This Plan provides specific objectives and recommendations for the short and long-term management of Mullica Hill Pond. Both in-lake and watershed management options are provided in the Plan. In-lake measures include physical, chemical and biological recommendations, while the watershed measures include structural and non-structural recommendations. The management measures were priority ranked; the ranking of the proposed measures being dependent upon applicability, regulatory constraints, technical feasibility, degree of effectiveness, initial implementation costs and operations and maintenance costs.

8.1 In-lake Restoration Techniques

In-lake restoration techniques are designed to improve the water quality of waterbody by alleviating specific symptoms of eutrophication. Although these measures typically provide only short-term relief without controlling the source of the pollutants, they can substantially improve the aesthetics of a lake while the long-term, watershed-based management practices are being implemented.

8.1.1 Copper-based Algacides Products

One of the most obvious and frequently used means of controlling excessive algal growth is the application of the algacide copper sulfate ($CuSO_4$). Copper sulfate and other copper-based algacides can be extremely effective in controlling algal growth; however, this control is often brief. Furthermore, the use of these products is aimed at only addressing a symptom of eutrophication (algae bloom) as opposed to correcting or controlling the cause of the bloom.

Several undesirable environmental impacts are known to be associated with copper sulfate treatments. Negative impacts include fish and zooplankton toxicity, the depletion of dissolved oxygen, copper accumulation in the sediments, increased internal nutrient recycling and increased tolerance to copper by some nuisance cyanophyte algae. Zooplankton, organisms which serve as a natural means of controlling excessive algal growth, are known to be more sensitive to copper than algae. In addition, the generation times of fish and zooplankton are substantially longer than algae. Therefore, these organisms require a longer amount of time to recover from copper treatments relative to algae. The result is a perturbation of the reservoir's food web; while the phytoplankton community can recover from a copper treatment within 1-2 weeks, recovery of zooplankton or fish can vary from several weeks to several years. Thus, the phytoplankton will rebound quicker than other aquatic organisms from copper treatments.

Although the depletion of dissolved oxygen will mostly likely not be a problem in Mullica Hill Pond due to its relative shallow depth and propensity for flushing and mixing, the potential still exist for such a situation to develop. Large-scale dissolved oxygen depletion events can occur especially when copper treatments are extensive and conducted frequently within a short period of time. DO depletion can result in fish kills and/or contribute to unpleasant tastes and odors.

One of the most convincing reasons for minimizing the frequency and magnitude of large-scale copper sulfate treatments is the fact that several studies have demonstrated that many of the nuisance cyanophytes, such as *Anabaena* and *Coelospaerium*, have actually increased in tolerance to long-term applications of copper sulfate (Hanson and Stefan, 1984). Indeed, studies have shown that cyanophyte tolerance to the liberal application of copper sulfate can increase to the point were it is no longer economically feasible to use copper sulfate as a means of algal control (Alhgren, 1970).

Thus, to prevent such a situation from developing in Mullica Hill Pond, any algacide treatment program should not be conducted on a set time schedule. Instead, the treatment programs should be integrated with findings from a water quality monitoring program. If algacide treatments are conducted early enough in the development of an algal bloom, the occurrence of undesirable ecosystem perturbation can be severely minimized. Such a strategy is in sharp contrast to waiting for an algal bloom to attain extremely high concentrations and then attempting to improve water quality conditions by quickly killing off the bloom with large quantities of $CuSO_4$.

A low-dose, treatment programming involving 5-7 treatments of the lake over the course of the growing season would likely cost in the range of $2,800 per event; thus likely $14,000 - $19,600 per year. If implemented carefully and with impunity following a low dose methodology, it will be possible to decrease the severity of the existing algae blooms without causing any significant secondary impacts. The application of algacides should be avoided once large amounts of algae biomass as the rapid die-off of the algae could lead to DO depletion and trigger a fish kill.

8.1.2 Biomanipulation

Within the scope of this study, biomanipulation is defined as "a series of manipulations of the biota of lakes and of their habitats to facilitate certain interactions and results which we as lake users consider beneficial - namely reduction of algal biomass and, in particular, of blue-greens" (Sharpiro, 1990). In effect biomanipulation is structuring the aquatic food web to favor the growth of non-scum forming algae and minimizing the density of blue-green algae. An increase in piscivore (large, game fish) biomass could result in a decrease in planktivore (smaller forage fish) biomass. This in turn would reduce grazing on the zooplankton and would lead to an increasing herbivore (zooplankton) biomass and a decrease in producer (phytoplankton) biomass. These conditions ultimately produce an increase in water clarity and quality. For this lake the impacts of the foraging activity of the bottom feeding Creek Chubsucker cannot be overlooked. Although we have no data to substantiate the impact of this fish on internal phosphorus loading and clarity, intuitively one would expect as the fish stir up the bottom as part of their feeding activities, sediment and phosphorus will be swept into the water column. The sediment has a direct impact on lake clarity and the phosphorus an impact on algal growth. Biomanipulation for Mullica Hill Pond therefore falls outside the typical phytoplankton-zooplankton control boundaries and has more meaning with regards to controlling internal nutrient recycling and sediment disturbance.

The fishery biomass as reported in Section 3.5 was dominated by large, bottom feeding Creek Chubsucker. In addition, there was an overall absence of larger piscivorous fish biomass. To mitigate the potential impact caused by the Creek Chubsucker a biomanipulation program for Mullica Hill Pond should start with imposing limits on the catch and removal of Largemouth Bass.

The program should also involve the stocking large, adult Largemouth Bass (greater than 12 inches). This will not only increase predation pressure on the Creek Chubsucker but will increase the spawning stock of the Largemouth Bass. This would accomplish several goals: recruitment would increase, more size-classes would be represented, and predation pressure on Creek Chubsuckers and Golden Shiners would increase. The fishery of Mullica Hill Pond is clearly impacted by abundant weed growth and impaired water quality, which is evidenced by the abundance of Creek Chubsuckers and the general lack of quality predators such Largemouth Bass and Chain Pickerel. These impairments in the fishery and overall water quality can be improved through the stocking of the Largemouth Bass.

There are several commercial hatcheries that could supply Largemouth Bass for Mullica Hill Pond. Stocking costs vary depending upon number of fish stocked, size of fish stocked, delivery charges and time of year that stocking occurs. As a general rule of thumb, a Largemouth Bass greater than 12 inches in length can be stocked for approximately $16.00 to $20.00 per fish. It is important to note that depending upon the species of fish stocked, the recommended number of fish to stock per acre differs. Generally, the larger the predator, the less number of fish needed per acre. For Mullica Hill Pond we recommend a Largemouth Bass stocking ratio of 15 adults per acre.

Even if stocked only to improve the lake's fishery, we feel that this option can be relegated to a higher priority. Potential additional benefits of the stocking relate to a decrease in internal TP loading attributable to the feeding behavior of the Creek Chubsucker and a reduction in fish-related grazing pressure on zooplankton.

8.1.3 Mechanical Harvesting

Based on its overall shallow nature, most sections of Mullica Hill Pond are susceptible to the proliferation of nuisance densities of rooted aquatic plants and filamentous mat algae. Mechanical harvesting is a cost effective and ecologically sound method of controlling the growth and development of both aquatic weeds and filamentous mat algae. One consistent advantage mechanical harvesting has over other management techniques, such as the application of herbicides (for weed control) or algacides (for mat algae control), is that phosphorus is removed from the lake along with the weed/algal biomass. Initiating a harvesting program at Mullica Hill Pond would be relatively easy. The lake has adequate access to launch either a conventional harvester or a hydrorake. A hydrorake will remove algae from the lake at the rate of 1-2 acres per day. What makes the hydrorake particularly effective is that the hydrorake removes submerged aquatic vegetation from the roots and algae mats that are still fixed to the lake's sediments. This increases the longevity and efficacy of the overall effort. Whether hydroraked or harvested, the collected aquatic vegetation and algae will need to be hauled offsite for final disposal. Any harvested aquatic vegetation and algae can be composted and used as a soil amendment, thus making it an attractive source of organic and nutrient material for any of the local agricultural operations. Compared to hauling the material to a landfill for disposal, this would significantly reduce disposal costs to a minimum. Hydroraking operations can typically cost up to $2,500.00 per acre ($235.00 per hour with 0.1 to 0.2 acres raked per hour). Basic harvesting should run in the vicinity of $500 per acre (with 1-2 acres harvested). As noted, these costs reflect only the cost to remove the weed/algae from the lake and do not include the cost of trucking and/or the disposal of the material. Approximately

10 acres of Mullica Hill Pond appeared to be impacted by filamentous algae during the 2007 field efforts. The mechanical control of this growth thus translates to a price of at least $5,000 if done with a conventional harvester to $25,000 if hydroraked. It may be necessary to repeat the harvesting twice over the course of the growing season (once in the early July and then again in late August). The hydroraking should be good for the entire year and as such should be scheduled for a mid-July implementation date.

We feel that harvesting, either using conventional or hydroraking machinery, is a high priority management option for the lake. Removal of the mats of weeds and algae will improve water flow, increase the lake's recreational use and make the lake better all around. It would also result in some nutrient reduction via the removal of plant and algae biomass,

8.1.4 Artificial Circulation

Artificial circulation, also known as aeration, is another management technique that can be used to reduce the impact of the internal phosphorus load on the water quality of a lake. Essentially, keeping the lake well mixed prevents the establishment of thermal stratification which, in turn, prevents the development of anoxic conditions in the bottom waters. By keeping the bottom waters oxygenated, phosphorus is not released from the sediments and remains bound to iron. This reduces the magnitude of the internal phosphorus load and helps reduce growing season algal blooms. Aeration systems are designed to aerate a lake through the use of pumps, jets, and bubbled air. Specifically, most aeration systems are comprised of a series of diffusers fed by a common or multiple air supply lines. The diffusers are strategically placed along the bottom of a lake. The release of the compressed air from the air supply compressor through the diffusers results in a fine air bubbles that rise to the lake's surface. This causes an "air lift" that physically disrupts the bottom water and raises it to the surface, in the process physically breaking down any thermal stratification and reestablishing the vertical mixing of the lake's water column. The bottom waters thus mix with the surface waters. This circulation in itself does not introduce or inject oxygen into the lake, but exposes the water to the atmosphere, which in turns promotes reoxygenation. Therefore, these systems are designed to prevent the establishment of stratification and thus prevent anoxic conditions from forming in the bottom waters.

For Mullica Hill Pond, the primary goal of an aeration system would be to keep the deeper portions of the lake well mixed. Mixing is currently hampered more so by the density of filamentous algae present in the lake than it is by any thermal stratification. Although the aerator would not need to address stratification problems, it could enhance mixing and water circulation in areas impacted by mat algae. In addition, the aerator would maintain ample DO at the bottom of the lake, thereby reducing the opportunity for internal phosphorus load, some of the more common supplemental benefits associated with an aeration system in a lake include the expansion of potential fish habitat into the deeper portions of the lake, preventing the formation of stagnant zones in select areas and, under certain conditions, reducing the magnitude of algal blooms/surface scums.

The goal of the aeration system will be to maintain in a fully mixed state all the deeper portions of the lake. The most cost effective means to accomplish this would be to place lines over the deepest areas; adjacent to the earthen dam and toward the southern end of the lake, in particular areas deeper

than 8 feet (approximately 2.0 m).

The cost of installing a destratification aeration system in Mullica Hill Pond is estimated between $8,000.00 and $10,000.00. This price includes the compressor(s) and associated equipment, the lines that run into the lake, installation of the system and one year of operation. This price does not include the construction of a small aerator compressor pump house. Annual maintenance costs to keep such a system operational are estimated to be approximately $500.00 per year. Electrical costs are expected to be approximately $360.00 to $480.00 per year, assuming the price per day to run the aeration system would be between $1.00 and $1.50. Over the course of a growing season, the aeration system is expected to be in operation for 4 months or 120 days.

At this stage of the lake's restoration we feel that aeration is a non-priority option. Although it could yield some positive benefits and would improve DO distribution throughout the lake, it is neither as important as algae control nor harvesting in terms of improving the lake's conditions and enhancing its recreational and aesthetic attributes.

8.1.5 Canada Geese Control

Canada geese have the potential to be major contributors to the phosphorus problem at Mullica Hill Pond and can also contribute substantial aesthetic problems by leaving large amounts of feces on the small park and picnic area. Canada geese can also be extremely aggressive towards people and other animals when they nest and fledge their young.

When the geese defecate in a lake, phosphorous is released into the water. In addition, there is a significant amount of runoff of geese feces into lake from the any maintained lawn or recreational land (where the geese prefer to reside) that may be adjacent to lakes. Thus, geese are a source of phosphorous contamination of lakes.

There are many methods currently in use that attempt to lower the populations of Canada geese that reside adjacent to waterways. They range from very simple and inexpensive to very costly and complicated. At best, most are only moderately successful.

The most common goose control technique is the erection of fencing around recreation areas. This does not remove the geese from the lake but in theory keeps them from using the fenced off areas. Also unless this results in a sizable decrease in the lake's geese population it will not help decrease the phosphorus problem within a lake. Rather it will make the recreation areas more aesthetically acceptable. Fencing is relatively inexpensive. Costs depend on the type of fencing purchased and the size of area that needs to be fenced. In practice, this method is only moderately successful as often the fencing is not maintained. More importantly, it may not actually decrease a lake's overall use by geese, and thus have little positive impact on reducing TP loading.

Another option that is commonly used is the constant harassment of geese. Of the various harassment techniques the one that seems to work the best is the use of border collies. These dogs will chase the geese either from the land to the water or the water to the land. These services can be provided by contractors alleviating the need to actually purchase and care for a dog. As with many

of the other harassment techniques, the geese may become acclimatized to the dogs. It is therefore necessary that the dogs be used on a frequent but irregular basis.

Many places that have goose population problems apply chemicals to lawn areas. Though the chemicals are not toxic to the geese they make the grass the geese eat unpalatable. The theory is that the geese will move to different areas that have better food sources. Although this technique works well, for most areas, this method is cost prohibitive. The chemicals alone are very expensive and need to reapplied after a rainfall or each time the grass is mowed. With all of the farm land in the Mullica Hill Pond watershed and the large wetland complex at the lake's upper end, it is not likely that grass treatments will have a big effect on deterring the use of the lake. It would be far more cost-effective to educate the park's patrons about not feeding any geese that may be present.

Finally, New Jersey issues special permits for the addling of eggs. Addling effectively destroys the eggs without physically altering them. The female goose will continue to sit on the eggs and not produce another set. Although this will not eliminate the entire goose population, it will keep the population from increasing.

In conclusion, there is no single fully effective goose control option. However, harassment by dogs, public education and egg addling are all fairly effective. For Mullica Hill Pond, any goose related nutrient load is far less important than nutrient loading arising from watershed development related activities. As such, although part of the overall nutrient control solution, the control of geese is not a top priority issue for Mullica Hill Pond.

8.1.6 Dredging

Dredging entails the removal of settled or accumulated material (i.e. sediments) from a waterbody. Stormwater and surface runoff transport soils and other particulate matter to Mullica Hill Lake. Sources of the accumulated organic sediments present in the bottom of the lake include leaf litter and partially decomposed algae and aquatic plants. Over time, the amount of inorganic and organic material that has accumulated in the bottom of Mullica Hill Pond has reached quantities that make sections of the lake noticeably shallow and impact water quality and recreational use.

From the data collected during the bathymetric survey, approximately 13,225 yds^3 of unconsolidated material is estimated to exist within Mullica Hill Pond. When the mean thickness of accumulated sediment averaged over the entire lake is only 1.0 foot (0.3 m). However, some portions of the lake have sediment depths of up to 4 feet. The deepest amount of unconsolidated sediments was located in areas approximately 150 feet from the earthen dam in the central portion of the lake and in the area where the Raccoon Creek enters Mullica Hill Pond in the southern portion of the lake. This is to be expected as these two specific areas are where water flow slows. A reduction in flow would facilitate the settling of any solids and thus leading to their accumulation in these areas. In the central portion of the lake, sediment thickness was between 2 to 3 feet, while at the southern end of the lake sediment thickness approached 4 feet. Thus, if the eventual dredging of Mullica Hill Pond had to be conducted in phases, the highest priority areas would be in the central and southern portions of the lake.

Dredging Mullica Hill Pond would enhance and improve its aesthetic and recreational value. Specifically, dredging the lake would remove a portion of the superficial unconsolidated material that fuels the growth of both rooted aquatic plants and benthic algae. While dredging the lake will not completely control the development of nuisance levels of rooted aquatic plants and mat algae, it will contribute toward limiting their rates of growth by reducing the internal nutrient load and deepening the average depth to reduce the amount of light that reaches the lake bottom. The net result of these habitat alterations will be a contribution toward lower levels of aquatic plant and benthic algae growth. Dredging Mullica Hill Pond will also improve water circulation and expand habitat for desirable aquatic organisms such as fish and benthic macroinvertebrates.

In order to dredge Mullica Hill Pond, both State and local permits will be required. The dredging will require both a Freshwater Wetlands State General Permit-13 (Maintenance Dredging) and a Flood Hazard Area Rule General Permit. As part of the NJDEP permit process the sediments will need to be tested (physical and chemical analyses) and a dredge material disposal site identified. In addition, any maintenance dredging within 200 feet of the dam will require a letter of approval by the NJDEP Department of Dam Safety. Local permitting will include a Gloucester County Soil Conservation District approved Erosion and Sediment Plan.

If the Mullica Hill Pond stakeholders decide to dredge the lake, and file for all of the necessary permits, a plan for the actual execution of the dredging needs to be developed. Some of the major issues that need to be considered in planning for the proposed dredging project include:

- The method of dredging to be progressed (mechanical vs. hydraulic),
- Access for the dredging equipment,
- Identification of disposal sites for the material,
- Distance required to transport the material to the disposal site, and
- Environmental testing & monitoring.

In addition, given the total volume of unconsolidated sediments, the size of the lake and scope of this proposed management technique, the dredging of Mullica Hill Pond may have to be implemented in phase over the course of several years. Budgetary constraints and the possible limitation of available space for the disposal of the material could also necessitate that the dredging of Mullica Hill Pond be a multi-year project.

There are a variety of methodologies and strategies that could be used to dredge Mullica Hill Pond. If a disposal site is located in uplands, relatively close to the lake, hydraulic dredging could be the most cost effective means of dredging the lake. If the disposal site is a considerable distance (> 1 mile) from the lake, the cost effectiveness of hydraulic dredging will be negatively impacted. Since material being hydraulically dredged will be nearly liquid in form, large-scale temporary sediment dewatering areas will be needed to accommodate the dredged material. Once the material is sufficiently dewatered it will then need to be transported to the final disposal site. This means the material is handled at least twice before final disposal. This adds to the overall cost.

In contrast to hydraulic dredging, if the water level can be lowered and a large portion of the sediments can be exposed to the air, more conventional equipment (i.e. backhoe, trackhoe, dragline bucket) can be used to remove the material. The water level is lowered, preferably during the

fall/winter when recreational use is at its seasonal minimal, and the exposed material is allowed to dry. The slurry is then either stock piled for a few days or immediately transported to the final disposal site. Thus, for mechanical dredging the associated costs of handling the material is lower relative to hydraulic dredging.

Conversely, the lake could be lowered and the sediments removed using mechanical dredging techniques. This may be difficult given the size of the lake's watershed and uncertainties concerning the physical ability to lower and main the lake in a dewatered state. However, given the flash boards present on the dam, it may be relatively easy to at least partially draw down the lake. Once the lake is drawn down, the sediments should sit in-place for approximately 1to 2 months, preferably during the fall, to assist in their dewatering and drying. Even so, until the sediments are fully tested, questions remain about their consistency and physical characteristics. More than likely it will be necessary to construct temporary haul roads within the lake for complete access of the excavator(s) and dump trucks to the unconsolidated materials.

A component of a dredging project that can greatly escalate project costs is the transportation and disposal of the sediments. For example, for a 25,000 yd^3 dredging project, a 5 mile round trip to the final disposal site can expect to cost approximately $150,000.00 in trucking. In contrast, a 25 mile round trip to the final disposal site for the same amount of dredged material can be expected to cost approximately $400,000.00 in trucking. Therefore, in order to minimize trucking costs, the final disposal site should be located in an upland area and as close to the lake as physically possible. If possible stakeholder-owned land within the immediate area, such as one of the nearby agricultural fields, should be used for final disposal of the dredging material. This would be expected to substantially reduce the associated costs. However, if a third party agrees to accept the material for disposal it is strongly recommended that the material by tested for the existence of contaminants in order to confirm that the material falls within the State clean-up criteria for dredged material. Testing of this nature was conducted in October 2006 with a single sample of the sediment within Mullica Hill Pond sampled and analyzed for Priority Pollutants + 40 parameters (PP+40). The October 2006 testing also involved the analysis of the sediment's physical parameters, specifically percent solids, percent organics and grain size; sediment properties that help define to potential contractors the handling and disposal characteristics of the material. A comparison of the PP+40 laboratory analytical results was completed with the NJDEP Site Remediation Program Soil Cleanup Criteria (NJDEP-SCC) for Residential Direct Contact, the most stringent of the NJDEP-SCC. The laboratory results reveal that all analyses, where detected, were below any of the residential direct contact NJDEP-SCC. It should be noted that although the sampling occurred in October 2006, the analytical results were compared with the recently revised (June 2008) NJDEP-SCC. Lastly, the physical testing of the sediment determined that the overwhelming majority (64%) of the material was coarse to fine sand, with the remaining percentage comprised of silt and clay. These factors should allow for the relative ease of sediment disposal onto a third party or local upland should dredging occur.

Whether dredged hydraulically or mechanically in a "dry" state, the dredging of ±13,000 yds^3 of sediments from Mullica Hill Pond is expected to cost at least $45 per cubic yard (~$600,000), assuming the material falls within the State's clean-up criteria of uncontaminated sediment and that the disposal site is located within a 5 mile round trip radius with the lake. This includes the actual dredging, transportation of the material to the local disposal site, all of the associated permitting and

environmental monitoring /management, and the restoration of the site after the project is complete. Given the size and scope of dredging the entire lake, the stakeholders may want to implement the project in a series of phase over a number of years. Such a strategy may be easier to implement in terms of project logistics and budgetary constraints. Potential sites of prioritization for the project include along the central portions of the lake and within the southern end of the lake. Once the State permits are obtained, they are valid for five years, so a multi-year dredging project of the entire lake could be implemented within one permit, assuming no budgetary limitation. In any event, when dredging the Mullica Hill Pond is under serious consideration, a Dredging Feasibility Study needs to be conducted. Such a study would collect the bathymetric and topographic data needed to generate the CADD drawings required for the permit, conduct more detailed sediment testing, locate possible sites for disposal and develop more site specific prices for the project.

In conclusion, it should be emphasized that the dredging of Mullica Hill Pond is not an "all or none" scenario. A dredging feasibility study would provide the additional information needed to more accurately estimate the dredging of the Mullica Hill Pond. Although expensive the project would measurably improve the condition of the lake. However, until the sources of sediment loading are managed and controlled we DO NOT recommend the lake be dredged.

8.2 Watershed Restoration and Management

In contrast to in-lake restoration, watershed restoration and management focuses on correcting the cause of eutrophication rather than addressing or mitigating the symptoms. Although watershed restoration and management measures may not yield immediate dramatic improvements as is often the case with in-lake restoration techniques, they are absolutely vital to producing long-term, sustainable improvement in water quality. For Mullica Hill Pond, that receives a significant quantity of nutrients and sediments from its watershed, the failure to implement meaningful watershed management and restoration measures will impede any effort to truly improve the lake.

Watershed control measures are designed to reduce non-point source (NPS) pollution. NPS pollution is very diffuse and generated over a relatively large area and produced by a wide variety of sources. Some examples of NPS pollutant sources include lawn and garden fertilizers, waste generated from pets and waterfowl, surface runoff from paved surfaces, construction sites, agricultural areas and the atmosphere. This type of pollution is sharply contrasted to point source pollution, where the pollutants are generated and discharged from a specific point or source. An example of a point source is a sewage treatment plant. Unfortunately, NPS pollutants can often be more difficult and expensive to control than point source pollutants. Nevertheless, for lakes such as Mullica Hill Pond where NPS pollutants account for all or large fractions of the total pollutant load, this source of pollution needs to be controlled if long-term improvements in water quality are to be realized.

8.2.1 Public Education

The following NPS management techniques can be lumped into the general category of Public Education. Basically, these measures rely on their voluntary implementation. To be successful, these measures must be embraced by the community. However, if rigorously implemented these

measures can have a pronounced positive effect on water quality and the overall lake trophic state. This is because they aim to reduce pollutant loading before it occurs by controlling its generation at the point of origin. The following recommendations are examples of watershed based homeowner directed initiatives. These initiatives can be specifically utilized on the new single family residential developments that have occurred in the watershed of Mullica Hill Pond in the recent years. Admittedly, it is difficult to accurately quantify the pollutant reductions that could be achieved through each of these measures. However, if done on a watershed-wide scale they can both protect the lake and its tributaries by reducing the generation of nutrients and sediments.

Minimizing Site Disturbance and Utilizing Alternative Landscaping - Minimizing disturbance and utilizing alternative landscaping are preventative pollutant load management techniques. If these techniques are properly implemented they can eliminate the need for the repeated fertilization of lawns, decrease the rate or frequency of pesticide applications and decrease irrigation requirements. This is particularly important in the newly built single family residential development that was observed throughout the watershed.

In already developed areas of the watershed, especially the single family residential areas immediately adjacent to Mullica Hill Pond and the Raccoon Creek, homeowners should be encouraged to allow nature to take its course in a portion of the property. Focus should be placed on maintaining natural ground covers in lieu of manicured lawns, and supplementing areas having sub-optimal ground cover with selected plantings. This practice can help minimize lawn areas and the associated use of nutrients and pesticides. By maintaining properly stabilized vegetative cover, a reduction in localized soil erosion can be achieved. Such measures should especially be promoted at transition points to wetlands and streams, especially along the Raccoon Creek just upstream of the Lake. By utilizing a combination of design, plants and mulches, homeowners and landscapers can create a landscape that decreases maintenance, is aesthetically pleasing and is environmentally suited to the area.

Fertilizer and Pesticide Management - As discussed above and factored into the pollutant loading analyses conducted in Section 7, environmental conditions conducive to the direct transport of nutrients and pesticides into Mullica Hill Pond prevail in the residential areas located along the shoreline of the lake, in particular the more steeply sloped sub-watersheds that immediately drain into sections of both Mullica Hill Pond and the overall Raccoon Creek areas just upstream of the Lake. This reinforces the need for the implementation of IPM techniques in upland areas within 300 feet of the lake and its overall tributaries in the watershed. Integrated pest management (IPM) is a common sense, but technically well structured approach to the use of fertilizers and pesticides. It can be used at the individual home level, but is more commonly utilized in respect to the maintenance of large intensive use areas such as golf courses, public parks, and ball fields. Central to the success of IPM, as a source control strategy, is the employment of environmentally friendly methods to maintain pests below defined damage levels. Unfortunately, a considerable amount of over application of pesticides and fertilizers occurs during the routine care of residential lawns. Homeowners often operate under the assumption that if "a little is good, more is better". This leads to the over-application of products and an increased potential for off-site transport of pesticides and fertilizers.

In addition to pesticide control, a key element of IPM is the limitation of the use of fertilizers, or the

use of specific types of fertilizers. By applying only the quantity of fertilizer necessary for optimum plant growth, the amount that can potentially be mobilized and transported to surface and groundwater resources is minimized. Use of non-phosphorus fertilizers or slow-release nitrogen fertilizers also decreases the loading to receiving waters. The effectiveness of fertilizer management is dependent upon cumulative effects within the watershed, and requires commitment on an area-wide basis. Not only is non-point source pollution (fertilizers, nutrients) reduced with this practice, but the homeowner will also save money. Thus, homeowners and lawn care services throughout the watershed must be educated regarding proper lawn maintenance. For example, slow release lawn fertilizers allow a more complete utilization of nutrients by lawns, thus decreasing the amount transported into the Raccoon Creek and eventually Mullica Hill Pond and its tributaries.

Fertilizer applications must also be timed properly to account for plant needs and to anticipate rainfall events. For example, nutrients are most needed in the spring and fall, not throughout the summer. Also, rain induced fertilizer losses are greatest immediately following an application because the material has neither become adsorbed by the soil nor taken up by the plants. Fertilizer uptake and retention is promoted by proper soil pH. A detailed survey of homeowners in Virginia commissioned as part of the Chesapeake Bay initiatives, found that less than 20% actually tested their soils to determine whether fertilization was actually necessary (Watershed Protection, 1994). Although soil pH can have a significant bearing on the ability of soils to retain nutrients, such testing is not commonly conducted by homeowners. The application of lime, especially in areas of acidic soils, can improve phosphorus uptake and retention. Other non-chemical lawn care treatments such as de-thatching and aeration are also rarely conducted (Watershed Protection, 1994). Urban soils, even those associated with lawns, can become compacted and function almost no differently in respect to the generation of runoff than impervious surfaces (Schueler, 1995). Aerating lawns helps promote better infiltration and the generation of less runoff.

An additional means by which to decrease fertilizer and pesticide use and the subsequent transport of these pollutants to the Raccoon Creek and Mullica Hill Pond is through the use of alternative lawn cover. Where appropriate, the use of native plants or plants that have lower irrigation needs than typical suburban lawns needs to be promoted. As part of the ongoing strategy to reduce the influx of lawn related pollutants into Chesapeake Bay, the National Park Service has started to use native ground covers to reduce the need for fertilization and irrigation (NPS News-Notes, 1996). Similar types of low maintenance vegetative cover have been promoted by NJDEP (NJDEP, 2004) and the Metropolitan Council of Governments (Schueler, 1987) as part of an overall strategy of reducing NPS loading.

IPM and fertilizer management ordinances, especially those that pertain to private, residential lawns, tend to be highly contested, and subject to extensive public opposition. These ordinances, similar to littering or pet waste ordinances tend to be difficult to police and enforce. The public's voluntary participation is therefore needed if IPM and fertilizer management ordinances are to be successful. This starts with the implementation of a well-structured public education effort. Specifically, the Gloucester County Soil Conservation District, Township of Harrison and other pertinent stakeholders should conduct a public education program that informs all the residents of the benefits of fertilizer and pesticide management, stressing the low cost alternatives and environmental benefits of such techniques. Residents should be educated about conducting soil pH and nutrient testing before applying any lawn care product to their lawn. They should also be informed about the

benefits of liming, aeration, thatch control, and other non-chemical lawn care measures. This is especially true in the recently constructed single family residential developments throughout the watershed.

Pet Waste - Another localized source of nutrients that can be easily controlled is that of pet wastes. In addition to providing an ample source of phosphorus these wastes are unsightly and may cause health concerns due to high fecal coliform bacteria concentrations in runoff waters coming into contact with the waste sources. Reduction of this nutrient source can be obtained through the implementation of town or county ordinances requiring the retrieval of pet wastes and through the pet owner's compliance. As stated prior, these ordinances, can be difficult to police and enforce.

8.2.2 Near Shore and Streambank Stabilization

The majority of the shoreline of Mullica Hill Pond is well stabilized due to that fact that the lake's nearshore slopes are not overly steep and are highly vegetated. The exception to these highly stabilized conditions is, as expected, the small recreational area in the northwestern portion of the lake. Obviously, no stabilization efforts (i.e. rip-rap, plantings) are recommended for this area in order to allow access and the recreational use of the lake. While the shoreline of Mullica Hill Pond was generally well stabilized, it is possible that some sections of the stream bank along the Raccoon Creek inlet and the Lakes overall tributaries are in need of stabilization. This was especially the case in the area surrounding the Clems Run, a Mullica Hill Pond tributary. Additionally, with a large (46%) portion of the watershed in agricultural use, it is likely owing to older farming practices that some of the streams dissecting active agricultural land lack a riparian zone and are unstable. This was observed in the Mount Pleasant Orchards are of Route 220 and Route 213.

To objectively implement a shoreline stabilization plan for the tributaries of Mullica Hill Pond, a stream visual assessment (SVA) should be conducted following the NJDEP's SVA protocol. Essentially, the survey would be used to prioritize those sections of streambank with the highest need of stabilization. Available funds (i.e. grants or other sources) would then be used to implement those projects that would provide the highest degree of return per dollar spent. The following proposed protocol is provided as a recommended means of initiating this watershed technique.

- Conduct a formal stream walk along the Raccoon Creek and all its tributaries. Field notes and digital photographs should be taken of the streambank sites in need of stabilization. The linear length and slope of the identified sites should be estimated. Finally, data on the environment and habitat immediately surrounding each streambank site, both within the stream and adjacent to the stream, should be collected.

- The data that were collected as part of the streambank survey should be complied into a database. The database would then be used to prioritize the projects. Prioritization parameters could include, but would not necessarily be limited to, length and slope of site, potential in-stream and riparian impacts if not stabilized and possible impacts on property of the lake or any private stakeholders.

- The results of the prioritization assessment would be placed into a final report, which

would include the digital photographs and a long-term prioritization plan for the implementation of the identified projects. In turn, this document could be used to justify the need to provide the lake with Federal, State, County and/or local funds to implement the targeted projects.

Depending on site-specific conditions, standard structural (i.e. rip-rap, gabions) and/or bioengineering (i.e. biologs, installation of vegetation) technique may be used to implement the identified streambank stabilization projects. However, without any site-specific elements, it is difficult to identify in detail which techniques should be used for which project. Thus, the prioritization assessment document should include guidance in the selection of the most appropriate stabilization technique(s).

Regardless of which technique or combination of techniques is implemented, the cost of stabilization tends to vary between $75.00 and $125.00 per linear foot. This estimated price range includes material and labor associated with implementing the project and ease of access to the site. However, the estimated price range does not include permitting and the development of design plans and bid specifications. The price per linear foot would decline if the Township or other stakeholders used its own personnel and equipment to implement the projects. Another means of reducing the estimated cost is to have volunteers assist in some of the planting of vegetation. Such volunteer assistance may include boy or girl scouts, middle or high school students, concerned local citizens or members of Americorp.

Princeton Hydro conducted a watershed walk, along with representatives of both the NJDEP and the CCSCD on March 7, 2008. During this watershed walk, some specific examples of this type of stream bank erosion were identified. These locations all represent tributaries to Mullica Hill Pond. Specifically, the following locations may be key examples of where this type of watershed restoration technique may be applicable.

- Mt. Pleasant Orchards – County Route 213/County Route 220.
- Harrison Estates Residential Development (basin and outlet).
- Clems Run, adjacent to the USGS gauging station
- Tributary located near Clems Run Road and Dillons Lane

Until the scope and extent of stream bank erosion is better defined it is not possible to develop any remediation cost estimates. We estimate the cost of a detailed SVA analysis of the watershed in the range of $20,000. We feel that the impact of stream erosion is great enough and has created enough of an impact to the lake, in addition to the large amount of agricultural land present in the watershed, to warrant the elevation of this recommended watershed restoration measure to a priority position.

8.2.3 Stormwater Retrofits

Surface runoff accounts for the majority of the annual phosphorus load entering Mullica Hill Pond, accounting for nearly 54% of the lake's annual phosphorus load. In addition, surface runoff

accounts for almost all of the TSS entering Mullica Hill Pond. Given these associated impacts of non-point source (NPS) pollution, some amount of stormwater management is required for both the local shoreline areas and the residential/urban portions of the watershed in general.

A portion of the land within the immediate Mullica Hill Pond watershed has been well established for residential and urban use. A large portion of surface runoff from this urbanized land flows over impervious areas. Given the intense proximity of these areas to the lake and its inlet, large structural Best Management Practices (BMPs) such as extended detention basins or retention ponds are not recommended. Instead, the use of storm water retrofits is recommended for use, especially in the single family residential development areas immediately adjacent to the Lake and the Raccoon Creek.

Stormwater retrofits are essentially modifications or enhancements that can be implemented to an existing stormwater conveyance system to improve the system's NPS pollutant reduction capacity. The advantages to such retrofits are that they require substantially smaller amounts of space for installation and are lower in cost relative to larger BMPs. However, as with any BMP, retrofits will require a certain degree of maintenance to optimize their effectiveness. In addition, the frequency of maintenance for retrofits may be higher than larger BMPs, especially during particularly wet years. In any event, stormwater retrofits are a very cost effective means of reducing the NPS pollutant loads (i.e. phosphorus and suspended solids) entering Mullica Hill Pond via stormwater surface runoff.

Provided below is a list of some of the stormwater retrofits that may be applicable for single family residential development areas immediately surrounding Mullica Hill Pond. Most of these retrofits are considered manufactured treatment devices (MTDs). The installation of MTDs or the applicability of a particular retrofit are largely dependent upon site specific conditions. As there a detailed inventory of the stormwater collection and conveyance system of the Mullica Hill Pond watershed was not part of this project, if such a detailed inventory does not exist one should be commissioned. We would expect a project of that nature to cost in the range of $25,000. Depending on the results of the survey some of the retrofits or MTDs that could be used to decrease stormwater loading to the lake include:

- ***SNOUT Oil-Water-Debris Separator*** – This is product specific device that consists of a fiberglass/plastic cowl placed over the exist pipe of a catch basin. The cowl converts a standard catch basin into a catch basin capable of removing gross particulates and heavy sediments, and segregating oils and grease. Primarily suited for the control of oils, particulate material and trash.

- ***Catch Basin Inserts and Screens*** – Very low-tech, low-cost approach to reducing particulate and sediment loading. Involves the placement of a screen immediately blow the catch basin grate to trap and filter out particulate material, floatables and sediment. Require a lot of maintenance. Though inexpensive, these devices must be inspected, cleaned and replaced fairly frequently.

- ***Water Quality Inlets*** - essentially catch basins with a baffled interior and/or sumped bottom. The inlet is designed to slow the flow of the stormwater thus allowing the

particulate material to settle out. The captured stormwater is either allowed to infiltrate into the underlying soils to be released in a controlled manner. Baffled and sumped basins have limited pollutant removal effectiveness due to their typically small size. These basins can be effective in reducing particulate pollutants and pollutants adsorbed onto this material (i.e. phosphorus).

- ***MTDs*** – MTDs use a variety of designs and hydraulic techniques to slow down the flow of stormwater and trap entrained sediments and particulate material. Most MTDs have 50% or greater TSS removal efficiencies and some approach 30-40% TP removal. They tend to be rather large, and as such cost much more to install than do the water quality inlets. They can be constructed on-line or off-line.

- ***Filter Style MTDs*** – MTDs designed to filter stormwater using a filter media usually contained in a filter cartridge of similar device. Filter media can be selected to reduce certain types of pollutants, including dissolved pollutants such as phosphorus and nitrogen. These MTDs tend to be large and very expensive. They also require a fiar amount of maintenance and in some cases the replacement of the filter media requires the use of the manufacturer.

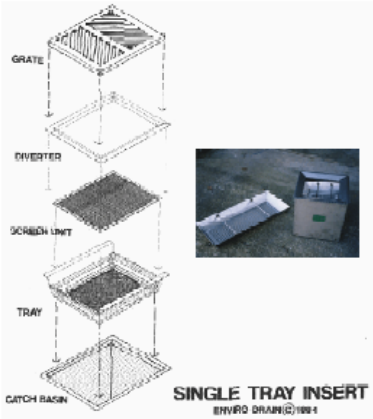
The design and installation of the stormwater retrofits listed above could be as low as $800.00 per structure (i.e. the SNOUT). However, prior to implementing any stormwater retrofit project, it is strongly recommended that the existing stormwater conveyance system of the immediate area be mapped. The field data could be collected with GPS technology and placed into a GIS format to develop digitized maps. In turn, the maps can be placed over other types of watershed data (i.e. slopes, soils, structures) to locate and target specific sites for stormwater retrofits. Finally, the local watershed data would be used to select the most cost effective retrofit for each targeted location. In addition, such a study would also provide a means of prioritizing the retrofit projects as funds are made available.

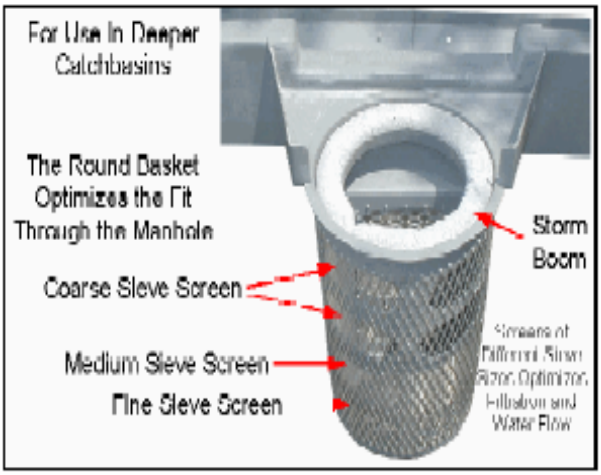
The BMPs mentioned previously, can be utilized in both a residential or agricultural setting. During the watershed walk of March 2007, several examples of residential developments that possessed no or little stormwater management were identified. Specifically, the residential development that is directly adjacent to the lake (Hazelton Terrace and Franklin Drive, near Route 322) would benefit from some type of basin retrofit stormwater management. Currently, all the storm basins in this development allow the direct flow of untreated stormwater into the lake. Additionally, the stormwater treatment basins that were observed at the Camelot and Harrison Estates residential developments, in addition to the basin observed at the new residential development located at the intersection of Clems Run Road and Dylan Lane all presented a minimal approach to storm water treatment. These basins would be ideal locations for additional watershed based storm water management techniques.

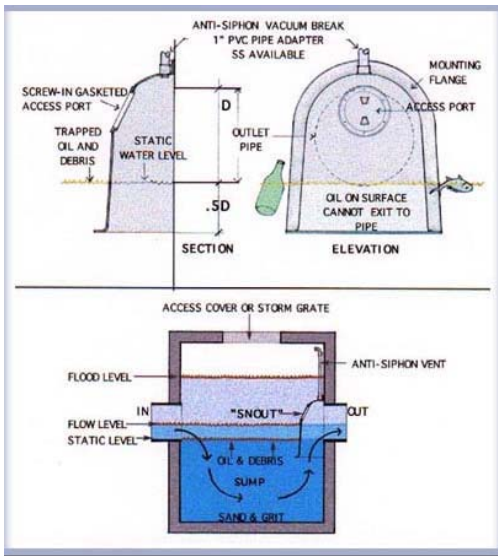
Maintenance is necessary for any storm water system, let alone one that is designed to reduce NPS pollution. Such maintenance can be as simple as the existing basins having sand and road grit removed a few times per year using a public works vac-all truck. However, certain MTDs may need a more rigorous detailed maintenance program. Such maintenance may include the aforementioned use of a vac-all truck for sand and grit removal, the changing of media cartridges or filters, the

removal of large debris and garbage (particularly after summer storms), the emptying of drain catch bags or screens and the disposal of all said collected material.

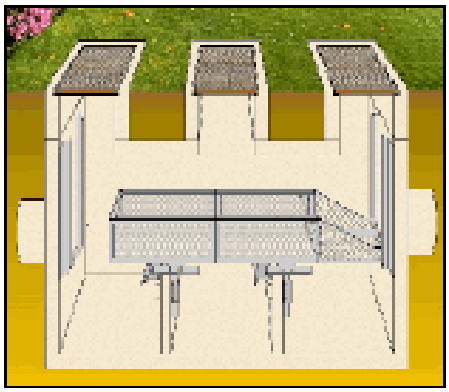
Catch Basin Inlet Filter

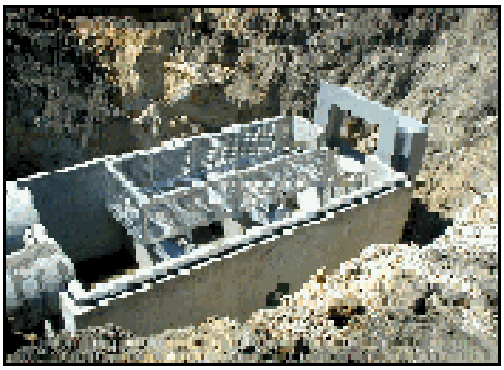


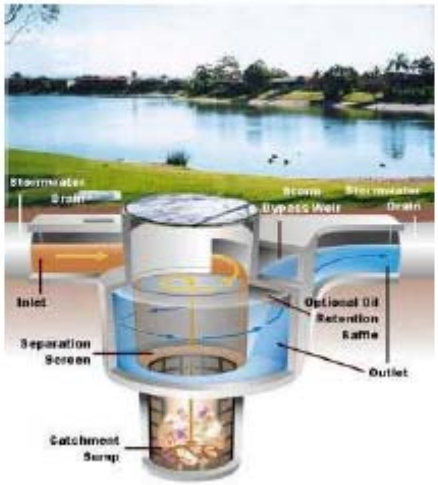


Snout Catch Basin Insert Device	
	

Manufactured Treatment Devices









8.2.4 Preservation of Existing land

This study revealed that approximately 31% of the Mullica Hill Pond watershed is forested and/or some type of wetland. Such existing land conditions are optimal for water quality since forested land tends to generate the lowest surface runoff pollutant loads and wetlands can function to actually assimilate nutrients and other pollutants. Therefore, in order to prevent any future degradation of the water quality of Mullica Hill Pond, the land within its watershed that is forested should remain forested.

Mullica Hill Pond lies in an area of southern New Jersey where residential development has increased in recent years. While the new NJDEP stormwater rules (2004) should make any concern over future development and/or earth-moving activities minimal, the potential for residential development of the watershed exists. Any earth-moving activities that are implemented by any new residential development should closely follow any County Soil Conservation District guidelines for soil and erosion control, to minimize any increase in the lake's current pollutant load. However, the preservation of any open land, forested or agricultural, would erase the concerns of future development within these areas.

8.2.5 Agricultural Land Specific Techniques

Agricultural land is the largest land type within the Mullica Hill Pond watershed, accounting for approximately 46% of the watershed's total area. In addition, surface runoff from agricultural land accounts for 78% of the lake's annual TP load. Thus, reducing the TP load originating from agricultural sources will be perhaps the most important factor in improving its water quality. Thus, the following recommendations are made:

- Clearly identify the number of farms within the watershed and what they produce (i.e. row crops, orchards, livestock).
- Reach out to the agricultural stakeholders in terms of providing information on the efforts designed to preserve and protect both the Raccoon Creek and Mullica Hill Pond.
- Provide information to stakeholders on potential agricultural BMPs and associated sources of funding that may be available for the implementation / installation of such BMPs. The information provided to the agricultural stakeholders needs to emphasize the economic benefits associated with the implementation of the suggested BMPs as well as identify the water quality and community-wide benefits.

From Princeton Hydro's experience with agricultural stakeholders, if funding / support is provided to farmers for the implementation of such projects, and there is a long-term economic benefit, most are more than willing to participate in watershed-based programs. Thus, briefly described below is a list of potential source of funding and/or support for the design and implementation of agricultural BMPs, as well as some examples of the types of agricultural BMPs that can be considered.

US Department of Agriculture:
Funds are available through the 2008 Farm Bill to assist farmers and ranchers to solve natural resource problems though the Environmental Quality Incentives Program (EQIP). The program is geared to help producers meet their conservation goals and supply the public with cleaner water, enhanced air quality, healthy soils, and abundance wildlife. The USDA and its agencies provide technical and financial assistance to Resource Conservation and Development programs (see below).

Natural Resources Conservation Service:
The Farmland Protection Policy Act of 1994 specifies the need to reduce the impact that Federal programs have on farmland that is being converted for non-agricultural use. The Farm and Ranch Land Protection Program (FRPP) provides matching funds to help purchase development rights to keep productive farms and ranchlands in agricultural use.

The Resource Conservation and Development Program (RC & D) encourages volunteer local elected and civic leaders to design and execute projects geared toward resource conservation and community development. The program provides for the purchase of conservation easements through the matching of funds to State, Tribal, local governments, and non-government organizations that have existing farm and ranch land protection programs.

The Natural Resources Conservation Service (NRCS) makes funding available through Conservation Innovation Grants (CIG). Grant funding is awarded to projects pertaining to one of the three categories: Natural Resource Concerns, Technology, and the Chesapeake Bay Watershed. The purpose of the Conservation Innovation Grants is to stimulate the development of and implementation of innovative conservation methods and technologies.

New Jersey Stormwater Permitting Program:
A program created by the Sussex County Soil Conservation District was designed to improve the overall water quality of New Jersey's rivers, lakes, and streams. Where construction and mining activities exist, a permit is required if one acre or more of land is disturbed. This program is managed by NJDEP and implemented by NJ Department of Agriculture and the State Soil Conservation Committee.

New Jersey Non-Point Source Pollution Program:
Under Section 319 of the Clean Water Act, funding is provided to each State for the implementation of projects to reduce the non-point source (NPS) pollution loads that enter our county's waterways. NJDEP typically has a Request for Proposals each year for projects that focus on reducing NPS pollution. Both the agricultural and residential stormwater projects identified in this document may be eligible for funding under the State's NPS grant program.

It should be noted that prior to the selection and implementation of any of the below identified agricultural BMPs, a watershed inventory of the existing farms, their size, and the agricultural products they produce should be conducted.

Streambank Restoration for Agricultural Lands - For agricultural streambanks, stabilization efforts may be as simple as fencing off the stream from livestock, to planting and establishing a riparian stream buffer, to a full scale re-grading and restoration of a streambank which may include

both vegetative and structural stabilization techniques. The two key elements in dictating what stabilization measures should be implementation at a specific site are:

- The presence / absence of livestock
- The slope, streambank soil type, and order of the stream

Constructed Wetlands for Agricultural Runoff - In addition to establishing riparian buffers along the stream reaches throughout the watershed, site-specific constructed wetlands for treatment of areas where excessive runoff from agricultural facilities may occur is a feasible BMP. Land use information through GIS technology has shown that a large majority of agricultural practices within the watershed area are associated with orchard land and row crops. One possible control measure throughout the watershed is the installation of constructed wetlands or bioswales for the capture and retention of runoff during storm events. Animal confinement areas which are located in close proximity to stream channels should be targeted first in developing wetlands or bioswales for nutrient and sediment retention. Prioritization for implementation would occur on a site by site basis with the following factors considered:

- Barnyard areas with dense animal concentrations should be a focus for runoff control. Impervious areas associated with roofing and compacted soils increases runoff volume which serves as a transport vector for nutrients derived from animal wastes and fertilizers.

- Areas of washwater effluent from manure transport/holding infrastructure.

- Downslope areas from manure holding facilities.

Manure storage control and Spreading management - Of particular importance throughout the watershed is that of proper waste handling, storage, and land application. Firstly, special care should be taken so that manure handling facilities are of the proper design and capacity to prevent site runoff during rain events. General considerations for manure handling facilities would consist of the following:

- Manure volume produced during the selected storage period
- Bedding added or used during the selected storage period
- Runoff from exposed lots and buildings during the storage period
- Sludge accumulation during the storage period
- Washwater or other freshwater additions during the storage period
- Treatment volume
- Rainfall-evaporation
- 25-year, 24-hour storm containment

Improper design of holding facilities will directly relate to increased nutrient loading during storm events as this nutrient source is washed offsite into any receiving tributaries and ultimately Mullica Hill Pond.

Additionally, focus should be placed on land application of manure. While a generally basic concept, the timing of manure application could have extremely detrimental effects on receiving water quality. Information gained from the hydrologic study of the area shows that the timing of most manure applications coincides with that of the highest hydraulic loading, namely, from April through early June and September through October. Special care should be taken during these times to minimize applications when the ground is saturated or significant rainfall is in the future. While this is often difficult to predict it should be given strong consideration and all measures possible to limit application during these timeframes.

Orchard Ground Cover Management - An important component in orchards in terms of nutrient runoff may be derived on ground cover practices. A preliminary study conducted by Ian Merwin of Cornell University indicates that alternative ground cover management may have significant effects on the nutrient uptake, fruit yield, and resultant runoff of nitrogen and phosphorus from orchard lands. This preliminary study shows the weak competitive ability apple trees have in comparison to turf grass groundcover in relation to nutrient uptake, especially nitrogen. Essentially, this report indicates that varying groundcover throughout the year between hardwood mulch and turf grass will affect the relative availability of nutrients and therefore uptake by orchard trees. Essentially, those times when nitrogen uptake is most crucial for orchard trees, during the late spring and early summer months, groundcovers should be consisted of hardwood mulch as opposed to turf grasses. This allows for the uptake of nutrients by the apple trees as opposed to turf grasses therefore reducing the overall amount of nutrients available for runoff into tributaries. At the end of the growing year groundcovers should be switched to turf grasses to allow for the uptake of any remaining soil nutrients and to assimilate those nutrients lost from the orchard trees through dropping of remaining fruit and leaves.

Glossary of Key Terms

- Acidity - The state of being acid that is of being capable of transferring a hydrogen ion in solution; solution that has a pH value lower than 7.

- Alkalinity - The capacity of water for neutralizing an acid solution. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates, carbonates and occasionally borates, silicates and phosphates. It is expressed in units of milligrams per liter (mg/l) of $CaCO_3$ (calcium carbonate) or as microequivalents per liter (µeq/l) 20 µeq/l = 1 mg/l of $CaCO_3$. A solution having a pH below 4.5 contains no alkalinity. Low alkalinity is the main indicator of susceptibility to acid rain. Increasing alkalinity is often related to increased algal productivity. Lakes with watersheds having a sedimentary carbonate rocks geology then to be high in dissolved carbonates (hard-water lakes), whereas those in a watershed with a granitic or igneous geology tend to be low in dissolved carbonates (soft water lakes).

- Anthropogenic activities – Impacted by, created by or resulting from human activities.

- Aeration - A process which promotes biological degradation of organic matter in water. The process may be passive (as when waste is exposed to air), or active (as when a mixing or bubbling device introduces the air).

- Algae - Microscopic plants which contain chlorophyll and live floating or suspended in water. They also may be attached to structures, rocks or other submerged surfaces. They are food for fish and small aquatic animals. Excess algal growths can impart tastes and odors to potable water. Algae produce oxygen during sunlight hours and use oxygen during the night hours. They can affect water quality adversely by lowering the dissolved oxygen in the water.

- Alum Treatment - Process of introducing granular or liquid alum (*Aluminum sulfate*) into the lake water, to create a precipitate or floc that is used to strip the water column of fine particles and algae or used to treat the bottom sediment for the purpose of limiting the internal recycling of phosphorus.

- Ammonia - A colorless gaseous alkaline compound that is very soluble in water, has a characteristic pungent odor, is lighter than air, and is formed as a result of the decomposition of most nitrogenous organic material.

- Bathymetry - The measurement and mapping of water depths and bottom contours.

- Best Management Practices - Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include but are not limited to treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or wastewater

disposal, or drainage from raw material storage. Practices or structures designed to reduce the quantities of pollutants -- such as sediment, nitrogen, phosphorus, and animal wastes that are washed by rain and snow melt from farms into surface or ground waters.

- Chlorophyll *a* - A green pigment found in photosynthetic organisms; used as an indicator of algal biomass.

- Clarity - The transparency of a water column. Commonly measured with a Secchi disk

- Composite water quality sample - A composite sample is a collection of individual samples obtained at regular intervals, usually every one or two hours during a 24-hour time span. Each individual sample is combined with the others in proportion to the rate of flow when the sample was collected The resulting mixture (composite sample) forms a representative sample and is analyzed to determine the average conditions during the sampling period.

- Detritus - Any loose material produced directly from disintegration processes. Organic detritus consists of material resulting from the decomposition of dead organic remains.

- Dissolved oxygen - The amount of oxygen dissolved in a stream, river or lake is an indication of the degree of health of the stream and its ability to support a balanced aquatic ecosystem. The oxygen comes from the atmosphere by solution and from photosynthesis of water plants. The maximum amount of oxygen that can be held in solution in a stream is termed the saturation concentration and, as it is a function of temperature, the greater the temperature, the less the saturation amount. The discharge of an organic waste to a stream imposes an oxygen demand on the stream. If there is an excessive amount of organic matter, the oxidation of waste by microorganisms will consume oxygen more rapidly than it can be replenished. When this happens, the dissolved oxygen is depleted and results in the death of the higher forms of life.

- Dredging - Removal of sediment from the bottom of a water body.

- Epilimnion- The upper layer of water in a thermally stratified lake or reservoir. This layer consists of the warmest water and has a fairly uniform (constant) temperature. The layer is readily mixed by wind action.

- Eutrophication - A process that occurs when a lake becomes over-rich in plant nutrients. As a consequence it becomes overgrown in algae and other aquatic plants. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a lake by human activity. Slightly or moderately eutrophic water can be healthful and support a complex web of plant and animal life.

- Erosion- The wearing away of land surface by wind or water. Erosion occurs naturally but can be caused by farming, residential or industrial development, mining, or timber-cutting.

- Fecal contamination - The presence in water bodies of living organisms (bacteria and

viruses) or agents derived by fecal bacteria that can cause negative human health effects. Fecal contamination may be a result of wildlife, livestock, pet, waterfowl or septic and sewage discharges.

- Herbicides - A compound, usually a man-made organic chemical, used to kill or control plant growth.

- Hydrology - The occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment. For lakes this is usually associated with the quantification of the water flow into and out of the system and the study of pollutant transport that occurs in concert with the inflow.

- Hypolimnion - Bottom waters of a thermally stratified lake. This layer consists of colder, more dense water. Its water temperatures remain relatively constant year around and it may experience little or no mixing with the upper warmer layers of the water body. The hypolimnion of a eutrophic lake is usually low or lacking in oxygen.

- Hypereutrophic - Pertaining to a lake characterized by excessive nutrient concentrations resulting high productivity. Such waters are often impacted by dense algal blooms and periods of oxygen deficiency.

- *In- situ* water quality parameters - in place; in situ measurements consist of measurements of water quality parameters in the field, rather than in a laboratory.

- Invasive species - A species whose presence in the environment causes economic or environmental harm or harm to human health.

- Limnology - The study of bodies of fresh water with reference to their plant and animal life, physical properties, geographical features, etc. The study of the physical, chemical, hydrological, and biological aspects of fresh water bodies.

- Littoral zone - 1. That portion of a body of fresh water extending from the shoreline lake ward to the limit of occupancy of rooted plants. 2. A strip of land along the shoreline between the high and low water levels.

- Land Use/ Land Cover (LU/LC)- The arrangement of land units into a variety of categories based on the properties of the land or its suitability for a particular purpose. It has become an important tool in rural land-use planning.

- Macroinvertebrates - An organism that lacks a backbone and can be seen with the naked eye.

- Macrophyte - A large macroscopic plant, used especially of aquatic forms such as kelp (variety of large brown seaweed which is a source of iodine and potash).

- Mesotrophic – Lakes with moderate quantities of nutrients and moderate productivity in terms of aquatic animal and plant life.

- Nitrogen - An essential nutrient in the food supply of plants and the diets of animals.

- Non Point Source Pollution - Water pollution that can not be traced to a specific source. Human-made or human-induced pollution caused by diffuse, indefinable sources that are not regulated as point sources, resulting in the alteration of the chemical, physical, biological, and/or radiological integrity of the water.

- Oligotrophic - Lakes that have a low supply of nutrients and thus contain little organic matter. Such lakes are typically deep, natural lakes characterized by high water transparency and high dissolved oxygen.

- pH - A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 to 14 with 7 representing a neutral state, 0 representing the most acid and 14, the most alkaline.

- Periphyton - Microscopic underwater plants and animals that are firmly attached to solid surfaces such as rocks, logs, and pilings.

- Phosphorus - An element that while essential to life, contributes to the eutrophication of lakes.
- Photosynthesis - The process by which plants transform carbon dioxide and water into carbohydrates and other compounds, using energy from the sun captured by chlorophyll in the plant. Oxygen is a by-product of the process. Photosynthesis is the essence of all plant life (autotrophic production) and hence of all animal life (heterotrophic production).

- Phytoplankton - Very tiny, often microscopic, plants found in lakes. Phytoplankton drift near the surface of the water where there is plenty of sunlight for growth. Phytoplankton form the basis for all aquatic food chains.

- Point Source Pollution - Source of water pollution emanating from discrete point of origin such as the discharge pipe from a factory, sewage treatment plant, or specific location or use.

- Pollutant Loading - The amount of polluting material that is transported into a lake over a given period of time. For most lakes, pollutant loading is expressed as Lbs or Kg/year.

- Secchi Disc Transparency – The clarity of a lake as measured using a flat, white/black approximately 9" diameter disc that is lowered into the water until it is just barely visible. At this point, the depth of the disc from the water surface is the recorded Secchi disc transparency. This depth is approximately equal to the 10% of the incident light as measured at the surface of the lake. It is also representative of the depth at which there is no longer enough light to support algal or phytoplankton photosynthesis.

- Sedimentation - Process of deposition of waterborne or windborne sediment or other material; also refers to the infilling of bottom substrate in a waterbody by sediment (siltation) as when soil particles (sediment) settle to the bottom of a lake.

- Specific Conductance - A rapid method of estimating the dissolved-solids content of a water supply. The measurement indicates the capacity of a sample of water to carry an electrical current, which is related to the concentration of ionized substances in the water. Also called conductance.

- Stormwater Runoff - Stormwater runoff, snow melt runoff, and surface runoff and drainage; rainfall that does not infiltrate the ground or evaporate because of impervious land surfaces but instead flows onto adjacent land or watercourses or is routed into drain/sewer systems.

- Stratification - Formation of water layers each with specific physical, chemical, and biological characteristics. As the density of water decreases due to surface heating, a stable situation develops with lighter water overlaying heavier and denser water. The tendency in deep water bodies for distinct density layers of water to form as a result of a vertical change in water temperature. During stratification, dissolved oxygen, nutrients, and other water chemistry parameters do not mix well between layers, resulting in chemical as well as thermal gradients.

- Submerged Aquatic Macrophyte - Large vegetation that lives at or below the water surface; an important habitat for young fish and other aquatic organisms.

- Total Suspended Solids - Solids that either float on the surface or are suspended in water or other liquids, and which are largely removable by laboratory filtering. 2) The quantity of material removed from water in a laboratory test, as prescribed in standard methods for the examination of water and wastewater.

- Thermocline - The middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth. Also called the Metalimnion

- Turbidity - A cloudy condition in water due to suspended silt or organic matter often attributable to algae blooms or increased sediment loads.

- Water Quality - The biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

- Watershed management - A holistic approach applied within an area defined by hydrological, not political, boundaries, integrating the water quality impacts from both point and nonpoint sources. Watershed management has a premise that many water quality and ecosystem problems are better solved at the watershed scale rather than by examining the individual waterbodies or dischargers. Use, regulation and treatment of water and land resources of a watershed to accomplish stated objectives.

- Weed harvesting – A mechanical means of controlling the growth of aquatic macrophytes. Involves both the cutting and removal of macrophyte biomass. Can be implanted on large scale using floating barge like machines or a small localized scale using hand tools.

- Zooplankton - Tiny, sometimes microscopic, floating, aquatic animals. Zooplankton generally feed upon phytoplankton and each other.

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APPENDIX A

IN-SITU DATA

In-Situ Monitoring for Mullica Hill Pond 5/29/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Mid-Lake	**1.5**	**1.5**	**Surface**	22.48	0.19	10.12	7.2
			1.0	21.92	0.19	9.74	7.16
			1.5	21.23	0.196	10.16	7.23

In-Situ Monitoring for Mullica Hill Pond 7/16/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Mid-Lake	**2.3**	**1**	**Surface**	25.89	0.193	3.94	6.76
			1.0	25.07	0.194	6.14	6.88
			2.0	24.73	0.194	5.33	6.85
			2.3	24.67	0.196	3.6	6.8

APPENDIX B

DISCRETE LABORATORY DATA

763.001

ECM

environmental compliance monitoring inc.

June 25, 2007

Chris Mikolajczyk
Princeton Hydro. LLC.
1180 Old York Road
Suite 1, P.O. Box 720
Ringoes, NJ 08551

Dear Mr. Mikolajczyk:

Analysis of the Mullica Hill Pond sample received May 29, 2007 has been completed. The results are presented in the attached table. An invoice is attached.

If you have any questions pertaining to the analysis, please feel free to contact me.

Very truly yours,

ENVIRONMENTAL COMPLIANCE MONITORING, INC.

Thomas Grenci
Laboratory Manager

#2073/9878

349 Route 206, Hillsborough, New Jersey 08844
PHONE: 908-874-0990 FAX: 908-874-0920 ecm-inc.@att.net
4787 Merlot Drive, Viera, Florida 32955
PHONE: 321-636-5010 FAX: 321-636-5010

REPORT OF ANALYSIS

COMPANY Princeton Hydro, LLC. REPORT DATE 06/25/07

ADDRESS 1108 Old York Road, Suite 1 JOB # 2073 LOT # 9878

CITY Ringoes STATE NJ ZIP 08551 PO # Verbal INVOICE # 278825

TO ATTN. OF Chris Mikolajczyk SAMPLE DATE 05/29/07

LAB CERTIFICATION # 18630

CLIENT SAMPLE ID Mullica Hill Pond

ECM, Inc. SAMPLE # 33634

Test Parameter	Method # *	Analysis Date/Time	Dilution Factor	MDL (mg/L)	Result (mg/L)
Alkalinity	2320B	05/30/07; 1645	1	1.7	27.3
Chlorophyll a (mg/m^3)	10200H 1&2	05/29/07; 1625	1	0.3	4.6
Ammonia-N	4500-NH_3 B&F	06/11/07; 1200	1	0.01	0.05
Nitrate-N	352.1	05/30/07; 0915	2	0.04	1.4
Total Phosphate-P	4500-P E & 4500-P B-5	06/05/07; 1030	1	0.01	0.08
Total Suspended Solids	2540D	06/01/07; 1200	1	3	9

*Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992/USEPA 600-4/79-02
ND – Non-detectable

QA Report - Duplicate and Matrix Spike Recovery

ANALYTE: Total Phosphate-P

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33638	0.15	0.30	0.44	97	69-125

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33638	0.15	0.30	0.45	100	-2.3	± 12

ANALYTE: Nitrate-N

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33613	0.08	0.40	0.54	115	62-152

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33613	0.08	0.40	0.47	98	14	± 27

ANALYTE: Ammonia-N

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33418	0.06	0.04	0.092	77	64-122

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33418	0.06	0.04	0.092	77	0	± 33

ANALYTE: Chlorophyll-a

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33499	0.95	1.2	-23	±39

ANALYTE: Total Suspended Solids

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33621	<3	<3	0	±20

ANALYTE: Alkalinity

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33594	12	12	0	±5.2

ECM
environmental compliance monitoring, inc.

SAMPLE RECEIVING CHECKLIST

Client/Site: 2073 - Mullica Hill Pond

Section 1. Laboratory Courier (omit if samples received directly from client or 3rd party)

1.1 Sample taken by lab personnel?	☐ Yes	☐ No	
Preserved in field?	☐ Yes	☐ No	☐ Not required
Stored on ice?	☐ Yes	☐ No	☐ Not required
Date/time last sample placed in cooler:			
1.2 Samples taken by customer or third party?	☐ Yes	☐ No	
Received under refrigeration?	☐ Yes (cooler)	☐ Yes (refrig.)	☐ No
If yes, cooler sealed?	☐ Yes	☐ No	
If no, ice present?	☐ Yes	☐ No	
Ice added?	☐ Yes	☐ No	
If refrig. Placed in cooler/iced?	☐ Yes	☐ No	

Section 2. Laboratory

2.1 Delivered by	☑ Client	☐ Lab personnel	☐ Parcel service
2.2 Packaging	☐ Cooler	☑ Other/none	
Custody Seals	☐ Present	☑ Absent	☐ Broken
Ice	☐ Present	☑ Absent	☐ Melted
Temperature (water samples only)	24	°C	
2.3 Documentation			
Airbill Present?	☐ Yes	☐ No	☑ N/A
Chain of Custody	☐ Received	☑ Prepared by Lab	
2.4 Sample containers			
Appropriate for specified analysis?	☑ Yes	☐ No*▽	
Intact?	☑ Yes	☐ No*	
Labeled, and labels legible?	☑ Yes	☐ No*	
Labels agree with COC?	☑ Yes	☐ No*	
2.5 Preservation (water samples only)			
Metals, hardness pH < 2, HNO_3	☐ Yes	☐ No*▽	☑ N/A
Cyanides pH > 12, NaOH	☐ Yes	☐ No*▽	☑ N/A
COD, TKN, NH_3 pH < 2, H_2SO_4	☑ Yes	☐ No*▽	☐ N/A
TPH, O&G, TPO_4 pH < 2, H_2SO_4	☑ Yes	☐ No*▽	☐ N/A
Were preservatives added at lab?	☐ Yes*	☑ No	☐ N/A

Responses marked "*" require detailed explanation; identify specific examples, what was wrong, and what was done
Responses marked "▽" indicate a non-standard condition which may affect the quality of results (nonconformance)

Comments: (N) 5/29/07

763,001
TASK 1

ECM

environmental compliance monitoring inc.

August 13 2007

RECEIVED
AUG 15 2007
BY:_____

Chris Mikolajczyk
Princeton Hydro. LLC.
1180 Old York Road
Suite 1, P.O. Box 720
Ringoes, NJ 08551

Dear Mr. Mikolajczyk:

Analysis of the Mullica Hill Pond sample received July 16, 2007 has been completed. The results are presented in the attached table. An invoice is attached.

If you have any questions pertaining to the analysis, please feel free to contact me.

Very truly yours,

ENVIRONMENTAL COMPLIANCE MONITORING, INC.

Thomas Grenci
Laboratory Manager

#2073/9964

349 Route 206, Hillsborough, New Jersey 08844
PHONE: 908-874-0990 FAX: 908-874-0920
ecm-inc.@att.net
4787 Merlot Drive, Viera, Florida 32955
PHONE: 321-636-5010 FAX: 321-636-5010

REPORT OF ANALYSIS

COMPANY	Princeton Hydro, LLC.	REPORT DATE	08/13/07
ADDRESS	1108 Old York Road, Suite 1	JOB # 2073	LOT # 9964
CITY Ringoes	STATE NJ ZIP 08551	PO # Verbal	INVOICE # 278944
TO ATTN. OF	Chris Mikolajczyk	SAMPLE DATE	07/16/07
		LAB CERTIFICATION #	18630

CLIENT SAMPLE ID Mullica Hill Pond 1

ECM, Inc. SAMPLE # 33928

Test Parameter	Method # *	Analysis Date/Time	Dilution Factor	MDL (mg/L)	Result (mg/L)
Alkalinity	2320B	07/18/07; 1130	1	1.7	31.9
Chlorophyll a (mg/m^3)	10200H 1&2	07/17/07; 1215	1	0.3	21.3
Ammonia-N	4500-NH_3 B&F	07/23/07; 1150	1	0.01	0.09
Nitrate-N	352.1	07/17/07; 1405	1	0.02	0.43
Total Phosphate-P	4500-P E & 4500-P B-5	07/26/07; 1154	1	0.01	0.08
Total Suspended Solids	2540D	07/17/07; 1500	1	3	5

*Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992/USEPA 600-4/79-02
ND – Non-detectable

QA Report - Duplicate and Matrix Spike Recovery

ANALYTE: Total Phosphate-P

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33920	0.05	0.30	0.34	96	69-125

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33920	0.05	0.30	0.34	96	0	± 12

ANALYTE: Chlorophyll-a

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33908	6.4	6.1	4.8	±49

ANALYTE: Alkalinity

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33934	8.47	7.97	6.1	±6.2

ANALYTE: Total Suspended Solids

REPLICATE

Lab Sample #	Result	Replicate Result	RPD	QC Limits
33898	<3	<3	0	±20

ANALYTE: Nitrate-N

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33771	3.45	4.0	7.57	103	64-152

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33771	3.45	4.0	8.03	115	-5.9	± 17

ANALYTE: Ammonia-N

MATRIX SPIKE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	QC Limit
33902	0.093	0.040	0.133	100	48-138

MATRIX SPIKE DUPLICATE

Lab Sample #	Result	Spike Addition	Spike Result	% Recovery	RPD	QC Limit
33902	0.093	0.040	0.142	124	-7.1	± 28

ECM
environmental compliance monitoring, inc.

SAMPLE RECEIVING CHECKLIST

Client/Site: Pittgro/Mullica Hill

Section 1. Laboratory Courier (omit if samples received directly from client or 3rd party)

1.1 Sample taken by lab personnel?	☐ Yes	☐ No	
Preserved in field?	☐ Yes	☐ No	☐ Not required
Stored on ice?	☐ Yes	☐ No	☐ Not required
Date/time last sample placed in cooler:			
1.2 Samples taken by customer or third party?	☐ Yes	☐ No	
Received under refrigeration?	☐ Yes (cooler)	☐ Yes (refrig.)	☐ No
If yes, cooler sealed?	☐ Yes	☐ No	
If no, ice present?	☐ Yes	☐ No	
Ice added?	☐ Yes	☐ No	
If refrig. Placed in cooler/iced?	☐ Yes	☐ No	

Section 2. Laboratory

2.1 Delivered by	☑ Client	☐ Lab personnel	☐ Parcel service
2.2 Packaging	☑ Cooler	☐ Other/none	
Custody Seals	☐ Present	☑ Absent	☐ Broken
Ice	☐ Present	☑ Absent	☐ Melted
Temperature (water samples only)	8	°C	
2.3 Documentation			
Airbill Present?	☐ Yes	☐ No	☑ N/A
Chain of Custody	☑ Received	☐ Prepared by Lab	
2.4 Sample containers			
Appropriate for specified analysis?	☑ Yes	☐ No*▽	
Intact?	☑ Yes	☐ No*	
Labeled, and labels legible?	☑ Yes	☐ No*	
Labels agree with COC?	☑ Yes	☐ No*	
2.5 Preservation (water samples only)			
Metals, hardness pH < 2, HNO_3	☐ Yes	☐ No*▽	☐ N/A
Cyanides pH > 12, NaOH	☐ Yes	☐ No*▽	☐ N/A
COD, TKN, NH_3 pH < 2, H_2SO_4	☑ Yes	☐ No*▽	☐ N/A
TPH, O&G, TPO_4 pH < 2, H_2SO_4	☑ Yes	☐ No*▽	☐ N/A
Were preservatives added at lab?	☐ Yes*	☐ No	☐ N/A

Responses marked "*" require detailed explanation; identify specific examples, what was wrong, and what was done
Responses marked "▽" indicate a non-standard condition which may affect the quality of results (nonconformance)

Comments: 7/17/07 (BB)

IAL
Integrated Analytical Laboratories LLC

ANALYTICAL DATA REPORT

Princeton Hydro, LLC
1108 Old York Road
Suite 1, PO Box 720
Ringoes, NJ 08551

Project Name: **MULLICA HILL POND**
IAL Case Number: **E06-12087**

These data have been reviewed and accepted by:

Michael H. Leffin, Ph.D.
Laboratory Director

273 Franklin Road
Randolph, NJ 07869
Phone: 973 361 4252
Fax: 973 989 5288

IAL is a NELAC New Jersey Certified Lab (14751) and maintains certification in Connecticut (PH-0699), New York (11402), Rhode Island (00126), Florida (E87670) and in the Department of Navy IR QA Program

Sample Summary

IAL Case No.

E06-12087

Client Princeton Hydro, LLC

Project MULLICA HILL POND

Received On 11/ 2/2006@19:00

Lab ID	*Client Sample ID*	*Depth Top/Bottom*	*Sampling Time*	*Matrix*	*# of Container*
12087-001	POND SEDIMENT	0/0.5	10/30/2006@12:00	Sediment	2

Integrated Analytical Labs ~ 273 Franklin Road, Randolph, NJ 07869 ~ (973) 361-4252 ~ Fax (973) 989-5288

INTEGRATED ANALYTICAL LABORATORIES, LLC.

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* Methodology is included in the IAL Project Information Page

INTEGRATED ANALYTICAL LABORATORIES, LLC.

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* Methodology is included in the IAL Project Information Page

INTEGRATED ANALYTICAL LABORATORIES, LLC.

MATRIX QUALIFIERS

A - Indicates the sample is an Aqueous matrix.

O - Indicates the sample is an Oil matrix.

S - Indicates the sample is a Soil, Sludge or Sediment matrix.

X - Indicates the sample is an Other matrix as indicated by Client Chain of Custody.

DATA QUALIFIERS

B - Indicates the analyte was found in the Blank and in the sample. It indicates possible sample contamination and warns the data user to use caution when applying the results of the analyte.

C - Common Laboratory Contaminant.

D - The compound was reported from the Diluted analysis.

D.F. - Dilution Factor.

E - Estimated concentration, reported results are outside the calibrated range of the instrument.

J - Indicates an estimated value. The compound was detected at a value below the method detection limit but greater than zero. For GC/MS procedures, the mass spectral data meets the criteria required to identify the target compound.

MDL - Method Detection Limit.

MI - Indicates compound concentration could not be determined due to Matrix Interferences.

NA - Not Applicable.

ND - Indicates the compound was analyzed for but Not Detected at the MDL.

REPORT QUALIFIERS

All solid sample analyses are reported on a dry weight basis.

All solid sample values are corrected for original sample size and percent solids.

Q - Qualifier

INTEGRATED ANALYTICAL LABORATORIES, LLC.

CONFORMANCE / NONCONFORMANCE SUMMARY

Integrated Analytical Laboratories, LLC. received one (1) other sample(s) from Princeton Hydro, LLC (Project: MULLICA HILL POND) on November 2, 2006 for the analysis of:

(1) VO+15, PP LIST
(1) BNA + 25
(1) PCB
(1) Pesticides
(1) PP Metals
(1) Cyanide, Total
(1) Particle Size
(1) TOC
(1) Total Recoverable Phenols

A review of the QA/QC measures for the analysis of the sample(s) contained in this report has been performed by:

Reviewed by

11/17/06
Date

INTEGRATED ANALYTICAL LABORATORIES, LLC.

LABORATORY DELIVERABLES CHECK LIST

Lab Case Number: E06-12087

		Check If Complete
1.	Cover Page, Title Page listing Lab Certification #, facility name & address and date of report preparation.	✓
2.	Table of Contents.	✓
3.	Summary Sheets listing analytical results for all targeted and non-targeted compounds.	✓
4.	Summary Table cross-referencing Field ID's vs. Lab ID's.	✓
5.	Document bound, paginated and legible.	✓
6.	Chain of Custody.	✓
7.	Methodology Summary.	✓
8.	Laboratory Chronicle and Holding Time Check.	✓
9.	Results submitted on a dry weight basis (if applicable).	✓
10.	Method Detection Limits.	✓
11.	Lab certified by NJDEP for parameters or appropriate category of parameters or a member of the USEPA CLP.	✓
12.	NonConformance Summary.	✓

QC Reviewed by

11/17/06
Date

INTEGRATED ANALYTICAL LABORATORIES
CONFORMANCE/NONCONFORMANCE SUMMARY
GC/MS VOLATILE ANALYSIS

Lab Case Number: E06 - 12087

	No	Yes
1. Chromatograms Labeled/Compounds Identified (Field Samples and Method Blanks).		✓
2. GC/MS Tuning Specifications: a. BFB Passed		✓
3. GC/MS Tuning Frequency - Performed every 24 hours for 600 series, 12 hours for 8000 series and 8 hours for 500 series.		✓
4. GC/MS Calibration - Initial calibration performed within 30 days before sample analysis and continuing calibration performed within 24 hours before sample analysis for 600 series, 12 hours for 8000 series		✓
5. GC/MS Calibration Requirements: a. Calibration Check Compounds		✓
b. System Performance Check Compounds		✓
6. Blank Contamination - If yes, list compounds and concentrations in each blank:	✓	
7. Surrogate Recoveries Meet Criteria (If not met, list those compounds and their recoveries which fall outside the acceptable range)		✓
If not met, were the calculations checked and the results qualified as "estimated"?		na
8. Matrix Spike/Matrix Spike Duplicate meet criteria (if not, list those compounds and their recoveries/% differences which fall outside the acceptable range)		✓
9. Internal Standard Area/Retention Time Shift meet criteria		✓
10. Extraction Holding Time Met If not met, list number of days exceeded for each sample:		✓
11. Analysis Holding Time Met If not met, list number of days exceeded for each sample:		✓
12. Sample Dilution Performed	✓	

High Target Compounds	High Nontarget Compounds	Matrix Interference	Other

13. Comments:

Organics Manager

11/10/06
Date

INTEGRATED ANALYTICAL LABORATORIES
CONFORMANCE/NONCONFORMANCE SUMMARY
GC/MS SEMIVOLATILE ANALYSIS

Lab Case Number: E06 - 12087

	No	Yes
1. Chromatograms Labeled/Compounds Identified (Field Samples and Method Blanks).		✓
2. GC/MS Tuning Specifications: a. DFTPP Passed		✓
3. GC/MS Tuning Frequency - Performed every 24 hours for 600 series, 12 hours for 8000 series.		✓
4. GC/MS Calibration - Initial calibration performed within 30 days before sample analysis and continuing calibration performed within 24 hours before sample analysis for 600 series.		✓
5. GC/MS Calibration Requirements: a. Calibration Check Compounds		✓
b. System Performance Check Compounds		✓
6. Blank Contamination - If yes, list compounds and concentrations in each blank:	✓	
a. B/N Fraction _____		
b. Acid Fraction _____		
7. Surrogate Recoveries Meet Criteria (If not met, list those compounds and their recoveries which fall outside the acceptable range)		✓
a. B/N Fraction _____		
b. Acid Fraction _____		
If not met, were the calculations checked and the results qualified as "estimated"?		na
8. Matrix Spike/Matrix Spike Duplicate meet criteria (if not, list those compounds and their recoveries/% differences which fall outside the acceptable range)		✓
a. B/N Fraction _____		
b. Acid Fraction _____		
9. Internal Standard Area/Retention Time Shift meet criteria		✓
10. Extraction Holding Time Met		✓
If not met, list number of days exceeded for each sample:		
_____		
_____		
11. Analysis Holding Time Met		✓
If not met, list number of days exceeded for each sample:		
_____		
_____		
12. Sample Dilution Performed	✓	

High Target Compounds	High Nontarget Compounds	Matrix Interference	Other

13. Comments:

_____

_____

_____ 11-9-06

Organics Manager Date

INTEGRATED ANALYTICAL LABORATORIES
CONFORMANCE/NONCONFORMANCE SUMMARY
GC ANALYSIS - PCB'S

Lab Case Number: E05 - 12087

		No	Yes
1.	Chromatograms Labeled/Compounds Identified (Field Samples and Method Blanks).		V
2.	Standards Summary submitted.		V
3.	Calibration - Initial calibration performed within 30 days before sample analysis and continuing calibration performed within 12 hrs of the sample analysis.		V
4.	Blank Contamination - If yes, list compounds and concentrations in each blank:	V:	
5.	Surrogate Recoveries meet criteria (if applicable). If not met, list those compounds and their recoveries which fall outside the acceptable range:		V
6.	Matrix Spike/Matrix Spike Duplicate meet criteria (if not, list those compounds and their recoveries/% differences which fall outside the acceptable range) acceptable range:		V
7.	Retention Time Shift Meet Criteria (if applicable).		V
8.	Extraction Holding Time Met. If not met, list number of days exceeded for each sample:		V
9.	Analysis Holding Time Met. If not met, list number of days exceeded for each sample:		V

Comments:

Organic Manager

11/08/06
Date

INTEGRATED ANALYTICAL LABORATORIES
CONFORMANCE/NONCONFORMANCE SUMMARY
GC ANALYSIS - PESTICIDES

Lab Case Number: E06 - 12087

	No	Yes
1. Chromatograms Labeled/Compounds Identified (Field Samples and Method Blanks).		✓
2. Standards Summary submitted.		✓
3. Calibration - Initial calibration performed within 30 days before sample analysis and continuing calibration performed within 12 hrs of the sample analysis.		✓
4. Blank Contamination - If yes, list compounds and concentrations in each blank:	✓	
5. Surrogate Recoveries meet criteria (if applicable). If not met, list those compounds and their recoveries which fall outside the acceptable range:		✓
6. Matrix Spike/Matrix Spike Duplicate meet criteria (if not, list those compounds and their recoveries/% differences which fall outside the acceptable range) acceptable range:		✓
7. Retention Time Shift Meet Criteria (if applicable).		✓
8. Extraction Holding Time Met. If not met, list number of days exceeded for each sample:		✓
9. Analysis Holding Time Met. If not met, list number of days exceeded for each sample:		✓

Comments:

Organic Manager

11/7/06
Date

rev 01/06

INTEGRATED ANALYTICAL LABORATORIES
CONFORMANCE/NONCONFORMANCE SUMMARY
METAL ANALYSIS

Lab Case Number: E06-12087

		No	Yes
1.	Calibration Summary Meet Criteria.		✓
2.	ICP Interference Check Sample Results Meets Criteria (if applicable)		✓
3.	Serial Dilution Summary Submitted (if applicable) / Meets Criteria		✓
4.	Internal Standards Meet Criteria (if applicable)		✓
5.	Laboratory Control Sample Summary Submitted (if applicable) / Meets Criteria		✓
6.	Blank Contamination: If yes, list compounds and concentrations in each blank:	✓	
7.	Matrix Spike/Matrix Spike Duplicate Recoveries Meet Criteria. (If not, list those compounds and their recoveries which fall outside the acceptable range).		✓
8.	Extraction Holding Time Met. If not, list number of days exceeded for each sample:		✓
9.	Analysis Holding Time Met. If not, list number of days exceeded for each sample:		✓

Additional Comments:

H. Falk-Pedersen
Inorganic Manager

November 8, 2006
Date

INTEGRATED ANALYTICAL LABORATORIES, LLC.

SUMMARY REPORT
Client: Princeton Hydro, LLC
Project: MULLICA HILL POND
Lab Case No.: E06-12087

	Lab ID:	**12087-001**	
	Client ID:	**POND SEDIMENT**	
	Depth:	**0/0.5**	
	Matrix:	**Sediment**	
	Sampled Date	**10/30/06**	
PARAMETER(Units)	Conc	Q	MDL
Volatiles (Units)	*(mg/Kg-ppm)*		
TOTAL VO's:	ND		
TOTAL TIC's:	ND		
TOTAL VO's & TIC's:	ND		
Semivolatiles - BNA (Units)	*(mg/Kg-ppm)*		
Phenanthrene	0.026	J	0.027
Fluoranthene	0.029		0.027
Pyrene	0.035		0.027
Benzo[a]anthracene	0.017	J	0.027
Chrysene	0.021	J	0.027
TOTAL BNA'S:	0.128	J	
TOTAL TIC's:	1.17		
TOTAL BNA'S & TIC's:	1.30	J	
PCB's (Units)	*(mg/Kg-ppm)*		
Aroclor-1016	ND		0.00109
Aroclor-1221	ND		0.00109
Aroclor-1232	ND		0.00109
Aroclor-1242	ND		0.00109
Aroclor-1248	ND		0.00109
Aroclor-1254	ND		0.00109
Aroclor-1260	ND		0.00109
Pesticides (Units)	*(mg/Kg-ppm)*		
alpha-BHC	ND		0.00273
beta-BHC	ND		0.00273
gamma-BHC	ND		0.00273
delta-BHC	ND		0.00273
Heptachlor	ND		0.00273
Aldrin	ND		0.00273
Heptachlor epoxide	ND		0.00273
Endosulfan I	ND		0.00273
4,4'-DDE	0.024		0.00273
Dieldrin	ND		0.00273
Endrin	ND		0.00273
Endosulfan II	ND		0.00273
4,4'-DDD	0.015		0.00273
Endrin aldehyde	ND		0.00273
Endosulfan sulfate	ND		0.00273
4,4'-DDT	0.00467		0.00273
Chlordane	ND		0.0082
Toxaphene	ND		0.0082

ND = Analyzed for but Not Detected at the MDL
J = The concentration was detected at a value below the MDL
All qualifiers on individual Volatiles &
Semivolatiles are carried down through
summation.

INTEGRATED ANALYTICAL LABORATORIES, LLC.

SUMMARY REPORT
Client: Princeton Hydro, LLC
Project: MULLICA HILL POND
Lab Case No.: E06-12087

	Lab ID:	**12087-001**	
	Client ID:	**POND SEDIMENT**	
	Depth:	**0/0.5**	
	Matrix:	**Sediment**	
	Sampled Date	**10/30/06**	
PARAMETER(Units)		Conc Q	MDL
Metals (Units)		*(mg/Kg-ppm)*	
Antimony		ND	1.64
Arsenic		10.7	1.64
Beryllium		1.36	0.820
Cadmium		2.11	0.410
Chromium		37.5	3.28
Copper		11.8	3.28
Lead		33.7	0.820
Mercury		0.131	0.020
Nickel		12.1	1.64
Selenium		ND	3.28
Silver		ND	0.820
Thallium		0.305	0.164
Zinc		119	3.28
General Analytical (Units)			
Cyanide, Total(mg/Kg-ppm)		ND	1.64
Total Recoverable Phenols(mg/Kg-ppm)		ND	4.11
Total Organic Carbons (TOC)(mg/Kg-ppm)		21200	1580
Particle Size % (Units)		%	
% GRAVEL		0	NA
% COARSE SAND		1.48	NA
% MEDIUM SAND		25.46	NA
% FINE SAND		37.08	NA
% SILT & CLAY		35.98	NA
Particle Size % (Units)		%	
on 3/8" screen		0	NA
on #4 screen		0	NA
on #10 screen		1.48	NA
on #40 Screen		25.46	NA
on #200 Screen		37.08	NA
% fines		35.98	NA

ND = Analyzed for but Not Detected at the MDL

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIMENT/0-0.5
Date Received: 11/02/2006
Date Analyzed: 11/08/2006
Data file: F0815.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: SEDIMENT-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 39.2

Compound	Concentration	Q	MDL
Chloromethane	ND		0.0082
Vinyl chloride	ND		0.0082
Bromomethane	ND		0.0082
Chloroethane	ND		0.0082
Trichlorofluoromethane	ND		0.0082
Acrolein	ND		0.0082
1,1-Dichloroethene	ND		0.0082
Methylene chloride	ND		0.0082
Acrylonitrile	ND		0.0082
trans-1,2-Dichloroethene	ND		0.0082
1,1-Dichloroethane	ND		0.0082
Chloroform	ND		0.0082
1,1,1-Trichloroethane	ND		0.0082
Carbon tetrachloride	ND		0.0082
1,2-Dichloroethane (EDC)	ND		0.0082
Benzene	ND		0.0082
Trichloroethene	ND		0.0082
1,2-Dichloropropane	ND		0.0082
Bromodichloromethane	ND		0.0082
2-Chloroethyl vinyl ether	ND		0.0082
cis-1,3-Dichloropropene	ND		0.0082
Toluene	ND		0.0082
trans-1,3-Dichloropropene	ND		0.0082
1,1,2-Trichloroethane	ND		0.0082
Tetrachloroethene	ND		0.0082
Dibromochloromethane	ND		0.0082
Chlorobenzene	ND		0.0082
Ethylbenzene	ND		0.0082
Total Xylenes	ND		0.0082
Bromoform	ND		0.0082
1,1,2,2-Tetrachloroethane	ND		0.0082
1,3-Dichlorobenzene	ND		0.0082
1,4-Dichlorobenzene	ND		0.0082
1,2-Dichlorobenzene	ND		0.0082

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS
Tentatively Identified Compounds

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIMENT/0-0.5
Date Received: 11/02/2006
Date Analyzed: 11/08/2006
Data file: F0815.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: SEDIMENT-mg/Kg (p
Dilution Factor: 1
% Moisture: 39.2

CAS #	Compound	Estimated Concentration	Retention Time

No peaks detected

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIM
Date Received: 11/02/2006
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Data file: C2854.D

GC/MS Column: DB-5
Sample wt/vol: 60.12g
Matrix-Units: Sediment-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 39.2

Compound	Concentration	Q	MDL
N-Nitrosodimethylamine	ND		0.027
Phenol	ND		0.027
Aniline	ND		0.027
bis(2-Chloroethyl) ether	ND		0.027
2-Chlorophenol	ND		0.027
1,3-Dichlorobenzene	ND		0.027
1,4-Dichlorobenzene	ND		0.027
Benzyl alcohol	ND		0.027
1,2-Dichlorobenzene	ND		0.027
2-Methylphenol	ND		0.027
bis(2-chloroisopropyl) ether	ND		0.027
4-Methylphenol	ND		0.027
N-Nitrosodi-n-propylamine	ND		0.027
Hexachloroethane	ND		0.027
Nitrobenzene	ND		0.027
Isophorone	ND		0.027
2-Nitrophenol	ND		0.027
2,4+2,5-Dimethylphenol	ND		0.027
bis(2-Chloroethoxy)methane	ND		0.027
Benzoic acid	ND		0.027
2,4-Dichlorophenol	ND		0.027
1,2,4-Trichlorobenzene	ND		0.027
Naphthalene	ND		0.027
4-Chloroaniline	ND		0.027
Hexachlorobutadiene	ND		0.027
4-Chloro-3-methylphenol	ND		0.027
2-Methylnaphthalene	ND		0.027
Hexachlorocyclopentadiene	ND		0.027
2,4,6-Trichlorophenol	ND		0.027
2,4,5-Trichlorophenol	ND		0.027
2-Chloronaphthalene	ND		0.027
2-Nitroaniline	ND		0.027
Dimethyl phthalate	ND		0.027

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIM
Date Received: 11/02/2006
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Data file: C2854.D

GC/MS Column: DB-5
Sample wt/vol: 60.12g
Matrix-Units: Sediment-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 39.2

Compound	Concentration	Q	MDL
2,6-Dinitrotoluene	ND		0.027
Acenaphthylene	ND		0.027
3-Nitroaniline	ND		0.027
Acenaphthene	ND		0.027
2,4-Dinitrophenol	ND		0.027
4-Nitrophenol	ND		0.027
2,4-Dinitrotoluene	ND		0.027
Dibenzofuran	ND		0.027
Diethyl phthalate	ND		0.027
Fluorene	ND		0.027
4-Chlorophenyl phenyl ether	ND		0.027
4-Nitroaniline	ND		0.027
4,6-Dinitro-2-methylphenol	ND		0.027
N-Nitrosodiphenylamine	ND		0.027
1,2-Diphenylhydrazine	ND		0.027
4-Bromophenyl phenyl ether	ND		0.027
Hexachlorobenzene	ND		0.027
Pentachlorophenol	ND		0.027
Phenanthrene	0.026	J	0.027
Anthracene	ND		0.027
Carbazole	ND		0.027
Di-n-butyl phthalate	ND		0.027
Fluoranthene	0.029		0.027
Benzidine	ND		0.027
Pyrene	0.035		0.027
3,3'-Dimethylbenzidine	ND		0.027
Butyl benzyl phthalate	ND		0.027
3,3'-Dichlorobenzidine	ND		0.027
Benzo[a]anthracene	0.017	J	0.027
Chrysene	0.021	J	0.027
bis(2-Ethylhexyl) phthalate	ND		0.027
Di-n-octyl phthalate	ND		0.027
Benzo[b]fluoranthene	ND		0.027
Benzo[k]fluoranthene	ND		0.027
Benzo[a]pyrene	ND		0.027
Indeno[1,2,3-cd]pyrene	ND		0.027
Dibenz[a,h]anthracene	ND		0.027
Benzo[g,h,i]perylene	ND		0.027
Total Target Compounds:	0.128	J	

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS
Tentatively Identified Compounds

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIM
Date Received: 11/02/2006
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Date File: C2854.D

GC/MS Column: DB-5
Sample wt/vol: 60.12g
Matrix-Units: Sediment-mg/Kg (ppm
Dilution Factor: 1
% Moisture: 39.2

CAS #	Compound	Estimated Concentration	Retention Time
	Unknown hydrocarbon	0.200	5.90
	Unknown hydrocarbon	0.367	6.41
	Unknown alkane	0.276	6.99
	Unknown hydrocarbon	0.129	7.01
	Unknown alkane	0.202	7.77

Total TICs = 1.17

INTEGRATED ANALYTICAL LABORATORIES

PCB's

Client/Project: PRINCETON/MULLIC

Lab ID: 12087-001
Client ID: POND_SEDI
Date Received: 11/02/2006
Date Extracted: 11/06/2006
Date Analyzed: 11/07/2006
Data file: R3417.D

GC Column: DB-5/DB1701P
Sample wt/vol: 30.10g
Matrix-Units: Sediment-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 39.2

Compound	Concentration	Q	MDL
Aroclor-1016	ND		0.00109
Aroclor-1221	ND		0.00109
Aroclor-1232	ND		0.00109
Aroclor-1242	ND		0.00109
Aroclor-1248	ND		0.00109
Aroclor-1254	ND		0.00109
Aroclor-1260	ND		0.00109

INTEGRATED ANALYTICAL LABORATORIES

PESTICIDES

Client/Project: PRINCETON/MULLICA

Lab ID: 12087-001
Client ID: POND_SEDIM
Date Received: 11/02/2006
Date Extracted: 11/06/2006
Date Analyzed: 11/07/2006
Data file: P2287.D

GC Column: DB-5/DB1701P
Sample wt/vol: 30.10g
Matrix-Units: SEDIMENT-mg/Kg (ppr
Dilution Factor: 10
% Moisture: 39.2

Compound	Concentration	Q	MDL
alpha-BHC	ND		0.00273
beta-BHC	ND		0.00273
gamma-BHC	ND		0.00273
delta-BHC	ND		0.00273
Heptachlor	ND		0.00273
Aldrin	ND		0.00273
Heptachlor epoxide	ND		0.00273
Endosulfan I	ND		0.00273
4,4'-DDE	0.024		0.00273
Dieldrin	ND		0.00273
Endrin	ND		0.00273
Endosulfan II	ND		0.00273
4,4'-DDD	0.015		0.00273
Endrin aldehyde	ND		0.00273
Endosulfan sulfate	ND		0.00273
4,4'-DDT	0.00467		0.00273
Chlordane	ND		0.0082
Toxaphene	ND		0.0082

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS

Client/Project: PRINCETON/MULLICA HILL POND

Lab ID: E06-12087-001
Client ID: POND SEDIMENT
Date Received: 11/02/06 19:00
Matrix-Units: Sediment-mg/Kg (ppm)
% Moisture: 39.2
Batch #: 465

Compound	Result	Q	DF	MDL	Date Analyzed	Method
Antimony	ND		1	1.64	11/07/06	6020
Arsenic	10.7		1	1.64	11/07/06	6020
Beryllium	1.36		1	0.820	11/07/06	6020
Cadmium	2.11		1	0.410	11/07/06	6020
Chromium	37.5		1	3.28	11/07/06	6020
Copper	11.8		1	3.28	11/07/06	6020
Lead	33.7		1	0.820	11/07/06	6020
Mercury	0.131		1	0.020	11/07/06	7471A
Nickel	12.1		1	1.64	11/07/06	6020
Selenium	ND		1	3.28	11/07/06	6020
Silver	ND		1	0.820	11/07/06	6020
Thallium	0.305		1	0.164	11/07/06	6020
Zinc	119		1	3.28	11/07/06	6020

INTEGRATED ANALYTICAL LABORATORIES, LLC.

GENERAL ANALYTICAL

Client/Project: PRINCETON/MULLICA HILL POND

Lab ID: 12087-001
Client ID: POND SEDIMENT 0/0.5
Date Received: 11/2/2006
% Solid: 60.8

Compound	Result	Q	Matrix-Unit	DF	MDL	Date Analyzed
Cyanide, Total	ND		Sediment-mg/Kg	1	1.64	11/09/06 13:00
Total Recoverable Phenols	ND		Sediment-mg/Kg	1	4.11	11/10/06 11:32
Total Organic Carbons (TOC)	21200		Sediment-mg/Kg	1	1580	11/06/06 09:45

INTEGRATED ANALYTICAL LABORATORIES, LLC

PARTICLE SIZE ANALYSIS

Client/Projcet: PRINCETON/MULLICA HILL POND

Date Received: 11/2/06 19:00
Batch ID: AP072-0006

Lab ID No.:	**12087-001**
Client ID No.:	**POND SEDIMENT**
Date Analyzed:	11/7/06 09:30
% GRAVEL	0
% COARSE SAND	1.48
% MEDIUM SAND	25.46
% FINE SAND	37.08
% SILT & CLAY	35.98

Results are based on the Unified Soil Classification System (USCS)

Particle Size Analysis Results are defined as follows:
% GRAVEL = the percentage of sample greater than #4 sieve size
% COARSE SAND = the percentage of sample greater than #10 sieve size but less than #4
% MEDIUM SAND = the percentage of sample greater than #40 sieve size but less than #10
% FINE SAND = the percentage of sample greater than #200 sieve size but less than #40
% SILT & CLAY = the percentage of sample less than #200 sieve size

INTEGRATED ANALYTICAL LABORATORIES, LLC

PARTICLE SIZE ANALYSIS

Client/Projcet: PRINCETON/MULLICA HILL POND

Date Received: 11/2/06 19:00
Batch ID: AP072-0006

Lab ID No.:	**12087-001**
Client ID No.:	**POND SEDIMENT**
Date Analyzed:	11/7/06 09:30
on 3/8" screen	0
on #4 screen	0
on #10 screen	1.48
on #40 Screen	25.46
on #200 Screen	37.08
% fines	35.98

% Fines is the % particle size < mesh.
Particle size analysis results are reported as % > sieve size.

VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

Lab File ID: F0558.D

BFB Injection Date: 10/30/2006

Inst ID: MSD_F

BFB Injection Time: 9:59

m/z	Ion Abudance Criteria	%Relative Abundance			
50	15 - 40.0% of mass 95	19.5			
75	30.0 - 60.0% of mass 95	48.3			
95	Base peak, 100% relative abundance	100.0			
96	5.0 - 9.0% of mass 95	6.5			
173	Less than 2.0% of mass 174	0.5	(	0.7	)1
174	Great than 50.0% of mass 95	76.4			
175	5.0 - 9.0% of mass 174	5.4	(	7.1	)1
176	95.0 - 101.0% of mass 174	74.2	(	97.1	)1
177	5.0 - 9.0% of mass 176	4.9	(	6.6	)2
	1-Value is % mass 174	2-Value is % mass 176			

This check applies to the following SAMPLES, MS, MSD, BLANKS and STANDARDS:

Client ID	Lab Sample ID	File ID	Date Analyzed	Time Analyzed
100PPB	STD-100PPB	F0559.D	10/30/2006	10:30
20PPB	STD-20PPB	F0560.D	10/30/2006	11:01
200PPB	STD-200PPB	F0561.D	10/30/2006	11:32
150PPB	STD-150PPB	F0562.D	10/30/2006	12:03
50PPB	STD-50PPB	F0563.D	10/30/2006	12:34
N/A	METHOD-BLK	F0565.D	10/30/2006	13:36
LCS-50PPB	BLK-SPK	F0566.D	10/30/2006	14:07
MS	SOIL-MS	F0567.D	10/30/2006	14:38
MSD	SOIL-MSD	F0568.D	10/30/2006	15:09
1/8.5	11850-001	F0569.D	10/30/2006	15:39
3/8.5	11850-005	F0571.D	10/30/2006	16:40
4/8.5	11850-007	F0572.D	10/30/2006	17:11
5/8.5	11850-009	F0573.D	10/30/2006	17:42
2/8.5	11850-003	F0574.D	10/30/2006	18:12
SB-6	11794-002	F0575.D	10/30/2006	18:43
S1	11848-001	F0576.D	10/30/2006	19:14

VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

Lab File ID: F0800.D

Inst ID: MSD_F

BFB Injection Date: 11/08/2006

BFB Injection Time: 15:37

m/z	Ion Abudance Criteria	%Relative Abundance			
50	15 - 40.0% of mass 95	18.8			
75	30.0 - 60.0% of mass 95	47.1			
95	Base peak, 100% relative abundance	100.0			
96	5.0 - 9.0% of mass 95	6.6			
173	Less than 2.0% of mass 174	0.6	(	0.8	)1
174	Great than 50.0% of mass 95	74.4			
175	5.0 - 9.0% of mass 174	5.5	(	7.4	)1
176	95.0 - 101.0% of mass 174	71.3	(	95.9	)1
177	5.0 - 9.0% of mass 176	4.6	(	6.4	)2
	1-Value is % mass 174	2-Value is % mass 176			

This check applies to the following SAMPLES, MS, MSD, BLANKS and STANDARDS:

Client ID	Lab Sample ID	File ID	Date Analyzed	Time Analyzed
100PPB	STD-100PPB	F0801.D	11/08/2006	16:08
N/A	METHOD-BLK	F0803.D	11/08/2006	17:10
LCS-50PPB	BLK-SPK	F0804.D	11/08/2006	17:41
MS	SOIL-MS	F0805.D	11/08/2006	18:12
MSD	SOIL-MSD	F0806.D	11/08/2006	18:43
B-8/12-13	12240-012	F0807.D	11/08/2006	19:14
B-10/12.5-13.5	12240-014	F0808.D	11/08/2006	19:45
PX1/1	12032-002	F0810.D	11/08/2006	20:48
PX4/1	12032-004	F0811.D	11/08/2006	21:19
1_COMP_SIDEW/	12227-001	F0813.D	11/08/2006	22:21
2_BOTTOM_S/7	12227-003	F0814.D	11/08/2006	22:52
POND_SEDIMEN	12087-001	F0815.D	11/08/2006	23:22
WC-1V/5-5.5	12267-002	F0816.D	11/08/2006	23:53
WC-6V/5-5.5	12667-008	F0817.D	11/09/2006	0:24
06-262	12152-001	F0819.D	11/09/2006	1:26
3025-B-13-7.5-8.0/	12164-001	F0820.D	11/09/2006	1:57
3025-B-12-5.0-5.5/	12158-002	F0821.D	11/09/2006	2:28
3025-B-12-6.5-7.0/	12158-003	F0822.D	11/09/2006	2:58

VOLATILE METHOD BLANK SUMMARY

Lab File ID: F0803.D Instrument ID: MSD_F

Date Analyzed: 11/08/2006 Time Analyzed: 17:10

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS & MSD:

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed
LCS-50PPB	BLK-SPK	11/08/2006	17:41
MS	SOIL-MS	11/08/2006	18:12
MSD	SOIL-MSD	11/08/2006	18:43
B-8/12-13	12240-012	11/08/2006	19:14
B-10/12.5-13.5	12240-014	11/08/2006	19:45
PX1/1	12032-002	11/08/2006	20:48
PX4/1	12032-004	11/08/2006	21:19
1_COMP_SIDEWALL	12227-001	11/08/2006	22:21
2_BOTTOM_S/7	12227-003	11/08/2006	22:52
POND_SEDIMENT/0-0.5	12087-001	11/08/2006	23:22
WC-1V/5-5.5	12267-002	11/08/2006	23:53
WC-6V/5-5.5	12667-008	11/09/2006	0:24
06-262	12152-001	11/09/2006	1:26
3025-B-13-7.5-8.0/7.5-8.0	12164-001	11/09/2006	1:57
3025-B-12-5.0-5.5/5-5.5	12158-002	11/09/2006	2:28
3025-B-12-6.5-7.0/6.5-7	12158-003	11/09/2006	2:58

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project:

Lab ID: METHOD-BLK
Client ID: N/A
Date Received:
Date Analyzed: 11/08/2006
Data file: F0803.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
Chloromethane	ND		0.005
Vinyl chloride	ND		0.005
Bromomethane	ND		0.005
Chloroethane	ND		0.005
Trichlorofluoromethane	ND		0.005
Acrolein	ND		0.005
1,1-Dichloroethene	ND		0.005
Methylene chloride	ND		0.005
Acrylonitrile	ND		0.005
trans-1,2-Dichloroethene	ND		0.005
1,1-Dichloroethane	ND		0.005
Chloroform	ND		0.005
1,1,1-Trichloroethane	ND		0.005
Carbon tetrachloride	ND		0.005
1,2-Dichloroethane (EDC)	ND		0.005
Benzene	ND		0.005
Trichloroethene	ND		0.005
1,2-Dichloropropane	ND		0.005
Bromodichloromethane	ND		0.005
2-Chloroethyl vinyl ether	ND		0.005
cis-1,3-Dichloropropene	ND		0.005
Toluene	ND		0.005
trans-1,3-Dichloropropene	ND		0.005
1,1,2-Trichloroethane	ND		0.005
Tetrachloroethene	ND		0.005
Dibromochloromethane	ND		0.005
Chlorobenzene	ND		0.005
Ethylbenzene	ND		0.005
Total Xylenes	ND		0.005
Bromoform	ND		0.005
1,1,2,2-Tetrachloroethane	ND		0.005
1,3-Dichlorobenzene	ND		0.005
1,4-Dichlorobenzene	ND		0.005
1,2-Dichlorobenzene	ND		0.005

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS
Tentatively Identified Compounds

Client/Project:

Lab ID: METHOD-BLK
Client ID: N/A
Date Received:
Date Analyzed: 11/08/2006
Date File: F0803.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

Response Factor Report MSD_F

Method Path : C:\MSDCHEM\1\METHODS\
Method File : FSO1030.M
Title : VOLATILE ORGANICS BY EPA METHOD 8260B
Last Update : Mon Oct 30 13:04:35 2006
Response Via : Initial Calibration

Calibration Files
20 =F0560.D 100 =F0559.D 50 =F0563.D
150 =F0562.D 200 =F0561.D

		Compound (ppb)	20	100	50	150	200	Avg	%RSD
1)	I	Pentafluorobenzene	----------ISTD----------						
2)	T	Dichlorodifluoromet	0.793	0.790	0.809	0.771	0.810	0.794	2.01
3)	P	Chloromethane	0.318	0.327	0.325	0.316	0.333	0.324	2.16
4)	C	Vinyl chloride	0.349	0.351	0.347	0.349	0.385	0.356	4.56
5)	T	Bromomethane	0.242	0.248	0.243	0.240	0.178	0.230	12.79
6)	T	Chloroethane	0.201	0.191	0.201	0.187	0.193	0.194	3.06
7)	T	Trichlorofluorometh	0.752	0.731	0.747	0.718	0.750	0.740	1.95
8)	T	Acrolein	0.002	0.002	0.002	0.001	0.002	0.002	14.34
9)	MC	1,1-Dichloroethene	0.343	0.334	0.343	0.327	0.340	0.337	2.04
10)	T	Acetone	0.058	0.056	0.052	0.041	0.053	0.052	12.60
11)	T	Carbon disulfide	0.937	1.044	0.999	0.969	1.002	0.990	4.03
12)	T	Vinyl acetate	1.246	1.301	1.278	1.159	1.262	1.249	4.37
13)	T	Methylene chloride	0.439	0.517	0.324	0.378	0.520	0.435	19.69
14)	T	Acrylonitrile	0.101	0.107	0.103	0.079	0.096	0.097	11.41
15)	T	tert-Butyl alcohol	0.023	0.025	0.027	0.021	0.028	0.025	11.61
16)	T	trans-1,2-Dichloroe	0.697	0.689	0.715	0.683	0.700	0.697	1.75
17)	T	Methyl tert-butyl e	0.948	0.993	1.017	0.928	1.037	0.985	4.67
18)	P	1,1-Dichloroethane	1.104	1.094	1.123	1.078	1.123	1.104	1.76
19)	T	Diisopropyl ether (	1.675	1.665	1.784	1.621	1.653	1.680	3.69
20)	T	cis-1,2-Dichloroeth	0.620	0.617	0.630	0.595	0.616	0.615	2.07
21)	T	2,2-Dichloropropane	0.881	0.899	0.942	0.922	0.932	0.915	2.74
22)	T	2-Butanone (MEK)	0.154	0.165	0.163	0.129	0.158	0.154	9.56
23)	T	Bromochloromethane	0.235	0.240	0.240	0.225	0.250	0.238	3.83
25)	C	Chloroform	1.002	0.982	1.000	0.970	1.024	0.996	2.08
26)	T	1,1,1-Trichloroetha	1.053	1.047	1.128	1.106	1.114	1.089	3.41
27)	T	Carbon tetrachlorid	1.013	0.997	1.086	1.043	1.036	1.035	3.28
28)	T	1,1-Dichloropropene	0.927	0.885	1.000	0.900	0.869	0.916	5.60
29)	T	1,2-Dichloroethane	0.574	0.575	0.589	0.528	0.580	0.569	4.18
30)	S	1,2-Dichloroethane-	0.346	0.372	0.348	0.329	0.381	0.355	5.84
31)	I	1,4-Difluorobenzene	----------ISTD----------						
32)	M	Benzene	1.579	1.493	1.663	1.517	1.442	1.539	5.52
33)	M	Trichloroethene	0.455	0.440	0.508	0.468	0.448	0.464	5.80
34)	C	1,2-Dichloropropane	0.349	0.333	0.367	0.333	0.324	0.341	5.01
35)	T	Dibromomethane	0.147	0.148	0.154	0.141	0.152	0.148	3.32
37)	T	Bromodichloromethan	0.407	0.413	0.437	0.421	0.430	0.422	2.87
38)	T	2-Chloroethyl vinyl	0.069	0.085	0.093	0.086	0.095	0.086	11.91
39)	T	cis-1,3-Dichloropro	0.430	0.453	0.488	0.464	0.469	0.461	4.59
40)	T	4-Methyl-2-pentanon	0.145	0.172	0.183	0.153	0.174	0.166	9.44
41)	S	Toluene-d8	0.914	0.927	0.911	0.906	0.914	0.914	0.83
42)	MC	Toluene	0.994	0.942	1.047	0.960	0.928	0.974	4.89
43)	T	trans-1,3-Dichlorop	0.316	0.344	0.376	0.349	0.360	0.349	6.28
44)	T	1,1,2-Trichloroetha	0.159	0.161	0.179	0.157	0.163	0.164	5.45
45)	T	Tetrachloroethene	0.476	0.446	0.512	0.460	0.434	0.466	6.53
46)	T	1,3-Dichloropropane	0.340	0.340	0.382	0.325	0.333	0.344	6.50
47)	T	2-Hexanone	0.113	0.131	0.142	0.118	0.135	0.128	9.42
48)	T	Dibromochloromethan	0.245	0.268	0.292	0.267	0.278	0.270	6.29
49)	T	1,2-Dibromoethane (	0.176	0.184	0.204	0.177	0.187	0.186	6.11
50)	I	Chlorobenzene-d5	----------ISTD----------						
51)	MP	Chlorobenzene	1.447	1.353	1.500	1.396	1.339	1.407	4.75
52)	T	1,1,1,2-Tetrachloro	0.451	0.453	0.505	0.483	0.463	0.471	4.83

53)	C	Ethylbenzene	2.657	2.554	2.825	2.687	2.530	2.651	4.45
54)	T	m,p-Xylene	1.082	0.989	1.109	1.004	0.926	1.022	7.24
55)	T	o-Xylene	0.940	0.889	0.996	0.908	0.844	0.915	6.22
56)	T	Styrene	1.436	1.380	1.518	1.388	1.310	1.406	5.47
57)	P	Bromoform	0.157	0.180	0.185	0.176	0.191	0.178	7.20
58)	T	Isopropylbenzene	2.512	2.388	2.707	2.520	2.370	2.500	5.39
59)	S	Bromofluorobenzene	0.499	0.491	0.500	0.493	0.501	0.497	0.94
60)	P	1,1,2,2-Tetrachloro	0.374	0.316	0.337	0.278	0.284	0.318	12.45
61)	T	Bromobenzene	0.505	0.489	0.527	0.490	0.483	0.499	3.60
62)	T	1,2,3-Trichloroprop	0.259	0.254	0.273	0.239	0.257	0.256	4.81
63)	T	n-Propylbenzene	3.129	2.955	3.318	3.096	2.899	3.080	5.32
64)	T	2-Chlorotoluene	1.708	1.625	1.781	1.685	1.611	1.682	4.07
65)	T	1,3,5-Trimethylbenz	2.192	2.053	2.297	2.114	1.963	2.124	6.04
66)	T	4-Chlorotoluene	1.918	1.795	1.975	1.806	1.693	1.837	6.04
67)	T	tert-Butylbenzene	2.057	1.929	2.213	2.057	1.905	2.032	6.07
68)	T	1,2,4-Trimethylbenz	2.099	2.000	2.211	2.084	1.994	2.078	4.27
69)	T	sec-Butylbenzene	3.056	2.854	3.268	2.986	2.757	2.984	6.58
70)	T	1,3-Dichlorobenzene	1.038	0.992	1.080	1.013	0.989	1.022	3.68
71)	T	4-Isopropyltoluene	2.494	2.351	2.661	2.466	2.299	2.454	5.74
72)	T	1,4-Dichlorobenzene	1.016	0.971	1.049	0.983	0.959	0.996	3.69
73)	T	n-Butylbenzene	1.189	1.122	1.279	1.161	1.057	1.162	7.08
74)	T	1,2-Dichlorobenzene	0.873	0.800	0.884	0.766	0.735	0.812	8.08
75)	T	1,2-Dibromo-3-chlor	0.035	0.042	0.043	0.038	0.044	0.040	9.79
76)	T	1,2,4-Trichlorobenz	0.469	0.479	0.527	0.506	0.505	0.497	4.68
77)	T	Hexachlorobutadiene	0.422	0.389	0.456	0.426	0.391	0.417	6.67
78)	T	Naphthalene	0.624	0.682	0.768	0.689	0.754	0.704	8.31
79)	T	1,2,3-Trichlorobenz	0.418	0.394	0.452	0.410	0.413	0.418	5.07
80)	T	1,1,2-Trichloro-1,2	0.435	0.399	0.429	0.419	0.403	0.417	3.71
81)	T	Methyl acetate	0.200	0.206	0.155	0.133	0.208	0.180	19.03
82)	T	Cyclohexane	1.550	1.396	1.578	1.453	1.340	1.463	6.88
83)	T	Methylcyclohexane	1.121	1.027	1.212	1.089	0.979	1.085	8.25

(#) = Out of Range

FSO1030.M Mon Oct 30 13:04:51 2006 RP1

Instrument ID: MSD_F
Method ID: FSO1030.M
Date: 10/30/2006

Average %RSD = 6.14

Refer to SW846 Method 8000B Section 7.5.1.

Evaluate Continuing Calibration Report

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0801.D
Acq On : 8 Nov 2006 16:08
Operator : BIN XU
Sample : 100PPB,STD-100PPB,S,5g,1
Misc :
ALS Vial : 2 Sample Multiplier: 1

Quant Time: Nov 08 17:03:09 2006
Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B
QLast Update : Mon Oct 30 13:27:48 2006
Response via : Initial Calibration

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.50min
Max. RRF Dev : 35% Max. Rel. Area : 200%

		Compound	AvgRF	CCRF	%Dev	Area%	Dev(min)
1	I	Pentafluorobenzene	1.000	1.000	0.0	98	0.00
2	T	Dichlorodifluoromethane	0.794	0.745	6.2	92	0.00
3	P	Chloromethane	0.324	0.293	9.6	87	0.00
4	C	Vinyl chloride	0.356	0.315	11.5	88	-0.01
5	T	Bromomethane	0.230	0.218	5.2	86	-0.01
6	T	Chloroethane	0.194	0.169	12.9	87	0.00
7	T	Trichlorofluoromethane	0.740	0.634	14.3	85	0.00
8	T	Acrolein	0.002	0.001	50.0	37	-0.01
9	MC	1,1-Dichloroethene	0.337	0.281	16.6	82	0.00
10	T	Acetone	0.052	0.054	-3.8	93	0.00
11	T	Carbon disulfide	0.990	0.827	16.5	77	-0.01
12	T	Vinyl acetate	1.249	1.137	9.0	85	0.00
13	T	Methylene chloride	0.435	0.297	31.7	56	-0.01
14	T	Acrylonitrile	0.097	0.090	7.2	82	0.00
15	T	tert-Butyl alcohol (TBA)	0.025	0.022	12.0	88	0.00
16	T	trans-1,2-Dichloroethene	0.697	0.600	13.9	85	-0.01
17	T	Methyl tert-butyl ether (MT	0.985	0.925	6.1	91	-0.01
18	P	1,1-Dichloroethane	1.104	0.951	13.9	85	-0.01
19	T	Diisopropyl ether (DIPE)	1.680	1.464	12.9	86	0.00
20	T	cis-1,2-Dichloroethene	0.615	0.553	10.1	88	0.00
21	T	2,2-Dichloropropane	0.915	0.768	16.1	83	0.00
22	T	2-Butanone (MEK)	0.154	0.163	-5.8	96	0.00
23	T	Bromochloromethane	0.238	0.235	1.3	96	0.00
25	C	Chloroform	0.996	0.878	11.8	87	0.00
26	T	1,1,1-Trichloroethane	1.089	0.927	14.9	87	-0.01
27	T	Carbon tetrachloride	1.035	0.915	11.6	90	0.00
28	T	1,1-Dichloropropene	0.916	0.809	11.7	89	0.00
29	T	1,2-Dichloroethane (EDC)	0.569	0.560	1.6	95	0.00
30	S	1,2-Dichloroethane-d4	0.355	0.367	-3.4	96	0.00
31	I	1,4-Difluorobenzene	1.000	1.000	0.0	95	0.00
32	M	Benzene	1.539	1.423	7.5	91	0.00
33	M	Trichloroethene	0.464	0.424	8.6	91	0.00
34	C	1,2-Dichloropropane	0.341	0.327	4.1	93	0.00
35	T	Dibromomethane	0.148	0.157	-6.1	101	0.00
37	T	Bromodichloromethane	0.422	0.416	1.4	96	0.00
38	T	2-Chloroethyl vinyl ether	0.086	0.084	2.3	93	0.00
39	T	cis-1,3-Dichloropropene	0.461	0.462	-0.2	97	0.00
40	T	4-Methyl-2-pentanone (MIBK)	0.166	0.177	-6.6	98	0.00
41	S	Toluene-d8	0.914	0.927	-1.4	95	0.00
42	MC	Toluene	0.974	0.911	6.5	92	0.01
43	T	trans-1,3-Dichloropropene	0.349	0.369	-5.7	102	0.00
44	T	1,1,2-Trichloroethane	0.164	0.178	-8.5	105	0.00
45	T	Tetrachloroethene	0.466	0.429	7.9	91	0.00
46	T	1,3-Dichloropropane	0.344	0.374	-8.7	104	0.00

47	T	2-Hexanone	0.128	0.133	-3.9	97	0.00
48	T	Dibromochloromethane	0.270	0.305	-13.0	108	0.00
49	T	1,2-Dibromoethane (EDB)	0.186	0.210	-12.9	108	0.00
50	I	Chlorobenzene-d5	1.000	1.000	0.0	94	0.00
51	MP	Chlorobenzene	1.407	1.382	1.8	96	0.00
52	T	1,1,1,2-Tetrachloroethane	0.471	0.491	-4.2	102	0.00
53	C	Ethylbenzene	2.651	2.473	6.7	91	0.01
54	T	m,p-Xylene	1.022	0.963	5.8	91	0.00
55	T	o-Xylene	0.915	0.884	3.4	93	0.00
56	T	Styrene	1.406	1.393	0.9	95	0.01
57	P	Bromoform	0.178	0.214	-20.2	111	0.00
58	T	Isopropylbenzene	2.500	2.326	7.0	91	0.00
59	S	Bromofluorobenzene	0.497	0.485	2.4	93	0.00
60	P	1,1,2,2-Tetrachloroethane	0.318	0.312	1.9	92	0.00
61	T	Bromobenzene	0.499	0.514	-3.0	99	0.00
62	T	1,2,3-Trichloropropane	0.256	0.287	-12.1	106	0.00
63	T	n-Propylbenzene	3.080	2.850	7.5	90	0.00
64	T	2-Chlorotoluene	1.682	1.611	4.2	93	0.00
65	T	1,3,5-Trimethylbenzene	2.124	2.005	5.6	91	0.00
66	T	4-Chlorotoluene	1.837	1.773	3.5	93	0.00
67	T	tert-Butylbenzene	2.032	1.900	6.5	92	0.00
68	T	1,2,4-Trimethylbenzene	2.078	1.978	4.8	93	0.00
69	T	sec-Butylbenzene	2.984	2.759	7.5	91	0.00
70	T	1,3-Dichlorobenzene	1.022	1.020	0.2	96	0.00
71	T	4-Isopropyltoluene	2.454	2.271	7.5	90	0.00
72	T	1,4-Dichlorobenzene	0.996	1.006	-1.0	97	0.00
73	T	n-Butylbenzene	1.162	1.036	10.8	87	0.00
74	T	1,2-Dichlorobenzene	0.812	0.854	-5.2	100	0.00
75	T	1,2-Dibromo-3-chloropropane	0.040	0.049	-22.5	110	0.00
76	T	1,2,4-Trichlorobenzene	0.497	0.500	-0.6	98	0.00
77	T	Hexachlorobutadiene	0.417	0.369	11.5	89	0.00
78	T	Naphthalene	0.704	0.769	-9.2	105	0.00
79	T	1,2,3-Trichlorobenzene	0.418	0.438	-4.8	104	0.00
80	T	1,1,2-Trichloro-1,2,2-trifl	0.417	0.425	-1.9	100	-0.01
81	T	Methyl acetate	0.180	0.131	27.2	59	0.00
82	T	Cyclohexane	1.463	1.265	13.5	85	-0.01
83	T	Methylcyclohexane	1.085	0.966	11.0	88	-0.01

(#) = Out of Range SPCC's out = 3 CCC's out = 0

FSO1030.M Wed Nov 08 17:03:15 2006 RP1

VOLATILE SURROGATE PERCENT RECOVERY SUMMARY

Date Analyzed: 11/08/2006

Lab Sample ID	Matrix	File ID	SMC1 #	SMC2 #	SMC3 #
METHOD-BLK	SOIL	F0803.D	111	96	87
BLK-SPK	SOIL	F0804.D	102	103	99
SOIL-MS	SOIL	F0805.D	110	97	90
SOIL-MSD	SOIL	F0806.D	111	96	88
12240-012	SOIL	F0807.D	94	95	83
12240-014	SOIL	F0808.D	111	94	73
12032-002	SOIL	F0810.D	99	94	84
12032-004	SOIL	F0811.D	98	95	86
12227-001	SOIL	F0813.D	103	94	82
12227-003	SOIL	F0814.D	109	96	84
12087-001	SOLID	F0815.D	120	95	82
12267-002	SOIL	F0816.D	100	96	82
12667-008	SOIL	F0817.D	102	97	83
12152-001	SOIL	F0819.D	114	96	83
12164-001	SOIL	F0820.D	98	97	82
12158-002	SOIL	F0821.D	109	96	83
12158-003	SOIL	F0822.D	100	97	83

	Concentration	Aqueous/Meoh	Soil
SMC1 = 1,2-Dichloroethane-d4	50 ppb	61-137	61-137
SMC2 = Toluene-d8	50 ppb	62-144	62-144
SMC3 = Bromofluorobenzene	50 ppb	66-142	66-142

Column to be used to flag recovery values

SOIL VOLATILE MATRIX SPIKE/SPIKE DUPLICATE RECOVERY

Matrix spike Lab sample ID: SOIL-MSD

Batch No.: FSO1108

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
1,1-Dichloroethene	50.0	0.0	38.0	76	70 - 145
Benzene	50.0	0.0	40.8	82	75 - 140
Trichloroethene	50.0	0.0	38.5	77	75 - 145
Toluene	50.0	0.0	42.3	85	79 - 130
Chlorobenzene	50.0	0.0	45.8	92	80 - 121

Compound	SAMPLE CONC. (ug/Kg)	MSD CONC. (ug/Kg)	MSD #	% REC	% RPD #	QC LIMITS RPD	QC LIMITS REC.
1,1-Dichloroethene	0.0	41.4		83	9	17	70 - 145
Benzene	0.0	44.6		89	8	19	75 - 140
Trichloroethene	0.0	42.9		86	11	17	75 - 145
Toluene	0.0	46.8		94	10	16	79 - 130
Chlorobenzene	0.0	50.8		102	10	18	80 - 121

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

RPD: __0___ out of __5__ outside limits

Spike Recovery: __0___ out of __10__ outside limits

VOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): F0559.D

Date Analyzed: 10/30/2006

Instrument ID: MSD_F

Time Analyzed: 10:30

	50UG/L	IS1 AREA	#	RT	#	IS2 AREA	#	RT	#	IS3 AREA	#	RT	#
	12 HOUR STD	457835		5.98		681333		6.79		477543		10.12	
	UPPER LIMIT	915670		6.48		1362666		7.29		955086		10.62	
	LOWER LIMIT	228917.5		5.48		340666.5		6.29		238771.5		9.62	
	LAB SAMPLE ID												
01	STD-20PPB	501011		5.98		729181		6.79		505385		10.12	
02	STD-200PPB	511204		5.98		781716		6.79		539888		10.12	
03	STD-150PPB	523672		5.98		775549		6.79		527314		10.12	
04	STD-50PPB	492699		5.98		728361		6.79		512920		10.12	
05	METHOD-BLK	451374		5.98		690027		6.79		465427		10.12	
06	BLK-SPK	469112		5.98		671550		6.79		470117		10.12	
07	SOIL-MS	447651		5.98		671204		6.79		461104		10.12	
08	SOIL-MSD	410864		5.98		630789		6.79		437328		10.12	
09	11850-001	452872		5.99		675676		6.79		465750		10.12	
10	11850-005	447122		5.99		677812		6.79		459189		10.12	
11	11850-007	453651		5.99		701075		6.79		486210		10.12	
12	11850-009	442879		5.98		697886		6.79		475451		10.12	
13	11850-003	432742		5.98		662395		6.79		434992		10.12	
14	11794-002	429011		5.98		659796		6.79		434701		10.12	
15	11848-001	388010		5.98		615370		6.79		417369		10.12	
16													
17													
18													
19													
20													
21													
22													

IS1 = PENTAFLUOROBENZENE
IS2 = 1,4-DIFLUOROBENZENE
IS3 = CHLOROBENZENE-D5

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = -50% of internal standard area
RT UPPER LIMIT = +0.50 minutes of internal standard RT
RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk
* Values outside of QC limits.

FORM 8

VOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): F0801.D

Date Analyzed: 11/08/2006

Instrument ID: MSD_F

Time Analyzed: 16:08

	50UG/L	IS1 AREA #	RT #	IS2 AREA #	RT #	IS3 AREA #	RT #
	12 HOUR STD	447367	5.98	647132	6.79	447178	10.12
	UPPER LIMIT	894734	6.48	1294264	7.29	894356	10.62
	LOWER LIMIT	223683.5	5.48	323566	6.29	223589	9.62
	LAB SAMPLE ID						
01	METHOD-BLK	378038	5.98	592373	6.79	395679	10.12
02	BLK-SPK	419013	5.98	594530	6.79	415372	10.12
03	SOIL-MS	396668	5.98	624206	6.79	426247	10.12
04	SOIL-MSD	396499	5.98	624104	6.79	423036	10.12
05	12240-012	409580	5.98	634149	6.79	404979	10.12
06	12240-014	227267	5.99	327128	6.79	238253	10.12
07	12032-002	399859	5.98	633981	6.79	401171	10.12
08	12032-004	385648	5.98	609479	6.79	393056	10.12
09	12227-001	419107	5.99	667061	6.79	422681	10.12
10	12227-003	412745	5.98	658305	6.79	428542	10.12
11	12087-001	343468	5.99	561831	6.79	365624	10.12
12	12267-002	399488	5.98	624670	6.79	396183	10.12
13	12667-008	409214	5.98	643722	6.79	416105	10.12
14	12152-001	362625	5.98	581270	6.79	382138	10.12
15	12164-001	371268	5.98	579314	6.79	372068	10.12
16	12158-002	354705	5.99	564413	6.79	363101	10.12
17	12158-003	369751	5.98	580385	6.79	373674	10.12
18							
19							
20							
21							
22							

IS1 = PENTAFLUOROBENZENE
IS2 = 1,4-DIFLUOROBENZENE
IS3 = CHLOROBENZENE-D5

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = -50% of internal standard area
RT UPPER LIMIT = +0.50 minutes of internal standard RT
RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk
* Values outside of QC limits.

FORM 8

Quantitation Report (QT Reviewed)

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0815.D
Acq On : 8 Nov 2006 23:22
Operator : BIN XU
Sample : POND_SEDIMENT/0-0.5,12087-001,Xs,5g,39.2
Misc : PRINCETON/MULLICA,10/30/06,11/02/06,1
ALS Vial : 16 Sample Multiplier: 1

Quant Time: Nov 09 15:06:31 2006
Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B
QLast Update : Mon Oct 30 13:27:48 2006
Response via : Initial Calibration

Internal Standards	R.T.	QIon	Response	Conc	Units	Dev(Min)
1) Pentafluorobenzene	5.993	168	343468	50.00	UG	0.01
31) 1,4-Difluorobenzene	6.795	114	561831	50.00	UG	0.00
50) Chlorobenzene-d5	10.124	117	365624	50.00	UG	0.00
System Monitoring Compounds						
30) 1,2-Dichloroethane-d4	6.287	65	145827	59.76	UG	0.00
Spiked Amount 50.000	Range 43 - 133		Recovery = 119.52%			
41) Toluene-d8	8.460	98	488008	47.50	UG	0.00
Spiked Amount 50.000	Range 39 - 137		Recovery = 95.00%			
59) Bromofluorobenzene	11.536	95	149472	41.15	UG	0.01
Spiked Amount 50.000	Range 23 - 145		Recovery = 82.30%			

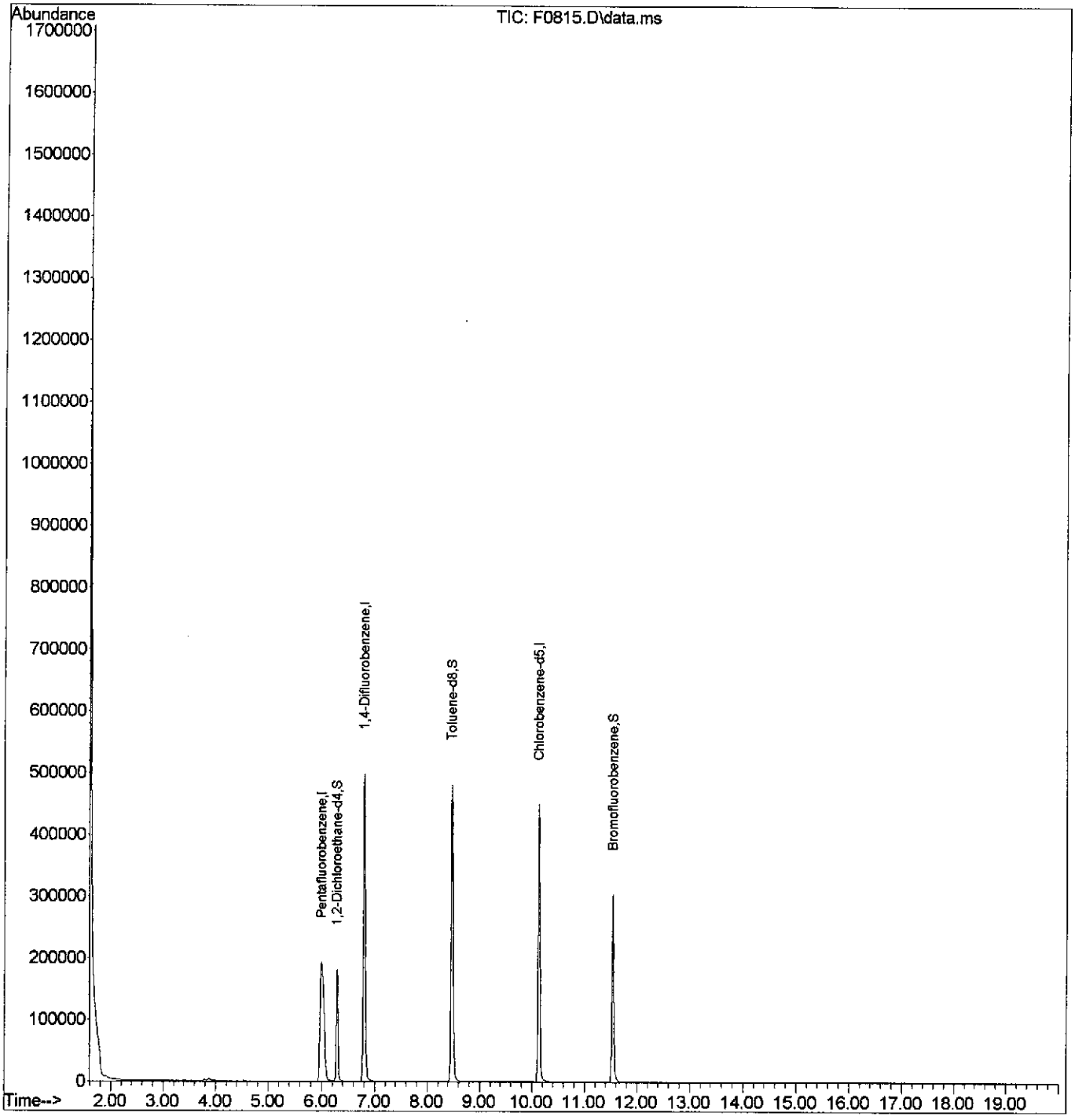
Target Compounds	Qvalue

(#) = qualifier out of range (m) = manual integration (+) = signals summed

Quantitation Report (QT Reviewed)

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0815.D
Acq On : 8 Nov 2006 23:22
Operator : BIN XU
Sample : POND_SEDIMENT/0-0.5,12087-001,Xs,5g,39.2
Misc : PRINCETON/MULLICA,10/30/06,11/02/06,1
ALS Vial : 16 Sample Multiplier: 1

Quant Time: Nov 09 15:06:31 2006
Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B
QLast Update : Mon Oct 30 13:27:48 2006
Response via : Initial Calibration



LSC Area Percent Report

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0815.D
Acq On : 8 Nov 2006 23:22
Operator : BIN XU
Sample : POND_SEDIMENT/0-0.5,12087-001,Xs,5g,39.2
Misc : PRINCETON/MULLICA,10/30/06,11/02/06,1
ALS Vial : 16 Sample Multiplier: 1

Integration Parameters: LSCINT.P
Integrator: RTE
Smoothing : ON Filtering: 5
Sampling : 1 Min Area: 1 % of largest Peak
Start Thrs: 0.2 Max Peaks: 100
Stop Thrs : 0 Peak Location: TOP

If leading or trailing edge < 100 prefer < Baseline drop else tangent >
Peak separation: 5

Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Title : VOLATILE ORGANICS BY EPA METHOD 8260B

Signal : TIC: F0815.

peak #	R.T. min	first scan	max scan	last scan	PK TY	peak height	corr. area	corr. % max.	% of total
1	3.871	223	226	244	rVB4	3710	14440	1.07%	0.249%
2	5.993	425	435	458	rBV	192856	1004990	74.27%	17.313%
3	6.287	458	464	480	rVB	180761	396773	29.32%	6.835%
4	6.795	507	514	541	rBV	499198	1249364	92.33%	21.523%
5	8.460	672	678	700	rBV	481674	1353123	100.00%	23.311%
6	10.124	836	842	869	rVB	450482	1080840	79.88%	18.620%
7	11.536	970	981	1003	rBV	304324	705168	52.11%	12.148%

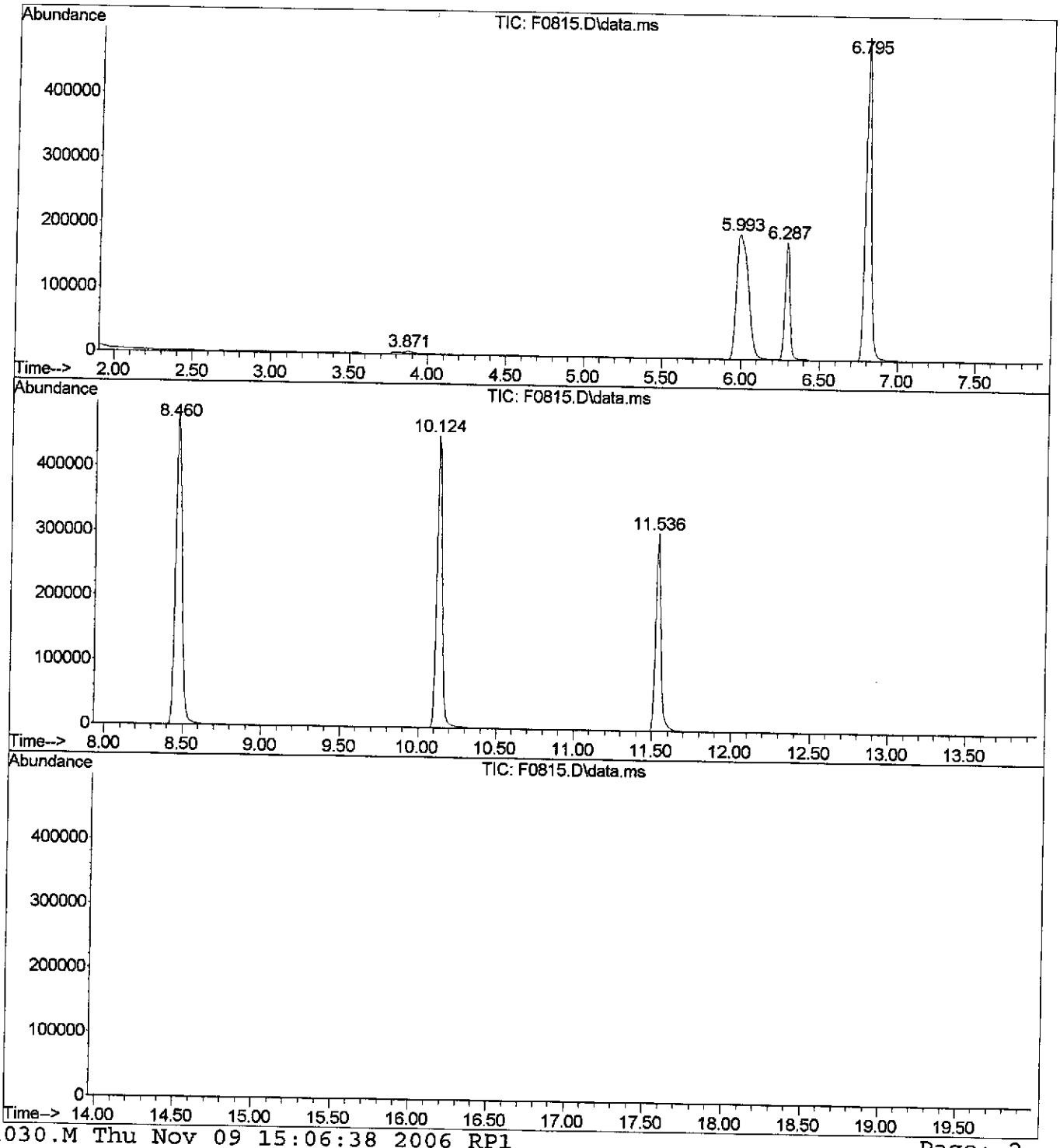
Sum of corrected areas: 5804698

LSC Report - Integrated Chromatogram

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0815.D
Acq On : 8 Nov 2006 23:22
Operator : BIN XU
Sample : POND_SEDIMENT/0-0.5,12087-001,Xs,5g,39.2
Misc : PRINCETON/MULLICA,10/30/06,11/02/06,1
ALS Vial : 16 Sample Multiplier: 1

Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B

TIC Library : C:\DATABASE\NIST98.L
TIC Integration Parameters: LSCINT.P



Quantitation Report (QT Reviewed)

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0803.D
Acq On : 8 Nov 2006 17:10
Operator : BIN XU
Sample : N/A,METHOD-BLK,S,5g,0
Misc :
ALS Vial : 4 Sample Multiplier: 1

Quant Time: Nov 09 16:54:15 2006
Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B
QLast Update : Mon Oct 30 13:27:48 2006
Response via : Initial Calibration

Internal Standards	R.T.	QIon	Response	Conc	Units	Dev(Min)
1) Pentafluorobenzene	5.982	168	378038	50.00	UG	0.00
31) 1,4-Difluorobenzene	6.795	114	592373	50.00	UG	0.00
50) Chlorobenzene-d5	10.124	117	395679	50.00	UG	0.00
System Monitoring Compounds						
30) 1,2-Dichloroethane-d4	6.287	65	148957	55.46	UG	0.00
Spiked Amount 50.000	Range 43 - 133		Recovery = 110.92%			
41) Toluene-d8	8.459	98	520339	48.04	UG	0.00
Spiked Amount 50.000	Range 39 - 137		Recovery = 96.08%			
59) Bromofluorobenzene	11.535	95	170039	43.26	UG	0.00
Spiked Amount 50.000	Range 23 - 145		Recovery = 86.52%			

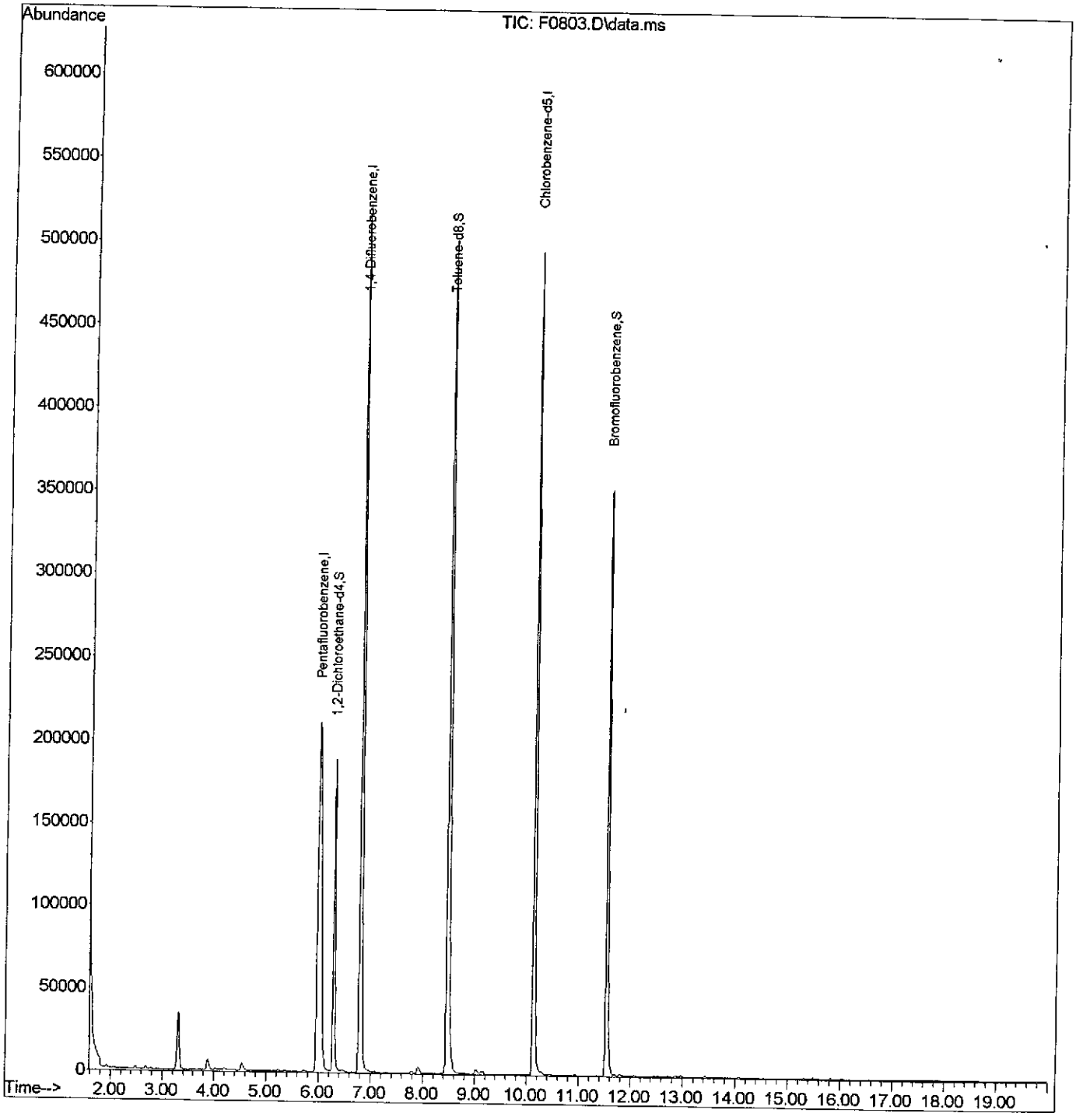
Target Compounds	Qvalue

(#) = qualifier out of range (m) = manual integration (+) = signals summed

Quantitation Report (QT Reviewed)

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0803.D
Acq On : 8 Nov 2006 17:10
Operator : BIN XU
Sample : N/A,METHOD-BLK,S,5g,0
Misc :
ALS Vial : 4 Sample Multiplier: 1

Quant Time: Nov 09 16:54:15 2006
Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B
QLast Update : Mon Oct 30 13:27:48 2006
Response via : Initial Calibration



LSC Area Percent Report

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0803.D
Acq On : 8 Nov 2006 17:10
Operator : BIN XU
Sample : N/A,METHOD-BLK,S,5g,0
Misc :
ALS Vial : 4 Sample Multiplier: 1

Integration Parameters: LSCINT.P
Integrator: RTE
Smoothing : ON
Sampling : 1
Start Thrs: 0.2
Stop Thrs : 0

Filtering: 5
Min Area: 1 % of largest Peak
Max Peaks: 100
Peak Location: TOP

If leading or trailing edge < 100 prefer < Baseline drop else tangent >
Peak separation: 5

Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Title : VOLATILE ORGANICS BY EPA METHOD 8260B

Signal : TIC: F0803.

peak #	R.T. min	first scan	max scan	last scan	PK TY	peak height	corr. area	corr. % max.	% of total
1	3.302	162	170	182	rVB	34276	103319	7.13%	1.624%
2	3.881	221	227	237	rVB4	6559	21264	1.47%	0.334%
3	4.531	286	291	302	rVB2	4325	15555	1.07%	0.245%
4	5.982	426	434	459	rBV	210979	1090695	75.31%	17.145%
5	6.287	459	464	476	rVV	188559	408030	28.17%	6.414%
6	6.795	506	514	539	rBV	522427	1311107	90.52%	20.609%
7	8.459	671	678	706	rBV	500649	1448339	100.00%	22.766%
8	10.124	829	842	865	rBV	495537	1168543	80.68%	18.368%
9	11.535	975	981	996	rBV	353174	794880	54.88%	12.495%

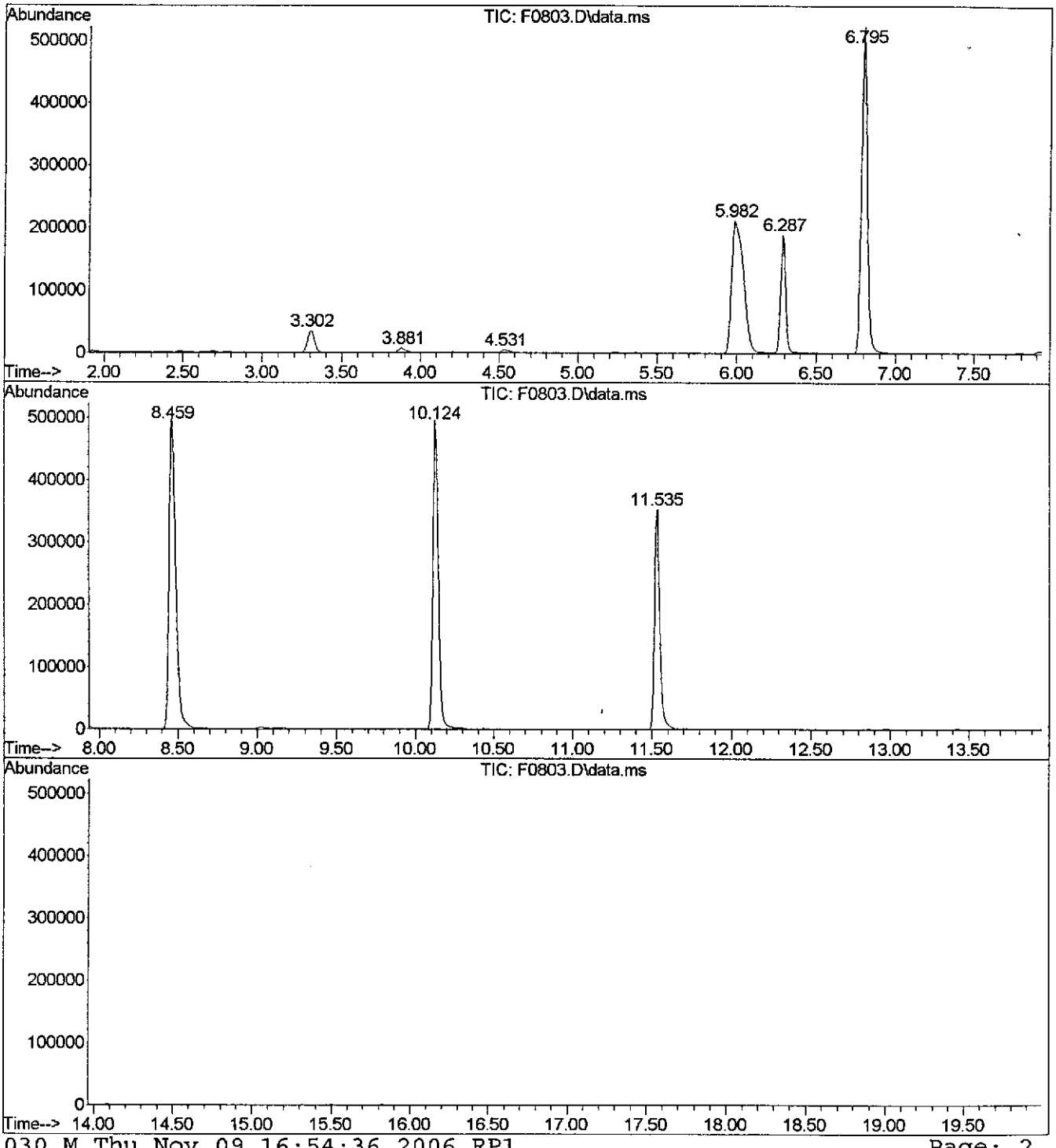
Sum of corrected areas: 6361732

LSC Report - Integrated Chromatogram

Data Path : C:\msdchem\1\DATA\11-08-06\
Data File : F0803.D
Acq On : 8 Nov 2006 17:10
Operator : BIN XU
Sample : N/A,METHOD-BLK,S,5g,0
Misc :
ALS Vial : 4 Sample Multiplier: 1

Quant Method : C:\MSDCHEM\1\METHODS\FSO1030.M
Quant Title : VOLATILE ORGANICS BY EPA METHOD 8260B

TIC Library : C:\DATABASE\NIST98.L
TIC Integration Parameters: LSCINT.P



0043

SEMIVOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

Lab File ID: C2387.D

DFTPP Injection Date : 10/23/2006

Inst ID: MSDC

DFTPP Injection Time: 06:46

m/z	Ion Abudance Criteria	%Relative Abundance			
51	30.0 - 60.0% of mass 198	48.0			
68	Less than 2.0% of mass 69	0.7	(	1.5	)1
69	Mass 69 relative abundance	49.5			
70	Less than 2.0% of mass 69	0.9	(	1.8	)1
127	40.0 - 60.0% of mass 198	58.3			
197	Less than 1.0% of mass 198	0.0			
198	Base peak, 100% relative abundance	100.0			
199	5.0 - 9.0% of mass 198	7.3			
275	10.0 - 30.0% of mass 198	24.0			
365	Greater than 1.0% of mass 198	3.1			
441	Present, but less than mass 443	11.57	(	71.7	)3
442	40.0 - 100.0% of mass 198	77.2			
443	17.0 - 23.0% of mass 442	16.1	(	20.9	)2

1-Value is % mass 69 2-Value is % mass 442 3-Value is % mass 443

This check applies to the following SAMPLES, MS, MSD, BLANKS and STANDARDS:

Client ID	Lab Sample ID	File ID	Date Analyzed	Time Analyzed
ABN079.06	20ngBNA_inj_FOR	C2388.D	10/23/2006	07:03
ABN080.06	50ngBNA_inj_FOR	C2389.D	10/23/2006	07:18
ABN081.06	80ngBNA_inj_FOR	C2390.D	10/23/2006	07:33
ABN082.06	120ngBNA_inj_FO	C2391.D	10/23/2006	07:48
ABN083.06	160ngBNA_inj_FO	C2392.D	10/23/2006	08:03
ABN089.06	160ngOLMO4_inj_	C2393.D	10/23/2006	08:18
ABN088.06	120ngOLMO4_inj_	C2394.D	10/23/2006	08:33
ABN087.06	80ngOLMO4_inj_F	C2395.D	10/23/2006	08:48
ABN086.06	50ngOLMO4_inj_F	C2396.D	10/23/2006	09:03
ABN085.06	20ngOLMO4_inj_F	C2397.D	10/23/2006	09:18
.	Method_Blank	C2398.D	10/23/2006	09:33
.	LCS	C2399.D	10/23/2006	09:48
TRANSMINE10-	11297-001	C2400.D	10/23/2006	10:03
TRANSMINE16-	11297-002	C2401.D	10/23/2006	10:18
TRANSMINE10-	11297-003	C2402.D	10/23/2006	10:34
TRANSMINE04-	11297-004	C2403.D	10/23/2006	10:49
TRANSMINE14-	11297-005	C2404.D	10/23/2006	11:04
B4-SB-11/12-	11369-004	C2405.D	10/23/2006	11:19
B2-PS-3/12-1	11370-001	C2406.D	10/23/2006	11:34
B3-PS-7/12-1	11370-005	C2407.D	10/23/2006	11:49
SIDEWALLS_1/	11402-002	C2408.D	10/23/2006	12:04
SIDEWALL_1/2	11496-002	C2409.D	10/23/2006	12:20
BOTTOM_5_2A/	11496-004	C2410.D	10/23/2006	12:36

SEMIVOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

Lab File ID: C2387.D DFTPP Injection Date : 10/23/2006

Inst ID: MSDC DFTPP Injection Time: 06:46

m/z	Ion Abudance Criteria	%Relative Abundance			
51	30.0 - 60.0% of mass 198	48.0			
68	Less than 2.0% of mass 69	0.7	(	1.5	)1
69	Mass 69 relative abundance	49.5			
70	Less than 2.0% of mass 69	0.9	(	1.8	)1
127	40.0 - 60.0% of mass 198	58.3			
197	Less than 1.0% of mass 198	0.0			
198	Base peak, 100% relative abundance	100.0			
199	5.0 - 9.0% of mass 198	7.3			
275	10.0 - 30.0% of mass 198	24.0			
365	Greater than 1.0% of mass 198	3.1			
441	Present, but less than mass 443	0.00	(	71.7	)3
442	40.0 - 100.0% of mass 198	77.2			
443	17.0 - 23.0% of mass 442	16.1	(	20.9	)2

1-Value is % mass 69 2-Value is % mass 442 3-Value is % mass 443

This check applies to the following SAMPLES, MS, MSD, BLANKS and STANDARDS:

Client ID	Lab Sample ID	File ID	Date Analyzed	Time Analyzed
.	Method_Blank	C2411.D	10/23/2006	12:51
.	LCS	C2412.D	10/23/2006	13:06
.	MS(11482-004)	C2413.D	10/23/2006	13:21
.	MSD(11482-004)	C2414.D	10/23/2006	13:36
B-3	11482-004	C2416.D	10/23/2006	14:07
B-6	11482-008	C2417.D	10/23/2006	14:22
B-7	11482-010	C2418.D	10/23/2006	14:37
B-8	11482-012	C2419.D	10/23/2006	14:52
B-9	11482-014	C2420.D	10/23/2006	15:08

SEMIVOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK

Lab File ID: C2832.D DFTPP Injection Date : 11/06/2006

Inst ID: MSDC DFTPP Injection Time: 10:06

m/z	Ion Abudance Criteria	%Relative Abundance			
51	30.0 - 60.0% of mass 198	31.6			
68	Less than 2.0% of mass 69	0.6	(	1.8	)1
69	Mass 69 relative abundance	33.0			
70	Less than 2.0% of mass 69	0.5	(	1.4	)1
127	40.0 - 60.0% of mass 198	47.1			
197	Less than 1.0% of mass 198	0.0			
198	Base peak, 100% relative abundance	100.0			
199	5.0 - 9.0% of mass 198	6.4			
275	10.0 - 30.0% of mass 198	26.6			
365	Greater than 1.0% of mass 198	3.6			
441	Present, but less than mass 443	13.90	(	76.4	)3
442	40.0 - 100.0% of mass 198	92.8			
443	17.0 - 23.0% of mass 442	18.2	(	19.6	)2

1-Value is % mass 69 2-Value is % mass 442 3-Value is % mass 443

This check applies to the following SAMPLES, MS, MSD, BLANKS and STANDARDS:

Client ID	Lab Sample ID	File ID	Date Analyzed	Time Analyzed
ABN080.06	50ngBNA_inj_FOR	C2833.D	11/06/2006	10:38
ABN086.06	50ngOLMO4_inj_F	C2834.D	11/06/2006	11:23
.	Method_Blank	C2844.D	11/06/2006	14:25
.	LCS	C2845.D	11/06/2006	14:41
.	MS(12112-001)	C2846.D	11/06/2006	14:56
.	MSD(12112-001)	C2847.D	11/06/2006	15:11
PE-1	12056-001	C2848.D	11/06/2006	15:26
VA-GP-3/3.5-	11886-003	C2849.D	11/06/2006	15:42
VA-GP-7/3.5-	11886-008	C2850.D	11/06/2006	15:57
261011_A	12112-001	C2851.D	11/06/2006	16:12
261489_A	12113-001	C2852.D	11/06/2006	16:27
HF-9/3-3.5	12027-004	C2853.D	11/06/2006	16:43
POND_SEDIM	12087-001	C2854.D	11/06/2006	16:58
S-2	12051-002	C2855.D	11/06/2006	17:13
SANITARY_LIN	11697-001	C2856.D	11/06/2006	17:43
SANITARY_LIN	11697-002	C2857.D	11/06/2006	17:58
SANITARY_LIN	11697-003	C2858.D	11/06/2006	18:13
SANITARY_LIN	11697-004	C2859.D	11/06/2006	18:28
SANITARY_LIN	11697-005	C2860.D	11/06/2006	18:44
SANITARY_LIN	11766-001	C2861.D	11/06/2006	18:59
SANITARY_LIN	11766-002	C2862.D	11/06/2006	19:14
VA-GP-7/3.5-	11886-008	C2863.D	11/06/2006	19:29
PE-1	12056-001	C2864.D	11/06/2006	19:59

SEMIVOLATILE METHOD BLANK SUMMARY

Lab File ID: C2844.D

Instrument ID: MSDC

Date Extracted: 11/06/06

Matrix: SOIL

Date Analyzed: 11/06/2006

Time Analyzed: 14:25

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS & MSD:

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed
.	LCS	11/06/2006	14:41
.	MS(12112-001)	11/06/2006	14:56
.	MSD(12112-001)	11/06/2006	15:11
PE-1	12056-001	11/06/2006	15:26
VA-GP-3/3.5-	11886-003	11/06/2006	15:42
VA-GP-7/3.5-	11886-008	11/06/2006	15:57
261011_A	12112-001	11/06/2006	16:12
261489_A	12113-001	11/06/2006	16:27
HF-9/3-3.5	12027-004	11/06/2006	16:43
POND_SEDIM	12087-001	11/06/2006	16:58
S-2	12051-002	11/06/2006	17:13
SANITARY_LIN	11697-001	11/06/2006	17:43
SANITARY_LIN	11697-002	11/06/2006	17:58
SANITARY_LIN	11697-003	11/06/2006	18:13
SANITARY_LIN	11697-004	11/06/2006	18:28
SANITARY_LIN	11697-005	11/06/2006	18:44
SANITARY_LIN	11766-001	11/06/2006	18:59
SANITARY_LIN	11766-002	11/06/2006	19:14
VA-GP-7/3.5-	11886-008	11/06/2006	19:29
PE-1	12056-001	11/06/2006	19:59

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS

Client/Project: N/A

Lab ID: Method_Blank
Client ID: .
Date Received: N/A
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Data file: C2844.D

GC/MS Column: DB-5
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
N-Nitrosodimethylamine	ND		0.033
Pyridine	ND		0.033
Benzaldehyde	ND		0.033
Phenol	ND		0.033
Aniline	ND		0.033
bis(2-Chloroethyl) ether	ND		0.033
2-Chlorophenol	ND		0.033
1,3-Dichlorobenzene	ND		0.033
1,4-Dichlorobenzene	ND		0.033
Benzyl alcohol	ND		0.033
1,2-Dichlorobenzene	ND		0.033
2-Methylphenol	ND		0.033
bis(2-chloroisopropyl) ether	ND		0.033
4-Methylphenol	ND		0.033
N-Nitrosodi-n-propylamine	ND		0.033
Acetophenone	ND		0.033
Hexachloroethane	ND		0.033
2,6-Dimethylphenol	ND		0.033
Nitrobenzene	ND		0.033
Isophorone	ND		0.033
2-Nitrophenol	ND		0.033
2,4+2,5-Dimethylphenol	ND		0.033
bis(2-Chloroethoxy)methane	ND		0.033
Benzoic acid	ND		0.033
2,4-Dichlorophenol	ND		0.033
1,2,4-Trichlorobenzene	ND		0.033
Naphthalene	ND		0.033
4-Chloroaniline	ND		0.033
Hexachlorobutadiene	ND		0.033
Caprolactam	ND		0.033
4-Chloro-3-methylphenol	ND		0.033
2-Methylnaphthalene	ND		0.033
3,5-Dimethylphenol	ND		0.033
Hexachlorocyclopentadiene	ND		0.033
2,4,6-Trichlorophenol	ND		0.033
2,4,5-Trichlorophenol	ND		0.033
Biphenyl	ND		0.033
2-Chloronaphthalene	ND		0.033
2-Nitroaniline	ND		0.033
Dimethyl phthalate	ND		0.033

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS

Client/Project: N/A

Lab ID: Method_Blank
Client ID: .
Date Received: N/A
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Data file: C2844.D

GC/MS Column: DB-5
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
2,6-Dinitrotoluene	ND		0.033
Acenaphthylene	ND		0.033
3-Nitroaniline	ND		0.033
Acenaphthene	ND		0.033
2,4-Dinitrophenol	ND		0.033
4-Nitrophenol	ND		0.033
2,4-Dinitrotoluene	ND		0.033
Dibenzofuran	ND		0.033
Diethyl phthalate	ND		0.033
Fluorene	ND		0.033
4-Chlorophenyl phenyl ether	ND		0.033
4-Nitroaniline	ND		0.033
1,2,4,5-Tetrachlorobenzene	ND		0.033
Hydroquinone	ND		0.033
4,6-Dinitro-2-methylphenol	ND		0.033
N-Nitrosodiphenylamine	ND		0.033
1,2-Diphenylhydrazine	ND		0.033
4-Bromophenyl phenyl ether	ND		0.033
Hexachlorobenzene	ND		0.033
Atrazine	ND		0.033
Pentachlorophenol	ND		0.033
Phenanthrene	ND		0.033
Anthracene	ND		0.033
Carbazole	ND		0.033
Di-n-butyl phthalate	ND		0.033
Fluoranthene	ND		0.033
Benzidine	ND		0.033
Pyrene	ND		0.033
3,3'-Dimethylbenzidine	ND		0.033
Butyl benzyl phthalate	ND		0.033
3,3'-Dichlorobenzidine	ND		0.033
Benzo[a]anthracene	ND		0.033
Chrysene	ND		0.033
bis(2-Ethylhexyl) phthalate	ND		0.033
Di-n-octyl phthalate	ND		0.033
Benzo[b]fluoranthene	ND		0.033
Benzo[k]fluoranthene	ND		0.033
Benzo[a]pyrene	ND		0.033
Indeno[1,2,3-cd]pyrene	ND		0.033
Dibenz[a,h]anthracene	ND		0.033
Benzo[g,h,i]perylene	ND		0.033

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

SEMIVOLATILE ORGANICS
Tentatively Identified Compounds

Client/Project: N/A

Lab ID: Method_Blank
Client ID: .
Date Received: N/A
Date Extracted: 11/06/2006
Date Analyzed: 11/06/2006
Data file: C2844.D

GC/MS Column: DB-5
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

Response Factor Report MSD_C

Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 09:43:17 2006
Response via : Initial Calibration

Calibration Files
120 =C2391.D 160 =C2392.D 20 =C2388.D
50 =C2389.D 80 =C2390.D

		Compound	120	160	20	50	80	Avg	%RSD
1)	I	1,4-Dichlorobenzene-d	ISTD						
2)	T	N-Nitrosodimethylam	0.677	0.640	0.671	0.636	0.615	0.648	4.00
3)	T	Pyridine	0.831	0.858	0.770	0.771	0.808	0.808	4.77
4)	S	2-Fluorophenol	1.338	0.969	1.385	1.327	1.062	1.216	15.40
5)	T	Benzaldehyde	1.041	0.929	0.584	0.627	0.605	0.757	28.05
6)	S	Phenol-d5	1.801	1.386	1.846	1.727	1.429	1.638	13.13
7)	MC	Phenol	1.472	1.527	1.497	1.548	1.511	1.511	1.90
8)	T	Aniline	0.742	0.721	0.695	0.669	0.664	0.698	4.81
9)	T	bis(2-Chloroethyl)	0.926	0.901	0.867	0.897	0.922	0.903	2.60
10)	M	2-Chlorophenol	1.243	1.250	1.078	1.047	1.142	1.152	8.06
11)	T	1,3-Dichlorobenzene	1.489	1.551	1.174	1.218	1.447	1.376	12.30
12)	MC	1,4-Dichlorobenzene	1.265	1.335	1.282	1.286	1.238	1.281	2.77
13)	T	Benzyl alcohol	0.722	0.794	0.677	0.718	0.703	0.723	6.04
14)	T	1,2-Dichlorobenzene	1.269	1.342	1.163	1.155	1.211	1.228	6.40
15)	T	2-Methylphenol	1.117	1.122	1.003	1.038	1.067	1.069	4.76
16)	T	bis(2-chloroisoprop	1.524	1.483	1.452	1.406	1.503	1.473	3.13
17)	T	4-Methylphenol	1.147	1.284	1.108	1.074	1.148	1.152	6.94
18)	MP	N-Nitrosodi-n-propy	1.042	0.942	0.913	0.967	0.967	0.966	4.97
19)	T	Acetophenone	1.872	1.823	1.629	1.744	1.778	1.769	5.20
20)	T	2-Aminotoluene +4-A	2.418	2.509	2.323	2.172	2.097	2.304	7.37
21)	T	Hexachloroethane	0.533	0.536	0.516	0.499	0.519	0.521	2.84
22)	T	2,6-Dimethylphenol	1.285	1.235	0.648	0.687	0.720	0.915	34.59
23)	I	Naphthalene-d8	ISTD						
24)	S	Nitrobenzene-d5	0.412	0.507	0.372	0.382	0.471	0.429	13.58
25)	T	Nitrobenzene	0.308	0.326	0.310	0.317	0.310	0.314	2.42
26)	T	Isophorone	0.535	0.525	0.518	0.515	0.548	0.528	2.53
27)	TC	2-Nitrophenol	0.156	0.167	0.158	0.151	0.154	0.157	3.81
28)	T	2,4+2,5-Dimethylphe	0.304	0.321	0.270	0.278	0.291	0.293	7.08
29)	T	bis(2-Chloroethoxy)	0.354	0.344	0.329	0.332	0.370	0.346	4.80
30)	T	Benzoic acid	0.161	0.167	0.128	0.153	0.145	0.151	10.00
31)	T	2,4-Dimethylaniline	0.323	0.319	0.306	0.291	0.273	0.303	6.84
32)	TC	2,4-Dichlorophenol	0.243	0.257	0.221	0.222	0.236	0.236	6.41
33)	M	1,2,4-Trichlorobenz	0.263	0.259	0.238	0.243	0.261	0.253	4.48
34)	T	Naphthalene	1.016	1.094	0.959	0.935	0.987	0.998	6.17
35)	T	4-Chloroaniline	0.561	0.576	0.482	0.504	0.532	0.531	7.29
36)	T	4-Aminoaniline						0.000	-1.00
37)	TC	Hexachlorobutadiene	0.133	0.137	0.126	0.129	0.133	0.132	3.16
38)	T	Caprolactam	0.126	0.124	0.125	0.125	0.125	0.125	0.64
39)		2-Aminoaniline						0.000	-1.00
40)	MC	4-Chloro-3-methylph	0.258	0.267	0.238	0.250	0.259	0.254	4.28
41)	T	2-Methylnaphthalene	0.691	0.743	0.579	0.587	0.675	0.655	10.76
42)	T	3,5-Dimethylphenol	0.289	0.293	0.174	0.187	0.195	0.228	25.71
43)	I	Acenaphthene-d10	ISTD						
44)	TP	Hexachlorocyclopent	0.282	0.313	0.245	0.249	0.274	0.273	10.12
45)	TC	2,4,6-Trichlorophen	0.257	0.278	0.223	0.221	0.253	0.246	9.86
46)	T	2,4,5-Trichlorophen	0.284	0.302	0.263	0.251	0.280	0.276	7.03
47)	S	2-Fluorobiphenyl	0.886	1.099	1.038	1.012	1.113	1.029	8.80

48)	T	Biphenyl	1.340	1.320	1.105	1.080	1.279	1.225	10.04
49)	T	2-Chloronaphthalene	0.886	0.967	0.796	0.785	0.872	0.861	8.62
50)	T	2-Nitroaniline	0.266	0.289	0.274	0.289	0.271	0.278	3.78
51)	T	Dimethyl phthalate	0.947	0.995	0.892	0.856	0.918	0.922	5.76
52)	T	2,6-Dinitrotoluene	0.214	0.214	0.195	0.191	0.217	0.206	5.82
53)	T	Acenaphthylene	1.465	1.633	1.400	1.402	1.449	1.470	6.49
54)	T	3-Nitroaniline	0.233	0.271	0.236	0.246	0.235	0.244	6.35
55)	MC	Acenaphthene	0.930	0.942	0.822	0.874	0.934	0.901	5.72
56)	TP	2,4-Dinitrophenol	0.173	0.240	0.230	0.170	0.182	0.199	16.66
57)	MP	4-Nitrophenol	0.213	0.213	0.202	0.221	0.223	0.215	3.96
58)	M	2,4-Dinitrotoluene	0.251	0.279	0.251	0.252	0.263	0.259	4.70
59)	T	Dibenzofuran	1.280	1.452	1.134	1.239	1.256	1.272	9.05
60)	T	Diethyl phthalate	0.954	1.049	0.885	0.891	0.967	0.949	7.01
61)	T	Fluorene	1.129	1.213	0.933	0.923	1.112	1.062	12.09
62)	T	4-Chlorophenyl phen	0.449	0.452	0.366	0.422	0.485	0.435	10.28
63)	T	4-Nitroaniline	0.296	0.289	0.244	0.264	0.307	0.280	9.11
64)	t	1,2,4,5-Tetrachloro	0.437	0.478	0.375	0.395	0.428	0.423	9.42
65)	T	Hydroquinone	0.572	0.532	0.335	0.364	0.348	0.430	26.20
66)	I	Phenanthrene-d10	----------ISTD----------						
67)	T	4,6-Dinitro-2-methy	0.116	0.127	0.088	0.099	0.111	0.108	13.95
68)	TC	N-Nitrosodiphenylam	0.473	0.516	0.388	0.399	0.461	0.448	11.93
69)	T	1,2-Diphenylhydrazi	0.745	0.769	0.684	0.709	0.712	0.724	4.59
70)	S	2,4,6-Tribromopheno	0.111	0.087	0.130	0.121	0.088	0.107	17.92
71)	T	4-Bromophenyl pheny	0.178	0.199	0.148	0.158	0.164	0.169	11.77
72)	T	Hexachlorobenzene	0.207	0.215	0.152	0.157	0.192	0.185	15.68
73)	T	Atrazine	0.156	0.159	0.127	0.113	0.086	0.128	23.97
74)	MC	Pentachlorophenol	0.108	0.118	0.084	0.091	0.104	0.101	13.65
75)	T	Phenanthrene	1.013	1.016	0.784	0.811	0.963	0.917	12.18
76)	T	Anthracene	0.993	1.077	0.801	0.863	0.929	0.933	11.60
77)	T	Carbazole	0.903	0.893	0.757	0.750	0.876	0.836	9.04
78)	T	Di-n-butyl phthalat	1.084	1.125	0.926	0.954	1.083	1.034	8.56
79)	TC	Fluoranthene	0.902	0.964	0.722	0.766	0.853	0.841	11.67
80)	T	Benzidine	0.407	0.400	0.235	0.226	0.210	0.296	33.49
81)		ISTD4x						0.000	-1.00
82)	I	Chrysene-d12	----------ISTD----------						
83)	M	Pyrene	1.287	1.360	1.082	1.164	1.291	1.237	9.04
84)	S	Terphenyl-d14	0.804	0.975	0.869	0.894	1.061	0.921	10.82
85)	T	3,3'-Dimethylbenzid	0.463	0.450	0.259	0.255	0.255	0.336	32.58
86)	T	Butyl benzyl phthal	0.451	0.473	0.417	0.411	0.454	0.441	5.99
87)	T	3,3'-Dichlorobenzid	0.215	0.222	0.301	0.251	0.218	0.241	15.01
88)	T	Benzo[a]anthracene	0.939	0.969	0.836	0.842	0.906	0.899	6.54
89)	T	Chrysene	0.904	0.951	0.789	0.802	0.869	0.863	7.91
90)	T	bis(2-Ethylhexyl) p	0.698	0.746	0.626	0.651	0.726	0.690	7.29
91)		ISTD5X						0.000	-1.00
92)	I	Perylene-d12	----------ISTD----------						
93)	TC	Di-n-octyl phthalat	1.383	1.392	1.363	1.409	1.492	1.408	3.55
94)	T	Benzo[b]fluoranthen	1.029	1.131	0.917	0.972	1.030	1.016	7.86
95)	T	Benzo[k]fluoranthen	1.132	1.052	0.991	0.988	1.074	1.047	5.78
96)	TC	Benzo[a]pyrene	0.975	0.994	0.867	0.885	0.929	0.930	5.89
97)	T	Indeno[1,2,3-cd]pyr	1.051	1.086	0.887	0.921	1.043	0.997	8.80
98)	T	Dibenz[a,h]anthrace	0.918	0.927	0.766	0.811	0.904	0.865	8.36
99)	T	Benzo[g,h,i]perylen	0.839	0.852	0.741	0.751	0.814	0.799	6.35

(#) = Out of Range

CS1806.M Mon Oct 23 09:43:25 2006 MSD_C

Instrument ID: MSD_C
Method ID: 1\METHODS\CS1806.M
Date: 10/23/2006

Average %RSD = 8.94

Refer to SW846 Method 8000B Section 7.5.1.

Evaluate Continuing Calibration Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2833.D
Acq On : 6 Nov 2006 10:38
Sample : ABN080.06,50ngBNA_inj_FOR_11/06/06
Misc : N/A,N/A,N/A,1
MS Integration Params: rteint.p

Vial: 97
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 21:33:50 2006
Response via : Multiple Level Calibration

		Compound	AvgRF	CCRF	%Dev	Area%	Dev(min)
1	I	1,4-Dichlorobenzene-d4	1.000	1.000	0.0	117	-0.04
2	T	N-Nitrosodimethylamine	0.648	0.611	5.7	112	-0.04
3	T	Pyridine	0.808	0.729	9.8	111	-0.04
4	S	2-Fluorophenol	1.216	1.202	1.2	106	-0.04
5	T	Benzaldehyde	0.757	0.900	-18.9	130	-0.04
6	S	Phenol-d5	1.638	1.652	-0.9	112	-0.03
7	MC	Phenol	1.511	1.419	6.1	107	-0.04
8	T	Aniline	0.698	0.588	15.8	103	-0.04
9	T	bis(2-Chloroethyl) ether	0.903	0.806	10.7	105	-0.04
10	M	2-Chlorophenol	1.152	1.136	1.4	127	-0.04
11	T	1,3-Dichlorobenzene	1.376	1.240	9.9	119	-0.04
12	MC	1,4-Dichlorobenzene	1.281	1.288	-0.5	117	-0.04
13	T	Benzyl alcohol	0.723	0.707	2.2	115	-0.04
14	T	1,2-Dichlorobenzene	1.228	1.213	1.2	123	-0.05
15	T	2-Methylphenol	1.069	1.063	0.6	120	-0.04
16	T	bis(2-chloroisopropyl) ethe	1.473	1.389	5.7	115	-0.04
17	T	4-Methylphenol	1.152	1.108	3.8	120	-0.04
18	MP	N-Nitrosodi-n-propylamine	0.966	0.890	7.9	107	-0.05
19	T	Acetophenone	1.769	1.653	6.6	111	-0.05
20	T	2-Aminotoluene +4-Aminotolu	2.304	1.954	15.2	105	-0.04
21	T	Hexachloroethane	0.521	0.469	10.0	110	-0.05
22	T	2,6-Dimethylphenol	0.915	1.251	-36.7	165	-0.04
23	I	Naphthalene-d8	1.000	1.000	0.0	116	-0.05
24	S	Nitrobenzene-d5	0.429	0.363	15.4	110	-0.05
25	T	Nitrobenzene	0.314	0.310	1.3	114	-0.05
26	T	Isophorone	0.528	0.502	4.9	113	-0.05
27	TC	2-Nitrophenol	0.157	0.153	2.5	118	-0.05
28	T	2,4+2,5-Dimethylphenol	0.293	0.279	4.8	117	-0.04
29	T	bis(2-Chloroethoxy)methane	0.346	0.338	2.3	118	-0.04
30	T	Benzoic acid	0.151	0.153	-1.3	116	-0.05
31	T	2,4-Dimethylaniline	0.303	0.237	21.8	94	-0.05
32	TC	2,4-Dichlorophenol	0.236	0.238	-0.8	125	-0.04
33	M	1,2,4-Trichlorobenzene	0.253	0.254	-0.4	121	-0.04
34	T	Naphthalene	0.998	0.911	8.7	113	-0.05
35	T	4-Chloroaniline	0.531	0.421	20.7	97	-0.04
36	T	4-Aminoaniline	0.000	0.000	0.0	119	-0.04
37	TC	Hexachlorobutadiene	0.132	0.136	-3.0	122	-0.04
38	T	Caprolactam	0.125	0.118	5.6	110	-0.05
39		2-Aminoaniline	0.000	0.000	0.0	117	-0.05
40	MC	4-Chloro-3-methylphenol	0.254	0.242	4.7	112	-0.04
41	T	2-Methylnaphthalene	0.655	0.570	13.0	113	-0.05
42	T	3,5-Dimethylphenol	0.228	0.279	-22.4	174	-0.09
43	I	Acenaphthene-d10	1.000	1.000	0.0	114	-0.04
44	TP	Hexachlorocyclopentadiene	0.273	0.204	25.3	93	-0.04

45	TC	2,4,6-Trichlorophenol	0.246	0.245	0.4	126	-0.04
46	T	2,4,5-Trichlorophenol	0.276	0.280	-1.4	127	-0.04
47	S	2-Fluorobiphenyl	1.029	1.153	-12.1	129	-0.04
48	T	Biphenyl	1.225	1.136	7.3	120	-0.05
49	T	2-Chloronaphthalene	0.861	0.792	8.0	115	-0.05
50	T	2-Nitroaniline	0.278	0.250	10.1	98	-0.05
51	T	Dimethyl phthalate	0.922	0.873	5.3	116	-0.05
52	T	2,6-Dinitrotoluene	0.206	0.206	0.0	122	-0.04
53	T	Acenaphthylene	1.470	1.405	4.4	114	-0.05
54	T	3-Nitroaniline	0.244	0.201	17.6	93	-0.05
55	MC	Acenaphthene	0.901	0.890	1.2	116	-0.04
56	TP	2,4-Dinitrophenol	0.199	0.177	11.1	118	-0.04
57	MP	4-Nitrophenol	0.215	0.157	27.0	81	-0.04
58	M	2,4-Dinitrotoluene	0.259	0.260	-0.4	117	-0.04
59	T	Dibenzofuran	1.272	1.226	3.6	112	-0.05
60	T	Diethyl phthalate	0.949	0.888	6.4	113	-0.05
61	T	Fluorene	1.062	0.947	10.8	117	-0.05
62	T	4-Chlorophenyl phenyl ether	0.435	0.429	1.4	115	-0.04
63	T	4-Nitroaniline	0.280	0.208	25.7	90	-0.05
64	t	1,2,4,5-Tetrachlorobenzene	0.423	0.418	1.2	120	-0.04
65	T	Hydroquinone	0.430	0.515	-19.8	121	-0.04
66	I	Phenanthrene-d10	1.000	1.000	0.0	109	-0.05
67	T	4,6-Dinitro-2-methylphenol	0.108	0.093	13.9	102	-0.04
68	TC	N-Nitrosodiphenylamine	0.448	0.458	-2.2	125	-0.04
69	T	1,2-Diphenylhydrazine	0.724	0.686	5.2	105	-0.04
70	S	2,4,6-Tribromophenol	0.107	0.132	-23.4	119	-0.04
71	T	4-Bromophenyl phenyl ether	0.169	0.165	2.4	114	-0.04
72	T	Hexachlorobenzene	0.185	0.188	-1.6	131	-0.05
73	T	Atrazine	0.128	0.109	14.8	105	-0.05
74	MC	Pentachlorophenol	0.101	0.084	16.8	100	-0.05
75	T	Phenanthrene	0.917	0.810	11.7	109	-0.05
76	T	Anthracene	0.933	0.853	8.6	108	-0.05
77	T	Carbazole	0.836	0.768	8.1	111	-0.05
78	T	Di-n-butyl phthalate	1.034	0.954	7.7	109	-0.05
79	TC	Fluoranthene	0.841	0.727	13.6	103	-0.06
80	T	Benzidine	0.296	0.291	1.7	141	-0.05
81		ISTD4x	0.000	0.000	0.0	0	0.00
82	I	Chrysene-d12	1.000	1.000	0.0	95	-0.05
83	M	Pyrene	1.237	1.233	0.3	101	-0.06
84	S	Terphenyl-d14	0.921	0.991	-7.6	105	-0.06
85	T	3,3'-Dimethylbenzidine	0.336	0.349	-3.9	137	-0.07
86	T	Butyl benzyl phthalate	0.441	0.479	-8.6	111	-0.08
87	T	3,3'-Dichlorobenzidine	0.241	0.227	5.8	86	-0.06
88	T	Benzo[a]anthracene	0.899	0.831	7.6	94	-0.05
89	T	Chrysene	0.863	0.783	9.3	93	-0.06
90	T	bis(2-Ethylhexyl) phthalate	0.690	0.705	-2.2	103	-0.06
91		ISTD5X	0.000	0.000	0.0	0	0.00
92	I	Perylene-d12	1.000	1.000	0.0	96	-0.11
93	TC	Di-n-octyl phthalate	1.408	1.518	-7.8	103	-0.09
94	T	Benzo[b]fluoranthene	1.016	0.916	9.8	90	-0.10
95	T	Benzo[k]fluoranthene	1.047	1.006	3.9	98	-0.10
96	TC	Benzo[a]pyrene	0.930	0.878	5.6	95	-0.11
97	T	Indeno[1,2,3-cd]pyrene	0.997	0.898	9.9	93	-0.19
98	T	Dibenz[a,h]anthracene	0.865	0.783	9.5	93	-0.19
99	T	Benzo[g,h,i]perylene	0.799	0.713	10.8	91	-0.19

(#) = Out of Range SPCC's out = 0 CCC's out = 0

C2389.D CS1806.M Mon Nov 06 10:52:39 2006 MSD_C

SEMIVOLATILE SURROGATE PERCENT RECOVERY SUMMARY

Date Analyzed: 11/06/2006

Lab Sample ID	Matrix	File ID	S1	S2	S3	S4	S5	S6
50ngOLMO4_inj_FO		C2834.D	N/A	N/A	N/A	N/A	N/A	N/A
Method_Blank	SOIL	C2844.D	81	89	54	94	104	84
LCS	SOIL	C2845.D	64	71	55	89	120	88
MS(12112-001)	SOIL	C2846.D	88	96	71	121	117	89
MSD(12112-001)	SOIL	C2847.D	97	106	66	126	126	89
11886-003	SOIL	C2849.D	N/A	N/A	55	95	N/A	81
11886-008	SOIL	C2850.D	N/A	N/A	54	90	N/A	63
12112-001	SOIL	C2851.D	N/A	N/A	70	116	N/A	106
12113-001	SOIL	C2852.D	N/A	N/A	58	102	N/A	95
12027-004	SOIL	C2853.D	N/A	N/A	45	76	N/A	82
12087-001	SOIL	C2854.D	69	83	47	79	98	74
12051-002	SOIL	C2855.D	71	72	38	70	54	78
11697-001	SOIL	C2856.D	61	69	42	72	80	75
11697-002	SOIL	C2857.D	69	74	46	82	108	78
11697-003	SOIL	C2858.D	59	69	42	73	80	73
11697-004	SOIL	C2859.D	61	67	46	82	95	79
11697-005	SOIL	C2860.D	58	73	43	77	86	73
11766-001	SOIL	C2861.D	63	73	34	60	98	68
11766-002	SOIL	C2862.D	60	72	43	72	83	76
11886-008	SOIL	C2863.D	N/A	N/A	49	89	N/A	50
12056-001	SOIL	C2864.D	78	85	50	84	126	86

	Aqueous	Soil
S1 (2FP) = 2-Fluorophenol	11-101	28-108
S2 (PHL) = Phenol-d5	10-101	34-107
S3 (NBZ) = Nitrobenzene-d5	29-101	26-104
S4 (FBP) = 2-Fluorobiphenyl	34-98	32-128
S5 (TBP) = 2,4,6-Tribromophenol	28-113	35-126
S6 (TPH) = Terphenyl-d14	39-121	32-135

* Column to be used to flag recovery values

SOIL SEMIVOLATILE MATRIX SPIKE/SPIKE DUPLICATE RECOVERY

Matrix spike Lab sample ID: 12112-001 Batch No.: C110606S

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
Phenol	100.0	0.0	81.8	82	46 - 98
2-Chlorophenol	100.0	0.0	84.7	85	42 - 96
1,4-Dichlorobenzene	50.0	0.0	45.1	90	35 - 119
N-Nitrosodi-n-propylamine	50.0	0.0	48.2	96	42 - 122
1,2,4-Trichlorobenzene	50.0	0.0	46.4	93	34 - 121
4-Chloro-3-methylphenol	100.0	0.0	97.5	98	53 - 103
Acenaphthene	50.0	1.4	60.6	118	32 - 120
4-Nitrophenol	100.0	0.0	73.6	74	56 - 122
2,4-Dinitrotoluene	50.0	0.0	47.5	95	40 - 141
Pentachlorophenol	100.0	0.0	96.4	96	38 - 124
Pyrene	50.0	9.9	58.6	97	27 - 150

Compound	SAMPLE CONC. (ug/Kg)	MSD CONC. (ug/Kg)	MSD % # REC	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Phenol	0.0	85.1	85	4	12	46 - 98
2-Chlorophenol	0.0	91.9	92	8	12	42 - 96
1,4-Dichlorobenzene	0.0	52.0	104	14	17	35 - 119
N-Nitrosodi-n-propylamine	0.0	56.1	112	15	16	42 - 122
1,2,4-Trichlorobenzene	0.0	51.5	103	10	17	34 - 121
4-Chloro-3-methylphenol	0.0	103.3	103	5	13	53 - 103
Acenaphthene	1.4	59.7	117	1	17	32 - 120
4-Nitrophenol	0.0	74.9	75	1	16	56 - 122
2,4-Dinitrotoluene	0.0	55.8	112	16	20	40 - 141
Pentachlorophenol	0.0	94.6	95	1	15	38 - 124
Pyrene	9.9	64.2	109	12	21	27 - 150

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

RPD: __0___ out of __11__ outside limits

Spike Recovery: __0___ out of __22__ outside limits

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2391.D

Date Analyzed: 10/23/2006

Instrument ID: MSDC

Time Analyzed: 07:48

	40UG/L	IS1 AREA #	RT #	IS2 AREA #	RT #	IS3 AREA #	RT #
	12 HOUR STD	96526	2.47	394736	3.02	253677	3.78
	UPPER LIMIT	193052	2.97	789472	3.52	507354	4.28
	LOWER LIMIT	48263	1.97	197368	2.52	126839	3.28
	LAB SAMPLE ID						
01	20ngBNA_inj_FOR_1	152095	2.47	603592	3.01	384984	3.78
02	50ngBNA_inj_FOR_1	133172	2.47	541890	3.01	350287	3.78
03	80ngBNA_inj_FOR_1	132589	2.47	529188	3.02	348426	3.78
04	160ngBNA_inj_FOR_	98117	2.47	404243	3.02	255280	3.78
05	160ngOLMO4_inj_FO	109284	2.47	426067	3.01	245457	3.78
06	120ngOLMO4_inj_FO	112028	2.47	426570	3.01	239734	3.78
07	80ngOLMO4_inj_FOR	96005	2.47	369222	3.01	199076	3.78
08	50ngOLMO4_inj_FOR	97671	2.47	374418	3.01	202766	3.78
09	20ngOLMO4_inj_FOR	108402	2.47	388857	3.01	194462	3.78
10	Method_Blank	104070	2.47	387262	3.01	207066	3.78
11	LCS	127259	2.47	472531	3.02	267571	3.78
12	11297-001	118450	2.47	459678	3.01	242219	3.78
13	11297-002	184102	2.47	705413	3.01	400902	3.78
14	11297-003	101134	2.47	426665	3.01	251901	3.78
15	11297-004	72863	2.47	309857	3.01	182986	3.78
16	11297-005	92538	2.47	366182	3.01	207794	3.78
17	11369-004	70653	2.47	298538	3.01	175594	3.78
18	11370-001	106825	2.47	428156	3.01	239508	3.78
19	11370-005	79213	2.47	318196	3.01	188027	3.78
20	11402-002	132927	2.47	519188	3.01	331351	3.78
21	11496-002	73884	2.47	309201	3.01	177673	3.78
22	11496-004	79304	2.47	333461	3.01	209014	3.78

IS1 = 1,4-Dichlorobenzene-d4

IS2 = Naphthalene-d8

IS3 = Acenaphthene-d10

AREA UPPER LIMIT = +100% of internal standard area

AREA LOWER LIMIT = -50% of internal standard area

RT UPPER LIMIT = +0.50 minutes of internal standard RT

RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk

* Values outside of QC limits.

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2391.D

Date Analyzed: 10/23/2006

Instrument ID: MSDC

Time Analyzed: 07:48

	40UG/L	IS4 AREA	#	RT	#	IS5 AREA	#	RT	#	IS6 AREA	#	RT	#
	12 HOUR STD	362751		4.44		266772		6.21		196689		7.59	
	UPPER LIMIT	725502		4.94		533544		6.71		393378		8.09	
	LOWER LIMIT	181376		3.94		133386		5.71		98345		7.09	
	LAB SAMPLE ID												
01	20ngBNA_inj_FOR_1	603436		4.44		412601		6.21		297346		7.59	
02	50ngBNA_inj_FOR_1	555928		4.44		376601		6.21		261921		7.59	
03	80ngBNA_inj_FOR_1	547176		4.44		368313		6.21		252216		7.59	
04	160ngBNA_inj_FOR_	355975		4.44		251587		6.21		194795		7.60	
05	160ngOLMO4_inj_FO	375335		4.44		267504		6.21		216730		7.58	
06	120ngOLMO4_inj_FO	383127		4.44		265082		6.20		207072		7.59	
07	80ngOLMO4_inj_FOR	319039		4.44		227082		6.21		177506		7.58	
08	50ngOLMO4_inj_FOR	335182		4.44		228885		6.21		164917		7.58	
09	20ngOLMO4_inj_FOR	321500		4.44		226268		6.20		165682		7.59	
10	Method_Blank	365356		4.44		259074		6.20		198918		7.59	
11	LCS	470082		4.44		354354		6.21		229608		7.59	
12	11297-001	416959		4.44		295534		6.21		242699		7.59	
13	11297-002	634741		4.44		430750		6.21		351305		7.60	
14	11297-003	431743		4.44		291272		6.21		240624		7.59	
15	11297-004	333899		4.44		227092		6.21		183061		7.58	
16	11297-005	344264		4.44		228085		6.21		203296		7.59	
17	11369-004	320478		4.44		226236		6.21		169534		7.59	
18	11370-001	452801		4.44		312031		6.21		234077		7.60	
19	11370-005	338696		4.44		244784		6.21		173871		7.59	
20	11402-002	560379		4.44		376970		6.21		279640		7.60	
21	11496-002	309494		4.44		199726		6.21		156958		7.59	
22	11496-004	396554		4.44		258719		6.21		199660		7.59	

IS4 = Phenanthrene-d10
IS5 = Chrysene-d12
IS6 = Perylene-d12

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = -50% of internal standard area
RT UPPER LIMIT = +0.50 minutes of internal standard RT
RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk
* Values outside of QC limits.

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2391.D

Date Analyzed: 10/23/2006

Instrument ID: MSDC

Time Analyzed: 07:48

	40UG/L	IS1 AREA #	RT #	IS2 AREA #	RT #	IS3 AREA #	RT #
	12 HOUR STD	96526	2.47	394736	3.02	253677	3.78
	UPPER LIMIT	193052	2.97	789472	3.52	507354	4.28
	LOWER LIMIT	48263	1.97	197368	2.52	126839	3.28
	LAB SAMPLE ID						
01	Method_Blank	77619	2.47	310127	3.01	180656	3.78
02	LCS	113892	2.47	456035	3.02	246666	3.78
03	MS(11482-004)	92397	2.47	365401	3.01	222801	3.78
04	MSD(11482-004)	74890	2.47	310385	3.01	192705	3.78
05	11482-004	50285	2.47	213446	3.01	127068	3.78
06	11482-008	84423	2.47	329773	3.01	199399	3.78
07	11482-010	72624	2.47	307240	3.01	179158	3.78
08	11482-012	56508	2.47	238565	3.01	133993	3.78
09	11482-014	65186	2.47	258482	3.01	146201	3.78
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22							

IS1 = 1,4-Dichlorobenzene-d4

IS2 = Naphthalene-d8

IS3 = Acenaphthene-d10

AREA UPPER LIMIT = +100% of internal standard area

AREA LOWER LIMIT = -50% of internal standard area

RT UPPER LIMIT = +0.50 minutes of internal standard RT

RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk

* Values outside of QC limits.

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2391.D

Date Analyzed: 10/23/2006

Instrument ID: MSDC

Time Analyzed: 07:48

	50UG/L	IS4 AREA #	RT #	IS5 AREA #	RT #	IS6 AREA #	RT #
	12 HOUR STD	362751	4.44	266772	6.21	196689	7.59
	UPPER LIMIT	725502	4.94	533544	6.71	393378	8.09
	LOWER LIMIT	181376	3.94	133386	5.71	98345	7.09
	LAB SAMPLE ID						
01	Method_Blank	312028	4.44	214033	6.21	166501	7.59
02	LCS	433428	4.44	292146	6.21	209244	7.59
03	MS(11482-004)	393136	4.44	258466	6.21	203570	7.59
04	MSD(11482-004)	363424	4.44	238897	6.21	185050	7.59
05	11482-004	245311	4.44	158758	6.21	120941	7.59
06	11482-008	359823	4.44	244637	6.21	185939	7.59
07	11482-010	315496	4.44	208161	6.21	168236	7.59
08	11482-012	242261	4.44	152996	6.21	126287	7.59
09	11482-014	274544	4.44	177764	6.21	145831	7.59
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IS4 = Phenanthrene-d10

IS5 = Chrysene-d12

IS6 = Perylene-d12

AREA UPPER LIMIT = +100% of internal standard area

AREA LOWER LIMIT = -50% of internal standard area

RT UPPER LIMIT = +0.50 minutes of internal standard RT

RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk

* Values outside of QC limits.

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2833.D

Date Analyzed: 11/06/2006

Instrument ID: MSDC

Time Analyzed: 10:38

	40UG/L	IS1 AREA	#	RT	#	IS2 AREA	#	RT	#	IS3 AREA	#	RT	#
	12 HOUR STD	155577		2.43		629550		2.97		398174		3.74	
	UPPER LIMIT	311154		2.93		1259100		3.47		796348		4.24	
	LOWER LIMIT	77789		1.93		314775		2.47		199087		3.24	
	LAB SAMPLE ID												
01	50ngOLMO4_inj_FOR	120660		2.43		515529		2.97		283966		3.74	
02	Method_Blank	102259		2.43		424274		2.97		221622		3.73	
03	LCS	105392		2.43		434940		2.97		226626		3.74	
04	MS(12112-001)	105233		2.43		515301		2.98		275298		3.74	
05	MSD(12112-001)	100487		2.43		510174		2.98		277337		3.73	
06	12056-001	108456		2.43		520936		2.97		278960		3.74	
07	11886-003	122838		2.43		491526		2.97		261332		3.73	
08	11886-008	113116		2.43		451712		2.97		231321		3.73	
09	12112-001	160212		2.43		754296		2.98		434996		3.74	
10	12113-001	126333		2.43		481965		2.97		253625		3.73	
11	12027-004	165196		2.43		691926		2.97		402722		3.74	
12	12087-001	89326		2.43		402729		2.97		241366		3.73	
13	12051-002	132261		2.43		565625		2.98		352411		3.74	
14	11697-001	123959		2.43		532729		2.97		304513		3.73	
15	11697-002	159650		2.43		613481		2.97		332289		3.74	
16	11697-003	107825		2.43		462304		2.97		260628		3.73	
17	11697-004	172229		2.43		685638		2.97		386091		3.73	
18	11697-005	81354		2.43		374471		2.97		231685		3.73	
19	11766-001	109900		2.43		476206		2.97		266435		3.74	
20	11766-002	82552		2.43		359245		2.97		224660		3.73	
21	11886-008	140114		2.43		540527		2.97		275180		3.74	
22	12056-001	107667		2.43		527495		2.97		344963		3.73	

IS1 = 1,4-Dichlorobenzene-d4

IS2 = Naphthalene-d8

IS3 = Acenaphthene-d10

AREA UPPER LIMIT = +100% of internal standard area

AREA LOWER LIMIT = -50% of internal standard area

RT UPPER LIMIT = +0.50 minutes of internal standard RT

RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk

* Values outside of QC limits.

SEMIVOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab File ID (Standard): C2833.D

Date Analyzed: 11/06/2006

Instrument ID: MSDC

Time Analyzed: 10:38

	40UG/L	IS4 AREA #	RT #	IS5 AREA #	RT #	IS6 AREA #	RT #
	12 HOUR STD	604917	4.39	357348	6.16	251032	7.49
	UPPER LIMIT	1209834	4.89	714696	6.66	502064	7.99
	LOWER LIMIT	302459	3.89	178674	5.66	125516	6.99
	LAB SAMPLE ID						
01	50ngOLMO4_inj_FOR	554676	4.39	369267	6.15	271878	7.49
02	Method_Blank	343774	4.39	239968	6.15	196117	7.48
03	LCS	357175	4.39	253980	6.15	194741	7.49
04	MS(12112-001)	373033	4.39	256611	6.15	214167	7.49
05	MSD(12112-001)	359299	4.39	234736	6.15	197586	7.48
06	12056-001	399424	4.39	267490	6.15	228413	7.48
07	11886-003	429119	4.39	271325	6.15	222768	7.49
08	11886-008	368027	4.39	309859	6.16	259493	7.51
09	12112-001	572914	4.39	325599	6.15	238566	7.49
10	12113-001	421625	4.39	271051	6.15	227858	7.49
11	12027-004	696621	4.39	374018	6.15	290180	7.49
12	12087-001	479538	4.39	334278	6.15	249003	7.49
13	12051-002	712484	4.40	518160	6.17	378593	7.53
14	11697-001	567837	4.39	339907	6.16	249853	7.50
15	11697-002	525673	4.39	331473	6.16	267057	7.49
16	11697-003	485307	4.39	312006	6.15	219132	7.49
17	11697-004	625757	4.39	355399	6.15	274294	7.49
18	11697-005	476225	4.39	347919	6.15	248677	7.49
19	11766-001	490909	4.39	314499	6.15	228162	7.49
20	11766-002	455589	4.39	335930	6.15	231582	7.49
21	11886-008	472372	4.39	602392	6.17	442296	7.55
22	12056-001	576467	4.39	356691	6.15	264663	7.50

IS4 = Phenanthrene-d10

IS5 = Chrysene-d12

IS6 = Perylene-d12

AREA UPPER LIMIT = +100% of internal standard area

AREA LOWER LIMIT = -50% of internal standard area

RT UPPER LIMIT = +0.50 minutes of internal standard RT

RT LOWER LIMIT = -0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk

* Values outside of QC limits.

Quantitation Report (QT Reviewed)

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D Vial: 18
Acq On : 6 Nov 2006 16:58 Operator: EDM
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0 Inst : MSD_C
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
MS Integration Params: rteint.p
Quant Time: Nov 06 17:08:27 2006 Quant Results File: CS1806.RES

Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 21:33:50 2006
Response via : Initial Calibration
DataAcq Meth : CS1806

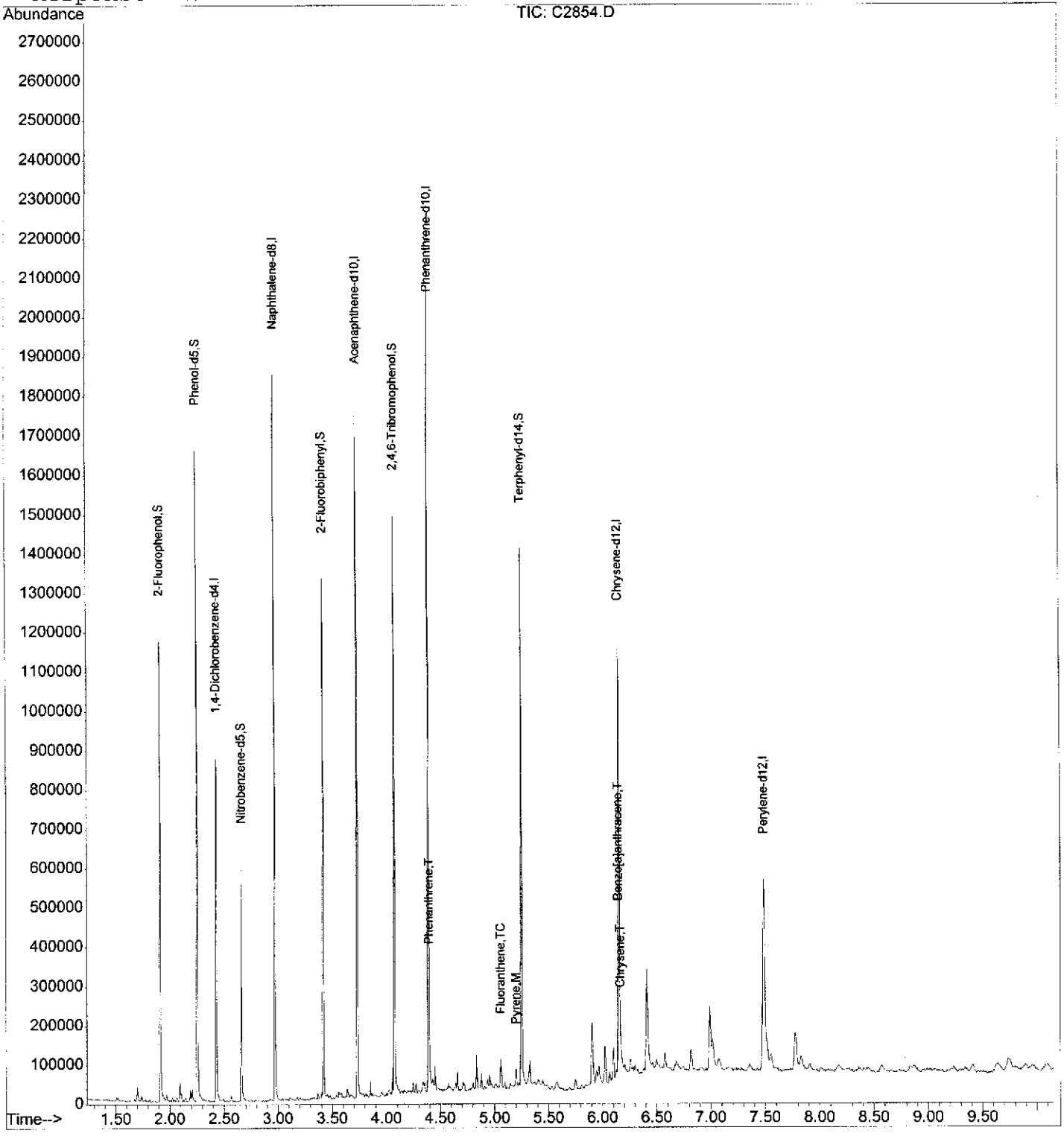
Internal Standards	R.T.	QIon	Response	Conc	Units	Dev(Min)
1) 1,4-Dichlorobenzene-d4	2.43	152	89326	40.00	UG	-0.04
23) Naphthalene-d8	2.97	136	402729	40.00	UG	-0.05
43) Acenaphthene-d10	3.73	164	241366	40.00	UG	-0.05
66) Phenanthrene-d10	4.39	188	479538	40.00	UG	-0.05
82) Chrysene-d12	6.15	240	334278	40.00	UG	-0.05
92) Perylene-d12	7.49	264	249003	40.00	UG	-0.11
System Monitoring Compounds						
4) 2-Fluorophenol	1.91	112	187707	69.10	UG	-0.04
Spiked Amount 100.000	Range 28 - 108		Recovery = 69.10%			
6) Phenol-d5	2.26	99	302157	82.61	UG	-0.04
Spiked Amount 100.000	Range 34 - 107		Recovery = 82.61%			
24) Nitrobenzene-d5	2.66	82	100533	23.30	UG	-0.05
Spiked Amount 50.000	Range 26 - 104		Recovery = 46.60%			
47) 2-Fluorobiphenyl	3.42	172	244935	39.43	UG	-0.04
Spiked Amount 50.000	Range 32 - 128		Recovery = 78.86%			
70) 2,4,6-Tribromophenol	4.08	330	126279	98.21	UG	-0.04
Spiked Amount 100.000	Range 35 - 126		Recovery = 98.21%			
84) Terphenyl-d14	5.25	244	283543	36.86	UG	-0.06
Spiked Amount 50.000	Range 32 - 135		Recovery = 73.72%			
Target Compounds						Qvalue
75) Phenanthrene	4.40	178	10464	0.95	UG	# 93
79) Fluoranthene	5.05	202	10604	1.05	UG	97
83) Pyrene	5.20	202	13213	1.28	UG	# 87
88) Benzo[a]anthracene	6.14	228	4680	0.62	UG	# 80
89) Chrysene	6.17	228	5465	0.76	UG	# 66

(#) = qualifier out of range (m) = manual integration (+) = signals summed

Quantitation Report (QT Reviewed)

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D Vial: 18
Acq On : 6 Nov 2006 16:58 Operator: EDM
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0 Inst : MSD_C
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
MS Integration Params: rteint.p
Quant Time: Nov 6 17:09 2006 Quant Results File: CS1806.RES

Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 21:33:50 2006
Response via : Initial Calibration



0065

LSC Area Percent Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D Vial: 18
Acq On : 6 Nov 2006 16:58 Operator: EDM
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0 Inst : MSD_C
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
MS Integration Params: Lscint.p

Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Smoothing : ON Filtering: 5
Sampling : 1 Min Area: 3 % of largest Peak
Start Thrs: 0.001 Max Peaks: 100
Stop Thrs : 0 Peak Location: TOP

If leading or trailing edge < 100 prefer < Baseline drop else tangent >
Peak separation: 5

Signal : TIC

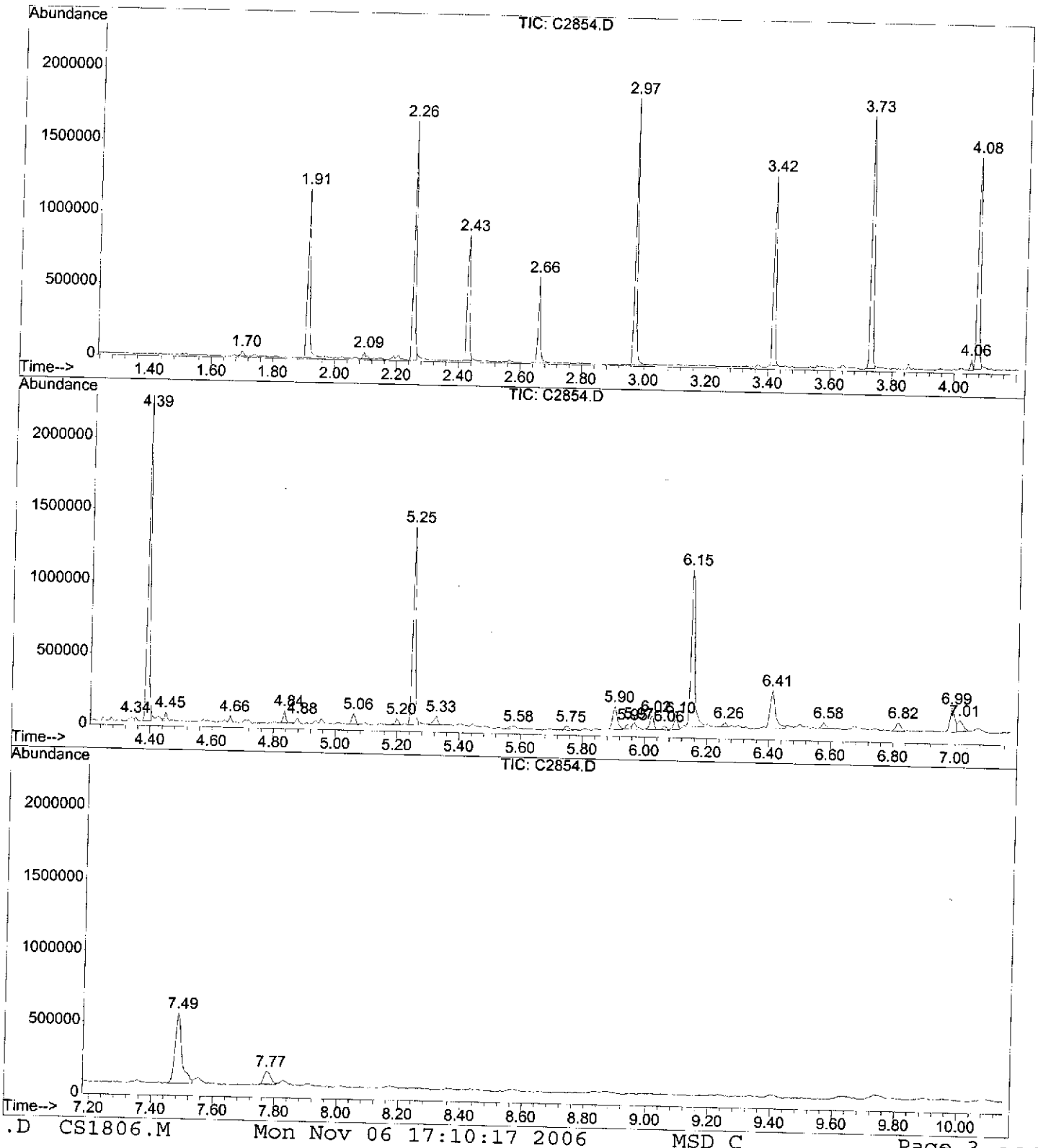
peak #	R.T. min	first scan	max scan	last scan	PK TY	peak height	corr. area	corr. % max.	% of total
1	1.699	85	88	91	rBV2	37218	23896	2.04%	0.214%
2	1.913	126	128	130	rBV	1170144	602702	51.34%	5.404%
3	2.095	159	162	167	rVB3	46390	33333	2.84%	0.299%
4	2.255	189	192	194	rBV	1655592	769018	65.51%	6.896%
5	2.431	222	225	227	rBV	869297	515884	43.94%	4.626%
6	2.661	266	268	274	rBV	592247	291026	24.79%	2.610%
7	2.971	323	326	333	rBV	1845223	828662	70.59%	7.431%
8	3.420	408	410	412	rBV	1313630	692600	59.00%	6.211%
9	3.729	466	468	471	rBV	1746213	1054957	89.87%	9.460%
10	4.055	527	529	530	rBV	69493	31009	2.64%	0.278%
11	4.077	530	533	535	rBV2	1462325	918339	78.23%	8.235%
12	4.339	578	582	584	rBV3	29861	31725	2.70%	0.284%
13	4.392	589	592	594	rBV	2259496	1173933	100.00%	10.527%
14	4.451	601	603	605	rVB	62070	31352	2.67%	0.281%
15	4.659	640	642	644	rVB	45711	21733	1.85%	0.195%
16	4.835	673	675	677	rVB2	85284	46617	3.97%	0.418%
17	4.878	680	683	687	rVB2	40894	28860	2.46%	0.259%
18	5.060	714	717	720	rVB2	74070	60513	5.15%	0.543%
19	5.199	740	743	746	rVB	41978	28565	2.43%	0.256%
20	5.252	750	753	756	rBV	1368735	850722	72.47%	7.628%
21	5.327	762	767	771	rVB3	60640	56460	4.81%	0.506%
22	5.578	808	814	820	rBV8	21899	41873	3.57%	0.375%
23	5.749	843	846	850	rBV5	25326	26111	2.22%	0.234%
24	5.904	871	875	880	rBV	159613	171753	14.63%	1.540%
25	5.947	880	883	885	rBV3	33189	32943	2.81%	0.295%
26	5.968	885	887	892	rVB4	42716	42451	3.62%	0.381%
27	6.021	894	897	902	rVB	92732	84863	7.23%	0.761%
28	6.064	902	905	908	rBV3	27799	24274	2.07%	0.218%
29	6.101	908	912	914	rBV3	84446	71460	6.09%	0.641%
30	6.150	918	921	929	rBV	1083727	946157	80.60%	8.484%
31	6.256	939	941	944	rBV3	29650	26518	2.26%	0.238%

32	6.411	966	970	978	rBV	259066	316961	27.00%	2.842%
33	6.577	998	1001	1005	rVB2	38343	32238	2.75%	0.289%
34	6.817	1042	1046	1050	rBV2	57941	69373	5.91%	0.622%
35	6.988	1074	1078	1081	rBV	164652	190074	16.19%	1.704%
36	7.015	1081	1083	1090	rVB3	72737	89172	7.60%	0.800%
37	7.485	1165	1171	1180	rBV	486534	754375	64.26%	6.765%
38	7.774	1221	1225	1231	rBV	88401	139456	11.88%	1.251%

Sum of corrected areas: 11151958

LSC Report - Integrated Chromatogram

File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D
Operator : EDM
Acquired : 6 Nov 2006 16:58 using AcqMethod CS1806
Instrument : MSD_C
Sample Name: POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0
Misc Info : PRINCETON/MULLICA_,10/30/06,11/02/06,1
Vial Number: 18
Quant File :CS1806.RES (RTE Integrator)



Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D
Acq On : 6 Nov 2006 16:58
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1
MS Integration Params: Lscint.p

Vial: 18
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

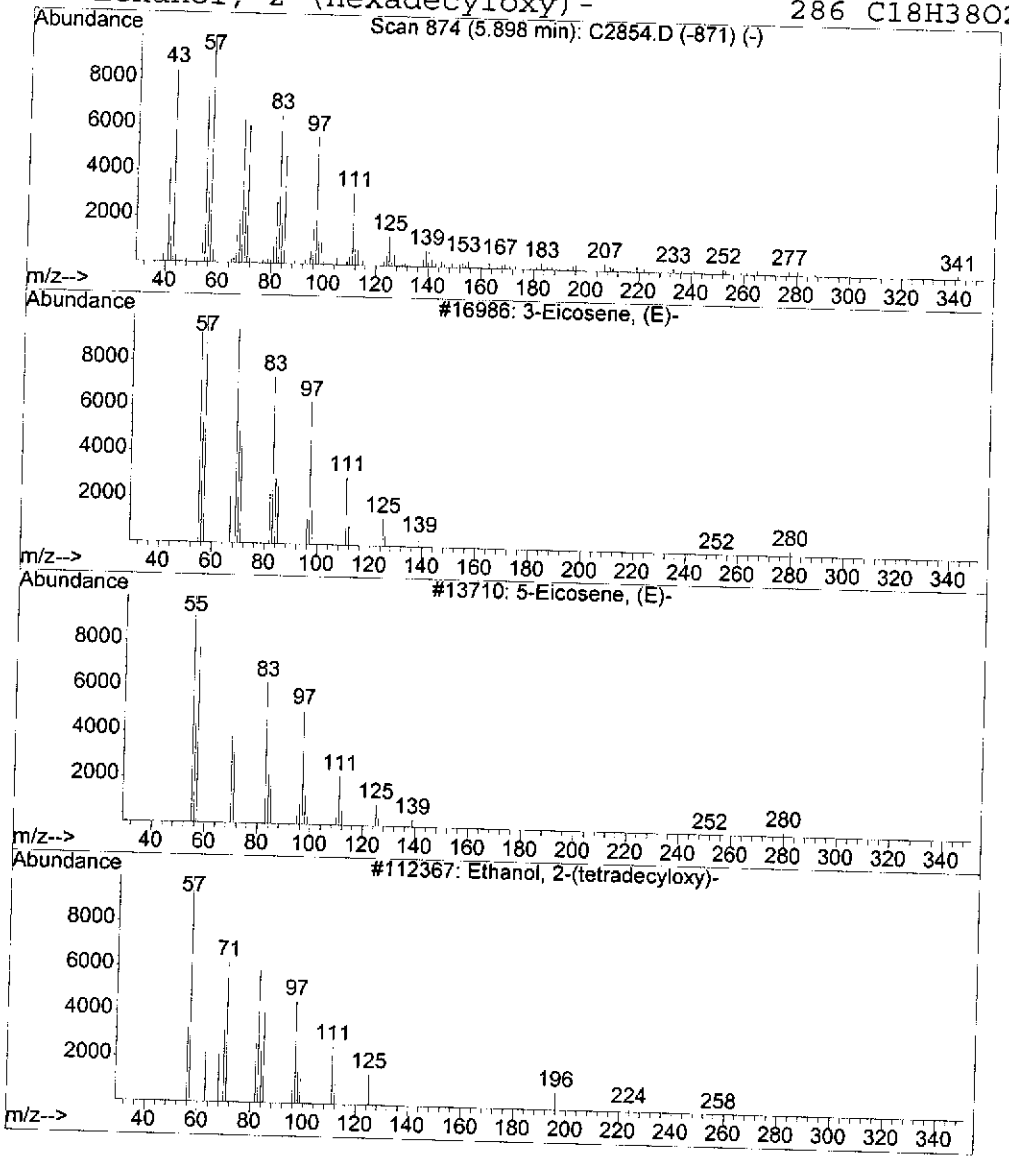
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

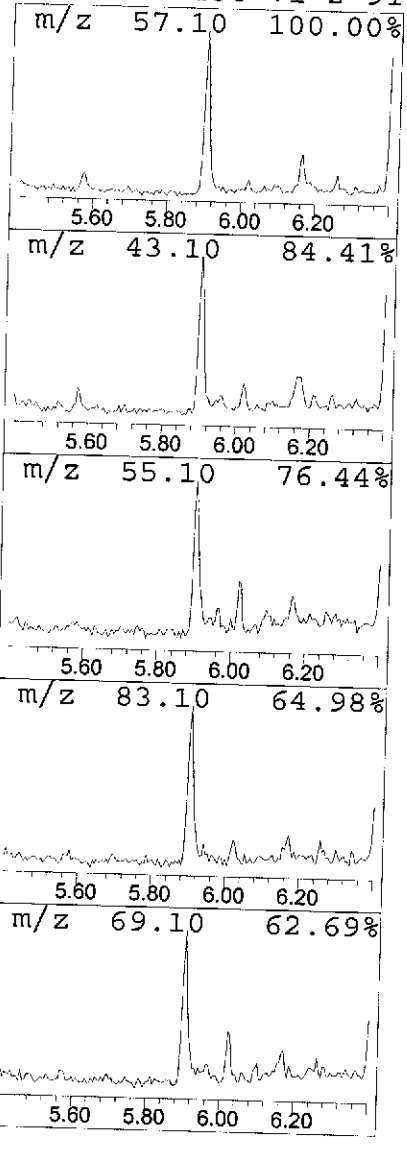
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Peak Number 1 Unknown hydrocarbon Concentration Rank 4

R.T.	EstConc	Area	Relative to ISTD	R.T.
5.90	7.26 UG	171753	Chrysene-d12	6.15

Hit# of 5	Tentative ID	MW	MolForm	CAS#	Qual
1	3-Eicosene, (E)-	280	C20H40	074685-33-9	96
2	5-Eicosene, (E)-	280	C20H40	074685-30-6	95
3	Ethanol, 2-(tetradecyloxy)-	258	C16H34O2	002136-70-1	91
4	Ethanol, 2-(hexadecyloxy)-	286	C18H38O2	002136-71-2	91





Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D
Acq On : 6 Nov 2006 16:58
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1
MS Integration Params: Lscint.p

Vial: 18
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

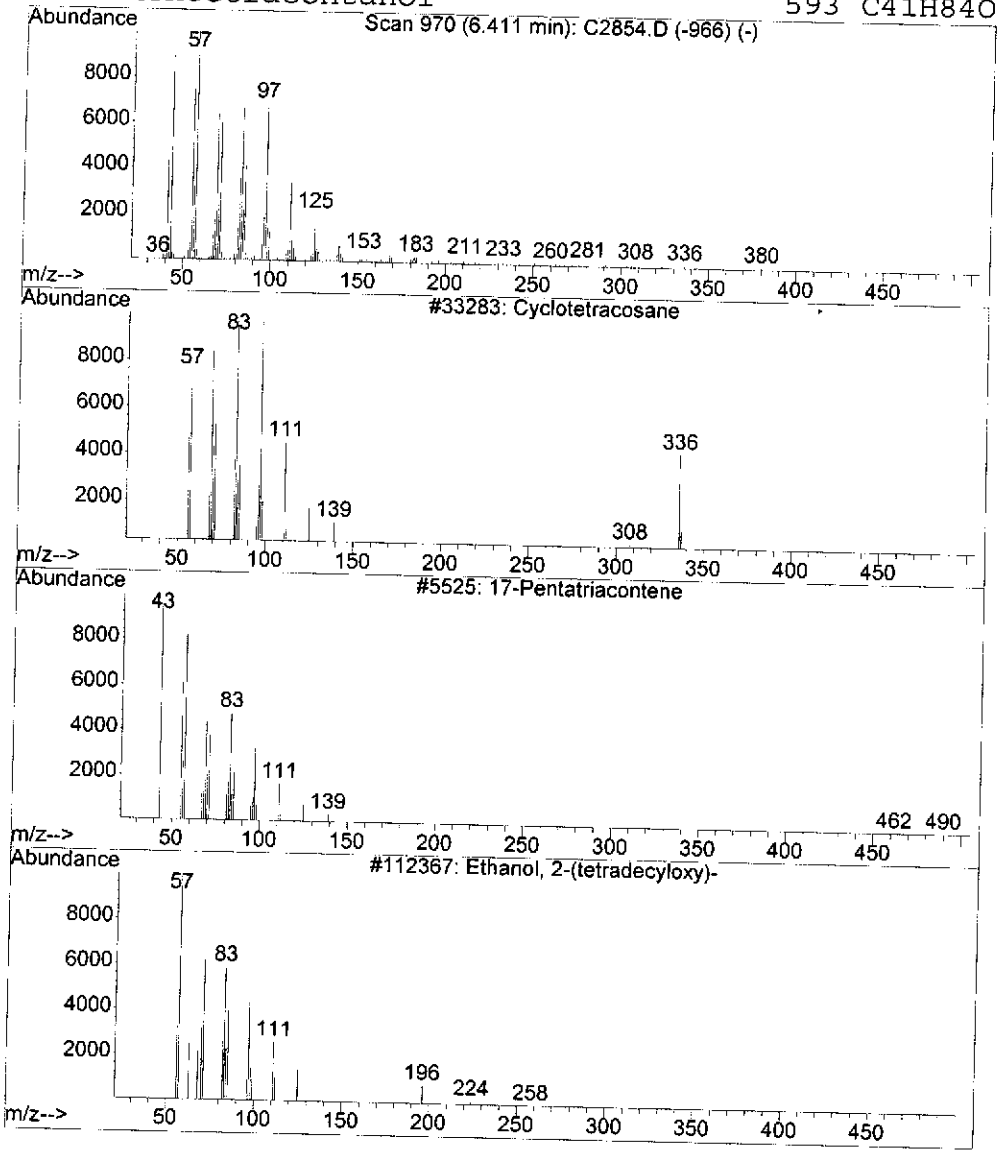
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

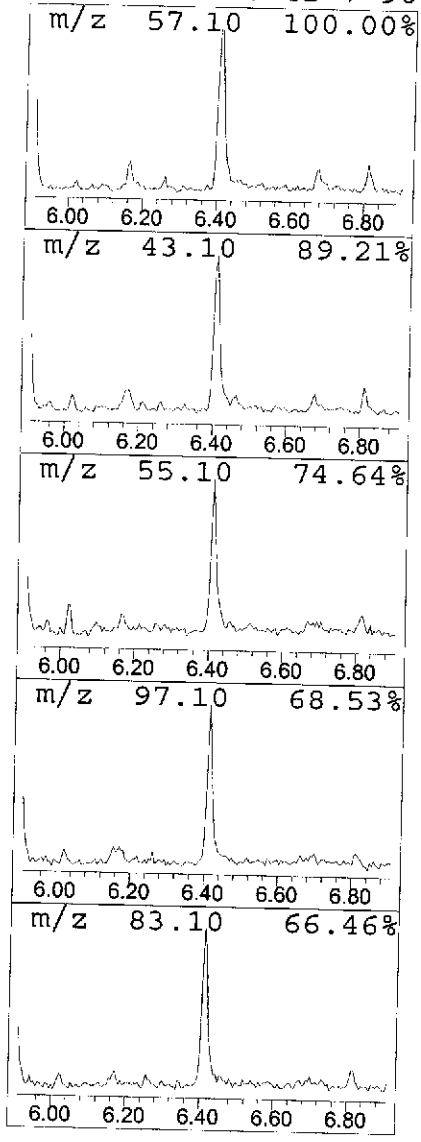
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Peak Number 2 Unknown hydrocarbon Concentration Rank 1

R.T.	EstConc	Area	Relative to ISTD	R.T.
6.41	13.40 UG	316961	Chrysene-d12	6.15

Hit# of 5	Tentative ID	MW	MolForm	CAS#	Qual
1	Cyclotetracosane	336	C24H48	000297-03-0	97
2	17-Pentatriacontene	491	C35H70	006971-40-0	91
3	Ethanol, 2-(tetradecyloxy)-	258	C16H34O2	002136-70-1	91
4	1-Hentetracontanol	593	C41H84O	040710-42-7	90





Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D
Acq On : 6 Nov 2006 16:58
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1
MS Integration Params: Lscint.p

Vial: 18
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

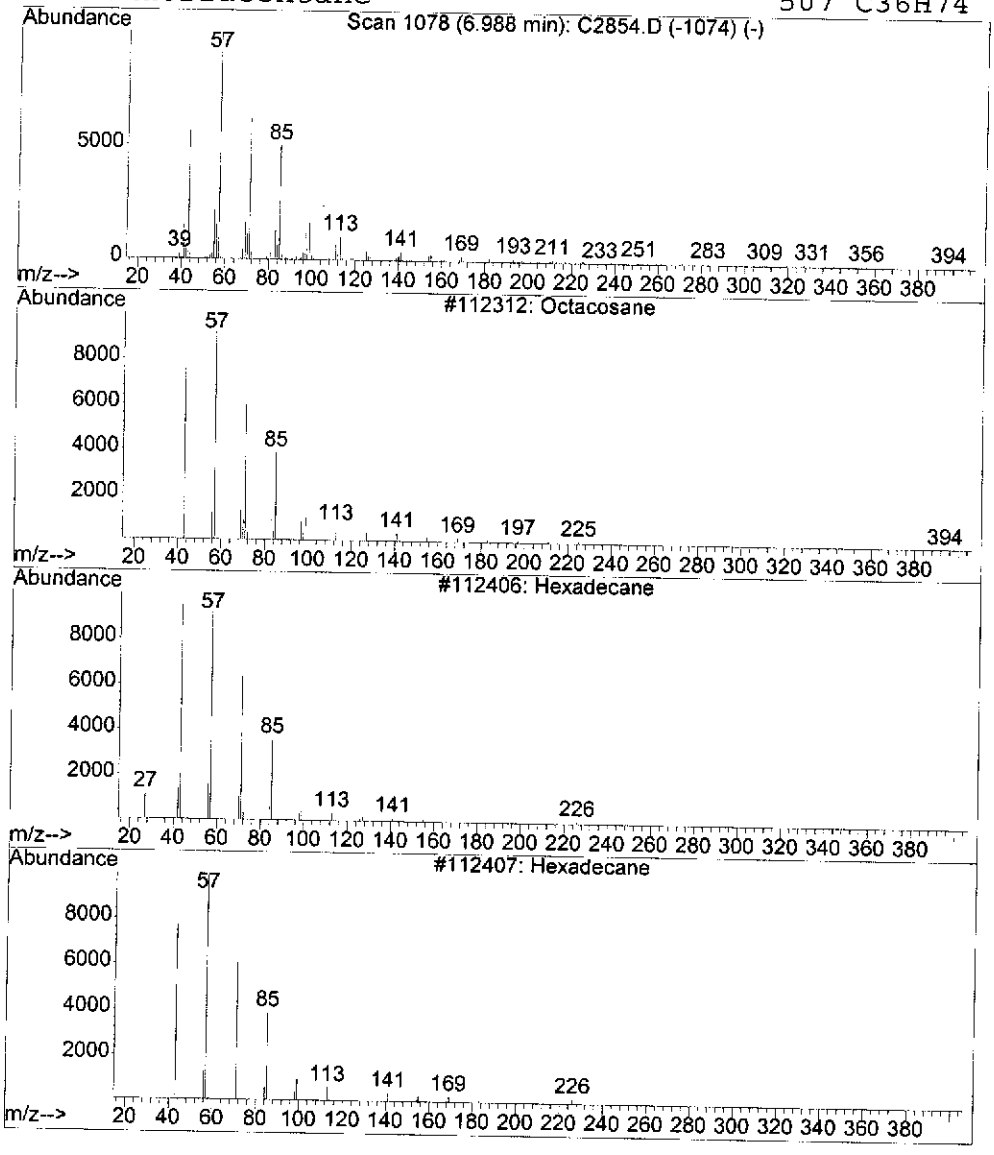
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

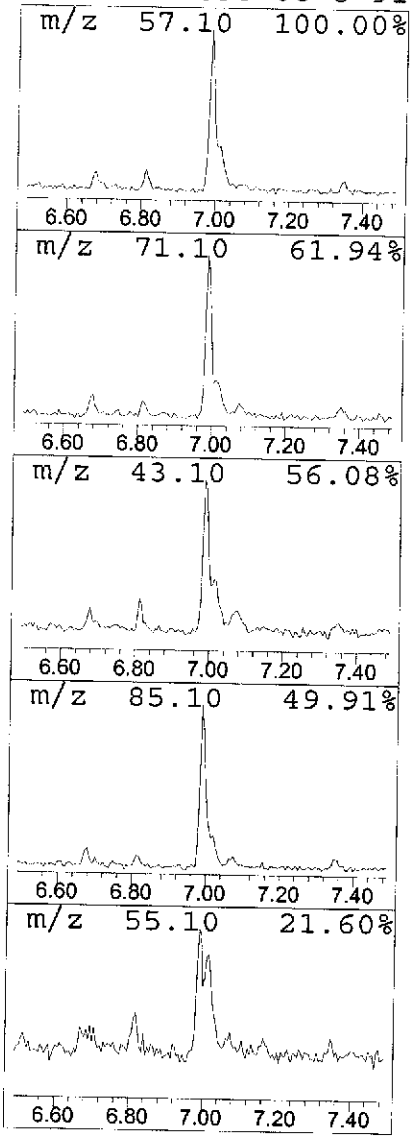
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Peak Number 3 Unknown alkane — Concentration Rank 2

R.T.	EstConc	Area	Relative to ISTD	R.T.
6.99	10.08 UG	190074	Perylene-d12	7.49

Hit# of 5	Tentative ID	MW	MolForm	CAS#	Qual
1	Octacosane	394	C28H58	000630-02-4	98
2	Hexadecane	226	C16H34	000544-76-3	93
3	Hexadecane	226	C16H34	000544-76-3	91
4	Hexatriacontane	507	C36H74	000630-06-8	91





Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D Vial: 18
Acq On : 6 Nov 2006 16:58 Operator: EDM
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0 Inst : MSD_C
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
MS Integration Params: Lscint.p

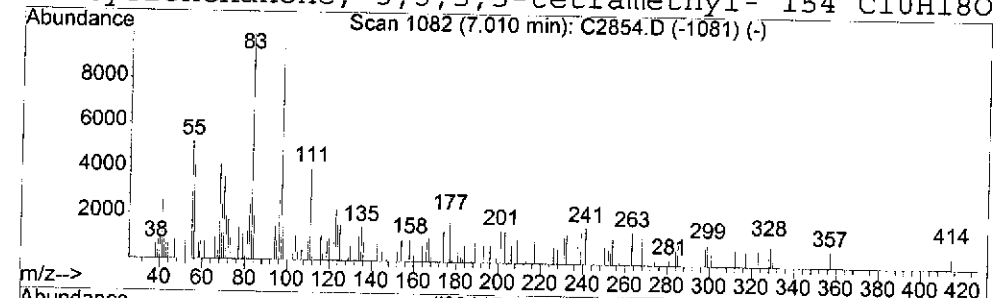
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

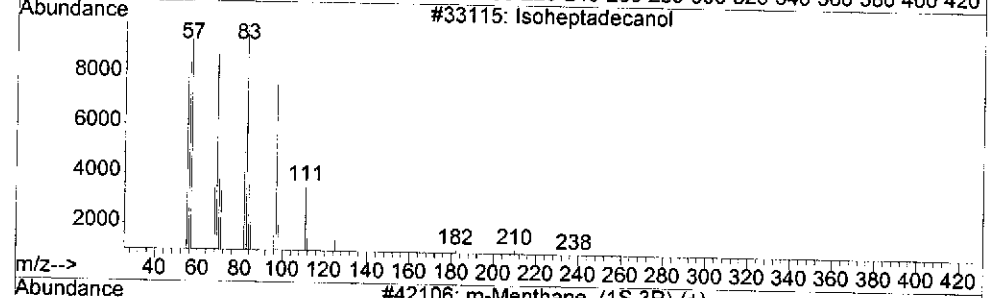
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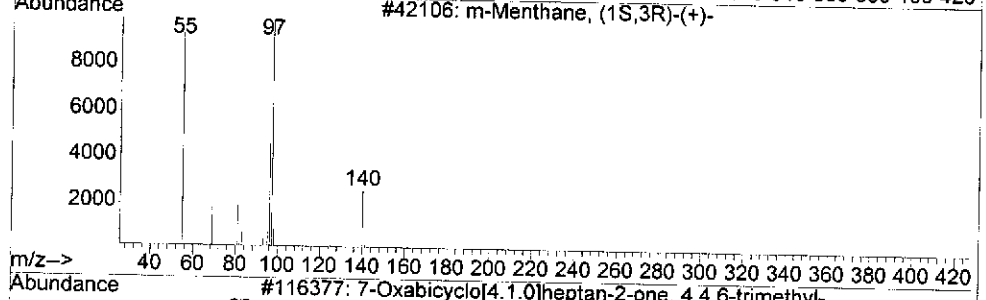
Peak Number 4 Unknown hydrocarbon Concentration Rank 5

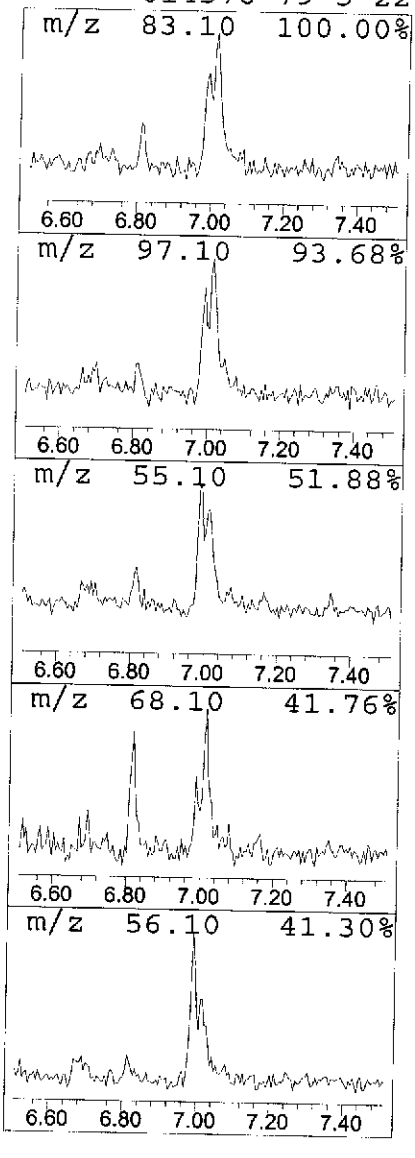
R.T.	EstConc	Area	Relative to ISTD	R.T.
7.01	4.73 UG	89172	Perylene-d12	7.49

Hit# of 5	Tentative ID	MW	MolForm	CAS#	Qual
1	Isoheptadecanol	256	C17H36O	057289-07-3	42
2	m-Menthane, (1S,3R)-(+)-	140	C10H20	013837-66-6	27
3	7-Oxabicyclo[4.1.0]heptan-2-one,...	154	C9H14O2	010276-21-8	25
4	Cyclohexanone, 3,3,5,5-tetramethyl-	154	C10H18O	014376-79-5	22









Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2854.D
Acq On : 6 Nov 2006 16:58
Sample : POND_SEDIM,12087-001,Xs,60.12g,39.2,11/0
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1
MS Integration Params: Lscint.p

Vial: 18
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

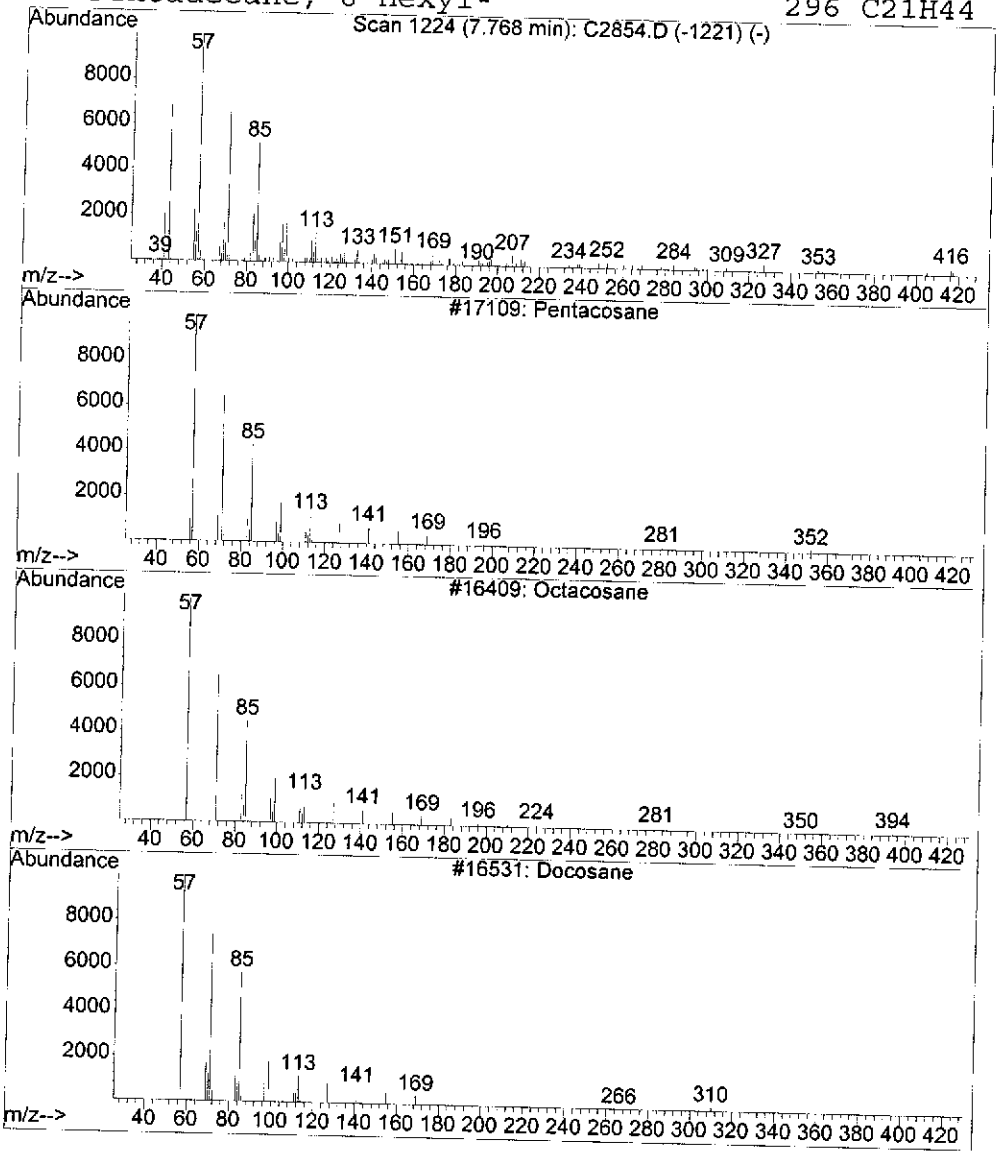
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

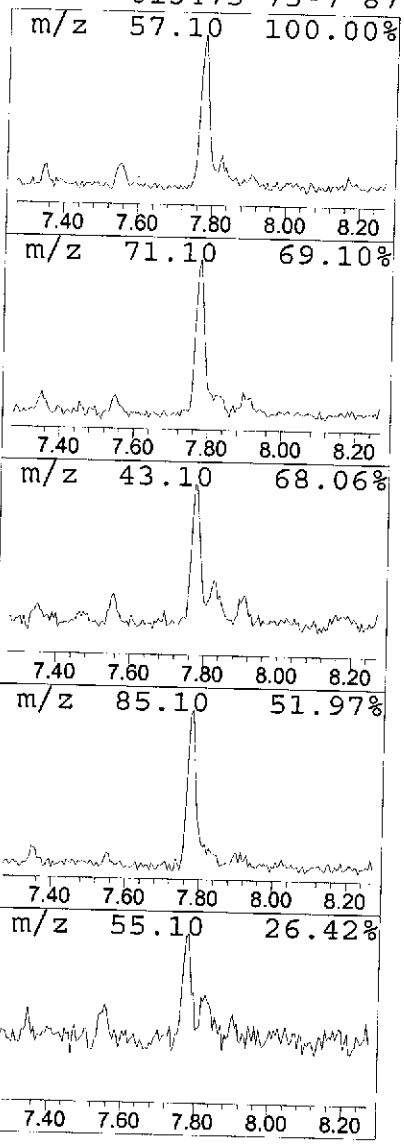
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Peak Number 5 Unknown alkane — Concentration Rank 3

R.T.	EstConc	Area	Relative to ISTD	R.T.
7.77	7.39 UG	139456	Perylene-d12	7.49

Hit# of 5	Tentative ID	MW	MolForm	CAS#	Qual
1	Pentacosane	352	C25H52	000629-99-2	91
2	Octacosane	394	C28H58	000630-02-4	91
3	Docosane	310	C22H46	000629-97-0	87
4	Pentadecane, 8-hexyl-	296	C21H44	013475-75-7	87





Quantitation Report (QT Reviewed)

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2844.D Vial: 1
Acq On : 6 Nov 2006 14:25 Operator: EDM
Sample : .,Method_Blank,S,30.00g,0,11/06/06 Inst : MSD_C
Misc : N/A,N/A,N/A,1 Multiplr: 1.00
MS Integration Params: rteint.p
Quant Time: Nov 06 14:35:44 2006 Quant Results File: CS1806.RES

Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 21:33:50 2006
Response via : Initial Calibration
DataAcq Meth : CS1806

Internal Standards	R.T.	QIon	Response	Conc	Units	Dev(Min)
1) 1,4-Dichlorobenzene-d4	2.43	152	102259	40.00	UG	-0.04
23) Naphthalene-d8	2.97	136	424274	40.00	UG	-0.05
43) Acenaphthene-d10	3.73	164	221622	40.00	UG	-0.04
66) Phenanthrene-d10	4.39	188	343774	40.00	UG	-0.05
82) Chrysene-d12	6.15	240	239968	40.00	UG	-0.06
92) Perylene-d12	7.48	264	196117	40.00	UG	-0.12
System Monitoring Compounds						
4) 2-Fluorophenol	1.91	112	251233	80.79	UG	-0.04
Spiked Amount 100.000	Range 28 - 108		Recovery = 80.79%			
6) Phenol-d5	2.26	99	373231	89.14	UG	-0.04
Spiked Amount 100.000	Range 34 - 107		Recovery = 89.14%			
24) Nitrobenzene-d5	2.66	82	123116	27.08	UG	-0.05
Spiked Amount 50.000	Range 26 - 104		Recovery = 54.16%			
47) 2-Fluorobiphenyl	3.42	172	266696	46.76	UG	-0.04
Spiked Amount 50.000	Range 32 - 128		Recovery = 93.52%			
70) 2,4,6-Tribromophenol	4.08	330	95776	103.91	UG	-0.04
Spiked Amount 100.000	Range 35 - 126		Recovery = 103.91%			
84) Terphenyl-d14	5.25	244	232902	42.17	UG	-0.06
Spiked Amount 50.000	Range 32 - 135		Recovery = 84.34%			

Target Compounds Qvalue

(#) = qualifier out of range (m) = manual integration (+) = signals summed

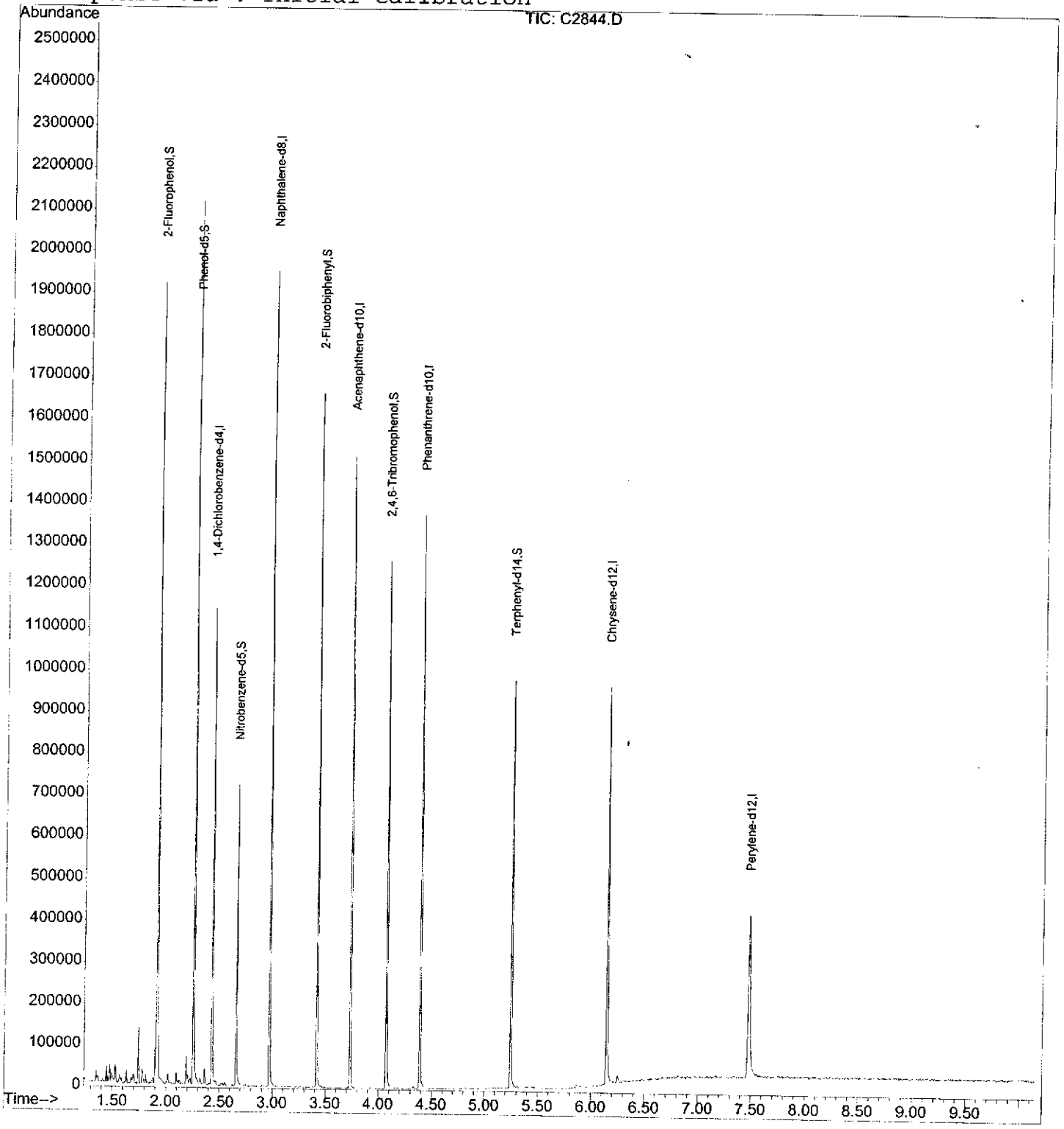
Quantitation Report (QT Reviewed)

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2844.D
Acq On : 6 Nov 2006 14:25
Sample : .,Method_Blank,S,30.00g,0,11/06/06
Misc : N/A,N/A,N/A,1
MS Integration Params: rteint.p
Quant Time: Nov 6 14:51 2006

Vial: 1
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

Quant Results File: CS1806.RES

Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Last Update : Mon Oct 23 21:33:50 2006
Response via : Initial Calibration



Library Search Compound Report

Data File : C:\MSDCHEM\1\DATA\11-06-06\C2844.D
Acq On : 6 Nov 2006 14:25
Sample : .,Method_Blank,S,30.00g,0,11/06/06
Misc : N/A,N/A,N/A,1
MS Integration Params: Lscint.p
Quant Method : C:\MSDCHEM\1\METHODS\CS1806.M (RTE Integrator)
Title : BNA CALIBRATION METHOD
Library : C:\DATABASE\NIST98.L

Vial: 1
Operator: EDM
Inst : MSD_C
Multiplr: 1.00

No Library Search Compounds Detected

****

C2844.D CS1806.M Mon Nov 06 14:51:42 2006 MSD_C

PCB METHOD BLANK SUMMARY

Lab File ID: R3256.D

Instrument ID: GC-R

Date Extracted: 10/31/2006

Matrix: SOIL

Date Analyzed: 11/01/2006

Time Analyzed: 02:43

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS & MSD:

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed
MR6290001I	11606-001	11/01/2006	03:00
MR6290002I	11606-002	11/01/2006	03:18
MR6290003I	11606-003	11/01/2006	03:35
MR6290004I	11606-004	11/01/2006	03:53
MR6290005I	11606-005	11/01/2006	04:11
PCB	11606-002-MS4	11/01/2006	04:28
PCB	11606-002-MSD4	11/01/2006	04:46
PCB	PBS1031-MS4	11/01/2006	05:03

INTEGRATED ANALYTICAL LABORATORIES

PCB's

Client/Project: NA

Lab ID: 1031-BLK4
Client ID: PCB
Date Received: NA
Date Extracted: 10/31/2006
Date Analyzed: 11/01/2006
Data file: R3256.D

GC Column: DB-5/DB1701P
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
Aroclor-1016	ND		0.000668
Aroclor-1221	ND		0.000668
Aroclor-1232	ND		0.000668
Aroclor-1242	ND		0.000668
Aroclor-1248	ND		0.000668
Aroclor-1254	ND		0.000668
Aroclor-1260	ND		0.000668

PCB METHOD BLANK SUMMARY

Lab File ID: R3416.D

Instrument ID: GC-R

Date Extracted: 11/06/2006

Matrix: SOIL

Date Analyzed: 11/07/2006

Time Analyzed: 17:45

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS & MSD:

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed
POND_SEDI	12087-001	11/07/2006	18:02
PCB	PBS1106-MS4	11/07/2006	18:20

INTEGRATED ANALYTICAL LABORATORIES

PCB's

Client/Project: NA

Lab ID: 1106-BLK4
Client ID: PCB
Date Received: NA
Date Extracted: 11/06/2006
Date Analyzed: 11/07/2006
Data file: R3416.D

GC Column: DB-5/DB1701P
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
Aroclor-1016	ND		0.000668
Aroclor-1221	ND		0.000668
Aroclor-1232	ND		0.000668
Aroclor-1242	ND		0.000668
Aroclor-1248	ND		0.000668
Aroclor-1254	ND		0.000668
Aroclor-1260	ND		0.000668

PCB INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/20/2006 **Instrument ID:** GC-R
GC Column (1st): DB-5

Data File: R2783.D R2782.D R2781.D R2780.D R2779.D

Compound	RT OF STANDARDS					MEAN	RT WINDOW	
	50	100	500	1000	2000	RT	FROM	TO
Aroclor-1016	3.73	3.73	3.73	3.73	3.73	3.73	3.66	3.80
Aroclor-1016 {2}	4.59	4.59	4.59	4.59	4.59	4.59	4.52	4.66
Aroclor-1016 {3}	5.16	5.16	5.16	5.16	5.16	5.16	5.09	5.23
Aroclor-1016 {4}	5.62	5.62	5.62	5.62	5.62	5.62	5.55	5.69
Aroclor-1016 {5}	6.08	6.08	6.08	6.08	6.08	6.08	6.01	6.15
Aroclor-1221			2.56				2.49	2.63
Aroclor-1221 {2}			3.52				3.45	3.59
Aroclor-1221 {3}			3.65				3.58	3.72
Aroclor-1221 {4}			3.73				3.66	3.80
Aroclor-1221 {5}			4.34				4.27	4.41
Aroclor-1232			3.73				3.66	3.80
Aroclor-1232 {2}			4.59				4.52	4.66
Aroclor-1232 {3}			5.16				5.09	5.23
Aroclor-1232 {4}			5.88				5.81	5.95
Aroclor-1232 {5}			6.08				6.01	6.15
Aroclor-1242			4.59				4.52	4.66
Aroclor-1242 {2}			5.62				5.55	5.69
Aroclor-1242 {3}			5.88				5.81	5.95
Aroclor-1242 {4}			6.58				6.51	6.65
Aroclor-1242 {5}			6.86				6.79	6.93
Aroclor-1248			5.01				4.94	5.08
Aroclor-1248 {2}			5.55				5.48	5.62
Aroclor-1248 {3}			5.88				5.81	5.95
Aroclor-1248 {4}			6.58				6.51	6.65
Aroclor-1248 {5}			6.86				6.79	6.93
Aroclor-1254			6.98				6.91	7.05
Aroclor-1254 {2}			7.43				7.36	7.50
Aroclor-1254 {3}			7.59				7.52	7.66
Aroclor-1254 {4}			8.03				7.96	8.10
Aroclor-1254 {5}			8.88				8.81	8.95
Aroclor-1260	8.88	8.88	8.88	8.88	8.88	8.88	8.81	8.95
Aroclor-1260 {2}	9.56	9.56	9.56	9.56	9.56	9.56	9.49	9.63
Aroclor-1260 {3}	10.03	10.03	10.03	10.03	10.03	10.03	9.96	10.10
Aroclor-1260 {4}	10.52	10.52	10.52	10.52	10.52	10.52	10.45	10.59
Aroclor-1260 {5}	11.58	11.58	11.58	11.58	11.58	11.58	11.51	11.65

PCB INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/20/2006 **Instrument ID:** GC-R

GC Column (1st): DB-5

Data File: R2783.D R2782.D R2781.D R2780.D R2779.D

Compound	CALIBRATION FACTORS 50	100	500	1000	2000	MEAN	%RSD
Aroclor-1016	476053	486899	409206	409211	368229	429920	11.65
Aroclor-1016 {2}	686146	730829	563299	561993	506440	609742	15.47
Aroclor-1016 {3}	902926	951612	718688	720553	659576	790671	16.22
Aroclor-1016 {4}	424267	452194	340143	339441	305312	372272	16.82
Aroclor-1016 {5}	642182	742663	592942	595660	541725	623035	12.16
Aroclor-1221			298048				
Aroclor-1221 {2}			457906				
Aroclor-1221 {3}			293915				
Aroclor-1221 {4}			1075929				
Aroclor-1221 {5}			254458				
Aroclor-1232			783728				
Aroclor-1232 {2}			456884				
Aroclor-1232 {3}			605344				
Aroclor-1232 {4}			430573				
Aroclor-1232 {5}			607826				
Aroclor-1242			893214				
Aroclor-1242 {2}			556230				
Aroclor-1242 {3}			763384				
Aroclor-1242 {4}			1400407				
Aroclor-1242 {5}			1028524				
Aroclor-1248			2503212				
Aroclor-1248 {2}			975658				
Aroclor-1248 {3}			1297658				
Aroclor-1248 {4}			2216903				
Aroclor-1248 {5}			1836408				
Aroclor-1254			2252783				
Aroclor-1254 {2}			1431247				
Aroclor-1254 {3}			2794700				
Aroclor-1254 {4}			2829286				
Aroclor-1254 {5}			2862899				
Aroclor-1260	1763509	1864174	1448864	1471077	1349352	1579395	14.04
Aroclor-1260 {2}	1082180	1129524	851014	866107	793638	944493	15.95
Aroclor-1260 {3}	2673703	2806564	2229532	2306604	2137878	2430856	12.03
Aroclor-1260 {4}	1306108	1397276	1106891	1129969	1031390	1194327	12.70
Aroclor-1260 {5}	794301	835196	722493	772316	691103	763082	7.50
					Average %RSD		13.45

PCB INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/20/2006

Instrument ID: GC-R

GC Column (2nd): DB-1701P

Data File: R2783.C R2782.C R2781.C R2780.C R2779.C

Compound	RT OF STANDARDS					MEAN	RT WINDOW	
	50	100	500	1000	2000	RT	FROM	TO
Aroclor-1016	4.09	4.09	4.09	4.09	4.09	4.09	4.02	4.16
Aroclor-1016 {2}	4.69	4.69	4.69	4.69	4.69	4.69	4.62	4.76
Aroclor-1016 {3}	5.45	5.45	5.45	5.45	5.45	5.45	5.38	5.52
Aroclor-1016 {4}	5.66	5.66	5.66	5.66	5.66	5.66	5.59	5.73
Aroclor-1016 {5}	5.84	5.84	5.84	5.84	5.84	5.84	5.77	5.91
Aroclor-1221			2.74				2.67	2.81
Aroclor-1221 {2}			3.75				3.68	3.82
Aroclor-1221 {3}			3.99				3.92	4.06
Aroclor-1221 {4}			4.09				4.02	4.16
Aroclor-1221 {5}			5.45				5.38	5.52
Aroclor-1232			4.09				4.02	4.16
Aroclor-1232 {2}			5.08				5.01	5.15
Aroclor-1232 {3}			5.66				5.59	5.73
Aroclor-1232 {4}			5.84				5.77	5.91
Aroclor-1232 {5}			6.44				6.37	6.51
Aroclor-1242			5.08				5.01	5.15
Aroclor-1242 {2}			5.84				5.77	5.91
Aroclor-1242 {3}			6.44				6.37	6.51
Aroclor-1242 {4}			6.59				6.52	6.66
Aroclor-1242 {5}			7.15				7.08	7.22
Aroclor-1248			5.45				5.38	5.52
Aroclor-1248 {2}			6.04				5.97	6.11
Aroclor-1248 {3}			6.44				6.37	6.51
Aroclor-1248 {4}			6.59				6.52	6.66
Aroclor-1248 {5}			6.94				6.87	7.01
Aroclor-1254			7.44				7.37	7.51
Aroclor-1254 {2}			8.03				7.96	8.10
Aroclor-1254 {3}			8.64				8.57	8.71
Aroclor-1254 {4}			8.87				8.80	8.94
Aroclor-1254 {5}			9.47				9.40	9.54
Aroclor-1260	8.87	8.87	8.87	8.87	8.87	8.87	8.80	8.94
Aroclor-1260 {2}	9.47	9.47	9.47	9.47	9.47	9.47	9.40	9.54
Aroclor-1260 {3}	10.07	10.07	10.07	10.07	10.07	10.07	10.00	10.14
Aroclor-1260 {4}	10.57	10.57	10.57	10.57	10.57	10.57	10.50	10.64
Aroclor-1260 {5}	12.21	12.21	12.21	12.21	12.21	12.21	12.14	12.28

PCB INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/20/2006 **Instrument ID:** GC-R

GC Column (2nd): DB-1701P

Data File: R2783.C R2782.C R2781.C R2780.C R2779.C

Compound	CALIBRATION FACTORS 50	100	500	1000	2000	MEAN	%RSD
Aroclor-1016	804463	851472	680483	680196	607277	724778	13.82
Aroclor-1016 {2}	1601292	1618208	1248161	1226825	1087071	1356312	17.66
Aroclor-1016 {3}	3442777	3632896	2893006	2951639	2699563	3123976	12.64
Aroclor-1016 {4}	1531563	1624928	1265516	1288195	1187426	1379526	13.64
Aroclor-1016 {5}	1132510	1138761	925541	927804	846679	994259	13.39
Aroclor-1221			577915				
Aroclor-1221 {2}			815293				
Aroclor-1221 {3}			484107				
Aroclor-1221 {4}			1729239				
Aroclor-1221 {5}			346313				
Aroclor-1232			1300854				
Aroclor-1232 {2}			489648				
Aroclor-1232 {3}			1086123				
Aroclor-1232 {4}			788527				
Aroclor-1232 {5}			1200568				
Aroclor-1242			917623				
Aroclor-1242 {2}			1518004				
Aroclor-1242 {3}			2195697				
Aroclor-1242 {4}			1879058				
Aroclor-1242 {5}			1747529				
Aroclor-1248			4443235				
Aroclor-1248 {2}			4823707				
Aroclor-1248 {3}			3411470				
Aroclor-1248 {4}			3174464				
Aroclor-1248 {5}			2064053				
Aroclor-1254			2993756				
Aroclor-1254 {2}			3255581				
Aroclor-1254 {3}			3213000				
Aroclor-1254 {4}			2073724				
Aroclor-1254 {5}			4868476				
Aroclor-1260	2322197	2379477	1821536	1822239	1648003	1998690	16.50
Aroclor-1260 {2}	2309787	2391994	1914674	1929754	1794968	2068235	12.81
Aroclor-1260 {3}	2032183	2059225	1729922	1656239	1529833	1801480	13.01
Aroclor-1260 {4}	4054567	4230538	3446301	3523544	3315312	3714052	10.85
Aroclor-1260 {5}	1104099	1155933	920872	933809	871566	997256	12.51
					Average %RSD		13.68

PCB CALIBRATION VERIFICATION SUMMARY

Date/Time Analyzed: 11/07/2006 **Instrument ID:** GC-R

Data File: R3415.D **GC Column (1st):** DB-5

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
Aroclor-1016	3.74	3.67	3.81	429920	454936	5.82
Aroclor-1016 {2}	4.60	4.53	4.67	609742	610885	0.19
Aroclor-1016 {3}	5.17	5.10	5.24	790671	810314	2.48
Aroclor-1016 {4}	5.63	5.56	5.70	372272	396575	6.53
Aroclor-1016 {5}	6.09	6.02	6.16	623035	670988	7.70
Aroclor-1260	8.89	8.82	8.96	1579395	1595329	1.01
Aroclor-1260 {2}	9.57	9.50	9.64	944493	895776	5.16
Aroclor-1260 {3}	10.04	9.97	10.11	2430856	2194870	9.71
Aroclor-1260 {4}	10.52	10.45	10.59	1194327	1030004	13.76
Aroclor-1260 {5}	11.58	11.51	11.65	763082	632421	17.12
					Average %D	6.95

Data File: R3415.C **GC Column (2nd):** DB-1701P

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
Aroclor-1016	4.08	4.01	4.15	724778	734816	1.39
Aroclor-1016 {2}	4.68	4.61	4.75	1356312	1419345	4.65
Aroclor-1016 {3}	5.44	5.37	5.51	3123976	3262686	4.44
Aroclor-1016 {4}	5.65	5.58	5.72	1379526	1422327	3.10
Aroclor-1016 {5}	5.83	5.76	5.90	994259	1103965	11.03
Aroclor-1260	8.85	8.78	8.92	1998690	2032801	1.71
Aroclor-1260 {2}	9.45	9.38	9.52	2068235	2101330	1.60
Aroclor-1260 {3}	10.04	9.97	10.11	1801480	1593279	11.56
Aroclor-1260 {4}	10.55	10.48	10.62	3714052	3419135	7.94
Aroclor-1260 {5}	12.18	12.11	12.25	997256	849978	14.77
					Average %D	6.22

PCB CALIBRATION VERIFICATION SUMMARY

Date/Time Analyzed: 11/08/2006 **Instrument ID:** GC-R

Data File: R3443.D **GC Column (1st):** DB-5

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
Aroclor-1016	3.74	3.67	3.81	429920	465561	8.29
Aroclor-1016 {2}	4.60	4.53	4.67	609742	622809	2.14
Aroclor-1016 {3}	5.17	5.10	5.24	790671	832116	5.24
Aroclor-1016 {4}	5.63	5.56	5.70	372272	411437	10.52
Aroclor-1016 {5}	6.08	6.01	6.15	623035	693062	11.24
Aroclor-1260	8.88	8.81	8.95	1579395	1707046	8.08
Aroclor-1260 {2}	9.56	9.49	9.63	944493	943518	0.10
Aroclor-1260 {3}	10.04	9.97	10.11	2430856	2422407	0.35
Aroclor-1260 {4}	10.52	10.45	10.59	1194327	1159084	2.95
Aroclor-1260 {5}	11.58	11.51	11.65	763082	772410	1.22
					Average %D	5.01

Data File: R3443.C **GC Column (2nd):** DB-1701P

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
Aroclor-1016	4.08	4.01	4.15	724778	754952	4.16
Aroclor-1016 {2}	4.68	4.61	4.75	1356312	1448474	6.80
Aroclor-1016 {3}	5.43	5.36	5.50	3123976	3368630	7.83
Aroclor-1016 {4}	5.65	5.58	5.72	1379526	1455887	5.54
Aroclor-1016 {5}	5.82	5.75	5.89	994259	1096418	10.27
Aroclor-1260	8.85	8.78	8.92	1998690	2161677	8.15
Aroclor-1260 {2}	9.45	9.38	9.52	2068235	2242826	8.44
Aroclor-1260 {3}	10.05	9.98	10.12	1801480	1550589	13.93
Aroclor-1260 {4}	10.55	10.48	10.62	3714052	3806630	2.49
Aroclor-1260 {5}	12.18	12.11	12.25	997256	995104	0.22
					Average %D	6.78

PCB SURROGATE PERCENT RECOVERY SUMMARY

Date Analyzed: 11/07/2006

Client ID	Lab Sample ID	Matrix	TCMX 1 % rec	#	DCB 1 % rec	#	TCMX 2 % rec	#	DCB 2 % rec	#
PCB	1106-BLK4	SOIL	63		33		62		35	
POND_SEDI	12087-001	SEDIMENT	84		38		85		38	
PCB	PBS1106-MS4	SOIL	62		33		61		37	

Surrogate QC Limits	Soil	Aqueous
TCMX = Tetrachloro-m-xylene	21-163	11-163
DCB = Decachlorobiphenyl	23-172	13-170

\# Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

SOIL PCB MATRIX SPIKE/SPIKE DUPLICATE RECOVERY

Matrix spike Lab sample ID: 11606-002-MSD4

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
Aroclor-1016	5.0	0.0	4.3	86	24 - 173
Aroclor-1260	5.0	0.0	4.0	80	24 - 194

Compound	SAMPLE CONC. (ug/Kg)	MSD CONC. (ug/Kg)	MSD % # REC	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Aroclor-1016	0.0	4.1	82	5	25	24 - 173
Aroclor-1260	0.0	4.1	82	2	28	24 - 194

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

RPD: __0___ out of __2__ outside limits

Spike Recovery: __0___ out of __4__ outside limits

SOIL PCB BLANK SPIKE RECOVERY

Matrix spike Lab sample ID: PBS1106-MS4

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
Aroclor-1016	5.0	0.0	4.2	84	24 - 173
Aroclor-1260	5.0	0.0	3.4	68	24 - 194

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

Spike Recovery: __0___ out of __2__ outside limits

PCB RETENTION TIME SHIFT SUMMARY

Instrument ID: GC-R **Column:** DB-5/DB-1701P

Surrogate RT from initial calibration :

TCMX 1 3.26 **DCB 1** 12.69 **TCMX 2** 3.19 **DCB 2** 12.83

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed	TCMX 1 RT	#	DCB 1 RT	#	TCMX 2 RT	#	DCB 2 RT	#
PCB	1106-BLK4	11/07/2006	17:45	3.26		12.69		3.19		12.83	
POND_SEDI	12087-001	11/07/2006	18:02	3.26		12.69		3.20		12.83	
PCB	PBS1106-MS4	11/07/2006	18:20	3.26		12.69		3.19		12.83	

Surrogate QC Limits

TCMX = Tetrachloro-m-xylene (± 0.08 Minutes)

DCB = Decachlorobiphenyl (± 0.08 Minutes)

\# Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3417.D\ECD1B.CH Vial: 3
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3417.D\ECD2A.CH
Acq On : 07 Nov 2006 18:02 Operator: MJ
Sample : POND_SEDI,12087-001,Xs,30.10g,39.2,11/06 Inst : GC_R
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 18:17:13 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Initial Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.26	3.20	4177.8E6	7369.2E6	83.740	84.897m
Spiked Amount 100.000	Range 75 - 125		Recovery =		83.74%	84.90%
2) S DCB	12.69	12.83	833.9E6	1112.0E6	37.709	38.325m
Spiked Amount 100.000			Recovery =		37.71%	38.33%
Target Compounds						
Sum Aroclor-1016			0	0	N.D.	N.D.
Average Aroclor-1016					0.000	0.000
Sum Aroclor-1221			0	0	N.D.	N.D.
Average Aroclor-1221					0.000	0.000
Sum Aroclor-1232			0	0	N.D.	N.D.
Average Aroclor-1232					0.000	0.000
Sum Aroclor-1242			0	0	N.D.	N.D.
Average Aroclor-1242					0.000	0.000
Sum Aroclor-1248			0	0	N.D.	N.D.
Average Aroclor-1248					0.000	0.000
Sum Aroclor-1254			0	0	N.D.	N.D.
Average Aroclor-1254					0.000	0.000
Sum Aroclor-1260			0	0	N.D.	N.D.
Average Aroclor-1260					0.000	0.000

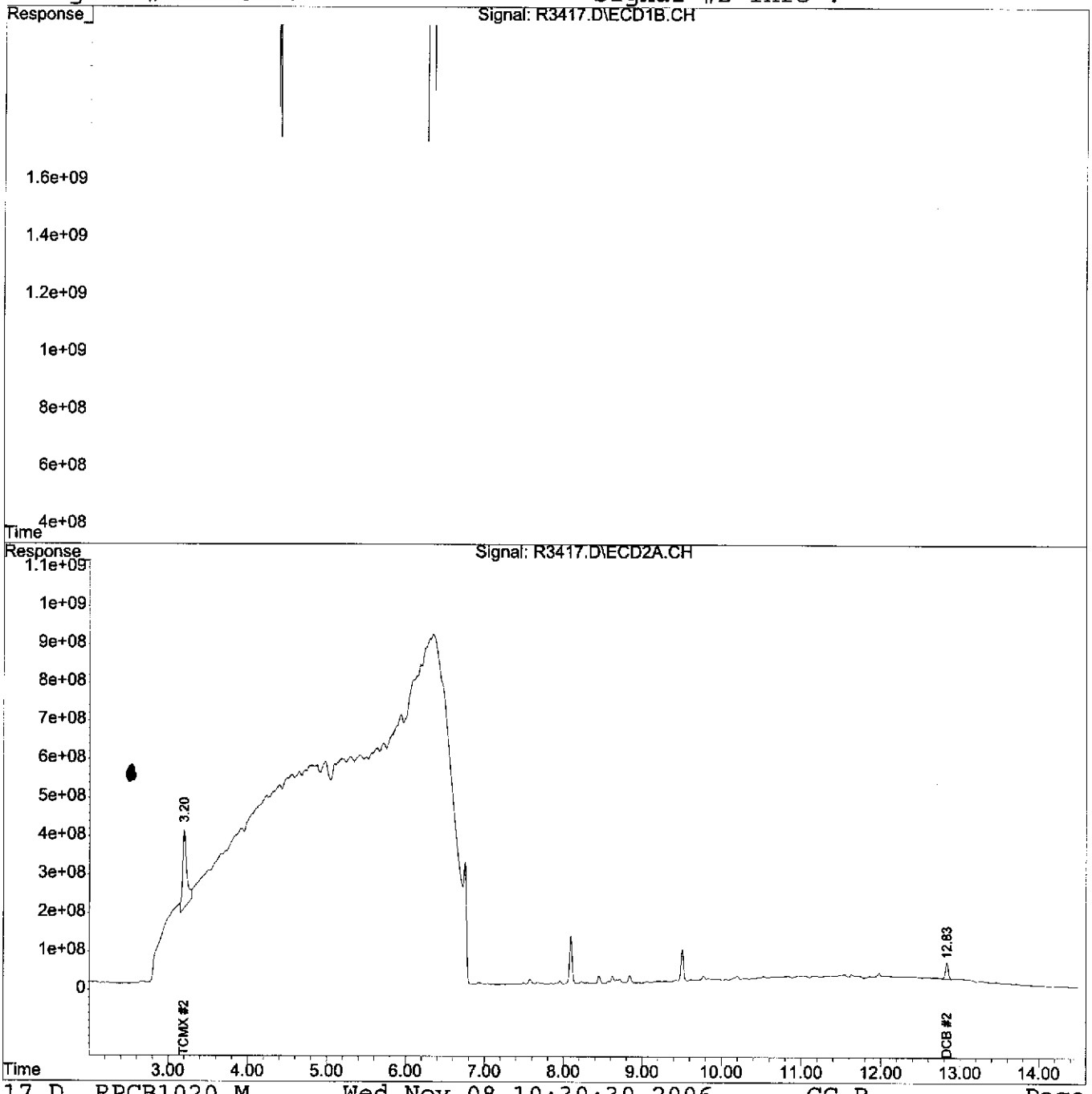
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

Quantitation Report (QT Reviewed)

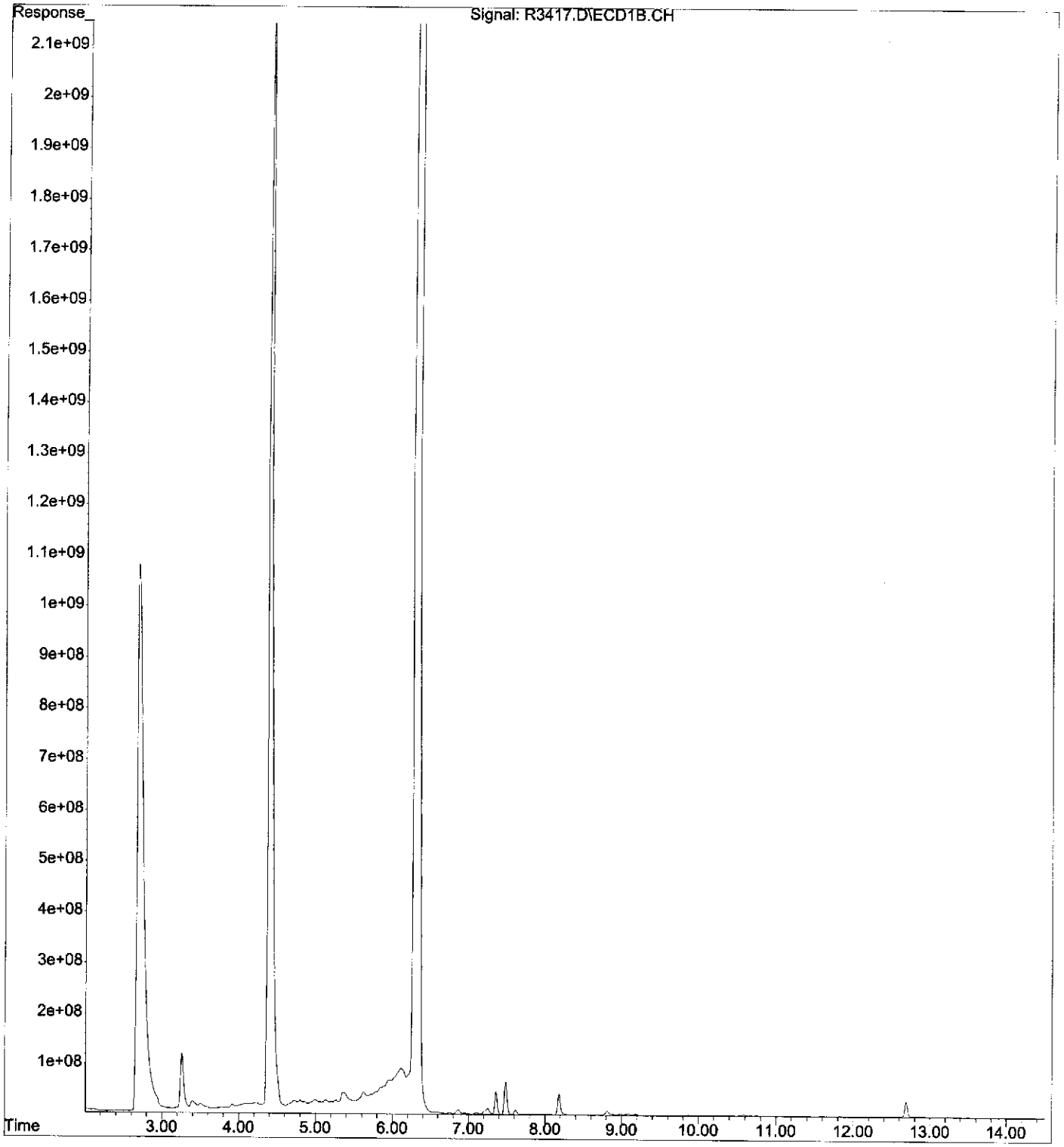
Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3417.D\ECD1B.CH Vial: 3
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3417.D\ECD2A.CH
Acq On : 07 Nov 2006 18:02 Operator: MJ
Sample : POND_SEDI,12087-001,Xs,30.10g,39.2,11/06 Inst : GC_R
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 8 9:37 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Multiple Level Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :



File : C:\MSDCHEM\1\DATA\11-07-06\R3417.D
Operator : MJ
Acquired : 07 Nov 2006 18:02 using AcqMethod RPCB1020.M
Instrument : GC_R
Sample Name: POND_SEDI,12087-001,Xs,30.10g,39.2,11/06
Misc Info : PRINCETON/MULLICA_,10/30/06,11/02/06,1
Vial Number: 3



Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3416.D\ECD1B.CH Vial: 2
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3416.D\ECD2A.CH
Acq On : 07 Nov 2006 17:45 Operator: MJ
Sample : PCB,1106-BLK4,S,30.00g,0,11/06/06,1 Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 17:59:48 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Initial Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.26	3.19	3141.0E6	5386.6E6	62.959	62.056
Spiked Amount 100.000	Range 75 - 125		Recovery =		62.96%#	62.06%#
2) S DCB	12.69	12.83	738.9E6	1012.8E6	33.413	34.905
Spiked Amount 100.000			Recovery =		33.41%	34.91%
Target Compounds						
Sum Aroclor-1016			0	0	N.D.	N.D.
Average Aroclor-1016					0.000	0.000
Sum Aroclor-1221			0	0	N.D.	N.D.
Average Aroclor-1221					0.000	0.000
Sum Aroclor-1232			0	0	N.D.	N.D.
Average Aroclor-1232					0.000	0.000
Sum Aroclor-1242			0	0	N.D.	N.D.
Average Aroclor-1242					0.000	0.000
Sum Aroclor-1248			0	0	N.D.	N.D.
Average Aroclor-1248					0.000	0.000
Sum Aroclor-1254			0	0	N.D.	N.D.
Average Aroclor-1254					0.000	0.000
Sum Aroclor-1260			0	0	N.D.	N.D.
Average Aroclor-1260					0.000	0.000

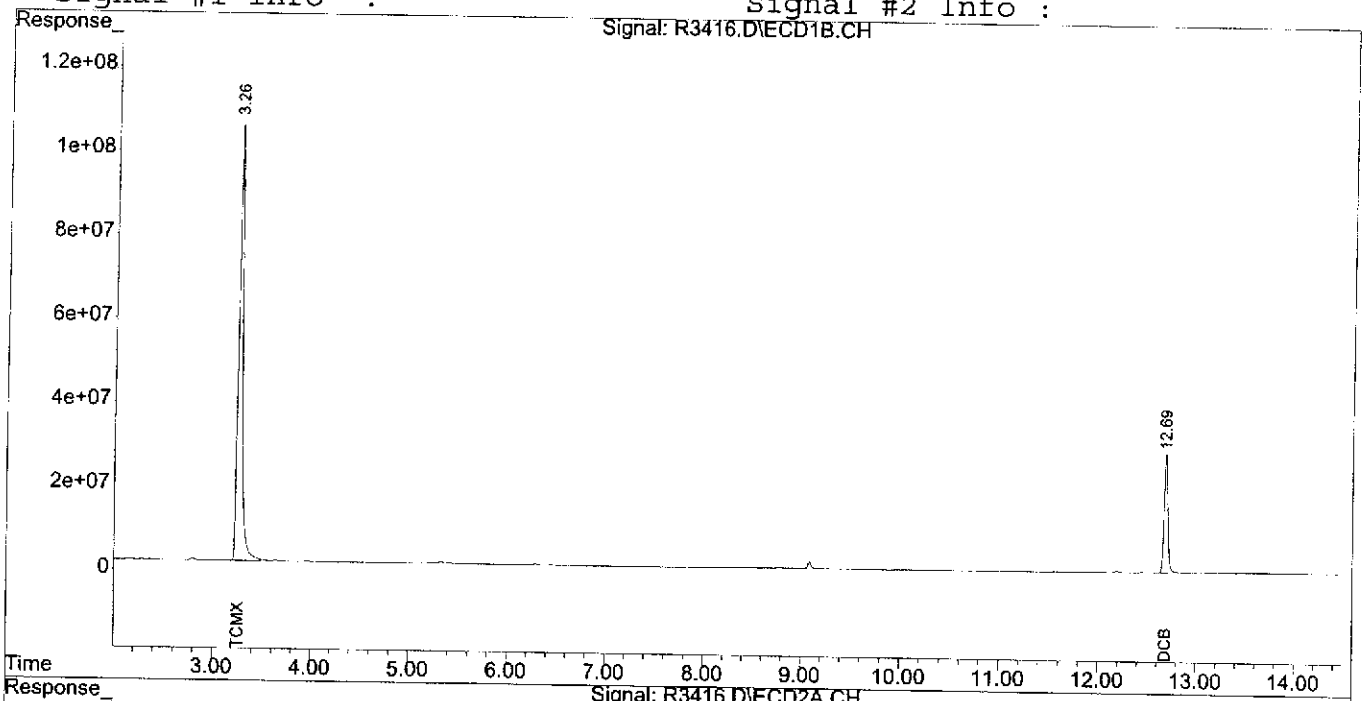
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

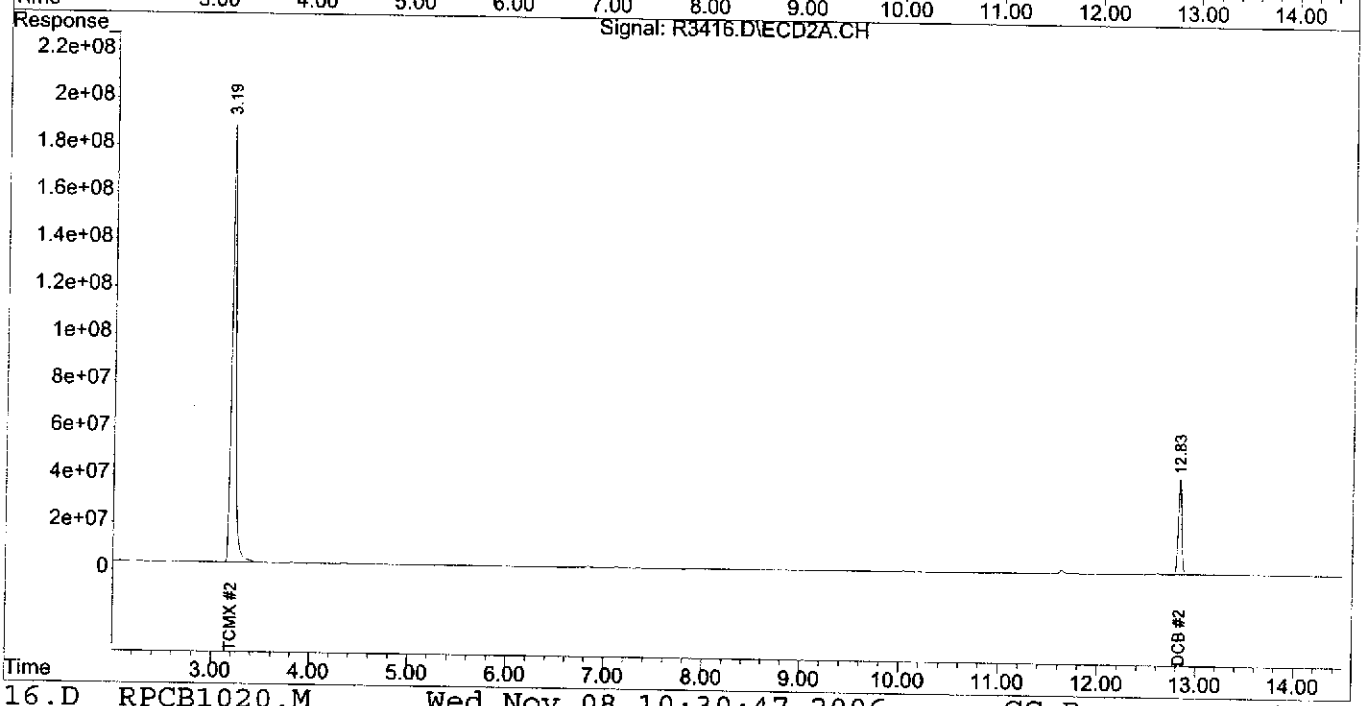
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3416.D\ECD1B.CH Vial: 2
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3416.D\ECD2A.CH
Acq On : 07 Nov 2006 17:45 Operator: MJ
Sample : PCB,1106-BLK4,S,30.00g,0,11/06/06,1 Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 8 9:30 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Multiple Level Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3415.D\ECD1B.CH Vial: 1
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3415.D\ECD2A.CH
Acq On : 07 Nov 2006 17:10 Operator: MJ
Sample : 8082_C_IAS_2707,0.5_PPM Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 17:24:46 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Initial Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.26	3.19	2207.4E6	3770.5E6	44.246	43.438
Spiked Amount 100.000	Range 75 - 125		Recovery =		44.25%#	43.44%#
2) S DCB	12.69	12.83	515.1E6	731.2E6	23.294	25.200
Spiked Amount 100.000			Recovery =		23.29%	25.20%
Target Compounds						
3) L2 Aroclor-1016	3.74	4.08	227.5E6	367.4E6	529.094	506.925
4) L2 Aroclor-1016 {2}	4.60	4.68	305.4E6	709.7E6	500.938	523.237
5) L2 Aroclor-1016 {3}	5.17	5.44	405.2E6	1631.3E6	512.422	522.201
6) L2 Aroclor-1016 {4}	5.63	5.65	198.3E6	711.2E6	532.643	515.513
7) L2 Aroclor-1016 {5}	6.09	5.83	335.5E6	552.0E6	538.484	555.170
Sum Aroclor-1016			1471.8E6	3971.6E6	2613.580	2623.046
Average Aroclor-1016					522.716	524.609
Sum Aroclor-1221			0	0	N.D.	N.D.
Average Aroclor-1221					0.000	0.000
Sum Aroclor-1232			0	0	N.D.	N.D.
Average Aroclor-1232					0.000	0.000
Sum Aroclor-1242			0	0	N.D.	N.D.
Average Aroclor-1242					0.000	0.000
Sum Aroclor-1248			0	0	N.D.	N.D.
Average Aroclor-1248					0.000	0.000
Sum Aroclor-1254			0	0	N.D.	N.D.
Average Aroclor-1254					0.000	0.000
33) L8 Aroclor-1260	8.89	8.85	797.7E6	1016.4E6	505.044	508.533
34) L8 Aroclor-1260 {2}	9.57	9.45	447.9E6	1050.7E6	474.210	508.001
35) L8 Aroclor-1260 {3}	10.04	10.04	1097.4E6	796.6E6	451.460	442.214m
36) L8 Aroclor-1260 {4}	10.52	10.55	515.0E6	1709.6E6	431.207	460.297
37) L8 Aroclor-1260 {5}	11.58	12.18	316.2E6	425.0E6	414.386m	426.159m
Sum Aroclor-1260			3174.2E6	4998.3E6	2276.308	2345.203
Average Aroclor-1260					455.262	469.041

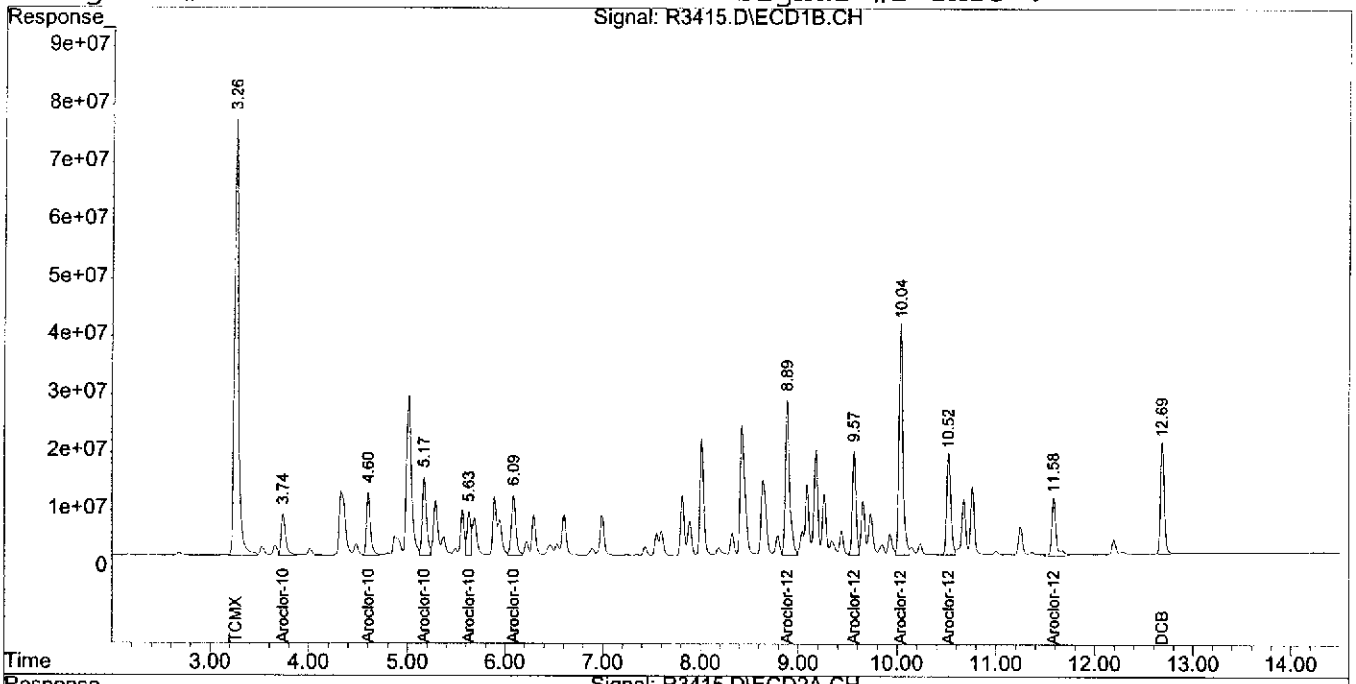
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

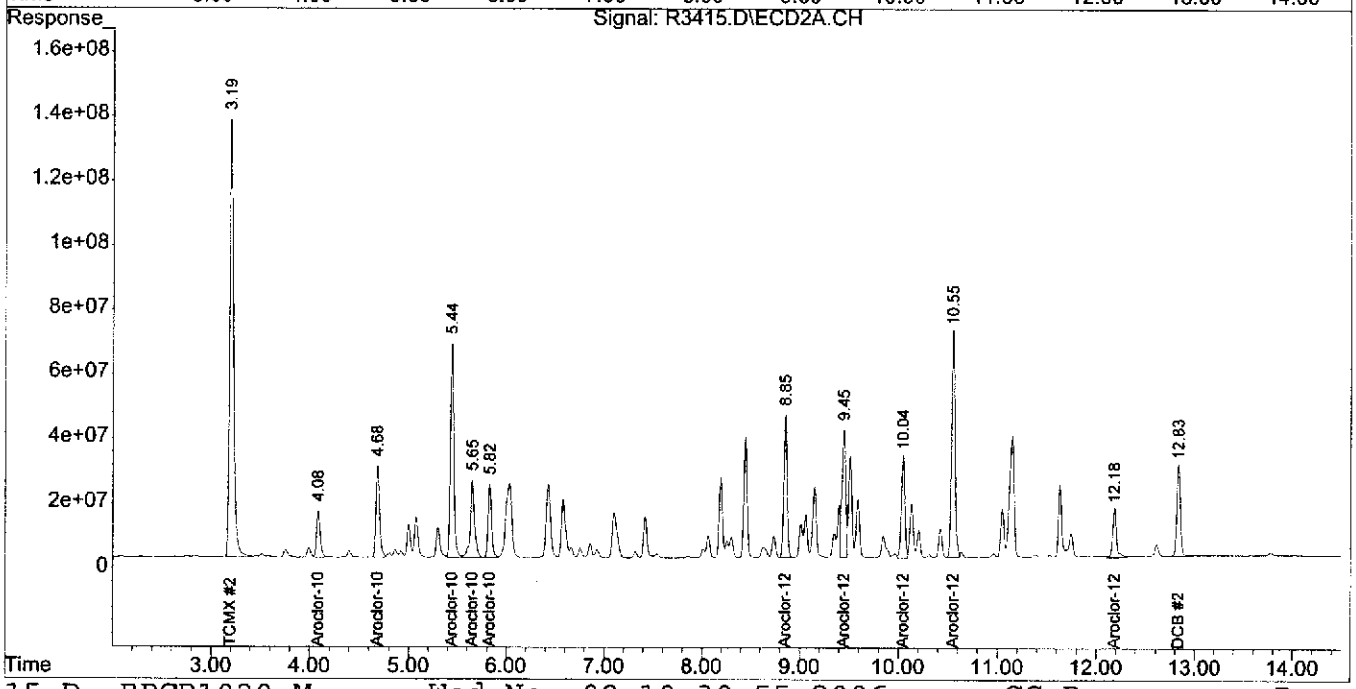
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3415.D\ECD1B.CH Vial: 1
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3415.D\ECD2A.CH
Acq On : 07 Nov 2006 17:10 Operator: MJ
Sample : 8082_C_IAS_2707,0.5_PPM Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 8 9:30 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Multiple Level Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3443.D\ECD1B.CH Vial: 30
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3443.D\ECD2A.CH
Acq On : 08 Nov 2006 2:48 Operator: MJ
Sample : 8082_C_IAS_2707,0.5_PPM Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 08 03:02:51 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Initial Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.25	3.19	2264.8E6	3904.2E6	45.396	44.979
Spiked Amount 100.000	Range 75 - 125		Recovery =		45.40%#	44.98%#
2) S DCB	12.69	12.83	641.5E6	905.8E6	29.010	31.218
Spiked Amount 100.000			Recovery =		29.01%	31.22%
Target Compounds						
3) L2 Aroclor-1016	3.74	4.08	232.8E6	377.5E6	541.451	520.816
4) L2 Aroclor-1016 (2)	4.60	4.68	311.4E6	724.2E6	510.716	533.975
5) L2 Aroclor-1016 (3)	5.17	5.43	416.1E6	1684.3E6	526.209	539.157
6) L2 Aroclor-1016 (4)	5.63	5.65	205.7E6	727.9E6	552.603	527.677
7) L2 Aroclor-1016 (5)	6.08	5.82	346.5E6	548.2E6	556.198	551.375m
Sum Aroclor-1016			1512.5E6	4062.2E6	2687.177	2673.000
Average Aroclor-1016					537.435	534.600
Sum Aroclor-1221			0	0	N.D.	N.D.
Average Aroclor-1221					0.000	0.000
Sum Aroclor-1232			0	0	N.D.	N.D.
Average Aroclor-1232					0.000	0.000
Sum Aroclor-1242			0	0	N.D.	N.D.
Average Aroclor-1242					0.000	0.000
Sum Aroclor-1248			0	0	N.D.	N.D.
Average Aroclor-1248					0.000	0.000
Sum Aroclor-1254			0	0	N.D.	N.D.
Average Aroclor-1254					0.000	0.000
33) L8 Aroclor-1260	8.88	8.85	853.5E6	1080.8E6	540.411	540.773
34) L8 Aroclor-1260 (2)	9.56	9.45	471.8E6	1121.4E6	499.484	542.208
35) L8 Aroclor-1260 (3)	10.04	10.05	1211.2E6	775.3E6	498.262	430.365
36) L8 Aroclor-1260 (4)	10.52	10.55	579.5E6	1903.3E6	485.246	512.463
37) L8 Aroclor-1260 (5)	11.58	12.18	386.2E6	497.6E6	506.113m	498.921m
Sum Aroclor-1260			3502.2E6	5378.4E6	2529.516	2524.731
Average Aroclor-1260					505.903	504.946

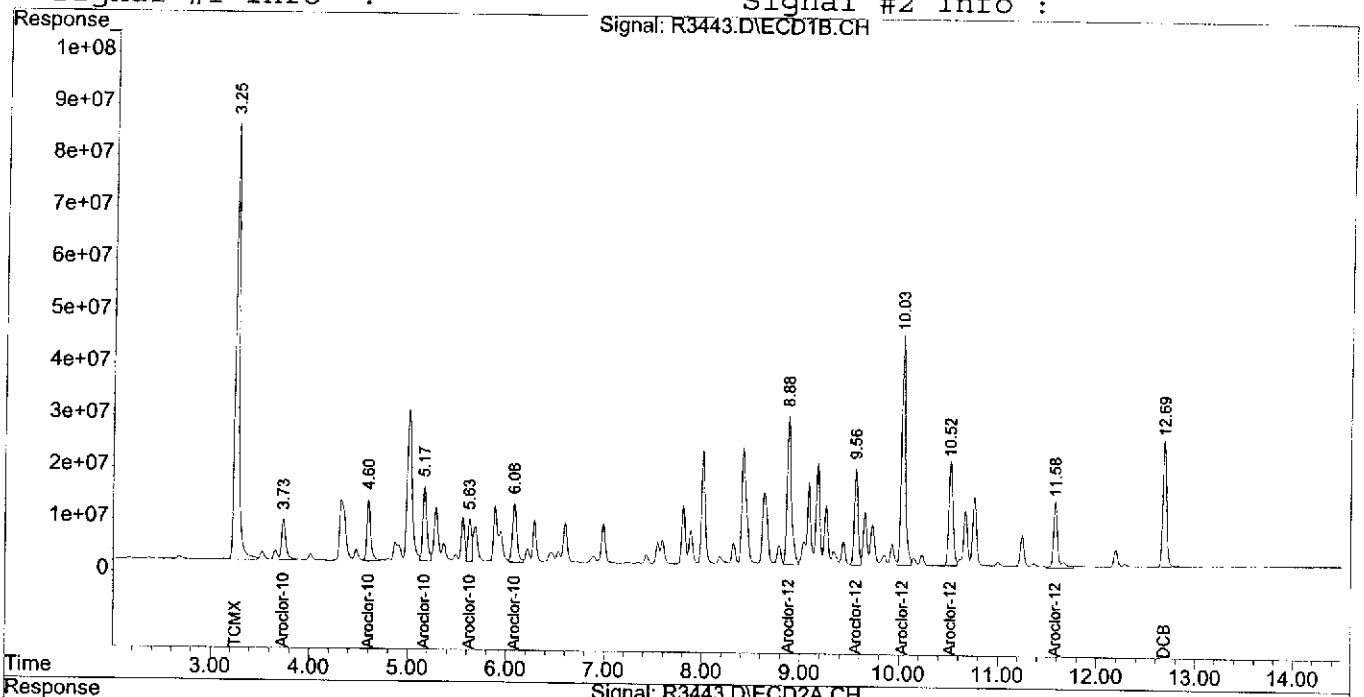
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

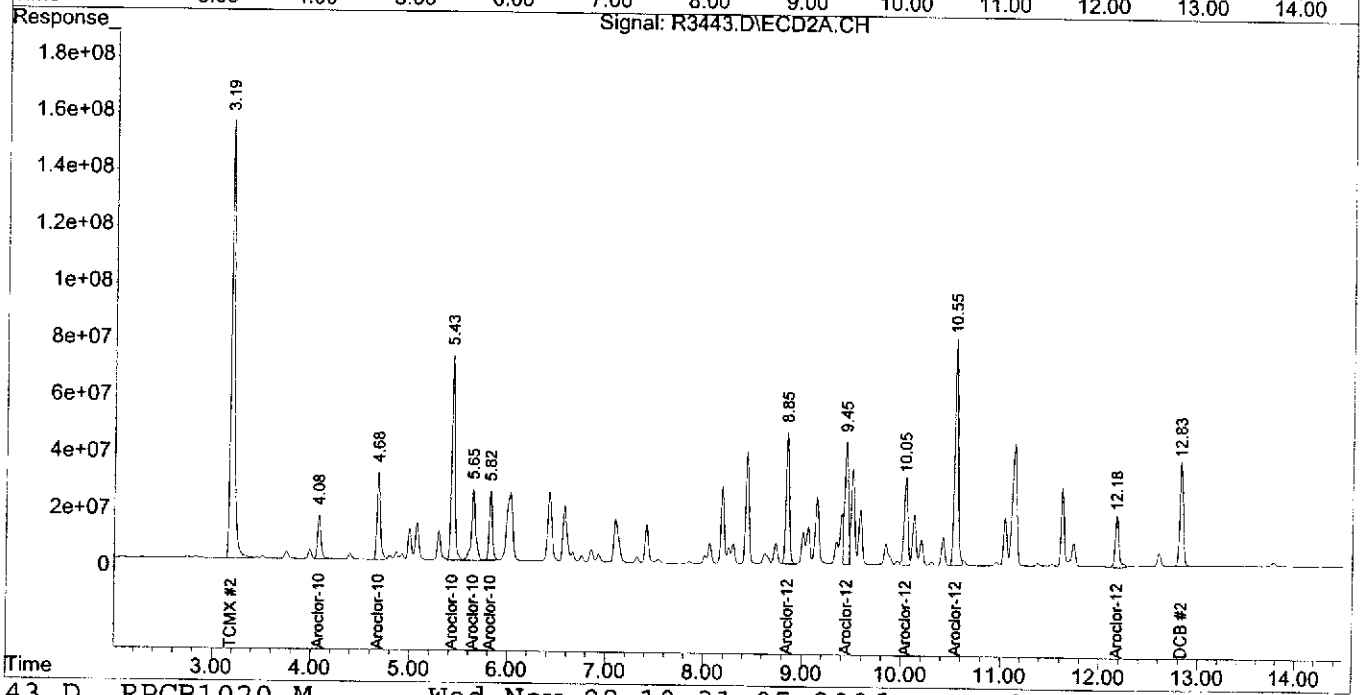
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\R3443.D\ECD1B.CH Vial: 30
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\R3443.D\ECD2A.CH
Acq On : 08 Nov 2006 2:48 Operator: MJ
Sample : 8082_C_IAS_2707,0.5_PPM Inst : GC_R
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 8 9:40 2006 Quant Results File: RPCB1020.RES

Quant Method : C:\MSDCHEM\1\METHODS\RPCB1020.M (Chemstation Integrator)
Title :
Last Update : Fri Oct 20 13:28:08 2006
Response via : Multiple Level Calibration
DataAcq Meth : RPCB1020.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





PESTICIDE METHOD BLANK SUMMARY

Lab File ID: P2286.D

Instrument ID: GC-P

Date Extracted: 11/06/2006

Matrix: SOIL

Date Analyzed: 11/07/2006

Time Analyzed: 05:16

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS & MSD:

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed
POND_SEDIM	12087-001	11/07/2006	05:30
PEST	12087-001-MS4	11/07/2006	05:44
PEST	12087-001-MSD4	11/07/2006	05:58
PEST	PBS1106-MS4	11/07/2006	06:13

INTEGRATED ANALYTICAL LABORATORIES

PESTICIDES

Client/Project: NA

Lab ID: 1106-BLK4
Client ID: .
Date Received: NA
Date Extracted: 11/06/2006
Date Analyzed: 11/07/2006
Data file: P2286.D

GC Column: DB-5/DB1701P
Sample wt/vol: 30.00g
Matrix-Units: Soil-mg/Kg (ppm)
Dilution Factor: 1
% Moisture: 0

Compound	Concentration	Q	MDL
alpha-BHC	ND		0.000167
beta-BHC	ND		0.000167
gamma-BHC	ND		0.000167
delta-BHC	ND		0.000167
Heptachlor	ND		0.000167
Aldrin	ND		0.000167
Heptachlor epoxide	ND		0.000167
Endosulfan I	ND		0.000167
4,4'-DDE	ND		0.000167
Dieldrin	ND		0.000167
Endrin	ND		0.000167
Endosulfan II	ND		0.000167
4,4'-DDD	ND		0.000167
Endrin aldehyde	ND		0.000167
Endosulfan sulfate	ND		0.000167
4,4'-DDT	ND		0.000167
Chlordane	ND		0.000501
Toxaphene	ND		0.000501

PESTICIDE INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/28/2006

Instrument ID: GC-P

GC Column (1st): DB-5

Data File: P1952.D P1953.D P1954.D P1955.D P1956.D

Compound	RT OF STANDARDS					MEAN	RT WI NDOW	
	10	50	100	200	300	RT	FROM	TO
alpha-BHC	3.73	3.73	3.73	3.73	3.73	3.73	3.67	3.79
beta-BHC	4.32	4.32	4.32	4.32	4.32	4.32	4.26	4.38
gamma-BHC	4.19	4.19	4.19	4.19	4.19	4.19	4.13	4.25
delta-BHC	4.59	4.59	4.59	4.59	4.59	4.59	4.53	4.65
Heptachlor	4.91	4.91	4.91	4.91	4.91	4.91	4.83	4.99
Aldrin	5.38	5.38	5.37	5.37	5.37	5.38	5.30	5.46
Heptachlor epoxide	6.35	6.35	6.35	6.35	6.35	6.35	6.27	6.43
Endosulfan I	6.99	6.98	6.98	6.98	6.98	6.98	6.90	7.06
4,4'-DDE	6.92	6.92	6.92	6.92	6.91	6.92	6.82	7.02
Dieldrin	7.38	7.38	7.38	7.38	7.38	7.38	7.28	7.48
Endrin	7.76	7.75	7.76	7.76	7.76	7.76	7.66	7.86
Endosulfan II	8.13	8.13	8.13	8.13	8.13	8.13	8.03	8.23
4,4'-DDD	7.90	7.90	7.90	7.90	7.90	7.90	7.80	8.00
Endrin aldehyde	8.81	8.81	8.81	8.81	8.81	8.81	8.69	8.93
Endosulfan sulfate	9.34	9.34	9.34	9.34	9.34	9.34	9.22	9.46
4,4'-DDT	8.36	8.36	8.36	8.36	8.36	8.36	8.24	8.48
Endrin ketone	9.62	9.62	9.62	9.62	9.62	9.62	9.50	9.74
Methoxychlor	9.09	9.08	9.09	9.09	9.08	9.09	8.97	9.21
alpha-Chlordane	6.77	6.77	6.77	6.77	6.77	6.77	6.69	6.85
gamma-Chlordane	6.55	6.55	6.55	6.55	6.55	6.55	6.47	6.63
Chlordane 500 ppb			4.91				4.83	4.99
Chlordane {2}			5.60				5.52	5.68
Chlordane {3}			6.55				6.47	6.63
Chlordane {4}			6.75				6.67	6.83
Chlordane {5}			8.01				7.93	8.09
Toxaphene 500 ppb			7.68				7.60	7.76
Toxaphene {2}			8.23				8.15	8.31
Toxaphene {3}			8.94				8.86	9.02
Toxaphene {4}			9.22				9.14	9.30
Toxaphene {5}			9.28				9.20	9.36

PESTICIDE INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/28/2006 **Instrument ID:** GC-P
GC Column (1st): DB-5

Data File: P1952.D P1953.D P1954.D P1955.D P1956.D

Compound	CALIBRATION FACTORS 10	50	100	200	300	MEAN	%RSD
alpha-BHC	335654	328935	342550	342837	360351	342065	3.42
beta-BHC	163948	132872	130931	126789	131801	137268	10.99
gamma-BHC	307341	304495	312975	312275	327958	313009	2.90
delta-BHC	293940	296104	310775	309181	330320	308064	4.72
Heptachlor	285100	273327	282500	283194	297797	284383	3.08
Aldrin	305897	288803	294192	294179	307422	298099	2.73
Heptachlor epoxide	283030	260348	264449	258626	269289	267148	3.66
Endosulfan I	276873	254458	255037	249094	259150	258922	4.11
4,4'-DDE	240458	234345	241492	239715	251883	241579	2.64
Dieldrin	286049	270227	274749	270321	282653	276800	2.61
Endrin	249831	238144	244235	241095	253834	245428	2.60
Endosulfan II	249173	225452	228162	222020	232469	231455	4.59
4,4'-DDD	211472	198400	201584	198618	208106	203636	2.89
Endrin aldehyde	175541	154582	161344	155742	165549	162551	5.23
Endosulfan sulfate	219448	194285	198651	193680	203933	202000	5.24
4,4'-DDT	193689	189305	198430	200165	213545	199027	4.60
Endrin ketone	264274	237799	240412	234231	245478	244439	4.84
Methoxychlor	127368	103033	102639	99609	104659	107462	10.49
alpha-Chlordane	283058	259880	262095	257308	269071	266283	3.89
gamma-Chlordane	277737	258195	263958	260279	273063	266646	3.16
Chlordane 500 ppb			13095				
Chlordane {2}			10384				
Chlordane {3}			33964				
Chlordane {4}			52946				
Chlordane {5}			8932				
Toxaphene 500 ppb			7839				
Toxaphene {2}			10158				
Toxaphene {3}			12581				
Toxaphene {4}			10990				
Toxaphene {5}			18510				

PESTICIDE INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/28/2006

Instrument ID: GC-P

GC Column (2nd): DB-1701P

Data File: P1952.C P1953.C P1954.C P1955.C P1956.C

Compound	RT OF STANDARDS					MEAN	RT WINDOW	
	10	50	100	200	300	RT	FROM	TO
alpha-BHC	3.57	3.57	3.57	3.57	3.57	3.57	3.51	3.63
beta-BHC	4.23	4.22	4.22	4.22	4.22	4.22	4.16	4.28
gamma-BHC	4.09	4.09	4.08	4.08	4.08	4.08	4.02	4.14
delta-BHC	4.67	4.66	4.66	4.66	4.66	4.66	4.60	4.72
Heptachlor	4.74	4.73	4.73	4.73	4.73	4.73	4.65	4.81
Aldrin	5.23	5.23	5.22	5.22	5.22	5.23	5.15	5.31
Heptachlor epoxide	6.16	6.15	6.15	6.15	6.15	6.15	6.07	6.23
Endosulfan I	6.78	6.78	6.78	6.78	6.78	6.78	6.70	6.86
4,4'-DDE	7.03	7.02	7.02	7.02	7.02	7.02	6.92	7.12
Dieldrin	7.23	7.23	7.23	7.23	7.23	7.23	7.13	7.33
Endrin	7.72	7.72	7.72	7.72	7.72	7.72	7.62	7.82
Endosulfan II	8.09	8.09	8.09	8.09	8.09	8.09	7.99	8.19
4,4'-DDD	7.99	7.99	7.99	7.99	7.99	7.99	7.89	8.09
Endrin aldehyde	8.67	8.66	8.66	8.66	8.66	8.66	8.54	8.78
Endosulfan sulfate	9.05	9.04	9.04	9.04	9.04	9.04	8.92	9.16
4,4'-DDT	8.50	8.50	8.50	8.50	8.50	8.50	8.38	8.62
Endrin ketone	9.61	9.61	9.61	9.61	9.61	9.61	9.49	9.73
Methoxychlor	9.42	9.42	9.42	9.42	9.42	9.42	9.30	9.54
alpha-Chlordane	6.70	6.70	6.70	6.70	6.70	6.70	6.62	6.78
gamma-Chlordane	6.46	6.46	6.46	6.45	6.45	6.46	6.38	6.54
Chlordane 500 ppb			4.51				4.43	4.59
Chlordane {2}			5.49				5.41	5.57
Chlordane {3}			6.45				6.37	6.53
Chlordane {4}			6.61				6.53	6.69
Chlordane {5}			6.69				6.61	6.77
Toxaphene 500 ppb			7.64				7.56	7.72
Toxaphene {2}			8.23				8.15	8.31
Toxaphene {3}			8.35				8.27	8.43
Toxaphene {4}			8.78				8.70	8.86
Toxaphene {5}			9.30				9.22	9.38

PESTICIDE INITIAL CALIBRATION SUMMARY

Date Analyzed: 10/28/2006

Instrument ID: GC-P

GC Column (2nd): DB-1701P

Data File: P1952.C P1953.C P1954.C P1955.C P1956.C

Compound	CALIBRATION FACTORS 10	50	100	200	300	MEAN	%RSD
alpha-BHC	1881956	1959200	2063205	2045633	2133707	2016740	4.84
beta-BHC	825162	765064	774097	753984	783955	780452	3.50
gamma-BHC	1755840	1774302	1834933	1814161	1888141	1813475	2.88
delta-BHC	1489907	1570801	1659857	1621878	1723397	1613168	5.49
Heptachlor	1611703	1684674	1756185	1698965	1724801	1695266	3.19
Aldrin	1680403	1674527	1699087	1638612	1674214	1673369	1.31
Heptachlor epoxide	1584617	1503568	1475150	1372124	1380027	1463097	6.09
Endosulfan I	1516895	1426845	1413355	1327328	1334824	1403849	5.52
4,4'-DDE	1329557	1343956	1371969	1349417	1394206	1357821	1.87
Dieldrin	1510968	1496489	1478498	1408424	1439328	1466742	2.88
Endrin	992879	1054240	1086318	1065463	1098427	1059465	3.87
Endosulfan II	1410052	1297787	1287309	1217913	1236557	1289924	5.82
4,4'-DDD	1076539	1070542	1103408	1074238	1110834	1087112	1.71
Endrin aldehyde	903088	833454	900875	847210	857482	868422	3.66
Endosulfan sulfate	1033121	1005183	1024083	986199	1036469	1017011	2.07
4,4'-DDT	805193	912587	1013718	1033731	1103488	973743	11.95
Endrin ketone	1209836	1136142	1157732	1071699	1129442	1140970	4.38
Methoxychlor	340639	448383	463077	426180	461905	428037	11.93
alpha-Chlordane	1514140	1447135	1467531	1422538	1471993	1464668	2.31
gamma-Chlordane	1541664	1491421	1517410	1482672	1537934	1514220	1.76
Chlordane 500 ppb			65397				
Chlordane {2}			57651				
Chlordane {3}			194774				
Chlordane {4}			156837				
Chlordane {5}			170651				
Toxaphene 500 ppb			50365				
Toxaphene {2}			63541				
Toxaphene {3}			32072				
Toxaphene {4}			66050				
Toxaphene {5}			77561				

PESTICIDE CALIBRATION VERIFICATION SUMMARY

Date Analyzed: 11/07/2006 **Instrument ID:** GC-P

Data File: P2261.D **GC Column (1st):** DB-5

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
alpha-BHC	3.74	3.67	3.79	342065	348742	1.95
beta-BHC	4.33	4.26	4.38	137268	128295	6.54
gamma-BHC	4.20	4.13	4.25	313009	315760	0.88
delta-BHC	4.59	4.53	4.65	308064	310021	0.64
Heptachlor	4.91	4.83	4.99	284383	285483	0.39
Aldrin	5.37	5.30	5.46	298099	290929	2.41
Heptachlor epoxide	6.34	6.27	6.43	267148	265148	0.75
Endosulfan I	6.98	6.90	7.06	258922	256508	0.93
4,4'-DDE	6.91	6.82	7.02	241579	250675	3.77
Dieldrin	7.37	7.28	7.48	276800	276473	0.12
Endrin	7.74	7.66	7.86	245428	254696	3.78
Endosulfan II	8.11	8.03	8.23	231455	232535	0.47
4,4'-DDD	7.89	7.80	8.00	203636	210332	3.29
Endrin aldehyde	8.79	8.69	8.93	162551	158935	2.22
Endosulfan sulfate	9.33	9.22	9.46	202000	198320	1.82
4,4'-DDT	8.35	8.24	8.48	199027	214837	7.94
Endrin ketone	9.61	9.50	9.74	244439	248539	1.68
Methoxychlor	9.08	8.97	9.21	107462	110866	3.17
alpha-Chlordane	6.76	6.69	6.85	266283	264012	0.85
gamma-Chlordane	6.54	6.47	6.63	266646	265311	0.50
					Average %D	2.20
Chlordane 500 ppb	4.90	4.83	4.99	13095	12538	4.25
Chlordane {2}	5.59	5.52	5.68	10384	10217	1.61
Chlordane {3}	6.54	6.47	6.63	33964	33323	1.89
Chlordane {4}	6.74	6.67	6.83	52946	52246	1.32
Chlordane {5}	7.99	7.93	8.09	8932	8689	2.71
Toxaphene 500 ppb	7.66	7.60	7.76	7839	7419	5.36
Toxaphene {2}	8.22	8.15	8.31	10158	9744	4.07
Toxaphene {3}	8.93	8.86	9.02	12581	12222	2.85
Toxaphene {4}	9.21	9.14	9.30	10990	10520	4.28
Toxaphene {5}	9.27	9.20	9.36	18510	18309	1.08
					Average %D	2.94

PESTICIDE CALIBRATION VERIFICATION SUMMARY

Date Analyzed: 11/07/2006 **Instrument ID:** GC-P

Data File: P2261.C **GC Column (2nd):** DB-1701P

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
alpha-BHC	3.58	3.51	3.63	2016740	1948778	3.37
beta-BHC	4.22	4.16	4.28	780452	720811	7.64
gamma-BHC	4.09	4.02	4.14	1813475	1744414	3.81
delta-BHC	4.66	4.60	4.72	1613168	1591843	1.32
Heptachlor	4.73	4.65	4.81	1695266	1571951	7.27
Aldrin	5.22	5.15	5.31	1673369	1583924	5.35
Heptachlor epoxide	6.14	6.07	6.23	1463097	1568554	7.21
Endosulfan I	6.76	6.70	6.86	1403849	1331877	5.13
4,4'-DDE	7.01	6.92	7.12	1357821	1341809	1.18
Dieldrin	7.21	7.13	7.33	1466742	1412850	3.67
Endrin	7.71	7.62	7.82	1059465	1117055	5.44
Endosulfan II	8.07	7.99	8.19	1289924	1226842	4.89
4,4'-DDD	7.97	7.89	8.09	1087112	1102299	1.40
Endrin aldehyde	8.65	8.54	8.78	868422	815854	6.05
Endosulfan sulfate	9.03	8.92	9.16	1017011	929320	8.62
4,4'-DDT	8.48	8.38	8.62	973743	1068919	9.77
Endrin ketone	9.60	9.49	9.73	1140970	2356405	106.53
Methoxychlor	9.41	9.30	9.54	428037	460515	7.59
alpha-Chlordane	6.68	6.62	6.78	1464668	1403279	4.19
gamma-Chlordane	6.44	6.38	6.54	1514220	1426373	5.80
					Average %D	10.31
Chlordane 500 ppb	4.50	4.43	4.59	65397	60868	6.93
Chlordane {2}	5.47	5.41	5.57	57651	52315	9.26
Chlordane {3}	6.44	6.37	6.53	194774	177443	8.90
Chlordane {4}	6.59	6.53	6.69	156837	141034	10.08
Chlordane {5}	6.68	6.61	6.77	170651	154511	9.46
Toxaphene 500 ppb	7.62	7.56	7.72	50365	45278	10.10
Toxaphene {2}	8.21	8.15	8.31	63541	58643	7.71
Toxaphene {3}	8.33	8.27	8.43	32072	29694	7.41
Toxaphene {4}	8.76	8.70	8.86	66050	61499	6.89
Toxaphene {5}	9.29	9.22	9.38	77561	74740	3.64
					Average %D	8.04

PESTICIDE CALIBRATION VERIFICATION SUMMARY

Date Analyzed: 11/07/2006 **Instrument ID:** GC-P

Data File: P2292.D **GC Column (1st):** DB-5

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
alpha-BHC	3.73	3.67	3.79	342065	349238	2.10
beta-BHC	4.32	4.26	4.38	137268	132019	3.82
gamma-BHC	4.19	4.13	4.25	313009	316255	1.04
delta-BHC	4.58	4.53	4.65	308064	327955	6.46
Heptachlor	4.90	4.83	4.99	284383	276614	2.73
Aldrin	5.37	5.30	5.46	298099	291392	2.25
Heptachlor epoxide	6.34	6.27	6.43	267148	264788	0.88
Endosulfan I	6.97	6.90	7.06	258922	256047	1.11
4,4'-DDE	6.90	6.82	7.02	241579	252966	4.71
Dieldrin	7.36	7.28	7.48	276800	277143	0.12
Endrin	7.74	7.66	7.86	245428	256607	4.56
Endosulfan II	8.11	8.03	8.23	231455	238784	3.17
4,4'-DDD	7.88	7.80	8.00	203636	233507	14.67
Endrin aldehyde	8.79	8.69	8.93	162551	173395	6.67
Endosulfan sulfate	9.33	9.22	9.46	202000	206243	2.10
4,4'-DDT	8.34	8.24	8.48	199027	169551	14.81
Endrin ketone	9.61	9.50	9.74	244439	241456	1.22
Methoxychlor	9.07	8.97	9.21	107462	84313	21.54
alpha-Chlordane	6.75	6.69	6.85	266283	263384	1.09
gamma-Chlordane	6.54	6.47	6.63	266646	264537	0.79
					Average %D	4.79

PESTICIDE CALIBRATION VERIFICATION SUMMARY

Date Analyzed: 11/07/2006 **Instrument ID:** GC-P

Data File: P2292.C **GC Column (2nd):** DB-1701P

Compound	RT	RT WINDOW FROM	RT WINDOW TO	Avg CF	CC CF	%D
alpha-BHC	3.57	3.51	3.63	2016740	2043804	1.34
beta-BHC	4.21	4.16	4.28	780452	760274	2.59
gamma-BHC	4.08	4.02	4.14	1813475	1806513	0.38
delta-BHC	4.65	4.60	4.72	1613168	1715890	6.37
Heptachlor	4.72	4.65	4.81	1695266	1589978	6.21
Aldrin	5.21	5.15	5.31	1673369	1657066	0.97
Heptachlor epoxide	6.13	6.07	6.23	1463097	1616110	10.46
Endosulfan I	6.76	6.70	6.86	1403849	1370474	2.38
4,4'-DDE	7.00	6.92	7.12	1357821	1377893	1.48
Dieldrin	7.21	7.13	7.33	1466742	1443355	1.59
Endrin	7.70	7.62	7.82	1059465	1201213	13.38
Endosulfan II	8.06	7.99	8.19	1289924	1250570	3.05
4,4'-DDD	7.96	7.89	8.09	1087112	1218962	12.13
Endrin aldehyde	8.64	8.54	8.78	868422	897346	3.33
Endosulfan sulfate	9.02	8.92	9.16	1017011	999349	1.74
4,4'-DDT	8.47	8.38	8.62	973743	852663	12.43
Endrin ketone	9.59	9.49	9.73	1140970	2403185	110.63
Methoxychlor	9.40	9.30	9.54	428037	334499	21.85
alpha-Chlordane	6.68	6.62	6.78	1464668	1443136	1.47
gamma-Chlordane	6.44	6.38	6.54	1514220	1465430	3.22
					Average %D	10.85

PESTICIDE SURROGATE PERCENT RECOVERY SUMMARY

Date Analyzed: 11/07/2006

Client ID	Lab Sample ID	Matrix	TCMX 1 % rec	#	DCB 1 % rec	#	TCMX 2 % rec	#	DCB 2 % rec	#
.	1106-BLK3	AQUEOUS	67		61		64		59	
102406-08	11911-001	AQUEOUS	60		55		57		54	
SP-GW1/10-	12027-012	AQUEOUS	77		88		73		82	
CP-GW1/10-	12027-013	AQUEOUS	88		115		80		146	
SP-GW2/10-	12027-014	AQUEOUS	74		78		66		73	
SP-GW3/10-	12027-015	AQUEOUS	81		146		72		142	
ESI_GW1	11956-003	AQUEOUS	70		85		65		73	
ESI_GW2	11956-004	AQUEOUS	66		135		61		64	
PEST	11911-001-MS3	AQUEOUS	69		60		66		56	
PEST	11911-001-MSD3	AQUEOUS	69		61		67		58	
PEST	PBA1106-MS3	AQUEOUS	71		64		69		59	
.	1106-BLK1	SOIL	62		57		61		53	
S1	11847-001	SOIL	77		58		73		54	
PE-1	12056-001	SOIL	78		76		82		74	
SB-6(D)	12178-001	SOIL	87		76		84		74	
SB-8	12178-002	SOIL	79		68		75		64	
SB-9	12178-003	SOIL	85		77		80		70	
SB-10	12178-004	SOIL	84		73		77		64	
SB-11	12178-005	SOIL	84		75		77		63	
PEST	12056-001-MS1	SOIL	77		73		86		63	
PEST	12056-001-MSD1	SOIL	76		72		83		66	
PEST	PBS1106-MS1	SOIL	57		48		54		43	
.	1106-BLK4	SOIL	69		58		65		52	
POND_SEDIM	12087-001	SEDIMENT	76		98		58		106	

Surrogate QC Limits	Soil	Aqueous
TCMX = Tetrachloro-m-xylene	21-163	11-163
DCB = Decachlorobiphenyl	23-172	13-170

\# Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

PESTICIDE SURROGATE PERCENT RECOVERY SUMMARY

Date Analyzed: 11/07/2006

Client ID	Lab Sample ID	Matrix	TCMX 1 % rec	#	DCB 1 % rec	#	TCMX 2 % rec	#	DCB 2 % rec	#
PEST	12087-001-MS4	SEDIMENT	72		77		90		88	
PEST	12087-001-MSD4	SEDIMENT	72		83		70		84	
PEST	PBS1106-MS4	SOIL	107		108		100		91	

Surrogate QC Limits	Soil	Aqueous
TCMX = Tetrachloro-m-xylene	21-163	11-163
DCB = Decachlorobiphenyl	23-172	13-170

\# Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

SOIL PESTICIDES MATRIX SPIKE/SPIKE DUPLICATE RECOVERY

Matrix spike Lab sample ID: 12087-001-MSD4

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
gamma-BHC	100.0	0.0	66.1	66	41 - 148
Heptachlor	100.0	0.0	96.7	97	37 - 164
Aldrin	100.0	0.0	84.2	84	37 - 151
Dieldrin	100.0	0.0	81.2	81	52 - 143
Endrin	100.0	0.0	94.1	94	54 - 166
4,4'-DDT	100.0	1.7	90.6	89	23 - 196

Compound	SAMPLE CONC. (ug/Kg)	MSD CONC. (ug/Kg)	MSD % # REC	% RPD #	QC LIMITS RPD	QC LIMITS REC.
gamma-BHC	0.0	66.5	67	2	18	41 - 148
Heptachlor	0.0	80.5	81	18	21	37 - 164
Aldrin	0.0	84.9	85	1	19	37 - 151
Dieldrin	0.0	80.4	80	1	15	52 - 143
Endrin	0.0	93.0	93	1	19	54 - 166
4,4'-DDT	1.7	79.3	78	13	26	23 - 196

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

RPD: __0___ out of __6__ outside limits

Spike Recovery: __0___ out of __12__ outside limits

SOIL PESTICIDES BLANK SPIKE RECOVERY

Matrix spike Lab sample ID: PBS1106-MS4

Compound	SPIKE ADDED (ug/Kg)	SAMPLE CONC. (ug/Kg)	MS CONC. (ug/Kg)	MS % REC #	QC LIMITS REC.
gamma-BHC	100.0	0.0	107.2	107	41 - 148
Heptachlor	100.0	0.0	101.0	101	37 - 164
Aldrin	100.0	0.0	103.0	103	37 - 151
Dieldrin	100.0	0.0	105.2	105	52 - 143
Endrin	100.0	0.0	110.5	111	54 - 166
4,4'-DDT	100.0	1.7	74.1	72	23 - 196

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

NC Non calculable

Spike Recovery: __0___ out of __6__ outside limits

PESTICIDE RETENTION TIME SHIFT SUMMARY

Instrument ID: GC-P **Column:** DB-5/DB-1701P

Surrogate RT from initial calibration :

TCMX 1 3.00 **DCB 1** 10.58 **TCMX 2** 2.78 **DCB 2** 10.80

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed	TCMX 1 RT	#	DCB 1 RT	#	TCMX 2 RT	#	DCB 2 RT	#
.	1106-BLK3	11/07/2006	12:07	3.00		10.58		2.78		10.80	
102406-08	11911-001	11/07/2006	12:21	3.00		10.58		2.78		10.80	
SP-GW1/10-	12027-012	11/07/2006	12:35	3.00		10.58		2.78		10.80	
CP-GW1/10-	12027-013	11/07/2006	12:49	3.00		10.58		2.78		10.79	
SP-GW2/10-	12027-014	11/07/2006	01:03	2.99		10.58		2.78		10.80	
SP-GW3/10-	12027-015	11/07/2006	01:17	3.00		10.58		2.78		10.79	
ESI_GW1	11956-003	11/07/2006	01:31	2.99		10.58		2.78		10.80	
ESI_GW2	11956-004	11/07/2006	01:45	2.99		10.58		2.78		10.80	
PEST	11911-001-MS3	11/07/2006	01:59	2.99		10.58		2.78		10.80	
PEST	11911-001-MSD3	11/07/2006	02:13	2.99		10.58		2.78		10.80	
PEST	PBA1106-MS3	11/07/2006	02:27	3.00		10.58		2.78		10.80	
.	1106-BLK1	11/07/2006	02:41	3.00		10.58		2.78		10.80	
S1	11847-001	11/07/2006	02:55	2.99		10.58		2.78		10.80	
PE-1	12056-001	11/07/2006	03:10	3.00		10.58		2.78		10.80	
SB-6(D)	12178-001	11/07/2006	03:24	2.99		10.58		2.78		10.80	
SB-8	12178-002	11/07/2006	03:38	3.00		10.58		2.78		10.80	
SB-9	12178-003	11/07/2006	03:52	3.00		10.58		2.78		10.80	
SB-10	12178-004	11/07/2006	04:06	3.00		10.58		2.78		10.80	
SB-11	12178-005	11/07/2006	04:20	3.00		10.58		2.78		10.80	
PEST	12056-001-MS1	11/07/2006	04:34	3.00		10.58		2.78		10.80	
PEST	12056-001-MSD1	11/07/2006	04:48	3.00		10.58		2.78		10.80	
PEST	PBS1106-MS1	11/07/2006	05:02	3.00		10.58		2.78		10.80	
.	1106-BLK4	11/07/2006	05:16	2.99		10.58		2.78		10.80	
POND_SEDIM	12087-001	11/07/2006	05:30	3.00		10.58		2.78		10.79	

Surrogate QC Limits

TCMX = Tetrachloro-m-xylene (± 0.08 Minutes)

DCB = Decachlorobiphenyl (± 0.08 Minutes)

Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

PESTICIDE RETENTION TIME SHIFT SUMMARY

Instrument ID: GC-P **Column:** DB-5/DB-1701P

Surrogate RT from initial calibration :

TCMX 1 2.99 **DCB 1** 10.58 **TCMX 2** 2.78 **DCB 2** 10.80

Client ID	Lab Sample ID	Date Analyzed	Time Analyzed	TCMX 1 RT	#	DCB 1 RT	#	TCMX 2 RT	#	DCB 2 RT	#
PEST	12087-001-MS4	11/07/2006	05:44	2.99		10.58		2.78		10.79	
PEST	12087-001-MSD4	11/07/2006	05:58	2.99		10.58		2.78		10.79	
PEST	PBS1106-MS4	11/07/2006	06:13	2.99		10.58		2.78		10.79	

Surrogate QC Limits

TCMX = Tetrachloro-m-xylene (± 0.08 Minutes)

DCB = Decachlorobiphenyl (± 0.08 Minutes)

\# Column to be used to flag recovery values
* Values outside of QC limits
D Surrogate diluted out
M Matrix interference

Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2287.D\ECD1B.CH Vial: 28
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2287.D\ECD2A.CH
Acq On : 07 Nov 2006 5:30 pm Operator: MEI
Sample : POND_SEDIM,12087-001,Xs,30.10g,39.2,11/0 Inst : GC_P
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,10 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 17:42:26 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

	Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
	System Monitoring Compounds						
1) S	TCMX	3.00	2.78	3788049	16337080	7.647	5.786m
	Spiked Amount 100.000			Recovery	=	7.65%	5.79%
2) S	DCB	10.58	10.79	1633620	7776170	9.750	10.593
	Spiked Amount 100.000			Recovery	=	9.75%	10.59%
	Target Compounds						
11) T	4,4'-DDE	6.90	7.00	1732921	11748538	7.173	8.652
15) T	4,4'-DDD	7.88	7.97	1114506	6178189	5.473m	5.683
18) T	4,4'-DDT	8.34	8.48	340403	1616141	1.710m	1.660
	Sum Chlordane			0	0	N.D.	N.D.
	Average Chlordane					0.000	0.000
	Sum Toxaphene			0	0	N.D.	N.D.
	Average Toxaphene					0.000	0.000

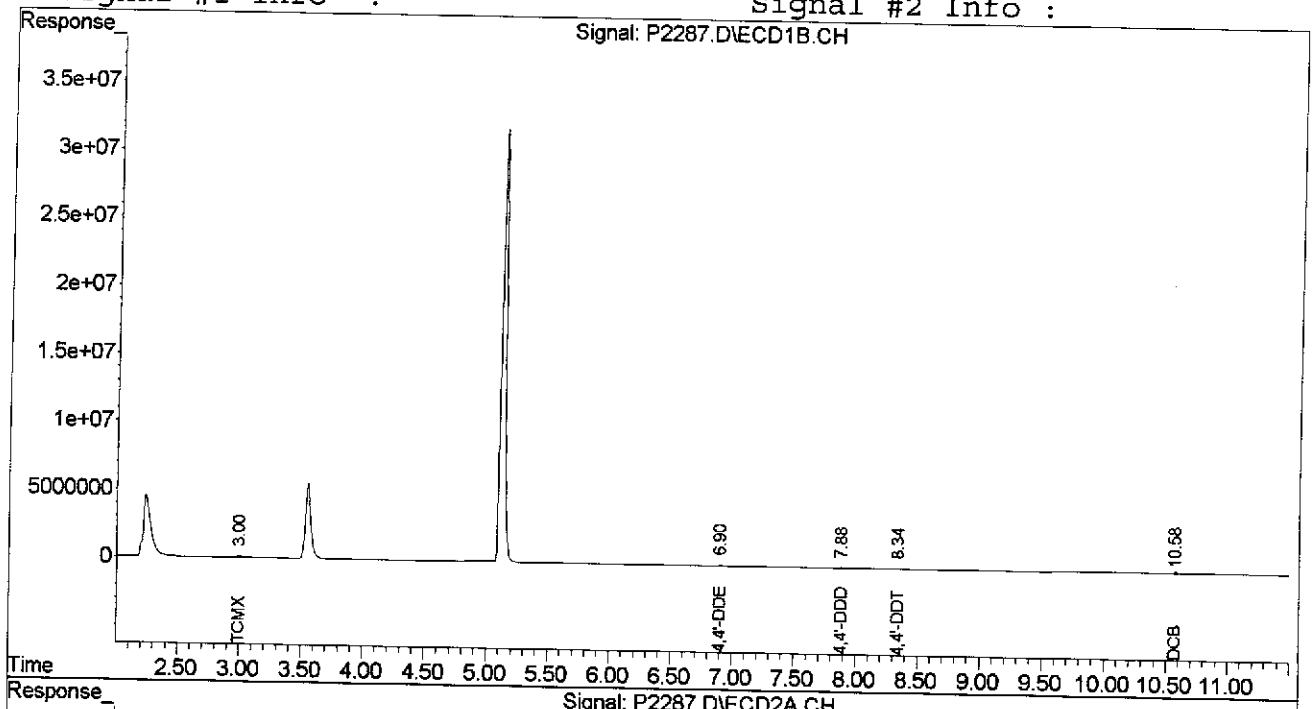
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

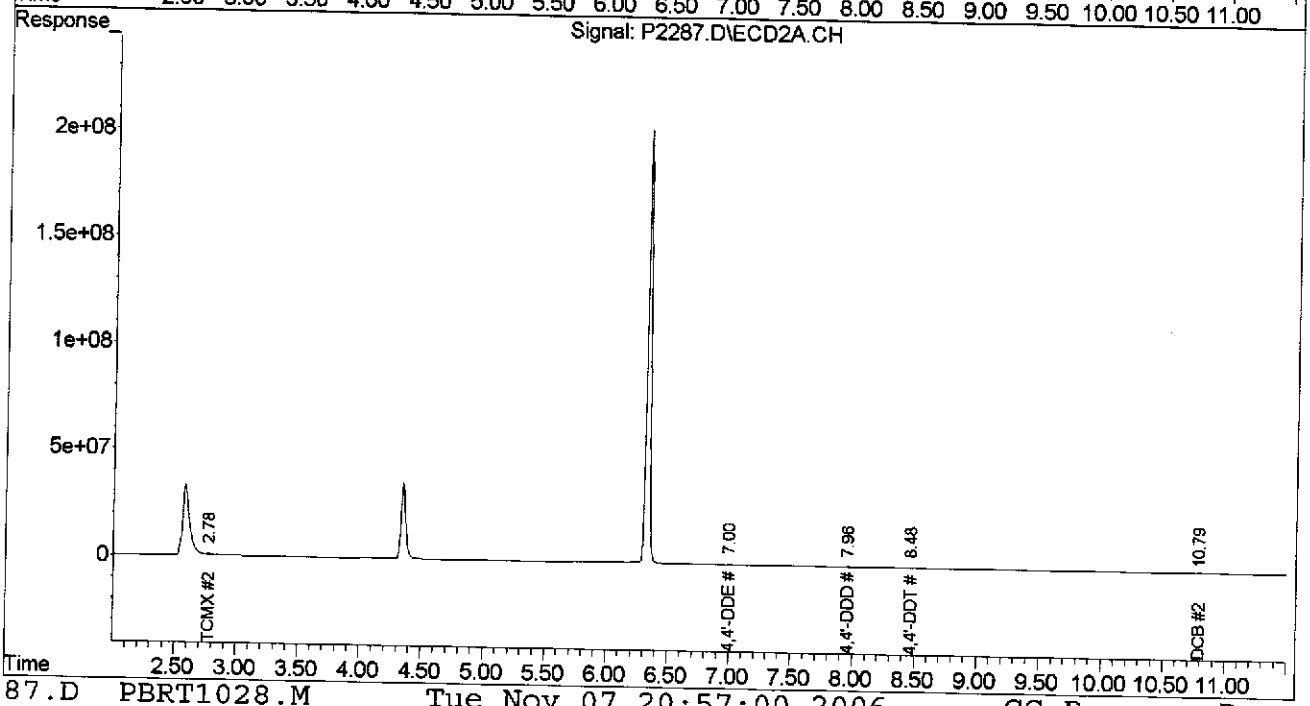
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2287.D\ECD1B.CH Vial: 28
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2287.D\ECD2A.CH
Acq On : 07 Nov 2006 5:30 pm Operator: MEI
Sample : POND_SEDIM,12087-001,Xs,30.10g,39.2,11/0 Inst : GC_P
Misc : PRINCETON/MULLICA_,10/30/06,11/02/06,10 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 20:56 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase :
Signal #1 Info :
Signal #2 Phase:
Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2286.D\ECD1B.CH Vial: 27
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2286.D\ECD2A.CH
Acq On : 07 Nov 2006 5:16 pm Operator: MEI
Sample : .,1106-BLK4,S,30.00g,0,11/06/06,1 Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 17:28:18 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	2.99	2.78	33984682	184.4E6	68.602	65.319
Spiked Amount 100.000			Recovery =		68.60%	65.32%
2) S DCB	10.58	10.80	9642882	38467765	57.552	52.401
Spiked Amount 100.000			Recovery =		57.55%	52.40%
Target Compounds						
Sum Chlordane			0	0	N.D.	N.D.
Average Chlordane					0.000	0.000
Sum Toxaphene			0	0	N.D.	N.D.
Average Toxaphene					0.000	0.000

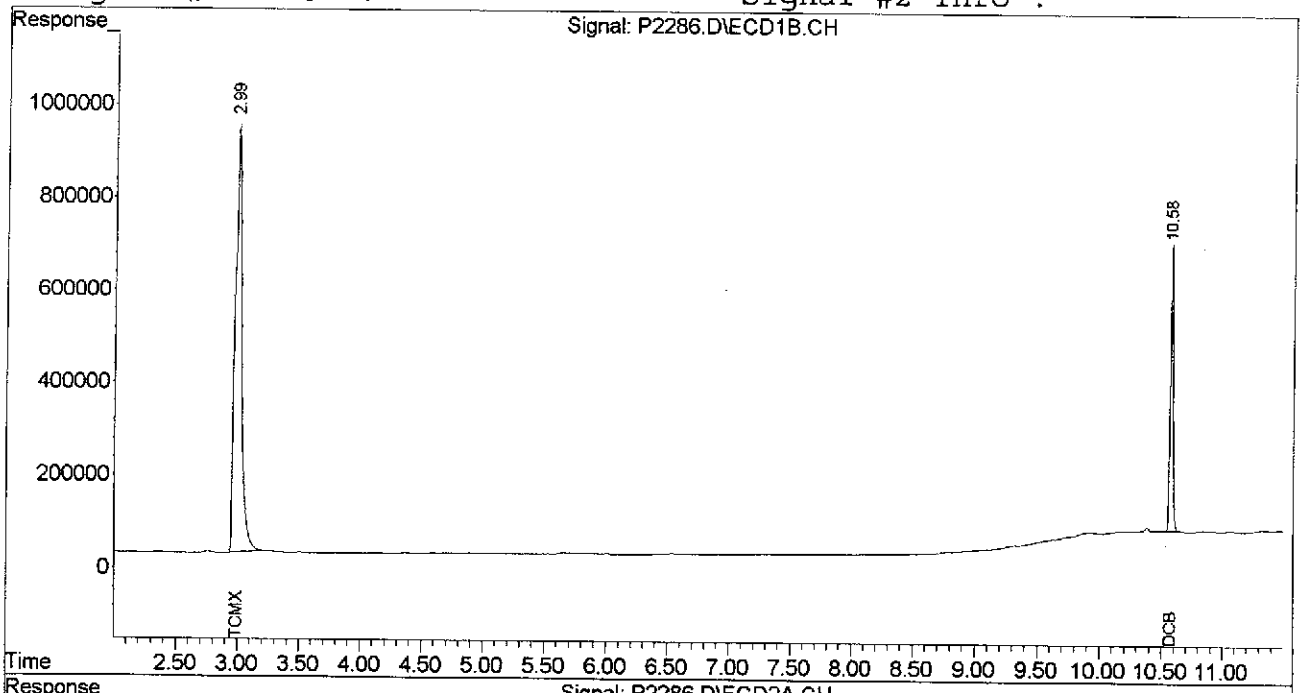
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

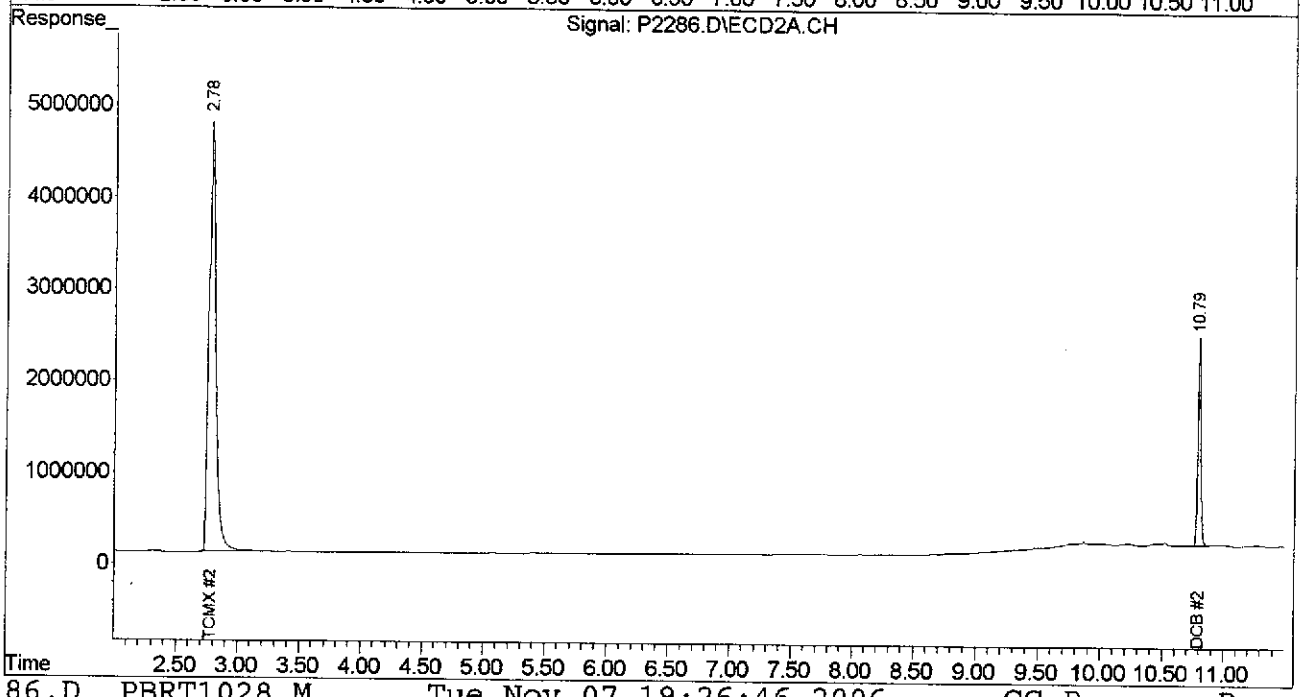
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2286.D\ECD1B.CH Vial: 27
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2286.D\ECD2A.CH
Acq On : 07 Nov 2006 5:16 pm Operator: MEI
Sample : .,1106-BLK4,S,30.00g,0,11/06/06,1 Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 19:26 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2261.D\ECD1B.CH Vial: 2
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2261.D\ECD2A.CH
Acq On : 07 Nov 2006 11:23 am Operator: MEI
Sample : PEST_C_IAS_2776,100_PPB Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 11:35:34 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

	Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
	System Monitoring Compounds						
1) S	TCMX	3.00	2.79	49991749	262.4E6	100.913	92.949
	Spiked Amount 100.000			Recovery	=	100.91%	92.95%
2) S	DCB	10.59	10.81	18579578	70236200	110.890	95.677
	Spiked Amount 100.000			Recovery	=	110.89%	95.68%
	Target Compounds						
3) T	alpha-BHC	3.74	3.58	34874250	194.9E6	101.952	96.630
4) T	beta-BHC	4.33	4.22	12829490	72081109	93.463	92.358
5) T	gamma-BHC	4.20	4.09	31575976	174.4E6	100.879	96.192
6) T	delta-BHC	4.59	4.66	31002085	159.2E6	100.635	98.678
7) T	Heptachlor	4.91	4.73	28548303	157.2E6	100.387	92.726
8) T	Aldrin	5.37	5.22	29092927	158.4E6	97.595	94.655
9) T	Heptachlor epoxi	6.34	6.14	26514784	156.9E6	99.251	107.208
10) T	Endosulfan I	6.98	6.76	25650831	133.2E6	99.068	94.873
11) T	4,4'-DDE	6.91	7.01	25067537	134.2E6	103.766	98.821
12) T	Dieldrin	7.37	7.21	27647257	141.3E6	99.882	96.326
13) T	Endrin	7.74	7.71	25469563	111.7E6	103.776	105.436
14) T	Endosulfan II	8.11	8.07	23253458	122.7E6	100.466	95.110
15) T	4,4'-DDD	7.89	7.97	21033199	110.2E6	103.288	101.397
16) T	Endrin aldehyde	8.79	8.65	15893472	81585390	97.775	93.947
17) T	Endosulfan sulfa	9.33	9.03	19831993	92932016	98.178	91.378
18) T	4,4'-DDT	8.35	8.48	21483749	106.9E6	107.944	109.774
19) T	Endrin ketone	9.61	9.60	24853860	235.6E6	101.677	206.526 #
20) T	Methoxychlor	9.08	9.41	11086625	46051531	103.168	107.588
21) T	alpha-Chlordane	6.76	6.68	26401248	140.3E6	99.147	95.809
22) T	gamma-Chlordane	6.54	6.44	26531058	142.6E6	99.499	94.198
	Sum Chlordane			0	0	N.D.	N.D.
	Average Chlordane					0.000	0.000
	Sum Toxaphene			0	0	N.D.	N.D.
	Average Toxaphene					0.000	0.000

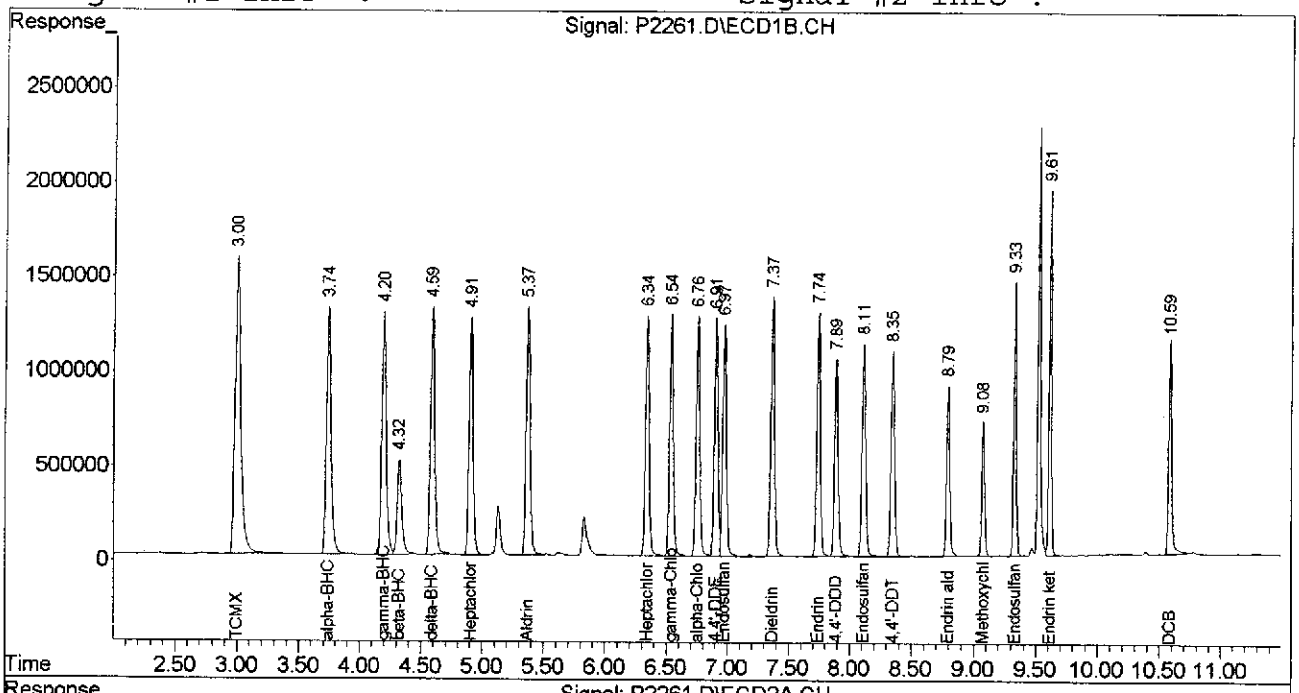
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

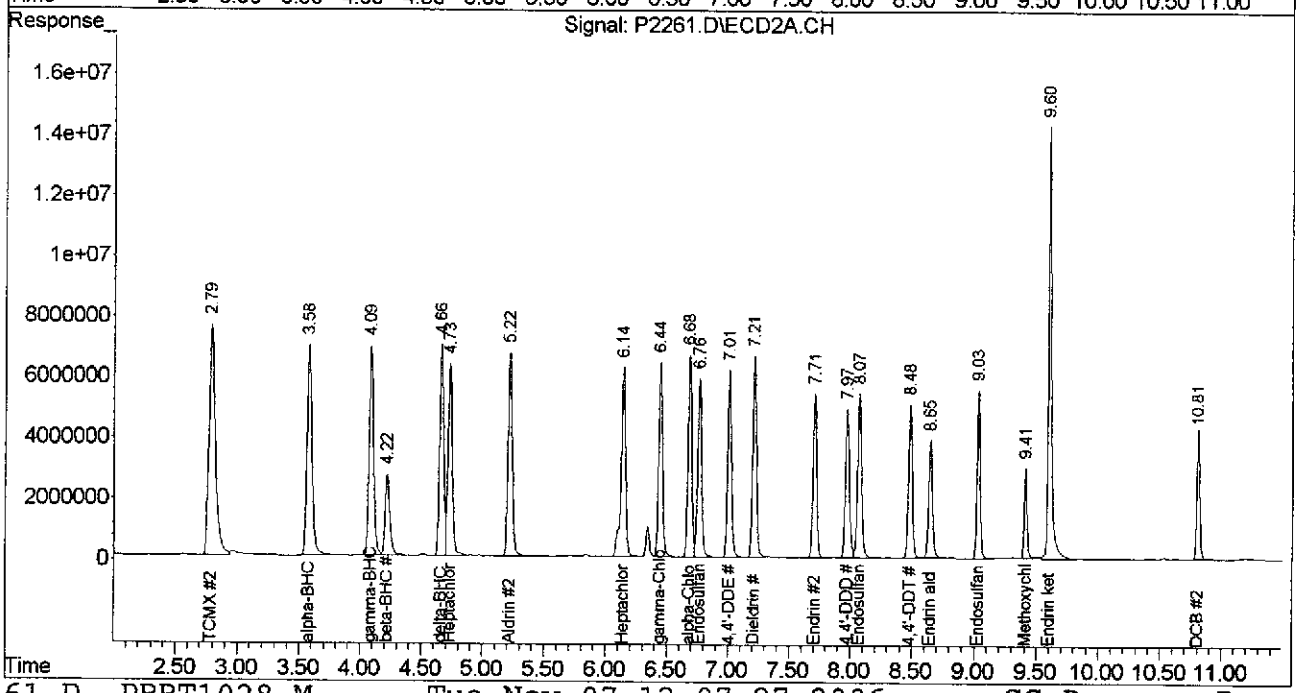
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2261.D\ECD1B.CH Vial: 2
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2261.D\ECD2A.CH
Acq On : 07 Nov 2006 11:23 am Operator: MEI
Sample : PEST_C_IAS_2776,100_PPB Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 12:07 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2262.D\ECD1B.CH Vial: 3
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2262.D\ECD2A.CH
Acq On : 07 Nov 2006 11:38 am Operator: MEI
Sample : TOX_C_IAS_2773,0.5_PPM Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 11:49:42 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.00	2.78	50777147	274.3E6	102.499	97.134
Spiked Amount 100.000			Recovery	=	102.50%	97.13%
2) S DCB	10.58	10.80	18066797	73425821	107.829	100.022
Spiked Amount 100.000			Recovery	=	107.83%	100.02%
Target Compounds						
Sum Chlordane			0	0	N.D.	N.D.
Average Chlordane					0.000	0.000
28) L2 Toxaphene	7.66	7.62	3709423	22639005	473.216	449.495
29) L2 Toxaphene {2}	8.22	8.21	4872208	29321324	479.646	461.457
30) L2 Toxaphene {3}	8.93	8.33	6111139	14847170	485.754m	462.930
31) L2 Toxaphene {4}	9.21	8.76	5259832	30749641	478.615	465.551
32) L2 Toxaphene {5}	9.27	9.29	9154724	37370133	494.594	481.818
Sum Toxaphene			29107326	134.9E6	2411.825	2321.250
Average Toxaphene					482.365	464.250

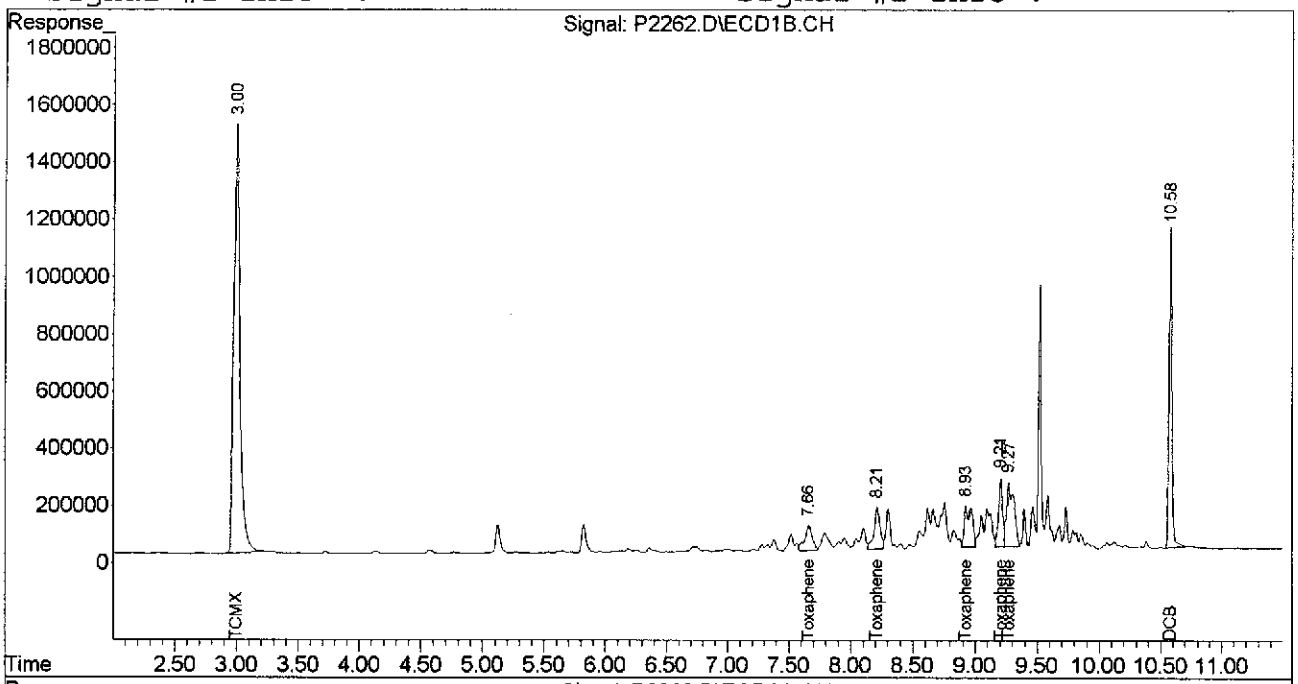
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

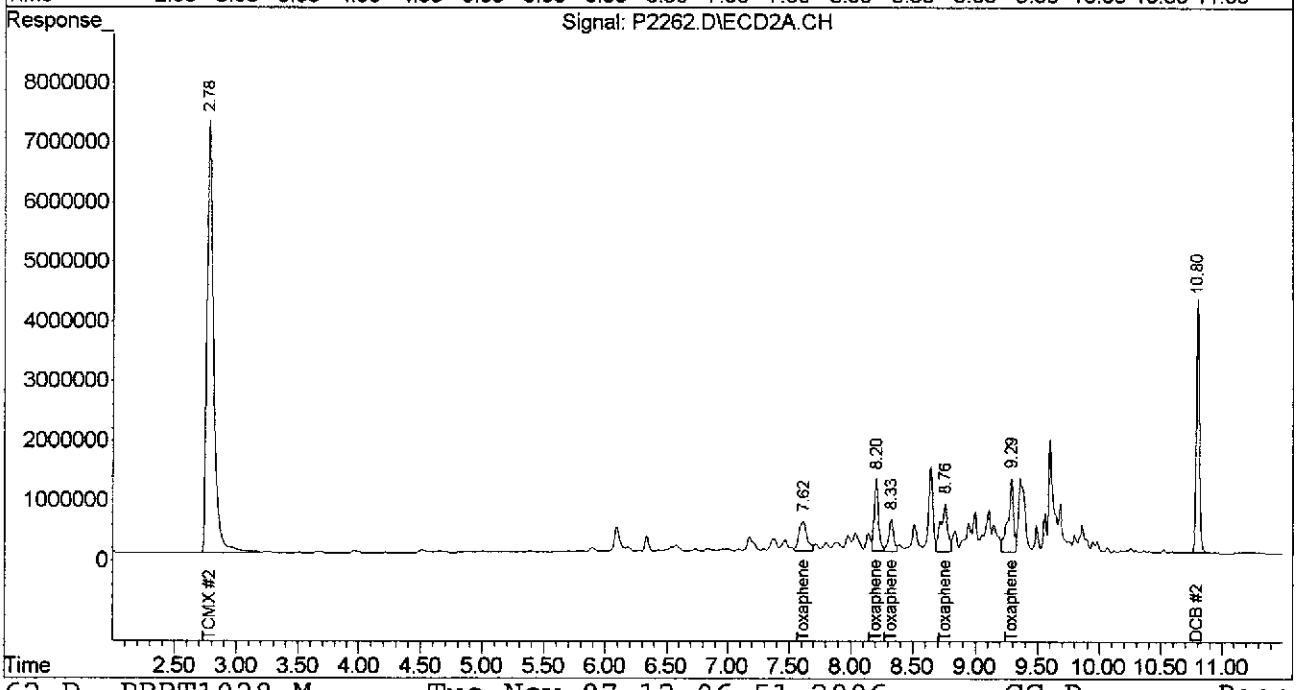
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2262.D\ECD1B.CH Vial: 3
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2262.D\ECD2A.CH
Acq On : 07 Nov 2006 11:38 am Operator: MEI
Sample : TOX_C_IAS_2773,0.5_PPM Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 12:06 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2263.D\ECD1B.CH Vial: 4
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2263.D\ECD2A.CH
Acq On : 07 Nov 2006 11:52 am Operator: MEI
Sample : CHLOR_C_IAS_2772,0.5_PPM Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 12:03:45 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds						
1) S TCMX	3.00	2.78	51266861	269.0E6	103.487	95.254
Spiked Amount 100.000			Recovery	=	103.49%	95.25%
2) S DCB	10.58	10.80	18696275	72524206	111.586	98.794
Spiked Amount 100.000			Recovery	=	111.59%	98.79%
Target Compounds						
23) L1 Chlordane	4.90	4.50	6268874	30434116	478.730	465.373
24) L1 Chlordane {2}	5.59	5.47	5108548	26157475	491.970	453.720
25) L1 Chlordane {3}	6.54	6.44	16661652	88721281	490.572	455.509
26) L1 Chlordane {4}	6.74	6.59	26123192	70516799	493.397	449.617
27) L1 Chlordane {5}	7.99	6.68	4344579	77255715	486.428	452.711
Sum Chlordane			58506845	293.1E6	2441.097	2276.930
Average Chlordane					488.219	455.386
Sum Toxaphene			0	0	N.D.	N.D.
Average Toxaphene					0.000	0.000

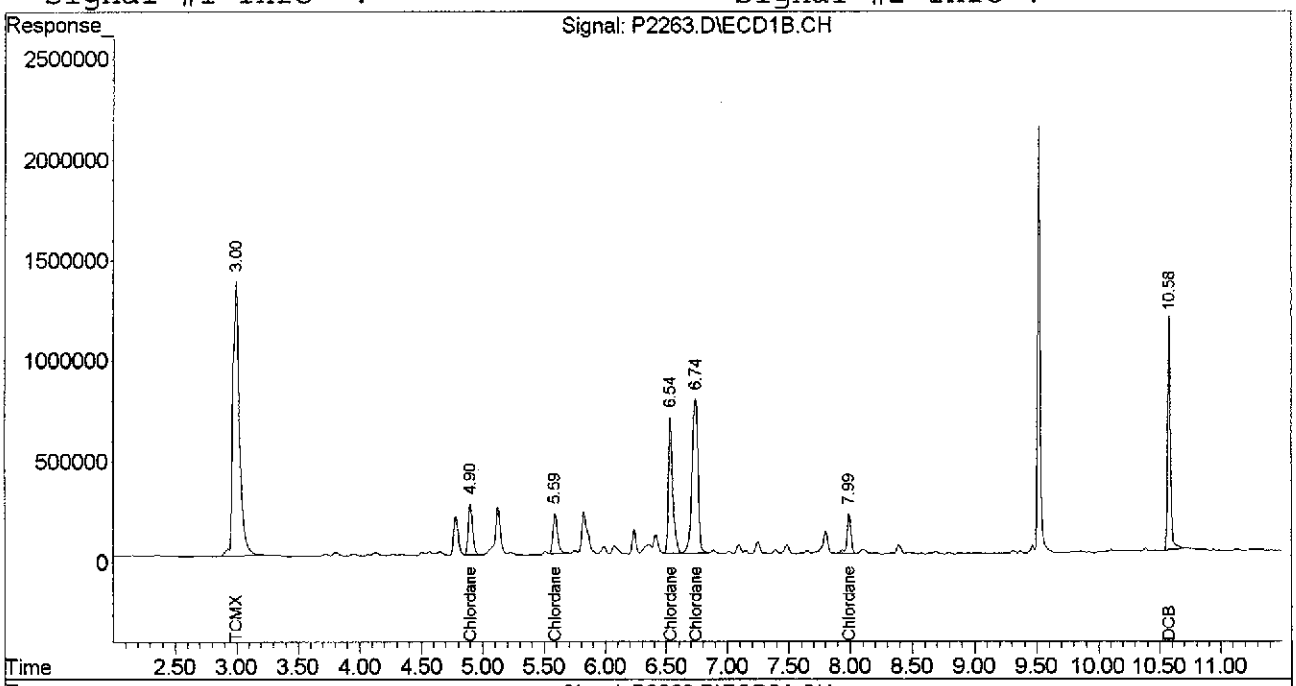
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

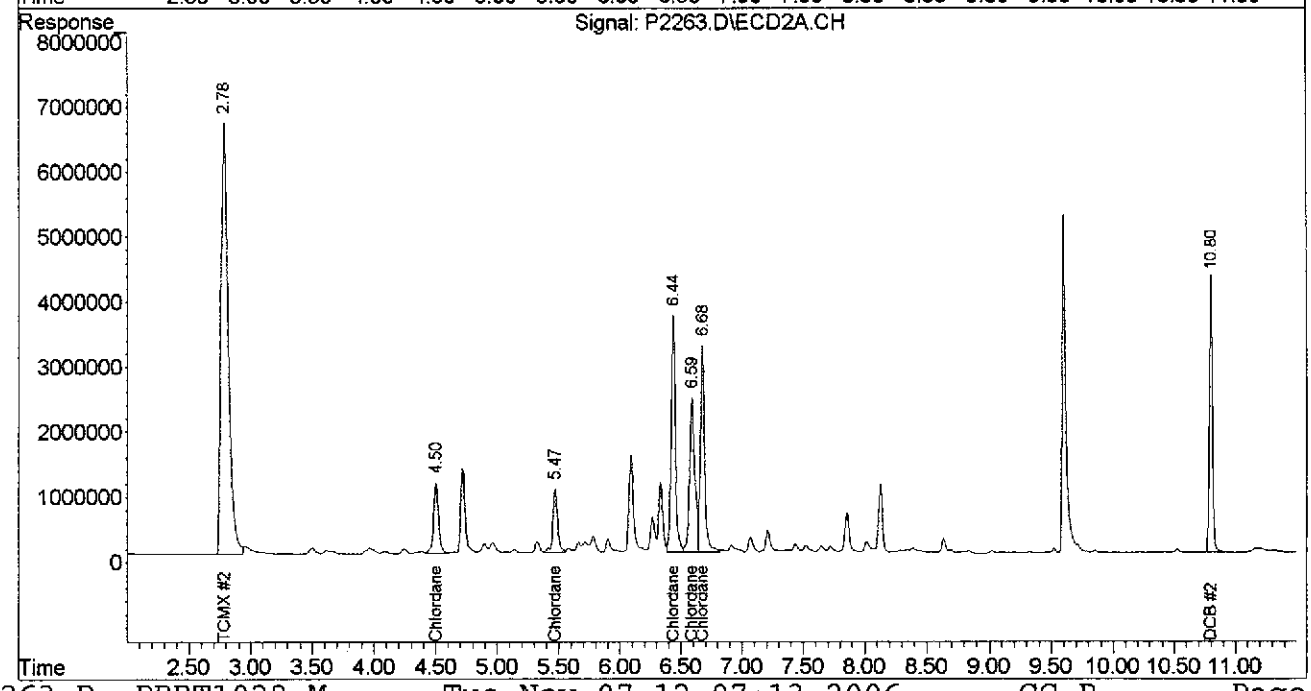
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2263.D\ECD1B.CH Vial: 4
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2263.D\ECD2A.CH
Acq On : 07 Nov 2006 11:52 am Operator: MEI
Sample : CHLOR_C_IAS_2772,0.5_PPM Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 12:07 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2292.D\ECD1B.CH Vial: 33
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2292.D\ECD2A.CH
Acq On : 07 Nov 2006 6:55 pm Operator: MEI
Sample : PEST_C_IAS_2776,100_PPB Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 07 19:06:50 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Initial Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :

	Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
	System Monitoring Compounds						
1) S	TCMX	2.99	2.78	50153780	270.0E6	101.240	95.639
	Spiked Amount 100.000			Recovery	=	101.24%	95.64%
2) S	DCB	10.58	10.79	17828962	65520335	106.410	89.253
	Spiked Amount 100.000			Recovery	=	106.41%	89.25%
	Target Compounds						
3) T	alpha-BHC	3.73	3.57	34923837	204.4E6	102.097	101.342
4) T	beta-BHC	4.32	4.21	13201890	76027402	96.176	97.415
5) T	gamma-BHC	4.19	4.08	31625500	180.7E6	101.037	99.616
6) T	delta-BHC	4.58	4.65	32795504	171.6E6	106.457	106.368
7) T	Heptachlor	4.90	4.72	27661358	159.0E6	97.268	93.789
8) T	Aldrin	5.37	5.21	29139170	165.7E6	97.750	99.026
9) T	Heptachlor epoxi	6.34	6.13	26478753	161.6E6	99.116	110.458
10) T	Endosulfan I	6.97	6.76	25604696	137.0E6	98.890	97.623
11) T	4,4'-DDE	6.90	7.00	25296572	137.8E6	104.714	101.478
12) T	Dieldrin	7.36	7.21	27714251	144.3E6	100.124	98.406
13) T	Endrin	7.74	7.70	25660729	120.1E6	104.555	113.379
14) T	Endosulfan II	8.11	8.06	23878411	125.1E6	103.166	96.949
15) T	4,4'-DDD	7.88	7.96	23350733	121.9E6	114.669m	112.128m
16) T	Endrin aldehyde	8.79	8.64	17339477	89734618	106.671	103.331
17) T	Endosulfan sulfa	9.33	9.02	20624269	99934916	102.101	98.263
18) T	4,4'-DDT	8.34	8.47	16955050	85266262	85.190m	87.565m
19) T	Endrin ketone	9.61	9.59	24145564	240.3E6	98.780	210.626 #
20) T	Methoxychlor	9.07	9.40	8431286	33449872	78.459	78.147
21) T	alpha-Chlordane	6.75	6.68	26338399	144.3E6	98.911	98.530
22) T	gamma-Chlordane	6.54	6.44	26453685	146.5E6	99.209	96.778
	Sum Chlordane			0	0	N.D.	N.D.
	Average Chlordane					0.000	0.000
	Sum Toxaphene			0	0	N.D.	N.D.
	Average Toxaphene					0.000	0.000

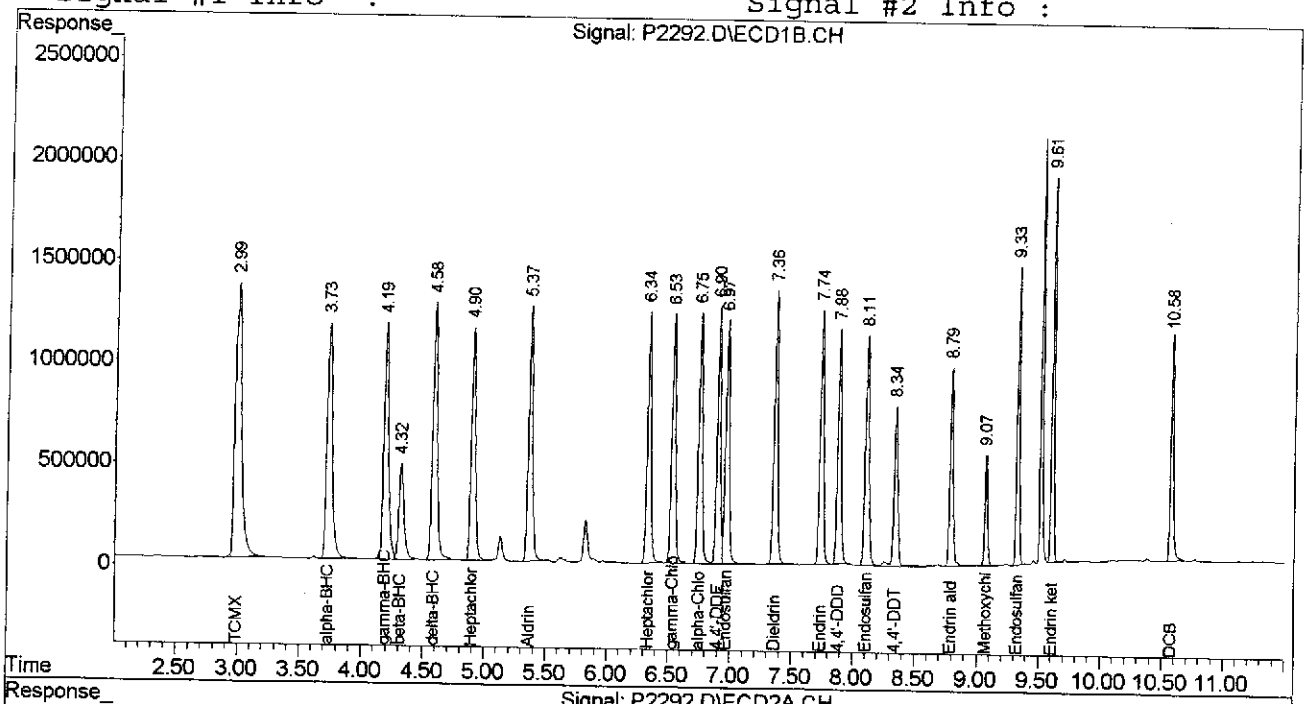
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25% (m)=manual int.

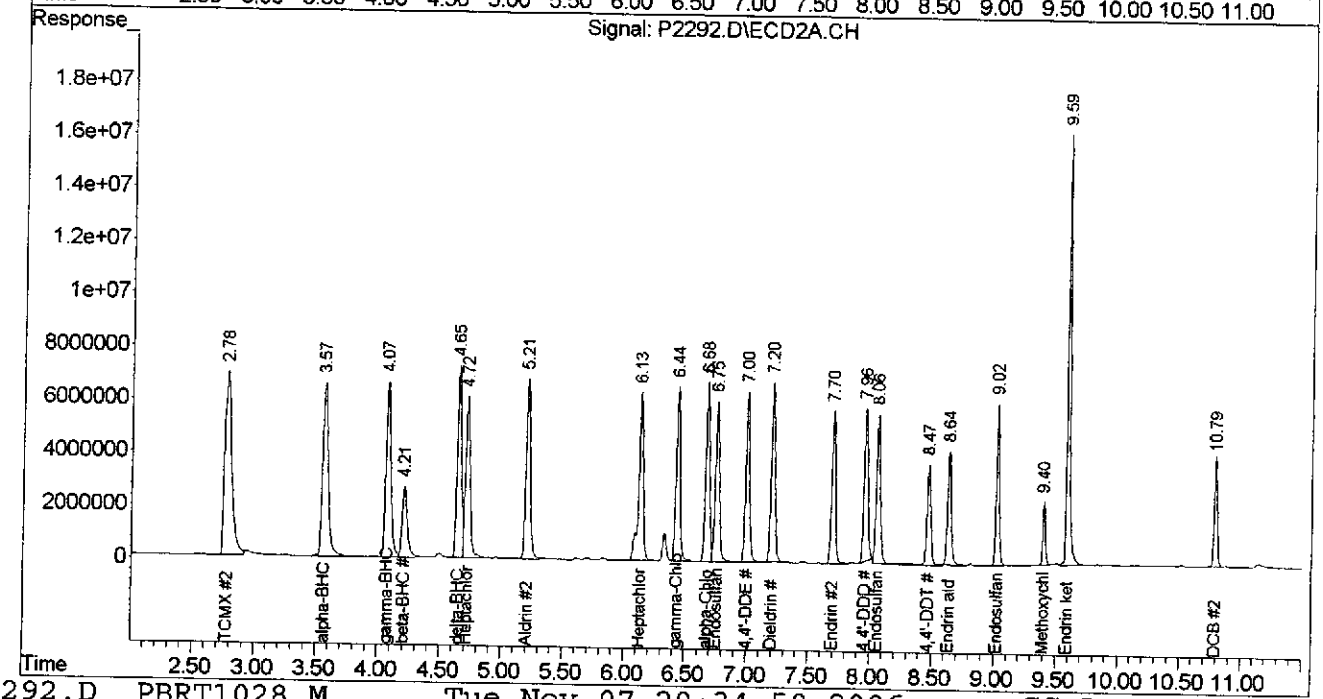
Quantitation Report (QT Reviewed)

Signal #1 : C:\MSDCHEM\1\DATA\11-07-06\P2292.D\ECD1B.CH Vial: 33
Signal #2 : C:\MSDCHEM\1\DATA\11-07-06\P2292.D\ECD2A.CH
Acq On : 07 Nov 2006 6:55 pm Operator: MEI
Sample : PEST_C_IAS_2776,100_PPB Inst : GC_P
Misc : NA,NA,NA,1 Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E
Quant Time: Nov 7 19:10 2006 Quant Results File: PBRT1028.RES

Quant Method : C:\MSDCHEM\1\METHODS\PBRT1028.M (Chemstation Integrator)
Title :
Last Update : Sun Nov 05 17:16:22 2006
Response via : Multiple Level Calibration
DataAcq Meth : PBRT1028.M

Volume Inj. :
Signal #1 Phase : Signal #2 Phase:
Signal #1 Info : Signal #2 Info :





INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS QUALITY CONTROL

BLANK 1 RESULTS SUMMARY

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184 12200, 12240

Matrix: Soil Concentration/Units: ppm (mg/kg)

ANALYTE	INITIAL CALIBRATION	CONTINUING CALIBRATION 1	CONTINUING CALIBRATION 2	INST. MDL	REAGENT BLANK	SAMPLE MDL	IDL
Antimony	ND	ND	ND	0.001	ND	1.00	
Arsenic	ND	ND	ND	0.001	ND	1.00	
Beryllium	ND	ND	ND	0.0005	ND	0.500	
Cadmium	ND	ND	ND	0.00025	ND	0.250	
Chromium	ND	ND	ND	0.002	ND	2.00	
Copper	ND	ND	ND	0.002	ND	2.00	
Lead	ND	ND	ND	0.0005	ND	0.500	
Mercury	ND	ND	ND	0.00025	ND	0.013	
Nickel	ND	ND	ND	0.001	ND	1.00	
Selenium	ND	ND	ND	0.002	ND	2.00	
Silver	ND	ND	ND	0.0005	ND	0.500	
Thallium	ND	ND	ND	0.0001	ND	0.100	
Zinc	ND	ND	ND	0.002	ND	2.00	

This QC Blank applies to the following samples:

12056-001; 12087-001; 12094-007; 12148-001
12153-005; 12156-001~002; 12167-001; 12168-001,003,006
12170-001; 12184-002; 12200-001; 12240-005,013~015,025
12240-027

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS QUALITY CONTROL

INITIAL & CONTINUING CALIBRATION VERIFICATION

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184, 12200, 12221 12222, 12240

Concentration/Units: ppb (µg/L)

ANALYTE	INITIAL CALIBRATION			CONTINUING CALIBRATION					INST.	IDL
	TRUE	FOUND	%R (1)	TRUE	FOUND	%R (1)	FOUND	%R (1)	MDL	
Antimony	120	127	106	120	123	103	118	98.3	1.00	
Arsenic	20.0	20.4	102	20.0	20.1	101	20.2	101	1.00	
Beryllium	10.0	10.8	108	10.0	10.4	104	9.57	95.7	0.500	
Cadmium	10.0	10.3	103	10.0	9.97	99.7	9.92	99.2	0.250	
Chromium	20.0	19.7	98.5	20.0	19.5	97.5	20.2	101	2.00	
Copper	50.0	50.2	100	50.0	48.9	97.8	49.2	98.4	2.00	
Lead	10.0	10.6	106	10.0	10.0	100	10.3	103	0.500	
Mercury	5.00	4.80	96.0	5.00	5.02	100	5.05	101	0.250	
Nickel	80.0	78.8	98.5	80.0	77.6	97.0	78.8	98.5	1.00	
Selenium	10.0	10.6	106	10.0	10.2	102	10.2	102	2.00	
Silver	20.0	19.7	98.5	20.0	19.2	96.0	19.7	98.5	0.500	
Thallium	20.0	20.5	103	20.0	19.5	97.5	20.0	100	0.100	
Zinc	40.0	41.0	103	40.0	40.1	100	39.4	98.5	2.00	

(1) Control Limits: Mercury 80-120, Other Metals 90-110

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS QUALITY CONTROL

ICP-MS ICSAB RESULTS SUMMARY

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184, 12200, 12221 12222, 12240

Matrix: Aqueous Concentration/Units: ppb (µg/L)

ANALYTE	TRUE		INITIAL FOUND			CONTROL LIMIT %R
	SOL A	SOL B	SOL A	SOL A+B	%R	
Chlorine	1000000	-	-	-	-	NA
Carbon	200000	-	-	-	-	NA
Aluminum	100000	-	LRG	> LRG	NA	NA
Calcium	100000	-	102000	102000	102	NA
Iron	100000	-	94800	95300	95.3	NA
Potassium	100000	-	> LRG	> LRG	NA	NA
Magnesium	100000	-	> LRG	> LRG	NA	NA
Sodium	100000	-	> LRG	> LRG	NA	NA
Phosphorus	100000	-	-	-	-	NA
Sulfur	100000	-	-	-	-	NA
Molybdenum	2000	-	2320	2320	116	NA
Titanium	2000	-	-	-	-	NA
Silver	-	20.0	0.214	19.6	96.9	80-120
Arsenic	-	20.0	0.538	17.9	86.8	80-120
Cadmium	-	20.0	0.445	18.0	87.8	80-120
Cobalt	-	20.0	0.648	20.4	98.8	80-120
Chromium	-	20.0	2.26	21.7	97.2	80-120
Copper	-	20.0	3.77	21.2	87.2	80-120
Manganese	-	20.0	3.14	23.8	103	80-120
Nickel	-	20.0	1.19	18.9	88.6	80-120
Zinc	-	20.0	7.78	25.5	88.6	80-120

%R = Percent Recovery

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS QUALITY CONTROL

SPIKE SAMPLE RECOVERY

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184 12200, 12240, 12221, 12222

Matrix: Soil Concentration/Units: ppm (mg/kg)

ANALYTE	SSR1	SR1	%R1	SA1	SSR2	SR2	%R2	SA2	CONTROL LIMIT %R
Antimony	50.3	ND	112	44.8	61.4	ND	122	50.4	75-125
Arsenic	47.0	1.61	101	44.8	54.7	3.16	102	50.4	75-125
Beryllium	43.9	0.718	96.4	44.8	49.3	ND	97.8	50.4	75-125
Cadmium	44.9	ND	100	44.8	50.2	ND	99.6	50.4	75-125
Chromium	57.9	15.4	94.9	44.8	57.3	7.63	98.6	50.4	75-125
Copper	67.3	23.0	98.9	44.8	58.4	8.76	98.5	50.4	75-125
Lead	61.5	17.1	99.1	44.8	58.2	7.09	101	50.4	75-125
Mercury	0.279	ND	99.6	0.280	0.316	ND	100	0.315	75-125
Nickel	59.7	17.0	95.3	44.8	63.0	13.6	98.0	50.4	75-125
Selenium	46.1	ND	103	44.8	52.5	ND	104	50.4	75-125
Silver	46.2	ND	103	44.8	52.5	ND	104	50.4	75-125
Thallium	43.8	0.133	97.5	44.8	50.5	ND	100	50.4	75-125
Zinc	88.6	44.6	98.2	44.8	87.5	38.2	97.8	50.4	75-125

SSR = Spike Sample Result
SA = Spike Added
SR = Sample Result
%R = Percent Recovery
NC = Non-calculable % R; Sample concentration > 4 x Spike Concentration.

QC Sample 1 12168-001
QC Sample 1 for following samples:
12056-001; 12087-001; 12094-007; 12148-001
12153-005; 12156-001~002; 12167-001; 12168-001,003,006
12170-001; 12184-002; 12200-001; 12240-005,013~015,025
12240-027

QC Sample 2 12240-009
QC Sample 2 for following samples:
12221-001~013; 12222-001~004; 12240-009

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS QUALITY CONTROL

DUPLICATE SAMPLE RECOVERY

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184 12200, 12240, 12221, 12222

Matrix: Soil Concentration/Units: ppm (mg/kg)

ANALYTE	CONTROL LIMIT 1	S1	D1	RPD1	CONTROL LIMIT 2	S2	D2	RPD2
Antimony	NA	ND	ND	NC	NA	ND	ND	NC
Arsenic	20	1.61	1.63	1.23	20	3.16	3.27	3.42
Beryllium	20	0.718	0.745	3.69	NA	ND	ND	NC
Cadmium	NA	ND	ND	NC	NA	ND	ND	NC
Chromium	20	15.4	15.4	0	20	7.63	7.69	0.783
Copper	20	23.0	23.0	0	20	8.76	8.88	1.36
Lead	20	17.1	17.6	2.88	20	7.09	7.21	1.68
Mercury	NA	ND	ND	NC	NA	ND	ND	NC
Nickel	20	17.0	17.2	1.17	20	13.6	13.8	1.46
Selenium	NA	ND	ND	NC	NA	ND	ND	NC
Silver	NA	ND	ND	NC	NA	ND	ND	NC
Thallium	20	0.133	0.137	2.96	NA	ND	ND	NC
Zinc	20	44.6	45.1	1.11	20	38.2	38.5	0.782

S1 = Sample 1
D1 = Duplicate 1
NA = Not Applicable
NC = Non-calculable RPD due to result (s) less than the detection limit.

S2 = Sample 2
D2 = Duplicate 2

QC Sample 1 12168-001
QC Sample 1 for following samples:
12056-001; 12087-001; 12094-007; 12148-001
12153-005; 12156-001~002; 12167-001; 12168-001,003,006
12170-001; 12184-002; 12200-001; 12240-005,013~015,025
12240-027

QC Sample 2 12240-009
QC Sample 2 for following samples:
12221-001~013; 12222-001~004; 12240-009

METALS QUALITY CONTROL

LABORATORY CONTROL SAMPLE

Batch (Page) #: 465

Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184 12200, 12240, 12221, 12222

Matrix: Soil Unit: ppm (mg/kg)

ANALYTE	BSS1			BSS2		
	TRUE	FOUND	%R(1)	TRUE	FOUND	%R(1)
Antimony	40.0	44.8	112	40.0	39.5	98.8
Arsenic	40.0	40.9	102	40.0	41.4	104
Beryllium	40.0	40.5	101	40.0	40.0	100
Cadmium	40.0	40.9	102	40.0	40.7	102
Chromium	40.0	38.1	95.3	40.0	39.7	99.3
Copper	40.0	40.0	100	40.0	40.2	101
Lead	40.0	40.4	101	40.0	40.8	102
Mercury	0.250	0.241	96.4	0.250	0.249	99.6
Nickel	40.0	39.4	98.5	40.0	39.8	99.5
Selenium	40.0	41.4	104	40.0	41.8	105
Silver	40.0	40.8	102	40.0	41.6	104
Thallium	40.0	38.2	95.5	40.0	39.1	97.8
Zinc	40.0	41.0	103	40.0	41.4	104

(1) Control Limits % Recovery = 85-115%

BSS1	BSS2
12056-001; 12087-001; 12094-007; 12148-001	12221-001~013; 12222-001~004; 12240-009
12153-005; 12156-001~002; 12167-001; 12168-001,003,006	
12170-001; 12184-002; 12200-001; 12240-005,013~015,025	
12240-027	

METALS QUALITY CONTROL

SERIAL DILUTIONS & POST SPIKES 1

Batch (Page) #: 465
Lab Case: E06- 12056, 12087, 12094, 12148, 12153, 12156, 12167, 12168, 12170, 12184
12200, 12240

Matrix: Soil Concentration/Units: ppm (mg/kg)

ANALYTE	SERIAL DILUTION		%	POST SPIKE		%
	SR	SDR	Difference	SPR	SA	Recovery
Antimony	ND			42.8	44.8	95.5
Arsenic	1.61			49.1	44.8	106.0
Beryllium	0.718			47.7	44.8	105.0
Cadmium	ND			46.9	44.8	105
Chromium	15.4			63.1	44.8	106.0
Copper	23.0			70.9	44.8	107.0
Lead	17.1	17.6	2.88			
Nickel	17.0			63.9	44.8	105.0
Selenium	ND			48.2	44.8	108
Silver	ND			47.5	44.8	106
Thallium	0.133			47.2	44.8	105.0
Zinc	44.6	47.1	5.45			

SR = Sample Result
SDR = Sample Dilution Result

SPR = Sample Post Spike Result
SA = Spike Added

Control Limits: (+) or (-) 10% Difference or 75 - 125% Recovery

QC Sample1 : 12168-001
QC Sample 1 for following samples:
12056-001; 12087-001; 12094-007; 12148-001
12153-005; 12156-001~002; 12167-001; 12168-001,003,006
12170-001; 12184-002; 12200-001; 12240-005,013~015,025
12240-027

Integrated Analytical Labs
273 Franklin Road
Randolph, NJ 07869
11/6/2006

Certified for NJDEP, NY(DOH)
NJ ID#14751
NY ID#11402

General Chemistry Quality Control

Matrix: Soil
Unit: mg/Kg

Batch ID: AP030-0072

Blank

Parameter	Method Blank	MDL	Analysis Date
Total Organic Carbons (TOC)	ND	500	11/06/06

Duplicate Recovery

Parameter	QC Sample	Result	Duplicate Result	RPD	RPD Limits
Total Organic Carbons (TOC)	11200-024S	123000	123000	0	20.0

Spike Recovery

Parameter	QC Sample	Result	Spike Added	Spike Result	%Spike Recovery	%Rec. Limits
Total Organic Carbons (TOC)	11200-024	67600	57500	123000	96.3	75 - 125

The above blank result applies to the follow samples:

E06-11200-022
E06-11200-023
E06-11200-024
E06-11200-024D
E06-11200-024S
E06-11200-024SD
E06-11200-025
E06-11200-026
E06-11200-027
E06-11200-028
E06-11200-029
E06-11200-030
E06-11200-031
E06-11200-040
E06-11200-041
E06-11200-043
E06-11200-044
E06-12087-001
E06-11984-002
E06-11985-001

++ = No Flash - Sample boiled at 100C
NA = Not Applicable
ND = Not Detected
NC = Non calculable RPD due to value less than the detection limit
No = Does Not Ignite
Yes = Sample Ignites

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Integrated Analytical Labs
273 Franklin Road
Randolph, NJ 07869
11/9/2006

Certified for NJDEP, NY(DOH)
NJ ID#14751
NY ID#11402

General Chemistry Quality Control

Matrix: Soil
Units: Soil-mg/Kg

Batch ID: AP013-0126

Blank

Parameter	Method Blank	MDL	Analysis Date
Cyanide, Total	ND	1.00	11/09/06

Duplicate Recovery

Parameter	QC Sample	Result	Duplicate Result	RPD	RPD Limits
Cyanide, Total	12087-001S	21.3	21.3	0	20

Spike Recovery

Parameter	QC Sample	Result	Spike Added	Spike Result	%Spike Recovery	%Rec. Limits
Cyanide, Total	12087-001	ND	20.6	21.3	103	75 - 125

The above blank result applies to the follow samples:

E06-12087-001
E06-12087-001D
E06-12087-001S
E06-12087-001SD
E06-12056-001
E06-12251-001
E06-12050-001
E06-12152-001

++ = No Flash - Sample boiled at 100C
NA = Not Applicable
ND = Not Detected
NC = Non calculable RPD due to value less than the detection limit
No = Does Not Ignite
Yes = Sample Ignites

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Integrated Analytical Labs
273 Franklin Road
Randolph, NJ 07869
11/10/2006

Certified for NJDEP, NY(DOH)
NJ ID#14751
NY ID#11402

General Chemistry Quality Control

Matrix: Soil
Units: Soil-mg/Kg

Batch ID: AP024-0118

Blank

Parameter	Method Blank	MDL	Analysis Date
Total Recoverable Phenols	ND	2.50	11/10/06

Duplicate Recovery

Parameter	QC Sample	Result	Duplicate Result	RPD	RPD Limits
Total Recoverable Phenols	12050-001S	57.6	60.9	6	20

Spike Recovery

Parameter	QC Sample	Result	Spike Added	Spike Result	%Spike Recovery	%Rec. Limits
Total Recoverable Phenols	12050-001	ND	58.9	57.6	97.8	75 - 125

The above blank result applies to the follow samples:

E06-12050-001
E06-12050-001D
E06-12050-001S
E06-12050-001SD
E06-12087-001
E06-12056-001
E06-12251-001
E06-12152-001

++ = No Flash - Sample boiled at 100C
NA = Not Applicable
ND = Not Detected
NC = Non calculable RPD due to value less than the detection limit
No = Does Not Ignite
Yes = Sample Ignites

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Phone # (973) 361-4252
Fax # (973) 989-5288

INTEGRATED ANALYTICAL LABORATORIES
CHAIN OF CUSTODY

273 Franklin Rd
Randolph, NJ 07869

CUSTOMER	
Company:	PRINCETON HYDRO
Address:	1108 OLD YORK RD
	RINGOES NJ 08551
Telephone #:	908 237 5660
Fax #:	908 237 5666
Project Manager:	C. MIKOLAJCIK
Sampler:	J. BELL
Project Name:	MULLICA HILL POND
Project Location (State):	NJ
Bottle Order #:	
Quote # :	

REPORTING INFO	
REPORT TO:	SAME
Address:	
Attn:	
FAX #	
INVOICE TO:	SAME
Address:	
Attn:	
PO #	

Turnaround Time (starts the following day if samples rec'd at lab > 5PM)

Lab notification is required for RUSH TAT prior to sample arrival. RUSH TAT IS NOT GUARANTEED WITHOUT LAB APPROVAL. RUSH SURCHARGES WILL APPLY IF ABLE TO ACCOMMODATE**

Conditional TPHC — Results needed by:

24 hr* 48 hr 72 hr NA

Verbal/Fax — 2 wk/Std

24 hr* 48 hr* 72 hr* 1 wk*

Hard Copy — 3 wk/Std

2 wk* call for price

Rush TAT Charge **

24 hr - 100%....
48 hr - 75%....
72 hr - 50%....
96 hr - 35%....
5 day - 25%....
6-9 day 10%

Report Format

Results Only
Reduced
Regulatory
Other (describe)

DISKETTE

SRP. dbf format
SRP.wk1 format
lab approved custom EDD
NO DISK/CD REQ'D

Sample Matrix

DW - Drinking Water AQ - Aqueous WW - Waste Water
OI - Oil LIQ - Liquid (Specify) OT - Other (Specify)
S - Soil SL - Sludge SOL - Solid W - Wipe

SAMPLE INFORMATION

ANALYTICAL PARAMETERS

Cooler Temp 4 °C

BOTTLES & PRESERVATIVES

Client ID	Depth	Sampling Date	Sampling Time	Matrix	# container	IAL #	PP+HO	TCL	% MOISTURE	GRAIN SIZE	HCl	NaOH	HNO3	H2SO4	MeOH	Other	None	Encore
POND SEDIMENT	0-6"	10/30/06	12	SED	2	1	X	X	X	X								

Known Hazard: Yes or (No) Describe:

Conc. Expected: (Low) Med High

MDL Req: Old GWQS - 11/05 GWQS - (SCC) - OTHER (SEE COMMENTS)

Please print legibly and fill out completely. Samples cannot be processed and the turnaround time will not start until any ambiguities have been resolved.

Signature/Company	Date	Time	Signature/Company
Relinquished by:	11/2/06	1500	Received by:
Relinquished by:	11/2/06	700	Received by:
Relinquished by:			Received by:
Relinquished by:			Received by:
Relinquished by:			Received by:

Comments:

Lab Case # 12087

PAGE: 1 of 1

LAB COPIES - WHITE & YELLOW; CLIENT COPY - PINK

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05/2006

Ref. No. D 020600903

PROJECT INFORMATION



Case No. E06-12087 **Project** MULLICA HILL POND

Customer	**Princeton Hydro, LLC**	**P.O. #**	
Contact	Chris Mikolajczyk	**Received**	11/2/2006 19:00
EMail	cmiko@princetonhydro.com ☐ EMail EDDs	**Verbal Due**	11/17/2006
Phone	(908) 237-5660 **Fax** 1(908) 237-5666	**Report Due**	11/28/2006

Report To

1108 Old York Road
Suite 1, PO Box 720
Ringoes, NJ 08551
Attn: Chris Mikolajczyk

Bill To

1108 Old York Road
Suite 1, PO Box 720
Ringoes, NJ 08551
Attn: Gail - Accounts Payable

Report Format **Reduced**

Additional Info ☐ State Form ☐ Field Sampling ☐ Conditional VOA

Lab ID	Client Sample ID	Depth Top / Bottom	Sampling Time	Matrix	Unit	# of Containers
12087-001	POND SEDIMENT	0 / 0.5	10/30/2006@12:00	Sediment	mg/Kg	2

Sample #	Tests	Status	QA Method
001	VO+15, PP LIST	Run	8260B
"	BNA + 25	Run	8270C
"	PCB	Run	8082
"	Pesticides	Run	8081A
"	PP Metals	Run	6020/7471A
"	Cyanide, Total	Run	9014
"	Particle Size	Run	ASTM C136-96A
"	TOC	Run	Modified Lloyd Kahn
"	Total Recoverable Phenols	Run	9066

11/03/2006 11:12 by Ellen - NOTE 1

PLEASE MEET SCC MDLs.

INTEGRATED ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIPT VERIFICATION

CASE NO: **E 06** **12087** CLIENT: P-Hydro

COOLER TEMPERATURE: 2° - 6°C: ✓ (See Chain of Custody)

Comments

COC: (COMPLETE) / INCOMPLETE

KEY
✓ = YES/NA
✗ = NO

✓	Bottles Intact	
✓	no-Missing Bottles	
✓	no-Extra Bottles	
✓	Sufficient Sample Volume	
✓	no-headspace/bubbles in VOs	
✓	Labels intact/correct	
✓	pH Check (exclude VOs)[1]	
✓	Correct bottles/preservative	
✓	Sufficient Holding/Prep Time[1]	
☐	Sample to be Subcontracted	

[1] All samples with "Analyze Immediately" holding times will be analyzed by this laboratory past the holding time. This includes but is not limited to the following tests: pH, Temperature, Free Residual Chlorine, Total Residual Chlorine, Dissolved Oxygen, Sulfite.

ADDITIONAL COMMENTS:

SAMPLE(S) VERIFIED BY: INITIAL [initials] DATE 11/2/06

CORRECTIVE ACTION REQUIRED: **YES** ☐ (SEE BELOW) **NO** ☐

CLIENT NOTIFIED: YES ☐ Date/ Time: _____ NO ☐

PROJECT CONTACT:

SUBCONTRACTED LAB:

DATE SHIPPED:

ADDITIONAL COMMENTS:

VERIFIED/TAKEN BY: INITIAL [initials] DATE 11.3.06

0140

REV 02/05

Laboratory Custody Chronicle

IAL Case No.

E06-12087

Client Princeton Hydro, LLC

Project MULLICA HILL POND

Received On 11/ 2/2006@19:00

Department: Volatiles			***Prep. Date***	***Analyst***	***Analysis Date***	***Analyst***
VO+15, PP LIST	12087-001	Sediment	n/a	n/a	11/ 8/06	Xing

Department: Semivolatiles			***Prep. Date***	***Analyst***	***Analysis Date***	***Analyst***
BNA + 25	-001	Sediment	11/ 6/06	Kou-Liang	11/ 6/06	JC

Department: GC			***Prep. Date***	***Analyst***	***Analysis Date***	***Analyst***
PCB	-001	Sediment	11/ 6/06	Archimede	11/ 7/06	Iwona
Pesticides	-001	Sediment	11/ 6/06	Archimede	11/ 7/06	Mei

Department: Metals			***Prep. Date***	***Analyst***	***Analysis Date***	***Analyst***
PP Metals	-001	Sediment	11/ 7/06	Lisa	11/ 7/06	Helge

Department: Wet Chemistry			***Prep. Date***	***Analyst***	***Analysis Date***	***Analyst***
Cyanide, Total	-001	Sediment	n/a	n/a	11/ 9/06	Jackie
Particle Size	-001	Sediment	n/a	n/a	11/ 7/06	Elma
TOC	-001	Sediment	n/a	n/a	11/ 6/06	Elma
Total Recoverable Phenols	-001	Sediment	n/a	n/a	11/10/06	Debbie

Review and Approval:

Integrated Analytical Labs ~ 273 Franklin Road, Randolph, NJ 07869 ~ (973) 361-4252 ~ Fax (973) 989-5288

APPENDIX C

PLANKTON DATA

Mullica Hill
5/29/2007

Phytoplankton	Abundance
Chrysophyta	
Dinobryon	Rare
Bacillariophyta	
Synedra	Rare
Fragilaria	Rare
Cyclotella	Rare
Navicula	Rare
Melosira	Rare
Chlorophyta	
Spirogyra	Rare
Cladophora	Rare

Mullica Hill

5/29/2007	
Zooplankton	Abundance
Cladocerans	
Bosmina	Common*
Chydorus	Present
Ceriodaphnia	Rare

Mullica Hill
7/16/2007

Phytoplankton	Abundance
Bacillariophyta	
Synedra	Present/Common*
Navicula	Present
Chlorophyta	
Haematococcus	Rare
Crucigenia	Rare
Scenedesmus	Rare
Cryptophyta	
Cryptomonas	Present
Rhodomonas	Rare
Chrysophyta	
Chrysocapsaceae	Rare
Chromulina	Rare
Cyanophyta	
Anabaena	Rare

Mullica Hill
7/16/2007

Zooplankton	Abundance
Copepods	
Cyclops	Rare*
nauplii	Rare

Hydrologic Parameters for Upper Raccoon Creek Watershed Regional Stormwater Management Plan

Prepared for Camden and Gloucester County, NJ Soil Conservation Districts

September 17, 2008

Schnabel Reference 07150006

Schnabel Engineering, LLC

510 East Gay Street, West Chester, Pennsylvania 19380
Phone 610-696-6066 Fax 610-696-7771

Paul I. Welle, P.E.
Senior Associate

HYDROLOGIC PARAMETERS FOR UPPER RACCOON CREEK WATERSHED REGIONAL STORMWATER MANAGEMENT PLAN

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Appendix A – Runoff Curve Numbers

1.0 – BACKGROUND

The Gloucester and Camden Soil Conservation Districts and Rowan University, with the cooperation of the Gloucester County Public Works Department – Division of Planning, prepared a Draft *Characterization and Assessment (C&A) of the Raccoon Creek Watershed*, dated February 2006. It is anticipated that The C&A Report will support the development of a Regional Stormwater Management Plan for the Raccoon Creek Watershed.

This C&A Report provided the stakeholders of the Raccoon Creek Watershed with a detailed understanding of the current condition of the surface water resources of this watershed and the information and tools to prepare and adopt an implementable Regional Stormwater Management Plan (RSMP).

The C&A Report reviewed many of the features impacting, or impacted by, surface water in the Raccoon Creek Watershed. It identified impairments, issues and concerns, and recommends strategies, solutions and ideas to be adopted in a Regional Stormwater Management Plan. A major area of concern noted in the report is the apparent over-estimation of existing condition runoff, leading to improperly designed stormwater facilities and unnecessary costs.

The authors of the report performed a characterization and assessment of the physical features of the watershed and a detailed hydrologic analysis of the watershed using the US Army Corps of Engineers' Hydrologic Modeling System (HEC-HMS). After calibration, the modeling data suggested that revised procedures should be implemented to manage stormwater discharges from development projects. Using the standard NRCS hydrologic procedures, it was found that the peak flows were over-predicted for the 2-, 10-, and 100-year storms by 73, 84, and 139 percent, respectively. Based on additional analysis, the following recommendations were made:

- Use the DelMarVa dimensionless unit hydrograph for all hydrologic analyses in the Raccoon Creek Watershed when the NRCS runoff methods are used.
- Use field indicators to verify the existing condition calculations, including evidence of overland flow where channel flow is said to occur, in order to improve accuracy of Time of Concentration calculations and drainage area delineation.
- Design bridges, dams, culverts and other similar structures using Curve Numbers calculated following standard engineering practices.
- Develop a regional table of Curve Numbers to reflect seasonally low runoff conditions and use these Curve Numbers to describe the existing hydrologic condition for all site development work.

The Raccoon Creek Regional Stormwater Management Committee (RCRSMC) desires to develop and adopt municipal level ordinances that provide greater protection to the Raccoon Creek Watershed and the stream network.

2.0 – DESCRIPTION OF WATERSHED

Located in Watershed Management Area 18, the Raccoon Creek flows from east to west in Gloucester County toward the Delaware River. The watershed encompasses a total area of 25.67 square miles with 63 linear miles of watercourse. The main stem drains approximately two-thirds of this area with the remainder draining to the South Branch Raccoon Creek. The downstream terminus of the project area is just below the confluence of the main stem and the South Branch at Tomlin Station Road (County Route #607). Four municipalities: Elk Township, Glassboro Borough,

Harrison Township and South Harrison Township, contain land within the watershed. The Raccoon Creek Watershed has recently experienced significant development and includes some of the fastest growing municipalities in the county. Despite this recent growth, the watershed remains predominantly agricultural land and the stream corridor remains largely intact without significant degradation. However, land use changes in the watershed are likely to impact both surface water quality and quantity.

3.0 – REVIEW OF PREVIOUS ANALYSIS

The hydrologic analysis performed for the C&A Report was reviewed to include the watershed and meteorological data. Specific observations and conclusions include:

- The availability of the watershed data in GIS files greatly aided the review process.
- The hydrologic analysis was thorough, correctly using HEC-HMS.
- The level of detail used for collecting the data and modeling the watershed is reasonable. The 25.67-square-mile watershed was divided into 39 subwatersheds ranging in size from 0.22 to 2.75 square miles. These subwatersheds were accurately delineated to reflect the stream network of the watershed.
- The results of the hydrologic model with standard hydrologic parameters (NRCS dimensionless unit hydrograph and Type III storm) and initial estimates of Runoff Curve Numbers (CN) are significantly higher than those developed from an analysis of the stream gage data at Tomlin Station Road (Table 3.1).

Table 3.1 – Comparison of Results - Standard Hydrology & Observations

Data Source	Peak Discharge (cfs)		
	2-year	10-year	100-year
Stream Gage	701	1680	3590
Standard Hydrology	1214	3089	8566
Standard Hydrology/Stream Gage	173%	184%	239%

3.1 Unit Hydrograph

The C&A Report recommended use of the NRCS DelMarVa dimensionless unit hydrograph instead of the standard NRCS dimensionless unit hydrograph. There are many similarities in the topography of the Raccoon Creek Watershed and the DelMarVa Peninsula. As shown in Table 3.2, the use of the DelMarVa dimensionless unit hydrograph resulted in a reduction of 28, 28, and 30 percent in the peak flows for the 2-, 10-, and 100-year events, respectively. This adjustment is considered warranted.

Table 3.2 – Comparison of Results – Standard NRCS & DelMarVa Hydrograph

Data Source	Peak Discharge (cfs)		
	2-year	10-year	100-year
Standard NRCS Hydrograph	1214	3089	8566
DelMarVa Hydrograph	877	2232	5961
Reduction	28%	28%	30%
DelMarVa Hydrograph/Stream Gage	125%	133%	166%

3.2 Hydrologic Condition

Most of the existing condition CNs were computed for each subwatershed appropriately using the NRCS digitized soil survey data and 2002 land use/land cover data. For several of the cover types, the fair hydrologic condition was used. Based on field observations, it is recommended that the good hydrologic condition be used for all cover types in the watershed.

3.3 Rainfall Distribution

NOAA Atlas 14 was appropriately used to obtain precipitation-frequency data. These values were distributed temporally using the NRCS Type III rainfall data. NRCS has recently developed temporal distributions for Gloucester County using data from Atlas 14. Unique distributions were developed for each frequency of precipitation. These distributions are preferable to the Type III distribution because they are based on the same data source that was used for precipitation volume. Therefore, it is recommended that the unique distributions be used instead of the Type III distribution.

3.4 Initial Abstraction

Research (Hawkins, et al., undated) indicates that an Initial Abstraction Ratio (Ia/S) of 0.05 fits observed rainfall-runoff data better than does the standard value of 0.2, upon which the current CN tables are based. A revised Initial Abstraction would require the computation of a revised CN. In the C&A Report, it is mentioned that the initial abstraction was varied and that HEC-HMS would automatically adjust the CN. It was not recommended that this adjustment be used because judgment of initial conditions would be too arbitrary. It is Schnabel's understanding that the HEC-HMS model does not automatically adjust the CN. Instead, the revised CN must be computed and entered into HEC-HMS. Schnabel agrees it would not be feasible to adjust the initial abstraction because the NRCS TR-20 and TR-55 hydrologic models do not allow the adjustment of the initial abstraction.

4.0 – SITE VISIT

The watershed was visited to observe typical land covers, hydrologic conditions, conservation practices, stormwater basins, other structures in the streams, and the general topography of the watershed. It was noted that there are many natural depressional areas not detected by available topographic data. It was also noted that the general hydrologic condition of the watershed is good.

5.0 – ADDITIONAL ANALYSIS

Schnabel performed additional analyses to address the issues identified above.

5.1 Revised Hydrologic Condition

As recommended by Schnabel, the authors of the C&A Report made the recommended revision to the computed CNs using the good hydrologic condition for all cover types and provided revised CNs for each subwatershed. Schnabel revised the HEC-HMS Hydrologic Model to include these revised CNs. For the entire watershed, this reduced the composite CN from 70 to 68. This resulted in a reduction in the composite CN for each subwatershed of from 1 to 4, and an average reduction of 2 for the entire watershed. As shown in Table 5.1, the resultant reductions in peak flows for the watershed were 8, 7, and 5 percent for the 2-, 10-, and 100-year events, respectively, for the entire watershed.

Table 5.1 – Comparison of Results – Fair/Good and Good Hydrologic Condition

Hydrologic Condition	Peak Discharge (cfs)		
	2-year	10-year	100-year
Fair/Good	877	2232	5961
Good	805	2073	5678
Reduction	8%	7%	5%
Good Hydrologic Condition/Stream Gage	115%	123%	158%

Note: All results include DelMarVa dimensionless unit hydrograph.

5.2 Rainfall Distribution

Schnabel incorporated the temporal rainfall distributions developed by NRCS using data from Atlas 14 into the HEC-HMS Hydrologic Model. For the Raccoon Creek Watershed, use of these distributions resulted in no change in the peak flow for the 2-year event, a 1-percent decrease for the 10-year event, and a 7-percent decrease for the 100-year event. While these changes are relatively minor, it is recommended that the rainfall distributions be used because they do result in better agreement with stream gage analysis.

Table 5.2 – Comparison of Results – Type III and Atlas 14 Rainfall Distributions

Data Source	Peak Discharge (cfs)		
	2-year	10-year	100-year
Type III	805	2073	5678
NOAA Atlas 14	804	2055	5300
Reduction	0%	1%	7%
NOAA Atlas 14/ Stream Gage	115%	122%	148%

Note: All results include DelMarVa dimensionless unit hydrograph and good hydrologic condition.

Cumulatively, these modifications to the standard NRCS hydrologic procedures resulted in much better agreement with the observed peak flows at the stream gage; however, the peak flows would still be over-predicted by 15, 22, and 48 percent for the 2-, 10-, and 100-year events, respectively.

5.3 Runoff Condition

In the C&A Report, it was recommended that a table of CNs be developed specifically for the Raccoon Creek Watershed that better reflect the runoff conditions in the watershed. As stated in the NRCS, Part 630, Chapter 10, rainfall-runoff data do not fit the CN runoff concept precisely. The variability in the CN results from rainfall intensity and duration, total rainfall, soil moisture conditions, cover density, stage of growth, and temperature. These causes of variability are collectively called the Antecedent Runoff Condition (ARC). ARC is divided into three classes: II for average conditions, I for dry conditions, and III for wetter conditions. The average runoff condition (ARC II) was used to develop the standard CNs shown in NRCS, Part 630, Chapter 9 and TR-55. The wet and dry ARCs serve as envelope curves that show the possible variation in CNs under different climatic and seasonal conditions (Figure 5.1).

Variation of the CN by interpolating between the ARCs has been used elsewhere with good success. For example, in Texas, NRCS has developed several tables of CNs that reflect the variable climatic conditions in the state (Hailey and McGill). The interpolation between the three ARCs achieves consistency in these adjustments.

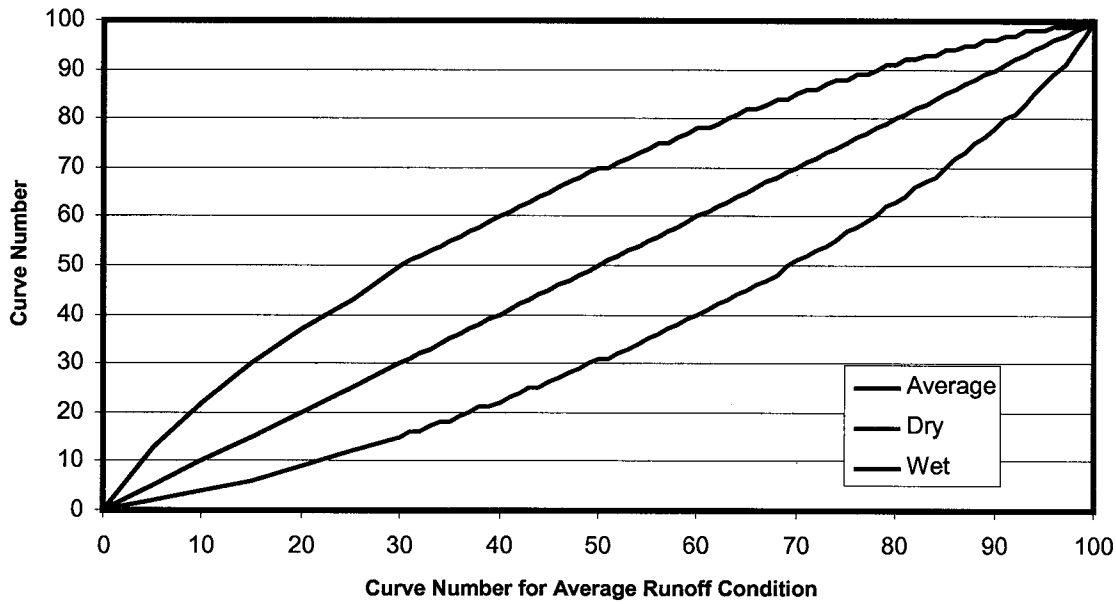


Figure 5.1 – Effect of Runoff Condition on Curve Number

An optimized set of CNs was developed for the 2-, 10-, and 100-year storms by adding a constant percentage of the difference between the CNs for average and dry runoff conditions to the CN for the dry runoff condition that resulted in the best agreement between the calculated and observed peak flows at the stream gage. The resultant percentages were 82, 71, and 33 percent for the 2- 10-, and 100-year storms, respectively. Equations representing this optimization are as follows:

2-year CN = CN (Dry) + 0.82*[CN (Ave) - CN (Dry)]
10-year CN = CN (Dry) + 0.71*[CN (Ave) - CN (Dry)]
100-year CN = CN (Dry) + 0.33*[CN (Ave) – CN (Dry)]

Figure 5.2 shows how these optimized CNs relate to those for ARCs I, II, and III.

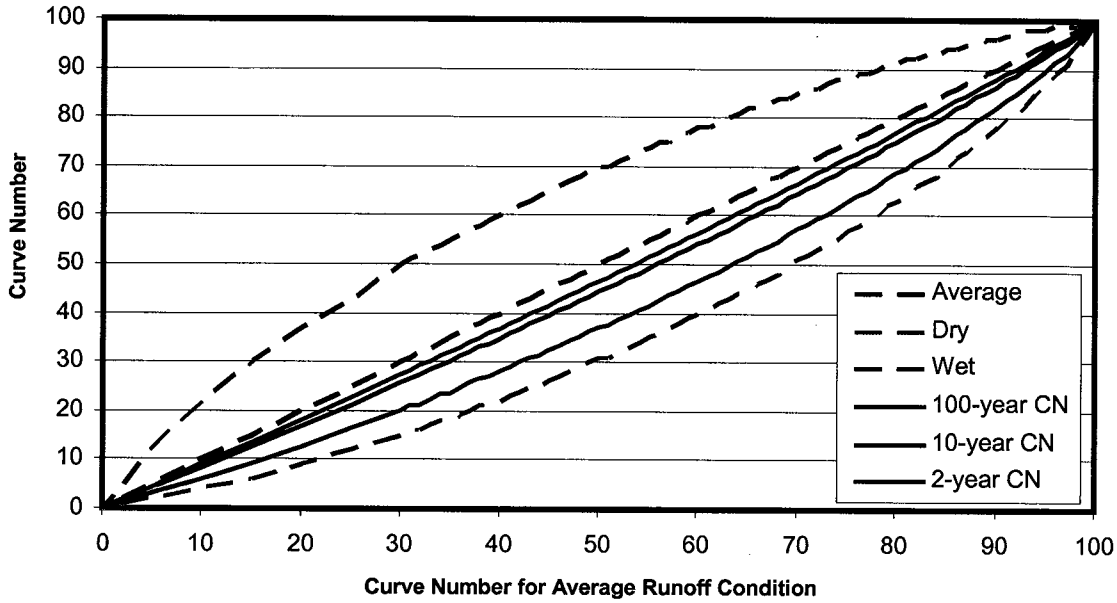


Figure 5.2 – Observed Curve Numbers

Table 5.3 – Comparison of Results – Average & Optimized ARCs

Runoff Condition	Peak Discharge (cfs)		
	2-year	10-year	100-year
Average ARC	804	2055	5300
Optimized	720	1657	3578
Reduction	10%	18%	32%
Optimized ARC/ Stream Gage	103%	99%	100%

Note: All results include DelMarVa dimensionless unit hydrograph, good hydrologic condition, and rainfall distribution from Atlas 14.

For the entire Raccoon Creek Watershed, the composite CN would be reduced from 68 for all storms to 64 for the 2-year storm, to 62 for the 10-year storm, and to 55 for the 100-year storm.

These values correspond well with the larger observed storms that occur in the summer and fall, shown in Table 5.4. These data tend to support the observation made in the C&A Report that there is a different runoff response from storms that occur in the summer and fall than from those that occur in the winter and spring.

Table 5.4 also shows that, although less prevalent, large storms can occur in the winter and spring. Therefore, the engineer should give careful consideration to the assumptions made and discuss them with regulatory agencies before these recommendations are used for other purposes.

Table 5.4 – Individual Storm Precipitation and Runoff Data

Storm Event	Average Precipitation (inches)	Total Runoff Volume (ac-ft)	Total Runoff Volume (inches)	Observed CN
9/15/1999	6.23	2634	1.77	56
3/21/2000	3.58	2515	1.70	80
4/12/2004	2.98	1895	1.24	80
9/28/2004	2.79	424	0.20	58
10/7/2005	4.74	1179	0.69	52

Use of optimized CNs for each frequency storm would result in peak discharges that very closely reflect those observed at the stream gage; however, their use would not be practical because it would require running a different model for each storm. In addition, if an event other than the 2-, 10-, or 100-year storm needed to be analyzed, there would not be a set of CNs for use.

5.4 Initial Abstraction

Hawkins, et al. reported that using an Ia/S = 0.05 fits observed rainfall-runoff data much better than does the handbook value of 0.2. They also point out that, with a different value for Ia/S, the values of S are not the same, requiring the use of a different CN. They developed a relationship of $S_{0.05} = 1.33S_{0.20}^{1.15}$ to relate values of S for the two conditions. Using this relationship, new CNs were developed for Ia/S = 0.05.

The revised Ia and CN values were entered into HEC-HMS for each subwatershed. The 2-, 10-, and 100-year storms, with the averaged ARC, were then modeled. As shown in Table 5.5, there is a slight increase in the peak discharge for the 2-year storm, and decreases for the 10- and 100-year storms.

Table 5.5 – Comparison of Results – Ia/S = 0.20 and 0.05

Runoff Condition	Peak Discharge (cfs)		
	2-year	10-year	100-year
Ia/S = 0.20	804	2055	5300
Ia/S = 0.05	815	1861	4577
Reduction	-1%	9%	14%
Ia=0.05/ Stream Gage	116%	111%	127%

Note: All results include DelMarVa dimensionless unit hydrograph, good hydrologic condition, rainfall distribution from Atlas 14, and average ARC.

Use of Ia/S = 0.05 instead of 0.20 and an average ARC would result in peak discharges that more closely reflect those observed at the stream gage; however, NRCS hydrologic models, WinTR-55 and WinTR-20, do not allow the use of any other value of Ia/S than 0.20. As a result, the use of Ia/S would not be practical at this time.

6.0 – RECOMMENDATIONS

The following recommendations are made for use in the Raccoon Creek Stormwater Management Plan. When using these recommendations, the engineer should give careful consideration to the assumptions made to assure that they apply to the situation for which they are used. In addition, these assumptions should be discussed with regulatory agencies before these recommendations are used for other purposes.

- The NRCS DelMarVa dimensionless unit hydrograph should be used.
- Good Hydrologic Soil Condition should be used throughout the watershed.
- The rainfall distributions developed by NRCS for Gloucester County using NOAA Atlas 14 should be used.
- The optimized CNs for the 10-year storm should be used for all storms.
- If NRCS develops the capability in WinTR55 and WinTR20 to adjust the initial abstraction, Ia/S = 0.05 should be used. The CNs would need to be adjusted to reflect the different Ia.

As shown in Table 6.1, adoption of the first four recommendations would provide good correlation with observed flows of the stream gage for the 10-year event with an underestimate of peak flows for the 2-year storm and an overestimate of peak flows for the 100-year storm. In addition, it would be practical for use by both NRCS and USACE hydrologic models for all frequency events. A table showing both CNs for the average runoff condition as shown in TR-55 and the CNs optimized for the 10-year storm is in Appendix A.

Table 6.1 – Summary of Results – Recommended Optimized CNs

Runoff Condition	Peak Discharge (cfs)		
	2-year	10-year	100-year
Stream Gage	701	1680	3590
Optimized CN for 10-year Storm	596	1657	4640
Optimized ARC/ Stream Gage	85%	99%	129%

NRCS Part 630, Hydrology, Chapter 5 states that the use of rainfall and associated streamflow data for annual floods is the best means of establishing CNs. The authors of the C&A Report obtained rainfall and runoff data for each storm occurring in the watershed from 1996 to 2005 with rainfall in excess of 3 inches. Using techniques similar to those in NRCS Part 630, Hydrology, Chapter 5, an average CN of 61 was computed for the entire watershed. This is in good agreement with the composite CN of 62 computed for the Raccoon Creek Watershed using the optimized ARC.

If NRCS software were modified to allow the selection of Ia, it would be advisable to consider the use of an optimized CN for the 10-year storm with Ia/S = 0.05 because it would better match the

observed flows at the stream gage by increasing the peak flow for the 2-year storm and decreasing the peak flow for the 100-year storm while holding the peak flow for the 10-year storm constant.

7.0 – REFERENCES

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APPENDIX A

Runoff Curve Numbers

Runoff curve numbers for agricultural lands in Raccoon Creek Watershed, Gloucester County, NJ

Cover Description				CN for hydrologic soil group			
cover type	treatment	hydrologic condition	Runoff Condition	A	B	C	D
Fallow	Bare Soil	---	Average	77	86	91	94
			Optimized[9/]	72	82	88	91
Row Crops	Crop residue cover (CR)	Good	Average	74	83	88	90
			Optimized[9/]	68	78	84	87
	Straight row (SR)	Good	Average	67	78	85	89
			Optimized[9/]	61	73	81	85
	SR + CR	Good	Average	64	75	82	85
			Optimized[9/]	58	70	77	81
	Contoured (C)	Good	Average	65	75	82	86
			Optimized[9/]	59	70	77	82
	C + CR	Good	Average	64	74	81	85
			Optimized[9/]	58	68	76	81
	Contoured & terraced (C & T)	Good	Average	62	71	78	81
			Optimized[9/]	56	65	73	76
	C & T + CR	Good	Average	61	70	77	80
			Optimized[9/]	55	64	72	75
Small grain	SR	Good	Average	63	75	83	87
			Optimized[9/]	57	70	78	83
	SR + CR	Good	Average	60	72	80	84
			Optimized[9/]	54	66	75	79
	C	Good	Average	61	73	81	84
			Optimized[9/]	55	67	76	79
	C + CR	Good	Average	60	72	80	83
			Optimized[9/]	54	66	75	78
	C & T	Good	Average	59	70	78	81
			Optimized[9/]	53	64	73	76
	C & T + CR	Good	Average	58	69	77	80
			Optimized[9/]	52	63	72	75
Close-seeded or broadcast legumes or rotation meadow	SR	Good	Average	58	72	81	85
			Optimized[9/]	52	66	76	81
	C	Good	Average	55	69	78	83
			Optimized[9/]	49	63	73	78
	C & T	Good	Average	51	67	76	80
			Optimized[9/]	45	61	71	75

See footnotes at end of table.

Runoff curve numbers for agricultural lands in Raccoon Creek Watershed, Gloucester County, NJ - Continued

Cover Description				CN for hydrologic soil group			
cover type	treatment	hydrologic condition	Runoff Condition	A	B	C	D
Pasture, grassland, or range- continuous forage for grazing[4/]	---		Average	39	61	74	80
			Optimized[9/]	34	55	68	75
Meadow-continuous grass, protected from grazing and generally mowed for hay		Good	Average	30[6/]	58	71	78
			Optimized[9/]	30[6/]	52	65	73
Brush- brush- forbs- grass mixture with brush the major element[5/]		Good	Average	30[6/]	48	65	73
			Optimized[9/]	30[6/]	42	59	67
Woods- grass combination (orchard or tree farm) [7/]		Good	Average	30[6/]	58	72	79
			Optimized[9/]	30[6/]	52	66	74
Woods [8/]		Good	Average	30[6/]	55	70	77
			Optimized[9/]	30[6/]	49	64	72
Farmstead- buildings, lanes, driveways, and surrounding lots		Good	Average	59	74	82	86
			Optimized[9/]	53	68	77	82
Roads (including right-of-way):							
Dirt		Good	Average	72	82	87	89
			Optimized[9/]	66	77	83	85
Gravel		Good	Average	76	85	89	91
			Optimized[9/]	71	81	85	88

1/ Ia = 0.2S

2/ Crop residue cover applies only if residue is on at least 5 percent of the surface throughout the year

3/ Hydrologic condition is based on combinations of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥20%), and (e) degree of surface toughness.

Good: Factors encourage average and better then average infiltration and tend to decrease runoff.

For conservation tillage good hydrologic condition, more than 20 percent of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain).

4/ Good: > 75% ground cover and lightly or only occasionally grazed.

5/ Good: > 75% ground cover.

6/ If actual curve number is less than 30, use CN = 30 for runoff computation.

7/ CN's shown were computed for areas with 50 percent woods and 50 percent grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

8/ Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

9/ CN = CN (Dry Runoff Condition) + 0.71*[CN (Average Runoff Condition) - (CN (Dry Runoff Condition)]

Runoff curve numbers for urban areas in Raccoon Creek Watershed, Gloucester County, NJ[1/]

Cover Description cover type and hydrologic condition	Average percent impervious area[2/]	Runoff Condition	~~~CN for hydrologic soil group~~~ A	 B	 C	 D
Fully developed urban areas (vegetation established)						
Open space (lawns, parks, golf courses, cemeteries, etc.)[3/]						
Good condition (grass cover > 75%)		Average	39	61	74	80
		Optimized[4/]	34	55	68	75
Impervious areas:						
Paved parking lots, roofs, driveways, etc.		Average	98	98	98	98
(excluding right of way)		Optimized[4/]	98	98	98	98
Streets and roads:						
Paved, curbs and storm sewers (excluding right-of-way)		Average	98	98	98	98
		Optimized[4/]	98	98	98	98
Paved: open ditches (including right-of-way)		Average	83	89	92	93
		Optimized[4/]	78	85	89	90
Gravel (including right-of-way)		Average	76	85	89	91
		Optimized[4/]	71	81	85	88
Dirt (including right-of-way)		Average	72	82	87	89
		Optimized[4/]	66	77	83	85
Urban districts:						
Commercial and business	85%	Average	89	92	94	95
		Optimized[4/]	88	92	94	95
Industrial	72%	Average	81	88	91	93
		Optimized[4/]	80	86	90	92
Residential districts by average lot size:						
1/8 acre or less (town houses)	65%	Average	77	85	90	92
		Optimized[4/]	76	83	88	90
1/4 acre	38%	Average	61	75	83	87
		Optimized[4/]	58	71	79	84
1/3 acre	30%	Average	57	72	81	85
		Optimized[4/]	53	68	77	82
1/2 acre	25%	Average	54	70	80	85
		Optimized[4/]	50	66	76	81
1 acre	20%	Average	51	68	79	84
		Optimized[4/]	47	64	74	80
2 acres	12%	Average	46	65	77	82
		Optimized[4/]	42	60	72	78
Developing urban areas						
Newly graded areas (pervious areas only, no vegetation)		Average	77	86	91	94
		Optimized[4/]	72	82	88	91

1/ $I_a = 0.2S$

2/ The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition.

3/ CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space type.

4/ For pervious areas, CN =CN (Dry Runoff Condition) + 0.71*[CN (Average Runoff Condition) - (CN (Dry Runoff Condition)]

RIPARIAN ZONE
MODEL ORDINANCE

(This Model Ordinance is modified from the original version prepared by the Passaic River Coalition by the New Jersey Department of Environmental Protection, Division of Watershed Management)
July 7, 2008

I. Intent and Purpose
II. Statutory Authority
III. Definitions
IV. Establishment of Riparian Zones
V. Uses Permitted in Riparian Zones
VI. Performance Standards for Riparian Zones
VII. Nonconforming Structures and Uses in Riparian Zones
VIII. Uses Prohibited in Riparian Zones
IX. Activities Permitted in Riparian Zones in the Case of No Reasonable or Prudent Alternative or Extreme Hardship
X. Riparian Zone Management Plan
XI. Boundary Interpretation, Appeals Procedures, Inspections, Conflicts, Severability
XII. Enforcement
XIII. Effective Date

[The requirements set forth in this Model Ordinance are consistent with those found in the State of New Jersey's Stormwater Management rules, N.J.A.C. 7:8, the Flood Hazard Area Control Act rules, N.J.A.C. 7:13 and the Water Quality Management Planning rules, N.J.A.C. 7:15.]

I. INTENT AND PURPOSE

The governing body of *[municipality]* finds that riparian lands adjacent to streams, lakes, or other surface water bodies that are adequately vegetated provide an important environmental protection and water resource management benefit. It is necessary to protect and maintain the beneficial character of riparian areas by implementing specifications for the establishment, protection, and maintenance of vegetation along the surface water bodies within the jurisdiction of *[municipality]*, consistent with the interest of landowners in making reasonable economic use of parcels of land that include such designated areas. The purpose of this Ordinance is to designate riparian zones, and to provide for land use regulation therein in order to protect the streams, lakes, and other surface water bodies of *[municipality]*; to protect the water quality of watercourses, reservoirs, lakes, and other significant water resources within *[municipality]*; to protect the riparian and aquatic ecosystems of *[municipality]*; to provide for the environmentally sound use of the land resources of *[municipality*], and to complement existing state, regional, county, and municipal stream corridor protection and management regulations and initiatives.

The specific purposes and intent of this Ordinance are to:

A. Restore and maintain the chemical, physical, and biological integrity of the water resources of *[municipality]*;
B. Prevent excessive nutrients, sediment, and organic matter, as well as biocides and other pollutants, from reaching surface waters by optimizing opportunities for filtration, deposition, absorption, adsorption, plant uptake, biodegradation, and denitrification, which occur when stormwater runoff is conveyed through vegetated buffers as stable, distributed flow prior to reaching receiving waters;
C. Provide for shading of the aquatic environment so as to moderate temperatures, retain more dissolved oxygen, and support a healthy assemblage of aquatic flora and fauna;
D. Provide for the availability of natural organic matter (leaves and twigs) and large woody debris (trees and limbs) that provide food and habitat for aquatic organisms (insects, amphibians, crustaceans, and small fish), which are essential to maintain the food chain;
E. Increase stream bank stability and maintain natural fluvial geomorphology of the stream system, thereby reducing stream bank erosion and sedimentation and protecting habitat for aquatic organisms;
F. Maintain base flows in streams and moisture in wetlands;
G. Control downstream flooding; and
H. Conserve the natural features important to land and water resources, e.g., headwater areas, ground water recharge zones, floodways, floodplains, springs, streams, wetlands, woodlands, and prime wildlife habitats.

II. STATUTORY AUTHORITY

The municipality of *[municipality]* is empowered to regulate land uses under the provisions of the New Jersey Municipal Land Use Law, N.J.S.A 40:55D-1 *et seq.*, which authorizes each municipality to plan and regulate land use in order to protect public health, safety and welfare by protecting and maintaining native vegetation in riparian areas. *[Municipality]* is also empowered to adopt and implement this Ordinance under provisions provided by the following legislative authorities of the State of New Jersey:

A. Water Pollution Control Act, N.J.S.A. 58:10A-1 *et seq.*
B. Water Quality Planning Act, N.J.S.A. 58:11A-1 *et seq.*
C. Spill Compensation and Control Act, N.J.S.A. 58:10-23 *et seq.*
D. Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 *et seq.*
E. Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 *et seq.*

III. DEFINITIONS

Acid producing soils means soils that contain geologic deposits of iron sulfide minerals (pyrite and marcasite) which, when exposed to oxygen from the air or from surface waters, oxidize to produce sulfuric acid. Acid producing soils, upon excavation, generally have a pH of 4.0 or lower. After exposure to oxygen, these soils generally have a pH of 3.0 or lower. Information regarding the location of acid producing soils in New Jersey can be obtained from local Soil Conservation District offices.

Administrative authority means the Planning Board or Board of Adjustment or Construction Office with all of the powers delegated, assigned, or assumed by them according to statute or ordinance.

Applicant means a person, corporation, government body or other legal entity applying to the Planning Board, Board of Adjustment or the Construction Office proposing to engage in an activity that is regulated by the provisions of this ordinance, and that would be located in whole or in part within a regulated Riparian Zone.

Category One waters or C1 waters shall have the meaning ascribed to this term by the Surface Water Quality Standards, N.J.A.C. 7:9B, for purposes of implementing the antidegradation policies set forth in those standards, for protection from measurable changes in water quality characteristics because of their clarity, color, scenic setting, and other characteristics of aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources.

Category Two waters or C2 waters means those waters not designated as Outstanding Natural Resource waters or Category One waters in the Surface Water Quality Standards, N.J.A.C. 7:9B, for purposes of implementing the antidegradation policies set forth in those standards.

Floodway shall have the meaning ascribed to this term by the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., and regulations promulgated there under published at N.J.A.C. 7:13 et seq., and any supplementary or successor legislation and regulations from time to time enacted or promulgated.

Intermittent Stream means a surface water body with definite bed and banks in which there is not a permanent flow of water and shown on the New Jersey Department of Environmental Protection Geographic Information System (GIS) hydrography coverages or, in the case of a Special Water Resource Protection Area (SWRPA) pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h), C1 waters as shown on the USGS quadrangle map or in the County Soil Surveys.

Lake, pond, or reservoir means any surface water body shown on the New Jersey Department of Environmental Protection Geographic Information System (GIS) hydrography coverages or, in the case of a Special Water Resource Protection Area (SWRPA) pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h), C1 waters as shown on the USGS quadrangle map or in the County Soil Surveys; that is an impoundment, whether naturally occurring or created in whole or in part by the building of structures for the retention of surface water. This excludes sedimentation control and stormwater retention/detention basins and ponds designed for treatment of wastewater.

Perennial stream means a surface water body that flows continuously throughout the year in most years and shown on the New Jersey Department of Environmental Protection Geographic Information System (GIS) hydrography coverages or, in the case of a Special Water Resource Protection Area (SWRPA) pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h), C1 waters as shown on the USGS quadrangle map or in the County Soil Surveys.

Riparian zone means the land and vegetation within and directly adjacent to all surface water bodies including, but not limited to lakes, ponds, reservoirs, perennial and intermittent streams, up to and including their point of origin, such as seeps and springs, as shown on the New Jersey Department of Environmental Protection's GIS hydrography coverages or, in the case of a Special Water Resource Protection Area (SWRPA) pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h), C1 waters as shown on the USGS quadrangle map

or in the County Soil Surveys. There is no riparian zone along the Atlantic Ocean nor along any manmade lagoon or oceanfront barrier island, spit or peninsula.

Riparian Zone Management Plan means a plan approved by the Engineer of *[municipality]*. The plan shall be prepared by a landscape architect, professional engineer or other qualified professional, and shall evaluate the effects of any proposed activity/uses on any riparian zone. The plan shall identify existing conditions, all proposed activities, and all proposed management techniques, including any measures necessary to offset disturbances to any affected riparian zone.

Special Water Resource Protection Area or SWRPA means a 300 foot area provided on each side of a surface water body designated as a C1 water or tributary to a C1 water that is a perennial stream, intermittent stream, lake, pond, or reservoir, as defined herein and shown on the USGS quadrangle map or in the County Soil Surveys within the associated HUC 14 drainage, pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h).

Surface water body(ies) means any perennial stream, intermittent stream, lake, pond, or reservoir, as defined herein. In addition, any regulated water under the Flood Hazard Area Control Act rules at N.J.A.C. 7:13-2.2, or State open waters identified in a Letter of Interpretation issued under the Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A-3 by the New Jersey Department of Environmental Protection Division of Land Use Regulation shall also be considered surface water bodies.

Threatened or endangered species means a species identified pursuant to the Endangered and Nongame Species Conservation Act, N.J.S.A. 23:2A-1 et seq., the Endangered Species Act of 1973, 16 U.S.C. §§1531 et seq. or the Endangered Plant Species List, N.J.A.C. 7:5C-5.1, and any subsequent amendments thereto.

Trout maintenance water means a section of water designated as trout maintenance in the New Jersey Department of Environmental Protection's Surface Water Quality Standards at N.J.A.C. 7:9B.

Trout production water means a section of water identified as trout production in the New Jersey Department of Environmental Protection's Surface Water Quality Standards at N.J.A.C. 7:9B.

IV. ESTABLISHMENT OF RIPARIAN ZONES

A. Riparian zones adjacent to all surface water bodies shall be protected from avoidable disturbance and shall be delineated as follows:

1. The riparian zone shall be 300 feet wide along both sides of any Category One water (C1 water), and all upstream tributaries situated within the same HUC 14 watershed. This includes Special Water Resource Protection Area's or SWRPA's as defined herein and shown on the USGS quadrangle map or in the County Soil Surveys within the associated HUC 14 drainage, pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h).
2. The riparian zone shall be 150 feet wide along both sides of the following waters <u>not</u> designated as C1 waters:
   a. Any trout production water and all upstream waters (including tributaries);
   b. Any trout maintenance water and all upstream waters (including tributaries) within one linear mile as measured along the length of the surface water body;

c. Any segment of a water flowing through an area that contains documented habitat for a threatened or endangered species of plant or animal, which is critically dependent on the surface water body for survival, and all upstream waters (including tributaries) within one linear mile as measured along the length of the surface water body; and
d. Any segment of a surface water body flowing through an area that contains acid producing soils.

3. For all other surface water bodies, a riparian zone of 50 feet wide shall be maintained along both sides of the water.

B. The portion of the riparian zone that lies outside of a surface water body is measured landward from the top of bank. If a discernible bank is not present along a surface water body, the portion of the riparian zone outside the surface water body is measured landward as follows:

1. Along a linear fluvial or tidal water, such as a stream or swale, the riparian zone is measured landward of the feature's centerline;
2. Along a non-linear fluvial water, such as a lake or pond, the riparian zone is measured landward of the normal water surface limit;
3. Along a non-linear tidal water, such as a bay or inlet, the riparian zone is measured landward of the mean high water line; and
4. Along an amorphously-shaped feature such as a wetland complex, through which water flows but which lacks a definable channel, the riparian zone is measured landward of the feature's centerline.

Where slopes (in excess of 15 percent) are located within the designated widths, the riparian zone shall be extended to include the entire distance of this sloped area to a maximum of 300 feet.

[Municipalities have the ability to include a series of options, as long as the minimum requirements are met. If an existing municipal ordinance includes more stringent buffer requirements, or if the municipality wished to propose more stringent requirements, then the more stringent requirements should be applied.]

For areas adjacent to surface water bodies for which the floodway has been delineated per the Flood Hazard Area Control Act rules at N.J.A.C. 7:13-3 or the State's adopted floodway delineations, the riparian zone shall cover the entire floodway area, or the area described in Section IV.A.1. or IV.A.2. above, whichever area has the greatest extent. Requests for alterations to the adopted delineations can be provided to the New Jersey Department of Environmental Protection for consideration if site specific information is available.

C. A riparian zone is an overlay to the existing zoning districts. The provisions of the underlying district shall remain in full force except where the provisions of the riparian zone differ from the provisions of the underlying district, in which case the provision that is more restrictive shall apply. These provisions apply to land disturbances resulting from or related to any activity or use requiring application for any of the following permits or approvals:

- Building permit
- Zoning variance
- Special exception
- Conditional use

- Subdivision/land development approval

D. A map of the riparian zones of the entire municipality of *[municipality]*, including all land and water areas within its boundaries, which designates surface water bodies, is included as part of this Ordinance, and is appended as Figure *[municipality to insert Figure # here]*. Maps of the municipality on which these designations have been overlain shall be on file and maintained by the offices of the Clerk of *[municipality]*. This map conforms to all applicable laws, rules and regulations applicable to the creation, modification and promulgation of zoning maps.

E. It shall be the duty of the Engineer of [municipality], every second year after the adoption of this Ordinance, to propose modifications to the map delineating riparian zones required by any naturally occurring or permitted change in the location of a defining feature of a surface water body occurring after the initial adoption of the riparian zone map, to record all modifications to the riparian zone map required by decisions or appeals under Section XI., and by changes made by the New Jersey Department of Environmental Protection in surface water classifications or floodway delineations.

F. The applicant or designated representative shall be responsible for the initial determination of the presence of a riparian zone on a site, and for identifying the area on any plan submitted to the *[municipality]* in conjunction with an application for a construction permit, subdivision, land development, or other improvement that requires plan submissions or permits. This initial determination shall be subject to review and approval by the municipal engineer, governing body, or its appointed representative, and, where required, by the New Jersey Department of Environmental Protection.

G. The municipal Master Plan provides the legal basis for zoning and land use regulation at the local level. The technical foundation for local riparian zones in this municipality should be incorporated into the Master Plan. A technical report on the need for riparian zones in *[municipality]* may be adopted as part of the Master Plan, N.J.S.A 40:55D-28b(11). The technical report should include the following information: a statement setting forth the rationale and need to protect riparian zones; and reference to the methods used to designate and delineate riparian zones.

H. Exemptions

Instead of the riparian zone protection requirements above, the applicant must demonstrate compliance with one of the following:

1. The proposed project or activity is not in the riparian zone established at section IV.A. above;
2. The proposed disturbance in a riparian zone is for a linear development with no feasible alternative route. If the riparian zone is associated with Category One waters, the linear development must also meet the requirements for Special Water Resource Protection Areas under the Stormwater Management rules at N.J.A.C. 7:8-5.5(h);
3. The proposed disturbance in a riparian zone is in accordance with a stream corridor restoration or stream bank stabilization plan or project approved by the New Jersey Department of Environmental Protection;
4. The proposed disturbance of a riparian zone is necessary to provide for public pedestrian access or water dependent recreation that meets the requirements of the Freshwater Wetlands Protection Act rules, N.J.A.C. 7:7A, the Flood Hazard Area Control Act rules, N.J.A.C. 7:13, or the Coastal Zone Management rules, N.J.A.C. 7:7E;

5. The proposed disturbance of a riparian zone is required for the remediation of hazardous substances performed with New Jersey Department of Environmental Protection or Federal oversight pursuant to the Spill Compensation and Control Act, N.J.S.A. 58:10-23.11a et seq. or the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§9601 et seq.;
6. The proposed disturbance is for redevelopment that does not exceed the limits of existing impervious surfaces;
7. The proposed disturbance would prevent extraordinary hardship on the property owner peculiar to the property; or prevent extraordinary hardship, provided the hardship was not created by the property owner, that would not permit a minimum economically viable use of the property based upon reasonable investment; and/or
8. Demonstrate through site plans depicting proposed development and topography that new disturbance is not located in areas with a 20 percent or greater slope, except as allowed under H.6. and H.7. above.

V. USES PERMITTED IN RIPARIAN ZONES

A. For riparian zones in Category One waters (C1 waters), permitted uses are governed by the Stormwater Management rules at N.J.A.C. 7:8-5.5(h) and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13, unless otherwise exempt.
B. Any other riparian zone area shall remain in a natural condition or, if in a disturbed condition, including agricultural activities, at the time of adoption of this ordinance may be restored to a natural condition. There shall be no clearing or cutting of trees and brush, except for removal of dead vegetation and pruning for reasons of public safety or for the replacement of invasive species with indigenous species. There shall be no altering of watercourses, dumping of trash, soil, dirt, fill, vegetative or other debris, regrading or construction. The following uses are permitted either by right or after review and approval by the municipality in riparian zones. No new construction, development, use, activity, encroachment, or structure shall take place in a riparian zone, except as specifically authorized in this Section. The following uses shall be permitted within a riparian zone:
    1. Open space uses that are primarily passive in character shall be permitted by right to extend into a riparian zone, provided near stream vegetation is preserved. These uses do not require approval by the Zoning Enforcement Officer or compliance with an approved Riparian Zone Management Plan. Such uses include wildlife sanctuaries, nature preserves, forest preserves, fishing areas, game farms, fish hatcheries and fishing reserves, operated for the protection and propagation of wildlife, but excluding structures. Such uses also include passive recreation areas of public and private parklands, including unpaved hiking, bicycle and bridle trails, provided that said trail have been stabilized with pervious materials.
    2. Fences, for which a permit has been issued by the Construction Code Office, to the extent required by applicable law, rule or regulation.
    3. Crossings by farm vehicles and livestock, recreational trails, roads, railroads, storm water lines, sanitary sewer lines, water lines and public utility transmission lines, provided that the land disturbance is the minimum required to accomplish the permitted use, subject to approval by the Zoning Enforcement Officer, provided that any applicable State permits

are acquired, and provided that any disturbance is offset by buffer improvements in compliance with an approved Riparian Zone Management Plan and that the area of the crossing is stabilized against significant erosion due to its use as a crossing.

4. Stream bank stabilization or riparian reforestation, which conform to the guidelines of an approved Riparian Zone Management Plan, or wetlands mitigation projects that have been approved by the New Jersey Department of Environmental Protection, subject to approval by the Zoning Enforcement Officer and subject to compliance with an approved Riparian Zone Management Plan.

VI. PERFORMANCE STANDARDS FOR RIPARIAN ZONES

A. All encroachments proposed into riparian zones in C1 waters shall comply with the requirements of the Stormwater Management rule at N.J.A.C. 7:8-5.5(h) and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13, and shall be subject to review and approval by the New Jersey Department of Environmental Protection, unless exempt.

B. For all other riparian zones, the following conditions shall apply:
   1. All new major and minor subdivisions and site plans shall be designed to provide sufficient areas outside of the riparian zone to accommodate primary structures, any normal accessory uses appurtenant thereto, as well as all planned lawn areas.
   2. Portions of lots within the riparian zone must be permanently restricted by deed or conservation easement held by *[municipality]*, its agent**,** or another public or private land conservation organization which has the ability to provide adequate protection to prevent adverse impacts within the riparian zone. A complete copy of the recorded conservation restriction that clearly identifies the deed book and pages where it has been recorded in the office of the clerk of the applicable county or the registrar of deeds and mortgages of the applicable county must be submitted to the municipality. The applicant shall not commence with the project or activity prior to making this submittal and receiving actual approval of the plan modification and receipt of any applicable permits from the New Jersey Department of Environmental Protection. The recorded conservation restriction shall be in the form approved by the municipality and shall run with the land and be binding upon the property owner and the successors in interest in the property or in any part thereof. The conservation restriction may include language reserving the right to make *de minimus* changes to accommodate necessary regulatory approvals upon the written consent of the municipality, provided such changes are otherwise consistent with the purpose and intent of the conservation restriction. The recorded conservation restriction shall, at a minimum, include:
      a. A written narrative of the authorized regulated activity, date of issuance, and date of expiration, and the conservation restriction that, in addition, includes all of the prohibitions set forth at N.J.S.A. 13:8B-2b(1) through (7);
      b. Survey plans for the property as a whole and, where applicable, for any additional properties subject to the conservation restrictions. Such survey plans shall be submitted on the surveyor's letterhead, signed and sealed by the surveyor, and shall include metes and bounds descriptions of the property, the site, and the areas subject to the conservation restriction in New Jersey State Plane Coordinates, North American Datum 1983, and shall depict the boundaries of the site and all areas subject to the conservation restriction as marked with flags or stakes onsite. All such

survey plans shall be submitted on paper and in digital CAD or GIS file on a media and format defined by the municipality. The flags or stakes shall be numbered and identified on the survey plan; and

c. A copy or copies of deeds for the property as a whole that indicate the deed book and pages where it has been recorded in the office of the clerk of the applicable county or the registrar of deeds and mortgages of the applicable county.

3. Any lands proposed for development which include all or a portion of a riparian zone shall as a condition of any major subdivision or major site plan approval, provide for the vegetation or revegetation of any portions of the riparian zone which are not vegetated at the time of the application or which were disturbed by prior land uses, including for agricultural use. Said vegetation plan shall utilize native and non-invasive tree and plant species to the maximum extent practicable in accordance with an approved Riparian Zone Management Plan, described in Section X.
4. For building lots which exist as of the date of adoption of this ordinance, but for which a building permit or a preliminary site plan approval has not been obtained or is no longer valid, the required minimum front, side, and rear setbacks may extend into the riparian zone, provided that a deed restriction and/or conservation easement is applied which prohibits clearing or construction in the riparian zone.
5. All stormwater shall be discharged outside of but may flow through a riparian zone and shall comply with the Standard For Off-Site Stability in the "Standards for Soil Erosion and Sediment Control in New Jersey", established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 *et seq.* (see N.J.A.C. 2:90-1.3.)
6. If stormwater discharged outside of and flowing through a riparian zone cannot comply with the Standard for Off-Site Stability cited in Section VI.5, then the proposed stabilization measures must meet the requirements of the Flood Hazard Area Control Act rules at N.J.A.C. 7:13-10.2 et seq., and have an approved flood hazard area permit.

VII. NONCONFORMING STRUCTURES AND USES IN RIPARIAN ZONES

Nonconforming structures and uses of land within the riparian zone are subject to the following requirements:

A. Legally existing but nonconforming structures or uses may be continued.
B. Any proposed enlargement or expansion of the building footprint within the riparian zone of a C1 water shall comply with the standards in the Stormwater Management rules at N.J.A.C. 7:8-5.5(h) and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13.
C. For all other riparian zones:
   1. Encroachment within the riparian zone shall only be allowed where previous development or disturbance has occurred and shall be in conformance with the Stormwater Management rules, N.J.A.C. 7:8, and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13.
   2. Existing impervious cover shall not be increased within the riparian zone as a result of encroachments where previous development or disturbances have occurred.
   3. Discontinued nonconforming uses may be resumed any time within one year from such discontinuance but not thereafter when showing clear indications of abandonment. No change or resumption shall be permitted that is more detrimental to the riparian zone, as

measured against the intent and purpose under Section I., than the existing or former nonconforming use. This one-year time frame shall not apply to agricultural uses that are following prescribed Best Management Practices for crop rotation. However, resumption of agricultural uses must be strictly confined to the extent of disturbance existing at the time of adoption of this ordinance.

VIII. USES PROHIBITED IN RIPARIAN ZONES

A. Any use within a riparian zone of a C1 water shall comply with the standards in the Stormwater Management rules at N.J.A.C. 7:8-5.5(h) and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13.
B. For other riparian zones, any use or activity not specifically authorized in Section V. or Section VII. shall be prohibited within the riparian zone. By way of example, the following activities and facilities are prohibited:
   1. Removal or clear-cutting of trees and other vegetation or soil disturbance such as grading, except for selective vegetation removal for the purpose of stream or riparian area stabilization or restoration projects that require vegetation removal or grading prior to implementation.
   2. Storage of any hazardous or noxious materials.
   3. Use of fertilizers, pesticides, herbicides, and/or other chemicals in excess of prescribed industry standards or the recommendations of the Soil Conservation District.
   4. Roads or driveways, except where permitted in compliance with Section V.
   5. Motor or wheeled vehicle traffic in any area, except as permitted by this Ordinance.
   6. Parking lots.
   7. Any type of permanent structure, except structures needed for a use permitted by Section V.
   8. New subsurface sewage disposal system areas. The expansion and replacement of existing subsurface sewage disposal system areas for existing uses is permitted.
   9. Residential grounds or lawns, except as otherwise permitted pursuant to this Ordinance.

IX. ACTIVITIES PERMITTED IN RIPARIAN ZONES IN THE CASE OF NO REASONABLE OR PRUDENT ALTERNATIVE OR EXTREME HARDSHIP

A. For riparian zones in C1 waters, requests for exemptions must be authorized by the New Jersey Department of Environmental Protection, as per the Stormwater Management rules at N.J.A.C. 7:8-5.5(h) and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13.
B. For other riparian zones, hardship variances may be granted by the Zoning Board of Adjustment in cases of a preexisting lot (existing at the time of adoption of this ordinance) when there is insufficient room outside the riparian zone for uses permitted by the underlying zoning and there is no other reasonable or prudent alternative to placement in the riparian zone, including obtaining variances from setback or other requirements that would allow conformance with the riparian zone requirements, and provided the following demonstrations are made:
   1. An applicant shall be deemed to have established the existence of an extreme economic hardship, if the subject property is not capable of yielding a reasonable economic return if its present use is continued or if it is developed in accordance with provisions of this

ordinance and that this inability to yield a reasonable economic return results from unique circumstances peculiar to the subject property which:

a. Do not apply to or affect other property in the immediate vicinity;
b. Relate to or arise out of the characteristics of the subject property because of the particular physical surroundings, shape or topographical conditions of the property involved, rather than the personal situations of the applicant; and are not the result of any action or inaction by the applicant or the owner or his predecessors in title.
c. The necessity of acquiring additional land to locate development outside the riparian zone shall not be considered an economic hardship unless the applicant can demonstrate that there is no adjacent land that is reasonably available or could be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity.

2. An applicant shall be deemed to have established compelling public need if the applicant demonstrates, based on specific facts that one of the following applies:
   a. The proposed project will serve an essential public health or safety need;
   b. The proposed use is required to serve an existing public health or safety need; or
   c. There is no alternative available to meet the established public health or safety need.
3. A variance can only be granted if it is shown that the activity is in conformance with all applicable local, state, and federal regulations, including but not limited to the Stormwater Management rules, N.J.A.C. 7:8, and the Flood Hazard Area Control Act rules, N.J.A.C. 7:13,and that the exception granted is the minimum relief necessary to relieve the hardship.

C. If such an exception is granted, the applicant shall rehabilitate an environmentally degraded riparian zone area within or adjacent to the same site, and at least equivalent in size to the riparian zone reduction permitted, or, if not possible, rehabilitate or expand a riparian zone area at least equivalent in size within a nearby site and, if available, within the same watershed. Rehabilitation shall include reforestation, stream bank stabilization and removal of debris, in accordance with a Riparian Zone Management Plan, as described in Section X below.

[The municipality may require a financial contribution be made to an Open Space or Municipal Stormwater Management Plan mitigation plan fund in exchange for this requirement.]

X. RIPARIAN ZONE MANAGEMENT PLAN

A. Within any riparian zone, no construction, development, use, activity, or encroachment shall be permitted unless the effects of such development are accompanied by preparation, approval, and implementation of a Riparian Zone Management Plan.
B. The landowner, applicant, or developer shall submit to *[municipal contact],* or its appointed representative, a Riparian Zone Management Plan prepared by an environmental professional, professional engineer or other qualified professional which fully evaluates the effects of any proposed uses on the riparian zone. The Riparian Zone Management Plan shall identify the existing conditions including:
   1. Existing vegetation;
   2. Field delineated surface water bodies;
   3. Field delineated wetlands;
   4. The 100-year floodplain;

5. Flood Hazard Areas, including floodway and flood fringe areas, as delineated by the New Jersey Department of Environmental Protection;
6. Soil classifications as found on Soil Surveys;
7. Existing subdrainage areas of site with HUC (Hydrologic Unit Code) 14 designations;
8. Slopes in each subdrainage area segmented into sections of slopes less than 15 %; above 15 % but less than 20%; and steep slopes greater than 20%.

The proposed plan shall describe all proposed uses/activities, and fully evaluate the effects of all proposed uses/activities in a riparian zone, and all proposed management techniques, including proposed vegetation and any other measures necessary to offset disturbances to the riparian zone. A discussion of activities proposed as well as management techniques proposed to offset disturbances and/or enhance the site to improve the riparian zone's ability to function effectively as a riparian zone shall also be included with the Riparian Zone Management Plan submittal to *[municipality]*.

C. The Plan shall be reviewed and must be approved by the Engineer of *[municipality]*, in consultation with the Environmental Commission, as part of the subdivision and land development process.

D. The Riparian Zone Management Plan must include management provisions in narrative and/or graphic form specifying:
   1. The manner in which the area within the riparian zone will be owned and by whom it will be managed and maintained.
   2. The conservation and/or land management techniques and practices that will be used to conserve and protect the riparian zone, as applicable.
   3. The professional and personnel resources that are expected to be necessary, in order to maintain and manage the riparian zone.
   4. A revegetation plan, if applicable, that includes: three (3) layers of vegetation, including herbaceous plants that serve as ground cover, understory shrubs, and trees that when fully mature, will form an overhead canopy. Vegetation selected must be native, non-invasive species, and consistent with the soil, slope and moisture conditions of the site. The revegetation plan shall be prepared by a qualified environmental professional, landscape architect, or professional engineer, and shall be subject to the approval of the Engineer of *[municipality]*, in consultation with the Environmental Commission. Dominant vegetation in the Riparian Zone Management Plan shall consist of plant species that are suited to the riparian zone environment. The Engineer of *[municipality]* may require species suitability to be verified by qualified experts from the Soil Conservation District, Natural Resources Conservation Service, New Jersey Department of Environmental Protection, US Fish and Wildlife Service and/or State or Federal forest agencies.

E. A Riparian Zone Management Plan is not required where the riparian zone is not being disturbed and conservation easements/deed restrictions are applied to ensure there will be no future clearing or disturbance of the riparian zone.

F. Performance of the Riparian Zone Management Plan shall be guaranteed for [*municipality to insert length of time. Minimum of two years suggested.*] by a surety, such as a bond, cash or letter of credit, which shall be provided to the *[municipality]* prior to the *[municipality]* issuing any permits or approving any uses relating to the applicable use or activity.

XI. BOUNDARY INTERPRETATION, APPEALS PROCEDURES, INSPECTIONS, CONFLICTS, SEVERABILITY

A. When a landowner or applicant disputes the boundaries of a riparian zone, or the defined bank-full flow or level, the landowner or applicant shall submit evidence to *[municipal contact]* that describes the riparian zone, presents the landowner or applicant's proposed riparian zone delineation, and presents all justification for the proposed boundary change, including but not limited to, a verification issued under the Flood Hazard Area Control Act rules at N.J.A.C. 7:13-6, or an approval from the New Jersey Department of Environmental Protection to encroach within the Special Water Resource Protection Area (SWRPA) of a C1 water pursuant to the Stormwater Management rules at N.J.A.C. 7:8-5.5(h)1ii.
B. Within 45 days of a complete submission of Section XI.A above, the Engineer of *[municipality]*, or appointed representative, shall evaluate all material submitted and shall make a written determination, a copy of which shall be submitted to *[municipal contact]* and the landowner or applicant. Failure to act within the 45-day period shall not be interpreted to be an approval of the proposed boundary change.
C. Any party aggrieved by any such determination or other decision or determination under Section XI.B. may appeal to the *[municipal contact]* under the provisions of this ordinance. The party contesting the location of the riparian zone boundary shall have the burden of proof in case of any such appeal.
D. Any party aggrieved by any determination or decision of the *[municipal contact]* under this Ordinance may appeal to the *[governing body]* of *[municipality]*. The party contesting the determination or decision shall have the burden of proof in case of any such appeal.
E. Inspections:
    1. Lands within or adjacent to an identified riparian zone shall be inspected by *[municipal representative]* when:
        a. A subdivision or land development plan is submitted;
        b. A building permit is requested;
        c. A change or resumption of a nonconforming use is proposed;
        d. A discontinued nonconforming use is resumed more than a year later, as described in Section VII.
    2. The riparian zone may also be inspected periodically by representatives from *[municipality]* if excessive or potentially problematic erosion is present, other problems are discovered, or at any time when the presence of an unauthorized activity or structure is brought to the attention of municipal officials or when the downstream surface waters are indicating reduction in quality.

    [Inspections are meant to be conducted on an as-needed basis, should the township feel that a problem exists. All inspections should be in accordance with local, state and federal requirements for property owner notification and permission.]

    [The township is not expected to conduct monitoring, but rather, is being given the ability to react to changes in water quality that are brought to light by either the Department or another reputable data collector.]
F. Conflicts: All other ordinances, parts of ordinances, or other local requirements that are inconsistent or in conflict with this ordinance are hereby superseded to the extent of any inconsistency or conflict, and the provisions of this ordinance apply.
G. Severability:
    1. Interpretation: This Ordinance shall be so construed as not to conflict with any provision of New Jersey or Federal law.

2. Notwithstanding that any provision of this Ordinance is held to be invalid or unconstitutional by a court of competent jurisdiction, all remaining provisions of the Ordinance shall continue to be of full force and effect.
3. The provisions of this Ordinance shall be cumulative with, and not in substitution for, all other applicable zoning, planning and land use regulations.

XII. ENFORCEMENT

A prompt investigation shall be made by the appropriate personnel of *[municipality]*, of any person or entity believed to be in violation hereof. If, upon inspection, a condition which is in violation of this Ordinance is discovered, a civil action in the Special Part of the Superior Court, or in the Superior Court, if the primary relief sought is injunctive or if penalties may exceed the jurisdictional limit of the Special Civil Part, by the filing and serving of appropriate process. Nothing in this Ordinance shall be construed to preclude the right of *[municipality]*, pursuant to N.J.S.A 26:3A2-25, to initiate legal proceedings hereunder in Municipal Court. The violation of any section or subsection of this Ordinance shall constitute a separate and distinct offense independent of the violation of any other section or subsection, or of any order issued pursuant to this Ordinance. Each day a violation continues shall be considered a separate offense.

[The municipality should include a discussion of compliance and enforcement actions taken in the event of non-compliance.]

XIII. EFFECTIVE DATE

This Ordinance shall take effect upon final adoption and publication in accordance with the law on *[date]*.

Fertilizer Application Model Ordinance

SECTION I. Purpose:

An ordinance to regulate the outdoor application of fertilizer so as to reduce the overall amount of excess nutrients entering waterways, thereby helping to protect and improve surface water quality. This ordinance does not apply to fertilizer application on commercial farms.

SECTION II. Basis and Background:

Elevated levels of nutrients, particularly phosphorus, in surface waterbodies can result in excessive and accelerated growth of algae and aquatic plants (eutrophication). Excessive plant growth can result in diurnal variations and extremes in dissolved oxygen and pH, which, in turn, can be detrimental to aquatic life. As algae and plant materials die off, the decay process creates a further demand on dissolved oxygen levels. The presence of excessive plant matter can also restrict use of the affected water for recreation and water supply.

While healthy vegetated areas are protective of water quality by stabilizing soil and filtering precipitation, when fertilizers are applied to the land surface improperly or in excess of the needs of target vegetation, nutrients can be transported by means of stormwater to nearby waterways, contributing to the problematic growth of excessive aquatic vegetation. Most soils in New Jersey contain sufficient amounts of phosphorus to support adequate root growth for established turf. Over time, it is necessary to replenish available phosphorus, but generally not at the levels commonly applied. Other target vegetation, such as vegetable gardens and agricultural/horticultural plantings, will have a greater need for phosphorus application, as will the repair or establishment of new lawns or cover vegetation. A soils test and fertilizer application recommendation geared to the soil and planting type is the best means to determine the amount of nutrients to apply. Timing and placement of fertilizer application is also critical to avoid transport of nutrients to waterways through stormwater runoff. Fertilizer applied immediately prior to a runoff-producing rainfall, outside the growing season or to impervious surfaces is most likely to be carried away by means of runoff without accomplishing the desired objective of supporting target vegetation growth. Therefore, the management of the type, amount and techniques for fertilizer application is necessary as one tool to protect water resources.

This ordinance does not apply to application of fertilizer on commercial farms, but improper application of fertilizer on farms would be problematic as well. Stewardship on the part of commercial farmers is needed to address this potential source of excess nutrient load to waterbodies. Commercial farmers are expected to implement best management practices in accordance with

conservation management plans or resource conservation plans developed for the farm by the Natural Resource Conservation Service and approved by the Soil Conservation District Board.

SECTION III. Definitions:

For the purpose of this ordinance, the following terms, phrases, words, and their derivations shall have the meanings stated herein unless their use in the text of this Ordinance clearly demonstrates a different meaning. When not inconsistent with the context, words used in the present tense include the future, words used in the plural number include the singular number, and words used in the singular number include the plural number. The word "shall" is always mandatory and not merely directory.

a. Buffer - the land area, 25 feet in width, adjacent to any waterbody. [The Department believes that 25 feet is the appropriate buffer width to be protective of water quality. However, in situations that warrant additional flexibility, such as where lot sizes are exceptionally small or where the 25 ft buffer constitutes the majority of the available property, the municipality may reduce the buffer to 10 feet in width, with the additional requirement that a drop spreader be used for fertilizer application]

b. Commercial farm - a farm management unit producing agricultural or horticultural products worth $2,500 or more annually.

c. Fertilizer - means a fertilizer material, mixed fertilizer or any other substance containing one or more recognized plant nutrients, which is used for its plant nutrient content, which is designed for use or claimed to have value in promoting plant growth, and which is sold, offered for sale, or intended for sale.

d. Impervious Surface - a surface that has been covered with a layer of material so that it is highly resistant to infiltration by water. This term shall be used to include any highway, street, sidewalk, parking lot, driveway, or other material that prevents infiltration of water into the soil.

e. Person - any individual, corporation, company, partnership, firm, association, or political subdivision of this State subject to municipal jurisdiction.

f. Phosphorus fertilizer - any fertilizer that contains phosphorus, expressed as P_2O_5, with a guaranteed analysis of greater than zero; except that it shall not be considered to include animal (including human) or vegetable manures, agricultural liming materials, or wood ashes that have not been amended to increase their nutrient content.

g. Soils Test - a technical analysis of soil conducted by an accredited soil-testing laboratory following the protocol for such a test established by Rutgers Cooperative Research and Extension.

h. Waterbody - a surface water feature, such as a lake, river, stream, creek, pond, lagoon, bay or estuary.

SECTION IV. Prohibited Conduct:

No person may do any of the following:

a) Apply fertilizer when a runoff producing rainfall is occurring or predicted and/or when soils are saturated and a potential for fertilizer movement off-site exists.

b) Apply fertilizer to an impervious surface. Fertilizer inadvertently applied to an impervious surface must be swept or blown back into the target surface or returned to either its original or another appropriate container for reuse.

c) Apply fertilizer within the buffer of any waterbody.

d) Apply fertilizer more than 15 days prior to the start of or at any time after the end of the recognized growing season **[insert season applicable to municipality as identified by the USDA Plant Hardiness Zones. USDA Plant Hardiness Zones mapping can be found in *The Standards for Soil Erosion and Sediment Control in New Jersey, July 1999*. The growing seasons are identified as follows: Zones 5b and 6a (northwestern New Jersey) - March 15 to October 31; Zone 6b (northeastern, central and part of southern New Jersey) – March 1 to November 15; Zones 7a and 7b (Atlantic Coastal area and southwestern New Jersey) – February 1 to November 30. Refer to USDA Plant Hardiness Zone mapping for more information]**.

SECTION V. Phosphorus Fertilizer Application

No person may do the following:

a) Apply phosphorus fertilizer in outdoor areas except as demonstrated to be needed for the specific soils and target vegetation in accordance with a soils test and the associated annual fertilizer recommendation issued by Rutgers Cooperative Research and Extension.

b) Exceptions

1. Application of phosphorus fertilizer needed for

a. establishing vegetation for the first time, such as after land disturbance, provided the application is in accordance with the requirements established under the

Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq. and implementing rules,

b. re-established or repairing a turf area.

2. Application of phosphorus fertilizer that delivers liquid or granular fertilizer under the soils surface, directly to the feeder roots.
3. Application of phosphorus fertilizer to residential container plantings, flowerbeds, or vegetable gardens.

SECTION VI. Enforcement:

This ordinance shall be enforced by the **[Police Department and/or other Municipal Officials]** of **[insert name of municipality]**.

SECTION VII. Violations and Penalties:

Any person(s) found to be in violation of the provisions of this ordinance shall be subject to a fine not to exceed **[insert amount]**.

SECTION VIII. Severability:

Each section, subsection, sentence, clause and phrase of this Ordinance is declared to be an independent section, subsection, sentence, clause and phrase, and the finding or holding of any such portion of this Ordinance to be unconstitutional, void, or ineffective for any cause, or reason, shall not affect any other portion of this Ordinance.

SECTION IX. Effective date:

This Ordinance shall be in full force and effect **[insert appropriate language for ordinance adoption in municipality such as: from and after its adoption and any publication as may be required by law]**.

ALL OF WHICH IS ADOPTED this ___day of _____, 2___, by the _____.

Harrison Township, Gloucester County

ARTICLE X Riparian Buffer Conservation Zone [Added 7-2-2001 by Ord. No. 23-2001]

§ 225-72. Legislative intent; purposes.

A. In recognition of the fact that natural features contribute to the welfare of residents, the following regulations have been enacted to provide reasonable controls governing the restoration, conservation, disturbance, and management of existing riparian buffers for all perennial and intermittent streams and all lakes and ponds in the sewer service area of the municipality by establishing designated Riparian Buffer Conservation Zones.

B. In addition, the specific purposes and intent of this article are to:

(1) Reduce the amount of nutrients, sediment, organic matter, pesticides, and other harmful substances that reach watercourses, wetlands, subsurface, and surface water bodies by using scientifically proven processes, including filtration, deposition, absorption, adsorption, plant uptake, biodegradation, denitrification and by improving infiltration, encouraging sheet flow, and stabilizing concentrated flows.

(2) Improve and maintain the safety, reliability and adequacy of the water supply for domestic, agricultural, commercial, industrial and recreational uses along with sustaining diverse populations of aquatic flora and fauna.

(3) Regulate the land use, siting and engineering of all development to be consistent with the intent and objectives of this article, accepted conservation practices, and to work within the carrying capacity of existing natural resources.

(4) Assist in the implementation of pertinent state laws concerning erosion and sediment control practices.

(5) Conserve the natural features important to land and water resources (e.g., headwater areas, groundwater recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats) and other features constituting high recreational value or containing amenities that exist on developed and undeveloped land.

(6) Work with floodplain, steep slope, and other ordinances that regulate environmentally sensitive areas to minimize hazards to life, property, and riparian features.

(7) Conserve natural, scenic, and recreation areas within and adjacent to riparian areas for the community's benefit.

§ 225-73. Definitions.

For the purposes of this article, the following definitions shall apply:

CLEAR-CUTTING — Clear cutting is defined as the large scale indiscriminate removal of trees, shrubs and undergrowth with the intention of preparing real property for nonagricultural development purpose.

INTERMITTENT STREAM — A stream with a drainage area of 50 acres or greater.

MUNICIPAL ENGINEER — Professional and licensed engineer appointed by the Township Committee.

PASSIVE RECREATION — Activities that involve inactive or less energetic activities, such as walking, sitting or picnicking.

PERENNIAL STREAM — A stream that flows continuously throughout the year in most years.

RIPARIAN BUFFER CONSERVATION ZONE — Areas surrounding municipally designated surface water bodies, including creeks, lakes and intermittent watercourses that intercept surface water runoff, wastewater, subsurface flow, and/or deep groundwater flows from upland sources and function to remove or buffer the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters. This area may also provide wildlife habitat, control water temperature, attenuate flood flow, and provide opportunities for passive recreation. This buffer area may or may not contain trees and other native vegetation at the time of the article's enactment.

SELECTIVE CUTTING — Not clear-cutting.

STREAM — A natural watercourse containing flowing water for at least part of the year.

§ 225-74. Establishment and measurement.

A. The establishment of the Riparian Buffer Conservation Zone applies to the following areas which are identified on the municipal riparian buffer map prepared by Remington & Vernick Engineers entitled "Riparian Buffer Map," dated May 21, 2001:
   (1) Lands adjacent to municipally designated streams within the municipality.
   (2) Lands adjacent to municipally designated intermittent watercourses within the

municipality.

(3) Lands at the margins of municipally designated lakes.

B. The measurement of the Riparian Buffer Conservation Zone shall extend a minimum of 75 feet from each defined edge of an identified watercourse or surface water body at bankfull flow or level, or shall equal the extent of the one-hundred-year floodplain, whichever is greater. The District will consist of two distinct zones designated as:

(1) Zone One: This zone will begin at each edge of an identified waterway (which can include wetlands and intermittent watercourses) and occupy a margin of land with a minimum width of 25 feet measured horizontally on a line perpendicular to the edge of water at bankfull flow. Where steep slopes (in excess of 25%) are located within 25 feet of a municipally designated watercourse, Zone One shall extend the entire distance of this sloped area. If the distance of this sloped area is greater than 75 feet, there will be no requirement for the establishment of Zone Two. If the distance is less than 75 feet, the width of Zone Two will be adjusted so that the total buffer width (Zone One and Zone Two) will be 75 feet maximum.

(2) Zone Two: This zone will begin at the outer edge of Zone One and occupy a minimum width of 50 feet in addition to Zone One.

(a) Where the one-hundred-year floodplain extends greater than 75 feet from the waterway, Zone One shall remain a minimum of 25 feet wide, and Zone Two shall extend from the outer edge of Zone One to the outer edge of the one-hundred-year floodplain.

(b) Width determination. The developer, applicant, or designated representative shall be responsible for the initial width determination of the riparian buffer and identifying this area on any plan that is submitted to the municipality for subdivision, land development, or other improvements that require plan submissions or permits. This initial determination shall be subject to review and approval by the Municipal Engineer, governing body, or its appointed representative.

§ 225-75. Uses permitted.

The following uses are permitted, either by right or after review and approval by the municipality in the Riparian Buffer Conservation Zone. However, within any buffer, no construction, development, use, activity, or encroachment shall be permitted unless the activity is described in the Riparian Buffer Management Plan, as outlined in 225-80.

A. Zone One.

(1) Uses permitted by right. Open space uses that are primarily passive in character shall be permitted to extend into the area defined as Zone One, including:

(a) Wildlife sanctuaries, nature preserves, forest preserves, fishing areas, passive areas of public and private parklands, and reforestation in

compliance with the guidelines of the Riparian Buffer Management Plan.

(b) Streambank stabilization in compliance with the guidelines of the Riparian Buffer Management Plan.

(c) Buffer crossings by farm vehicles and livestock.

(d) All agricultural uses.

(e) Hunting, trapping and fishing as licensed by the State of New Jersey Fish and Wildlife Department

(2) Uses requiring municipal review and approval: recreational trails, roads, railroads, centralized sewer and/or water lines, and public utility transmission lines, provided that any disturbance is offset by buffer improvements identified in the Riparian Buffer Management Plan.

B. Zone Two.

(1) Uses permitted by right. The following uses which are primarily passive in character shall be permitted by right to extend into the area defined as Zone Two:

(a) Open space uses including wildlife sanctuaries, nature preserves, forest preserves, passive areas of public and private parklands, and recreational trails.

(b) Reforestation in compliance with the guidelines of the Riparian Buffer Management Plan.

(c) Minimum required front, side, and rear yards on private lots, provided that no yard may extend into Zone Two more than half the distance between the outer boundaries of Zone One and Zone Two.

(d) All agricultural uses.

(e) Buffer crossings by farm vehicles and livestock.

(f) Hunting, trapping and fishing as licensed by the State of New Jersey Fish and Wildlife Department.

(2) Uses requiring municipal review and approval.

(a) Roads, railroads, centralized sewer and/or water lines, and public utility transmission lines, provided that any disturbance is at a minimum, offset by buffer improvements identified in the Riparian Buffer Management Plan.

(b) Centralized sewer and/or water lines and public utility transmission lines running along the buffer, provided that any disturbance is, at a minimum, offset by buffer improvements identified in the Riparian Buffer Management Plan. These lines shall be located as far from Zone One as practical.

(c) Areas such as camps, campgrounds, picnic areas and golf courses. Active

recreation areas such as ball fields, playgrounds, and courts, provided these uses are designed in a manner that will not permit concentrated flow.

(d) Naturalized stormwater basins in compliance with the guidelines in the Riparian Buffer Management Plan. The entire basin shall be located a minimum of 50 feet from the defined edge of identified watercourses.

§ 225-76. Uses specifically prohibited.

All use or activity not authorized within § 225-75 shall be prohibited within the Riparian Buffer Conservation Zone. By way of example, the following activities and facilities are specifically prohibited:

A. Clear-cutting of trees and other vegetation.

B. Selective cutting of trees and/or the clearing of other vegetation within Zone One, except where such clearing is necessary to prepare land for a use permitted under § 225-75A and where the effects of these actions are mitigated by revegetation as specified under 225-80.

C. Selective cutting of trees and/or the clearing of other vegetation within Zone Two, except where such clearing is necessary to prepare land for a use permitted by § 225-75B and where the effects of these actions are mitigated by revegetation, as specified under 225-80.

D. Removal of trees in excess of selective cutting, except where such removal is necessary as a means to eliminate dead, diseased, or hazardous tree stands that jeopardize public safety or as part of a reforestation project, provided that the removal is in compliance with a Riparian Buffer Management Plan approved by the Municipal Engineer, governing body, or its appointed representative.

E. Removal or disturbance of vegetation in a manner that is inconsistent with erosion control and buffer protection.

F. Storage of any hazardous or noxious materials.

G. Use of fertilizers, pesticides, herbicides, and/or other chemicals in excess of prescribed industry standards.

H. Roads or driveways, except where permitted as buffer crossings in compliance § 225-75 III of this article.

I. Motor vehicle or wheeled-vehicle traffic in any area not designed to accommodate adequately the type and volume.

J. Parking lots.

K. Any type of permanent structure, including fences, except structures needed for a use permitted in § 225-75.

L. Subsurface sewage disposal areas.

M. Sod farming.

§ 225-77. Nonconforming structures and uses.

Nonconforming structures and uses of land within the Riparian Buffer Conservation Zone shall be regulated under the provisions of the Harrison Township Land Use Ordinance (existing nonconformance regulations). The following additional regulations also shall apply:

A. Existing nonconforming structures or uses within Zones One or Two that are not permitted under § 225-75 may be continued but shall not have the existing building footprint or uses expanded or enlarged.

B. Discontinued nonconforming uses may be resumed any time within one year from such discontinuance but not thereafter when showing clear indications of abandonment. No change or resumption shall be permitted that is more detrimental to the Riparian Buffer Conservation Zone, as measured against the intent and objectives under § 225-72, than the existing or former nonconforming use. This one-year time frame shall not apply to agricultural uses which are following prescribed best management practices for crop rotation.

§ 225-78. Boundary interpretation and appeals procedure.

A. When a landowner or applicant disputes the Zone One or Two boundaries of the riparian buffer or the defined edge of a watercourse, surface water body, the landowner or applicant shall submit evidence to the municipality that describes the boundary, presents the landowner's or applicant's proposed boundary, and presents all justification for the proposed boundary change.

B. The Municipal Engineer, governing body or appointed representative shall evaluate all material submitted and shall make a written determination within 45 days, a copy of which shall be submitted to the governing body, Municipal Planning Board, and landowner or applicant.

C. Any party aggrieved by any such determination or other decision or determination under this section may appeal to the municipality under the provisions this article. The party contesting the location of the district boundary shall have the burden of proof in case of any such appeal.

§ 225-79. Inspections.

A. Lands within an identified Riparian Buffer Conservation Zone will be inspected by the Municipal Engineer when:
   (1) A subdivision or land development plan is submitted.
   (2) A building permit that requires a grading review is requested.

(3) A change or resumption of nonconforming use that requires a grading review is proposed.

B. The district may also be inspected periodically by the municipal representatives for compliance with an approved restoration plan, excessive or potentially problematic erosion or at any time when the presence of an unauthorized activity or structure is brought to the attention of municipal officials.

§ 225-80. Riparian Buffer Management Plan.

Within any municipally identified buffer area, no construction, development, use, activity, or encroachment shall be permitted unless the effects of such development are accompanied by implementation of an approved Riparian Buffer Management Plan, as specified below.

A. The landowner or developer shall submit to the Municipal Engineer, governing body, or its appointed representative, a Riparian Buffer Management Plan prepared by a landscape architect, professional engineer or other qualified professional.

B. The Riparian Buffer Management Plan shall fully evaluate the effects of any proposed uses upon the Riparian Buffer Conservation Zone.

C. The Riparian Buffer Management Plan shall identify the existing conditions present on the site under review to include the following at a minimum:

(1) Existing vegetation.

(2) One-hundred-year floodplain.

(3) Soils.

(4) Slopes.

(5) Wetlands.

D. The plan shall be reviewed by the Municipal Engineer, governing body, or appointed representative in order to determine the effects of the proposed activity upon the Riparian Buffer Conservation Zone.

§ 225-81. Vegetation selection

To function properly, dominant vegetation in the Riparian Buffer Management Plan shall be selected from a list of plants most suited to the riparian buffer. Plants not included on the lists may be permitted by the Municipal Engineer, governing body, or its appointed representative when evidence is provided from qualified sources certifying their suitability. The municipality may require species suitability to be verified by qualified experts in the Gloucester County Conservation District, Natural Resources Conservation Service, New Jersey Department of Environmental Protection, the United States Fish and Wildlife Service, or state and federal forest agencies.

A. In Zone One, dominant vegetation shall be composed of a variety of native riparian trees, shrub species, tall grasses and appropriate plantings necessary for streambank stabilization.

B. In Zone Two, dominant vegetation shall be composed of riparian trees and shrubs, with an emphasis on native species and appropriate plantings necessary to stabilize the soil.

C. Disturbed areas shall be revegetated with riparian buffer plants, in compliance with an approved Riparian Buffer Management Plan.

D. Areas that cannot be revegetated shall be restored in compliance with an approved Riparian Buffer Management Plan.

RACCOON CREEK WATERSHED
REGIONAL STORMWATER MANAGEMENT PLAN
STAKEHOLDER REPORT

May 11, 2004 – Stakeholder Meeting

The Gloucester County Department of Public Works – Planning Division sponsored the initial stakeholders meeting for the Raccoon Creek Watershed Regional Stormwater Management Plan on May 11, 2004, in the Gloucester County Offices of Government Services Auditorium, 1200 North Delsea Drive, Clayton, New Jersey.

Representatives from the following agencies and stakeholders attended the meeting:

- Sickels and Associates
- Gloucester County Utilities Authority
- Rowan University
- Camden County Soil Conservation District
- Gloucester County Office of Emergency Management
- Remington and Vernick Engineers
- Gloucester County Soil Conservation District
- Gloucester County Department of Health and Senior Services
- Elk Township Municipal Clerk
- Elk Township Mayor
- Churchill Consulting Engineers
- Federation of Gloucester County Watersheds
- Delaware Valley Regional Planning Commission
- New Jersey Department of Agriculture
- Gloucester County Planning Division
- New Jersey Department of Environmental Protection Division of Watershed Management

Agenda for the meeting:

1. Introduction – Charles Romick, Planning Director, Gloucester County Planning Division

2. Stormwater Management Planning Statewide Perspective – Mike Haberland, NJDEP Division of Watershed Management

3. Overview – Upper Raccoon Creek Watershed Regional Stormwater Management Plan – Craig McGee, Project Director, Camden County Soil Conservation District

4. Watershed Characterization and Assessment – Craig McGee, Camden County Soil Conservation District

5. Local Concerns

6. Charge to Stakeholders

Stakeholders at the meeting discussed the following issues, concerns, and/or recommendations pertaining to the watershed area:

1. Potential impacts on Raccoon Creek from the expansion of a trailer park.
2. Potential impacts of development on wetlands (i.e. exceptional resource wetlands in South Harrison Township).
3. Funding for stormwater management projects in environmentally sensitive areas.
4. Recommended retrofits for development should be identified in the Plan.
5. Funds for restoration projects are available from the Delaware Estuary Program.
6. Develop a report on the state of basins located within the watershed.
7. Discuss the remediation of privately owned basins.
8. Responsibility for maintenance of basins by homeowners associations.
9. Mechanism for enforcement of basins maintenance by homeowner associations.
10. Maintenance of the downstream area of public or private structures.
11. Maintenance of County owned stormwater facilities.
12. Sharing the costs for the maintenance of stormwater facilities on County roads.
13. Use a stormwater utility to maintain, upgrade or install infrastructure (example - the State of Florida).
14. The level of maintenance needed for stormwater basins (i.e. the basin functioning as a wetland).
15. Managing higher frequency storms.
16. Educational component of the project for homeowner associations.

17. A homeowner being responsible for maintaining basins.

18. The liability issue concerning a private owner or public owner of a basin should there be an accident.

19. Harrison Township ordinance concerning fences around basins depending on the depth of the water.

20. County involvement in stormwater management planning or issues.

21. The complicated issue of basin ownership.

22. Utilize stormwater as a resource rather than waste.

23. The municipality assumes responsibility of maintaining basins.

24. There are two ordinances for stormwater management in Harrison Township (best management practices and riparian buffers involving residential and commercial development). Harrison Township also has an ordinance for stormwater outfall mapping by State Plane coordinates. The township's GIS system has soils, wetlands, tax, roads and parcel data.

25. The NJDOT and consultant study on Route 322 flooding issues.

26. The Plan superceding local regulations and the development of regional ordinances.

27. Inter-local agreements between the County, GCIA and the municipalities for stormwater management issues.

28. Protocols for a stormwater outfall database have been developed. The mapping information will be submitted to DVRPC.

29. The Plan dealing with municipalities on a watershed basis or on an individual basis.

30. The regulatory process to designate Category 1 Waters by NJDEP.

31. Developing a stream channel evolution model to evaluate the condition of stream channels, health of the watershed and predict changes in the channel.

32. Include information on threatened and endangered species in the Plan (i.e. Swamp Pink).

33. A representative from the U.S. Fish and Wildlife Service attending future meetings.

34. The GIS completing the build-out analysis which will generate pollutant loadings for streams.

35. The availability of freshwater wetland delineations for developments in a digital format which could be used for the project.

36. The format for the data to be collected and the process to exchange data.

37. Recruiting members for the Regional Stormwater Management Committee.

38. Presentation of the Project to the municipalities.

39. The width of the freshwater wetlands buffer area.

40. The impact of the Plan on property rights and economic viability of the municipalities.

41. Develop a list of data needed for the project.

October 4, 2004 Stakeholder Meeting

The Gloucester County Department of Public Works – Planning Division sponsored the second stakeholders meeting for the Raccoon Creek Watershed Regional Stormwater Management Plan on October 4, 2004 in the Gloucester County Offices of Government Services Auditorium, 1200 North Delsea Drive, Clayton, New Jersey.

Representatives from the following agencies and stakeholders attended the meeting:

- Rowan University
- Borough of Glassboro Public Works
- Remington and Vernick Engineers
- NJDEP Division of Watershed Management
- Churchill Consulting Engineers
- Camden County Soil Conservation District
- Gloucester County Office of Emergency Management
- Delaware River Keeper Network
- Gloucester County Department of Health and Senior Services
- Borough of Glassboro Planning Board
- Gloucester County Engineering Division
- Gloucester County Planning Division
- Gloucester County Soil Conservation District
- Perks Reutter Associates
- Sickels and Associates

- Federation of Gloucester County Watersheds

Agenda for the meeting:

1. Introduction – Charles Romick, Planning Director, Gloucester County Planning Division.

2. Overview – Upper Raccoon Creek Watershed Regional Stormwater Management Plan – Craig McGee, Project Director, Camden County Soil Conservation District.

3. Local concerns.

4. Charge to Stakeholders.

Stakeholders at the meeting discussed the following issues, concerns, or recommendations pertaining to the watershed area:

1. The Project Team should review the beaver dams in Mullica Hill adjacent to Spicer Estates and Route 77.

2. Ownership of the Mullica Hill Pond dam is a legal question. NJDOT is participating in the dam study.

3. An engineering company is evaluating flooding problems on Rt. 322 and Rt. 45 in Mullica Hill, Harrison Township.

4. The Project Team should request input from Public Works Departments (County and municipal) on flooding issues in the watershed.

5. The Project should consider the restoration of Mullica Hill Pond as an amenity.

6. The Project should contact the Municipal Emergency Management Coordinators to obtain a copy of the FEMA Mitigation 20/20 Report for each municipality in the watershed. The Planning Division will provide a list of the Coordinators for the watershed.

7. According to the Glassboro Public Works Department, there are no flooding issues in Glassboro.

8. James Sickels will contact the Elk Township Public Works Department concerning flooding problems in Elk Township. Mr. Sickels will review the Elk Township list of stormwater management facilities. Mr. Sickels also has concerns with flooding problems at Camelot in Glassboro.

9. Representatives from Harrison Township will review the Harrison Township stormwater management facility list and database.

10. Sediment issues discussed include:

    A. The impact of sediment on aquatic habitat.

    B. The volume and grain size of sediment and how it changes the characteristics of the stream.

    C. Identify streambank erosion in the watershed.

    D. The influence of geology and soil conditions on water quality in the watershed.

    E. Develop a map of geologic features in the watershed and compare it with areas of sedimentation.

    F. The location of erodible soils in the watershed and the changing runoff rates.

    G. Develop sediment management strategies.

    H. Sedimentation from agricultural lands in the watershed. The Project Team should request input on this issue from the Extension Agent.

    I. Review conservation plans which have been developed for farms in the watershed.

    J. The percent of agriculture land use in the watershed.

    The Project Team will review DVRPC 2000 Land Use Data as a current evaluation of land uses has not been completed. The Project team will also contact DVRPC concerning the GIS project for Harrison Township.

    K. The Project Team should request additional input for the project from the agricultural community.

11. Issues discussed pertaining to the NJDEP Ambient Biomonitoring Network (AMNET) included:

    A. Requesting NJDEP to conduct a new survey.

    B. Requesting AmeriCorps staff to undertake a new assessment.

    C. The dates when NJDEP conducted the sampling program.

D. Developing a water quality sampling program for the watershed.

E. The AMNET data is biased as a result of sedimentation and the substrate.

F. Sampling data from lakes in the watershed. The Gloucester County Health Department has bacteriological data for Lake Gilman.

G. Request input from the Pinelands Commission on their sampling programs.

H. The use of pesticide and herbicides in the watershed and the impacts on water quality.

I. Using USEPA protocols for sampling low gradient streams.

12. The Stakeholders discussed stream flow peaks as a result of development and the watershed response.

13. Issues concerning stormwater basins include:

A. Identify low impact development sites.

B. Review the Willowbrook (water quality swales) and Horse Shoe Run subdivisions (example of low impact).

C. Harrison Township requires State Plan coordinates for outfall structures.

D. The Project Team needs information on the location of benchmarks. Elevation data on known datum and stream inverts at bridges, culverts, and dams, is also needed.

E. The Project Team will identify areas where information is needed.

14. Other issues discussed included:

A. Identify impacts of development in the watershed (i.e. development in the headwaters area in Elk Township).

B. Encourage trails and recreation in the watershed.

C. The impact of the new NJDEP stormwater rules on the watershed (i.e. groundwater recharge, stream baseflow).

D. Based on the NDEP AMNET data, determine if the watershed is impaired.

E. The status of the Gloucester County Stormwater Program.

F. Integrating the watershed project with the Gloucester County project.

G. During October 2004, Gloucester County will request proposals from engineering firms to undertake the Gloucester County Stormwater Project. The County is currently determining how the project will be financed.

15. The Planning Division recommended that the Project Team contact NJDEP concerning water quality sampling data for the Henry Harris Landfill and Raccoon Creek.

May 17, 2005 Stakeholder Meeting

The Project Team for the Raccoon Creek Watershed Regional Stormwater Management Plan presented an overview of the project to the Gloucester County Planning Board on May 17, 2005 in the Gloucester County Office of Government Services, 1200 North Delsea Drive, New Jersey.

Representatives from the following agencies and stakeholders attended the meeting:

- Lake Gilman Owners
- Gloucester County Planning Division
- Elk Township Committee
- Gloucester County Improvement Authority
- Camden County Soil Conservation District
- Gloucester County Soil Conservation District
- Churchill Consulting Engineers

Agenda for the meeting:

1. Raccoon Creek Regional Stormwater Management Plan – Craig McGee, Project Director, Camden County Soil Conservation District.

2. Questions.

After the presentation, the following issues were discussed:

1. Will the watershed be eligible to receive assistance from federal funding programs?

2. After completing the Plan, what will the next steps entail?

3. The watershed will be eligible for NJDEP Section 319(h) Grants for Nonpoint Source Pollution Control.

4. The Lake Gilman Owners requested that they are included on the Stakeholders mailing list. The Homeowners will also be able to provide information.

5. Will the project place an emphasis on groundwater recharge or water quality?

6. What are the impacts of the new stormwater rules (i.e. ground water recharge requirements) on the watersheds?

7. The dam at Wrights Mill Lake has been removed. In removing the dam, safety issues and the lake benefits (i.e. habitat) must be addressed.

8. Rowan University will propose a study to measure the changes in the stream channel at Wrights Mill.

9. Other issues identified or discussed include:

   A. The problems facing the owners of private lakes.

   B. Sedimentation entering Raccoon Creek and Lake Gilman from the Camelot Subdivision. Enforcement actions are being taken by NJDEP and the Gloucester County Soil Conservation District.

   C. Detention basins on Ellis Mill Road are always full. The developer, who is pumping water from the basins, must control the sedimentation through the use of filters.

   D. Current and future water quality sampling in Raccoon Creek.

   E. An abandoned dumping area on the banks of Raccoon Creek including the migration of contaminants into the stream.

   F. The problem of Homeowner Associations owning dams.

   G. Identify the parameters currently being sampled and analyzed. The watershed stakeholders could identify the parameters of concern.

   H. An application could be submitted to NJDEP in the next funding cycle to develop a Watershed Restoration and Protection Plan for the watershed.

   I. Areas in the watershed that could be identified as special (i.e. ground water recharge areas, undisturbed forests, habitat, endangered species).

   J. Raccoon Creek has been proposed for designation as a Category One Waterbody.

K. The County will provide assistance to the municipalities in developing watershed plans and municipal stormwater plans.

L. Water quality sampling is conducted at lakes during the swimming season.

M. The timeline for the development of the Plan:

The Watershed Characterization and Assessment Report will be released during the Summer 2005. The Project Team hopes to publish the Management Plan by Spring 2006. However, NJDEP could provide a time extension for the Project.

March 30, 2006 Stakeholder Meeting

The Gloucester County Department of Public Works – Planning Division sponsored the third stakeholders meeting for the Raccoon Creek Watershed Regional Stormwater Management Plan on March 30, 2006 in the Gloucester County Office of Government Services, 1200 North Delsea Drive, Clayton, New Jersey.

Representatives from the following agencies and stakeholders attended the meeting:

- Gloucester County Soil Conservation District
- Camden County Soil Conservation District
- Rowan University
- Gloucester County Department of Health and Senior Services
- Gloucester County Office of Emergency Management
- New Jersey Department of Agriculture – State Soil Conservation Committee
- Borough of Glassboro Public Works
- Delaware Valley Regional Planning Commission
- Remington and Vernick Engineers
- Perks and Reutter Associates
- NJDEP Division of Watershed Management
- Gloucester County Utilities Authority
- Gloucester County Department of Public Works
- Gloucester County Planning Division

Agenda for the meeting:

1. Introduction – Charles Romick, Planning Director, Gloucester County Planning Division.

2. Overview – Upper Raccoon Creek Watershed Regional Stormwater Management Plan – Craig McGee, Project Director, Camden County Soil Conservation District.

3. Overview – Draft Raccoon Creek Watershed Characterization and Assessment Report – Craig McGee, Project Director, Camden County Soil Conservation District.

4. Local Concerns or issues.

5. Charge to Stakeholders.

   Stakeholders at the meeting discussed the following issues, concerns, or recommendations pertaining to the watershed area:

A. The Stakeholders will define and finalize watershed issues.

B. A management or implementation plan will be developed for the project.

C. Riparian buffers are needed at the Mullica Hill Pond. Consideration should be given to the depth of the pond, sediment accumulation, and dredging the pond.

D. New curve numbers will be developed for the watershed.

E. Public education will be a component of the management plan.

F. Special protection for forest areas is needed.

G. The Stakeholders will identify and discuss management strategies.

April 3, 2008 Stakeholder Meeting

The Gloucester County Department of Public Works – Planning Division sponsored the technical stakeholders meeting for the Raccoon Creek Watershed Regional Stormwater Management Plan on April 3, 2008 in the Gloucester County Offices of Government Services Auditorium, 1200 North Delsea Drive, Clayton, New Jersey.

Representatives from the following agencies and stakeholders attended the meeting:

- Gloucester County Planning Division
- Gloucester County Soil Conservation District
- Camden County Soil Conservation District
- NJDEP Division of Watershed Management
- NJDEP Dam Safety and Flood Control
- New Jersey Department of Agriculture
- Fralinger Engineers
- Borough of Glassboro Public Works

- Urban Engineers
- Rowan University
- Natural Resources Conservation Service
- Harrison Township Committee
- South Harrison Township Environmental Commission
- Remington and Vernick Engineers
- Leonard Jackson Associates
- Bach Design Group
- Churchill Consulting Engineers
- South Jersey Resource Conservation and Development Council

Agenda for the meeting:

1. Introduction – Charles Romick, Planning Director, Gloucester County Planning Division.

2. Status – Upper Raccoon Creek Watershed Regional Stormwater Management Plan- Craig McGee, Project Director, Camden County Soil Conservation District.

3. Review – Raccoon Creek Watershed Regional Stormwater Management Plan – Paul I. Welle, P.E., Schnabel Engineering.

4. Local Concerns or issues.

5. Charge to the Stakeholders.

   Stakeholders at the meeting discussed the following issues, concerns, or recommendations pertaining to the watershed area:

   A. Ordinances for non-residential, residential, and commercial development in the municipalities.

   B. The percent of developed area in the watershed.

   C. Location of drain tile pipes in agricultural areas.

   D. Drained and undrained soil classifications in the watershed.