WALLKILL RIVER WATERSHED MANAGEMENT GROUP

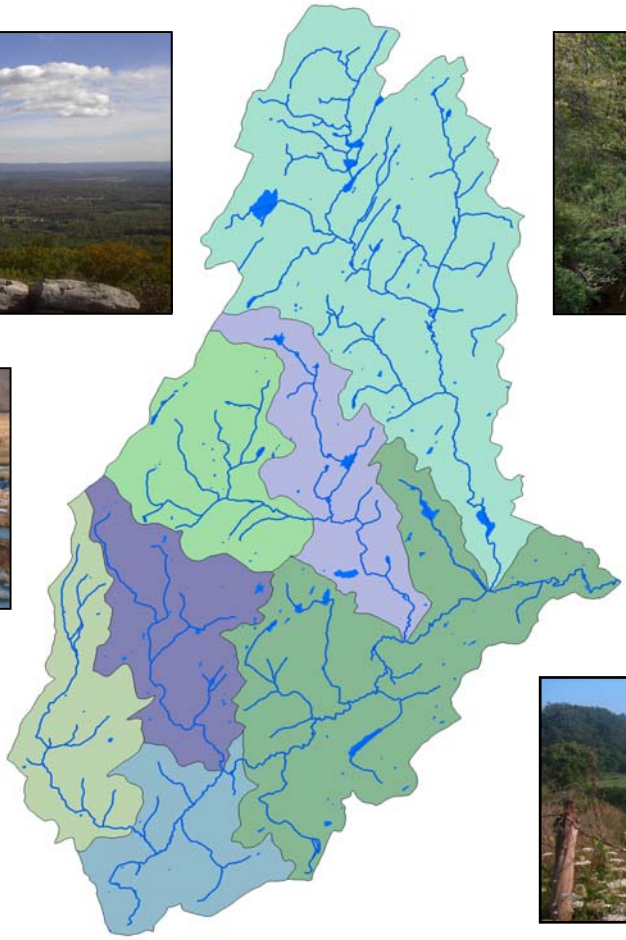
Papakating Creek Watershed Restoration Plan

NJDEP Project RP05-088









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Profile of the Wallkill River Watershed Management Group (WRWMG)

In 1994, the Sussex County Board of Chosen Freeholders designated the Sussex County Municipal Utilities Authority (SCMUA) as the lead agency to develop a Wallkill River Watershed Management Plan. As a result, in March 2000, the NJDEP awarded a contract to the SCMUA to facilitate the Wallkill River Watershed Management Project and to bring together local stakeholders to work in partnership to develop a plan to insure the restoration, maintenance and enhancement of the waterways within the Watershed. Over the previous eight years, unique stakeholder partnerships have been established and a strong sense of stewardship toward the Watershed has been generated. Most importantly, the stakeholders have formed the WRWMG. The key roles of the WRWMG are to:

1. Raise Watershed awareness and promote environmental stewardship
2. Generate stakeholder participation in Watershed management initiatives
3. Conduct water quality monitoring of local Watershed surface waters
4. Drive efforts for potential “on the ground” Watershed restoration projects
5. Serve as a Watershed management and water quality liaison for residents, municipal officials, and county government organizations

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Executive Summary

A Restoration Plan is presented that addresses the Papakating Creek as an impaired waterway for non-attainment of total phosphorus (TP) and fecal coliform / *E.coli* within six of seven HUC 14 sub-basins of the Papakating Creek Watershed. A separate Restoration Plan for the seventh HUC 14 (02020007020060), which contains Clove Acres Lake / Lakeshed and the Clove Brook sub-basin, has been developed and is being released concurrently with the Papakating Creek Restoration Plan.

The Papakating Creek Watershed is one of five U.S. Geological Survey (USGS) HUC 11 Watersheds that comprise the Wallkill River Watershed, located in Sussex County, New Jersey. The Papakating Creek Watershed includes approximately 38,798 acres or 60.6 square miles of total area. Based on 2002 NJDEP Land Use Aerial Maps, the Watershed is 47% forested, 21.9% agricultural, 17% wetlands, 11.2% urban, 1.3% water, and 0.7% barren. The Watershed encompasses all or portions of the following municipalities: Frankford Township, Lafayette Township, Wantage Township, Sussex Borough, and a small section of Montague Township (essentially all forested).

In years 2003 and 2004, the NJDEP approved seven Total Maximum Daily Loads (TMDLs) to address the identified pollutant impairments.

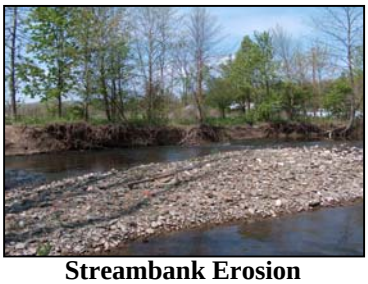
Restoration Plan Goals: The total phosphorus (TP) and fecal coliform / *E.coli* reduction goals developed by the NJDEP, which were later modified by the WRWMG and approved by NJDEP, resulted in the following established Restoration Plan goals:

- Papakating Creek Streamshed (six HUC 14 sub-basins) - a reduction of 6,841 pounds / year of TP, which is a 43% reduction in the estimated 2004 total TP loading of 15,909 pounds/year (7,231.3 kilograms/year)
- Papakating Creek Streamshed (six HUC 14 sub-basins) - an annual reduction of 92% to 99% in fecal coliform / *E.coli*
- Papakating Creek Watershed (seven HUC 14 sub-basins) - in combination with the Clove Acres Lake/Lakeshed and Clove Brook Restoration Plan, a reduction of 9,459.5 pounds/year, which is a 43.4% reduction in the estimated 2004 total TP loading of 21,795 pounds/year (9,906.8 kilograms/year)

In accordance with an approved NJDEP Quality Assurance / Quality Control Project Plan, the WRWMG collected additional chemical and fecal coliform / *E.coli* data to augment data

previously collected by NJDEP and United States Geological Survey (USGS). Efforts by the WRWMG were supplemented by professional services provided by HydroQual, Inc. and Garden State Laboratories. Findings confirmed that the Papakating Creek is impaired with respect to TP and fecal coliform / *E.coli*. Total phosphorus exceedances were slightly to significantly above NJDEP Surface Water Quality Standards: TP exceedance values ranged from 0.11 to 0.25 mg/l relative to the Standard of 0.10 mg/l for streams, fecal coliform exceedances (5-event geometric means) ranged from 205 to 1400 colonies/100 ml relative to the Standard of 200 colonies/100 ml, and *E.coli* exceedances (5-event geometric means) ranged from 239 to 1553 colonies/100 ml relative to the Standard of 126 colonies/100 ml.

An extensive pollutant source-tracking survey was conducted to identify potential sources and causes for the TP and fecal coliform / *E.coli* impairments. Within the Papakating Creek Watershed, non-point pollution is the predominate issue of concern versus point source (end of pipeline). The key non-point sources of TP were identified as follows: streambank erosion, agricultural land erosion and drainage, undeveloped land erosion and drainage, improper / overuse of both agricultural and residential fertilizer applications, stormwater runoff from developed and undeveloped lands and roads, typical urban area sources (one specific area) and, to a lesser extent, septic systems. Potential sources of fecal coliform / *E.coli* were identified as wildlife, agricultural animals in the streams, improper animal manure management, loadings from moderate to severe storm events, pet wastes, and septic systems at localized areas within the Watershed. In addition, major storm events (rainfall exceeding two to three inches/day) have been observed to be a key factor in the transport of TP and fecal coliform / *E.coli* pollutants and sediment to the Papakating Creek.



Streambank Erosion

Agricultural Runoff

Stormwater Road Runoff

Development of a holistic Management Plan addressing the stated pollutant sources, mitigation of the impacts identified, and achievement of the desired goals is a complex and challenging undertaking that will require many years of concerted, targeted effort by the entire Watershed community. To begin the long-term journey to protect the Watershed's critical natural resources (e.g., stream water quality), proposed reduction strategies and implementation measures are developed to cover five identified 2009 implementation projects as well as subsequent efforts addressing pollution reduction stream-related projects, in-lake treatment approaches, Watershed-wide projects / controls, urban projects / controls, and suggested municipal actions. As noted below, one of the five key implementation projects proposed for 2009 is the establishment of the WRWMG as a Watershed project-management-oriented entity to not only manage the identified implementation projects but also to provide a coordination and integration role addressing the necessary and critical Watershed project implementation efforts required by WRWMG's partners. Experiences have shown that unless an entity is assigned to drive and track pollutant reduction pound by pound, month by month, one key farmer and/or community member at a time within a given large Watershed area, ultimate success of achieving TMDL goals may prove elusive.

The Plan was developed with the following leadership behaviors in mind:

- Awareness of the entire Watershed community (recognizing that the farming community is a significant part of the local economy)
- Teamwork (working with the **right** organizations interacting at the **right** time with the **right** projects (strong focus on implementation-type projects) and with the **right** working processes)
- Speed (demonstrating a sense of urgency)
- Innovation (striving for continuous improvement)
- Performance (setting, measuring, and achieving ambitious goals)
- Adaptive management style (dealing with challenges, change, successes, failures, and annual funding / resource limitations)

A summary of key recommendations and proposed implementation projects for 2009 - 2012 is presented:

Note: The project locations identified below are within HUC subwatershed #02020007020070, which has been determined to be contributing greater than 30% of the TP and *E.coli* loadings to the Papakating Creek as stated in the TMDL

Proposed Implementation Projects for 2009 – 2012

The five proposed projects listed below, if implemented together, are estimated to reduce the Watershed TP loading by a minimum of a 100 to 150 pounds/year.

Project AA:

Identification of the WRWMG as the coordinating project management-oriented entity for the overall implementation of the Papakating Creek Restoration Plan. This will provide the WRWMG with the ability and means to not only manage the identified implementation projects being executed but also to provide coordination, technical guidance, and an integration role addressing the necessary and critical Watershed project implementation efforts required by WRWMG's partners and Watershed community members. Technical guidance to cover a broad range of topics (e.g., pollutant source tracking, water resource protection, development of implementation projects, pollutant transport paths, post-monitoring to verify achievement of estimated pollutant reductions). Also included within the scope of work is an effort to provide watershed technical guidance / involvement with the Wallkill River National Wildlife Refuge in their effort to expand the current refuge boundary by 9,550 acres, of which, approximately 7,600 acres lie within the Papakating Creek Watershed. When this goal is realized, a potential 1,500 pounds/year total phosphorus reduction would be achieved (this amount presents 15% of the 10,000 pounds/year reduction targeted for the Papakating Creek Watershed. as stated in the TMDL). These services are not available from any other organizations within Sussex County and the actions proposed for the WRWMG are in congruence with the resource protection goals of the NJDEP as well as the recently promulgated Program Activity Measures (PAMs) established by the U.S. Environmental Protection Agency (EPA).

Full Project Implementation to be completed within a 40-month schedule at an estimated budget of $80,000

Project BB:
Facilitate the development and/or updating of the Agricultural Conservation Plans for approximately 800 acres of active farmland that straddles the Papakating Creek with a focus on identifying riparian restoration, manure management, and stream fencing field projects with local farm operators (deliverables to include updated Conservation Plans by NRCS, specific field implementation project work scopes, reconfirmation of project benefits, identified funding sources, and integration of potential pollutant reductions to be achieved by others into a comprehensive pollutant reduction summary balance for the entire Watershed under study). The project area specifically contains 3 large dairy operations, 5 large horse farms, and the WRWMG sampling station "K", which is located at Route 565.

Full Project Implementation to be completed within a 28-month schedule at an estimated budget of $62,800.

Project CC:
Initiate and complete a characterization and assessment of Lake Neepaulin consistent with NJDEP - BEAR's "Requirements for Lake Characterization" protocol. The Lake Neepaulin local region has been identified as a prime source for total phosphorus, sediment, and urban runoff loadings to the Papakating Creek. The work scope also encompasses a GIS initiative to identify all stormwater inlets / outlets within the local lake region. The results will be incorporated within a lake management plan that addresses total phosphorus reduction opportunities.

Full Project Implementation to be completed within a 30-month schedule at an estimated budget of $53,500.

Project DD:
Installation of stormwater treatment devices into catch basins with direct discharge to Lake Neepaulin and the Neepaulakating Creek.

Full Project Implementation to be completed within a 12-month schedule at an estimated budget of $47,500.

Project EE:
Streambank stabilization, riparian restoration, and floodplain enlargement on the Papakating Creek at Route 565 in Wantage Township: (The site is upstream and contiguous with an operating farm included within the scope of Project DD.

Full Project Design and Implementation to be completed within a 36-month schedule at an estimated budget of $385,400.

Note: The top five 2009 implementation projects identified for and contained within the Clove Acres Lake / Clove Brook Watershed Restoration Plan are labeled as Projects A, B, C, D, & E, which therefore is why the top five projects identified for and contained within this Restoration Plan for the Papakting Creek Watershed are labeled as Projects AA, BB, CC, DD, and EE.

Projects AA, BB, CC, DD, and EE are designed to be completely implemented over the course of forty (40) months for an estimated total budget cost of $629,200. (Includes an estimated in-kind contribution of $ 30,000, dispersed throughout all five projects.)

Proposed Long-term Watershed Restoration Strategies: 2009 - 2025

Watershed-Wide (WRWMG / NJDEP as Lead Partners and with potential NJDEP funding)

- Part of the WRWMG Implementation Entity Role: Monitor, track, and report on the efforts of the USDA Natural Resource Conservation Service (NRCS) and Rutgers Extension Cooperative in the development and updating of approximately 8 agricultural Conservation Plans (to address agricultural farms and commercial / large hobby horse operations); foster relationships with local farmers to encourage them to actively seek the available services from NRCS (overcoming reluctance of some members to seek active support); provide guidance and monitoring of efforts to implement the developed Conservation Plans
- Identification, coordination, and implementation of streambank and riparian restoration projects
- Provide local oversight, coordination and support during implementation of identified streambank restoration projects
- Integration and coordination of the Restoration Plans developed for the Papakating Creek by the WRWMG, the Restoration Plan developed for Clove Acres Lake / Lakeshed by Princeton Hydro, LLC and the Restoration Plan developed by the WRWMG for the Clove Brook sub-basin (a HUC 14 that falls within the Papakating Creek Watershed)
- Stream flow monitoring (relates to pollutant transport balances, flooding, etc.)
- Implementation of a Pre- and Post-Monitoring Plan as presented in the Restoration Plan

Watershed-Wide (WRWMG / Municipalities / Other Local Organizations as Lead Partners and Potential Sources of Funding)

- Implementation of a communication plan to advise / inform / drive water quality improvements through reduction of non-point pollutant sources and establishment of Restoration Plan metrics for monitoring of Plan progress
- Coordination of Watershed-wide efforts with County and Municipal departments (Town Councils, Planning Boards, Departments of Public Works, Open Space Committees, Environmental Commissions, etc.)
- Assessment and implementation of lake restoration projects to protect water quality both within and downstream from Clove Acres Lake and Lake Neepaulin
- Development and implementation of various educational campaigns and programs to raise watershed awareness and solicit stakeholder / volunteer participation in watershed plan implementation initiatives
- Sponsorship of a stormwater seminar to address effectiveness / noneffectiveness of present practices and foster consideration / acceptance of voluntary adoption of several Tier A guidelines by Tier B municipalities (all participating municipalities within the Papakating Creek Watershed fall within the Tier B category; Tier A guidelines are more extensive / restrictive than Tier B guidelines). (Note: Coordination of this action with NJDEP is recommended)

- Sponsorship of a winter road-maintenance seminar to address usage of de-icers, grits, etc. and Best Management applications / equipment maintenance practices
- Address the need for new ordinances in support of the Restoration Plan goals
- Assessment / evaluation / recommendations of open space land candidates for purchase by Federal, State, County, government agencies, municipalities, and various Land Trust organizations. Prime focus to be on the identification of land parcels offering significant water-quality benefits if preserved.
- Development of an invasive species identification and control plan
- Monitor the upgrade of the High Point High School Wastewater Treatment Facility planned for 2010 by the Board of Education (results in a decrease of TP loading to the downstream tributary)
- Work with Sussex County Engineering in the review and enhancement of stream-related bridge / road design standards to incorporate Best Engineering Practices relating to streambank erosion, sediment, stream disturbances, and road runoff control in order to minimize pollutant transport and adverse impacts on stream water quality

Recommended Implementation Projects Within 0 - 40 Months From Approval of NJDEP Funding

Five implementation projects noted above (see Projects AA, BB, CC, DD, and EE) as well as the distribution, communication, and discussion of the developed Restoration and Protection Plans by the WRWMG to the entire watershed community included within the project area.

Funding for the implementation of the Restoration Plan will be sought from the following sources:

- NJDEP SFY 2009 319(h) Implementation Grants

- Development of Conservation Plans (in-kind services from USDA - NRCS and Rutgers Cooperative Extension)

- Implementation of Conservation Plans: USDA and other sources (e.g., CREP, CRP, EQIP, WHIP, ICM, etc. Some funding / in-kind services from individual farmers / landowners may be required.

- In-kind services (e.g., County, municipalities, Sussex County Municipal Utilities Authority, Municipal Boards and Committees, etc.)

- Other sources to be identified / investigated (e.g., Dodge Foundation, private corporations, US Fish & Wildlife Service)

Overall Schedule: Initial Implementation Projects for 2009 - 2012
(Initial Phase of an overall timeline of 10 to 15 years with annual planned projects and pollutant reductions)

	Months	4	8	12	16	20	24	28	32	36	40
		2									
Task	**Description**										
Mobilization											
Project AA	**Establish Project Management Oriented Entity**										
Project BB	**Facilitate Updating of Farm Conservation Plans**										
Project CC	**Lake Neepaulin Characterization & Assessment**										
Project DD	**Lake Neepaulin Local Region Stormwater Treatment Devices**										
Project EE	**Route 565 Streambank Restoration**										
Title Block											
Implementation of the Papakating Creek Watershed Restoration Plan			**Activity**								

Pre- and Post-Monitoring Plan:

Considering that the Restoration Plan is to be implemented over a period of 10 to 15 years (primarily impacted by restricted annual funding levels), a Plan is presented that considers objectives, monitoring elements, management policies, monitoring metrics, resource needs, a communication plan, and management strategies best suited for overall management of long-term projects. The use of an adaptive management approach is strongly recommended in pursuing a cost-effective and efficient journey to achieve the desired goals of restoring and protecting the Papakating Creek Watershed with respect to TP. Basically, the implementer is continuously testing assumptions, evaluating the effectiveness of prior decisions / actions, adapting and reacting to new information, and altering future plans based on the totality of current knowledge.

Contributing Plan Success Factors:

- Continued operation and maintenance of the USGS real-time monitoring flow station at Pelletown Road (USGS #01367800)
- Sufficient resources of the Natural Resource Conservation Service, Rutgers Extension Cooperative, and the Soil Conservation District to support the Plan in a timely manner
- Availability of required program / project funding levels to match Plan requirements
- Monitor research findings relating to effective placement of Best Management Practices on agricultural properties and within the Watershed
- Receptivity and support of the Plan by the Watershed community

The goals of the Papakating Creek Restoration Plan are consistent with the vision established in the Sussex County Strategic Growth Plan and the aims and goals of the Sussex County Agriculture Development Board:

Sussex County Strategic Growth Plan

- Protect and preserve environmentally sensitive areas
- Maintain and enhance surface and groundwater quality / water quantity
- Protect open space
- Encourage farmland preservation
- Protect the Papakating Creek flood plain
- Protect and maintain the quality of life within the Papakating Creek Watershed

Sussex County Agriculture Development Board

- Preserve both farmland and farmers
- Conservation of natural resources on farms
- Ensure clean and plentiful water
- Implement waste management and recycling
- Encourage farmland preservation
- Support and protect the Right-To-Farm Act (ordinances in place by all the participating municipalities within the Papakating Creek Watershed)

A FY 2005 319(h) Nonpoint Source Pollution Control and Management Implementation Grant provided funding for the development of the Restoration Plan from the New Jersey Department of Environmental Protection and significant in-kind services from the Sussex County Municipal Utilities Authority (SCMUA) and the SCMUA Board of Commissioners

Project Description

Introduction

The New Jersey *2002, 2004, and 2006 Integrated Water Quality Monitoring and Assessment Reports* [1] identified the Papakating Creek as an impaired waterway for non-attainment of Total Phosphorus and Fecal Coliform. In years 2003 and 2004, the New Jersey Department of Environmental Protection (NJDEP) proposed and the U.S. Environmental Protection (USEPA) approved seven Total Maximum Daily Loads (TMDLs) [2, 3] as listed in *Table 1* below to address total phosphorus and fecal coliform (subsequently requested by NJDEP to address both Fecal Coliform and *E.coli*) in the Papakating Creek Watershed.

Table 1: Pollutant-Impaired Stream Segments

Station Name/ Waterbody ID	Pollutant	NJDEP Site ID	Affected River Miles (Acres if Stated)
Papakating Creek at Sussex	Phosphorus	01367910	2.5
Clove Acres Lake	Phosphorus	Clove Lake-02	34 Acres
Papakating Creek near Wykertown	Fecal Coliform	01367780	4.6
Papakating Creek at Pelletown	Fecal Coliform	01367800	21.7
West Branch Papakating Creek at McCoys Corner	Fecal Coliform	01367850	13.5
Papakating Creek at Pelletown	Fecal Coliform	01367800	1.7
Papakating Creek at Sussex	Fecal Coliform	01367910	2.57

In December 2006, the NJDEP released the 2006 New Jersey Integrated Water Quality Monitoring and Assessment Report that listed two of the above sites (Papakating Creek at Sussex and Papakating Creek at Route 565 in Wantage) on the 2006 Sublist 5 for nitrate impairment. Although outside the scope of this Grant Report, some commentary is provided later (page 55) with respect to the nitrate sampling results obtained by the WRWMG for these sites.

As part of the administrative process, NJDEP promulgated and submitted to the USEPA a request for approval of certain amendments to the Sussex County Water Quality Management Plan (SCWQMP) [2] relating to the issued TMDLs. In response to the NJDEP and USEPA actions, the Wallkill River Watershed Management Group (WRWMG) submitted and received approval for a fiscal year 2005 319(h) Grant [4] to address both the impairments and the development of a Restoration and Protection Plan for the Papakating Creek Watershed. Prior to Grant submittal, the Papakating Creek was identified as a Watershed Management Area 02 Priority Stream Segment under the former NJDEP Watershed management structure. At the request of NJDEP, the Papakating Creek Watershed, consisting of seven HUC 14 drainage areas, was split into two

components: six HUC 14 areas that comprise the Papakating Creek headwaters, West Branch, and the Papakating Creek mainstem and one HUC 14 area that comprises Clove Acres Lake / Lakeshed and the Clove Brook streamshed.

The seven TMDLs are to serve as the basis for the development of a Restoration and Protection Plan aimed at identifying the sources of fecal coliform / *E.coli* and total phosphorus, setting goals for pollutant annual load reductions, and implementation of private and community measures, i.e., application of Best Management Practices (BMPs) in order to attain the applicable Surface Water Quality Standards (SWQS), and a Monitoring Plan to measure the achieved progress.

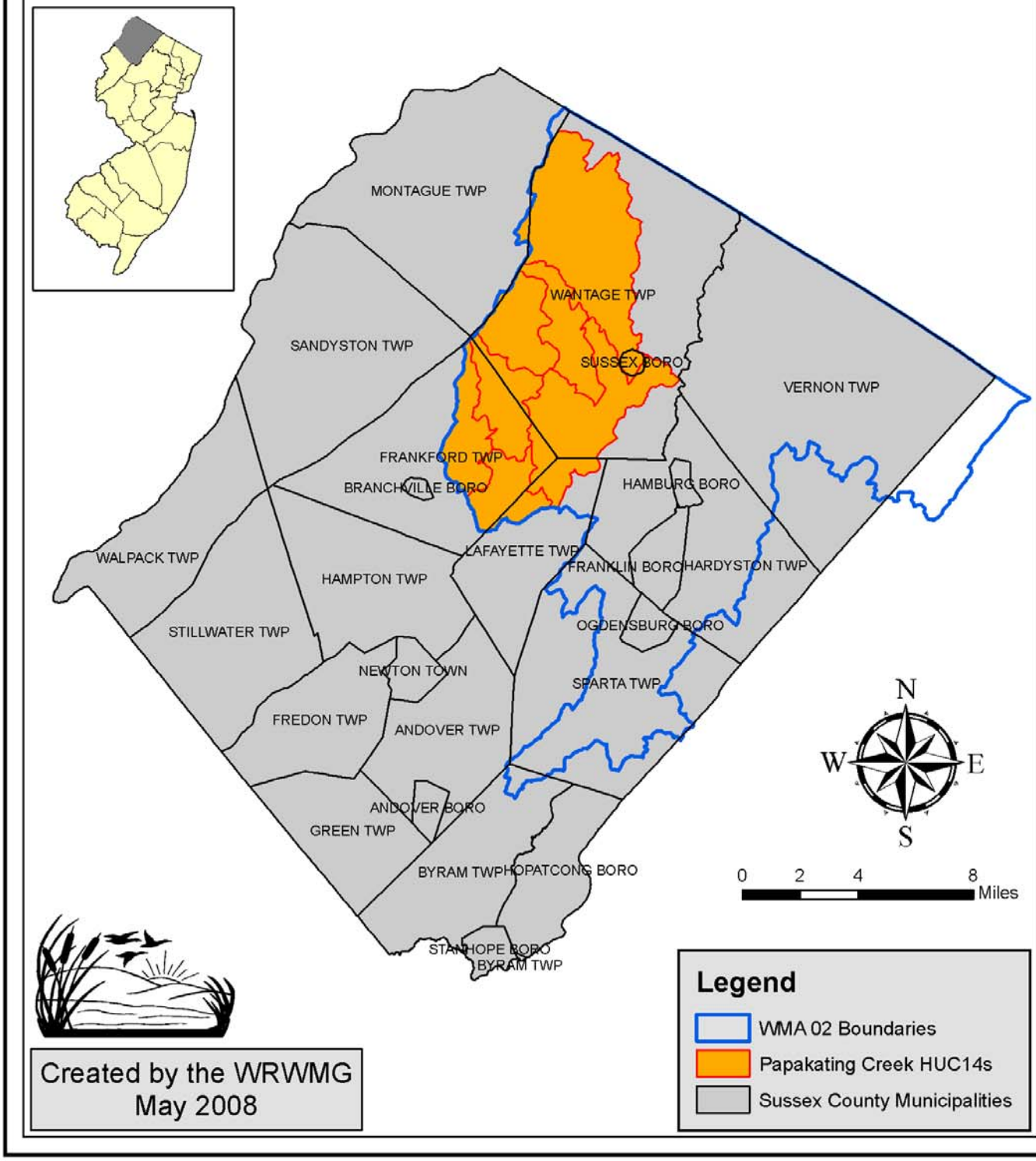
For reference, a TMDL[4, 5] quantifies the assimilative (carrying) capacity of a stream, taking into consideration point and non-point sources of pollutants of concern (in this case, fecal coliform / *E.coli* and total phosphorus), without exceeding the limits established by the SWQS. Within the WMA 02 Watershed, Papakating Creek non-point sources of fecal coliform / *E.coli* and total phosphorus are the predominant pollutant sources of concern versus point sources (end of pipeline discharge). The TMDL also takes into consideration non-point sources in the form of load allocations (LAs) and, as applicable, reserve capacity and a margin of safety. Usually, a TMDL also considers point sources in the form of wasteload allocations (WLAs), but this is not necessary, in this case due to the minor nature of the point source annual loadings as identified within the Papakating Creek Watershed.

Background

The Papakating Creek Watershed is one of five U.S. Geological Survey HUC 11 Watersheds that comprise the entire Wallkill River Watershed in New Jersey. This largely rural, agricultural, and forested Watershed is approximately 61 square miles in area, located within Frankford, Wantage, Lafayette Townships, Sussex Borough, and Montague Township. The Papakating Creek is the primary surface water within the drainage basin, which including all its tributaries, covers approximately 80 river miles before its confluence with the Wallkill River. The *New Jersey 2002 and 2004 Integrated Water Quality Monitoring and Assessment Reports*[1] identified the Papakating Creek as an impaired waterway and placed it on Sublist 5 for non-attainment of total phosphorus and fecal coliform. As a result, in 2003, the New Jersey Department of Environmental Protection (NJDEP) proposed and EPA approved five Total Maximum Daily Loads (TMDLs) to address fecal coliform in the Papakating Creek Watershed. In April 2004, NJDEP proposed two additional TMDLs to 1) address total phosphorus in the Papakating Creek Watershed (for six of the seven HUC 14 subwatersheds that comprise the entire Watershed) and 2) to address total phosphorus in the Clove Acres Lake / Lakeshed and Clove Brook streamshed (the seventh Papakating Creek HUC 14 subwatershed).

Refer to *Figure 1* showing the location and orientation of the Papakating Creek Watershed with respect to the Wallkill River Watershed (WMA 02) and Sussex County.

Figure 1:
Sussex County Municipalities / WMA 02 Boundaries / Papakating Creek Watershed HUC 14s



In March 2004, the Wallkill River Watershed Management Group (WRWMG), under the guidance of the Division of Watershed Management of NJDEP, received a $25,000 Priority Stream Segment Grant to address the mainstem of the Papakating Creek. The Priority Stream Grant was in response to the seven TMDLs released by NJDEP [2,3]. The Grant was intended to later serve as a basis for submittal of 319(h) Grant projects for the development of Restoration and Protection Plans for the Papakating Creek and Clove Acres Lake / Clove Brook subwatersheds. Three Tasks were undertaken as components of the Priority Stream assessment:

Task 1: Characterization / assessment of the Papakating Creek Watershed

Task 2: Identification of key data gaps including conducting limited sampling

Task 3: Development of overall work plans, calculation methodologies, identification of potential pollutant sources, approaches for identifying management strategies and practices for reducing pollutant sources, and the identification of potential funding sources

The Task 1 Report [6] was released in July 2004. Upon issuance, WRWMG was authorized to initiate Tasks 2 and 3. Task 2, which covered limited sampling to address key data gaps, was undertaken shortly thereafter. Field sampling was conducted for the balance of 2004 and continued throughout 2005. Sampling data collected under the $25,000 Grant was augmented by data collected as part of the WRWMG third-year contract. All field-sampling events were conducted in accordance with an approved NJDEP Quality Assurance Project Plan (QAPP).

Task 2 findings confirmed the NJDEP claimed Papakating Creek impairments with respect to total phosphorus and fecal coliform. Some evidence was found indicating that both total phosphorus and fecal coliform may be correlated with annual farming / agricultural field operations as well as with storm events and typical non-point pollutant sources. Both parameters show seasonality effects, which indicate the need for appropriate field sampling throughout the year.

Shortly thereafter, the Wallkill River Watershed Management Group (WRWMG) submitted two Grant Proposals [7] as follows:

- Development of a Watershed Restoration and Protection Plan for the Papakating Creek covering six HUC 14 subwatersheds. The Grant proposal was budgeted at $168,850 and outlined a 36-month project timeline to develop an overall Restoration and Protection Plan. Measurement of flow rates relating to the field-sampling plan conducted by the WRWMG was subcontracted to HydroQual, Inc.

- Development of a Watershed Restoration and Protection Plan for the Clove Acres Lake / Lakeshed (the seventh HUC 14 subwatershed of the Papakating Creek Watershed). The Grant Proposal was budgeted at $138,050 and outlined a 30-month project timeline to develop an overall Restoration and Protection Plan. The WRWMG engaged Princeton Hydro, LLC to conduct a detailed Clove Acres Lake characterization assessment using the NJDEP-approved methodology. The Clove Acres Lake / Lakeshed / Clove Brook Streamshed Restoration Plan will be issued separately from this Report.

Papakating Creek
Wantage Township

Clove Acres Lake
Sussex Borough

Project / Watershed Goals

The total phosphorus and fecal coliform / *E.coli* TMDL reduction goals developed by the NJDEP, later modified as a result of studies conducted by the WRWMG, resulted in the following established Restoration Plan reduction goals:

- NJDEP 319(h) Papakating Creek Watershed Grant (NJDEP Contract RP05-088): The Restoration Plan for the Papakating Creek Streamshed (six of seven HUC 14s), when implemented, is to result in the achievement of an overall 31% reduction in the estimated total phosphorus loading of 7,231.3 kilograms/year (15,909 pounds/year) and a 99% fecal coliform reduction, as presented in the referenced TMDLs.

- NJDEP 319(h) Clove Acres Lake / Lakeshed and Clove Brook Streamshed Watershed Grant (NJDEP Contract RP05-090): The Restoration Plan for the Clove Acres Lake / Lakeshed (the seventh HUC 14 of the Papakating Creek Watershed), when implemented, is to result in the achievement of an overall 77% reduction in the estimated (TP) loading of 2,676.1 kilograms/year (5,887 pounds/year) (See Attachment # 10.) The Restoration Plan for the Clove Acres Lake / Lakeshed will be issued separately.

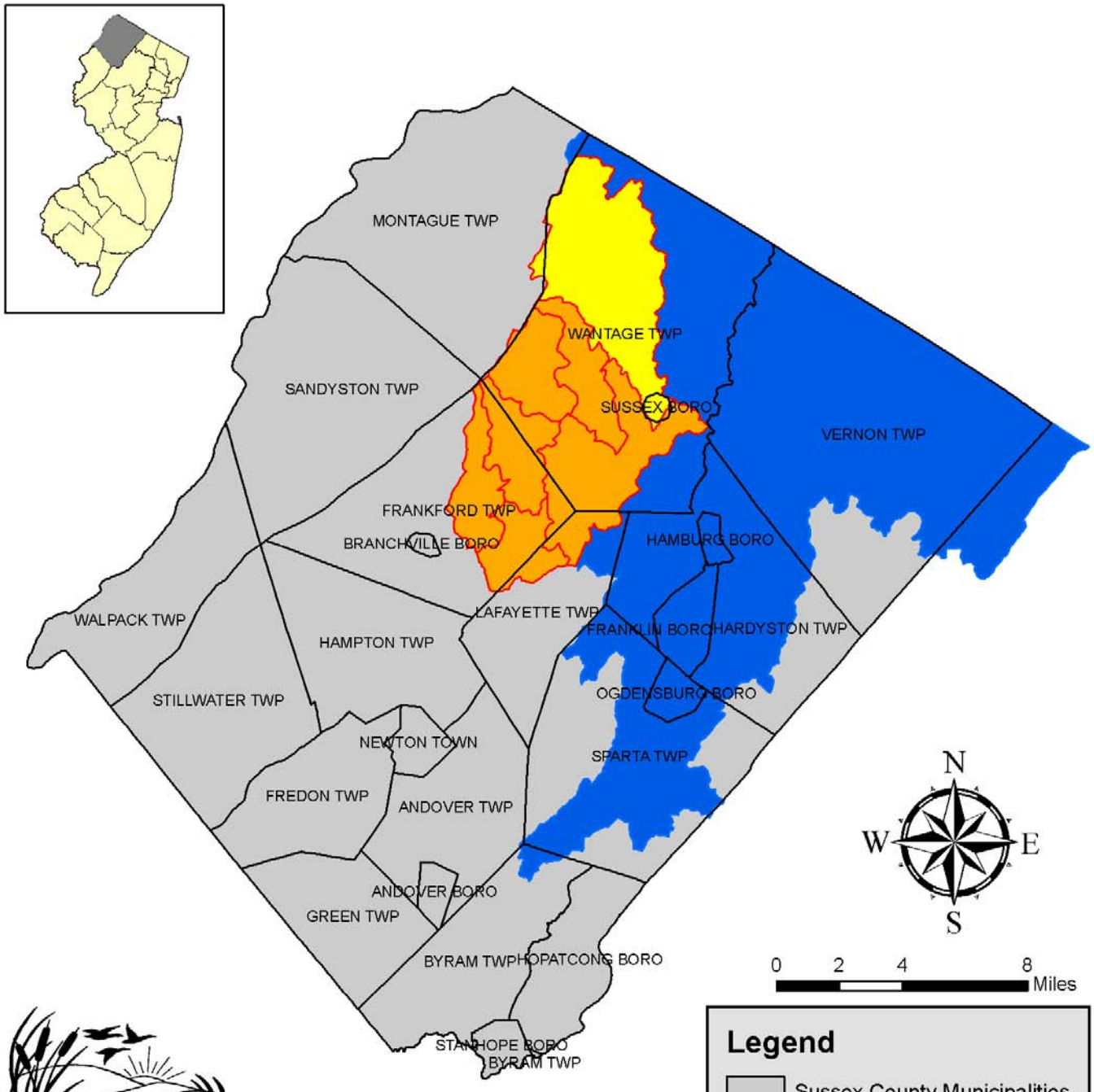
Overall Summary: Both Grants, taken together, are to achieve a 43.4% reduction in a TP annual loading of 21,796 pounds/year for the entire Papakating Creek Watershed (seven HUC 14 drainage areas) and a 92% to 99% reduction in fecal coliform for the Papakating Creek Watershed (excluding the Clove Acres Lake and Clove Brook drainage area).

Re-estimation of the Required Total Phosphorus Reduction Percentages for the Papakating Creek Watershed and Clove Lake / Clove Brook Lakeshed: As noted above, the TP TMDL for the Clove Brook subwatershed (sub-basin) specified a required reduction percentage of 77%. Upon detailed analysis, it was shown that achieving a 77% reduction was equivalent to returning the Clove Brook subwatershed to a natural state (100% forest, barren land, and water land cover). Since this state is not a feasible outcome, the WRWMG and NJDEP agreed to reallocate the targeted annual TP reduction loading of 9,459.5 pounds/year (21,796 x 0.434) between the two Watershed Grants: Papakating Creek and the Clove Brook. A methodology was proposed by the WRWMG to keep the approach to theoretical the same for the two Watershed Grants. The analysis resulted in resetting the 31% reduction percentage for the Papakating Creek to 43% and resetting the 77% reduction percentage to 44.5% for the Clove Brook. For reference, the theoretical minimum loading within the Watershed was estimated based upon the entire Watershed being returned to a natural state (defined as consisting of land cover types such as forests, vegetative areas, ravines, water streams, wetlands, and barren lands).

The theoretical percentage reduction (or maximum feasible percentage reduction) is defined as the estimated annual input loading less the natural state loading divided by the annual input loading times 100. The approach to theoretical is defined as the targeted reduction percentage divided by the theoretical percentage reduction times 100. It is recognized that through chemical-based treatment approaches (chemical processes), loadings less than the estimated natural state loading level can be achieved but these approaches are beyond the realm of applicable cost-effective approaches under consideration as part of the Restoration Plan.

Refer to *Figure 2* showing the breakdown of the six HUC14s comprising the Papakating Creek Watershed Restoration Plan Project Area and the one HUC 14 comprising the Clove Acres Lake / Lakeshed Watershed Restoration Plan Project Area.

Figure 2:
Papakating Creek Watershed & Clove Acres Lakeshed Grant Proposals Project Area Breakdown



Translation of Project/Watershed Goals into Management Objectives

Table 2 summarizes the translation of Watershed goals to proposed management strategies for achieving the targeted Watershed pollutant reductions with respect to total phosphorus and fecal coliform / *E.col.i*

Table 2: Project Goals Linked to the Causes and Sources of Impacts to Management Objectives

Goals	Indicators	Cause or Source of Impact	Management Objectives	Indicator and Target Value
Support designated uses for the Papakating Creek Streamshed:				
1) Nutrient-loading reduction of 9,466 pounds/year	Total Phosphorus	In-stream channel processes (erosion), surface erosion (sediment transport), agricultural / land use operations, and, to a much lesser extent, septic issues (specific locations)	Pollutant reduction and implementation of conservation plans and BMPs, educational / outreach efforts, and municipal actions	Part of Post-Monitoring Plan that addresses both source control and delivery reduction; target is to achieve a level of 0.1 mg/l of Total Phosphorus in the Papakating Creek Monitoring Plan
2) Bacteria reduction of 99%	Fecal coliform / *E.coli*	Farm and domestic animals, wildlife, and possibly septic issues (specific locations)	Animal exclusion from waterbodies, manure management, farming land use BMPs, and septic management	Target is to achieve a geometric mean Fecal Coliform level of 200 or less CFU/100 ml and a geometric mean *E.coli* level of 140 CFU/100 ml or less

3) Assess the likely causes for benthic macro-invertebrate health impairments detected at several specific sites identified by NJDEP 4) Assess an alleged metal impairment at the Papakating Creek Sussex location (WRWMG Site "L")	Deleted from scope of work per NJDEP advise / guidance Arsenic level	1. Indigenous (geology related) 2. Anthropo-genic 3. Back flow from the Wallkill River (site is just upstream from the confluence of the Papakating Creek and the Wallkill River)	NJDEP has advised that this alleged impairment will be addressed outside this Grant	
Conduct a sampling program to address data gaps and to augment NJDEP total phosphorus and fecal coliform / *E.coli* databases	Parameters are identified in the Grant's Quality Assurance Project Plan	Not Applicable	Conduct a one-year sampling program to address data gaps; data to augment NJDEP's database	Monitor against the NJDEP Surface Water Quality Standards
Conduct a parameter source tracking assessment	Monitor for Total Phosphorus and fecal coliform / *E.coli*)	Sources to be identified	Estimate annual loadings and compliance against NJDEP's Surface Water Quality Standards (SWQS)	Target values as set by NJDEP's SWQS

Address fecal coliform wasteload allocation reductions for NJPDEP-regulated stormwater discharges			Since the entire Papakating Creek Watershed includes only Tier B stormwater-defined municipalities, no regulatory-related actions are presently required; voluntary adoption of several Tier A requirements may be appropriate in addressing corrective measures to be proposed for the Papakating Creek Watershed	
Identification of restoration and implementation actions/projects			Identify suitable BMPs, funding sources, municipal ordinances and community actions	
Identification of implementation funding sources			Coordinate WRWMG actions with funding sources	
Identification / development of monitoring criteria and a Post-Monitoring Plan			Develop a Post-Monitoring Plan (data to be collected to address both pre- and post-sampling results)	
Development and implementation of an Education and Outreach Program			Develop and implement an Education and Outreach Program	

Subwatershed Characteristics (the provided data augments the assessment / characterization information provided in the WRWMG Priority Segment Report [7])

Land Use / Land Cover

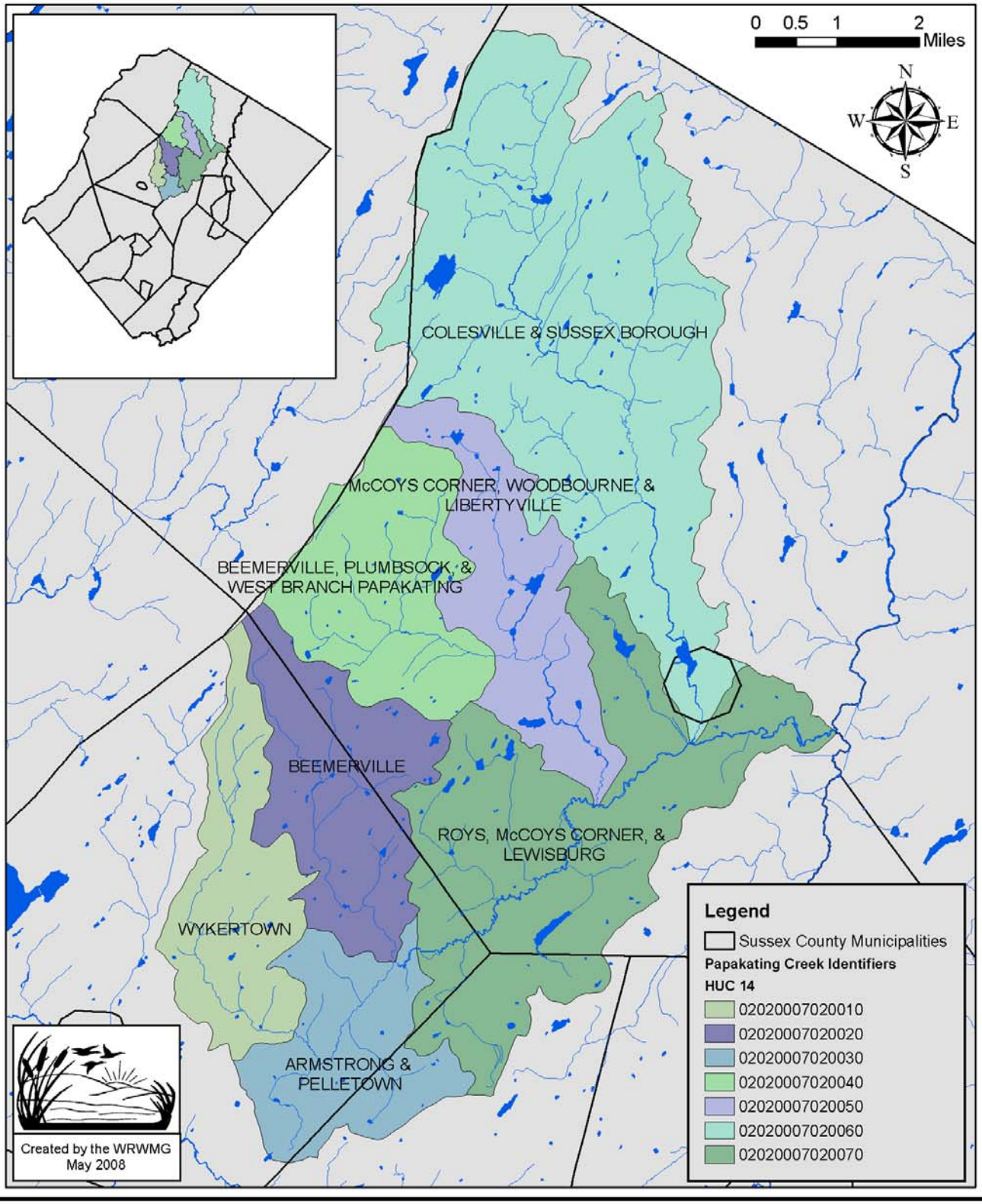
The predominant land uses in the Papakating Creek Watershed include forest and woodland, agriculture, low to high-density residential, lake communities (isolated), commercial (Sussex Borough), wetlands, barren lands, and surface waterbodies. The total estimated size of the Watershed is approximately 38,798 acres or 60.6 square miles. Of the 16,449 acres of forested land, 2,850 acres or 17.3% of that land is dedicated federal or state open space, which essentially precludes further development pressure.

For purposes of report clarity and understanding, HUC 14 identifiers were given to each of the HUC sub-basins as noted in *Table 3* and depicted in *Figure 3*.

Table 3: HUC 14 Watershed Name Identifiers

HUC 14	Watershed Area Identifiers
02020007020010	Wykertown
02020007020020	Beemerville
02020007020030	Armstrong and Pelletown
02020007020040	Beemerville, Plumbsock, West Branch of the Papakating Creek, etc.
02020007020050	McCoys Corner, Woodbourne, and Libertyville
02020007020060	Colesville and Sussex Borough
02020007020070	Roys (Roys Road), McCoys Corner, and Lewisburg

Figure 3:
Papakating Creek Watershed HUC 14 Identifiers



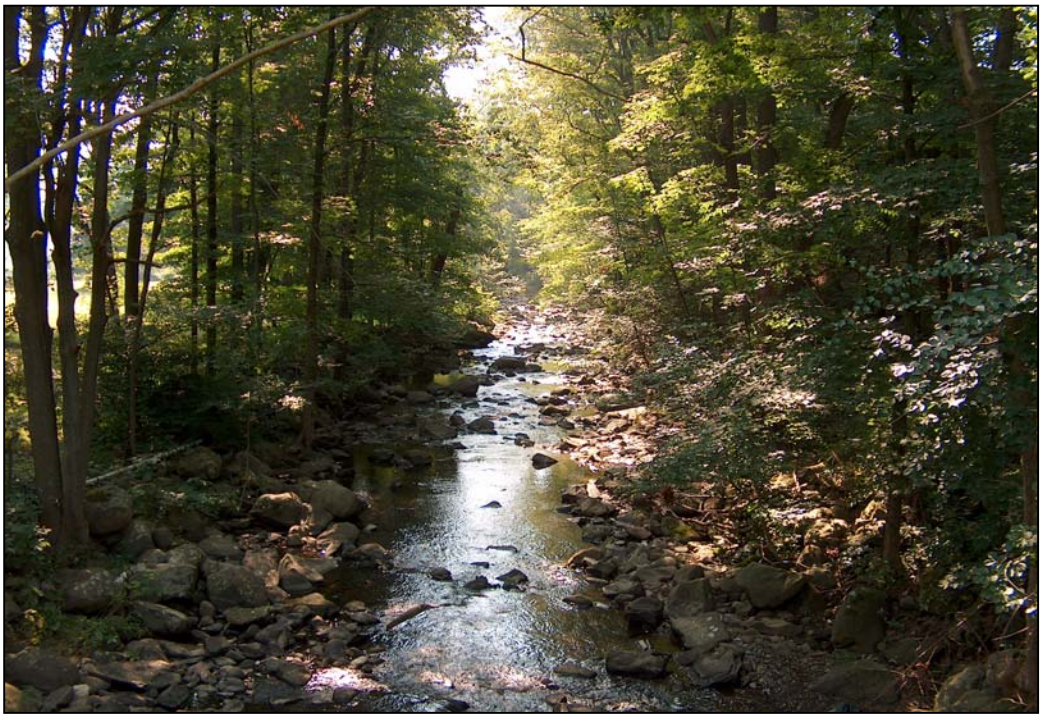
Land Use Classifications and HUC 14 subwatershed areas are summarized in Table 4:

Table 4: Papakating Creek Watershed Land Use Classifications/HUC 14 Areas

Based on 2002 NJDEP Land Use Aerial Maps

HUC	Agriculture	Barren	Forest	Urban	Water	Wetlands	Total Acres
02020007020010	953.7	4.9	1512.7	332.4	14.9	442.8	3261.3
02020007020020	1315.1	46.3	1301	467.4	29.7	654.4	3813.9
02020007020030	1345.2	36.4	941.8	384.4	10.2	304.8	3022.8
02020007020040	1114.6	16.9	1668.2	462.2	23.8	534.2	3819.9
02020007020050	898.9	19.9	1453.4	645.6	78.1	445.4	3541.3
02020007020060	2815.9	87.8	6151.9	1440.7	168.6	2176.4	12841.3
02020007020070	2316.6	85.4	3419.6	1087	165.5	1424.2	8498.3
Totals	**10760**	**297.6**	**16448.6**	**4819.7**	**490.8**	**5982.2**	**38798.9 (60.6 sq. mi)**
Percent (includes all seven HUC 14s)	**27.7%**	**0.8%**	**42.4%**	**12.4%**	**1.3%**	**15.4%**	**100%**
Percent (includes only HUC 02020007020060 (Clove Acres Lake/ Lake-shed and Clove Brook Stream-shed)	**21. 9%**	**0.7%**	**47.9%**	**11.2%**	**1.3%**	**17.0%**	**100%**

Reference: NJDEP Data Source -*'Total Maximum Daily Load to Address Phosphorus in the Clove Acres Lake and Papakating Creek Northwest Water Region,"* April 19, 2004



Portion of Each Municipality Within the Papakating Creek Watershed by Acres

Table 5 quantifies the distribution of Watershed acres that fall within each municipality as well as the percent of each municipality's total acreage that lies within the Papakating Creek Watershed. The acreage noted for Montague Township is relatively minor. Sussex Borough is noted as 100% within the Watershed, although actual data would show approximately 99+%.

Table 5: Percentage of Township's Papakating Creek Watershed Acres to the Township's Total Acres (Watershed acreage defined by seven HUC 14 areas)

Municipality Land Acres	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township	Total Acres
Total Acres	**43,039.15**	**403.15**	**22,525.89**	**11,797.61**	**28,717.98**	
Acres within the Papakating Creek Watershed	**27,256.12**	**403.15**	**8,818.08**	**2,007.49**	**313.43**	**38,798.3 versus 38,798.9 stated in TMDL**
Percentage of Township's Watershed Acres to the Township's Total Acres	**63.3%**	**100%**	**39.1%**	**17.0%**	**1.1%**	

Table 6: Percentage of Township's Papakating Creek Watershed Acres to the Total Papakating Creek Watershed Acres (Watershed defined by seven HUC 14 areas)

Municipality Land Acres	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township	Total Acres
Acres within the Papakating Creek Watershed	**27,256.12**	**403.15**	**8,818.08**	**2,007.49**	**313.43**	**38,798.3 versus 38,798.9 stated in TMDL**
Percentage of Township's Watershed Acres to the Total Papakating Creek Watershed Acres	**70.3%**	**1.%**	**22.7%**	**5.2%**	**0. 8%**	**100.%**

Figure 4:
Muncipalities Within the Papakating Creek Watershed

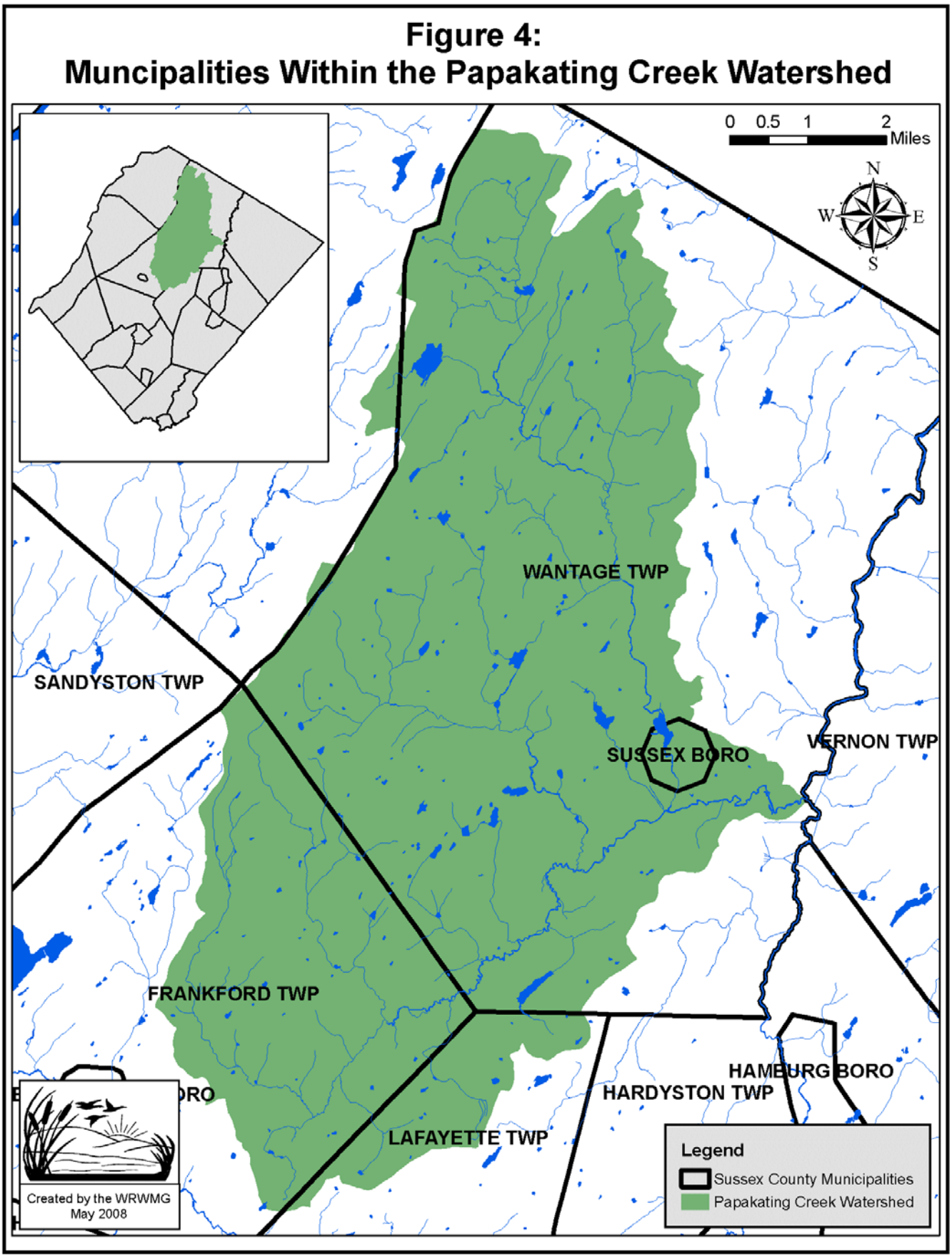


Table 7 below summarizes calculations undertaken to estimate the population of residents living within the Papakating Creek Watershed. Of approximately 148,680 residents residing within Sussex County (2002 Census), approximately 11,602 presently reside within the subject Watershed. This figure is forecast to increase to approximately 12,530 residents by the year 2010.

Table 7: Estimation of the Papakating Creek Watershed Population

Municipality	Total Population (2002 Census)	Total Square Miles	Total HUC 14s Square Miles	Papakating Creek Watershed Population (2002 Census)
Wantage	10,853	67.54	43.60	7,006
Frankford	5,449	35.43	13.80	2,122
Lafayette	2,378	18.06	2.50	329
Montague	3,494	45.34	0.50	Negligible
Sussex Borough	2,145	0.62	0.62	2145
Sub-Total	24,319	166.37	61.0	11,602
Use			(Versus 60.6 shown elsewhere - attributed to estimation methodology)	11,602

Land Parcels Bordering the Papakating Creek, Clove Acres Lake, and the Clove Brook

As part of the source-tracking assessment, an analysis was conducted to identify the approximate number and size of lots bordering the Papakating Creek and the Clove Brook. The intent was to prioritize those lots that may have the highest potential to directly contribute to pollutant loadings or potentially serve as buffers and/or be appropriate for open space acquisition. Results of the analysis are noted in *Table 8*:

Table 8: Size Distribution of Parcels Bordering the Papakating Creek and Clove Brook Waterways

Stream	Papakating Creek	Clove Brook	Papakating Creek Plus Clove Brook	Percentage
Lots ≤ 10 Acres	1,113	1,615	2728	85%
Lots > 10 Acres	300	191	491	15%
Total Lots	1,413	1,806	3,219	100%

Recognizing that the Restoration Plan will be directed to all residents and land owners within the project area, the initial Education and Outreach Program could be directed along the following communication channels: 1) communicate first with approximately 491 lot owners (lot sizes ranging from 10 acres to 250 acres), 2) followed by 2,728 lot owners (lots equal to or less than 10 acres), and 3) followed by all lot owners (a total of 7,784 parcels) within the project area.

The results of the above analysis were also used to prioritize those sites identified for initial visual studies as part of the source-tracking survey. The data further show that the majority of lots (85%) bordering the waterways are 10 acres or less and that the preponderance of lot sizes greater than 10 acres generally ranges from 10 to 75 acres.

Chart 1: Frequency of Lot Sizes Bordering the Papakating Creek

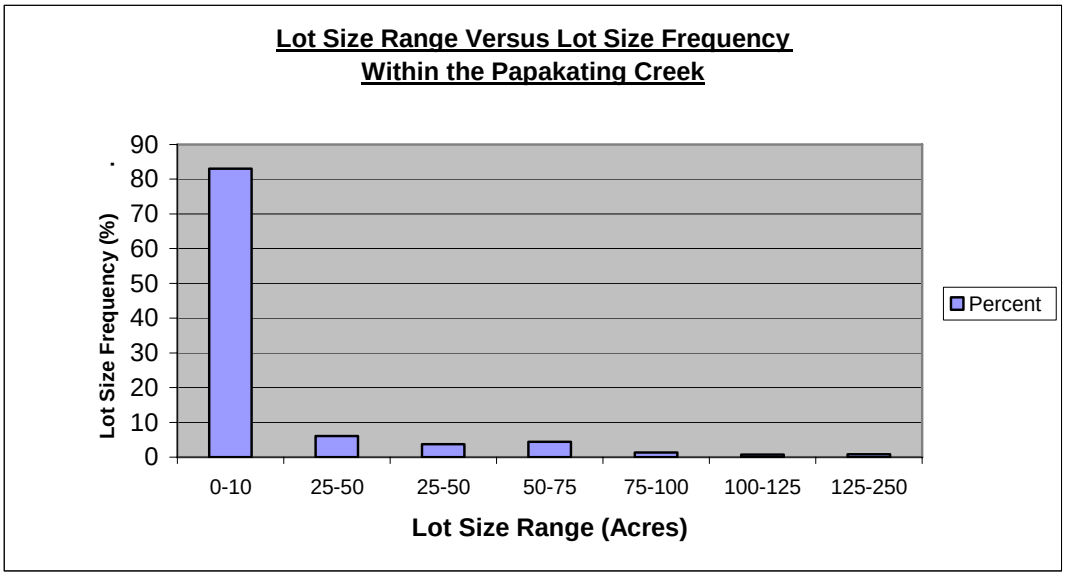
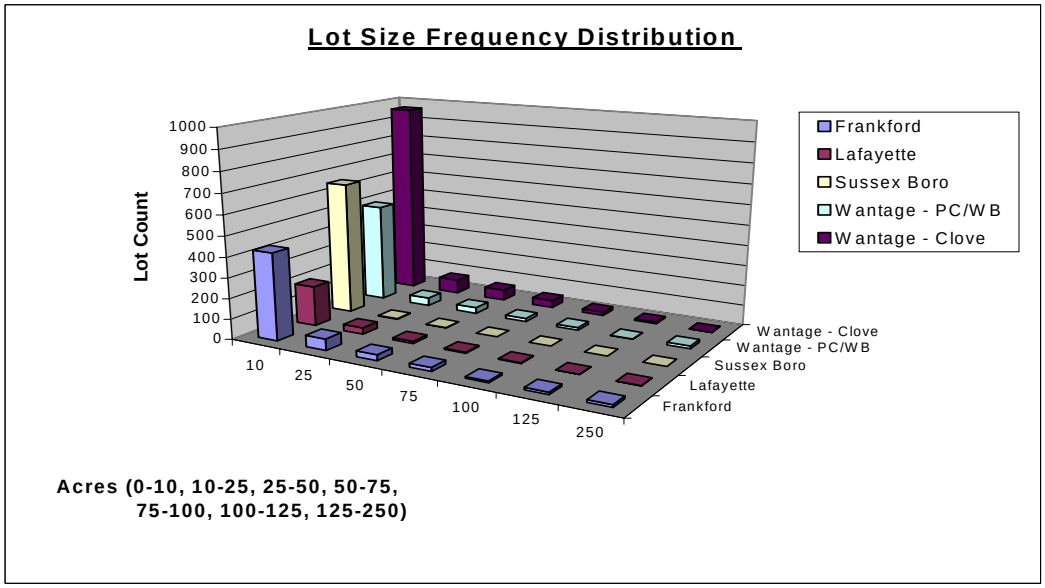


Chart 2: Distribution of Lot Sizes Bordering the Papakating Creek and Clove Brook



In addition to the above stated purpose, the developed lot-size data were intended to support ongoing efforts to identify critical source areas that significantly contribute to phosphorus transport from adjacent lands to nearby water streams. This work will be further addressed in ongoing discussions with Dr. Zeyuan Qiu of the New Jersey Institute of Technology and Grace Messinger from North Jersey Resource Conservation and Development. Critical source areas are those hydrologically sensitive areas that generate significant polluted runoff. If these areas can be identified, then further insight is gained in identifying and implementing effective conservation and land management approaches.

Waterways / Streams

Using NJDEP-available GIS information, stream lengths for the Papakating Creek and Clove Brook within each HUC 14 of the Papakating Creek Watershed were calculated as follows:

Table 9: Stream Lengths Within Each HUC 14

HUC 14	Watershed Area Identifiers	Stream Lengths
		(miles)
02020007020010	Wykertown	10.77
02020007020020	Beemerville	10.40
02020007020030	Armstrong and Pelletown	8.98
02020007020040	Beemerville and Plumbsock	11.73
02020007020050	McCoys Corner, Woodbourne, and Libertyville	10.54
02020007020060	Clove Brook including Clove Acres Lake	48.86
02020007020070	Roys (Roys Road), McCoys Corner, and Lewisburg	26.78
Total Stream Length		128.06 miles (sum for seven individual GIS HUC 14 stream layers versus 128.06 miles for the composite HUC stream layer)

Specific impaired stream lengths as reported in the NJDEP Total Phosphorous and Fecal Coliform TMDLs are summarized in *Table 10* and *Figures 5 & 6*

Table 10: 2002 and 2004 Integrated Lists: Papakating Creek Watershed Waterbodies / Impairments / Segment Descriptions

Waterbody	Station Name	Site ID	Impaired River Miles/Lake Area	Segment Description
2002 Integrated List - Total Phosphorus Impairments)				
Papakating Creek (Refer to Note A)	Papakating Creek at Sussex WRWMG Sampling Site "L"	01367910	2.5 miles (the spatial extent defined for this Grant is the entire Papakating Creek)	
Clove Acres Lake (Refer to Note A)	Clove Acres Lake WRWMG Sites "I" and "J" Princeton Hydro, LLC Sites "S-1," "L-3," "L-2" and "L-1"	Clove Lake - 02	Approx. 34 acres (the spatial extent defined for the Clove Acres Lake / Clove Brook Watershed is the entire length of the Clove Brook)	

Waterbody	**Station Name**	**Site ID**	**Impaired River Miles/Lake Area**	**Segment Description**
2002 Integrated List - Fecal Coliform Impairments			**Impaired River Miles (spatial extent - total miles included in the implementation Plan)**	
Papakating Creek (Refer to Note A)	Papakating Creek near Wykerton WRWMG Site "U"	01367780	4.6 miles (5.6)	
(Refer to Note A)	Papakating Creek at Pelletown WRWMG Site "R"	01367800	21.7 miles (45)	
(Refer to Note A)	WB Papakating Creek at McCoys Corner WRWMG Site "N"	01367850	13.5 miles (23.5)	West Branch (WB) Papakating Creek to the confluence of the WB Papakating Creek with the Papakating Creek
(Refer to Note A) (Refer to Notes A and B)	Papakating Creek near Sussex WRWMG Site "K" Papakating Creek at Sussex WRWMG Site "L"	01367860 01367910 and 01367909	1.7 miles 2.5 miles (8.3 miles relating to NJDEP stream segments 01367860 and 01367910)	From the confluence of the WB Papakating Creek to the confluence of the Papakating Creek with the Wallkill River
	Sub-total miles		44 miles impaired (82.4 miles included in Plan)	

Note A: Listed on Sublist 4 of the *2004 Integrated List* (Document dated June 1, 2005) (List refers to TMDLs already prepared and approved by NJDEP and EPA)

Note B: Listed in Appendix K of the *2006 Integrated Water Quality Monitoring Assessment Methods Document*, dated December 2006

Figure 5:
Papakating Creek Watershed HUC 14s on the 2006 Integrated List Sublist 4A TMDL Established for Total Phosphorus

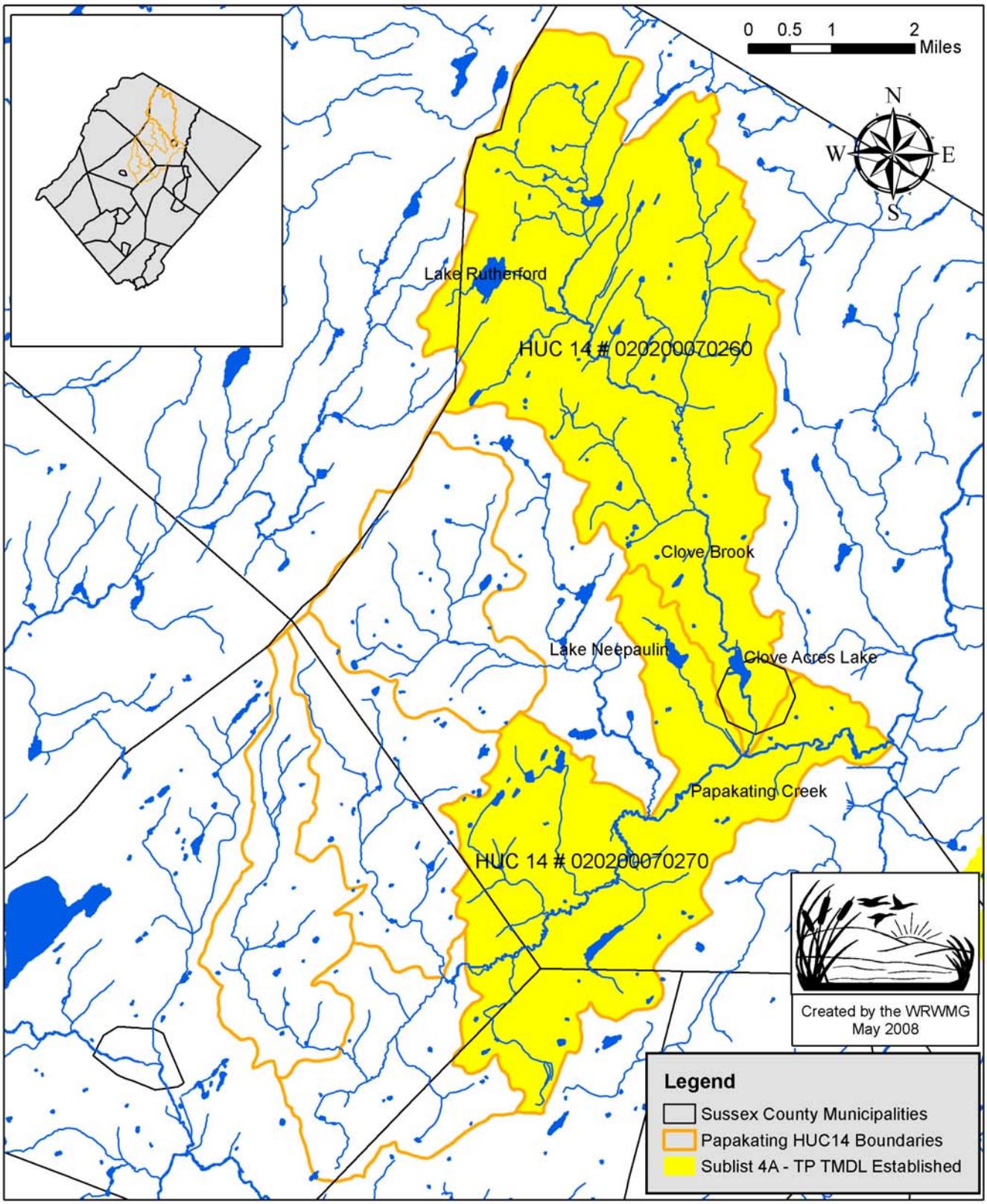
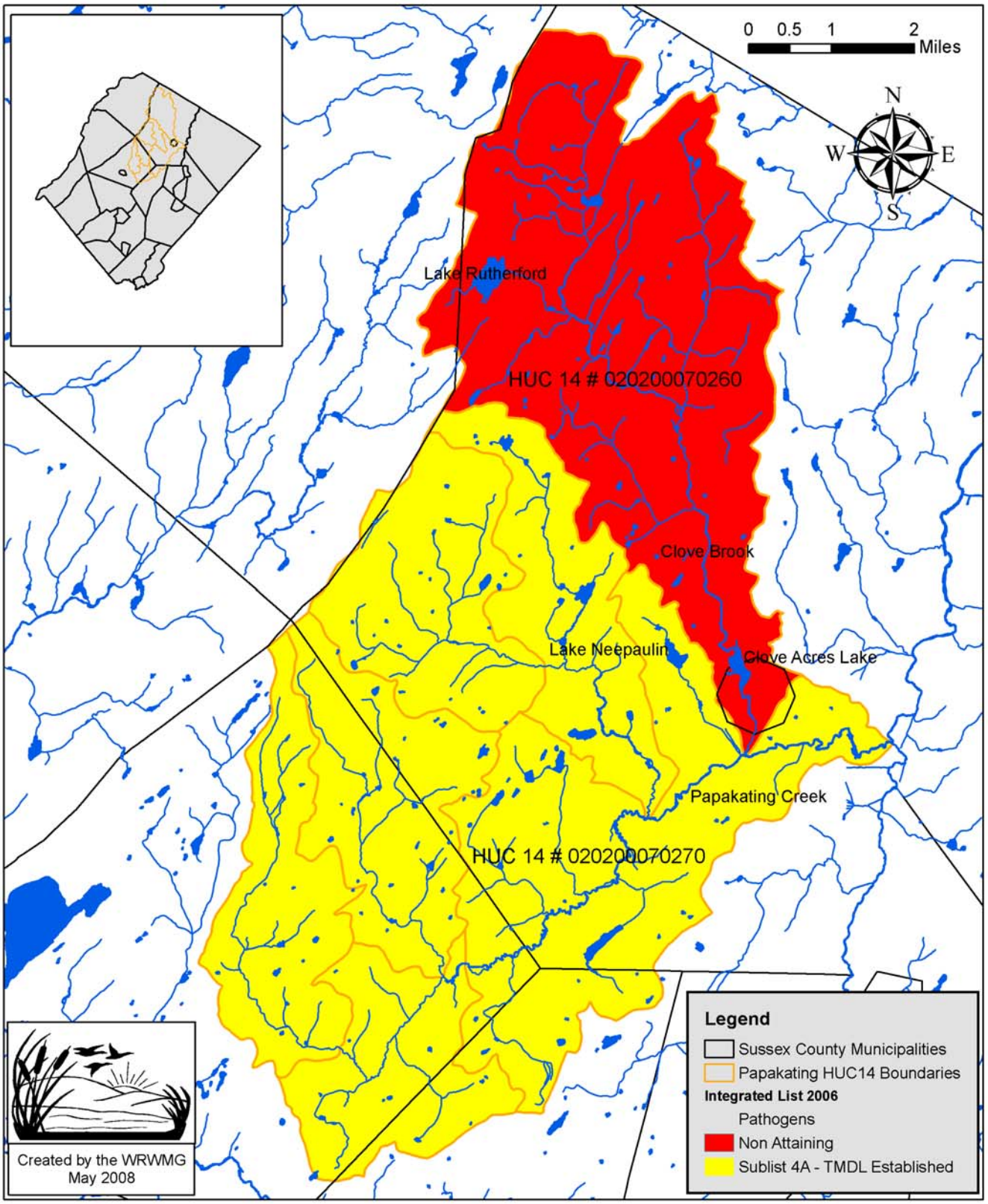


Figure 6:
Papakating Creek Watershed HUC 14s on the 2006 Integrated List for Pathogens (Fecal Coliform / E.coli)



Estimation of Agricultural / Domestic (Horses) / Wildlife Count Within Sussex County and the Papakating Creek Watershed [10, 11, 12, 13, 14, 15]

Typical agricultural, domestic, and wildlife animals found within the Papakating Creek Watershed include dairy and beef cattle, goats, chickens, horses, pigs, llamas, turkeys, deer, bear, beavers, coyotes, geese, etc. Dogs and cats are excluded from Table 11. The actual number of farm animals within the subwatersheds has been decreasing as a result of both economic and development pressures.



The intent of the exercise to estimate both domestic and wildlife within the Papakating Creek Watershed was threefold:

- To establish the magnitude of both domestic and wildlife animals as potential pollutant sources of *E.coli* / fecal coliform to streams, lakes, and ponds. Conclusion: The developed estimates, although very basic, do indicate a high likelihood that both domestic and wildlife animals are factors to be considered in source-tracking efforts.

- To develop justification that microbial source-tracking needs to be funded and incorporated into future *E.coli* / fecal coliform sampling and tracking studies. Conclusion: The WRWMG strongly recommends that microbial source-tracking methods be funded and included in future *E.coli* / fecal coliform studies. The importance of having MST methods available is to define the presence / absence of a human contribution to pathogen load first and foremost before distinguishing the source contribution as a percentage of distinct animal species.

- To serve as a benchmark for future post-monitoring *E.coli* / fecal coliform watershed studies. At this time, due to a lack of funding, it was not possible to establish / estimate the pollutant loadings from domestic and wildlife animals as a percentage of the total measured *E.coli* / fecal coliform pollutant loadings found at the various sampling stations. The feasibility of achieving the targeted 96% - 98% reduction goal also remains questionable. Conclusion: Statement 3 further supports the need for microbial source-tracking methods as a part of future *E.coli* / fecal coliform studies.

Table 11: Animal Population Estimates Within the Papakating Creek Watershed (Seven HUC 14 Areas)

Animal Species	Data Timeframe	Total Within State	Area As Stated	Within Sussex County	Within Papakating Creek Watershed	References
Confined						
Cattle & Calves	2002	41,747		6,069	668	a
Cows & Heifers	2002	20,534		219	24	a
Beef Cows	2002	8,037		1,098	121	a
Other Cattle	2002	21,213		219	24	a
Hogs & Pigs	2002	14,162		276	30	a
Poultry	2002			6,806	750	a
Horses & Ponies	2002	26,896		2,737	300	a
Sheep & Lambs	2002	15,336		1,865	205	a
Milk Goats	2002	1,688		425	47	a
Milk Cows	2002			1,943	214	a
Angora Goats	2002	277		13	2	a
Miscellaneous						a
Bison	2002	202		-		
Llamas		656		96	11 (probably low)	
Mules, Donkeys, & Burros		507		98		
Rabbits.		2,937		176	19 (probably much higher)	
Turkeys				613	67 (probably much higher)	
Ducks, Geese, & Other Poultry		30, 149 (sold)		1,102 (sold)		
Pheasants		155,168		13,135	1,445	
Wildlife						
Black Bear	2003/2004	3,278 (7,417 sq. miles)	1,777 (1,558 sq. miles) north of Route 80 & west of Route 287	642 (562 sq. miles)	69 (60.6 sq. miles)	b

White-Tailed Deer	2001, 2005, & 2007	170,000 (59,652 harvested in 2005)		(5,715 harvested in 2006; an average of 6,858 /year over 1995 to 2006)	(629 harvested in 2006 (may be high); a forested area can support 20 deer/sq. mile; (higher counts / sq. mile are common (e.g., in Lake Mohawk, Sparta Twp. counts up to 122/sq. mile are common)	c, d
Coyote (primarily found in Sussex, Warren, Passaic, Morris, and Hunterdon counties	2006	3,000				e
Red Fox	2003	2,000 to 3,000 harvested each year				f
Wild (Others): Squirrel, Chipmunk, Rabbit, Woodchuck, Opossum, Skunk, Quail, Grouse, Geese, Etc.	Lack of data				Almost all are present Geese - Likely more than a significant problem for farms, lake communities, and at ponds and streams	

a. New Jersey State and County Data, Volume 1: Geographic Area Series Part 30, AC-02-A-30," *2002 Census Of Agriculture*"
http://www.nass.usda.gov/census/census02/volume1/nj/NJVolume104.pdf

b. NJDEP, NJDF&W, Bureau of Wildlife Management "*Black Bear in New Jersey, Status Report 2004,"*
http://www.njfisfandwildlife.com/pdf/2004/bear_report04.pdf

c. Division of Fish & Wildlife, 2007, "*White-tailed Deer in New Jersey,*"
http://www.state.nj.us/dep/fgw/deer.htm

d. New Jersey Monthly Magazine, August 9, 2006, "*In Defense of Deer Hunting,*"
http://www.wildnj.com/njm2.htm

e. August 8, 2006, "New Jersey's Great Northwest Skylands"
http://www.njskylands.com/odcoyotes.htm

f. New Jersey Division of Fish & Wildlife, 2003, "*Small Game Season Opens November 8,*"
http://www.state.nj.us/dep/fgw/news/2003/smgmopns03.htm

Soils

Three key aspects of soil characteristics are covered below:

1. Phosphorus content of sediments emanating from the Watershed during stormwater events
2. Septic suitability criteria
3. General soil types within the watershed

Sediment Phosphorus Analysis / Annual Loading - Sussex County soil data for 2002 was requested from the Rutgers Soil Testing Laboratory for farm, commercial, lawn, ornamental, and vegetable garden samples submitted for measurement of total pounds of phosphorus / acre. Collected data are summarized in *Table 12*.

Table 12: Analysis of Sussex County Soil Samples [16] (ppm = parts / million)

Parameter	**Farm/Commercial**	**Lawn/Ornamental/Vegetable Garden**	**Comments**
Number of Samples	41	57	
Maximum Value	710 ppm	1243 ppm	
Minimum Value	5 ppm	10 ppm	
Average Value	208 ppm	265 ppm (as a general rule, values approaching 500 ppm are typically cited in the technical community)	Values over 130 ppm are defined as "very high" by the Rutgers Soil Testing Laboratory
Potential Annual Phosphorus Loading Contribution (pounds/year)	For the entire Watershed, using the sediment areal coefficients from the BMP manual, potential annual phosphorus loadings of 720 pounds (corresponding to 265 ppm) and 1200 pounds (corresponding to 500 ppm) were estimated Note: Estimated phosphorus loadings are assumed to be part of the phosphorus loadings estimated using the phosphorus areal loading coefficients, as reported elsewhere in this Report		Further validates the need to reduce the sediment (soil) phosphorus content, as well as the annual generation loss rate of sediments to the various Watershed streams

Watershed Soil Types: *Table 13* summarizes the soils, including their pertinent properties, found within the Papakating Creek Watershed (seven HUC 14s). The noted information was obtained from the Natural Resources Conservation Service's *(NRCS) Soils Searcher* mapping program distributed by the Sussex County Soils Conservation District. The *Soils Searcher* is a digital soil data viewer, delivered on a CD-ROM, containing a certified *Soil Survey Geographic Database* (SSURGO).

A second source for soil information used is from NRCS's *Web Soil Survey*, which can be found at http://websoilsurvey.nrcs.usda.gov.

Specific parcel soil properties can be defined by the application of GIS tools using the NRCS soil maps overlayed with area parcel maps. Refer to *Figure 7* for a GIS soil map for the entire Papakating Creek Watershed and *Figure 8* for a GIS Soil Map developed for Sussex Borough (a portion of HUC 14 - 02020007020060).

Table 13: Types and Characteristics of Soils Found Within the Papakating Creek Watershed

HUC Number	HUC Identifier	Soil Types	Applicable Characteristics / Properties		
		Major Coverage	**Texture**	**Depth to Water Table**	**Septic Suitability**
02020007020010	Wykertown	Nassau-Manlius, Hazen-Hoosic, Fredon-Halsey, Hoosic-Otisville, Venango, Wurtsboro-Swartswood, etc. Generally, the first four soil types comprise approx. 80% of the soil series (these soil types are further described as very rocky or very stony)	Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Rated
02020007020020	Beemerville		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Rated
02020007020030	Armstrong and Pelletown		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Very Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Limited
020200070200-40	Beemerville and Plumbsock		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Very Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Rated
02020007020050	McCoys Corner, Woodbourne, & Libertyville		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Rated
02020007020060	Clove Acres Lake/Clove Brook		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments)	Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Limited
02020007020070	Roys (Roys Road), McCoys Corner, & Lewisburg		Loam, Silt, and Silt Loam (with thin and flat limestone, sandstone, or schist fragments	Very Deep (majority of area) to very shallow	Very Limited (majority of area) to Not Limited

Figure 7:
Papakating Creek Watershed Soils Breakdown

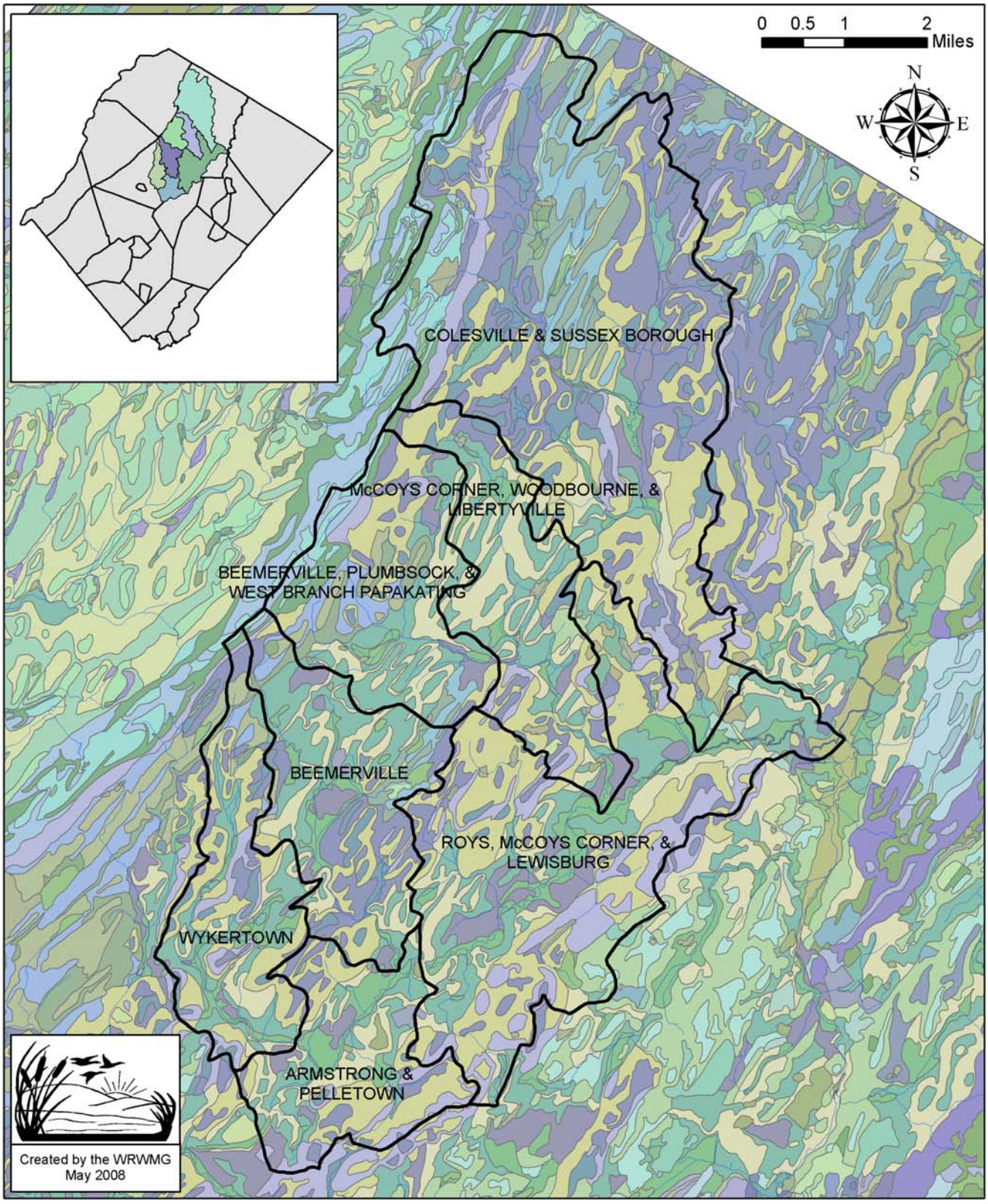
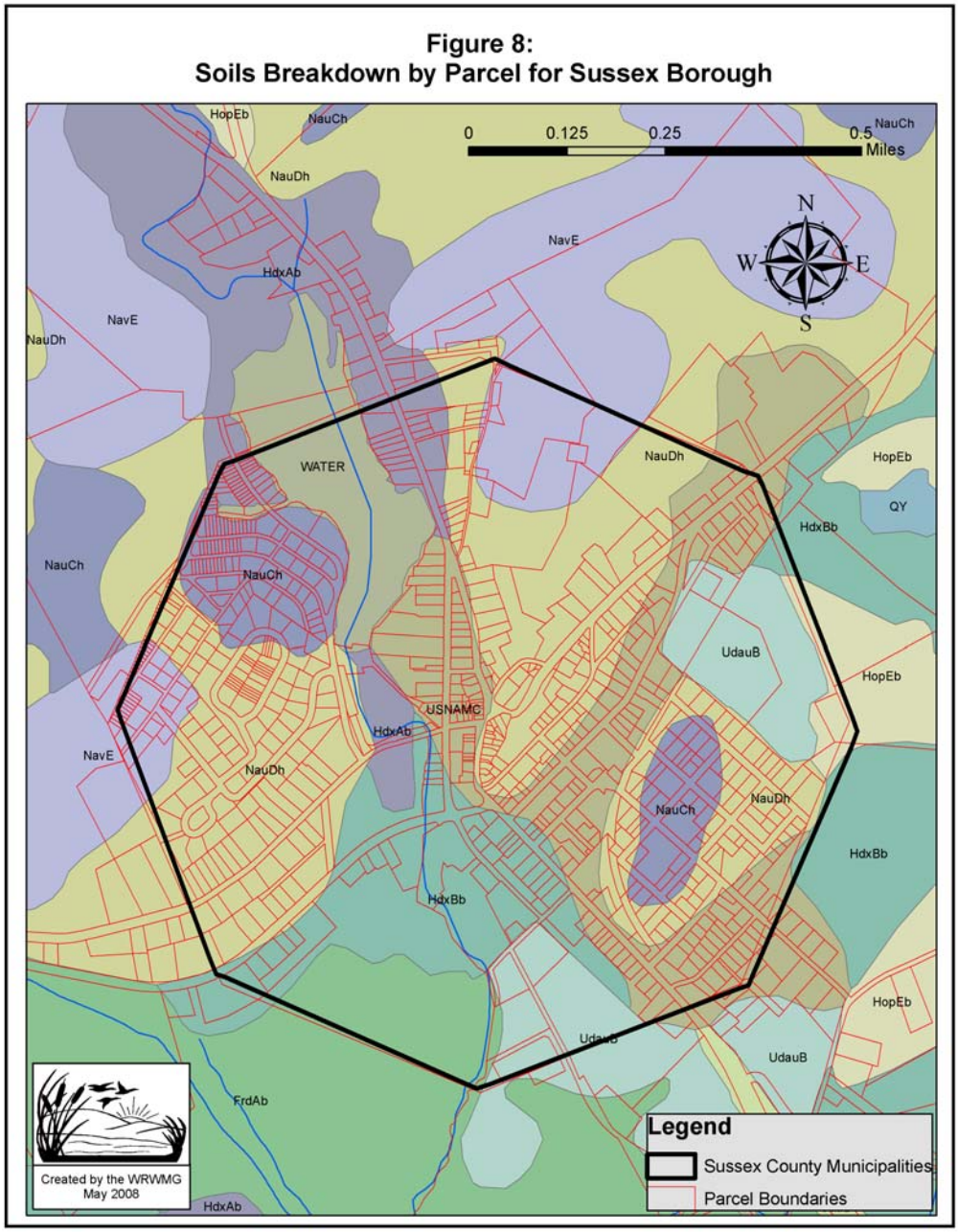


Figure 8:
Soils Breakdown by Parcel for Sussex Borough



Soil Abbreviations:

FrdAb: Fredon-Halsey complex, 0-3% slopes
HdxAb: Hazen-Hoosic complex, 0-3% slopes
HopEb: Hoosic-Otisville complex, 25-60% slopes
NauCh: Nassau-Manlius complex, 8-15 % slopes
NauDh: Nassau-Malius complex, 15-35 % slopes
NavE: Nassau-Rock outcrop complex, 35-60 % slopes
QY: Quarry
UdauB: Udorthents-Urban land complex, 0-8%
USNAMC: Urban land-Nassau-Manlius complex, 8-15 % slopes

Additional Notes: Septic Suitability Criteria - Most of he Watershed area is served by onsite septic systems, with the exception of Sussex Borough that sends their wastewater to the Sussex County Municipal Utilities Authority via a pump station located adjacent to Brookside Park. Except for Lake Neepaulin, Sussex Borough, and several small subdivisions, existing residential lots typically range from one/half to one acre, 1 to 3 acres, and up to 3 to 10 acres. Where soil suitability / water table elevation may rule out conventional septic designs, alternative systems may need to be considered (raised mounds, peat systems, drip irrigation, spray irrigation, advanced designs, etc). Soil suitability must meet the New Jersey Department of Environmental Protection Requirements defined in N.J.A.C. 7:9A-4 and 5.

Topography [8]

The topography of the Watershed ranges from gently rolling terrain in the east to strongly sloping terrain in the west, up to elevations approaching 1,200 to 1,500 feet above sea level. At High Point, the elevation peaks at 1,803 feet, the highest point in New Jersey. Both High Point State Park and Stokes State Forest are located within the Kittatiny Mountain Ridge. Steep slopes are encountered scattered throughout the Watershed with areas of significant steep slopes around the Clove Brook and the western portion of the Watershed. Minor slopes are generally classified 0% - 10%, moderate / precautionary slopes of 10% to < 20%, and steep slopes of ≥ 20%.

Overlooking the Papakating Creek Watershed from Sunrise Mountain, which is part of the Kittatiny Mountain Ridge

Threatened and Endangered Species [8]

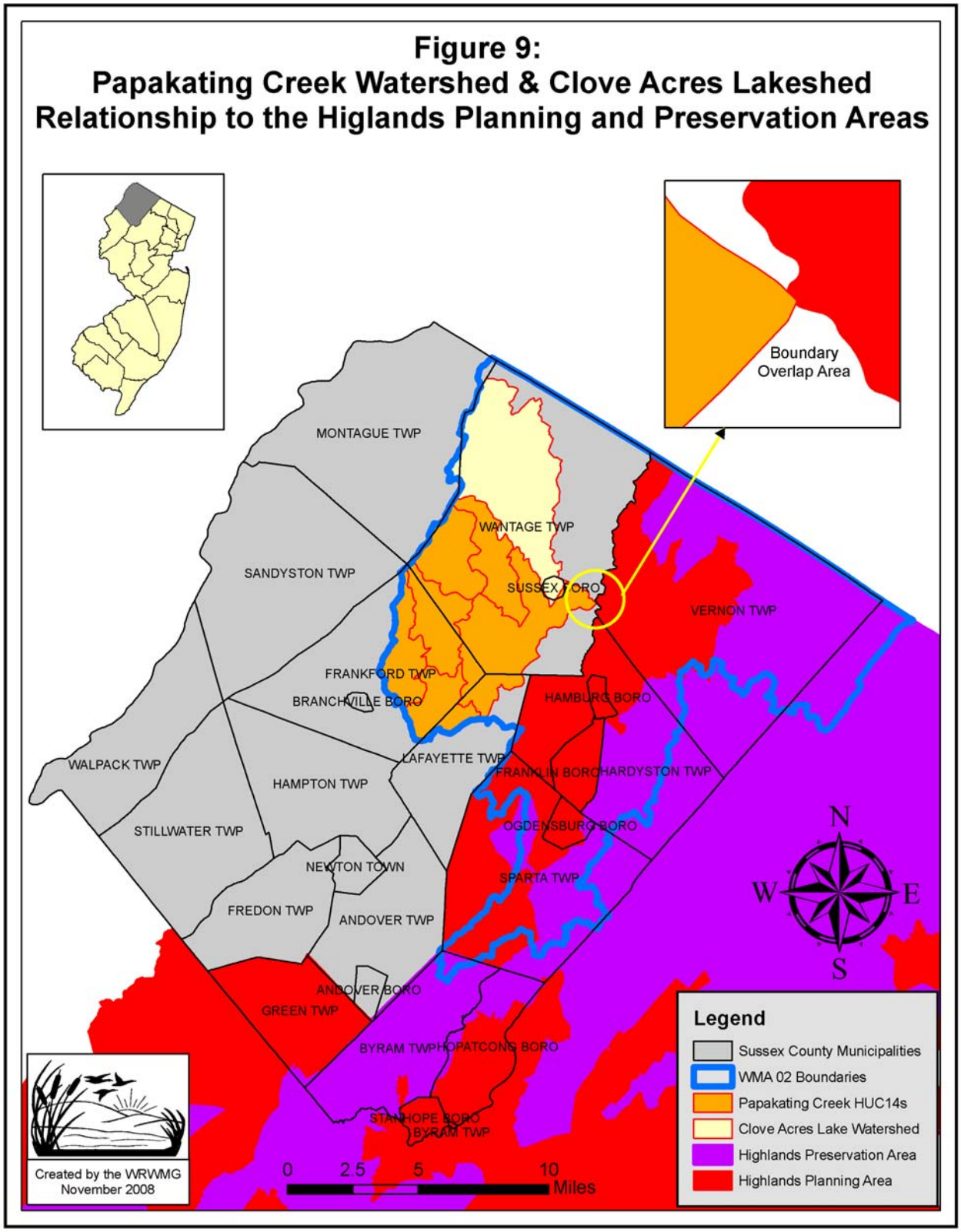
The Watershed's diverse topography and land use patterns provide excellent habitat for many animal and plant species. There are two state-maintained databases that highlight important habitat for threatened and endangered species: 1) the Natural Heritage Database and 2) the Landscape Project Database. Both can be accessed from either the NJDEP's Office of Land Management or Division of Fish and Wildlife websites. Classifications cover State Endangered Species (SE), State Threatened Species (ST), Breeding Population Only (Br), and Non-breeding Population Only (NB). Within the Watershed (an area contained within the Kittatiny Valley region), the databases list the following species: Wood turtle (SE), Bog turtle (SE), Bobcat (SE), Great blue heron (ST), Red-shouldered hawk (SE, Br), Barred owl (ST), Northern harrier (SE, Br), Timber rattlesnake (SE), Cooper's hawk (ST), Northern goshawk (SE, Br), Bobolink (ST), Savannah sparrow (ST), Vesper sparrow (ST, NB), Red-headed woodpecker (ST), and Grasshopper sparrow (ST, Br).

Relationship of the Papakating Creek Watershed to the Highlands Area

On the basis of both NJDEP and Highlands GIS maps, it was determined that the Papakating Creek Watershed is outside of the Highlands Preservation Area and minimally overlays a small portion of the Highlands Planning Area (borders the Wallkill River Watershed HUC 14 # 02020007030010). Using GIS tools, the overlay is approximately 0.029 acres (an area equivalent to a land parcel measuring 34 feet by 34 feet). As shown in *Figure* 9, the area was determined by the intersection of the Planning Area boundary with the Papakating Creek HUC 14 # 02020007020070. For all

practical purposes, the overlap area determined is considered below a de minimus value to be a factor regarding the Papakating Creek Restoration Plan.

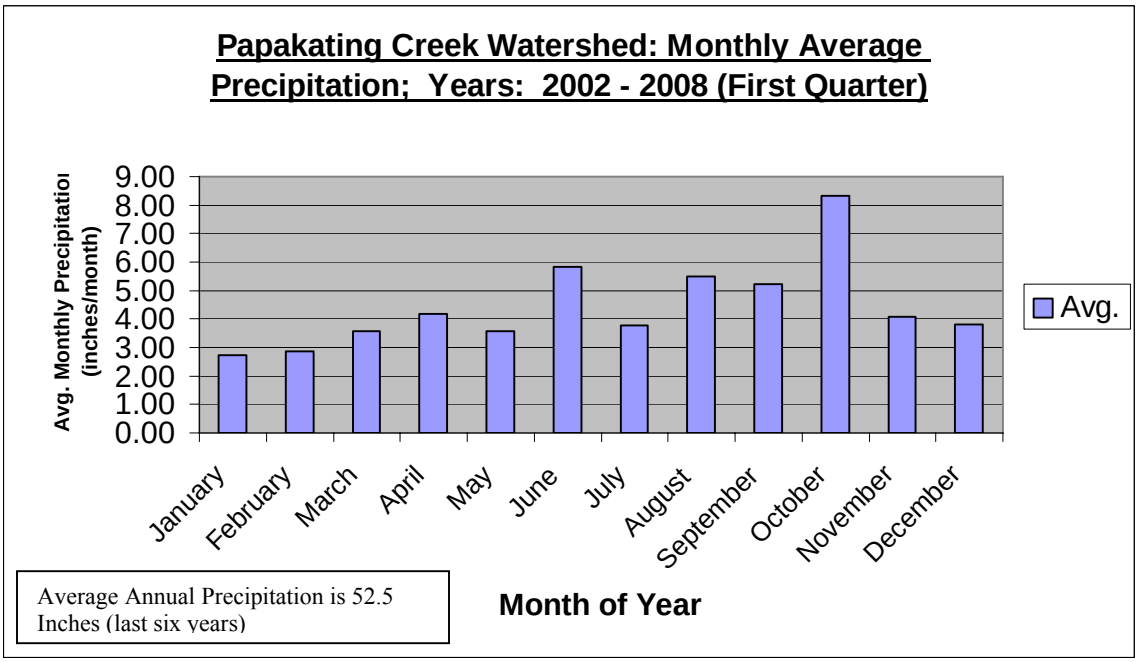
Reference Sources: The approved Highlands Master Plan (2008) and the Highlands 2008 Technical Report titled " Water Resources Volume II - Water Use and Availability, Section on the Hydrologic Units of the Highlands" (page 5)



Papakating Creek Watershed Precipitation: Years 2002 - 2008 (first quarter)

The WRWMG obtained daily precipitation recordings taken at the Sussex County Municipal Utilities Authority's Solid Waste Facility located in Lafayette Township. Although this location is just outside the boundaries of the Papakating Creek Watershed, the data are considered representative of actual daily precipitation events occurring within the Watershed. The obtained data were transformed into an Excel format as presented in *Chart 3.*

Chart 3: Watershed Precipitation: Years 2002 - 2008 (first quarter)
(Data Source: SCMUA / WRWMG Records)



Restoration Plan Drivers

NJDEP-Related TMDLs and 2002, 2004, 2006 Integrated Lists [1]

In accordance with Section 305(b) of the Federal Clean Water Act, the NJDEP established in April 2003 five TMDLs for fecal coliform impairments pertaining to five stream segments on the Papakating Creek within Watershed Management Area (WMA) 02. The intent of the TMDL is to identify all the contributors to surface water quality impacts and to set goals for load reductions for fecal coliform as necessary to meet the Surface Waters Quality Standards (SWQS). Calculated fecal coliform reductions ranging from 92% to 99% were established as TMDL goals (specific goals for the five segments were listed as 92%, 96%, 99%, 99% and 99%). Management control strategies were to be developed based on accurate source assessments, matching reduction strategies with sources, selecting responsible community entities and aligning financial resources to effect implementation.

NJDEP Surface Waters Quality Standards [5]

- Phosphorus, Total (mg/l):

  Lakes: Phosphorus as total phosphorus (TP) shall not exceed 0.05 mg/l in an lake, pond, or a tributary at the point where it enters such bodies of water, except where site-specific criteria are developed pursuant N.J.A.C. 7:9B-1.5(g)3.

  Streams: Except as necessary to satisfy the more stringent criteria noted above where site-specific criteria are developed pursuant to N.J.A.C. 7:9B1.5(g)3, phosphorus as total phosphorus (TP) shall not exceed 0.1 mg/l in any stream, unless it can be demonstrated that TP is not a limiting nutrient and will not otherwise render the waters unsuitable for the designed uses.

In order to protect public health in New Jersey, fecal coliform / *E.coli* bacteria criteria were established in the Surface Water Quality Standards N.J.A.C. 7:9B-1.14(d) for FW2 waters which states that:

- Fecal coliform levels should not exceed a geometric mean of 200 fecal coliforms/100 ml and fecal coliform levels should never be greater than 400 fecal coliforms/100 ml for 10% of the total samples taken during any 30-day period (Basis: TMDL Document).

- *E.coli* levels should not exceed a geometric mean of 126 colonies/100 ml and *E.coli* levels should never exceed 235 colonies in any single sample.

  Note: The developed Implementation Plan must ensure attainment of both sets of criteria values. Typically, achieving the sample daily maximum is more restrictive than one based on a geometric mean.[17]

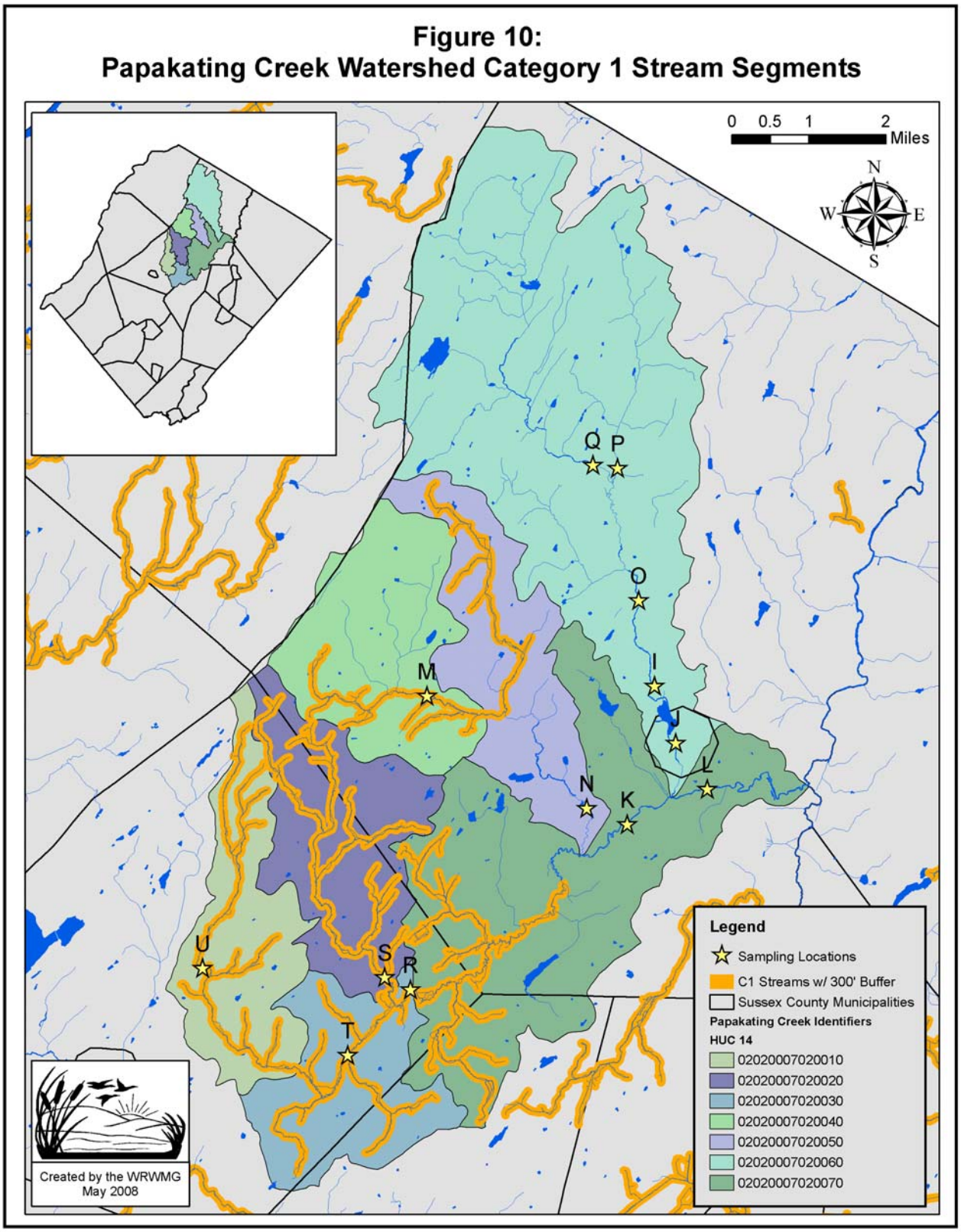
2007 Proposed / 2008 Adopted C1 List

On June 16, 2008 the NJDEP adopted amendments to the Surface Water Quality Standards (SWQS) at N.J.A.C. 7:9B that changed the designation of a significant number of streams within the Papakating Creek Watershed from Category C2 to Category C1 Classification. Category C1 waterways are those waters designated for protection from measurable changes in water quality based on exceptional ecological significance, exceptional water supply significance, exceptional fisheries resource(s), and present surface water quality. A Category C1 Classification mandates a 300-foot buffer adjacent to waterways to provide protection of water quality in accordance with the Stormwater Rules (N.J.A.C. 7:8) and the Flood Hazard Area Control Rules (FHACA at N.J.A.C. 7:13). In regard to the Papakating Creek Watershed, the following Papakating Creek segments have been changed from Category C2 to Category C1 Classification:

- Headwaters and mainstem within Frankford Township including all tributaries emanating from Wantage Township
- All tributaries within Lafayette Township
- Papakating Creek west of Roy's
- Mainstem north of Roy's to the Lehigh and New England Railroad crossing in Wantage Township (downstream from confluence with Lake Windsor Tributary)
- Some headwater segments of the Papakating Creek West Branch mainstem
- Libertyville Tributary

See *Figure 10* for a map of the Category 1 stream segments found within the Papakating Creek Watershed. For specific details, refer to the official version of the C1 amendments on the NJDEP website and / or the *New Jersey Register*, dated June 16, 2008.

Figure 10:
Papakating Creek Watershed Category 1 Stream Segments



Chemical Databases: NJDEP / USGS / WRWMG / HydroQual, Inc / Princeton Hydro, LLC [17, 18]

WRWMG Quality Assurance Project Plan: All project and field sampling work tasks were in accordance with the QA/QC document prepared by HydroQual, Inc; dated March 4, 2002 for the WMA 02 Phase I Contract Task B Program and as amended in May 2003, December 2004, September 2005, and November 2005. The November 2005 Amendment Work Plan revisions reflect supplementary monitoring for approved 2005 SFY 319(h) TMDLs / Restoration Plan Projects for the Papakating Creek and Clove Acres Lake / Clove Brook Watersheds.

The scope of supplementary monitoring covered the following sampling Tasks:

- Conduct chemical sampling at five sites on the Clove Brook (Sites "I"&"J" quarterly), and new Sites "O," "P," and "Q" monthly) and two sites on the Papakating Creek (Sites "K" & "L" quarterly)

- Conduct monthly chemical sampling at four new Sites on the Papakating Creek (Sites "R," "S," "T," and "U")

- Conduct fecal coliform / *E.coli* sampling at selected sites on the Papakating Creek mainstem and targeted property sites draining to the Papakating Creek and Clove Brook

- Conduct selected but limited spot chemical sampling in Clove Acres Lake during and following lake characterization studies by Princeton Hydro, LLC. (provides verification of analytical consistency when different laboratories are utilized by Princeton Hydro, LLC and WRWMG, and serves to provide follow-up monitoring by WRWMG during Restoration Plan implementation)

- Conduct monthly chemical sampling at two sites on the West Branch Papakating Creek (Sites "M" and "N")

- Conduct fecal coliform fecal coliform / *E.coli* sampling at selected sites on the West Branch of the Papakating Creek

See *Figure 11* and *Figure 12* for maps displaying the location of the WRWMG's chemical and fecal coliform / E.coli sampling sites.

Figure 11:
WRWMG Papakating Creek Watershed
Chemical Sampling Locations

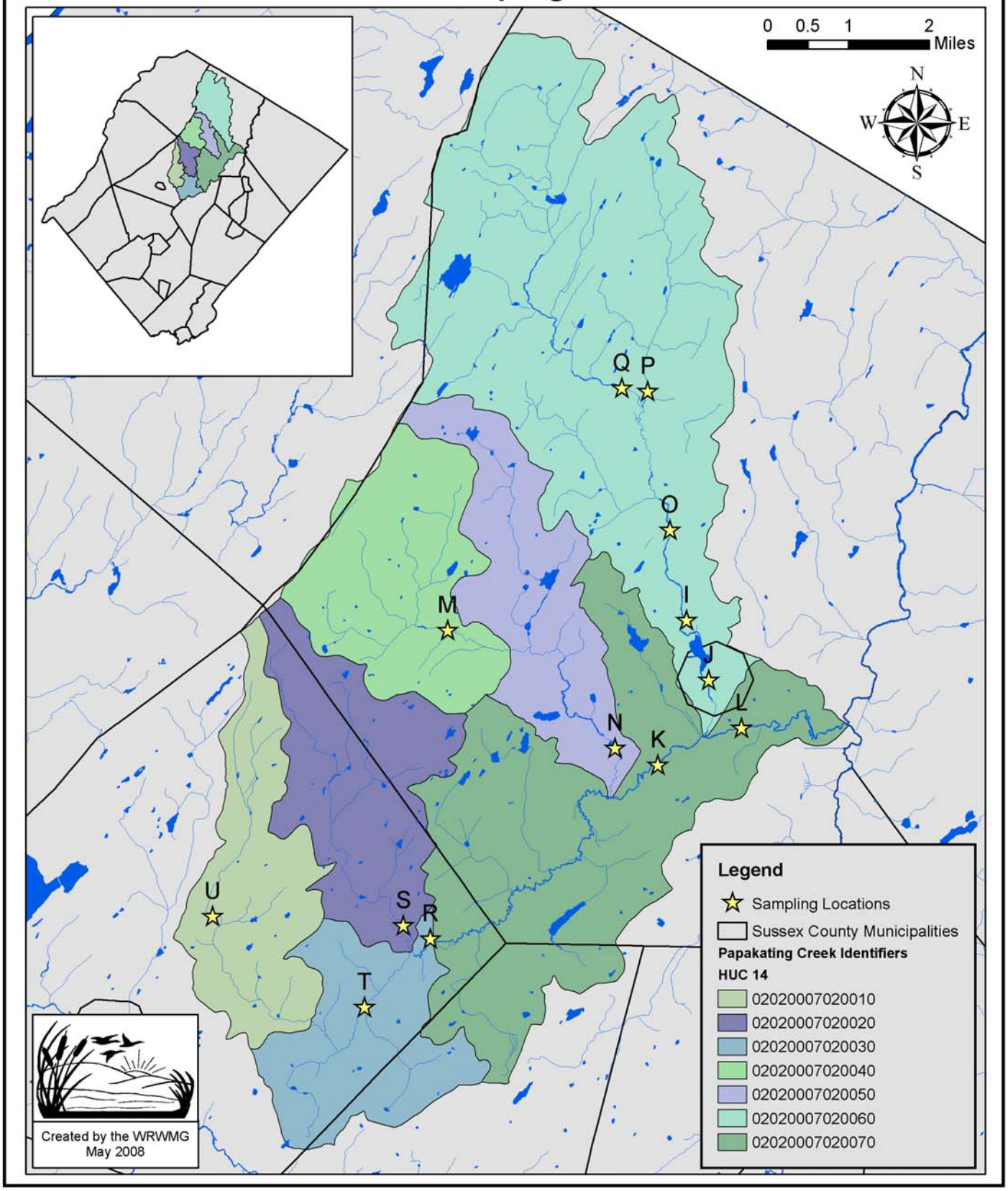
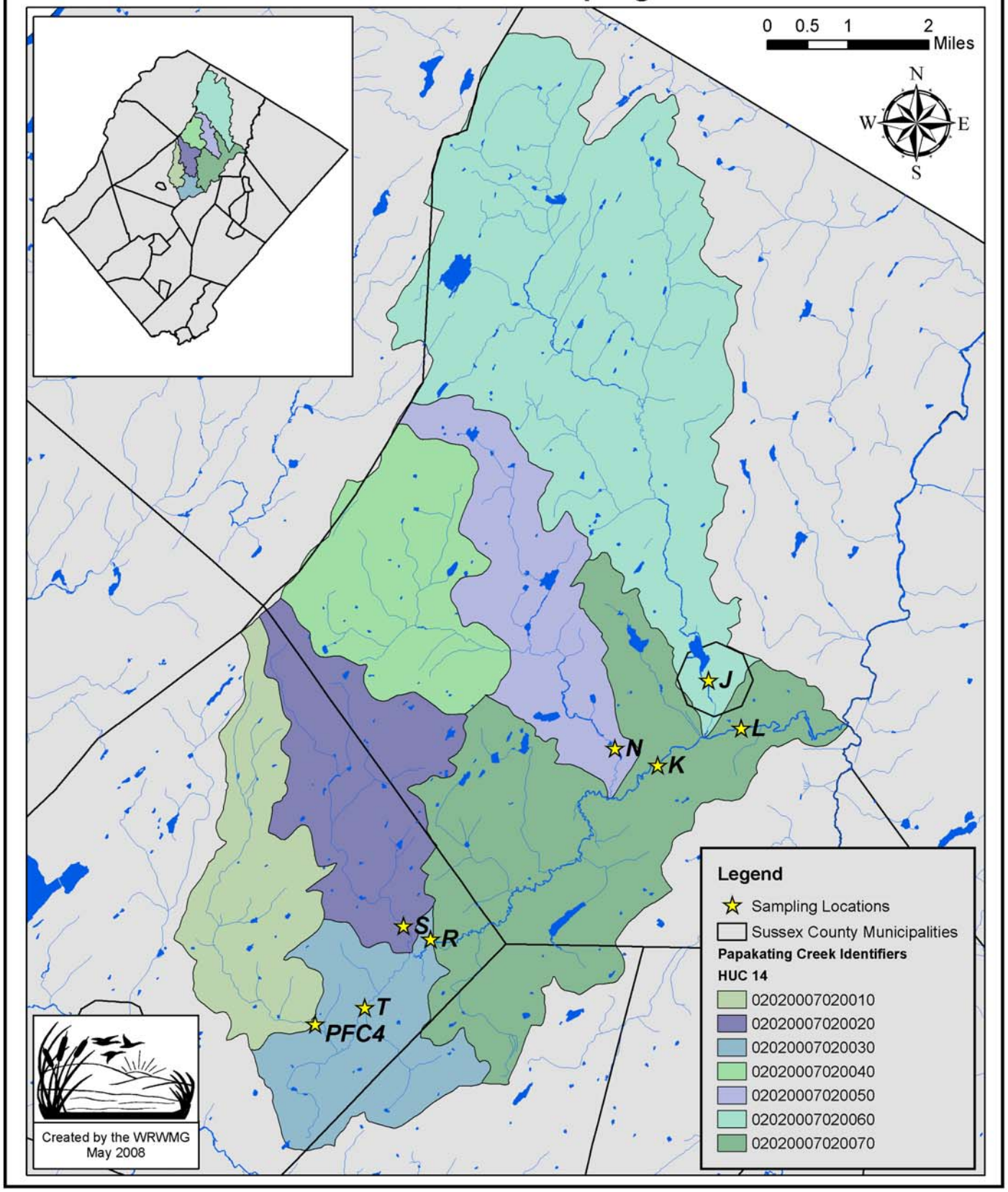


Figure 12:
WRWMG Papakating Creek Watershed
Fecal Coliform / E.coli Sampling Locations



Augmented Sampling: Selection of Water Quality Parameters

Nine specific parameters plus related stream physicals considered to be important indicators of water quality within the Papakating Creek subwatersheds were selected for assessment. The parameters / physicals selected were as follows:

Ammonia: an essential compound in biological processes

Un-ionized Ammonia: excessive concentrations lead to fish toxicity; concentrations were calculated from total ammonia, water pH, and water temperature

Total Kendal Nitrogen (TKN): a measurement of organic nitrogen plus any ammonia-nitrogen in the stream sample; TKN is important because organic nitrogen represents oxygen demand in the stream

Total Phosphorus: a measure of all phosphorus forms found in a water sample; concentrations are important to stream health; it is a primary nutrient for algae and aquatic plants and can stimulate excessive growth

Ortho-Phosphates: the dissolved inorganic phosphorus form found in aquatic environments; form used by photosynthesizing organisms; also defined as the "algal available" or "bioavailability phosphorus"

Nitrate + Nitrite: represents the oxidized forms of nitrogen in the stream

Fecal Coliform / *E.coli:* bacteria that are associated with human or animal wastes; serves as a measure of the sanitary quality of the stream water

Conductance: a measure of the total amount of ions in an aqueous sample; lakes and streams with a high quantity of dissolved materials that act as charged particles will have a high conductivity

Total Dissolved Solids (TDS): high values can impact the taste of water, as well as stream ecosystems

Total Suspended Solids (TSS): the health of stream ecosystems are effected by concentrations of TSS; level impacted by storm runoff and streambank erosion

pH: the water standard for pH is > 6.5 and < 8.5; values less than 7 are considered acidic and values greater than 7 are considered basic; this parameter directly influences the types of plants and animals that can live in a lake or stream

Dissolved Oxygen: a measurement of oxygen dissolved in water; a measure of the overall quality of the stream water; the concentration depends on the physical, chemical, and biological characteristics of the stream water; desired instantaneous levels are > 4 mg/l in no trout waters, > 5 mg/l in waters classified as trout maintenance, and > 7 mg/l in waters classified as trout production

Oxygen Saturation: a measure of how much oxygen is present as a percentage of the maximum it could contain

Water Temperature: influences the chemical and biological processes in a stream; warmer waters hold less oxygen than cooler waters

Ambient Temperature: a measure of the local air temperature

Stream Flow: a measure of the amount of water passing per unit of time (generally expressed as cubic feet/second (cuffs)

Precipitation: a measure of rainfall in inches/day

All stream samples were collected by the WRWMG and analyzed by Garden State Laboratories under an approved NJDEP Quality Assurance Project Plan (QAPP). Flow measurements were taken by HydroQual, Inc. All reported analytical data were reviewed by Garden State Laboratories as well as the WRWMG. Only total phosphorus and fecal coliform / *E.coli* parameters were found to exceed NJDEP's Surface Water Quality Standards (SWQS). All collected data were incorporated into a project database that is available from the WRWMG upon request. Copies were issued to NJDEP as part of the developed project deliverables, as well as for the development of the 2008 Water Quality Limited Segment List.

Total Phosphorus Database Sources

Database Source: NJDEP

Refer to Appendix F, page 66, of NJDEP's *"TMDL to Address Phosphorus in the Clove Acres Lake and Papakating Creek Northwest Region,"* dated April 19, 2004.

Stream water data for total phosphorus are provided for Papakating Creek at Sussex (Station 01367910), Papakating Creek at Sussex (Station 01367909), and WRWMG's Sampling Site "L' at Sussex, as well as from flow data collected from February 1994 to January 2004.

Database Source: WRWMG / HydroQual, Inc.

WRWMG sampling and HydroQual, Inc flow data for 13 sites within the Papakating Creek Watershed for the January 2004 through June 2007 time period are summarized in *References 6 and 23.*

Database Source: USGS

USGS real-time flow station data (01367800) for Site "R" (Papakating Creek at Pelletown) are listed in the WRWMG database, dated 2004 through June 2007. Additional USGS parameter data are available from their website, http://waterdata.usgs.gov/nj/nwis/uv?cb_00065=on&cb_00060=on7cb-00021=on&format.

USGS Gage Station located on the Papakating Creek
Pelletown Road, Frankford Township, NJ

Database Source: Princeton Hydro, LLC

This subject is covered in the Clove Acres Lake Characterization and Restoration Plan [19] developed by Princeton Hydro, LLC dated July 2008, and the Clove Brook Restoration Plan prepared by the WRWMG, dated July 2008. The assessment of Clove Acres Lake performed by Princeton Hydro, LLC in accordance with the NJDEP Lake Characterization Protocol encompassed the following: lake characterization, a variety of in-lake studies (e.g., in-situ water quality data, a bathymetric survey, plankton sampling, aquatic saprophyte studies, and a fishery survey), relevant watershed data, the quantification of the lake's annual hydrologic and pollutant budgets, and development of a Restoration Plan for the Lake and the Clove Brook sub-basin. Key recommendations developed by Chris Mikolajczyk and Fred Lubnow of Princeton Hydro, LLC that are relevant to the development of the Papakating Creek Restoration Plan are:

- "*Clove Acres Lake is a eutropic to hypereutrophic waterbody that has the potential, and periodically does, experience nuisance water quality conditions (e.g., algal mats, excessive densities of rooted aquatic plants, etc.), particularly during the mid-summer season.*"

- The Clove Brook is a significant contributor of total phosphorus loading to the Papakating Creek

- "*Long-term management of the lake should concentrate on managing the lake as a eutropic waterbody, reduce phosphorus and solid loadings entering the lake, and also consider measures to enhance the lake's recreational fishery potential and control / eradication of the invasive species Eurasian watermilfoil*."

The report by Princeton Hydro, LLC addresses in great detail all the data, assessments, and studies noted above as well as specific recommendations applicable for the restoration and protection of Clove Acres Lake / Lakeshed.

Fecal Coliform / *E.coli* Databases - NJDEP / Wallkill River Watershed Management Group / USGS

Fecal Coliform Database Source: NJDEP

Refer to Pages 22, 23, 33, 34, and Appendix C of NJDEP's *"Fecal Coliform TMDL for Northwest Water Region,"* dated April 21, 2003.

Fecal Coliform / *E.coli* Database Source: WRWMG / USGS

WRWMG sampling and USGS flow data (Site "R") for eight sites within the Papakating Creek Watershed for the August to September 2006 time period.

Papakating Creek Subwatersheds - Augmented Sampling Time Grid

Initial efforts by the WRWMG consisted of analyzing available NJDEP and prior WRWMG sampling data for the purpose of identifying data gaps hindering the development of sound Restoration / Protection Plans. In summary, *Table 14* lists the sources of available data, data collected to address defined data gaps, and the time frames in which the data were collected. Best efforts were made to develop a five-year profile of all data in support of making sound technical decisions. Data needs: address individual farms, specific residential properties, and other related land-use properties; to be addressed at a later time period as part of a future implementation grant proposal.

Table 14: Papakating Creek Sampling Database / Sampling Time Grid (2003 to August 2007)

Total Phosphorus (TP)		**Time Periods**		
A.	NJDEP Data	Prior to 2003 plus referenced TP TMDL		
B.	WMA 02 (WRWMG) (2 Sites - "K" and "L")	2003	2004	
C. Gap	Monthly sampling at seven sites - "K," "L," "N," "R," "S," "T," and "U" (Priority Stream Segment Grant - WRWMG)	2005		
	Quarterly sampling at two sites - "K" and "L"	May 2006 to May 2007		
	Monthly monitoring at six sites - "M," "N," "R," "S," "T," and "U" (Papakating Creek Restoration Grant - WRWMG)	May 2006 to August 2007		

Fecal Coliform (FC)		Time Periods		
A.	NJDEP Data	Prior to 2003 plus referenced FC TMDL		
B. Gap	WMA 02 (WRWMG) (one set - 13 sites; one set - 5 sites) Coliphage - 2 sites (Priority Stream Segment) Sampling at eight sites – "PFC # 4, "T," "S," "R," "K," "J," and "L" (5 events over 30 days)	2003 August 10, 2006 to September 7, 2006	2005	

Notes: For reference, the above data sampling programs were designed in order to address the following questions /issues:

- What are the pollutant loads of major tributaries to the Papakating Creek as well as the mainstem (need to prioritize subwatershed areas for immediate attention)?
- Develop an understanding of pollutant loadings as a function of seasonality (weather changes, farming and agricultural field practices and operations, storm events, abnormal conditions, etc.).
- What are the data uncertainty issues?
- Are there sufficient data to support decision-making with respect to selection of restoration / protection BMPs?
- With respect to the implications of the sampling results, how best to gain acceptance of local stakeholders to support and actively participate in the proposed restoration / protection plans?

For future consideration: TP and fecal coliform / *E.coli* sampling results / time trends are subject to seasonality. Additional sampling data should be collected over various time periods within a given year as well as over a 2 - 3 year period.

Assessment of Chemical Sampling / Findings: Papakating Creek [20, 21, 22, 23]

Overall Findings

The analytical and field measurement results for the sites sampled on the Papakating Creek, within the TMDL-defined HUC14 areas, showed the Papakating Creek to be in compliance except for total phosphorus and fecal coliform / *E.coli.* Specifically, results show 100% compliance with the Surface Water Quality Standards (SWQS) for each of the following parameters measured: total ammonia, nitrate, nitrite, un-ionized ammonia, Total Kjeldahl Nitrogen (TKN), orthophosphorous, conductance, dissolved solids, water temperature (for

nontrout waters), dissolved oxygen (for trout maintenance waters), and pH. In accordance with NJDEP guidelines, a water stream is not impaired with respect to a specific parameter if ≥ 90% of the samples meet SWQS requirements.

Exceedances Found with Respect to Total Phosphorus (refer to *Charts 4* and *5*)

Total Phosphorous (TP):

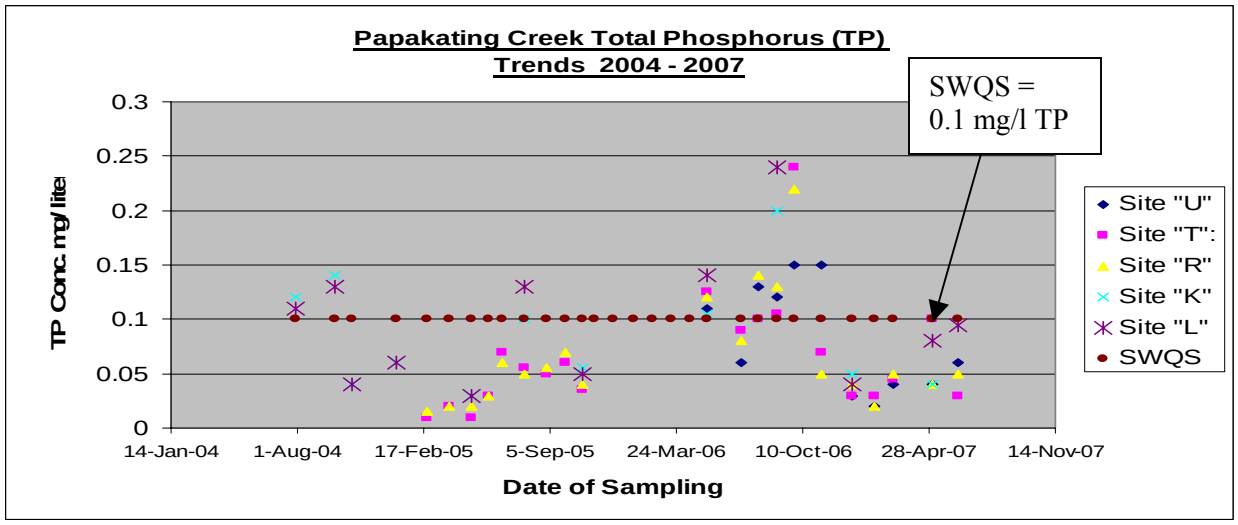
> All sites sampled for TP had data sets exhibiting greater than 10% exceedances relative to the SWQS of 0.1 mg/l TP (implies impairment). Range of TP compliances were 61% to 86% with Site "M" at 27% and Site "N" at 58%.

Refer to *Charts 4* and *5* and *Table 15* for findings relative to sampling results and the impact of precipitation and local annual farming practices on TP loadings.

Table 15: Data Trend Observations

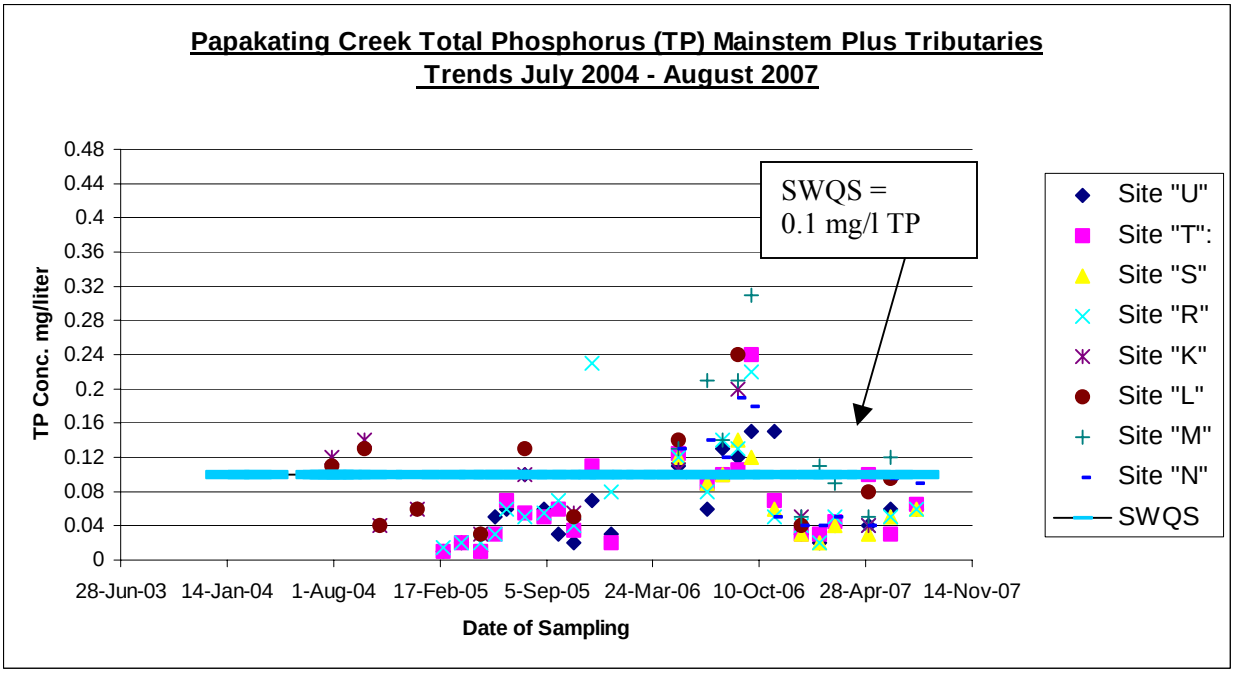
Chemical Parameter	**Time Periods Wherein Monthly Results Trended Higher**		**Likely Independent Variables**
Total Phosphorus	July - September 2004 July and November 2005 August - November 2006 June - August 2007		1. Precipitation (results in increased streambank erosion and sediment land erosion transport) Observed abnormal precipitation periods (strong correlation with months wherein higher TP trends were observed): August - September 2004 (12.6 inches of rain over two months) October 2005 (15.9 inches of rain in one month) August - October 2006 (17 inches of rain over three months) June - August 2007 (18 inches of rain over three months) Base Reference: Typical monthly rainfall averages 3.8 inches/month and 45 to 48 inches/year for the Papakating Creek Watershed. Within the last six years, annual precipitation averaged 52.5 inches/year. 2. Farming Practices - seasonality is a factor Pollutant loadings influenced by: typical manure spreading and management practices, cattle in streams, animal waste and field stormwater drainage, tillage practices, horse pasture practices, and lack of stream buffers 3. NJPDES Dischargers - not an issue in this Watershed

Chart 4: Augmented Sampling Program for Total Phosphorus (Papakating Creek Mainstem)



Note: The sampling data set (74 values) used for *Chart 4* shows 72% compliance with the SWQS.

Chart 5: Augmented Sampling Program for Total Phosphorus (Papakating Creek Mainstem Plus Tributaries)



TP stream concentration spikes (above 0.1 mg/l but below 0.3 mg/l) were observed in December 2005 at almost all sampling sites; suspect elevated concentrations are strongly influenced by adjacent farming / agricultural field operations concurrent with frequent significant storm events. The sampling data set (120 values) used for *Chart 5* also shows 72% compliance with the SWQS for streams.

As indicated in NJDEP's TP TMDL, Site "L" (Papakating Creek at Sussex) serves as the integrator site for the Papakating Creek and Clove Brook waterbodies. Preliminary studies addressing annualized TP and stream flow rates around the confluence of the Papakating Creek and the Clove Brook and Site "L" (just downstream) show that the TP load allocation at Site "L" is estimated at 15% - 20% from the Clove Brook and 85% - 80% from the Papakating Creek.

The data sets for each of the sampling sites were further analyzed using box and whisker diagrams [24, 25. 26] (term used interchangeably with box plots) to visually show the dispersion of data within and among the various data sets. For background, a box plot provides a graphical summary of a set of data based on the quartiles of that data set: quartiles are used to split the data set into four groups - Q1 (25th percentile), Q2 (50th percentile; same as the medium value), and Q3 (75th percentile). Each whisker (vertical line) represents 25% of the data measurements and the extremities of these whiskers are the minimum and maximum values of the data. As an example, the data developed for Site "L" were as shown in *Table 16*:

Table 16: Site "L" Box Plot Statistics
(terminal point and integrator site for the Papakating Creek)

Parameter	Value
Data set	**13 values**
Water quality parameter	Total Phosphorus (TP)
Maximum value	0.24 mg/l
75% Percentile	0.13 mg/l (Q3)
Mean	0.095 mg/l
50% Percentile (median)	0.09 mg/l (Q2)
25% Percentile	0.05 mg/l (Q1)
Minimum value	0.03 mg/l
Interquartile range	Q3 - Q1 = 0.13 – 0.05 = 0.08 mg/l
NJDEP Surface Water Quality Standard (SWQS)	Conc. not to exceed 0.1 mg/l
Remarks Sampling Site is Impaired - more than 10% of the values exceed 0.1 mg/l TP (SWQS); since Q2 and the mean are essentially the same value, the data set appears to be normally distributed; relative to the calculated interquartile range, the minimum value of 0.03 mg/l is a valid data value and the maximum value of 0.24 mg/l is considered as a mild outlier (approximately three times the interquartile range) Reference Article: Box Plots – Wikipedia	

Chart 6, below, shows developed box plots (called parallel box plots) for the sampling sites on the Papakating Creek and the Clove Brook. Key points and observations are noted below:

- Data sets were comprised of 11 to 21 individual values per data set. A data set of 11 values is considered relatively small but adequate to make some definitive statements about the data distribution including symmetry.

- All sampling sites show total phosphorus impairment except site “Q”

- All sites except sites “T,” “N,” “P,” and “L” show the data sets are skewed to the right (greater height difference of the 50th percentile to the 75th percentile relative to the height difference of the 25th percentile to the 50th percentile). The top whisker is much longer than the bottom whisker and the 50th percentile line is trending to the bottom of the box. Site “L” is slightly skewed to the left.

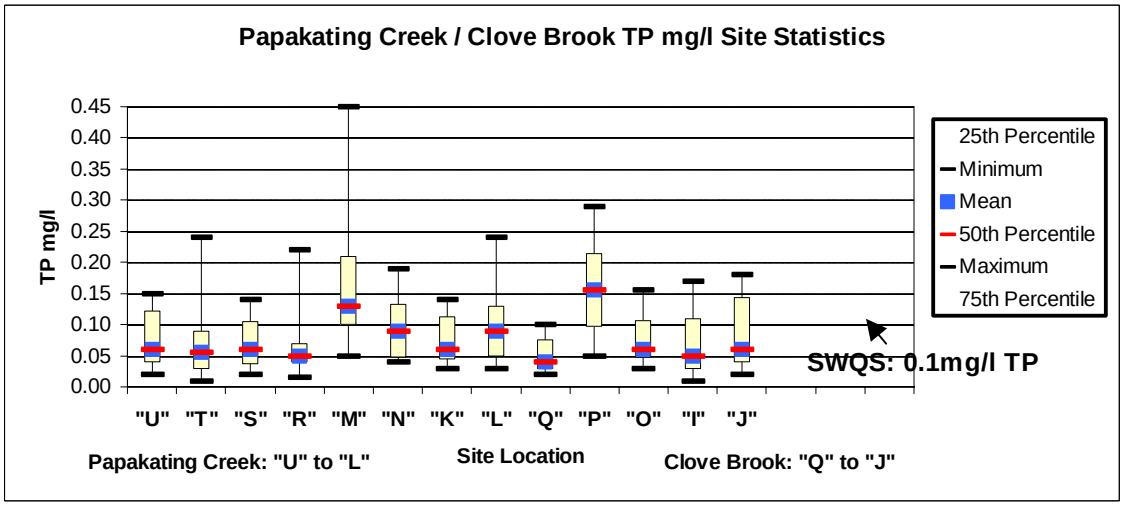
- The data set for the Site “M” box plot had several values falling between the 75th percentile and the maximum value. Labeling the maximum value as a possible outlier is suspect and indicates further data collection and statistical studies are indicated.

- Sites “Q,” “O,” “P,” “I,” and “J” box plots will be discussed in the Clove Brook Restoration and Protection Plan Report.

- The simplicity of the box plot renders it ideal as a means of comparing many sampling site data sets simultaneously one time. Obvious differences are immediately apparent by visually comparing the constructed parallel box plots.

- The developed box plots will serve as a baseline for monitoring stream quality improvements during the implementation of the developed Restoration and Protection Plan.

Chart 6: Papakating Creek / Clove Brook Augmented Sampling Site Statistics for Total Phosphorus (Parallel Box Plots)



On the basis of mass balance calculations (concentrations times stream flow rates times a conversion factor), *Table 17* shows an attempt to rank each HUC 14 with respect to its pollutant contribution to the total loading emanating from Site "L" (considered the last accessible terminal point of the Papakating Creek prior to the confluence with the Wallkill River). Refer to the last row of *Table 17*.

Table 17: HUC 14 Total Phosphorus (TP) Contribution to Loading at Site "L" (Terminal point of seven HUC 14s)

HUC 14		Annual Percent TP Contribution (HUC Area - Areal Coefficients Method)		Annual Percent TP Contribution (Concentration - Flow Mass Balance Method; Data Smoothed and Rounded)
020200070	20010	8.41%		9%
	20020	9.83%		6%
	20030	7.79%		12%
	20040	9.85%		15%
	20050	9.13%		7%
	20060	33.10%		30%
	20070	21.90%		21%
		100%		100%
Relative Ranking Order to Site "L" (Terminal Point of Watershed) Largest Contributor to Smallest		020200070 - 20060 20070 20040 20020 20050 20010 20030		020200070 - 20060 20070 20040 20030 20010 20050 20020

Concurrent with the above approach to identify potential total phosphorus non-point sources, research studies by others [27, 28, 29] are underway to identify "critical area sources" within a watershed where both total phosphorus land concentration and local transport factors are assessed together for the purpose of identifying "risk areas" that may be responsible for significant total phosphorus loadings to nearby streams. The benefit of this approach would be to allow a more focused effort on those parcels classified as "critical source areas," rather than addressing all lands along a stream or within the entire watershed. Research progress and potential application of this evolving methodology will be monitored and, if found useful, the findings will be incorporated in the proposed Implementation Plan and/or Post-Monitoring Plan at a later date.

Discussion of Nitrate Exceedances Reported in the 2006 NJDEP Integrated List

The *New Jersey 2006 Integrated Report* (Appendix C - December 2006 - Sublist 5) [1] lists two stations (sites) on the Papakating Creek as impaired with respect to "nitrate":

1. Papakating Creek at Sussex (Station 01367910 / Station 01367909 [also referred to as 2-PAP-1 and WRWMG Site "L"]); both stations are in very close proximity with 01367909 being upstream from 01367910)

2. Papakating Creek at Rt.565 in Wantage Township (AN0307; WRWMG Site "K"). For sources of potable water, the Federal and State nitrate-N concentration is 10 mg/l.

An exceedance is established if the sampling result is in excess of 10 mg/l nitrate-N. No sampling results obtained by the WRWMG over a time period of 40 months (years 2004 to early 2007) for these stations / sites showed any exceedances. The maximum nitrate-N analytical result found was 1.45 mg/l. NJDEP was requested to review all available data in preparation for the 2008 or 2010 Integrated Report. Reference ongoing discussions between the WRWMG and NJDEP - Bureau of Water Quality Standards and Assessment on this issue, NJDEP advised in October 2008 that both of the above two stations will be delisted for nitrate on the basis of new information received by the Department.

Assessment of Fecal Coliform / E.coli Sampling / Findings: Papakating Creek Watershed [30]

Overall Findings

Of the seven sites sampled on the Papakating Creek, six had FC geometric means in excess of 200 colonies/100 ml and seven had *E.coli* geometric means in excess of 126 colonies/100 ml. Refer to *Tables 18, 19, and 20* for further details. The one site sampled on the Clove Brook (Site "J" located just prior to the confluence with the Papakating Creek) also had FC and *E.coli* geometric means in excess of the Standard. Site "J" is presently excluded from the impaired stream segments identified in the NJDEP FC TMDL for the Papakating Creek. Five of the seven sites sampled in 2004 on the Papakating Creek also had FC geometric means in excess of Standard (*E.coli* was not measured in the 2004 sampling event). The 2004 and 2006 results plus the findings from the Sussex County Division of Health's Summer Ambient Bacteriology Program further validate the pollutant loadings reported in the NJDEP-developed FC TMDL for the Papakating Creek Watershed.

Upstream and Downstream Views of Clove Brook Site "J"
Newton Avenue, Sussex Borough, NJ

Table 18: Comparison of WRWMG Fecal Coliform Sampling Results
Data of 2006 vs. Data of 2004 - Papakating Creek and Clove Brook (Site "J")

2006 Sampling Program			2004 Sampling Program	
Site Identifier	**5-Day FC Geometric Mean (colonies/100 ml)**		**5-Day FC Geometric Mean (colonies/100 ml)**	**Equivalent Site Identifier**
PFC # 4	387		344	PFC # 4
"T"	1401			
			432	PFC # 6 **(Note A)**
"S"	166		275	PFC # 13
"R"	330		501	PFC # 8
"N"	205			Not Sampled
"K"	647			Not Sampled
"J"	277			Not Sampled
"L"	486		589	PFC #14

Note A: PFC # 6 is located approximately 50 yards upstream from Site "T"; there is a small tributary stream feeding the Papakating Creek mainstem between PFC # 6 and "T"; limited fecal coliform monitoring on this tributary in 2006 showed negligible fecal coliform loading relative to the levels found at Site "T."

Table 19: E.coli Sampling Results
WRWMG Data of 2006 - Papakating Creek and Clove Brook (Site "J")

2006 Sampling Program	
Site Identifier	**5-Day *E.coli* Geometric Mean (colonies/100 ml)**
PFC # 4	472
"T"	1553
"S"	221
"R"	360
"N"	239
"K"	792
"J"	366
"L"	503

Table 20: Sussex County Division of Health
Fecal Coliform / E.coli Sampling Trend Data of 1999 - 2006
Summer Ambient Bacteriology Monitoring Program Conducted for NJDEP
Sites "R"(Papakating Creek) and Clove Brook at Loomis Avenue, Sussex Borough

Monitoring Year	Site "R" Pelletown USGS 01367800 5-Day Geo. Mean		Clove Brook near Sussex (Loomis Ave.) USGS 01367902 5-Day Geo. Mean	
	Fecal Coliform	*E.coli*	Fecal Coliform	*E.coli*
2006	373	359	159	75
2005	189	570	197	2460
2004	319	428	Not Measured	Not Measured
2003	517	4058	" "	" "
2002	318	373	" "	" "
2001	1340	2165	" "	" "
2000	1033	600	" "	" "
1999	818	Not Measured		

Discussion of Sampling Results

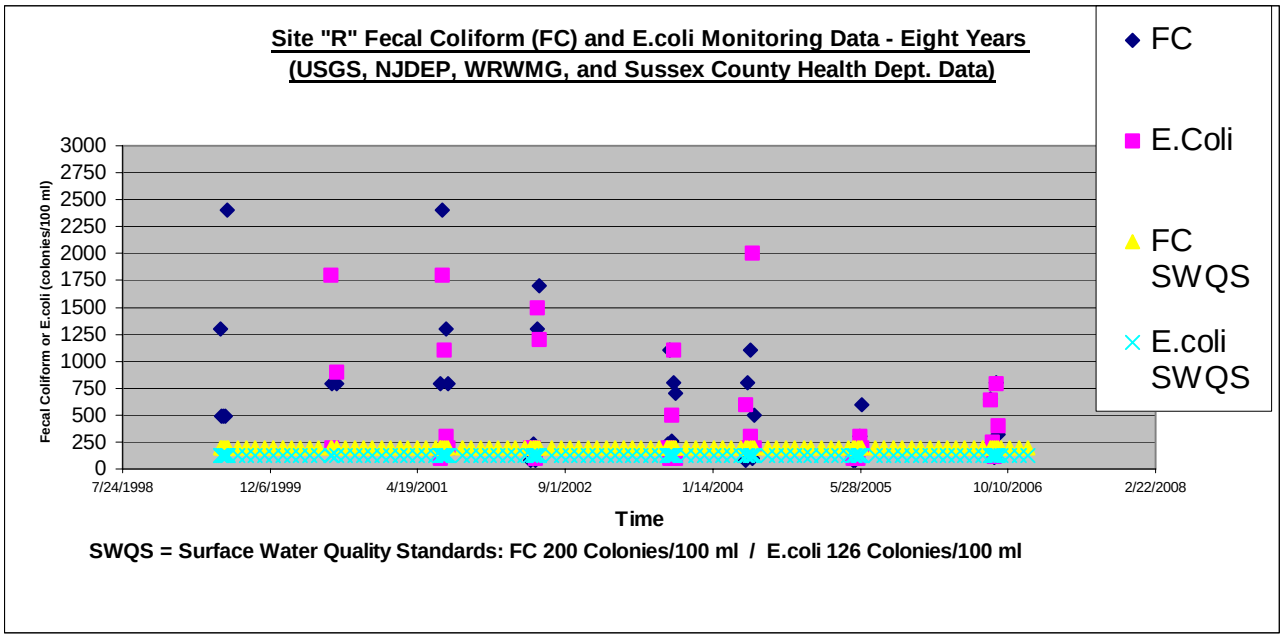
Interpretation of *Tables 18 & 19*: Considering the scatter in many of the five-value data sets, the WRWMG advises caution in the strict interpretation of the calculated geometric means. The data does warrant further study by conducting multiple fecal coliform / *E.coli* sampling rounds in the future, possibly as a Task of a future Clove Brook Watershed fecal coliform / *E.coli* Assessment and Characterization study or as part of a Post-Monitoring Task concurrent with implementation of the developed Restoration Plan.

Chart 7 shows fecal coliform and *E.coli* monitoring data for Site "R" (May to early September time frame for years 1999 - 2006.) The data clearly show the frequency and magnitude of the fecal coliform and *E.coli* impairments for Site "R." The data set for fecal coliform consists of 38 monitoring values, of which 82% of the values show impairment. The data set for *E.coli* consists of 33 monitoring values, of which 76% of the values show impairment.

FC stream concentrations are believed strongly influenced by non-point sources including annual farming / agricultural operations/practices (e.g., grazing practices, lack of manure management practices, manure field spreading operations, hobby and commercial horse operations, domestic animals directly in water streams, etc.) and wildlife.

A discussion of developed Load Duration Curves is presented elsewhere. [3, 6, 17, 31, 32]

Chart 7: Fecal Coliform and E.coli Monitoring Data For Site "R"
(May to Early September, Years 1999 - 2006)



Fecal Coliform / E.coli HUC 14 Material Balances

As a novel approach, an attempt was made to rank each of the Papakating Creek HUC 14 sub-basins with respect to pollutant load contributions of fecal coliform and *E.coli* relative to Site "L," which is considered the terminal point on the Papakating Creek prior to the confluence with the Wallkill River. A material balance algorithm was developed taking into account the pollutant loadings and stream flow rates entering and exiting each of the HUC 14 sub-basins. Assumptions were made regarding the appropriateness of using the developed fecal coliform / *E.coli* geometric means and a smoothed stream-flow velocity profile. Also, the calculation did not attempt to account either for bacteria decay and/or growth along the tributaries and mainstem of the Papakating Creek. Results are shown in *Table 21*.

Table 21: HUC 14 Fecal Coliform / E.coli Contributions to the Loading at Site "L"
(Terminal point of the seven HUC 14s)

HUC 14		Annual Percent Fecal Coliform Contribution		Annual Percent *E.coli* Contribution
20200070	20010	8%		10%
	20020	4%		5%
	20030	10%		8%
	20040	8%		9%
	20050	Included in 20040		Included in 20040
	20060 (Clove Acres Lake/Lakeshed)	22%		27%
	20070	48%		41%
Total		100%		100%

Relative Ranking Order to Site "L" (Terminal Point of Watershed) Largest Contributor to Smallest		**20200070 - 20070 20060 20030 20010 20040/20050 20020**		**20200070 – 20070 20060 20010 20040/20050 20030 20020**

Although the above calculation approach is limited in scope, the results do suggest:

- HUC sub-basin 02020007020070 is the major bacteria pollutant-contributor to the seven HUC 14 sub-basins

- The Clove Brook HUC 14 sub-basin (02020007020060) should be assessed and characterized with respect to fecal coliform impairment; in addition, if the above Clove Brook impact on the Papakating Creek result is substantiated, attainment of the stated bacteria reductions for the Papakating Creek will be limited until the Clove Brook is addressed.

- Additional studies are now possible to derive unit pollutant loads of each of the HUC 14 sub-basins (fecal coliform and *E.coli* loadings/acre/unit time)

Fecal Coliform / *E.coli* Future Sampling Considerations

The approach used by NJDEP for the fecal coliform TMDL as well as by the WRWMG, was based on collecting data during the summer months when in-stream fecal coliform concentrations are typically highest. Although sampling during this period is considered adequate for meeting annual water quality protections and designated uses, sampling during each quarter of the year is advisable in order to correlate sampling results versus land-use practices over a twelve-month period.

The fecal coliform TMDL also states that the desired site(s) load allocations including a margin of safety ranged from 92% to 99% for the four specific sites listed for the Papakating Creek. Follow-up monitoring will be required following completion of implementation projects to track effectiveness in achieving targeted reduction goals.

Considering that the quantification (rough estimates) of farm and wildlife animals estimated within the Papakating Creek Watershed (see *Table 8*) may be significant, future source tracking studies should employ Microbial Source Tracking methodologies [33, 34, 35,] to distinguish among human-farm animals-wildlife. Unless the loading and impact from wildlife is quantified, the achievement of 92% to 99% fecal coliform / *E.coli* reductions may be unattainable. In addition, future studies should address the fecal coliform / *E.coli* contribution from the Clove Brook to the Papakating Creek (not presently covered in the Papakating Creek fecal coliform / *E.coli* TMDL.

Project Plan Pollutant Assessments and Goals

Total Phosphorus Pollutant Budget:

As previously stated (page 10), the present annual estimated total phosphorus load leaving the Papakating Creek Watershed including the Clove Brook subwatershed is 21,796 pounds /year. The TMDL goal is to reduce this loading by 43.4%, an overall reduction of 9,459.5 pounds /year.

Total Fecal Coliform / *E.coli* Pollutant Budget:

The TMDL targeted fecal coliform/*E.coli* reduction ranges from 92% to 99% from present estimated loadings.

Tracking Effectiveness of Implementation Projects Towards Achievement of Targeted Reduction Goals

Chart 8 (Papakating Creek) *and Chart 9* (Clove Acres Lake / Clove Brook) were developed to show:

1. Estimated total phosphorus loadings (TP TMDL)
2. Estimated total phosphorus loadings plus the contribution of buildout (full buildout to occur over 30 years based upon present zoning regulations
3. Targeted loadings after achieving specified reduction percentage
4. Theoretical loadings assuming the entire Watershed is returned to a natural state (forest, barren and water land covers)
5. A hypothetical (theoretical) example showing the tracking of achieved results following completion of successive implementation projects (to be further discussed under the subject of Post-Monitoring Plans)

Chart 8: Papakating Creek (six HUC 14s) Total Phosphorus Annual Load, Target Reduction Goal, and Forecast Reduction Trend

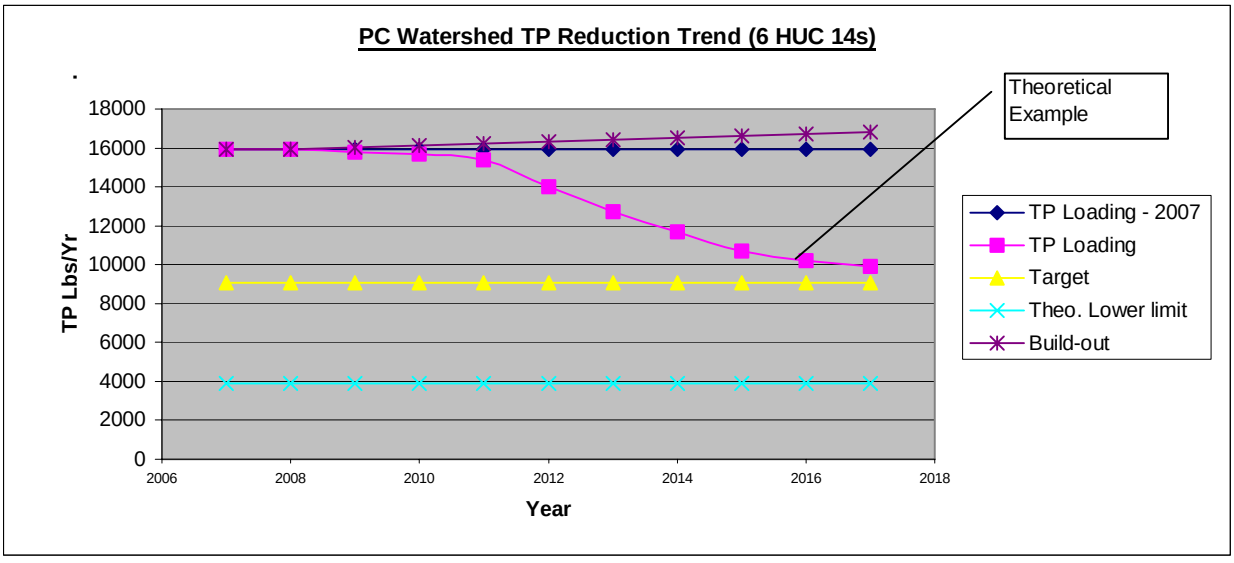
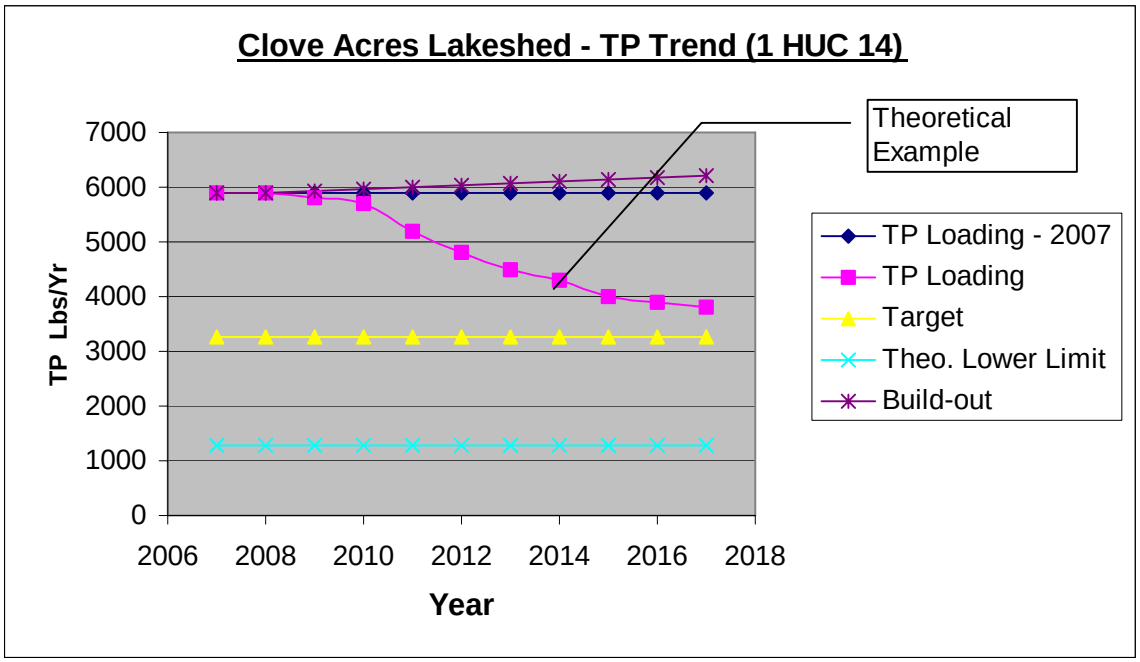


Chart 9: Clove Acres Lake/Lakeshed/Clove Brook Subwatershed Total Phosphorus Annual Load, Target Reduction Goal, and Forecast Reduction Trend



Restoration Control Measures

Background

Agricultural land use within the Papakating Creek Watershed accounts for approximately 28% of the total Watershed area. Therefore, particular focus was devoted to the assessment of current agricultural operations consisting of dairy, non-dairy cattle, crop, pastureland, nurseries, floriculture, and equestrian, as well as residential properties in the process of being placed in farmland assessment status. Based on limited information, the majority of farmers, having larger dairy operations appear to have already implemented a number of Best Management Practices (Conservation Plan, Comprehensive Nutrient Management, rooftop rain water isolation drainage, filtering of rain water from animal holding stalls, collection and recycle closed systems for waste waters, use of concrete slabs in selected places, and, in many cases, lands with natural stream buffer strips in place [although limited in many areas]). From a priority setting viewpoint, attention to non-dairy, crop, and commercial / hobby equestrian operations, likely offers the best short-term opportunities for effecting total phosphorus and fecal coliform / *E.coli* pollutant reductions.

In addition, information searches [36, 37] were conducted to collect available agricultural crop information as well as results of research studies addressing alternatives in farming practices that can be considered in controlling / limiting annual total phosphorus loadings to a watershed. The more significant variables identified by the researchers were:

- Tillage practices (conventional, mulch, and no-till)
- Crop farming (no practices, contour, stripcropping, and terraces)
- Phosphorus loss with waterborne sediment
- Phosphorus dissolved in surface water runoff
- Type(s) of crop(s) grown
- Type and application rate of fertilizer(s)
- Soil characteristics
- Weather conditions

The above list clearly shows that the annual rate of total phosphorus losses (lbs/year) from a given parcel of land in an agricultural land-use application is a function of many controllable and uncontrollable variables / practices. Preliminary experimental results showed a potential of reducing total phosphorus losses by 13% for "mulch / no-till" versus "conventional" and 28% for "contour / stripcropping / terraces" versus "no practices." In addition, significant pollutant-reductions approaching 32% were found in the direct deposition of fecal phosphorus through pasture management and streambank fencing. The pollutant reduction percentages found can be used as first-pass estimates of expected benefits to be derived for implementation projects relating to adaptations made on farming properties. Reduction efficiencies for other practice changes will be further researched and incorporated into the Post-Monitoring Plan database. Studies by the same authors point out that significant variations are typically found even within a localized area. Considering both the complexity and lack of specific agricultural onsite information, a major component of the Restoration Plan will deal with the development / updating of Conservation Plans, establishment of an Agricultural Panel to provide guidance and oversight during implementation of the Restoration Plan, and development of a pollutant reduction efficiency database.

Of equal importance, significant attention to the local equine community is recommended. Results from an equine survey, conducted within the last three years by the Orange County Horse Council / NY Horse Council / Orange and Ulster Soil & Water Conservation Districts for an adjacent watershed in New York, is available to jump start a similar effort recommended for the Papakating Creek Watershed.

Recommended Management Plan

Executive Summary

A Restoration Plan is presented that addresses the Papakating Creek as an impaired waterway for non-attainment of total phosphorus (TP) and fecal coliform / *E.coli* within six of seven HUC 14 sub-basins of the Papakating Creek Watershed. A separate Restoration Plan for the seventh HUC 14 (02020007020060), which contains Clove Acres Lake / Lakeshed and the Clove Brook sub-basin, has been developed and is being released concurrently with the Papakating Creek Restoration Plan.

The Papakating Creek Watershed is one of five U.S. Geological Survey (USGS) HUC 11 Watersheds that comprise the Wallkill River Watershed, located in Sussex County, New Jersey. The Papakating Creek Watershed includes approximately 38,798 acres or 60.6 square miles of total area. Based on 2002 NJDEP Land Use Aerial Maps, the Watershed is 47% forested, 21.9% agricultural, 17% wetlands, 11.2% urban, 1.3% water, and 0.7% barren. The Watershed encompasses all or portions of the following municipalities: Frankford Township, Lafayette Township, Wantage Township, Sussex Borough, and a small section of Montague Township (essentially all forested).

In years 2003 and 2004, the NJDEP approved seven Total Maximum Daily Loads (TMDLs) to address the identified pollutant impairments.

Restoration Plan Goals: The total phosphorus (TP) and fecal coliform / *E.coli* reduction goals developed by the NJDEP, which were later modified by the WRWMG and approved by NJDEP, resulted in the following established Restoration Plan goals:

- Papakating Creek Streamshed (six HUC 14 sub-basins) - a reduction of 6,841 pounds / year of TP, which is a 43% reduction in the estimated 2004 total TP loading of 15,909 pounds/year (7,231.3 kilograms/year)
- Papakating Creek Streamshed (six HUC 14 sub-basins) - an annual reduction of 92% to 99% in fecal coliform / *E.coli*
- Papakating Creek Watershed (seven HUC 14 sub-basins) - in combination with the Clove Acres Lake/Lakeshed and Clove Brook Restoration Plan, a reduction of 9,459.5 pounds/year, which is a 43.4% reduction in the estimated 2004 total TP loading of 21,795 pounds/year (9,906.8 kilograms/year)

In accordance with an approved NJDEP Quality Assurance / Quality Control Project Plan, the WRWMG collected additional chemical and fecal coliform / *E.coli* data to augment data previously collected by NJDEP and United States Geological Survey (USGS). Efforts by the WRWMG were supplemented by professional services provided by HydroQual, Inc. and Garden State Laboratories. Findings confirmed that the Papakating Creek is impaired with respect to TP and fecal coliform / *E.coli*. Total phosphorus exceedances were slightly to significantly above NJDEP Surface Water Quality Standards: TP exceedance values ranged from 0.11 to 0.25 mg/l relative to the Standard of 0.10 mg/l for streams, fecal coliform exceedances (5-event geometric means) ranged from 205 to 1400 colonies/100 ml relative to the Standard of 200 colonies/100 ml, and *E.coli* exceedances (5-event geometric means) ranged from 239 to 1553 colonies/100 ml relative to the Standard of 126 colonies/100 ml.

An extensive pollutant source-tracking survey was conducted to identify potential sources and causes for the TP and fecal coliform / *E.coli* impairments. Within the Papakating Creek Watershed, non-point pollution is the predominate issue of concern versus point source (end of pipeline). The key non-point sources of TP were identified as follows: streambank erosion, agricultural land erosion and drainage, undeveloped land erosion and drainage, improper / overuse of both agricultural and residential fertilizer applications, stormwater runoff from developed and undeveloped lands and roads, typical urban area sources (one specific area) and, to a lesser extent, septic systems. Potential sources of fecal coliform / *E.coli* were identified as wildlife, agricultural animals in the streams, improper animal manure management, loadings from moderate to severe storm events, pet wastes, and septic systems at localized areas within the Watershed. In addition, major storm events (rainfall exceeding two to three inches/day) have been observed to be a key factor in the transport of TP and fecal coliform / *E.coli* pollutants and sediment to the Papakating Creek.

Development of a holistic Management Plan addressing the stated pollutant sources, mitigation of the impacts identified, and achievement of the desired goals is a complex and challenging undertaking that will require many years of concerted, targeted effort by the entire Watershed community. To begin the long-term journey to protect the Watershed's critical natural resources (e.g., stream water quality), proposed reduction strategies and implementation measures are developed to cover five identified 2009 implementation projects as well as subsequent efforts addressing pollution reduction stream-related projects, in-lake treatment approaches, Watershed-wide projects / controls, urban projects / controls, and suggested municipal actions. As noted below, one of the five key implementation projects proposed for 2009 is the establishment of the WRWMG as a Watershed project-management-oriented entity to not only manage the identified implementation projects but also to provide a coordination and integration role addressing the necessary and critical Watershed project implementation efforts required by WRWMG's partners. Experiences have shown that unless an entity is assigned to drive and track pollutant reduction pound by pound, month by month, one key farmer and/or community member at a time within a given large Watershed area, ultimate success of achieving TMDL goals may prove elusive. *Table 22* summarizes a consensus of needed programs and projects.

The Plan was developed with the following leadership behaviors in mind:

- Awareness of the entire Watershed community (recognizing that the farming community is a significant part of the local economy)
- Teamwork (working with the **right** organizations interacting at the **right** time with the **right** projects (strong focus on implementation-type projects) and with the **right** working processes)
- Speed (demonstrating a sense of urgency)
- Innovation (striving for continuous improvement)
- Performance (setting, measuring, and achieving ambitious goals)
- Adaptive management style (dealing with challenges, change, successes, failures, and annual funding / resource limitations)

A summary of key recommendations and proposed actions is presented:

Proposed Implementation Projects for 2009 - 2012

The five proposed projects listed below, if implemented together, are estimated to reduce the Watershed TP loading by a minimum of a 100 to 150 pounds/year.

Note: The project locations identified below are within HUC subwatershed #02020007020070, which has been determined to be contributing greater than 30% of the TP and *E.coli* loadings to the Papakating Creek as stated in the TMDL

Project AA:

Identification of the WRWMG as the coordinating project management-oriented entity for the overall implementation of the Papakating Creek Restoration Plan. This will provide the WRWMG with the ability and means to not only manage the identified implementation projects being executed but also to provide coordination, technical guidance, and an integration role addressing the necessary and critical Watershed project implementation efforts required by WRWMG's partners and Watershed community members. Technical guidance to cover a broad range of topics (e.g., pollutant source tracking, water resource protection, development of implementation projects, pollutant transport paths, post-monitoring to verify achievement of estimated pollutant reductions). Also included within the scope of work is an effort to provide watershed technical guidance / involvement with the Wallkill River National Wildlife Refuge in their effort to expand the current refuge boundary by 9,550 acres, of which, approximately 7,600 acres lie within the Papakating Creek Watershed. When this goal is realized, a potential 1,500-pounds/year total phosphorus reduction would be achieved (this amount presents 15% of the 10,000 pounds/year reduction targeted for the Papakating Creek Watershed. as stated in the TMDL). These services are not available from any other organizations within Sussex County and the actions proposed for the WRWMG are in congruence with the resource protection goals of the NJDEP as well as the recently promulgated Program Activity Measures (PAMs) established by the U.S. Environmental Protection Agency (EPA).

Full Project Implementation to be completed within a 40-month schedule at an estimated budget of $80,000

Project BB:

Facilitate the development and/or updating of the Agricultural Conservation Plans for approximately 800 acres of active farmland that straddles the Papakating Creek with a focus on identifying riparian restoration, manure management, and stream fencing field projects with local farm operators (deliverables to include updated Conservation Plans by NRCS, specific field implementation project work scopes, reconfirmation of project benefits, identified funding sources, and integration of potential pollutant reductions to be achieved by others into a comprehensive pollutant reduction summary balance for the entire Watershed under study). The project area specifically contains 3 large dairy operations, 5 large horse farms, and the WRWMG sampling station "K", which is located at Route 565.

Full Project Implementation to be completed within a 28-month schedule at an estimated budget of $62,800.

Project CC:

Initiate and complete a characterization and assessment of Lake Neepaulin consistent with NJDEP - BEAR's "Requirements for Lake Characterization" protocol. The Lake Neepaulin local region has been identified as a prime source for total phosphorus, sediment, and urban runoff loadings to the Papakating Creek. The work scope also encompasses a GIS initiative to identify all stormwater inlets / outlets within the local lake region. The results will be incorporated within a lake management plan that addresses total phosphorus reduction opportunities.

Full Project Implementation to be completed within a 30-month schedule at an estimated budget of $53,500.

Project DD:

Installation of stormwater treatment devices into catch basins with direct discharge to Lake Neepaulin and the Neepaulakating Creek.

Full Project Implementation to be completed within a 12-month schedule at an estimated budget of $47,500.

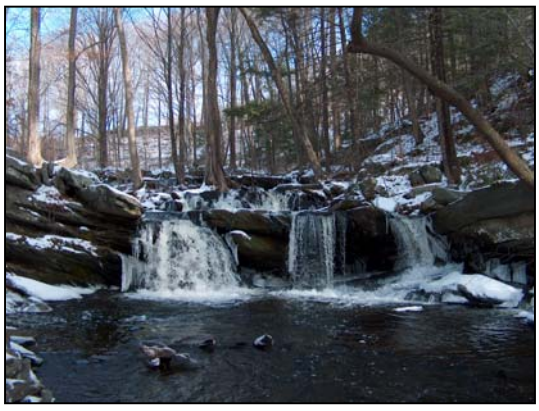
Project EE:

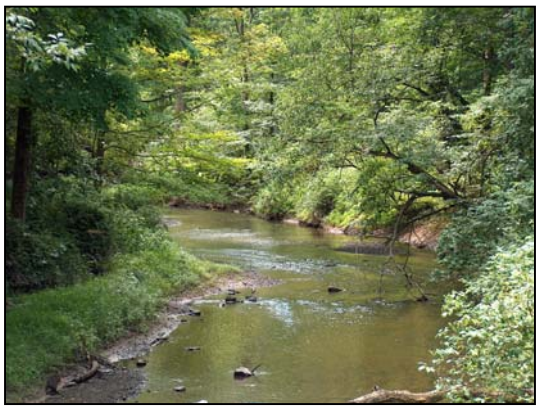
Streambank stabilization, riparian restoration, and floodplain enlargement on the Papakating Creek at Route 565 in Wantage Township: (The site is upstream and contiguous with an operating farm included within the scope of Project DD.

Full Project Design and Implementation to be completed within a 36-month schedule at an estimated budget of $385,400.

Note: The top five 2009 implementation projects identified for and contained within the Clove Acres Lake / Clove Brook Watershed Restoration Plan are labeled as Projects A, B, C, D, & E, which therefore is why the top five projects identified for and contained within this Restoration Plan for the Papakating Creek Watershed are labeled as Projects AA, BB, CC, DD, and EE.

Projects AA, BB, CC, DD, and EE are designed to be completely implemented over the course of forty (40) months for an estimated total budget cost of $629,200. (Includes an estimated in-kind contribution of $ 30,000, dispersed throughout all five projects.)





Proposed Long-term Watershed Restoration Strategies: 2009 - 2025

Watershed-Wide (WRWMG / NJDEP as Lead Partners and with potential NJDEP funding)

- Part of the WRWMG Implementation Entity Role: Monitor, track, and report on the efforts of the USDA Natural Resource Conservation Service (NRCS) and Rutgers Extension Cooperative in the development and updating of approximately 8 agricultural Conservation Plans (to address agricultural farms and commercial / large hobby horse operations); foster relationships with local farmers to encourage them to actively seek the available services from NRCS (overcoming reluctance of some members to seek active support); provide guidance and monitoring of efforts to implement the developed Conservation Plans
- Identification, coordination, and implementation of streambank and riparian restoration projects
- Provide local oversight, coordination and support during implementation of identified streambank restoration projects
- Integration and coordination of the Restoration Plans developed for the Papakating Creek by the WRWMG, the Restoration Plan developed for Clove Acres Lake / Lakeshed by Princeton Hydro, LLC and the Restoration Plan developed by the WRWMG for the Clove Brook sub-basin (a HUC 14 that falls within the Papakating Creek Watershed)
- Stream flow monitoring (relates to pollutant transport balances, flooding, etc.)
- Implementation of a Pre- and Post-Monitoring Plan as presented in the Restoration Plan

Watershed-Wide (WRWMG / Municipalities / Other Local Organizations as Lead Partners and Potential Sources of Funding)

- Implementation of a communication plan to advise / inform / drive water quality improvements through reduction of non-point pollutant sources and establishment of Restoration Plan metrics for monitoring of Plan progress
- Coordination of Watershed-wide efforts with County and Municipal departments (Town Councils, Planning Boards, Departments of Public Works, Open Space Committees, Environmental Commissions, etc.)
- Assessment and implementation of lake restoration projects to protect water quality both within and downstream from Clove Acres Lake and Lake Neepaulin
- Development and implementation of various educational campaigns and programs to raise watershed awareness and solicit stakeholder / volunteer participation in watershed plan implementation initiatives
- Sponsorship of a stormwater seminar to address effectiveness / noneffectiveness of present practices and foster consideration / acceptance of voluntary adoption of several Tier A guidelines by Tier B municipalities (all participating municipalities within the Papakating Creek Watershed fall within the Tier B category; Tier A guidelines are more extensive / restrictive than Tier B guidelines). (Note: Coordination of this action with NJDEP is recommended)
- Sponsorship of a winter road-maintenance seminar to address usage of de-icers, grits, etc. and Best Management applications / equipment maintenance practices

- Address the need for new ordinances in support of the Restoration Plan goals
- Assessment / evaluation / recommendations of open space land candidates for purchase by Federal, State, County, government agencies, municipalities, and various Land Trust organizations. Prime focus to be on the identification of land parcels offering significant water-quality benefits if preserved.
- Development of an invasive species identification and control plan
- Monitor the upgrade of the High Point High School Wastewater Treatment Facility planned for 2010 by the Board of Education (results in a decrease of TP loading to the downstream tributary)
- Work with Sussex County Engineering in the review and enhancement of stream-related bridge / road design standards to incorporate Best Engineering Practices relating to streambank erosion, sediment, stream disturbances, and road runoff control in order to minimize pollutant transport and adverse impacts on stream water quality

Recommended Implementation Projects Within 0 - 40 Months From Approval of NJDEP Funding

Five implementation projects noted above (see Projects AA, BB, CC, DD, and EE) as well as the distribution, communication, and discussion of the developed Restoration and Protection Plans by the WRWMG to the entire watershed community included within the project area.

Funding for the implementation of the Restoration Plan will be sought from the following sources:

- NJDEP SFY 2009 319(h) Implementation Grants
- Development of Conservation Plans (in-kind services from USDA - NRCS and Rutgers Cooperative Extension)
- Implementation of Conservation Plans: USDA and other sources (e.g., CREP, CRP, EQIP, WHIP, ICM, etc. Some funding / in-kind services from individual farmers / landowners may be required.
- In-kind services (e.g., County, municipalities, Sussex County Municipal Utilities Authority, Municipal Boards and Committees, etc.)
- Other sources to be identified / investigated (e.g., Dodge Foundation, private corporations, US Fish & Wildlife Service)

Key field findings by the WRWMG regarding non-point sources of total phosphorus and fecal coliform / *E.coli* were identified as:

Total Phosphorus (TP):

- Sediment from streambank erosion, improper / overuse of fertilizers including animal waste products on agricultural and residential lands, agricultural and residential soils subject to erosion, total phosphorus dissolved in surface water runoff, total phosphorus dissolved in leachate and carried through the soil profile, undeveloped land erosion and drainage, stormwater runoff from developed and undeveloped lands and roads, typical urban area sources (one specific area) and, to a lesser extent, septic systems.

Fecal Coliform / *E.coli*:

Wildlife, agricultural animals observed on lands and in the streams, localized populations of geese and birds, improper animal manure management, loadings from moderate to severe storm events, pet wastes, and septic systems at localized areas within the Watershed.
The identified pollutant sources generally have varying negative impacts on the environment, including but not limited to:

- Exceedances of NJDEP Water Quality Standards for total phosphorus and fecal coliform and *E.coli*

- Sediment loadings resulting in the transport of pollutants to streams, settling of soil particles causing sediment bars in streams (alteration of stream hydrology), cover up of habitat required by fish and other aquatic organisms, increase in water turbidity causing a murky, muddy condition of the water and increased stress on fish within the stream

- Alteration of water temperature and stream hydrology

- Depletion of oxygen content of the stream

- Creation of algae blooms (visual field observations did not show this impact as being significant)

- Degradation of stream riparian buffers due to disturbance of streambanks

- Acceleration of the rate of lake eutrophication. It is well known and documented [38, 39] that lakes within urban watersheds are sensitive to urbanization (from fertilizers, septic systems, high-density zoning, etc.) and stormwater discharges since lake water quality is critically linked to the quality of the incoming water from the watershed. Human-induced disturbances in the watershed dramatically increase nutrient, fecal coli form / *E.coli*, and soil / organic loads into the lake that can accelerate the rate of eutrophication.

- Stormwater Runoff: adverse impacts to the environment, including stream ecosystems, due to residential and commercial development that predominately took place prior to the adoption of the NJDEP Stormwater Management Rules [40] and publication of a Stormwater Best Management Manual in February of 2004. Focus is now on the application of nonstructural versus structural approaches to stormwater management (e.g., the use of vegetated swales instead of routing stormwater through storm sewer pipes).

- Stormwater Road and Parking Lot Runoff: transport of pollutants, alteration of stream hydrology, intensification of area flooding issues, etc.

Streambank Erosion

Agricultural Runoff

Stormwater Road Runoff

Project Ranking and Prioritization

Pending further working sessions with project partners, the following draft ranking / prioritization methodology was established based on priorities throughout the watershed as a whole:

Ranking Categories:

A - High Priority (implementation 0 to 3 years); Notation is provided for those priority projects recommended for NJDEP funding within the 2009 funding cycle
B - Moderate Priority (implementation 2 to 5 years)
C - Low Priority (implementation 3 to 7 years)
D - Supportive (reassess / quantify potential value to meet project objectives)
E - Task proceeding independently of the Restoration Plan

Prioritization: Relates to prioritization of projects within each Ranking Category (projects listed in decreasing order of perceived value, availability of technical resources, and timing with respect to funding sources; "1" being the highest; "2" being of next highest priority, etc.)

Value is defined in terms of pollutant reduction potential / unit of funding expended. The objective is to implement those projects that can bring the greatest value / benefit per unit of funding and / or unit of elapsed timing.

Summary Table - Restoration and Protection Plan

Focused projects that lead to reduction of priority pollutants (total phosphorus, fecal coliform and *E.coli*, sediment) and potential attainment of TMDL goals and stream SWQS

Animal Intrusion in Streams

Stream Debris Dams

Stream Flooding

Table 22: Summary of Watershed Restoration and Protection Plan Projects

IMPLEMENTATION PROJECTS AND THEMES (Many identified tasks to be concurrently addressed with the implementation of the Clove Brook Watershed Restoration Plan)				
Watershed-Wide				
Project / Task / Initiative	**Ranking Category - Priority Within Ranking Category**	**Project Location - Field or Meeting Rooms**	**Further Details - Refer to Appendix**	**Potential NJDEP Funding Projects**
1. Serve as a Watershed Liaison / Organization Within Sussex County for the Implementation of the Papakating Creek and Clove Brook Restoration Plans	**A - 1**		**I - 1**	**Project AA in this Plan; Also Identified in SFY 2009 319(h) Request**
a. Education and Outreach relating to the implementation of the Restoration Plan (general public, agricultural, and municipal and county organizations and Boards, etc.)	**A - 1,**	**Meeting Rooms**	**I - 5, I - 10**	
b. For Consideration: Development of three advisory panels addressing: • General Restoration Plan Implementation • Agricultural Interests • Participating Municipalities - Dept. of Public Works, Open Space, etc. (Note: all with specific roles with minimum overlap of responsibilities)	**A - 9**	**Meeting Rooms**		
c. Future grant funding solicitation / proposal development	**B**	**Meeting Rooms**		
d. Non-point pollutant transport / flooding monitoring	**B**	**Meeting Rooms & Field**		

Project / Task / Initiative	Ranking Category - Priority Within Ranking Category	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
2. Facilitate Development of Agricultural Conservation Plans	**A - 2**		**I - 2**	**Project BB in this Plan; Also Identified in SFY 2009 319(h) Request**
a. Work with USDA-NRCS / Rutgers / NJRCD / Sussex County Board of Agriculture: (Ultimate Goal - develop and/or update approximately 50 Conservation Plans addressing agricultural, horse, and tree farms)	**A - 2**	**Meeting Rooms & Field**	**I - 2**	
b. Build working partnerships with individual farmers	**A - 2**	**Field**		
c. Stream-fencing projects	**A - 2**	**Field**	**I - 2, I - 7**	
d. Manure-management programs	**A - 2**	**Field**	**I - 2, 1 - 1**	
e. Water-quality monitoring on farm properties	**A - 10**	**Field**		
Development of farm riparian buffers (CREP, WHIP, etc.)	**A - 2**	**Field**	**I - 6**	
3. Coordinate Streambank Restoration Projects				
a. Papakating Creek @ Winding Brook Farm	**B**	**Field**		
b. Papakating Creek @ Roy Road	**D**	**Field**		
c. Papakating Creek @ Route 565	**A - 5**	**Field**	**I - 5**	**Project EE in this Plan; Also Identified in SFY 2009 319(h) Request**
d. Papakating Creek @ Route 23	**B**	**Field**		
e. TBD - Stakeholder Identified Locations	**B**	**Field**		
f. Multiple locations - removal of stream debris to protect stream habitat and for flood control	**A - 13**	**Field**		

Project / Task / Initiative	Ranking Category - Priority Ranking	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
4. Sponsor Municipal Outreach Programs				
a. Arrange / sponsor a winter road-maintenance workshop - develop guidelines and support shared service arrangements for winter road issues (use of road de-icers, maintenance of spreaders, etc.); intended for municipalities within and outside the project	**B**	**Meeting Rooms**		
b. Support / encourage road maintenance shared- service agreements	**B**	**Meeting Rooms**		
c. Provide guidance / advise regarding multiple road drainage issues (for reduction of pollutants to streams; e.g., consideration of catch basins at selected sites and addressing runoff pipes from roads that directly drain to nearby streams and lakes)	**B**	**Meeting Rooms & Field**		
d. New Ordinances	**A - 11**	**Meeting Rooms**		
e. Low Impact Development (LID) guidelines (recommend for consideration and incorporation into subdivision approvals and Planning Board guidelines; relates to water quality issues	**B**	**Meeting Rooms**		
5. Recommended Areas for Open Space Preservation	**A - 6**	**Field**		
a. Papakating Creek @ Haggerty Road, north of Meyer Road (ravine parcel) - Wantage Township			**I - 9**	
b. Winding Brook Farms (Route 565) - Frankford Township			**I - 9**	
c. Armstrong Bog / Road Area - Frankford Township			**I - 9**	
d. Papakating Preserve along Lewisburg Road - Wantage Township				
e. Historic rail trails / current gas pipelines – Frankford and Wantage Townships				

Project / Task / Initiative	Ranking Category - Priority Ranking	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
6. Monitor Regulatory Programs				
a. Flood Hazard Control Act – address / advise implementation implications	**B**	**Meeting Rooms & Field**		
b. C1 Status – advise / provide Watershed technical guidance	**B**	**Meeting Rooms**		
7. General Education and Outreach Efforts (Supplementary Programs)				
a. Coordinate / Facilitate Key E&O Initiatives • Manure management • Septic management (partner with County Health Department) • Storm drain stenciling • Watershed clean-ups • Website management • Newsletters • Internet mapping services • Outreach Presentations • Restoration Site ID / Educational Information Signs • Establish contact with local residents	**A - 11**	**Meeting Rooms & Field**		
b. Provide Information to Target Groups • County and municipal officials • Local lake associations • Non-profit organizations • Community groups, clubs, and general public • Schools / educational institutions • Sussex County MUA - Board of Commissioners • Sussex County Agricultural Board • Sussex County Soil Conservation District • Sussex County Engineering, Planning, and GIS Depts. • Sussex County Chamber of Commerce • US Fish and Wildlife Service	**A - 12**	**Meeting Rooms & Field**		

Project / Task / Initiative	Ranking Category - Priority Ranking	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
8. Longer Range Efforts				
a. Lusscroft Farms - establish a Watershed Education Center (Wantage)	**C**	**Field**		
b. Provide assistance and watershed expertise regarding the National Wildlife Refuge's Comprehensive Conservation Plan (CCP) to seek authorization for increasing the land acreage of the Refuge by purchasing an additional 9,500 acres from willing sellers (approx. 90% of the acres are within the Papakating Creek Watershed)	**A - 7**	**Meeting Rooms & Field**		
c. Equine-industry Education and Outreach materials	**B**	**Field**		
d. Cross-sharing Watershed information with the Orange County Land Trust (Middletown, NY); listed here, as well as on page	**B**	**Meeting Rooms & Field**		
e. Maintenance water-quality monitoring	**B**	**Field**		
f. Recreational / public use trails along the Papakating Creek	**B**	**Field**		
g. Improve trout fishing in the Papakating Creek and Clove Brook	**D**	**Field**		
h. Stream / Tributary Identification Signs	**C**	**Field**		
i. Develop an Auto-Tour program for the Papakating Creek Watershed	**C**	**Field**		
j. Work with County Engineering in the review and enhancement of bridge / road design standards to incorporate Best Engineering Practices relating to sediment and road runoff control in order to minimize adverse impacts on stream water quality	**B**	**Meeting Rooms & Field**		

Project / Task / Initiative	Ranking Category - Priority Ranking	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
9. Post Implementation Plan Activities **a.** Development of a Post-Monitoring Plan (to include pre- and post- monitoring data and trends) **b.** NJDEP / WRWMG communications **c.** Monitoring MST technology developments **d.** Continuing discussions with key partners / contacts • Ag-Choice Inc. (horse manure reprocessing / upgrading within Sussex County) • Dave Derrick (US Army Research Center - streambank restoration technical guidance) • Others	**A - 8**	**Meeting Rooms**		
Municipality-Specific				
Project / Task / Initiative	**Ranking Category - Priority Ranking**	**Project Location - Field or Meeting Rooms**	**Further Details - Refer to Appendix**	**Potential NJDEP Funding Projects**
Wantage Township: **a.** High Point Regional High School wastewater system upgrade - NJPDES Permit No. NJ0031585; upgrade planned for 2010 by the local School Board of Education	**E**	**Meeting Rooms & Field**		

b. Lake Neepaulin - multiple projects				**Project CC in this Plan; Also Identified in SFY 2009 319(h) Request** **Project DD in this Plan; Also Identified in SFY 2009 319(h) Request**
• Dam upgrade - in planning / funding phase by Lake Neepaulin, the Township, and other partners	**E**	**Field**	**I - 3, I - 4**	
• Installation of storm water sedimentation basins (one is very critical to address a water quality issue)	**B**	**Field**		
• Address multiple stormwater drainage issues from nearby roads to the lake and to the Neepaulakating Creek (the tributary from Lake Neepaulin to the Papakating Creek)	**A - 4**	**Field**		
• Lake Neepaulin Characterization and Assessment; Identification of stormwater sites for implementation projects	**A - 3**	**Field**		
• Initiate a minor dredging project to remove a sediment bar at the inlet section of the lake (a water quality issue)	**B**	**Field**		
• Institute a total phosphorus management system (low phosphorus fertilizers, septic pumping ordinance, etc. to control a recurring lake weed problem)	**B**	**Field**		
• Address an apparent anoxic condition near / at the bottom of the lake (dissolved oxygen less than 1 mg/l)	**B**	**Field**		
• Implement a stormwater drain stenciling project (work scheduled for the spring / summer of 2008)	**B**	**Field**		
• Provide Education and Outreach to the Friends of Lake Neepaulin (FOLN)	**B**	**Field**		
• Initiate a consistent / long-term lake water-quality monitoring program	**B**	**Field**		
• Consider the practicality and feasibility of constructing recreational trails along the Neepaulakating Creek	**C**			

Project / Task / Initiative	Ranking Category - Priority Ranking	Project Location - Field or Meeting Rooms	Further Details - Refer to Appendix	Potential NJDEP Funding Projects
Frankford Township: (list excludes Projects noted above that fall within Frankford Township)				
a. New ordinances	**B**	**Meeting Rooms**		
b. Participation on a municipal road winter maintenance panel	**B**	**Meeting Rooms**		
c. Geese control	**B**	**Meeting Rooms & Field**		
d. Education and Outreach	**B**	**Meeting Rooms**		
Lafayette Township:				
a. New ordinances	**B**	**Meeting Rooms**		
b. Participation on a municipal road winter maintenance panel	**B**	**Meeting Rooms**		
c. Geese control	**B**	**Meeting Rooms & Field**		
d. Education and Outreach	**B**	**Meeting Rooms & Field**		
Montague:				
a. The only activity of note relates to forest protection and maintenance	**B**	**Field**		
b. Participation on a municipal road winter maintenance panel	**B**	**Meeting Rooms**		
c. Education and Outreach	**B**	**Meeting Rooms & Field**		

Leading Management Strategies for Addressing Non-point Pollutant Sources

40, 41, 42, 43, 44, 45, 46,47,48

Future Funding of the Wallkill River Watershed Management Group for Implementation of Specific Papakating Creek and Clove Acres Lake Pollutant Reduction Projects, Dissemination of the Watershed Restoration Plans, Centralized Leadership, Address Plan Revisions and Amendments, and Provide Overall Monitoring and Data Trending of all Watershed-wide Efforts to Achieve Both NJDEP and EPA Water Quality and Strategic Goals

Key Project Partners:

- NJDEP Division of Watershed Management
- Wallkill River Watershed Management Group
- Sussex County Municipal Utilities Authority

Proposed Project Concept: Identifying / Selecting the WRWMG as a Watershed Restoration Plan Implementation Entity

The Wallkill River Watershed Management Group (WRWMG) has become known, not only throughout the Wallkill River Watershed but also, throughout all of Sussex County as the primary local resource for area stakeholders in matters relating to water quality and water resource management. Through the successful completion of several Section 319 (h) and CBT Grant funded projects, the reputation of the WRWMG has progressed such that they have become an indispensable resource for the New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management (DWM) in implementing Total Maximum Daily Loads (TMDL's) and attaining water quality goals in the Wallkill River Watershed. The WRWMG has evolved to serve a critical role as the liaison between the Department and the general public of Sussex County, allowing for the Department to hear and address the concerns of the stakeholders within the county to a much more intimate degree than would normally be afforded a state agency.

Through the development of two separate, but intertwined, Watershed Restoration Plans for the Papakating Creek and Clove Acres Lake Watersheds, the WRMWG has successfully fostered crucial stakeholder partnerships, identified viable restoration initiatives, and generated strong momentum towards the successful implementation of these Restoration Plans. In addition, because the WRWMG is the entity that has developed the Restoration Plans for these two contiguous watershed areas, they already have a comprehensive knowledge and understanding of the Watershed, water quality impairments, and restoration needs. As such, the WRWMG is already in perfect position to hit the ground running and effectively implement identified restoration strategies, initiatives, and projects once funding is secured.

Proposed Mission of the WRWMG (efforts to be integrated within approved implementation projects):

Based on watershed-wide accomplishments to date, the WRWMG is the necessary organization needed to serve as the umbrella entity serving the needs of the Watershed community. Besides management of specific implementation projects, the WRWMG proposes to accept the added role of maintaining pollutant reduction records as well as documenting the initiatives undertaken by both the WRWMG through funded grants as well as community organizations and municipalities to show a demonstrable watershed-wide improvement. This effort is congruent with the EPA strategic water quality improvement goals that all states are expected to meet. The WRWMG's unique ability to know all of the activities underway in the watershed as well as inside knowledge of *where* municipalities and local groups should be working to make the largest water quality improvement allows the WRWMG to serve in a similar capacity as the 'County Watershed Agents' that Rutgers has partnered with the NJDEP to fund. In essence, the WRWMG will be the organization responsible for keeping tabs on everything from agricultural projects, stormwater projects, lake community projects, equine programs, etc. that could report *all* of these improvements to the NJDEP and conduct water quality monitoring to show measurable change as these initiatives are undertaken. The WRWMG has a niche role to fill, and is the best group to do so within Sussex County.

For NJDEP Consideration, the WRWMG Submits a Concept That Offers Better Alignment of All Watershed-wide Efforts and Achievement of Earlier Results Than Attainable Through Current Protocols and Business Processes: Establishment of Three Advisory Panels in Support of the Papakating Creek and Clove Brook Restoration Plans

Achievement of the desired Restoration Plan(s) goals is a complex and challenging undertaking that will require many years of concerted, targeted effort by the entire Watershed Community. Identification and establishment of project leadership teams to lead and guide the effort will be critical. Considering the network / complexity of interrelated tasks to be undertaken, the WRWMG proposes to establish three leadership advisory panels to address:

- Restoration Plan
- Agricultural elements
- Municipal elements

Establishment of a Restoration Plan Leadership / Advisory Panel

Tasks:

- Provide project / program management leadership guidance with strong focus on representing specific entities within the Watershed
- Represent the majority interests of the entire Watershed community
- Provide a consistency / compliance check with ongoing Municipal and County programs, plans, initiatives, and local planning efforts
- Provide guidance and advice to municipalities with respect to proposed implementation projects (one representative from each major municipality within the project area)
- Provide specific skills / know-how / organizational strengths and capabilities with respect to program direction and overcoming unforeseen program obstacles
- Provide long-range continuity during the multiple-year implementation phases and Post-Monitoring program

Potential Participating Organizations:

Municipalities (Frankford, Wantage, Sussex Borough, Lafayette, and Montague)
Sussex County Planning / Sussex County Office of GIS (SCOGIS)
Sussex County Board of Agriculture
New Jersey Forest Service
Wallkill River Watershed Management Group
Sussex County Municipal Utilities Authority
New Jersey Department of Environmental Protection

Meeting Schedule: Quarterly during the first year; semi-annually during the second year; to be followed as developments dictate thereafter

Establishment of an Agricultural Advisory Panel

Accelerating the adoption of farming Best Management Practices and implementation of Conservation Plans by the farming community is likely to offer the best opportunities for reducing total phosphorus and fecal coliform / *E.coli* pollutant loadings within the Watershed. The effect of wildlife on pollutant loadings is also considered important but will need to await development of suitable microbial source-tracking methods that are expected to be available within the next 0 to 3 years. Considering the criticality and significant role played by the farming community, leadership of such an important effort to reduce pollutant loadings is best accomplished / achieved through establishment of an Advisory Panel that is tasked to:

Tasks:

- Provide technical expertise in the fields of agricultural practices, restoration and protection Best Management Practices (BMPs) including cost-effectiveness and BMP pollutant-reduction efficiencies, GIS applications, and septic/wastewater matters
- Provide ideas and feedback on Grant-related nonpoint pollutant-reduction strategies
- Review the agricultural and farming technical aspects of the developed Restoration and Protection Plans
- Provide guidance and assistance relating to the identification of funding sources for implementation efforts
- Select committee members to serve as contacts with specific agricultural community members for the purpose of developing / updating agricultural Conservation Plans
- Assist in the implementation of the Papakating Creek and Clove Acres Lake / Lakeshed / Clove Brook Restoration Plans
- Participate in various outreach efforts to disseminate information and educational materials
- Provide long-range continuity during the multiple-year implementation phases and Post-Monitoring programs

Potential Participating Organizations:

Municipalities (Frankford, Wantage, Sussex Boro, Lafayette, and Montague)
Sussex County Planning / Sussex County Office of GIS (SCOGIS)
Sussex County Board of Agriculture
Sussex County Agriculture Development Board
Sussex County Soil Conservation District
North Jersey RC&D Council
Natural Resources Conservation Service (NRCS)
New Jersey Forest Service
Rutgers Cooperative Extension of Sussex County
Public Stakeholders
Wallkill River Watershed Management Group
Sussex County Municipal Utilities Authority
New Jersey Department of Environmental Protection

Meeting Schedule: Every two months during the first year; to be followed as developments dictate thereafter

Panel Mission: Agricultural Operations - Development / Updating of Conservation Plans and Implementation of Best Management Practices

Within the Papakating Creek Watershed (six HUC 14 sub basins), there are more than 100 parcels / tracks where various active, significant agricultural operations are practiced. Based on discussion with several of WRWMG's partners, it was concluded that development / updating of Conservation Plans would be most appropriate to address long-term water quality improvement initiatives within the Papakating Creek Watershed. Overall, the concept of a Conservation Plan encompasses the following efforts, work scope, and potential benefits:

- Partnering with an NRCS natural resource specialist (conservationist) to develop an overall plan that addresses the management of natural resources within the selected agricultural site

- The format of the Plan is not only to address the soil, water, air, plant, and animal resources with respect to appropriate Best Management Practices but also to address the economic improvement of the land operations as practiced by the land operator.

- The Plan also helps to identify appropriate available federal, state and local assistance and cost-share programs.

- The Conservation Plan is essentially cost-free through the efforts of the U.S. Department of Agriculture Natural Resource Conservation Service in cooperation with the local Soil Conservation District.

- Expected outcomes from implementing the Conservation Plan are improvement of water quality within the area (focus to be on total phosphorus, fecal coliform / *E.coli*, and sediment losses), protection of soil properties, productivity enhancements, protection of the productive value of the land, and compliance with applicable environmental regulatory requirements.

- Considerable data and information with respect to the development of Conservation Plans can be obtained from the U.S.D.A. Natural Resources Conservation Service at http://www.nj.nrcs.usda.gov/programs

Establishment of a Municipal Advisory Panel

Literature and experience gained from other Grant studies confirm that participating municipalities within a watershed can play an important role in the identification and implementation of projects to reduce pollutant loadings to streams and waterways. Suggested opportunities are: a) projects directed at stormwater sediment reduction b) reduction of the use of de-icers during winter periods (without sacrificing road safety), c) sharing of winter road maintenance experiences d) erosion control practices along streams and roads, and, possibly, equipment and/or equipment calibration procedures, e) sharing of lessons learned from implemented Stormwater Plans, and all while realizing benefits through shared service arrangements. The role of the Advisory Panel is envisioned as follows:

Tasks:

- Provide technical expertise in the fields of stormwater management practices and lessons learned, winter road practices / maintenance activities relating to the use of road de-icers, guidance on municipal flooding issues, municipal drainage issues, and feedback on stream erosion / sediment control projects

- Provide ideas and feedback on Grant-related non-point pollutant-reduction strategies

- Provide guidance and assistance relating to proposed streambank and riparian restoration projects

- Provide guidance and assistance relating to the identification of funding sources for implementation efforts

- Participate in various outreach efforts to disseminate information and educational materials within the departments of each municipality

- Sponsor workshops on topics of winter road maintenance, stormwater, erosion and sediment control, etc.

Potential Participating Organizations:

Municipalities within the Papakating Creek Watershed

The Department of Public Works or Road Department of each municipality

Sussex County Department of Engineering

Public Stakeholders

Wallkill River Watershed Management Group

Sussex County Municipal Utilities Authority

New Jersey Department of Environmental Protection

Meeting Schedule: Quarterly for the first year; to be followed as developments dictate thereafter

Panel Mission: Targeted Actions for Municipalities [40, 47, 48]

The five municipalities falling within the project area are all classified as Tier B with respect to the Municipal Stormwater Rules. Tier B is less restrictive than Tier A, which has been assigned to more urban/developed municipalities (Tier A municipalities within Sussex County are Andover Township, Byram Township, Hopatcong Borough, Town of Newton, Sparta Township, and Stanhope Borough). Considering the ultimate goal of protecting stream water quality, the voluntary adoption of the following Tier A requirements are proposed for consideration by the Tier B municipalities:

- Improper Disposal of Waste: Adopt and enforce ordinances covering pet waste, litter, improper waste disposal, and yard waste
- Municipal Separate Storm Water Systems (MS4) Outfall Pipe Mapping – addresses outlet pipes that discharge to surface waters
- Road Erosion Sediment Controls: Develop a roadside erosion control maintenance program to identify and stabilize roadside erosion
- De-icing Material Storage: Need for a permanent enclosed storage facility and/or equipment for handling liquid brine solution
- Review and enhance Tier B local public education requirements
- Adopt / implement an employee-training program (include a focus on the spreading procedure pertaining to de-icers and spreader maintenance / calibration requirements

Note: Stormwater runoff containing road salts has become a source of contamination of surface and subsurface waterbodies. In addition, the impact of salt runoff on the environment as well as high corrosion rates in relation to highway structures and vehicles is well recognized. To further education regarding how best to minimize the impact of road / de-icing materials, a Sussex County/ Papakating Creek Watershed seminar should be considered to address a broad range of winter road maintenance practices and operations (spreading materials, de-icing chemicals, spreader calibration, salt storage, liquid brine equipment, etc.). Training programs conducted by the New Jersey Local Technical Assistance Program and the New Jersey Water Supply Authority in 2004, 2005, and 2007 in support of the Raritan Basin System Watershed studies[47, 48] could serve as role models for conducting similar workshops within Sussex County. A recommendation is made to form an advisory panel consisting of municipal, County, and WRWMG personnel to initiate, develop, and sponsor a seminar addressing the above training and cooperative effort.

Best Management Practices Tool Box

Table 23 summarizes well-documented Best Management Practices for the reduction and prevention of pollutant loadings to streams, aquifers, roadways, and local lands. The list is not intended to be all inclusive of known practices.

Table 23: Conservation / Farming Protection Choices (Best Management Practices Tool Box)

Erosion & Sediment Control	Nutrient Management	Livestock Barnyard. Manure, and Waste Management	Livestock Grazing Management	Pest and Pesticide Management	Irrigation Management
Conservation Cover	Agricultural Composting	Combined Waste Facility	Alternate Water Supply	Appropriate Biological Controls	Backflow Prevention
Conservation Crop Rotation	Filter Strips	Diversion(s)	Fencing	Appropriate Cultural Controls	Efficient Irrigation System
Contour Farming	Conservation Crop Rotation	Filter Strip	Pasture Management	Appropriate Physical Controls	Irrigation Water Management
Contour Strip-cropping	Cover Cropping	Heavy Use Area Protection(s)	Plan for Proper Grazing	Maintain and Calibrate Application Equipment	Tailwater Recovery System(s)
Contour Buffer Strips	Equipment Calibration	Manure Composting	Prescribed Grazing	Data Collection	Water Measuring System(s)
Cover Cropping	Fertilizer Storage, Handling, & Containment	Manure Storage Facility(s)	Riparian Buffer	Application Plans and Records	Farm Pond
Critical Area Planting	Green Manure Cropping	Manure Storage Field Stacking Area	Stream Crossing	Protect and Enhance Natural Controls	
Diversion(s)	Intercropping	Plan for Manure and Waste Utilization	Vegetative Stabilization	Safe Storage, Mixing, Loading, and Disposal	
Field Borders	Nutrient Budgeting	Roof runoff Management		Scout for Pests	
Field Strip-cropping	Nutrient Record Keeping	Silage Leachate Waste Management		Special Handling of Sensitive Areas	
Filter Strip	Plant Tissue Testing	Wastewater Treatment System(s)			

Erosion & Sediment Control	Nutrient Management	Livestock Barnyard. Manure, and Waste Management	Livestock Grazing Management	Pest and Pesticide Management	Irrigation Management
Grade Stabilization Structure	**Proper Timing and Application Methods**	**Petroleum Product Storage**			
Grassed Waterway(s)	**Soil Nitrate Testing**	**Hazardous and Household Waste Management**			
Mulching	**Soil Testing**				
Outlet or Lined Waterway(s)	**Yield Data**				
Pasture and Hayland Planting					
Residue Management: No-till, Strip Till, Mulch Till, Ridge Till					
Riparian Buffer					
Sediment Basin(s)					
Stream Channelization Measures					
Tree Planting					
Windbreak					
Brush Management					
Wetlands and Wetlands Enhancement					

References:

a. NRCS Guide, USDA, titled "*Conservation Choices*"
b. Ag-Choice Composting Facility (Manure Management), Sussex County, Andover, New Jersey
c. Farm Bill 2002, titled "*Conservation Practices and Programs for Your Farm*"
d. Division of Agricultural and Natural Resources: Criteria and Standards for Animal Waste Management, Proposed New Rules: N.J.A.C. 2:91
e. Orange and Ulster Soil and Water Conservation Districts, et al, 2007, "*Wallkill River Watershed Conservation and Management Plan*"

Existing Implemented Relevant Municipal Ordinances

Table 24 summarizes a survey that was conducted with each participating municipality to establish the status of applicable ordinances that are generally considered essential in support of the goals of a Restoration Plan. The information will be used to identify where new ordinances may be required.

Table 24: Summary of Applicable/Status of Municipal Ordinances Within the Papakating Creek Watershed (seven HUC 14 areas)

Ordinances	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township
Stormwater Tier	**B**	**B**	**B**	**B**	**B**
Stormwater Management Plan	**In place**	**In place**	**In place**	**In place**	**In place**
Formulation of De-icers and Sand Mixtures Used Within the Township	**Sodium chloride / sand - grit mixture**	**Sodium chloride / sand - grit mixture**	**Sodium chloride / sand - grit mixture**	**Sodium chloride / sand - grit mixture**	**Sodium chloride / sand - grit mixture**
Soil / Sediment Conservation	**Refer to Soil Conservation District ordinance**	**Refer to Soil Conservation District ordinance**	**In place by ordinance and County Soil Conservation**	**Refer to Soil Conservation District ordinance**	**In place by ordinance**
Steep Slope Protection	**In place**	**No need**	**In place**	**In place**	
Stream Buffer/ Riparian Corridor Conservation	**No current ordinance**	**No current ordinance**	**Follow NJDEP requirements**	**No current ordinance**	**Follow NJDEP requirements**
Tree Preservation / Removal	**No current ordinance**	**No current ordinance**	**Covered under land use site design**	**No current ordinance**	**No current ordinance**
Wetlands Protection	**Covered under NJDEP regulations**	**Covered under NJDEP regulations**	**Follow NJDEP requirements**	**Covered under NJDEP regulations**	**Follow NJDEP requirements**
Fertilizer Application Formulation	**No current ordinance**	**No current ordinance**	**No current ordinance**	**No current ordinance**	**No current ordinance**

Ordinances	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township
Stormwater Tier	B	B	B	B	B
Septic Management Program	System designs and inspections covered under the County of Sussex County Health Depart-ment (septic tank pump-out program not currently required within Township)	98% of Township on central waste-water system (Sussex County Municipal Utilities Authority); 2% of Township on conventional septic systems	Septics; under supervision of Sussex County Health Department	Septics; under supervision of Sussex County Health Department	Septics; under supervision of Sussex County Health Department
Geese Management	No current ordinance	In place but review suggested	No current ordinance	No current ordinance	No current ordinance
Standard for Dry Well Installation	No current ordinance	No current ordinance	No current ordinance	No current ordinance	No current ordinance
Limestone / Carbonate	No current ordinance	No Need	No Need	No Current ordinance	No Need
Impervious Cover Limitations	Addressed in zoning ordinance	Addressed in zoning ordinance	Addressed in zoning ordinance	Addressed in zoning ordinance	Addressed in zoning ordinance
Streambank Stabilization Ordinance	No current ordinance	No current ordinance	No current ordinance	No current ordinance	No current ordinance
Sediment and Erosion Control Plan	Covered Under Soil Conservation District Ordinance	Covered Under Soil Conservation District Ordinance	Covered Under Soil Conservation District Ordinance	Covered Under Soil Conservation District Ordinance	Covered Under Soil Conservation District Ordinance
Low-impact Development	No current ordinance	No current ordinance	No current ordinance	No current ordinance	No current ordinance
Right-To-Farm Ordinance	In place	In place	In place	In place	In place

Ordinances	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township
Stormwater Tier	**B**	**B**	**B**	**B**	**B**
Wellhead Protection Plan	**Mentioned in the Aquifer Protection / Well Testing Ordinance; provisions for full wellhead protection is advisable**	**Potable water served from Rutherford Lake (development of a specific protection ordinance is advisable)**	**Yes**	**No; all private wells**	**No**
Full/Part Time Enforcement Officer	**Full Time**	**Part time (arrangement with Wantage Township)**	**Part Time**	**Part Time**	**Part Time**

Pollutant Source-Tracking Assessment

Tables 25 and *26* summarize typical generic pollutant sources for total phosphorus and fecal coliform / *E.coli* that were observed during source-tracking field tours conducted within the Watershed. The list can be used to aid in devising / selecting appropriate reduction strategies to achieve the targeted Restoration Plan pollutant reduction goals.

Potential Total Phosphorus Sources

Table 25: Major Total Phosphorus Sources by Municipality

Potential Pollutant Sources	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague
Fertilizers	Applicable	Applicable	Applicable	Applicable	
Sediment/Erosion	Applicable	Applicable	Applicable	Applicable	Applicable
Loss of Riparian Buffers	Applicable	Applicable	Applicable	Applicable	
Rural Stormwater	Applicable		Applicable	Applicable	Applicable
Urban Stormwater		Applicable			
Mal-operating Onsite Septic Systems	Don't know		Unknown	Unknown	
Manure-Related Practices	Applicable		Applicable	Applicable	
NJGDES- permitted Facilities	One NPJDES site; not a major factor; upgrade planned for 2010				

Potential Fecal Coliform / *E.coli* Sources

Table 26: Major Fecal Coliform / E.coli Pollutant Sources by Municipality

Potential Pollutant Source	Wantage Township	Sussex Borough	Frankford Township	Lafayette Township	Montague Township
Agricultural Operations	Applicable		Applicable		
Residential Equestrian Facilities	Applicable		Applicable		
Loss of Riparian Buffers	Applicable	Applicable	Applicable	Applicable	Applicable
Sediment Loading	Applicable	Applicable	Applicable	Applicable	Applicable
Rural Stormwater	Applicable		Applicable	Applicable	Applicable
Urban Stormwater		Applicable			
Malfunctioning Onsite Septic Systems	Lake Communities (not known)	Probable for residential homes not connected to the central wastewater system	Unknown	Unknown	
Domestic Pets	Applicable	Applicable	Applicable	Applicable	
Wildlife Geese Indigenous Animals Birds	Applicable	Applicable	Applicable	Applicable	Applicable
NJPDES-permitted Facilities	One NPJDES site; not considered a factor				
Combined Sewer Overflow Systems		Applicable			
Lake Neepaulakating Tributary / Lake Neepaulin	Applicable (subject to verification)				

Overall Summary of Field Observational Findings

The HUC 14 parcel and stream assessments were performed by traveling along local roads, walking portions of rail beds that run parallel to various stream segments, and observations at road crossings as well as from aerial and GIS-developed maps. Assessments also included taking photographs of all field findings and observations and holding discussions with various community members. *Table 27* below summarizes the field assessments covering six of the seven HUC 14s that comprise the Papakating Creek Watershed. The seventh HUC 14 sub-basin (- 060) will be covered in a separate Report covering the Clove Acres Lake / Lakeshed.

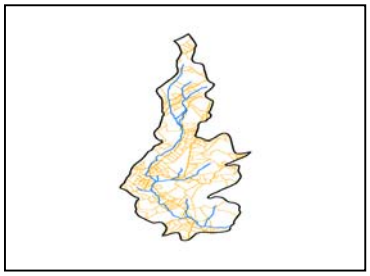
Note: An extensive photographic database was developed while conducting the individual HUC 14 parcel and stream assessments. Although individual photographs are not included in this overall summary of field observational findings, this photographic database has been organized, catalogued, labeled and formatted electronically onto a compact disc, and is readily available upon request.

Table 27: Summary of HUC 14 Project Area Land Users (As Observed in Field)

HUC 14 02020007020-	Acres	Farms	Horse Farms	Tree Nurseries	Other	Sub-total
010	3,251.3	3	3		1 (nursery)	7
020	3,813.9	7	1	1	1 (zoo)	10
030	2,922.8	2	4	1	1 (poultry)	8
040	3,820.0	9	1		1 (pheasants) 1 (orchard) 1 (poultry) 1 (Lusscroft Farm)	15
050	3,536.9	3				3
070	8,498.4	3	5			6
Sub-total	25,853.3	27	14	2	7	51
Probable Count (assume 80% actually observed in the field)		34	18	3	9	64

HUC 14 Parcel and Stream Assessment Field Notes and Observations

HUC 14 - 02020007020010



HUC AREA IDENTIFIER: WYKERTOWN

Areas along segments of Routes 519 (Wantage Ave.) and 629 (Wykertown Road), Gunn Road, George Hill Road, and Plains Road;

HUC contains Papakating Creek headwaters

Key Facts: Percent Impervious Cover: 1.57%
HUC Acres: 3,261.32
Predominate Land Cover: rural, very low-residential density, agricultural, and highly forested
Stream Antidegredation Designation: C1
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural, Nursery, and Horse Operations:

Nursery and Landscaping Business (George Hill Road near intersection of Pines Road) - flowers, nursery stock, florist supplies, merchant wholesaler, and landscaping service; stream runs behind property; considerable buffer of hemlock trees between stream and property, property is a candidate for a Conservation Plan and other related BMPs. Note: A Conservation Plan may already be in effect.

Farm - established within last five to ten years; observed seven cows and a manure pile, extensive grazing lands, stream is behind property, property is a candidate for a Conservation Plan and/or Education and Outreach, and other related BMPs

Horse Riding Farm (Gunn Road) - provides riding lessons, stables, and boarding; property is a candidate for a Conservation Plan and/or Education and Outreach, as well as related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris)

Farm (opposite horse riding farm) - observed three cattle; property is a candidate for a Conservation Plan and/or Education and Outreach, and other related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris)

Horse Farm (Crigger Road and Nelson Road) - property is a candidate for a Conservation Plan and/or Education and Outreach, and other related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris)

Farm (Route 519, north of Frankford Park) - observed goats; property is a candidate for a Conservation Plan and/or Education and Outreach, and other related BMPs

Farm - observed two goats, three horses, and one pony; property is a candidate for a Conservation Plan and/or Education and Outreach, and other related BMPs

Other Tracks / HUC Observations:

George Hill Road - observed two low-density residential sub-divisions; area is highly forested and noted for wildlife

Wykertown Road - observed one low-density residential sub-division at the intersection of George Hill and Wykerton Roads; area is highly forested and noted for wildlife

Gunn Road - observed two low-density residential sub-divisions; area is highly forested and noted for wildlife; the Papakating Creek runs parallel, close to Gunn Road, and intersects Gunn Road at several locations

Wantage Avenue and Reservoir Avenue - location of Frankford Township's Community Park

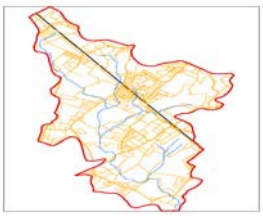
In general, observed relatively steep slopes on one side of most roads (generally greater than 15% steepness) and dense brush, wetlands, and several very small ponds on the opposite side; stormwater drainage is generally in the direction of the stream(s); residential areas are generally 3 to 10+ acres served by septics and potable wells.

Stormwater Catch Basins/Stormwater Flows - within the sub-basin road system, reliance is on conventional street storm sewers and underground piping to transport runoff to low-lying areas including wetlands and streams. It appears that no one-discharge point is sufficient to justify installation of structural devices to reduce sediment loadings. Application of nonstructural approaches for new development is now mandatory via local / county / NJDEP requirements.

Another source of pollutants that has been widely addressed in the literature and present within the project sub-basins is the use of road de-icers and sand/grits to melt ice and provide traction. While the use of winter road materials provides obvious benefits, excessive use can result in environmental damage to roadside vegetation, streams, surface waters, and wetlands. Each of the HUC sub-basins within the project area has winding roads, various degrees of steepness, and stormwater road drainage to adjacent vegetative strips, forested areas, wetlands, and streams. While the NJDEP Stormwater Regulations does cover the storage aspects of de-icers, sand, grit, etc., little guidance is offered regarding the selection, application, and maintenance practices of road equipment

(applicators and spreaders); this subject deserves attention and follow-up by the participating municipalities within the targeted project area (a WRWMG recommendation); regarding the selection of suitable de-icer chemicals, the literature has identified the use of magnesium chloride as effective from a road safety perspective but highly corrosive to most metals.

HUC 14 - 02020007020020



***HUC AREA IDENTIFIER*: BEEMERVILLE**
Areas along segments of Routes 519 (Wantage Ave.), 629 (Wykertown Road), 635 (Haggerty Road), and 637 (Beemer Church Road), Davis Road, Meyer Road, Plains Road, Dennis Phillips Road, and Neilson Road;
HUC contains Space Farms

Key Facts: Percent Impervious Cover: 2.25%
HUC Acres: 3,813.95
Predominate Land Cover: rural, low residential density, limited active agricultural land uses, and highly forested
Stream Antidegredation Designation: C1
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural, a Zoo, and Horse Operations:

Observed two farms (crop production) (Davis Road, north of Myer Road (Route 629); one farm is in Farmland Preservation, properties are candidates for a Conservation Plan, installation of related BMPs, and/or Education and Outreach.

Farm (Beemer Church Road) - observed presence of swine, site consists of large grazing pasturelands; property is a candidate for a Conservation Plan, installation of related BMPs, and/or Education and Outreach.

Zoo (intersection of Wantage Avenue and Route 629) - drainage from an onsite pond forms a minor tributary to the Papakating Creek; the tributary is well buffered and is a considerable distance upstream from the WRWMG chemical sampling site known as Site "S" (Plains Road just south of intersection with Davis Road). The Zoo is a major tourist attraction and is considered an important asset within Sussex County; the site is a candidate for Education and Outreach along with efforts to review and enhance present management practices.

Farm (Across from Clydesdale Ridge Road on Route 629) - presently in Farmland Preservation; a review of the present Conservation Plan is recommended; the farm is a candidate for Education and Outreach

Farm (Route 629 and Wykertown Road) - approximately equidistant between Dory Roe Road and Beemer Hill Road; observed several horses; property is a candidate for a Conservation Plan, Education and Outreach and related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris)

Tree Farm (Wykertown Road just north of North Dory Roe Road) - property is a candidate for Education and Outreach

Farm (relatively large) (Dennis Phillips Road south of Crigger Road) - provides equine services (horse riding, boarding, and lessons); property is a candidate for a Conservation Plan, Education and Outreach and related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris); site is well maintained and may already have an effective management plan in place

Farm (Nelson Road near Crigger Road) - sign on site states availability of soaps, eggs, and goats; property is a candidate for a Conservation Plan and/or Education and Outreach and related BMPs

Farm (Myer Road east of Haggerty Road (Route 635)) - observed dairy cows; drainage in direction of stream; property is a candidate for a Conservation Plan and/or Education and Outreach

Development Sub-divisions:

Several small, low-density residential sub-divisions are located within the HUC project area. Lot sizes appear to range from 2 to 10 acres/residential site. Residences are serviced by septic systems and wells.

Commercial Operations:

Essentially no commercial operations other than agricultural tree farms, a zoo, and horse stables

Other Tracks / HUC Observations:

Observed a small pond off Dalrymple Road between Beemer Church Road and Little Road; drainage received from an agricultural field; stream is channelized (appearance of a ditch)

The tributary originating from the pond located on the zoo property joins another small tributary emanating from the west (west of Dennis Phillips Road and south of Crigger Road); this tributary is highly buffered, located within extensive wetlands and forested areas, and considered to be a very marginal source for either total phosphorus or fecal coliform / *E.coli*

Open-Space Candidates:

Recommend protection / preservation of picturesque ravine area located off Haggerty Road (Route 635, north side), north of intersection with Meyer Road (Route 629). Local geology, presence of a waterfall, and the steepness and limited width of the ravine rule out development opportunities.

Visual Observations:

Observed wildlife (deer, red-tailed hawk); the countryside is picturesque, rural, dominated by rolling hills, streams, forested areas, one significant ravine, old agricultural fields, farms, wetlands, low density residential development, and presence of considerable stream buffers, vegetated areas, and wildlife

Stormwater Catch Basins / Stormwater Flows - within the sub-basin road system, reliance is on conventional street storm wetlands and streams. Some evidence of flooding on private properties attributable to stormwater runoff from steep slopes emanating from low-density residential housing above the road and bordering one side of two or three major local roadways (areas subject to flooding are at significant distances from local streams). Minimization of potential flooding from stormwater runoff from new developments sewers and underground piping to transport runoff to low-lying areas, including is now addressed through the recently adopted NJDEP Stormwater Regulations.

HUC 14 - 02020007020030

HUC AREA IDENTIFIER: ARMSTRONG & PELLETOWN

Areas along segments of Route 565 (Ross Corner - Sussex Road) Plains Road, Linn Smith Road, Armstrong Road, Losey Road, and Pelletown Road; HUC contains Winding Brook Farm, Armstrong Bog, Bailey Green Development, High Ridge Estates, and USGS Real Time Flow Gage - Station ID 01367800

Key Facts:

Percent Impervious Cover: 1.77%
HUC Acres: 2,922.79
Predominate Land Cover: rural, very low residential density, agricultural, and highly forested
Stream Antidegredation Designation: C1
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural Operations:

Farm (South side of Plains Road, north of the WRWMG FC Sampling Site PFC #4 and west of stream) - horse stables / fields; property is a candidate for a Conservation Plan and/or Education and Outreach; property is well maintained

Farm (North side of Plains Road, north of the WRWMG FC Sampling Site PFC #4) - seven to eight cows observed; excessive animal density observed in 2006 as judged by NRCS; stream flow is through property; property is a candidate for a Conservation Plan and/or Education and Outreach

Farm Animal Site (mixed animal types) off Linn Smith Road south of stream (beyond 300 feet) - property is a candidate for a Conservation Plan and/or Education and Outreach; property is well maintained

Horse Farm (north side of Linn Smith Road southeast of Plains Road, south of stream (beyond 300 feet)); 10 to 12 horses observed; property is a candidate for a Conservation Plan and Education and Outreach including related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris); property is well maintained

Horse Farm (Linn Smith Road, between Route #565 and Plains Road) - services include boarding, training, lessons and horse sales; property is a candidate for a Conservation Plan and/or Education and Outreach and related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris): the WRWMG understands that a manure management practice is in effect but further details would be appropriate in order to establish possible management practice enhancements; property is well maintained

Winding Brook Farm (Route #565) - currently being considered for development or open space; candidate for reforestation / tree canopy plantings for stream temperature protection; presently, the stream within the property has a 0% tree canopy

Poultry Farm (west of Route #565 and intersection of local railroad bed and Armstrong Road, just west of stream) - site consists of approximately six to eight chicken sheds, 10 to 12 smaller coops, and one farmhouse; sheds/coops are located approximately 10 to 15 feet west of stream; site is a candidate for a Conservation Plan and/or Education and Outreach including streambank buffers and poultry manure management

Tree Farm (Plains Road) - candidate for a Conservation Plan and /or Education and Outreach, property appears well maintained

Farm Property / Large Horse Operation (rear of Armstrong Bog tract) - observed approximately 25 horses; property is a candidate for a Conservation Plan and Education and Outreach and related BMPs addressing horse wastes (manure, urine, bedding materials, and feed debris)

Development Sub-divisions:

Bailey Green Development (just south of Route #565; approximately 95 to 100 residences/ lots) - constructed about 12 years ago, observed detention basin with runoff into nearby wetlands and to other low areas; possible candidate for local ordinances (septic management, low phosphate fertilizer, etc.); signage indicates pet waste 0rdinance in effect; suggest checking with the Township regarding the effectiveness and maintenance of the detention system; the WRWMG's understanding is that there is no Homeowners' Association for the Bailey Green Development

High Ridge Estates (High Ridge Lane off Route 565) - approximately 39 lots, under construction by Toll Brothers, construction in early development (a very low level of activity was observed); drainage appears to be west to east in the direction of Dennis Road (flows from Frankford Township into Lafayette Township); propose monitoring effort by the Township/Soil Conservation District to confirm compliance with stormwater management rules, erosion/sediment control ordinance, and other local / county / NJDEP regulations

Commercial Operations:

Topsoil / sub-surface soil quarry (off Route #565; at this location, Route #565 is near and parallels the stream) - propose monitoring by Township / Soil Conservation District regarding compliance with local land use /zoning / ordinance requirements

Recreational Land Tracks (local railroad bed):

Observed horse manure droppings (easy path / run-off to adjacent stream; avoidance of pollutant source is not readily apparent nor are corrective measures easily implemented)

Other Tracks / HUC Observations:

Intersection of Route #565, Pelletown Road, and the Papakating Creek (USGS Real-time Station at Pelletown Road) - observed streambank erosion and sediment collection on both sides and under the overpass bridge on Route 565; possible candidate for streambank stabilization (approximately 100' on each side of the bridge, both sides of the streambank) but priority is considered relatively low

Open-Space Candidates:

Winding Brook Farm (Route #565; west-north boundary of parcel parallels a local railroad bed (Utility Propane Gas Company - KCS Group, Houston Texas); property consists of 28 acres on the southside of Route #565 and 95.8 acres on the northside of Route #565) - currently being considered for residential development or open space; due to property boundary configuration (high width-to-depth ratio), stream flow path is across width of property; the fact that this land is considered environmentally sensitive and that the stream in on the proposed 2007 C1 Nomination List, this property is best considered as a candidate for open space acquisition.

Armstrong Bog Area (between Plains Road and Route #565, Armstrong Road runs through the defined bog area, property is approximately 312 acres) - currently being considered for residential development or open space; the stream runs along the southeast section of the bog area; if development is considered, site is a candidate for cluster zoning, Low Impact Development plus compliance with existing and proposed local / county / State (Town Center Designation) / NJDEP regulations including stream and wetlands protection Ordinances

Stormwater Catch Basins / Stormwater Flows - within the sub-basin road system, reliance is on conventional street storm sewers and under ground piping to transport runoff to low lying areas including wetlands and streams. It appears that no one-discharge point is sufficient to justify installation of structural devices to reduce sediment loadings. Application of non-structural approaches (if feasible and practicable) for new development is now mandatory by local / county / NJDEP Stormwater requirements.

Visual Observations:

Observed wildlife (deer, hawk); the countryside is rural, dominated by rolling hills, streams, forested areas, old agricultural fields, farms, wetlands, very low level of residential development, and presence of considerable stream buffers, vegetated areas, and wildlife; (for reference, Frankford Plains Cemetery is located on Plains Road, north of the intersection of Plains Road and Linn Smith Road).

HUC 14 - 02020007020040

***HUC AREA IDENTIFIER*: BEEMERVILLE & PLUMBSOCK**
Areas along segments of Routes 519 (Wantage Ave.), 628, and 649, Neilson Road, Card Road, and Rutgers Road;
HUC contains West Branch Papakating Creek headwaters and Lusscroft Farm

Key Facts: Percent Impervious Cover: 1.97%
HUC Acres: 3,820
Predominate Land Cover: rural, low-to-moderate residential density, some agricultural, old agricultural fields, numerous small ponds, and highly forested (particularly on the north-west boundary of the sub-basin)
Stream Antidegredation Designation: Both C1 segments / C2 segments
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural and Horse Operations:

Farm (Dyer Road, south of Route 628) - observed 10 cows; property is a candidate for a Conservation Plan, installation of related BMPs, and/or Education and Outreach

Horse Farm (Libby Hills Farm - near Holland Road)

Farm (Holland Road; before Route 519) - pheasants; drainage to wetlands

Poultry Farm (chickens) - Dyer Road and Route 628

Farm - Routes 519 and 628

Large Farm (crest of road, Route 519, north of Route 628) - farm is well maintained; observed a manure collection tank; farm runoff may impact water quality of local tributaries

Dairy Farm - (located on Route 649, north of Route 519)

Farm (Route 649 near Card Road)

Farm (Route 649, north of Card Road)

Apple Orchard (Route 649); drainage to Route 649

Farm (Routes 649 and 519)

Dairy Farm (Route 519)

Lusscroft Farm (Neilson Road, west of Route 519) - acquired and administered by the New Jersey Department of Environmental Protection, Division of Parks and Forestry; site consists more than 35 buildings and farming structures; property is to be used as an agricultural and environmental facility for educational and public use as well as other passive environmental uses; Lusscroft farm is / will be an integral part of the Sussex County's agritourism and ecotourism plans

Large Farm (Route 519 and File Road) - well maintained; not near tributaries to the Papakating Creek

Residential Sub-divisions:

Observed medium residential housing surrounding Dyer Road and Holland Road (1 acre plus zoning)

Commercial Operations:

Local commercial businesses include an excavating company and an auto wrecking company (observed junk cars on premises; a buffer exists between the site and local stream)

Other Tracks / HUC Observations:

Stormwater runoff problem at intersection of Route 519 and Route 628; road runoff bypasses local road catch basins and flows directly overland, down one side of the bridge abutment carrying road sediment as well as picking up erosion sediments from an adjacent lawn; the side yard setback of the house to the stream is approximately 20 feet (this issue should be addressed by the municipality as an element of a future road maintenance project).

Small Cemetery (intersection of Routes 649 and 519)

The western boundary of the sub-basin is comprised exclusively of State Parks and Stokes State Forest; drainage from the Parks is in the direction of the sub-basin

Open-Space Candidates:

To be discussed with the local municipalities

Visual Observations:

Identified a potential integrator site for future field monitoring to assess pollutant loadings from the West Branch of the Papakating Creek. The site is at the intersection of the stream and Berry Road, just north of Route 628. The stream is in a slight ravine and is well buffered. The land south of the site (along Dyer Road) consists of old agricultural fields and very low density-residential homes.

A large percentage of the residential homes located that eventually drain to the Papakating Creek have large well maintained lawns (candidates for low-to-zero phosphate fertilizers)

Observed two tributary crossings under Route 649, north of Degroat Road; the first tributary is within 10 to 15 feet of the road with buffers ranging from 8 to 15 feet; the second tributary receives drainage from nearby homes; both tributaries have sparse buffering

HUC 14 – 02020007020050

HUC AREA IDENTIFIER: MCCOY'S CORNER, WOODBOURNE & LIBERYVILLE

Areas along segments of Routes 565 (Ross Corner - Sussex Road) 628, 519, and 650 (Libertyville Road), Pigeon Hill Road, Sherman Ridge Road, Hickory Road, and Coykendall Road;

HUC contains West Branch Papakating Creek headwaters, Woodbourne Park, Wantage Dog Park, and High Point Regional High School

Key Facts: Percent Impervious Cover: 3.03%
HUC Acres: 3,536.98
Predominate Land Cover: rural, low-to-moderate residential density, some agricultural, old agricultural fields, numerous small ponds, and highly forested
Stream Antidegredation Designation: Both C1 segments / C2 segments
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural and Horse Operations:

Farm (Lewisburg Road, north of Beaver Run and south of Route 565 / Compton Road intersection) - considered a major dairy farm; observed approximately 20 cows, silos, and a manure holding tank; property is well maintained; area consists of many open fields and few residential homes; this site is a candidate for a Conservation Plan and/or Education and Outreach; most likely this farm may already have a Conservation Plan in place; plan enhancements and additional funding dollars may be in order to accelerate various elements of the approved plan

Goat Farm (Route 650, west of Sherman Ridge Road) - this site is a candidate for a Conservation Plan and/or Education and Outreach

Animal Farm (intersection of Route 650 and Route 519) - observed 12 cattle; farm is at a considerable distance from the Papakating Creek; this site may or may not be a candidate for a Conservation Plan and/or Education and Outreach strictly on the basis of improving stream water quality; a Conservation Plan would provide other benefits to the landowner

Residential Sub-divisions:

Rural-to-moderate residential areas; zoning is approximately 0.5 to 5 acres / residential unit; homes serviced by septic systems and individual potable wells; most areas are candidates for appropriate BMPs (dog waste ordinance, low phosphate fertilizers, septic management, etc.)

Commercial Operations:

Sussex Airport is located within this sub-basin, bordered by Route 565 and Route 639; adjacent to the airport, are a used car dealership (25 to 30 cars), a mulch garden supply distributor, and a gas station; a distributor of food products to restaurants, etc. is located nearby

Other Tracks / HUC Observations:

Local Roads - many local roads run parallel to the Papakating Creek within five to 20 feet from the stream bank; consideration of suitable buffers in these areas is not feasible;

Stanton Pond is located on Route 565, south of the intersection of Route 565 and Route 628; the overflow from the pond drains to the Papakating Creek at the WRWMG's chemical sampling Site "N"; an unnamed pond behind the High Point Regional High School serves as an impoundment before draining to the Papakating Creek; the discharge from the Regional High School wastewater treatment package discharges to the Papakating Creek just beyond the second waterfall on Route 628; the area surrounding the High School consists mostly of open fields and forested areas

Wantage Dog Park (private) located off Route 628 and west of Sherman Ridge Road; the park is fenced on four sides; animal waste BMPs are already in place; the park is well maintained and supported by many local partners; stormwater from the park flows through wetlands and buffered areas before eventually joining the Papakating Creek

Woodbourne Park (located off Sherman Ridge Road; the Papakating Creek is located at the extreme rear of the park) - steam corridors are buffered (varying widths) and there is little justification for consideration of streambank restoration projects

Unnamed Old Agricultural Pond (located east of Route 519, west of Coykendall Road, and north of University Lane) - the pond drains to the West Branch of the Papakating Creek

Large Unnamed Pond (located north of Route 650 and east of Hickory Road) appears as a very small pond on older travel maps; pond is surrounded by forest land, is well buffered, and drains to the Papakating Creek

Open Space Candidates:

To be discussed with the local municipalities

Visual Observations:

High Point State Park forms the northern boundary of this sub-basin

HUC 14 – 02020007020070

***HUC AREA IDENTIFIER*: ROYS, MCCOY'S CORNER, LEWISBURG**
Areas along segments of Routes 565 (Ross Corner - Sussex Road), 639, and 23, Pelletown Road, Roy Road, and Lewisburg Road;
HUC contains High Ridge Estates, Lake Windsor, Papakating Creek Preserve, Lake Neepaulin, Sussex Airport, A&P Plaza, Proposed Lower Unionville Road Development, Route 23 Bridge, Wallkill River Wildlife Refuge Property

Key Facts: Percent Impervious Cover: 2.69%
HUC Acres: 8,498.35
Predominate Land Cover: rural, very low residential density, both active farms as well as many old agricultural fields, extensive buffering of tributaries, and sub-basin highly forested
Stream Antidegredation Designation: Both C1 segments / C2 segments
Stream Percent Tree Canopy: ≥ 50%
Stream Buffers: ≥ 50% (varying widths)
Targeted Pollutant Reductions: Total Phosphorus (including erosion / sediment) and fecal coliform / *E.coli*

Key Field Findings:

Agricultural and Horse Operations:

Dairy Farm (both sides of Route 565, south of intersection of Route 637 and Roy Road) - the farm is a major distance from local tributaries with extensive buffering between the farm and the stream

Former Farm (Lewisburg Road, north of Roy Road) - abandoned

Large Diary Farm (Lewisburg Road, south of Route 565) - observed four silos, manure storage facility and dairy cattle; farm appears well maintained; further participation with the farm operator is proposed to discuss management strategies / Conservation Plan elements and to obtain feedback on both installed and potential application of new BMPs to protect stream water quality

Horse Boarding Farm (Route 565)

Large Horse Farm (Pidgeon Hill Road, just north of Route 637; western side of farm borders Route 635) - farm appears well maintained; drainage is to a local tributary flowing east to join the Papakating Creek mainstem; this farm is a major and dominant operation within the HUC 14 sub-basin

Horse Farm (Route 635, just north of Route 637)

Farm (off Pelletown Road and Statesville Quarry Road) - observed 10 to 12 cattle, three drainage ditches on property join with a tributary that flows to the Papakating Creek mainstem

Horse Farm (boarding) (Route 565, south of Route 628)

Horse Farm (Route 565, just north of Compton Road)

Residential Sub-divisions:

Residential areas are of very low density with lot sizes from 1 to 5+ acres. A major sub-division application has been filed for a site located on Lower Unionville Road and Judge Beach Road. Since the site is not within the latest Sussex County Wastewater Management Plan (recently submitted to NJDEP for approval), the developer will need to apply for an amendment to the submitted Wastewater Plan.

Commercial Operations:

Observed a plant nursery and a used auto dealer (10 to 15 cars) off Route 565. A car wash is located on Newton Avenue, northwest of Route 639 (method of handling spent car wash waters is unknown at this time). Potential pollutant drainage to a nearby tributary to the Pakakating Creek mainstem will need to be investigated.

Other Tracks / HUC Observations:

The WRWMG's chemical sampling site, known as Site "R," is located at Route 565 and Pelletown Road. The surrounding area is comprised of old agricultural fields and very Low-density residential housing; an old railbed parallels the Papakating Creek from Site "R" to the confluence of the Papakating Creek with the Wallkill River; the Elizabethtown gas line parallels the railbed

Observed a large tract of land on the right of Route 565 North, intended for construction of a golf course; project appears abandoned

Potential Implementation Streambank Restoration Project (Intersection of the Papakating Creek and Roy Road) - no buffer on the north side of the Papakating Creek and the streambank shows modest scouring; this site is a potential source of sediment / total phosphorus loading to the Papakating Creek

Tributary from Lake Windsor - the tributary crosses Beaver Run, then Lewisburg Road, and flows west to join the Papakating Creek; the headwaters of the tributary originates from Lake Windsor, a private community of 25 to 30 residences serviced by septics and wells; the entire tributary is extensively buffered with forests on both sides; potential sources of pollution are wildlife, possibly geese in summer, and potentially septics; the west side of Lake Windsor is totally forested (residential housing is strictly on the eastern shore); drainage from land on both sides is toward the lake; the lake is served by an earthen dam with a spillway

Unnamed Tributary to the Papakating Creek Mainstem - low-order tributary originates from wetlands/small pond located east of Route 635 and north of Route 637; the entire area surrounding the tributary is highly forested with the presence of considerable wetlands

Lake Neepaulin (off North Shore Drive via Newman Road from Route 639) - a 25-acre lake with a circumference of approximately one mile; the Lake Neepaulin organization, known as the Friends of Lake Neepaulin, Inc. (FOLN), in partnership with Wantage Township, is presently planning a project for the reconstruction of the lake's dam; the overflow stream from the dam (known as Neepaulakating Creek) joins another tributary
before joining with the Papakating Creek mainstem; Lake Neepaulin may be a candidate for total phosphorus, fecal coliform / *E.coli*, and septic management ordinances; the
WRWMG's Watershed Ambassador (Jennifer Gately) and the FOLN are presently planning a storm drain-labeling project within the lake community during the spring of 2008. The labeling project was started and will be continued by the current Watershed Ambassador as well as several volunteers from the FOLN organization. The effort will continue until the project is completed. Lake Neepaulin presents a number of opportunities for both stream / lake water quality protection and correction / mitigation of several long-standing problems:

- Roadside stormwater flows directly to the lake and/or the tributary from the lake
- Existence of a sediment bar at the inlet portion of the lake as a result of sediment dropout from the inlet stream
- The outlet stream from the lake flows through a ravine that is highly buffered with steep slopes; drainage from the steep slopes results in significant sediment transport to the tributary
- Lake Neepaulin is highly developed with small lots served by septics and potable wells; no sedimentation basins were observed; residences are situated on various tiers surrounding the lake; pollutant transport to the lake may be significant
- A geese problem exists, as observed in December 2007
- Since most internal roads do not have catch basins, stormwater flows directly to wherever low spots exist

On the positive side, the FOLN organization is highly motivated and active in protection of the lake and their lake community and is well aware of the need for a number of infrastructure-type projects. Available funding has been an obstacle in the past. Present focus of the FOLN organization is the rebuilding of their dam, and arranging financing and establishing a cooperative agreement with their municipality

Open-Space Candidates:

An important land area bordered by Beemer Church Road (west of Route 565), Roy Road (east of Route 565), and Route 565 (north and south of Roy Road) offers opportunities for multiple interested parties, either as open space, residential development, extension of the Wallkill River National Wildlife Refuge property, and/or purchase by various land trust organizations. A due-diligence / monitoring effort is recommended for and by the WRWMG to keep abreast of the evolving land use scenarios under consideration.

Papakating Creek Preserve (along Lewisburg Road, north and south of Beaver Run) - approximately 120 to 140 acres; land recently purchased by State of New Jersey / Natural Land Trust; site is extensively forested; the land was procured to protect / conserve natural resources and diversity

Route 23 Bypass (Bridge) Project:

This project envisions the replacement and realignment of the road structure over the Papakating Creek and numerous roadway and access improvements surrounding the A&P Shopping Center, at Lower Unionville Road and exiting Route 23, and at various nearby intersections. This project presents a number of opportunities for streambank stabilization and riparian buffer projects on both sides of the Papakating Creek, which flows under the overhead roadway structure. Coordination of efforts is advisable as well as the monitoring of the project over the next several years. The sponsor of the project is the New Jersey Department of Transportation. As reported by the *New Jersey Herald* on March 25, 2008 the project is still awaiting full approval of $38.2 million to cover the cost of the proposed Route 23 Bypass project. Efforts are in progress by the County to obtain limited funding to cover limited design and right-of-way work. The project location is known as Site "L" in the WRWMG chemical and fecal coliform / *E.coli* sampling program and is considered the integrator site for the entire Papakating Creek.

Visual Observations:

The confluence of the Papakating Creek and the Wallkill River is located within a valley that is comprised mainly of wetlands and forested areas. Accessibility is very limited.

Supplementary Pollutant Reduction Strategies [47, 48]

In-lake Treatment: (relates to the Clove Brook Watershed Plan; builds on the findings and recommendations from Princeton Hydro)

Urban Area(s) - Sussex Borough:

TP Sources: urban streets, parking lots, lawns, driveways, leaking wastewater transfer lines, air deposition, internal loading from Clove Acres Lake, etc. Studies have shown that leaves and other organic debris left in roadways to be a significant contributor to the urban phosphorus load. Another key source is local soils within the watershed area that generally contain excess amounts of phosphorus.

Pollutant Reduction Action - Wantage Township's High Point Regional High School: ***(information source: Sussex County Wastewater Disk)***

This existing wastewater treatment facility (NJPDES Permit No. NJ0031585) serves 1,000 students of the High Point Regional High School located on Pidgeon Hill Road. The current annual average flow for this facility is approximately 10,000 gal/day and the future annual average flow is projected to be 14,000 gal/day. By September 2010, the process facility will be modified to reduce the annual loading of total phosphorus from 97 pounds/year (NJDEP estimate; no present permit limit is specified) to approximately 20 pounds/year (14,000 gpd at a monthly average permit limit of 0.488 mg/l of total phosphorus). The net decrease of total phosphorus to the Papakating Creek will be approximately 77 pounds/year. This amount represents 0.77% of the 10,000 pounds / year targeted reduction for the Papakating Creek. The treated wastewater is surface discharged to a nearby tributary of the Papakating Creek. The treatment plant is owned and operated by the High Point Regional High School Board of Education. On the basis of discussions with the Sussex County Planning Department and the WRWMG, there should be no impact to the High Point treatment facility by the recent new provisions and major changes to the Water Quality Management Planning Rules. For reference, the Waste Water Management Plan drafted by Sussex County is with NJDEP for review and approval.

Agricultural Related Projects - Funding Source Contacts:

Rutgers Cooperative Extension of Sussex County
Steve Komar, County Agricultural Agent (973-946-3040)

U.S. Natural Resource Conservation Service
Kent Hardmeyer, Ron Phelps, and Janice Reid
(908-852-2576)

Wallkill River Watershed Management Group
Sussex County Municipal Utilities Authority
Nathaniel Sajdak: Watershed Coordinator (973-579-6998 ext. 109)
Ernest Hofer PE: Watershed Specialist (973-579-6998 ext. 111)

Agricultural Related Projects - Project Funding Sources:

Table 28 summarizes available funding programs. Changes are likely following approval by Congress of the pending Farm Bill (2008 or 2009 approval)

Table 28: Agricultural Conservation Programs / Funding of Best Management Practices

Funding Sources	**Scope / Purpose**	**Typical Terms (may differ in the version presently under consideration by Congress); Cost share refers to potential funding from the indicated Program**
Conservation Reserve Enhancement Program (CREP)	Addresses high-priority conservation issues, such as impacts to water suppliers, loss of critical habitat, and soil erosion; supports practices such as filter strips, forested buffers, and restoration of wetlands; provides farmers with a sound financial package for conserving and enhancing the natural resources of farms	Administered by the U.S. Department of Agriculture (USDA); requires a 10-to-15 year commitment to keep lands out of agricultural production; provides a maintenance incentive payment plus up to 50 % of the eligible costs to install the various conservation practices
USDA Farm Service Agency Outreach Program (FSA)	Administration of farm commodity and conservation programs and makes loans to farmers unable to obtain conventional credit	For more information about FSA programs, visit FSA at **www.fsa.usda.gov**.
Conservation Reserve Program (CRP)	Conversion of highly eroded cropland to a less intensive use; assists with the cost, and establishment of conservation practices; relates to renting lands from farmers for buffers	Cost share up to 50%
Conservation Security Program (CSP)	Provides a security plan to install and / or maintain high levels of conservation practices on working lands; provides rewards and incentives for achieving the desired goals	Cost share up to 50%
The New Jersey Division Of Fish and Wildlife's Endangered and Nongame Species Program (ENSP)	State biologists work with private landowners to protect the habitat of threatened and endangered species	

Funding Sources	**Scope / Purpose**	**Typical Terms (may differ in the version presently under consideration by Congress); Cost share refers to potential funding from the indicated Program**
Environmental Quality Incentives Program (EQIP)	Provides for a broad range of conservation and environmental practices; includes practices relating to soils, water, and grazing lands	Cost share up to 75%
Wildlife Habitat Incentives Program (WHIP)	Prepare and develop a wildlife habitat development program including endangered species	Cost share up to 75%
Forest Land Enhancement program (FLEP)	Provides financial, technical, and educational assistance to forest land owners	Cost share up to 75%
Forest Legacy Program (FLP)	Supports acquisition of properties and easements with the objective of protecting environmentally sensitive forest lands	Cost share up to 75%
Forest Stewardship Program (FSP)	Development of forest- related protection plans	Cost share may be available from other programs
Farm and Ranch Lands Protection Program (FRLPP)	Development of a conservation plan and compliance with the terms of an easement agreement; helps fund purchase of permanent easements	One-time upfront payment for the easement
Grassland Reserve Program (GRP)	Restoration of grasslands and shrublands	Cost share up to 90%
Integrated Crop Management (ICM)	Assistance with both pest management and nutrient management practices	Provides specific dollars / acre for fruit trees, vegetable plantings, and field crops
Landowner Incentive Program (LIP)	State biologists work with private landowners to protect critical habitats	Cost share up to 75%
Wetlands Reserve Program (WRP)	Restoration, protection, and enhancement of wetlands on farm properties; relates to establishment of a conservation easement	Up to 100% reimbursement for restoration costs (10-year restoration agreement)

Funding Sources	**Scope / Purpose**	**Typical Terms (may differ in the version presently under consideration by Congress); Cost share refers to potential funding from the indicated Program**
Conservation Plan (an NRCS service)	Development of a written record of conservation practices, management decisions, and goals; provides engineering and agronomic assistance in applying conservation practices	Assist in identifying cost share assistance programs; Contact source: ***www.nj.nrcs.usda.gov***
Pest Management Assistance		Service available from Rutgers Extension Division; Contact source: ***http://pestmanagement.rutgers.edu***
New Jersey Department of Environmental Protection 319(h) approved Implementation Projects	A broad range of conservation and protection practices	Cost share - up to 100%

Education and Outreach Plan

The ongoing mission of the Wallkill River Watershed Management Group (WRWMG) has always been to raise awareness about the Wallkill River Watershed and generate stakeholder participation in various watershed management initiatives to maintain, restore, and enhance the watershed. From the onset, the key to successfully accomplishing this mission is developing and maintaining an aggressive education and outreach campaign.

The WRWMG has extensive experience with many different approaches, which have successfully generated interest and fostered important stakeholder partnerships.

- Numerous educational watershed newsletters, informational brochures, and a calendar have been produced and distributed
- A WRWMG website has been developed and utilized to effectively reach out to stakeholders via the Internet
- A watershed sign campaign has led to the installation of roadside Wallkill River Watershed and individual stream identification signs
- Educational programs have been presented in the schools and at publicly attended events
- Formal informational outreach presentations have been given at regular county and municipal meetings, special group meetings (rotary clubs, County Chamber of Conference breakfast meetings, League of Municipalities Dinner Meetings, etc.) conferences, and seminars.
- Other successful initiatives include a Watershed Walks Program, Watershed Clean-up Days, and educational demonstrations at the Wallkill River National Wildlife Refuge, the Vernon Earthfest, and the Sussex County Farm and Horse Show / New Jersey State Fair
- Actively working with the Sussex County Office of GIS to develop many Watershed related GIS mapping initiatives, including building an interactive internet mapping service that provides watershed residents with an easy way to access watershed related data and information

It has long since been the stance of the WRWMG that the way to get stakeholders to develop a sense of commitment to the Watershed and a desire to be involved in the efforts to protect it, is to make sure they are continuously aware of the ongoing project efforts and allow them to develop a sound understanding of how they can participate. Throughout the entire development period of the Watershed Restoration Plan for the Papakating Creek, the WRWMG has aggressively reached out to and maintained communications with the county officials, the municipalities and the public stakeholders who are a part of this project area to:

- Share collected water quality data and other pertinent project information
- Solicit input and feedback
- Provide Plan development updates
- Encourage active participation in future implementation efforts

Once the Restoration Plan is formally approved by NJDEP, the next step is to begin the design and implementation of the recommended restoration strategies, initiatives, and projects. As part of this process, there exists a need to bridge the gap between restoration planning and implementation funding cycles, maintain already established momentum, and initiate initial design and implementation of approved restoration initiatives and strategies. The proposed program will help raise awareness about the completed Plan, generate active participation to help implement it, and ultimately generate stakeholder buy-in and belief in its overall value.

The following is an outline for the proposed community outreach program specific to the Papakating Creek Watershed Restoration Plan:

Task 1: Raise awareness about the approved Restoration Plan and distribute throughout the Papakating Creek Watershed

- Provide summary presentations and distribute copies of Plan at public meetings (County 208 Water Quality PAC, municipal committees, County Board of Agriculture, etc.)
- Issue press announcements to local papers about the Plan and provide information on how to obtain a copy
- Generate informational handouts / posters for distribution at various public locations (county and township buildings, SCMUA, Wallkill River National Wildlife Refuge, public kiosks, etc.)
- Post Plan on the WRWMG website

Task 2: Develop, Initiate, Promote hands-on outreach campaigns and projects to share / spread educational information for key topics

- Identification of pollutant reduction implementation projects
- Septic management practices
- Manure management approaches / practices
- Stormwater management regarding pollutant loading reductions to surface waters
- Winter road maintenance regarding salt / de-icing practices
- Lake management plans
- Available public recreational uses within the Watershed

Task 3: Build a GIS Internet Mapping Service Website designed to track the implementation progress of the Restoration Plan

- Pollutant load reductions achieved
- Water quality trend data
- Stream restoration sites
- Stream debris removal sites
- Stream flooding locations / pollutant loading implications
- Open Space Properties (focus on potential benefits to yearly stream water quality issues)

Task 4: Plan / institute a long - term sustainability plan for the continued coordination, implementation, and maintenance of the initiatives, projects, and strategies contained within the Restoration Plan (projects sponsored directly by the WRWMG as well as by other community organizations and stakeholders)

- Linkage of the Education and Outreach and Post-Monitoring Plans

- Documentation and publication of pollutant reduction project successes achieved both internally and externally by other Watershed Implementation Plan sponsors
- Provide a communication channel between watershed stakeholders and NJDEP, educational institutions, and manufacturing companies in applicable areas relating to non-point pollutant(s) reduction techniques
- Address approaches / considerations that target maintaining the economic viability of the agricultural community within the watershed.

Task 5: Explore innovative and ongoing outreach programs to 1.) generate active stakeholder involvement in achieving the Papakating Creek Watershed Restoration Plan goals, 2.) identification of future implementation projects, and 3.) encouragement of overall watershed stewardship with respect to the restoration, protection, and pursuit of the Plan's surface water quality goals

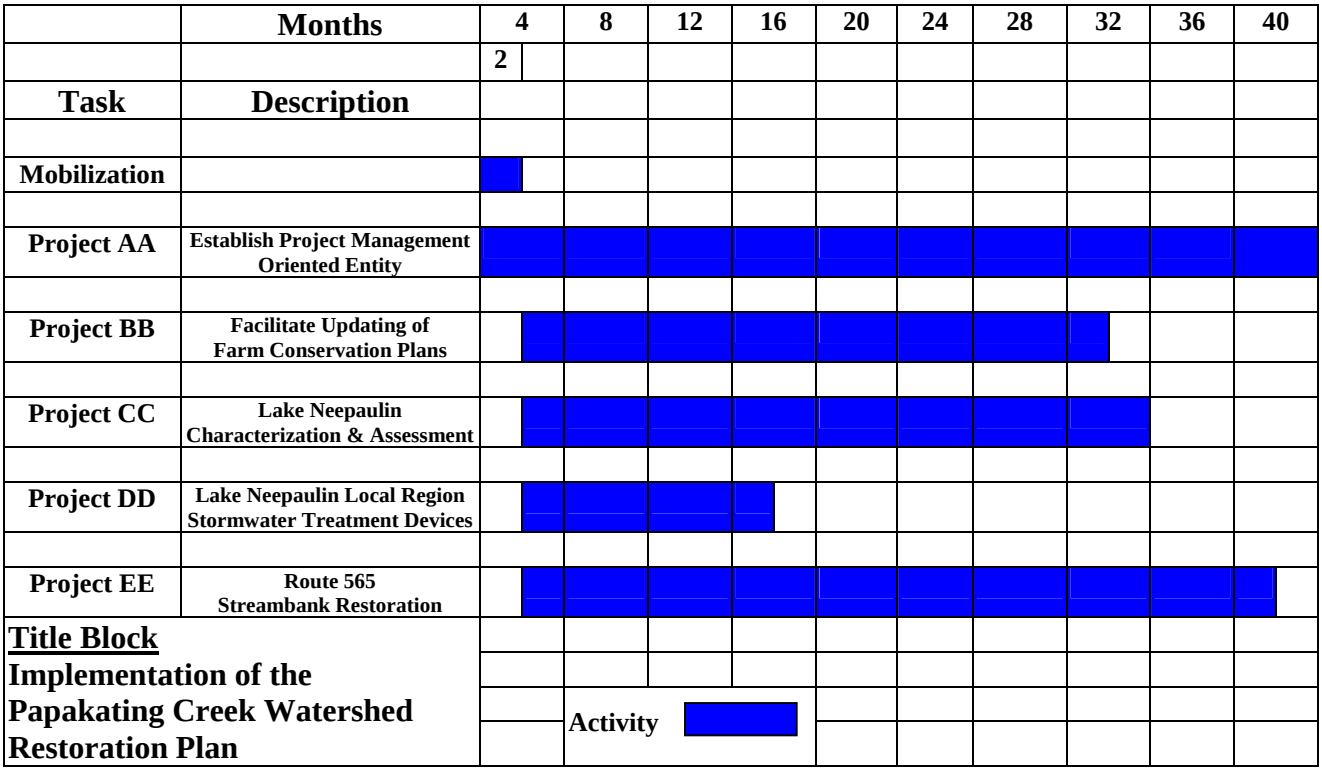
- Seasonal watershed clean-ups program
- Stream identification signs
- Volunteer restoration projects
- Farm tours to promote ongoing water quality activities / practices
- Auto Tour Guides
- Storm drain stenciling
- Sponsor canoe / kayak trips

Ultimately, an education and outreach campaign is a continuously evolving component of any watershed project. As such, there will always be a constant need to monitor and assess the program to insure that the desired results are being achieved. Although it may not be considered a formal restoration practice or project, a successful outreach campaign is crucial to the long-term successful implementation of any watershed restoration plan, and obtaining the necessary water quality improvements.

Project Schedule:

The following *Schedule* shows the tentative scheduling for the five top priority projects within the Papakating Creek Watershed (excludes the Clove Brook HUC 14). The initial time phase is 40-months from funding authorization. Subject to funding levels and timing, the Schedule will be amended periodically as new information is developed.

Schedule: Initial Implementation Projects for 2009 - 2012
(Initial Phase of an overall timeline of 10 to 15 years with annual planned projects and pollutant reductions)



Keys for Restoration Plan Success

- Effective integration of science and planning
- Teamwork and partnerships (all levels)
- Dedication and persistence
- Willingness / openness to learn and improve
- Benchmarking - sharing of experiences, skills, and lessons learned
- Funding availability
- Innovation (use of microbial source-tracking tools, application of "critical source areas" within a watershed to identify effective placement of Best Management Practices, correlation of Best Management Practices and associated pollutant reduction efficiencies, and use of Geographical Information Systems (GIS) for assessments and information analysis)
- Use of adaptive management techniques for planning future program steps
- Establishing a "living" organizational structure to accomplish the goals targeted over the next 10 to 15 years

Pre- and Post-Monitoring Plan [41, 52, 53, 54]

Considering that the Pre- and Post-Monitoring Plan will extend over a 10-to-15 year time period, the Plan must be carefully designed to be cost-effective. Based on a number of References [45, 46] the following general considerations are offered:

Objectives:

Monitor the effectiveness of Implementation Projects with respect to desired pollutant reductions (conduct both pre- and post-monitoring as each implementation project is executed (specific objective)

Establishment of specific panels / advisory groups to partner, assess, monitor, and implement the various facets of the Restoration Plan (specific objective)

80% completion / implementation / updating of Conservation Plans for agricultural farms and commercial / hobby horse land operations (specific objective)

Achieve NJDEP total phosphorus and fecal coliform / *E.coli* Surface Water Quality Standards for the Papakating Creek (general objective)

Achieve NJDEP total phosphorus Surface Water Quality Standards for the Clove Acres Lake and the Clove Brook (general objective)

Implementation of a successful Education and Outreach Program (general objective)

Procurement of necessary funding levels to permit landowners, land operators, and municipalities to implement the desired projects (general objective)

Monitoring Plan Elements:

What to Sample: Papakating Creek and Clove Brook surface waters

Where to Sample: WRWMG Sites "R," "K," "L," and "J" (minimum number of sites)

When To Sample: Three-year intervals; twice / year (spring / summer periods)

Number of Samples to Collect / Site: One original plus one replicate

How to Sample: In accordance with an approved NJDEP Quality Assurance Project Plan

What to Analyze in Samples: total phosphorus, ortho phosphorus, dissolved oxygen, and *E.coli* (part of a geometric mean design format) (These parameters are considered the minimum number of parameters to be measured; corresponding stream flow rates would also be beneficial to have for development of mass balances)

Flow Rate Measurements: Augment information from USGS real-time monitoring station 01367800, staff gages at Sites "I," "J," and "K" with field measurements at selected locations

Application of Monitoring Data: To develop long-term trend charts for the purposes of a) tracking effectiveness of implemented projects, b) altering the then-current project activities and plans if necessary, and c) sharing the information with program partners

Plan Management Policy:

The use of an adaptive management approach as defined in a reference by authors Salafsky, Nick, et al, [49] is essential in pursuing a cost-effective and efficient journey to achieve the desired goals of restoring and protecting the Papakating Creek and Clove Brook Watersheds over an extended 10-to-20 year time period. Basically, an adaptive management policy is a practice based on the integration of analysis, management practices and decisions, full-scale field experimentation and monitoring to evaluate progress and, if indicated, to alter or adapt new courses of action based on lessons learned. Basically, the practitioner is continuously testing assumptions, questioning prior decisions, adapting / reacting to new information, and learning / benefiting from the sum of one's experiences.

Development of Long-Term Monitoring Metrics - Total phosphorus concentrations (mg/l) at specific stream locations, fecal coliform / E.coli stream measurements at specific locations, NJDEP stream SWQS for total phosphorus and fecal coliform / *E.coli*, cumulative funding expended, effectiveness of dollars expended / unit of pollutant reduction, cycle times for implementation of various BMPs, population changes (related to build-out), as well as other metrics as deemed necessary

Charting of Metrics - Develop prior to start of Plan implementation; use the developed metric information to establish the actual impact of management decisions, the level of progress achieved, including the extent of total phosphorus and fecal coliform / *E.coli* water quality improvements, and the need for Plan alterations.

Monitoring of Organizational Structure and Resource Needs - Develop prior to start of Plan implementation

Development of a Long-Term Schedule - Develop prior to start of Plan implementation; identify short-term and long-term milestones

Development of a Long-Term Funding Plan - Develop prior to start of Plan implementation

Conduct Program Reassessments - Conduct a detailed assessment every five years but monitor annually

Development of a Communication Plan - Develop at start of Post-Monitoring Plan implementation (maximize use of electronic formats)

Linkages to the Sussex County Strategic Growth Plan (SGP) [50, 51] and the Sussex County Agriculture Development Board [55]

Sussex County Strategic Growth Plan

The goals of the Papakating Creek Restoration Plan are consistent with the vision established in the Sussex County Strategic Growth Plan:

- Protect and preserve environmentally sensitive areas
- Maintain and enhance surface and groundwater quality / water quantity
- Protect open space
- Encourage farmland preservation
- Protect the Papakating Creek flood plain
- Protect / maintain the quality of life within the Papakating Creek Watershed
- Protect endangered and threatened species
- Support clustering of development within defined "centers" and protection of Sussex County's rural environs

Other aspects of the Restoration Plan are not believed to be in conflict with the overall vision established in the SGP for Sussex County.

Sussex County Agriculture Development Board

The goals of the Papakating Creek Restoration Plan, consistent with the vision of the Sussex County Agriculture Development Board, as presented in the *"Comprehensive Farmland Preservation Plan - Updated November 2007"* as compiled by the Morris Land Conservancy with input from the Sussex County Agriculture Development Board and other local organizations and community groups, are to:

- Preserve both farmland and farmers
- Conserve natural resources on farms
- Ensure clean and plentiful water
- Implement waste management and recycling
- Encourage farmland preservation (9,458 acres preserved to date with approximately 2,522 acres pending as of November 2007)
- Support and protect the Right-To-Farm Act (ordinances in place by all the municipalities within the Papakating Creek Watershed

With respect to other aspects of the Papakating Creek Restoration Plan, efforts will be made to work in harmony with the agricultural community so as not to adversely impact the future of agriculture within Sussex County and the Papakating Creek Watershed.

Acronyms, Abbreviations, and Definitions

These definitions are not intended to be complete but to aid the reader in understanding the words / terms used within the body of the report.

Accretive - waters increasing by addition or growth; inflows

Adaptive Implementation - periodic assessing and altering, if necessary, a series of sequential tasks that comprise an implementation work plan in to achieve the desired result

Aquifer - a subsurface geological formation or a group of formations that are water bearing; a natural underground layer, often of sand or gravel, that contains water

Antigradation - policies which ensure protection of water quality for a particular water body

AMNET - Ambient Biomonitoring Network

ASMN - Ambient Stream Monitoring Network

Assimilative capacity - the capacity of a natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water

Base Flow - the sustained low flow of a stream; also defined as streamflow from ground-water seepage into a stream

Best Management Practices (BMPs) - actions that may be implemented that lead to the reduction of pollutants to waterways, such as constructing stream corridor buffers

Box of the Plot - a rectangle that encloses the middle half of the sample, with an end at each quartile

Box Plot - generally presents six sample statistics – the minimum, the lower quartile, the medium, the mean, the upper quartile, and the maximum – in a visual display; various statistical plotting software show the sample statistics including sample values in slightly different formats

C1 - Category One Waters; those waters designated for implementation of antigradation policies

C2 - Category Two Waters; those waters not designated for implementation of antigradation policies

Clean Water Act - Act passed by U.S. Congress in 1972 to control water pollution

Coarse Textured Soil - sand or loamy soil

Coliform - a group of related bacteria whose presence in water may indicate contamination by disease-causing microorganisms

Coliphage - viruses that infect bacteria of the coliform group (e.g. *E.Coli*)

Consumptive - that part of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate environment

Depletive - water transfers

Designated Uses - water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act

Dissolution - (also called chemical solution) – the process of chemical weathering of bedrock in which the combination of water and acid slowly removes mineral compounds from solid bedrock and carries them away in liquid solution

DNA - deoxyribonucleic acid; the genetic material of organisms

E. coli - an indicator organism whose presence is strongly correlated with the presence of pathogens

Ecosystem - an integrated system of living species, their habitat, and the processes that affect them

EPA - United States Environmental Protection Agency

Erosion - The wearing away of land / streambank surfaces by a stream flow, stormwater runoff, and wind

Eutrophication - The process of nutrient enrichment followed by a rapid increase in nutrient levels creating "algal blooms." On death, bacterial decomposition of the excess algae may seriously deplete oxygen levels. The extremely low oxygen concentrations that result may lead to the death of fish, creating a further "oxygen demand" leading to further deaths

Geometric Mean - the n-th root of the product of n sample values;
Geometric mean = $(\text{Sample Result}_{\#1} \text{ x..x Sample Result}_{\#n})^{1/n}$

GIS - Geographical Information System

Glacial - of or relating to the presence and activities of ice and glaciers

Horse Waste - Manure, urine, bedding, and feed waste products

Hydrograph - presents cumulative stream flow information; developed using the long-term flow database and plotting the points on a frequency table; shows percent of days flow is met or exceeded

Hydrologic Unit Code (HUC) - A classification system devised by the USGS that divide the United States into regions, subregions, accounting units and cataloging units for the purpose of delineating river basins. An example of the numbering system is presented as follows:

02 = region (i.e., Mid-Atlantic Region)
0202 = subregion (i.e., Upper Hudson Basin)
020200 = accounting unit (i.e., Upper Hudson, New Jersey)
02020007 = calculating unit (i.e., Rondout, New Jersey and New York)
02020007010 = watershed (i.e., Wallkill River, New Jersey, Above Route 565)
02020007010010 = subwatershed (i.e., Wallkill River, Lake Mohawk, Above Station Park in Sparta Township)
020200070100100000 = catchment (further breakdown within a subwatershed)

Igneous - rocks transported as molten liquids followed by solidification

Impaired Waterbodies - waterbodies not fully supporting their uses; a waterbody with chronic or recurring monitored violations of the applicable numeric and / or narrative Surface Water Quality Standards

Infiltration - flow of water from the land surface into the subsurface

Invasive Plant - non-indigenous, non-native

Karst - underlain by limestone land forms; a type of topography formed in limestone, gypsum, or other soluble rocks by dissolution, and characterized by closed depressions, sinkholes, caves and underground drainage

Load Duration Curve (LDC) - a visual display of water quality impairment as a function of cumulative stream flow rate, season (spring runoff, summer base flow, winter low); LDC is based upon the hydrograph of the observed stream flows

Loam - soil material that is 7% to 27% clay particles, 28% to 50% silt particles, and less than 52% sand particles

Lower Hinge - 25th percentile (refers to the construction of box plots)

LULC - Land Use / Land Cover

Mean Value - the sum of a list of numbers, divided by the total numbers in the list

Median Value - the middle value of a list of numbers

NAAQS - National Ambient Air Quality Standards

Narrative Criteria - non-numeric, qualitative guidelines that describe a desired water quality goal

NJDEP - New Jersey Department of Environmental Protection

Non-point Pollution - The diffuse discharge of pollutants that can occur over extensive areas, such as fertilizers from lawns, dog waste, etc.

Old Fields - Term used in the Land Use / Land Cover Classification System (Reference Line Item 4410) that defines land cover including open spaces that have less than 25 % brush cover

Percent Slope - vertical distance divided by the horizontal distance, then multiplied by 100

PH - values less than 7 are considered acidic and values greater than 7 are considered basic; this parameter directly influences the types of plants and animals that can live in a lake or stream

Point Source Pollution - pollutant loads discharged through a discrete conveyance

Reach - a length of stream that has generally similar physical and biological characteristics

Recharge - water added to an aquifer; sometimes defined as that portion of rainfall that seeps into the ground

RNA F+ - group of coliphages

RNA male specific - group of coliphages; used interchangeably with "RNA F+"

RNA - ribonucleic acid; plays a key role in protein synthesis

Runoff - the precipitation discharged into stream channels from an area

SIC Code - Standard Industrial Classification (SIC) codes are four digit numerical codes assigned by the U.S. government to business establishments to identify the primary business of the establishment

Silt - as a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter)

Sinkhole - a closed, circular or elliptical depression formed either by dissolution of the surface of underlying bedrock or by collapse of underlying caves within bedrock

Steep Slopes - generally defined as slopes greater than 20 percent

Stony - refers to a soil containing stones in numbers and sizes that interfere with or prevent tillage

Stressor - any substance or condition that adversely impacts the aquatic ecosystem

SWQS - Surface Water Quality Standards

TAC - Technical Advisory Committee

TMDL (Total Maximum Daily Load) - quantifies the assimilative (carrying capacity) of a stream or a lake; the sum of the individual wasteload allocation (for an individual pollutant) for point sources, load allocations for nonpoint sources and natural background, and a margin of safety; any pollutant loading above the TMDL results in violation of applicable water quality standards

Upper Hinge - 75th percentile (refers to the construction of Box Plots)

USGS - United States Geological Survey

Water Table - the surface (interface) between the zone of pure saturation (water) and the zone of pure aeration (air) underground

Watershed - a natural region defined by the land area from which precipitation drains into a particular body of water (a river or stream)

Whiskers - vertical lines that end in a horizontal stroke (refers to the construction of Box Plots)

WMA - Watershed Management Area

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APPENDIX: VOLUME I

I. Recommended Implementation Projects (Top Priority)

I - 1: **Project AA:** Identification of the WRWMG as the Coordinating Organization / Entity for the Overall Implementation of the Papakating Creek Watershed and Clove Acres Lake / Clove Brook Watershed Restoration Plans

I - 2: **Project BB:** Working with NRCS, Expedite the Development and/or Updating of Agricultural Conservation Plans for 800 Acres of Active Farmland that Straddles the Papakating Creek

I - 3: **Project CC:** Characterization and Assessment of Lake Neepaulin consistent with NJDEP's BEAR "Requirements for Lake Characterization" Protocol

I - 4: **Project DD:** Installation of Stormwater Treatment Devices into Catch Basins With Direct Discharge to Lake Neepaulin and Neepaulakating Creek

I - 5: **Project EE:** Streambank Stabilization, Riparian Restoration, and Floodplain Enlargement on the Papakating Creek at Route 565 in Wantage Township

I - 6: Implementation of Low-cost Riparian Buffer Projects on Agricultural Lands

I - 7: Implementation of Fencing on Agricultural Lands to Minimize Intrusion of Animals into Streams

I - 8: Implementation of Low-cost Projects to Remove Stream Debris

I - 9: Identification of Open Space Land Candidates

I - 10: Community Efforts Supporting the Acceptance and Implementation of Recommended Plan Projects

II. GIS Nonpoint Source Pollutant Modeling by SCOGIS and the WRWMG

III. Total Phosphorus - HUC 14 Mass Balance Methodolgy for the Papakating Creek Watershed

IV. Pollutant Source-Tracking Investigation Map: HUC 14 #02020007020070

V. Preserved Farmland in the Papakating Creek Watershed

VI. Preserved Open Space in the Papakating Creek Watershed

APPENDIX: VOLUME II

PROJECT QUALITY ASSURANCE PROJECT PLANS (QAPP)

I. SFY 2005 319(h) Grant: Watershed Restoration Plan for the Papakating Creek and the Surrounding Watershed (RP05-088)

Quality Assurance Project Plan

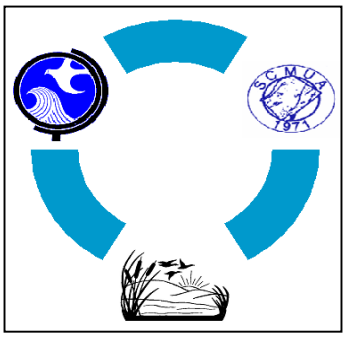
Prepared By: Wallkill River Watershed Management Group

WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I – 1
Proposed Implementation Projects for 2009 - 2012

PROJECT AA:
Identification of the WRWMG as the Coordinating Organization / Entity for the Overall Implementation of the Papakating Creek Watershed and Clove Acres Lake / Clove Brook Watershed Restoration Plans

MUNICIPALITIES



WATERSHED STAKEHOLDERS

Watershed Objective:
Achieve surface-water quality standards through a coordinated project leadership approach for the identification / implementation of projects leading to the reduction of total phosphorus and fecal coliform / *E.coli* loadings to surface waterways and lakes.

Project Description:
The Wallkill River Watershed Management Group (WRWMG) has become known, not only throughout the Wallkill River Watershed but also, throughout all of Sussex County as the primary local resource for area stakeholders in matters relating to water quality and water resource management. **Project AA proposes to establish the WRWMG as a project management-oriented entity to not only manage the identified implementation projects being executed by the WRWMG but also to provide coordination, technical guidance, and an integration role addressing the necessary and critical Watershed project implementation efforts required by WRWMG's partners and Watershed community members.** The technical guidance to be provided by the WRWMG will cover a broad range of topics (e.g., pollutant source tracking, water resource protection, development of implementation projects, pollutant transport paths, post-monitoring of initiatives undertaken by both the WRWMG through funded grants, as well as community organizations and municipalities to show demonstratable watershed-wide improvement. Also included within the scope of work is an effort to provide watershed technical guidance / involvement with the Wallkill River National Wildlife Refuge in their effort to expand the current refuge boundary by 9,550 acres, of which, approximately 7,600 acres lie within the Papkating Creek Watershed. When this goal is realized, a potential 1,500-pounds/year total phosphorus reduction would be achieved (this amount presents 15% of the 10,000 pounds/year reduction targeted for the Papakating Creek Watershed. as stated in the TMDL). These services are not available from any other organizations within Sussex County and the actions proposed for the WRWMG are in congruence with the resource protection goals of the NJDEP as well as the recently promulgated Program Activity Measures (PAMs) established by the U.S. Environmental Protection Agency (EPA).

Project Benefits:

- Serve as a resource for the New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management (DWM) in implementing projects to attain both TMDL and water quality goals in the Wallkill River Watershed.

- Extend the current reach of the WRWMG by providing means for the continuation of Watershed surface water quality impairment analysis, "on the ground" Watershed restoration and planning, with prime focus on the NJDEP-approved Papakating Creek and Clove Acres Lake/Clove Brook Watershed Restoration and Protection Plans

- Serve as the liaison between the Department and the general public of Sussex County, allowing for the Department to hear and address the concerns of the stakeholders within the county to a much more intimate degree than would normally be afforded a state agency.

Project Objectives:

- Serve as a communication liaison to the various Watershed entities regarding Restoration Plan implementation opportunities, changing applicable NJDEP Rules, Regulations and Standards, and identification of new implementation projects

- Presentations at county, municipal, and public committee meetings (minimum of 15 presentations)

- Coordination of activities with USDA-NRCS, NJRC&D, USGS, NJGS, Rutgers Cooperative Extension, County Agricultural Board and individual farmers regarding new / revised Conservation Plans / implementation plans

- Initiate conceptual / basic design of water quality structural and nonstructural BMP's

- Conduct literature searches addressing pollutant load reductions for specific BMP's and discussions with research / engineering organizations working in the field

Project Tasks:

1. Work with local stakeholders, county and municipal representatives to design and implement water quality and stormwater structural / nonstructural BMP's to attain water quality goals.

2. Provide oversight and documentation for each BMP selected for implementation and coordinate with the DWM project manager to discuss permit requirements and Land Use Regulation Review for structural / nonstructural measures prior to the award of project funding.

3. Provide report-outs on literature searches that show scientifically proven load reductions for specific BMP's, particularly from nonstructural measures.

4. Work with partners such as USDA - NRCS, Rutgers Cooperative Extension, NJRC&D, USGS, NJGS, and the Sussex County Board of Agriculture to maintain existing working partnerships as well as build new working partnerships with individual farmers and facilitate the review / revision / development of agricultural Conservation Plans to address water quality concerns and impairments.

5. Identification of funding sources that contribute to water quality improvement

6. Assess, evaluate, and recommend open space land candidates for purchase by Federal, State, and County government agencies, municipalities, and various Land Trust organizations

7. Serve as a communication liaison between the local Sussex County residents and officials and the NJDEP DWM on such issues as Category One stream classifications, Flood Hazard Control Act regulations, stormwater policies, existing and future TMDL's, existing and future Integrated Lists / Reports, and Surface Water Quality

Key Project Partners:

1. New Jersey Department of Environmental Protection
2. Sussex County Municipal Utilities Authority
3. Municipalities within the selected project areas (Sussex Borough, Wantage Township)
4. Agricultural Community
5. Sussex County 208 Water Quality Public Advisory Committee
6. Sussex County Board of Chosen Freeholders

Overall Project E Schedule: 40 Months

Project AA Budget:

Total Project Amount Requested:	$ 80,000.00
In-Kind Contributions:	$ 6,500.00 (allocated amount)
Total Project Cost:	$ 86,500.00

APPENDIX I – 2
Proposed Implementation Projects for 2009 - 2012

PROJECT BB:
Working with NRCS, Expedite the Development and/or Updating of Agricultural Conservation Plans for 800 Acres of Active Farmland that Straddles the Papakating Creek

Dairy Farm

Crop Growing

Equine Farm

Watershed Objective:
Achieve surface-water quality standards through reduction of total phosphorus and fecal coliform / *E.coli* loadings from agricultural operations

Project Description:
Field studies [54, 55] have shown that significant pollutant reductions, ranging from 5% to 40% per Best Management Practice implemented, may be achievable on operating agricultural farm sites, particularly in the case of sites adjacent to surface streams. The WRWMG proposes to work with the Natural Resource Conservation Service (NRCS), Rutgers Cooperative Research & Extension Sussex County office, Sussex County Soil Conservation District, Sussex County Agricultural Board, and the farming community to develop / upgrade Conservation Plans. Assistance will be provided to farmers regarding USDA funding sources / programs.

As part of **Project BB**, proposed for implementation in 2009, the WRWMG will facilitate the development and/or updating of the Agricultural Conservation Plans for approximately 800 acres of active farmland that straddles the Papakating Creek with a focus on identifying riparian restoration, manure management, and stream fencing field projects with local farm operators (deliverables to include updated Conservation Plans by NRCS, specific field implementation project work scopes, reconfirmation of project benefits, identified funding sources, and integration of potential pollutant reductions to be achieved by others into a comprehensive pollutant reduction summary balance for the entire Watershed under study). The HUC 14 subwatershed that is the primary focus for Project BB (#02020007020070) specifically contains 3 large dairy operations, 5 large horse farms, and the WRWMG sampling station “K”, which is located at Route 565.

Project Goal:
Reduction of total phosphorus and fecal coliform / *E.coli* loadings to the Papakating Creek

Project Objectives:

- Work with the identified farmers to gain their buy-in to request from NRCS the development and/or upgrade of current Conservation Plans to address the identified BMPs. (Note: Without the one-on-one role by the WRWMG, the probability of this step being taken by the local farmers may be many years into the future, if at all. The longer this step is delayed, the more delay is incurred with respect to the installation of efficient BMPs for pollutant reduction.) Potential pollutant reductions are believed to be in the range of several hundred pounds/year for the larger farms.
- Assist farmers in the procurement of required USDA funding
- Achieve surface-water quality standards through the identification / implementation of riparian buffer, manure management, and fencing restoration projects on the identified agricultural lands.

Project Tasks:

- Conduct meetings/field visits with project partners including specific local farmers
- Development / updating of Conservation Plans by NRCS (2 to 5 Plans)
- Conduct work meetings regarding funding sources, and funding proposals/submittals
- Further analysis of expected pollutant reductions and project benefits for the agreed upon BMPs to be implemented
- Provide assistance during the scoping phase of the proposed implementation projects
- Provide coordination and project management services with respect to the farming community within Sussex County (includes the Sussex County Agricultural Board) on issues covering stream and lake water quality, achieving TMDL requirements, targeted pollutant reductions, limited and targeted monitoring assistance, etc.
- Conduct assessments addressing the translation of programs and expected results to the entire project area within the Papakating Creek Watershed
- Documentation and issuance of technical and progress project reports

Project Benefits:

- Stabilization of eroding streambanks
- Reduction of fecal coliform / *E.coli* loadings to lakes and surface waterways
- Reduction of sediment pollutant loading to lakes and surface waterways
- Motivation of the Watershed community to support the Papakating Creek Watershed Restoration Plan

Necessary Partners:

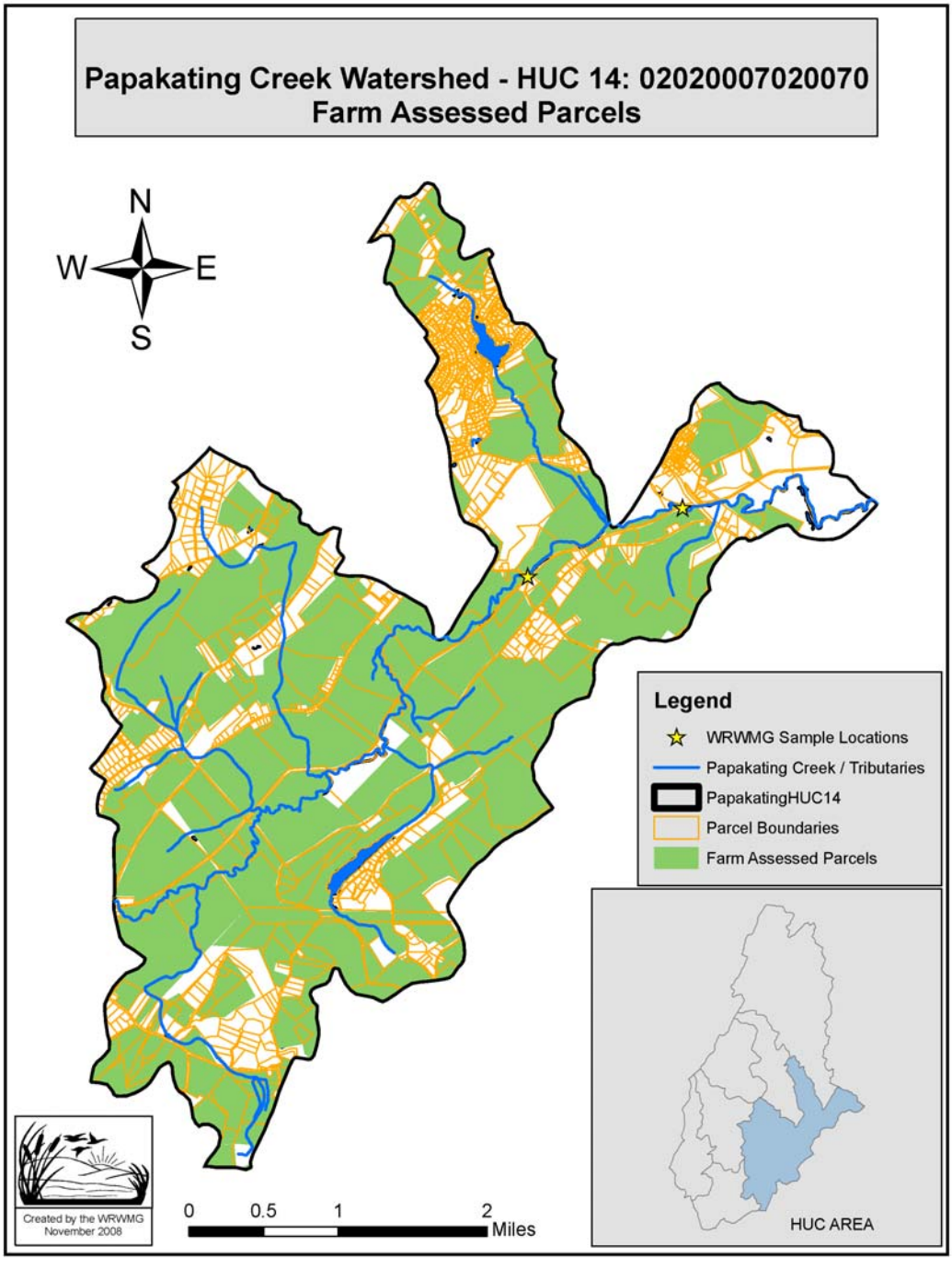
- Local farm community
- Natural Resource Conservation Service
- Rutgers Cooperative Research & Extension Sussex County Office
- USDA funding sources / programs / contacts
- Sussex County Soil Conservation District
- Sussex County Board of Agriculture
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group

Overall Project BB Schedule: **28 Months**

Project BB Budget:

Total Project Amount Requested:	**$ 54,200.00**
In-Kind Contributions:	**$ 8,600.00 (allocated amount)**
Total Project Cost:	**$ 62,800.00**

Project BB GIS Map:



WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I - 3

Proposed Implementation Project for 2009 - 2012

Project CC
Characterization and Assessment of Lake Neepaulin consistent with NJDEP's BEAR "Requirements for Lake Characterization" Protocol

Lake Neepaulin

Lake Neepaulin Dam / Spillway

Watershed Objective:
Support FOLN in developing a lake and tributary Management Plan that addresses the reduction of total phosphorus and fecal coliform / *E.coli* pollutant loadings to Lake Neepaulin as well as to the Papakating Creek. Assist in program development, identification of Best Management Practices, task prioritization, and funding sources for implementation of pollutant reduction projects. The goal of all tasks is the achievement of applicable lake and stream surface water quality standards.

Project Overview:
Water quality data collected by the WRWMG as part of the efforts to develop the Watershed Restoration Plan for the Papakating Creek Watershed Restoration Plan as well as pollutant source tracking field investigations have indicated that Lake Neepaulin, and it's exiting tributary, Neepaulakating Creek (a tributary to the Papakating Creek) may be a significant source of total phosphorus and fecal coliform / E.coli loading to the Papakating Creek. The WRWMG proposes to maintain an existing relationship with the extremely active community lake association, know as the Friends of Lake Neepaulin (FOLN) to conduct a comprehensive lake characterization and assessment, consistent with NJDEP's lake assessment criteria, and ultimately develop a lake and tributary Management Plan that addresses the reduction of total phosphorus and fecal coliform / *E.coli* pollutant loadings. Included as part of the characterization effort will be a partnership with the Sussex County Office of GIS to implement a GIS mapping and modeling initiative to 1.) identify, map, and study the stormwater loading patters to the Lake and 2.) identify suitable sites for catch basin retrofit projects.

Project Goals:

- Achieve applicable lake and stream / surface-water quality standards through a coordinated project leadership approach for the identification / implementation of projects leading to the reduction of total phosphorus and fecal coliform / *E.coli* loadings to lakes and surface waterways
- Assist in program development, identification of Best Management Practices, task prioritization, and funding sources for implementation of pollutant reduction projects

Project Benefits:

Identification of Specific Implementation Projects Leading to:

- Reduction of Total Phosphorus loadings to the Papakating Creek
- Reduction of fecal coliform/*E.coli* loadings to the Papakating Creek
- Reduction of sediment pollutant loading to the Papakating Creek
- Motivation of the lake community to support the Clove Brook and Papakating Creek Watershed Restoration Plans

Project Tasks:

- Initiate a comprehensive lake characterization and assessment study, including a chemical and biological sampling program to assess existing water quality conditions
- Implement a GIS mapping and modeling initiative to 1.) identify, map, and study stormwater loading patterns to the Lake and 2.) identify suitable sites for catch basin retrofit projects.
- Institute a total phosphorus management system (low phosphorus fertilizers, septic-pumping ordinance, etc. to control a recurring lake weed problem
- Identify potential in-lake and out of lake BMP's for implementation, geared towards reducing total phosphorus and fecal coliform / E.coli loading to the Lake
- Assist the existing lake association with the development of a community wide education and outreach program to raise awareness and generate increased stewardships efforts
- Develop a consistent / long-term lake water-quality monitoring program

Key Project Partners:

- Lake Neepaulin - FOLN organization
- Lake Neepaulin's lake / water-treatment consultants
- Municipal / County departments regarding road / stormwater drainage issues
- County Health Department (beach monitoring)
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group

Overall Project CC Schedule: 24 Months

Project CC Budget:

Total Project Amount Requested:	$ 52,000.00
In-Kind Contributions:	$ 4,300.00 (allocated amount)
Total Project Cost:	$ 56,300.00

APPENDIX I – 4

Proposed Implementation Projects for 2009 - 2012

PROJECT DD:

Installation of Stormwater Treatment Devices Into Catch Basins With Direct Discharge to Lake Neepaulin and Neepaulakating Creek

Watershed Objective:

Achieve surface-water quality standards through reduction of total phosphorus, sediment, and fecal coliform / *E.coli* loadings from stormwater runoff

Project Description:

Consistent with the Project B from the developed Clove Acres Lake / Clove Brook Restoration Plans by the WRWMG and Princeton Hydro, LLC, which will provide for the installation of stormwater treatment devices into six catch basins on Lakeshore Drive with direct discharge to Clove Acres Lake, the WRWMG also proposes to implement a similar project, **Project DD** for Lake Neepaulin and it's exiting stream, Neepaulakating Creek, which in turn is a significant tributary to the Papakating Creek. The Project will consist of two phases:

Phase I: Project deliverables will include project details, design drawings and specifications, reconfirmation of project benefits, as well as a finalized budget and timeline for project implementation.

Phase II: Upon reconfirmation of project benefits, proceed with full field implementation.

Project Goal:

Reduction of nonpoint sources of total phosphorus (TP) to Lake Neepaulin and the Neepaulakating Creek (a tributary to the Papakating Creek)

Project Objectives:

Complete design plans for a catch basin retrofit project along Northshore Drive, located adjacent to Lake Neepaulin in Wantage Township, as well as complete field installation

Project Benefits:

Reduction of total phosphorus, sediment, and fecal coliform / E.coli loadings via stormwater into Lake Neepaulin and the Neepaulakating Creek, and hence to the Papakating Creek.

Project Tasks:

Task 1: Finalize already existing arrangements / partnerships with Friend of Lake Neepaulin (FOLN) and Wantage Township
Task 2: Engage contractor to complete scoping / field / permitting / design efforts
Task 3: Services from Princeton Hydro, LLC.
Task 4: Consultation from Princeton Hydro, LLC to the WRWMG
Task 5: Technical, Project, and Accounting Management Services by the WRWMG

Overall Project DD Schedule: **12 Months**

Project DD Budget:

Total Project Amount Requested:	$ 47,500.00
In-Kind Contributions:	$ 4,300.00 (allocated amount)
Total Project Cost:	$ 51,800.00

Note: Project DD can be implemented either independently of Project CC, or at a future time after Project CC is completed and can therefore serve to provide further proof of the need for the stormwater treatment devices.

APPENDIX I - 5

Proposed Implementation Projects for 2009 - 2012

PROJECT EE:

Streambank Stabilization, Riparian Restoration, and Floodplain Enlargement on the Papakating Creek at Route 565 in Wantage Township

Papakating @ Route 565
Upstream View, Normal Flow Conditions

Papakating @ Route 565
Upstream View, Flooding Conditions

Watershed Objective:
Achieve surface-water quality standards through the reduction of streambank erosion, and the resultant sediment and total phosphorus loadings to lakes and surface waterways

Project Description:
This quarter (1/4) mile section of the Papakating Creek, which is approximately 2 miles upstream from the confluence with the Wallkill River, is currently suffering from severe streambank erosion on both sides of the stream, lack of a healthy riparian buffer, and massive overland flooding during significant storm events. These overland flooding events appear to be a major cause of the observed bank erosion, which in turn is a major source of sediment loading to the Papakating Creek and in turn, the Wallkill River. The WRWMG wishes to coordinate efforts to restore and enhance this section of the Papakating Creek by stabilizing both sides of the streambanks, increasing the size of the existing floodplain, and planting native vegetation to improve the health of the riparian buffer.

Project EE, proposed for implementation in 2009 – 2012 accounts for the entire design phase of the project, including the development of all project details, design drawings and specifications, reconfirmation of project benefits, and a budget timeline for full implementation. Full Project Implementation can be completed within 36 months at an estimated budget of $385,400 (includes design phase costs).

Project Scope:

Phase 1: Complete set of design plans for a streambank stabilization, riparian restoration and floodplain enlargement project along the Papakating Creek at Route 565; Phase 2: Complete field installation

Project Goal:

Reduction of nonpoint sources of total phosphorus (TP) to the Papakating Creek at Route 565 (WRWMG Sampling Site "K")

Project Benefits:

- Stabilization of eroding streambank and improvement of riparian buffer
- Reduction of sediment pollutant loading to the Papakating Creek and Wallkill River
- Reduction of flooding impacts downstream agricultural and residential areas
- Decrease water temperature, increase dissolved oxygen levels within the stream reach
- Improvement of aquatic habitat and health of macroinvertebrate community
- Improvement of overall stream corridor aesthetics

Deliverables:

- Development of certified engineering design plans for site restoration
- Restoration, stabilization, and re-vitalization of riparian corridor for 400 feet of streambank on each side
- Restoration of natural stream flow conditions
- Coordination of a community volunteer restoration effort to assist with the project
- Educate the community about the benefits of streambank restoration projects

Proposed Project Design Concepts

- Site visits (conceptualize technical work scope including a preliminary stream flooding hydraulic assessment / assess project complexity)
- Site meetings with adjacent landowners / Sussex County Engineering and Road Department / Wantage Township (build partnerships)
- Identify technical partners (firms with proven experiences and accomplishments; i.e. Princeton Hydro, NRCS, specialized streambank stabilization firms)
- Investigate permitting regulations / requirements and compliance needs with NJDEP's Flood Hazard Area Control Act Rules
- Establish project goals / benefits / constraints
- Develop implementation strategies / options for economic assessment
- Consider the following likely strategy: [1]
    1. Work with landowner to conceptualize an initial plan

2. Princeton Hydro develops concept plan based upon the following considerations: applicable Flood Hazard Rules, development of survey maps, use of debris materials to be removed (tree logs, stumps, etc. for use in streambank stabilization); select appropriate stream repair practices (revetments, streambank shaping, live stacks, rock and/or "J" vanes, erosion control fabrics, vegetation establishments, scour protection, toe protection, and buffer plantings)
3. Conduct meetings with partners including a representative from Wantage Township
4. Develop a budget project cost for funding purposes
5. Arrange / obtain funding
6. Competitive bidding followed by contract award
7. Satisfy NJDEP, County, Township and other agency permitting requirements (obtain approval for waiving of NJDEP permitting fees)
8. Complete preparation of final design drawings including specifications
9. Complete balance of required tasks leading to field mobilization, construction, project management activities, project completion and acceptance , and inclusion of project as part of the Papakating Creek Post-Monitoring Plan

Note 1: Based on discussions with Linda Peterson (NRCS) and Dr Steve Souza (Princeton Hydro, LLC)

Necessary Partners:

Wantage Township
Sussex County Division of Engineering
North Jersey Resource Conservation District
Sussex County Municipal Utilities Authority
Gleim Environmental Group
Private Landowner
Princeton Hydro, LLC
NRCS
WRWMG

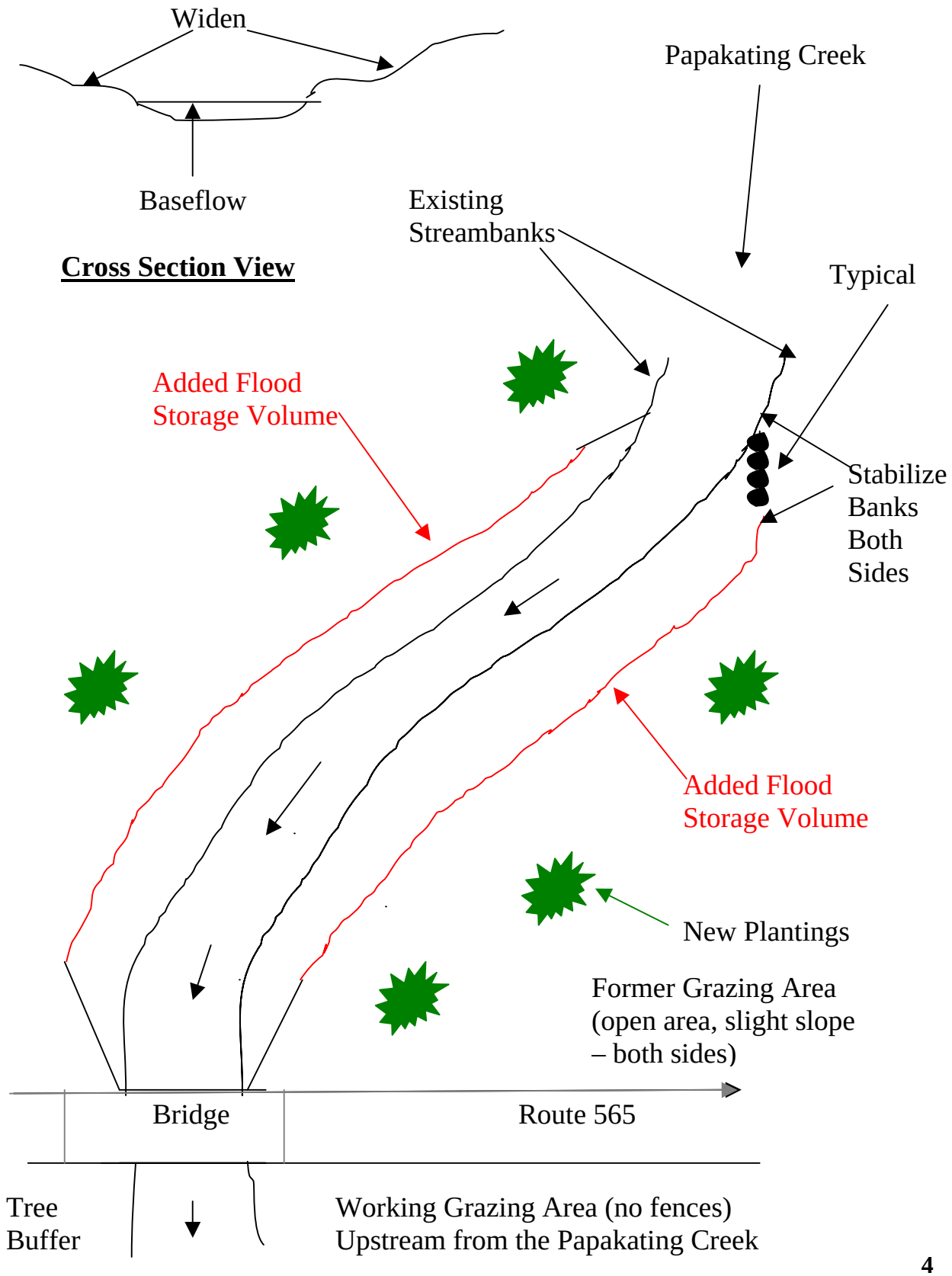
Overall Project EE Schedule:

Phase 1: 12 Months (Project Design)
Phase 2: 36 Months (Project Design and Implementation)

Project EE Budget:

Total Phase 1 Amount Requested:	$ 82,100.00
Total Phase 2 Amount Requested:	$ 303,300.00
Total Project Amount Requested:	$ 385,400.00
In-Kind Contributions:	$ 4,300.00 (allocated amount)
Total Project Cost:	$ 389,700.00

Project EE Site Drawings:



WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I - 6

Recommended Implementation Project Within the 0-3 years

Implementation of Low Cost Riparian Buffer Projects on Agricultural Lands

Papakating Creek @ Route 565 (Looking Upstream)

Papakating Creek @ Route 565 (Looking Downstream)

Watershed Objective:

Achieve surface-water quality standards through the identification / implementation of riparian buffer restoration projects on agricultural lands leading to the reduction of total phosphorus and fecal coliform / *E.coli* loadings to lakes and surface waterways

Project Description:

Several agricultural areas within the watershed have been identified as desirable sites for riparian buffer restoration projects. These locations are currently lacking a viable riparian buffer and as a result are a potential location for pollutant loading to the stream, particularly during major storm events. The WRWMG proposes to work with the Natural Resource Conservation Service, Rutgers Cooperative Research & Extension Sussex County Office, Sussex County Soil Conservation District, Sussex County Agricultural Board, and the farming community to identify farmers who are willing to explore implementing a riparian restoration project on their particular farm. The WRWMG will work to identify and secure funding sources, build partnerships to provide site design, and coordinate overall efforts to implement the projects.

Project Benefits (Papakating Creek Watershed):

- Stabilization of eroding streambanks
- Reduction of fecal coliform / *E.coli* loadings to lakes and surface waterways
- Reduction of sediment pollutant loading to lakes and surface waterways
- Reduction of flooding impacts to streamside fields and properties

- Improvement of riparian corridor health
- Decrease water temperature, increase dissolved oxygen levels in stream reaches
- Improvement of aquatic habitat and health of macroinvertebrate community
- Improvement of overall stream corridor aesthetics

Specific Tasks:

- Conduct meetings with identified partners
- Conduct extensive field visits with project partners and local farmers
- Conduct extensive Education and Outreach efforts to convince farmers of the necessity for and benefits of the proposed projects
- Development of implementable riparian buffer site designs

Necessary Partners:

- Local farm community
- Natural Resource Conservation Service
- Rutgers Cooperative Research & Extension Sussex County Office
- USDA funding sources / programs / contacts
- Sussex County Soil Conservation District
- Sussex County Board of Agriculture
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group

Work Processes:

- Team Building
- Field / farmer visits
- Value analysis approaches to show relationship of Watershed stewardship to value to individual farmers
- Concept Plans
- Education & Outreach to the farming community on issues addressing the "need for" / "value of" pollutant reduction implementation projects (the most important key task if the program is to be a success)

Deliverables:

- Identification of applicable farm sites / implementation projects
- Assistance in supporting farmers with funding source applications
- Restoration, stabilization, and re-vitalization of riparian corridor for identified streambank locations
- Educate the community about the benefits of streambank restoration projects
- Integration / Coordination with Projects AA and BB

WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I - 7

Recommended Implementation Project Within 0-3 years

Implementation of Fencing on Agricultural Lands to Minimize Intrusion of Animals into Streams

Potential Candidate Sites:

Papakating Creek at Route 565
WRWMG Sampling Site "K"

Clove Brook at Route 23

Watershed Objective:

Achieve surface-water quality standards through reduction of total phosphorus and fecal coliform / *E.coli* loadings from intrusion of farm animals into adjacent farm streams

Project Description:

Field studies [54, 55] have shown that significant reductions in pollutants in the direct deposition of fecal phosphorus, approaching 32%, were effected through pasture management and streambank fencing. Fencing is a relatively low cost Best Management Practice to implement and results in a rapid and significant pollution reduction opportunity. Suitable farm sites in addition to the above two sites are to be identified. Work to be coordinated with the Natural Resource Conservation Service, Rutgers Cooperative Research & Extension Sussex County Office, and USDA funding sources / programs.

Project Benefits:

Reduction of total phosphorus and fecal coliform / *E.coli* pollutant loadings to the Papakating Creek and Clove Brook

Specific Tasks:

- Conduct meetings with identified partners
- Coordinate work tasks with updating / development of farm Conservation Plans
- Develop concept field plans
- Support local farmers in soliciting program funding

Necessary Partners:

- Natural Resource Conservation Service
- Rutgers Cooperative Research & Extension of Sussex County
- USDA funding sources / programs
- Individual farm partners
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group

Estimated Funding Requirements:

Included within the estimate developed for establishing the WRWMG as a Watershed entity for the implementation of the Papakating Creek and Clove Brook Restoration Plans (Project AA)

Work Processes:

- Team Building
- Application of Best Management Practices (Conservation Plans)
- Field / Farmer Visits
- Concept Plans
- Outreach support to farmers
- Education and Outreach relating to the "need for" / "value of" pollutant reduction implementation projects (the most important key task if the program is to be a success)

Deliverables:

- Identification of applicable farm sites
- Concept plans
- Assistance in supporting farmers with funding source applications
- Inclusion of implemented projects within the Papakating Creek Post-Monitoring Plan
- Integration / Coordination with Projects AA and BB

WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I - 8

Recommended Implementation Project Within 0-3 years

Implementation of Low-Cost Projects to Remove Stream Debris

(Related to Minimization of Streambank Erosion and Reduction of Flooding Intensity)

Potential Candidate Sites:

Clove Brook in Sussex Borough

Papakating Creek in Frankford Township

<u>Watershed Objective</u>:

Achieve surface-water quality standards through the removal of woody stream debris at locations throughout the watershed which alter stream flow patterns, exacerbate stream flooding, and increase rates of reduction of streambank erosion, which results in sediment and total phosphorus loadings to lakes and surface waterways

<u>Project Description</u>:

Numerous stream reaches throughout the Papakating Creek Watershed suffer from stream debris conditions as depicted in the photographs above. These debris dams serve to clog normal stream flow patterns, cause litter buildup, and drastically impacting flow patterns, particularly during high flow periods. These altered flow patterns are then a major cause of the streambank erosion, which in turn is a source of sediment loading to the impacted surface waterways. The WRWMG wishes to coordinate efforts to clean-up stream reaches such as these by removing the woody debris dams and all collected litter and return flow patterns to a more normal state.

Project Benefits:

- Reduction of streambank erosion
- Reduction of sediment pollutant loading to the watershed surface waters
- Reduction of flooding impacts to adjacent properties
- Increase dissolved oxygen levels in stream reaches
- Improvement of aquatic habitat and health of macroinvertebrate community
- Improvement of overall stream corridor aesthetics

Necessary Partners:

- Municipal Public Works Departments
- Watershed Volunteers
- North Jersey Resource Conservation District
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group
- Contractors selected for the streambank stabilization / restoration projects

Estimated Funding Requirements:

These projects are intended to be low cost, volunteer driven efforts, aided by in-kind services from local municipal public works departments, and site location property owners.

Work Processes:

- Field visits
- Visual assessment reports
- Outreach meetings to participating communities
- Partnership building

Deliverables:

- Stream bank litter clean-up
- Restoration of natural stream flow conditions
- Coordination of a community volunteer efforts to assist with the projects
- Educate the community about the benefits of streambank restoration projects

WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I – 9

Recommended Implementation Project Within 0-3 years

Identification of Open Space Land Candidates for Potential Preservation Within the Papakating Creek Watershed

Watershed Objective:
Achieve and / or maintain surface-water quality standards through the protection of open space lands high with water resource value, healthy riparian corridors, or recreational opportunities, or that offer a location for the implementation of an identified non-point source pollutant reduction strategy or best management practice.

Project Description:
The WRWMG will develop and facilitate an identification, assessment, and recommendation process for open space land candidates for purchase by Federal, State, and County government agencies, municipalities, and various Land Trust organizations.

Project Benefits:
The WRWMG is not and does not have the capabilities to be a land acquisition organization. However, the WRWMG has an extensive knowledge of the Papakating Creek Watershed lands as a result of the detailed, parcel by parcel, HUC investigations. This knowledge could be offered to Federal, State, and County government agencies, municipalities, and various Land Trust organizations so that more informed decisions can be made when it comes to selecting parcels for open space preservation.

Upon long term completion of the approved Wallkill River National Wildlife Refuge expansion of approximately 7,600 acres, reduction of total phosphorus loading to the Papakating Creek is estimated at 1,500 pounds/year (682 kg/year). The estimated loading reduction is approximately 10% of the TMDL targeted reduction of 10,000 pounds/year (4545 kg/year).

Necessary Partners:

- Wallkill River National Wildlife Refuge
- Sussex County Open Space Committee
- Municipal Open Space Committees
- Non-profit Land Preservation Organizations (i.e. Natural Lands Trust, Nature Conservancy, etc.)
- New Jersey Department of Environmental Protection
- Sussex County Municipal Utilities Authority
- Wallkill River Watershed Management Group

Estimated Funding Requirements:

Included within the estimate developed for establishing the WRWMG as a Watershed entity for the implementation of the Papakating Creek and Clove Brook Restoration Plans (Project AA).

Specific Tasks:

- Field visits / site meetings
- Continued visual assessments / parcel investigations
- GIS mapping / aerial photography review
- Partnership building
- Identification of funding sources
- Facilitate contact / dialogue with non-profit land acquisitions organizations

Deliverables:

- Development of and maintenance of a recommendation list of open space candidates for distribution to Federal, State, and County government agencies, municipalities, and various Land Trust organizations.
- Continuous field investigations to maintain awareness of watershed lands / parcels that enter the real estate market and that could have potential open space candidates that
- Work with the U.S. Fish and Wildlife Service, and specifically the Wallkill River National Wildlife Refuge to promote and help encourage the implementation of the Refuge Comprehensive Conservation Plan which includes a proposed expansion of the current refuge boundary to include areas designated along the Papakating Creek corridor. The WRWMG's involvement is based on the assumption that all additional lands will be procured only from willing sellers.

WALLKILL RIVER WATERSHED MANAGEMENT GROUP
Sussex County Municipal Utilities Authority

APPENDIX I – 10

Recommended Implementation Project Within the 0-3 years

Community Efforts Supporting the Acceptance and Implementation of Recommended Plan Projects

Watershed Objective:
The ongoing mission of the Wallkill River Watershed Management Group (WRWMG) has always been to raise awareness about the Wallkill River Watershed and generate stakeholder participation in various watershed management initiatives to maintain, restore, and enhance the watershed. From the onset, the key to successfully accomplishing this mission is developing and maintaining an aggressive education and outreach campaign covering initial watershed assessments to full scale implementation projects.

Project Description:
It has long since been the stance of the WRWMG that the way to get stakeholders to develop a sense of commitment to the Watershed and a desire to be involved in the efforts to protect it, is to make sure they are continuously aware of the ongoing project efforts and allow them to develop a sound understanding of how they can participate. As part of implementing the Watershed Restoration Plan for the Papakating Creek Watershed, the WRWMG will aggressively reach out to and maintain communications with the county officials, the municipalities and the public stakeholders who are a part of this project area to:

- Share collected water quality data and other pertinent project information
- Solicit input and feedback
- Provide Plan development updates
- Encourage active participation in both short-term and long-term implementation projects

Project Benefits:

Once the Restoration Plan is formally approved by NJDEP, the next step is to begin the design and implementation of the recommended restoration strategies, initiatives, and projects. As part of this process, there exists a need to bridge the gap between restoration planning and implementation funding cycles, maintain already established momentum, and initiate initial design and implementation of approved restoration initiatives and strategies. The proposed program will help raise awareness about the completed Plan, generate active participation to help implement it, and ultimately generate stakeholder buy-in and belief in its overall value.

Specific Tasks:

The following is an outline for the proposed community outreach program specific to the Papakating Creek Watershed Restoration Plan:

Task 1: Raise awareness about the approved Restoration Plan and distribute throughout the Papakating Creek Watershed

- Provide summary presentations and distribute copies of Plan at public meetings (County 208 Water Quality PAC, municipal committees, County Board of Agriculture, etc.)
- Issue press announcements to local papers about the Plan and provide information on how to obtain a copy
- Generate informational handouts / posters for distribution at various public locations (county and township buildings, SCMUA, Wallkill River National Wildlife Refuge, public kiosks, etc.)
- Post Plan on the WRWMG website

Task 2: Develop, Initiate, Promote hands-on outreach campaigns and projects to share / spread educational information for key topics

- Identification of pollutant reduction implementation projects
- Septic management practices
- Manure management approaches / practices
- Stormwater management regarding pollutant loading reductions to surface waters
- Winter road maintenance regarding salt / de-icing practices
- Lake management plans
- Available public recreational uses within the Watershed

Task 3: Build a GIS Internet Mapping Service Website designed to track the implementation progress of the Restoration Plan

- Pollutant load reductions achieved
- Water quality trend data
- Stream restoration sites
- Stream debris removal sites
- Stream flooding locations / pollutant loading implications
- Open Space Properties (focus on potential benefits to yearly stream water quality issues)

Task 4: Plan / institute a long-term sustainability plan for the continued coordination, implementation, and maintenance of the initiatives, projects, and strategies contained within the Restoration Plan (projects sponsored directly by the WRWMG as well as by other community organizations and stakeholders)

- Linkage of the Education and Outreach and Post-Monitoring Plans
- Documentation and publication of pollutant reduction project successes achieved both internally and externally by other Watershed Implementation Plan sponsors
- Provide a communication channel between watershed stakeholders and NJDEP, educational institutions, and manufacturing companies in applicable areas relating to non-point pollutant(s) reduction techniques
- Address approaches / considerations that target maintaining the economic viability of the agricultural community within the watershed.

Task 5: Explore innovative and ongoing outreach programs to 1.) generate active stakeholder involvement in achieving the Papakating Creek Watershed Restoration Plan goals, 2.) identification of future implementation projects, and 3.) encouragement of overall watershed stewardship with respect to the restoration, protection, and pursuit of the Plan's surface water quality goals

- Seasonal watershed clean-ups program
- Stream identification signs
- Volunteer restoration projects
- Farm tours to promote ongoing water quality activities / practices
- Auto Tour Guides
- Storm drain stenciling
- Sponsor canoe / kayak trips

Deliverable:

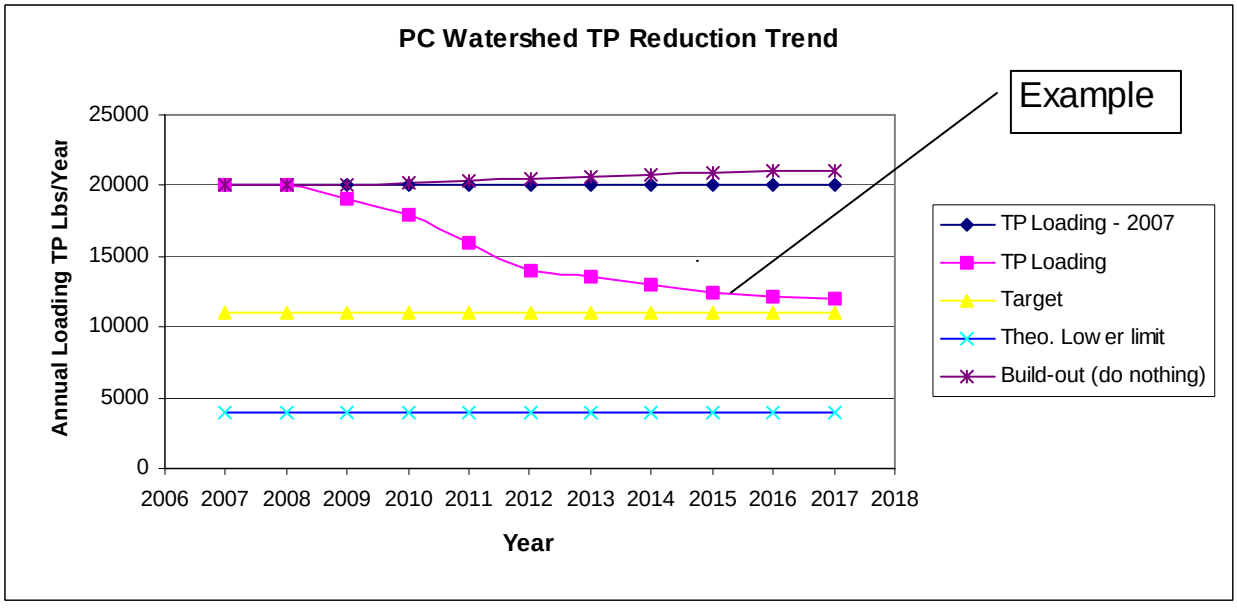
- An outreach campaign that will provide the leadership, coordination, and sponsorship of the full implementation of the Papakating Creek Watershed Restoration Plan

Appendix II

Non-Point Source Pollutant GIS Modeling in the Papakating Creek Watershed

Sussex County, New Jersey

As part of the Wallkill River Watershed's Management Groups (WRWMG) efforts to develop Watershed Restoration Plans for both the Papakating Creek and Clove Acres Lake Watersheds, the WRWMG partnered with the Sussex County Office of GIS to develop a GIS-based methodology / model for estimating annual surface water pollutant loads using ESRI's Model Builder and GIS data and tables such as: HUC14 Watersheds, 2002 Land Use / Land Cover (LU/LC), Developable lands from the Sussex County Strategic Growth Plan, Best Management Practice (BMP) loading coefficients, parcel data, and current municipal zoning. The developed methodology can be used for technical calculations addressing the quantification of annual total phosphorus, nitrogen, and sediment loads for a watershed under present, future (100% build-out), future (following implementation projects), and natural state conditions for a single or multiple HUC 14 sub-watershed level within the State of New Jersey. The methodology can also to be used for sensitivity studies typically undertaken to establish theoretical lower limit annual pollutant loads, reality testing of established reduction goals, tracking annual pollutant reductions as a result of completing implementation projects, quantifying future pollutant load contributions from new development projects, assessment of alternative loading coefficients, etc. Charting of results using programs such as Microsoft Excel can then be used to visually display the data for trending analysis.

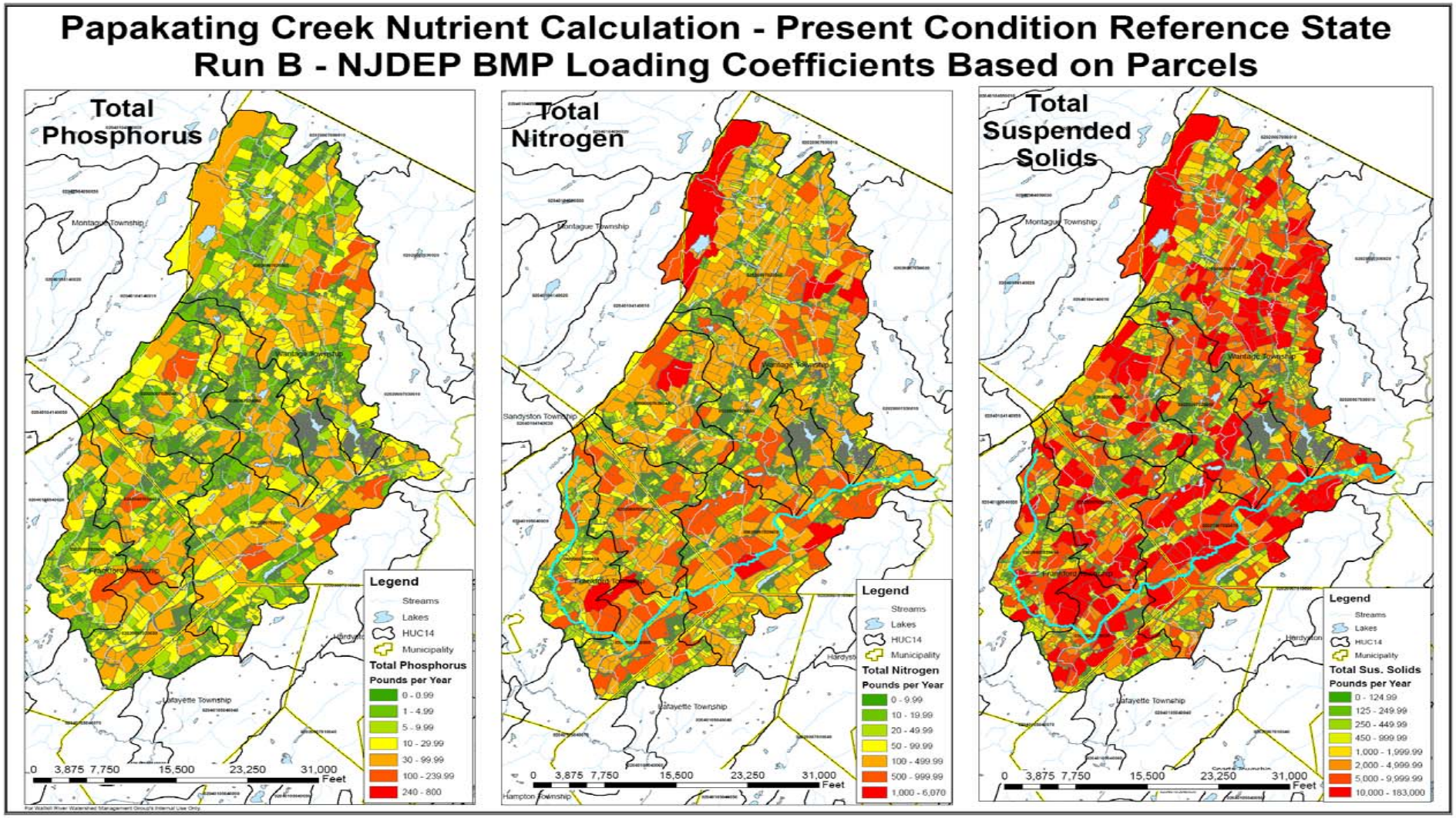


PROJECT TEAM

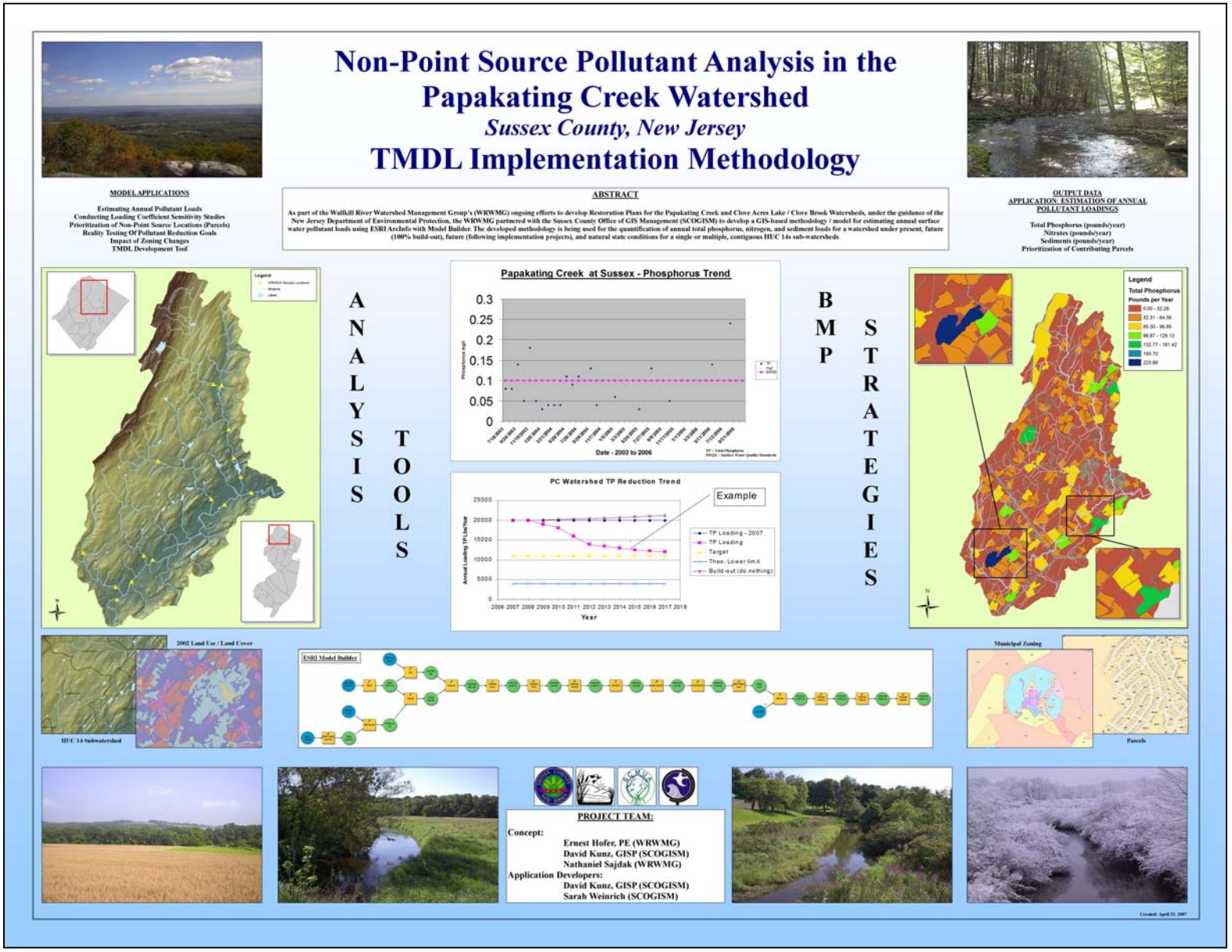
Concept Developers:
Ernest Hofer, PE (WRWMG)
David Kunz, GISP (SCOGISM)
Nathaniel Sajdak (WRWMG)

Application Developers:
David Kunz (SCOGISM)
Sarah Weinrich (SCOGISM)

Appendix II - Continued



Appendix II – Continued



In April 2007, the SCOGISM and the WRWMG participated in the NJDEP's 20th Annual GIS Mapping Competition, with the map displayed above, and placed second in the category of "Best Analytical Presentation". The map was also selected by the New Jersey Academy of the Sciences as "Best Scientific Map" displayed at the competition.

Appendix III

Total Phosphorus - HUC 14 Mass Balance Methodology
Papakating Creek Watershed
Sussex County, New Jersey

Background:

A methodology was developed to 1) approximate the individual total phosphorus load contribution from each of the seven Papakating Creek HUC 14 subwaterheds and 2) to prioritize (rank) the seven HUC 14s to identify where emphasis should be placed with respect to early implementation projects. The methodology is generic and can be applied to similar pollutant load assessments. The general principles are based on standard chemical engineering unit process fundamentals. The uncertainty associated with the approximated results can be reduced by the use of larger databases for the measured parameters (i.e., stream flow rates, pollutant concentrations, higher frequency of sampling).

Specifically, the developed mass balance methodology is an attempt to rank each HUC 14 with respect to its' pollutant contribution to the total loading emanating from the WRWMG Site "L" (considered the last assessable point of the Papakating Creek prior to the confluence with the Wallkill River). The mass balance approach is based on calculating the load contribution (concentration times flow rate times a conversion factor) for each stream entering and exiting each HUC 14 subwatershed. Sampling locations were previously selected at the boundaries of each HUC 14 subwatershed. The presence of a USGS real-time flow station within one of the HUC subwatersheds is a positive factor with respect to daily and long-term stream flow trends.

Calculation Concept:

Example: HUC …020070 Material Balance

Input + Internal Loadings / Generation = Output

Internal Loadings / Generation = Output - Input

Note: neglect air deposition; no known point sources

HUC …20070 Internal Loadings / Generation = Output from Site"L" - (Input from Site"R" + Input from Site"N" + Input from Site "J")

Note: Sites R, N, and J represent outputs from three other HUC 14 subwatersheds draining to HUC …020070

Each Input and Output Loading can be defined as "Stream Concentration x Flow Rate x Conversion Factor"

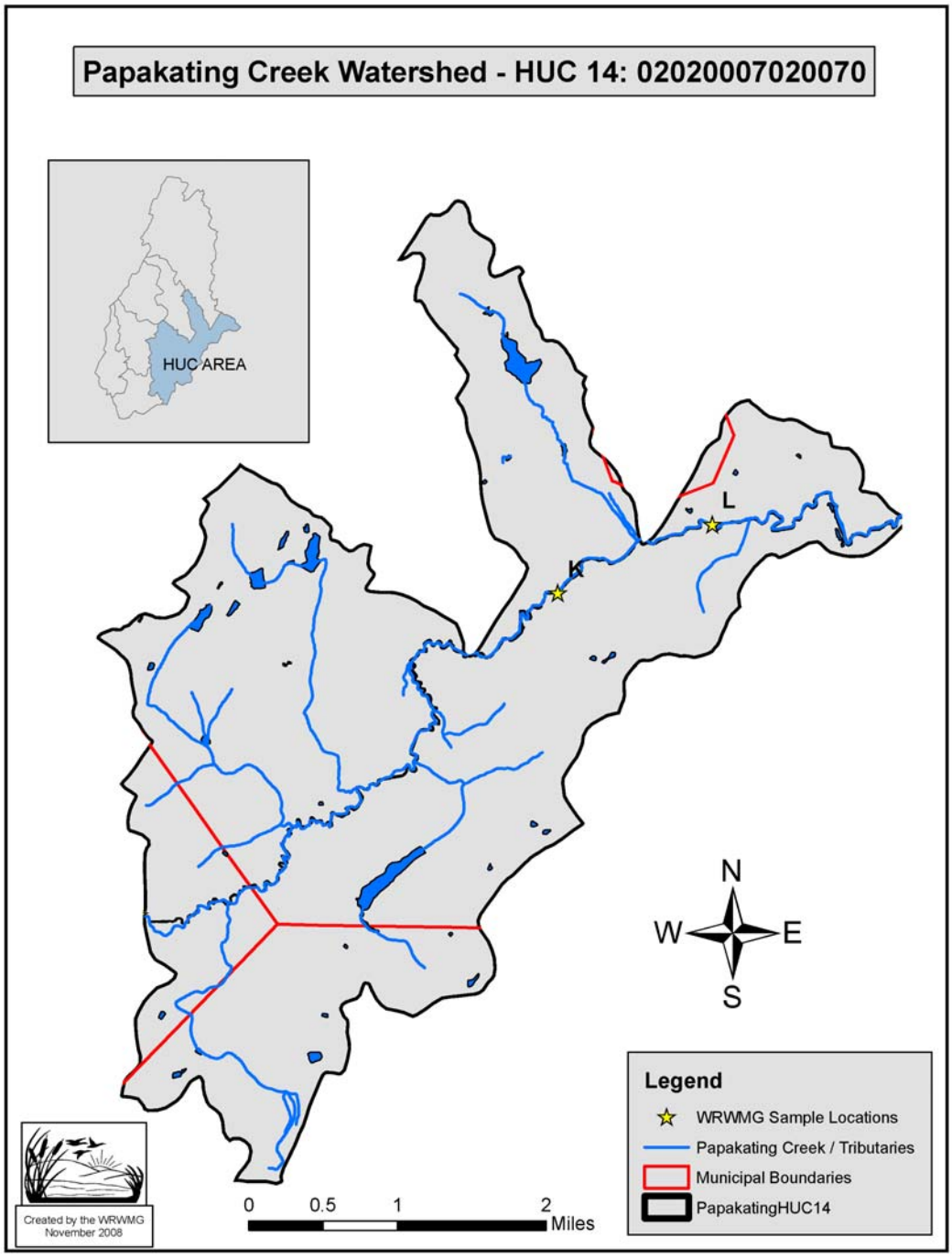
Percent HUC …20070 Internal Loading / Generation of the reference Site L loading can be defined as (Internal Loading / Contribution) x 100 / Output from Site"L"

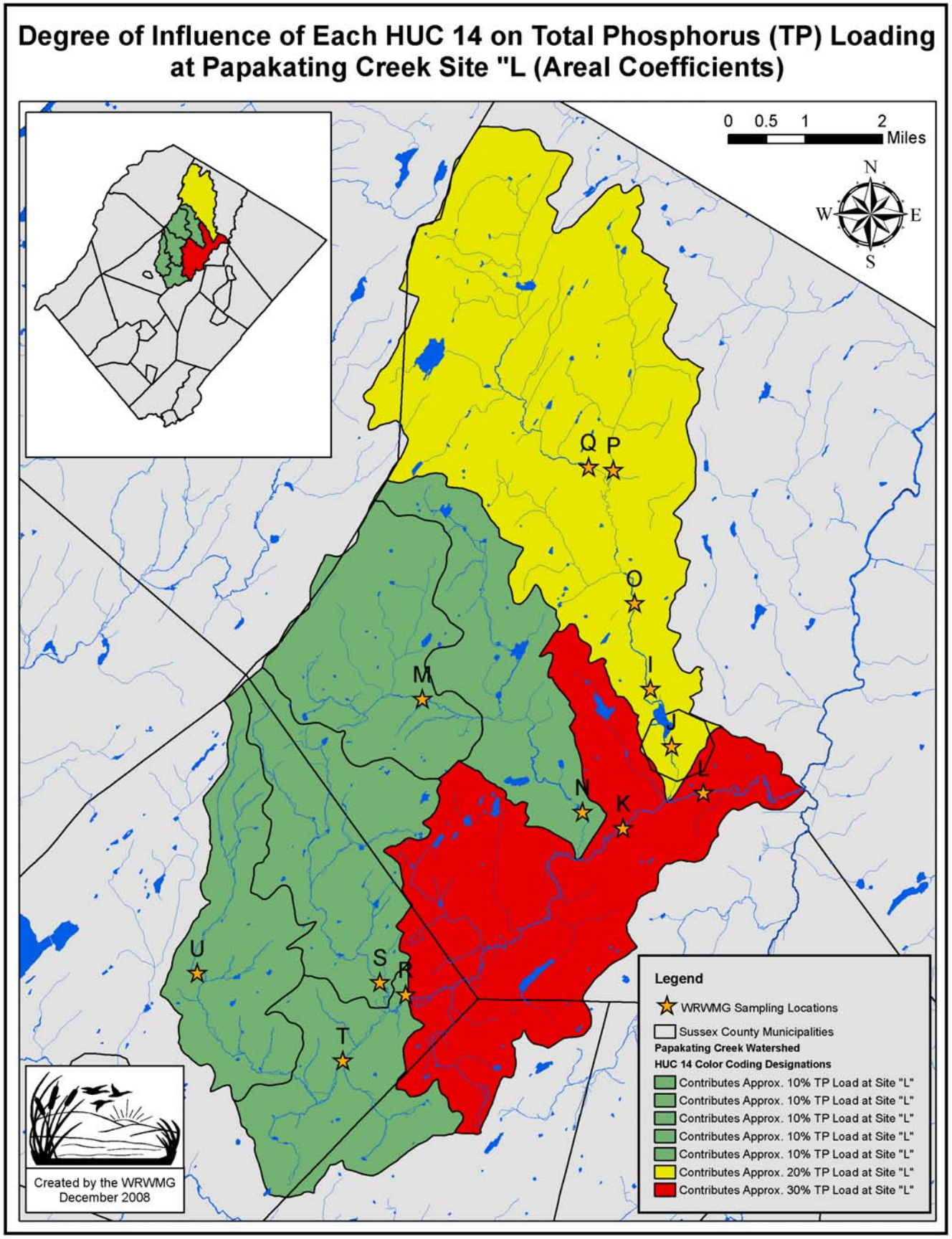
Note: Each of the seven HUC 14 subwatersheds can be ranked with respect to its' loading contribution to Site "L"

Database Sources: Monthly chemical and flow rate measurements plus multi-year flow measurements for the USGS real-time flow station at Site R. Some data point smoothing was used. As noted above, the degree of uncertainty can be reduced by the use of more frequent sampling as well as a longer time period for the calculation. Estimation results were in general agreement with a similar methodology based on the use of total phosphorus areal coefficients.

Calculations Results:
Refer to *Tables 16 - Total Phosphorus* (page 52) and *21 - Fecal Coliform / E.coli* (page 58)

GIS Mapping:




Degree of Influence of Each HUC 14 on Total Phosphorus (TP) Loading at Papakating Creek Site "L (Areal Coefficients)
0 0.5 1 2
Miles
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W
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S
Q
P
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I
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L
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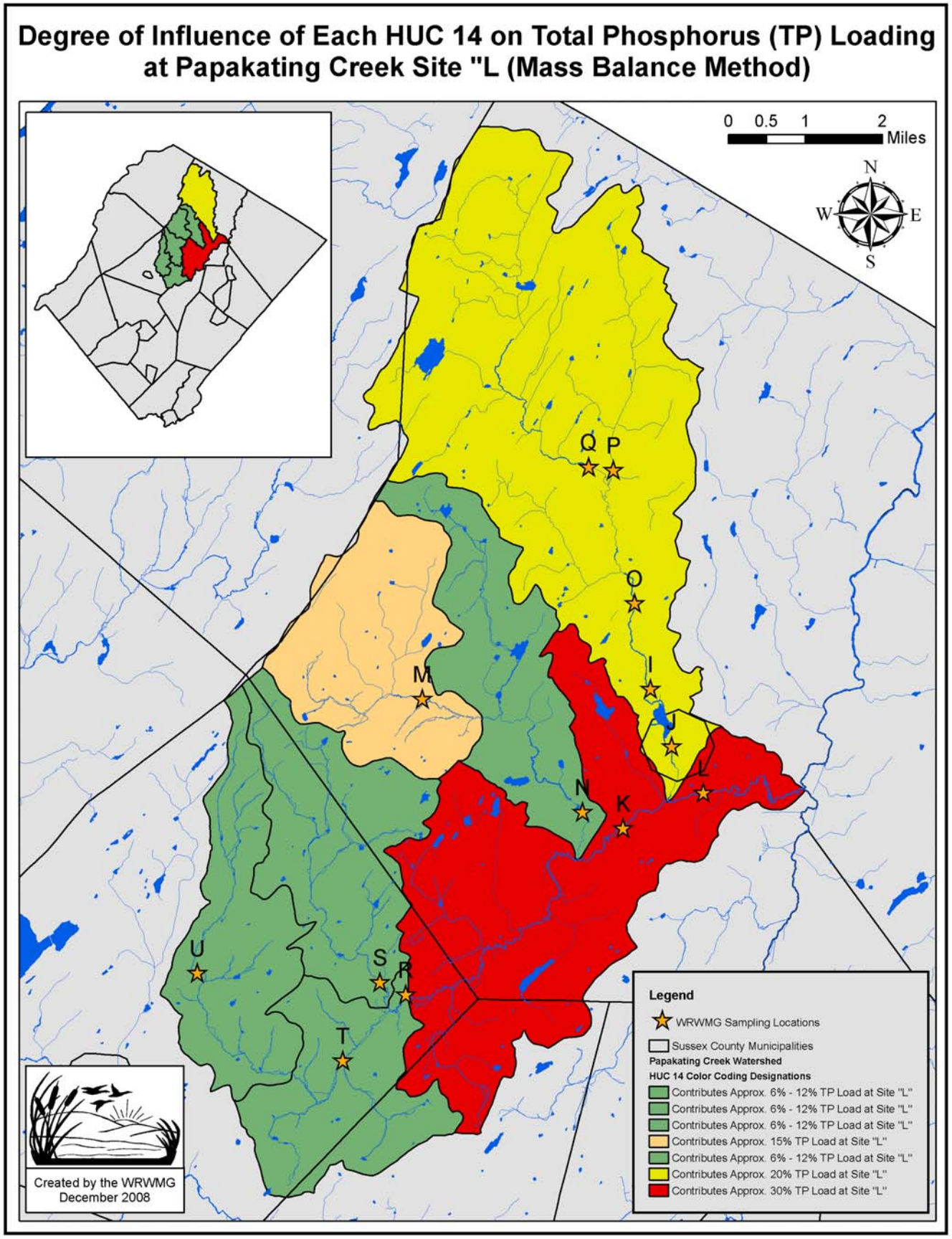
K
U
S
R
T
Legend
WRWMG Sampling Locations
Sussex County Municipalities
Papakating Creek Watershed
HUC 14 Color Coding Designations
Contributes Approx. 10% TP Load at Site "L"
Contributes Approx. 10% TP Load at Site "L"
Contributes Approx. 10% TP Load at Site "L"
Contributes Approx. 10% TP Load at Site "L"
Contributes Approx. 10% TP Load at Site "L"
Contributes Approx. 20% TP Load at Site "L"
Contributes Approx. 30% TP Load at Site "L"
Created by the WRWMG
December 2008


Degree of Influence of Each HUC 14 on Total Phosphorus (TP) Loading at Papakating Creek Site "L (Mass Balance Method)
0 0.5 1 2
Miles
N
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Q
P
O
I
M
J
L
N
K
U
S
R
T
Legend
WRWMG Sampling Locations
Sussex County Municipalities
Papakating Creek Watershed
HUC 14 Color Coding Designations
Contributes Approx. 6% - 12% TP Load at Site "L"
Contributes Approx. 6% - 12% TP Load at Site "L"
Contributes Approx. 6% - 12% TP Load at Site "L"
Contributes Approx. 15% TP Load at Site "L"
Contributes Approx. 6% - 12% TP Load at Site "L"
Contributes Approx. 20% TP Load at Site "L"
Contributes Approx. 30% TP Load at Site "L"
Created by the WRWMG
December 2008

Appendix IV
Papakating Creek Watershed Source Tracking Investigations
HUC 14: 02020007020070

Historic Railbeds /
Current Gas Pipelines /
Future Public Use Trails

Lake Neepaulin

Future Route 23
Reconstruction Project

Large Dairy Farm

Large Horse Farm

Stormwater Flooding of
Agricultural Fields

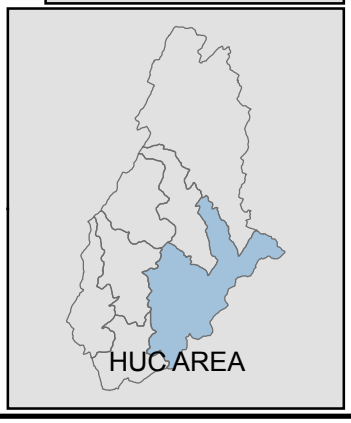
Preserved Open Space
"Papakating Preserve"

Potential Large Development

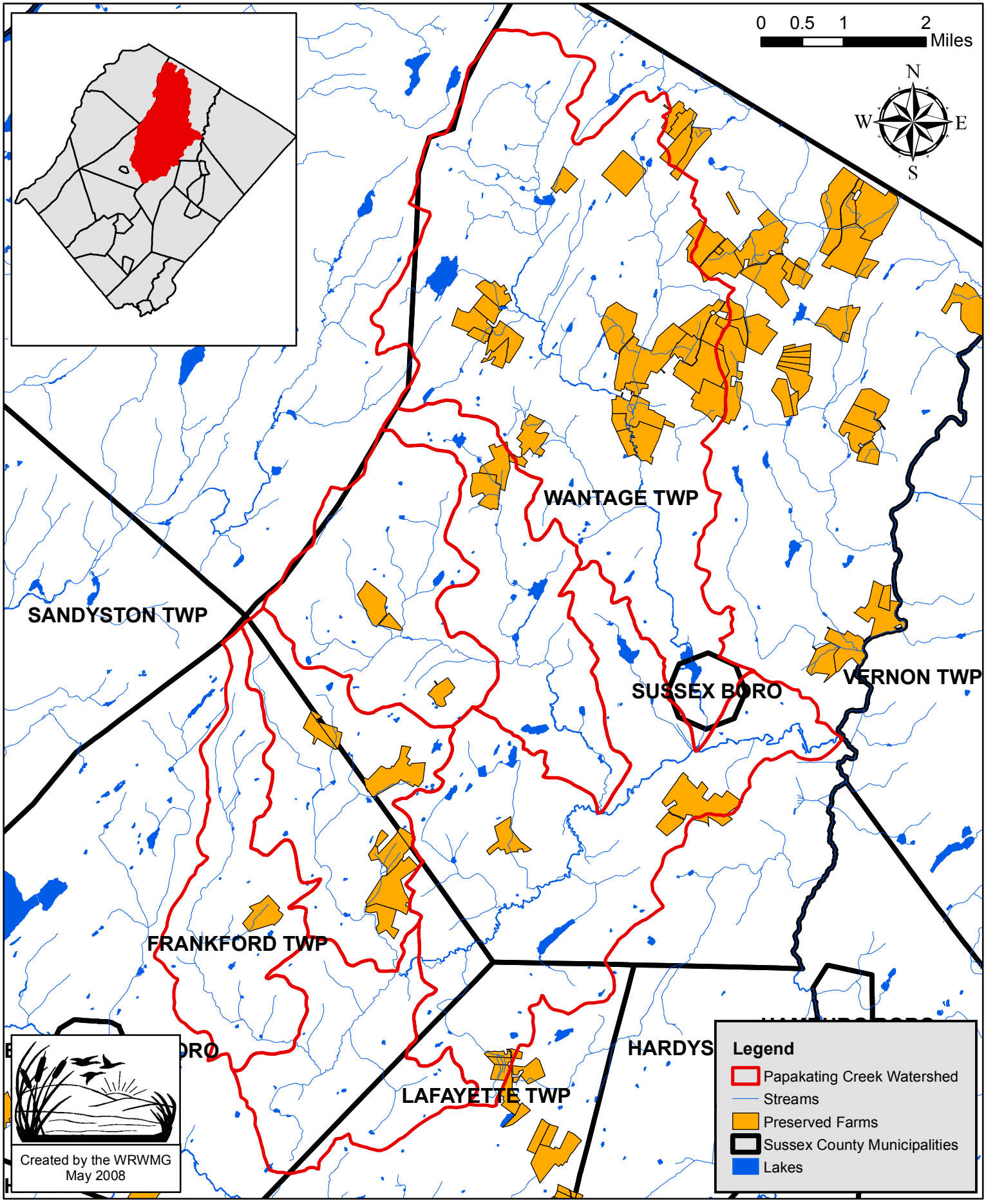
N
W E
S

0 0.5 1 2 Miles

Legend
Parcel Boundaries
WRWMG Sample Locations



Appendix V:
Preserved Farmland within the Papakating Creek Watershed



Appendix VI:
Open Space within the Papakating Creek Watershed