

The Upper Tohickon Rivers Conservation Plan

December 1, 2005

Prepared for:

Richland Township
Bucks County, Pennsylvania

Prepared by:

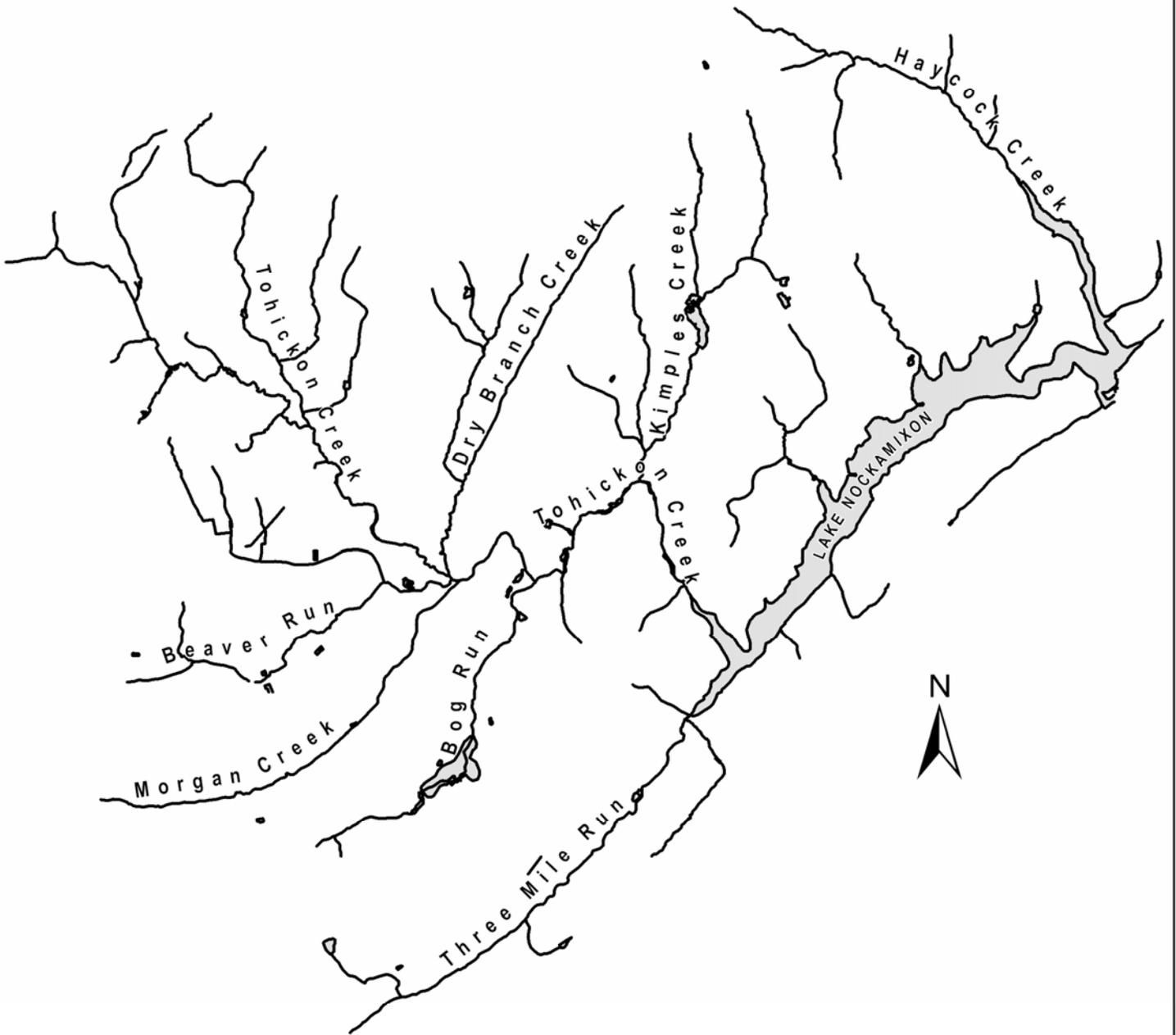
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East Rockhill Township
Haycock Township
Milford Township
Nockamixon Township
Springfield Township
West Rockhill Township
Perkasie Borough
Quakertown Borough
Richlandtown Borough
Trumbauersville Borough

**A Community Conservation Partnership Program
Pennsylvania Department of Conservation and Natural Resources
Rivers Conservation Program**

UPPER TOHICKON CREEK WATERSHED



Acknowledgments

We would like to thank the following organizations and individuals for their efforts in preserving the Upper Tohickon Creek Watershed. We acknowledge and appreciate their dedicated service and expertise which was vital to the research and completion of this plan.

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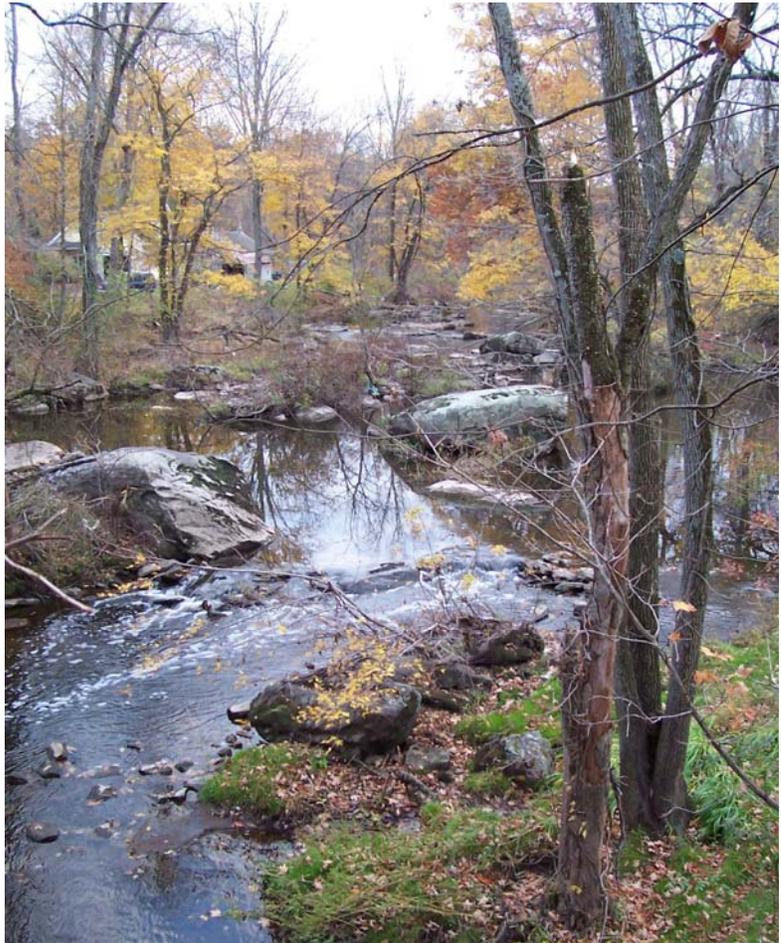
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Executive Summary

The Upper Tohickon Rivers Conservation Plan represents the efforts and contributions from a broad project team dedicated to studying this unique watershed and identifying the necessary steps to preserve its resources and, where needed, restore the health of both the natural and human communities residing within its boundaries. A grant from the Pennsylvania Department of Conservation and Natural Resources allowed Richland Township (Bucks County) to initiate the planning process for the Upper Tohickon Rivers Conservation Plan and assemble the team of partners and supporters to successfully complete this study. The Plan Advisory Committee (PAC) for the study included municipal and school district representatives, conservancy members, members of Township and Borough Environmental Advisory Boards and Open Space Commissions, and interested citizens. Public participation was important at every stage of the study, and was encouraged by an active PAC, advertised meetings, a volunteer stream watershed assessment program, newsletter articles, press releases, and interviews.

Overwhelmingly, residents wanted to preserve the scenic rural character of the area, as well as the recreational opportunities such as fishing, hiking and other natural activities. Water quality was voted as the most important issue facing the streams, followed by sustainability for future generations, water quality and quantity, conservation, education and open space/recreational use development. An area of concern among residents was the increase in land development and resulting increase in stormwater issues within the watershed.

The Upper Tohickon watershed covers 74 square miles in Upper Bucks County, Southeastern Pennsylvania, in an area north of the Philadelphia metropolitan area and south of the Allentown-Bethlehem-Easton urban complex. The entire Tohickon Creek watershed is the second largest in Bucks County next to Neshaminy Creek. Lake Nockamixon serves as the dividing line for the Upper Tohickon Creek watershed, with all lands draining to the Tohickon Creek above the lake's dam being defined as the Upper Tohickon Creek watershed. The watershed includes all or portions of 12 municipalities: Richland, East Rockhill, Haycock, Milford, Nockamixon, Springfield, Bedminster, and West Rockhill Townships; and Perkasio, Quakertown, Richlandtown and Trumbauersville Boroughs. The watershed is characterized by extensive areas of contiguous forests, hills and ridges contrasted against gently sloping valleys and plateaus, colonial and pre-colonial historic resources, state and county parklands, productive farmlands, extensive areas of isolated wetlands, and a number of notable aquatic habitats (e.g., the Quakertown Swamp, Lake Nockamixon, Lake Towhee). There are eight major tributaries that drain the watershed's landscape:



The Upper Tohickon Creek

Beaver Run, Bog Run, Dry Branch Creek, Haycock Creek, Kimples Creek, Morgan Creek, Threemile Run and Tohickon Creek. These tributaries and their associated watersheds serve as the structural template upon which this Rivers Conservation Plan is organized.

The Upper Tohickon landscape is dominated by forested land cover. Across the watershed, 66% of the land remains forested, with the forested lands closely matching the areas with diabase bedrock. Largely unsuitable for intensive human development, this igneous diabase bedrock is highly resistant to weathering and forms one of the two major bedrock formations within the watershed (the other being the Lockatong and Brunswick shales). Agricultural lands are the second most dominant land cover across the Upper Tohickon watershed, with 25% of land still utilized for some form of agricultural production. The agricultural lands center on the areas with shale bedrock and the more suitable soils overlying these shale formations. Intensively developed land constitutes a very small fraction of the entire watershed; only 4% of watershed area is classified as either low-density or high-density development, with much of this area arising from the urban environment in and around Quakertown. Finally, surface water and emergent wetlands (the last of the dominant land cover categories) extends over an area nearly as large as the land classified as developed, with 4% of the watershed occupied by surface water bodies (lakes, ponds, and open-water wetlands, particularly Lake Nockamixon and the Quakertown swamp). All twelve of the municipalities located within the watershed recognize the importance of protecting the watershed and its resources. This is most clearly demonstrated in the municipalities' Zoning and Subdivision and Land Development Ordinances, as well as in their Comprehensive Plans.

The water quality in the Upper Tohickon watershed continues to be affected by past land alterations as well as current land uses. The erosion of stream banks, the channelization and down-cutting of the streambeds, and the filling of channels with fine sediments have all resulted from the historical clearing and intensive use of the land, particularly in the upper sections of the watershed around Quakertown. Water quality in the major tributaries varies throughout the watershed, with a number of streams moderately to severely degraded compared to their historical condition, as well as streams retaining relatively high water quality, particularly in areas with extensive forests and wetlands. The locations of the most degraded streams are closely related to the geology, topography, and history of land use in the watershed. Specifically, the upper basin surrounding and including Quakertown contains the majority of stream miles that are listed by the PADEP as degraded, and this has resulted from the greater suitability of this area for agriculture and human habitation, and thus the greater human disturbance of these stream systems. Although both current point-source and non-point source disturbances continue to affect these streams, particularly in the urban areas around Quakertown that drain to Beaver Run, much of the impairment within the watershed comes through historical legacies of poor conservation practices. Although the agricultural community now effectively manages soil erosion for the majority of farms within the watershed, agricultural activities 100 to 200 years ago were far less mindful of problems of soil erosion. As a result, streams within the primary agricultural zones still suffer from a number of problems that stem from the high sediment loads delivered to the streams and their floodplains over long periods of time.

Among the natural resources present within the watershed, groundwater is of paramount importance. Nearly all residents within the watershed receive their potable water supply from groundwater wells, both private and public. Other valued resources include the extensive wetlands, the forests, the rich agricultural soils, and the diversity of plants and wildlife present within the watershed. Fourteen priority sites, as identified by the Natural Areas Inventory of Bucks County, are located within the watershed. In addition, the diversity of plants and animals within the watershed is noteworthy, with several Species of Special Concern present in different areas of the watershed. A large number of bird species, including nineteen rare breeders, live in the watershed. The combination of natural wetlands and forest with old fields, meadows, and open water habitats sustain a broader diversity of bird species than would likely be found if the watershed were to revert to contiguous forest. The importance of these biological and

broader natural resources is recognized in local planning documents.

Land ownership within the watershed is varied, with most lands privately held. However, large tracts are owned and managed by State and County agencies, including both State and County parks (19% of the watershed's area) and State Game Lands (5% of the watershed). In addition, private conservancies have made important contributions to the overall extent of preserved open space in the Upper Tohickon watershed. The Heritage Conservancy is the most prominent of these organizations and has taken an assertive role in helping preserve the Quakertown Swamp, with over 100 acres of preserved land within the watershed. Although agriculture remains an important component of the local economy, agricultural production continues to decline here, much like elsewhere in Pennsylvania. As land use shifts away from agriculture, these lands typically are faced with two extreme development scenarios – land preservation or suburban residential expansion. Part of the focus of this plan is to highlight the need for sound planning as these land use transformations occur, and to prioritize the areas that will make the greatest positive contribution to the Upper Tohickon Creek watershed, if they were to be preserved. Recreational resources within the watershed include state and county parks with nature trails, picnic areas, swimming, and camping. Hunting is popular within the State Game Lands. Along with publicly owned recreational areas, there are several privately owned areas which offer recreational activities such as golfing, horseback riding, archery, and ice skating.

Most of Bucks County, including the Upper Tohickon watershed was originally inhabited by the Lenni Lenape Indians. Tohickon is an Indian place name, changed only slightly from the Indian word “To-hick-han” or “To-hick-hanne”. Heckewelder interprets this word to mean ‘stream over which we pass by means of a bridge of drift wood,’ but more recent students of the Indian tongue take exception to this definition and say it means ‘Deer Bone Creek’. The Lenape lived amicably with European settlers until the mid-1700s, and sites sacred to these cultures are located within the watershed. The early European influence within the watershed can be observed in the settled villages and hamlets dating from the 1700s. Many of the place names within the watershed reflect these early settlers, and the watershed boasts many historic buildings and districts on the National Register. In addition, the Tohickon Creek has been noted for its large mill dams and imported grist mills.

Based on this history, these natural resources, the priorities of residents within the watershed, and the opportunities to affect positive changes within the watershed, the Project Advisory Committee has developed a set of nine (9) management goals for the Upper Tohickon Watershed:

- **Goal One:** Coordinate the goals and outcomes of the Upper Tohickon Rivers Conservation Plan with those of the Lower Tohickon Creek Watershed Conservation Plan, the Delaware River Basin, and the Highlands Region.
- **Goal Two:** Protect and Improve Surface Water Quality to Improve the Quality of Life for Current and Future Inhabitants of the Watershed.
- **Goal Three:** Foster Environmental Protections.
- **Goal Four:** Effectively Manage Stormwater to Protect Natural Resources and Properties.
- **Goal Five:** Protect Cultural Resources to Enhance the Link Between the Present and the Past.
- **Goal Six:** Provide Educational Awareness and Recreational Opportunities to Improve the General Health, Welfare, and Quality of Life of the Community.

- **Goal Seven:** Explore impacts of flooding and minimize human-induced flooding hazards throughout the watershed.
- **Goal Eight:** Minimize the negative impacts while maximizing the positive impacts of land uses on watershed resources.
- **Goal Nine:** Encourage commitment of resources from the public and private sectors to implement the goals of this plan



**Downstream End of the Upper Tohickon Watershed
Lake Nockamixon Spillway**

Table of Contents

Subject

Page Number

Acknowledgments	
Executive Summary	
Table of Contents	
Introduction and Background	
Section 1. Project Area Characteristics	1
1.1 Location	1
1.2 Watershed Area.....	1
1.3 Topography	1
1.4 Major Tributaries	2
1.5 Land Cover and Land Use	3
1.6 Land Use Planning within the Watershed Corridor	4
1.6.1 County-Wide and Municipal Land Use	4
1.6.2 Comprehensive Planning Efforts	5
1.6.3 Zoning.....	11
1.6.4 Subdivision and Land Development.....	31
1.6.5 Additional Planning Efforts	41
1.7 Population Information	42
1.8 Transportation Facilities	43
1.9 Employment Sources	44
1.10 Outstanding or Unique Features	44
Section 2. Identify Issues, Concerns, Constraints, and Opportunities through Public Participation	46
2.1 The Public Participation Process	46
2.2 The Plan Advisory Committee.....	46
2.3 Public Meetings	46
2.4 Plan Advisory Committee Work Sessions	48
2.5 Volunteer Watershed and Corridor Assessment	48
2.6 Other Public Participation and Outreach Efforts	49
Section 3. Water Resources	50
3.1 Introduction.....	50
3.2 Watersheds within the Upper Tohickon Creek Watershed	50
3.2.1 Major Tributaries of the Upper Tohickon Creek Watershed	51
3.2.2 Surface Water Quality Protection of the Tohickon Creek and its Tributaries	52
3.2.3 Surface Water Quality in the Upper Tohickon Creek Watershed.....	52
3.2.4 Ground Water Quality and Quantity of the Upper Tohickon Creek Watershed.....	61
3.3 Wetlands of the Upper Tohickon Creek Watershed	62
3.4 Floodplains of the Upper Tohickon Creek Watershed.....	64
3.5 Lakes and Ponds	65

Section 4.	Land Resources	68
4.1	Introduction.....	68
4.2	Land Ownership.....	68
4.3	Geologic Characteristics	68
4.4	Soil Characteristics	70
4.5	Land Preservation Programs and Preserved Land	73
4.6	Potential Hazard Areas	74
Section 5.	Biological Resources	75
5.1	The Landscape of the Upper Tohickon Creek Watershed	75
5.2	Flora and Fauna	76
	5.2.1 The Flora of the Upper Tohickon Creek Watershed.....	76
	5.2.2 The Fauna of the Upper Tohickon Creek Watershed	78
5.3	Endangered and Threatened Species in the Upper Tohickon Creek Watershed.....	80
5.4	Bucks County Natural Areas Inventory	81
Section 6.	Historic, Cultural, Scenic, and Recreational Resources.....	83
6.1	Introduction.....	83
6.2	Historic Overview.....	83
6.3	Historic Villages and Structures	83
6.4	Scenic, Natural and Recreational Resources.....	88
Section 7.	Watershed Assessment and Creek Corridor Inventory	92
7.1	Introduction.....	92
7.2	Assessment Protocol	92
7.3	Volunteer Training.....	93
7.4	Assessment Results.....	93
Section 8.	The Conservation Management Plan.....	97
8.1	Introduction.....	97
8.2	Goals, Objectives, and Recommendations	97
Section 9.	References Cited, Contacts & Electronic Resources	103

Section 10. Appendices and Figures

- Appendix I. Zoning Maps
- Appendix II. Top 50 Employers List
- Appendix III. Press Releases and News Articles
- Appendix IV. Stream Visual Assessment Packet
- Appendix V. Stream Visual Assessment Narrative Results
- Appendix VI. Bog Run Sub-Watershed Hydrology
- Appendix VII. Possible and Known At-Risk Species
- Appendix VIII. Watershed Figures/Maps

- Figure 1. Aerial Photograph
- Figure 2. Topography
- Figure 3. Watershed Management Units
- Figure 4. Land Use / Land Cover
- Figure 5. Geology
- Figure 6. FEMA Flood Hazard Areas
- Figure 7. Cultural Resources
- Figure 8. Quakertown Swamp (produced by The Heritage Conservancy)
- Figure 9. Prime Agricultural Soils
- Figure 10. Erodible Soils
- Figure 11. Soils - Upper Tohickon Management Unit
- Figure 12. Soils - Dry Branch Creek Management Unit
- Figure 13. Soils - Kimples Creek Management Unit
- Figure 14. Soils - Haycock Creek Management Unit
- Figure 15. Soils - Beaver Run Management Unit
- Figure 16. Soils - Middle Tohickon Management Unit
- Figure 17. Soils - Lake Nockamixon Management Unit
- Figure 18. Soils - Morgan Creek Management Unit
- Figure 19. Soils - Bog Run Management Unit
- Figure 20. Soils - Three Mile Run Management Unit

Tables

Table 1.1	1990-2000 Population Comparison	42
Table 3.1	Summary of Sub-Watersheds and Streams within the Upper Tohickon Creek Watershed	58
Table 4.1	Soil Mapping Units That Qualify as Prime Farmland in Tohickon Creek Watershed	71
Table 4.2	Soil Mapping Units That Qualify as Additional Farmland of Statewide Importance in the Tohickon Creek Watershed	72
Table 7.1	Median Grid Scores for Each Sub-Watershed of the Upper Tohickon Creek Watershed.....	95

Introduction and Background

Conservation can be defined as the management of natural resources, such as trees, slopes, bodies of water, and open spaces. However, preserving these and other resources is not an easy task to undertake. On the local level, natural resources are often identified briefly in the municipal comprehensive plan or other planning documents and protected through a municipal code, typically the Zoning Ordinance. Effective protection is dependent on an attentive code enforcement staff, conscientious developers, as well as alert and concerned citizens. While this methodology can be effective, specific studies of a particular resource can identify special features, outline issues and concerns, and suggest preservation and protection strategies, all with the goal of conserving the individual resource. The Upper Tohickon Rivers Conservation Plan is one such document that focuses its study on the watershed of the Upper Tohickon Creek.

The process to develop the Upper Tohickon Conservation Plan began in Richland Township. The Richland Township Preservation Board, an appointed volunteer citizen group, labored to advise its Township Supervisors on matters related to creek corridors during the recent growth pressures experienced by the Township. Lacking any formalized Rivers Conservation document, Township officials feared that opportunities to protect and preserve the creeks would be missed. Richland Township originally submitted a grant application to study the portion of the watershed within the Township's municipal boundaries. The application was not successful due to the lack of participation of the other municipalities in the watershed area. With the encouragement of the Department of Conservation and Natural Resources (DCNR), an application was submitted and approved to study the entire segment of the Tohickon Creek, upstream of the Nockamixon Dam. Richland, East Rockhill, Haycock, Milford, Nockamixon, Springfield and West Rockhill Townships, as well as Perkasio, Quakertown, Richlandtown and Trumbauersville Boroughs have joined together to provide the necessary resources to produce this document for the effective management of the watershed area. Further, other groups such as the Pennridge School District, Quakertown Area Community School District, the Tinicum Conservancy, Heritage Conservancy, and Bucks County Conservation District as well as a number of private citizens, have provided numerable assets that aided in the resource inventory and the identification of issues.

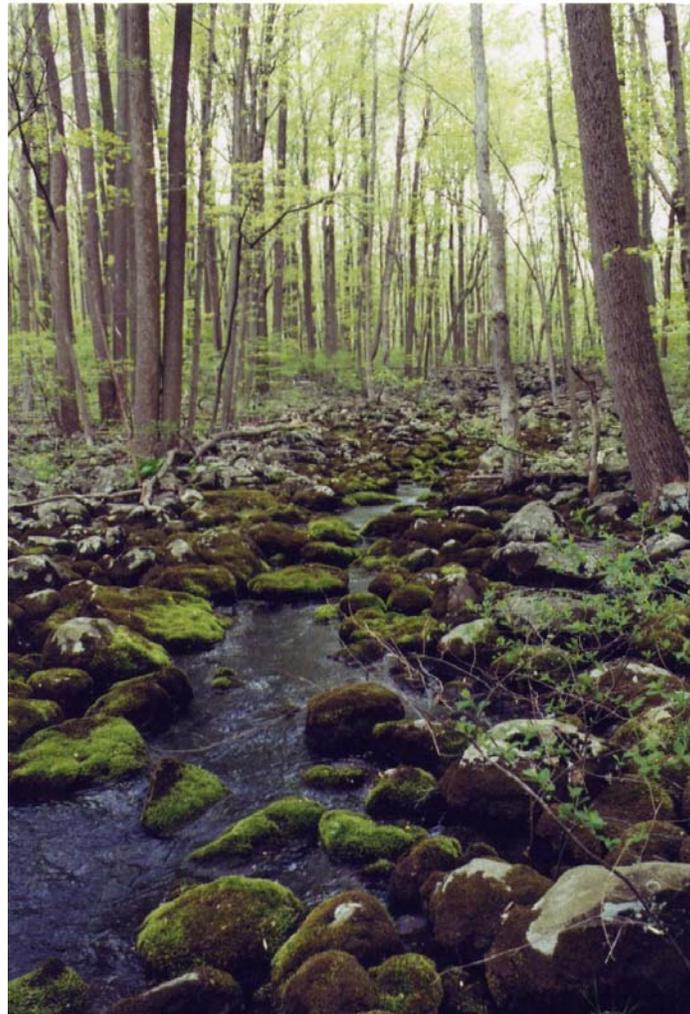
The methodology used to create this document was provided by DCNR. Their Watershed Planning process outlines a number of milestones and key events that need to happen in order to prepare a Rivers Conservation Plan and complete subsequent implementation projects. The Lower Tohickon Creek Watershed Conservation Plan also provided a model for The Upper Tohickon Rivers Conservation Plan presented herein.

The initial meeting, held in July 2001, gathered support for the project by providing information about the proposed watershed management plan to the municipalities within the watershed area and various public and private groups prior to submitting the grant application to DCNR. Once the grant was submitted and the project approved, an introductory meeting was held with the various stakeholders to form the Plan Advisory Committee (PAC) and begin the task of data collection. A number of meetings were held with the PAC to solicit and gather information, assign specific tasks, and complete field work.

The Plan Advisory Committee (PAC) for this study included municipal representatives, conservancy members, members of Township and Borough Environmental Advisory Boards and Open Space Commissions, and interested citizens. Public participation was important at every stage of the study, and was encouraged by an active PAC, advertised meetings, a watershed assessment tour, newsletter articles, press releases, and interviews. Please refer to the acknowledgement section of this report for a complete listing of the participants of this report.

Data collection was a very involved and dedicated process that involved many professional and volunteer hours. Most of the project area characteristics included in the report were taken from existing documentation. Planning documents, such as comprehensive plans, open space plans, Zoning Ordinances, subdivision and land development Ordinances, etc., for each of the municipalities in the watershed area, as well as county and census data, were studied to determine land use, zoning, and other related information. Issues and concerns were developed through an active public outreach program with the PAC. Watershed resources, such as land, water, and recreation, were determined through field work, scientific studies and analysis, published resources, and interviews. Specific tasks and data analysis techniques are discussed in detail throughout the report.

The Upper Tohickon Rivers Conservation Plan is intended to be a working document. Filled with volumes of information related to rivers, its watershed, and surrounding areas, this plan is designed to protect and enhance the watershed for the benefit of all. Achievable goals and objectives will ensure the effectiveness of this document and provide direction for future implementation.



Unnamed Tributary to Lake Nockamixon

Section 1. Project Area Characteristics

The Project Area Characteristics section of this report is recommended for inclusion in the River Conservation Plan Format provided by the Pennsylvania Department of Conservation and Natural Resources (DCNR) for Watershed Planning. This section is provided in order for the reader to better understand the overall character of the watershed area. Specific details related to the environmental resources of the watershed are discussed in later sections of this report.

1.1 Location

The Tohickon Creek is located in northern Bucks County and is a tributary to the Delaware River. For purposes of this plan, however, the area of study has been limited to what is considered the Upper Tohickon watershed. This study area originates in the headwaters of the Tohickon Creek in Springfield Township and extends to Lake Nockamixon and includes the extent of the lake to the Nockamixon Dam. The area is approximately 73.7 square miles and includes portions of Richland, East Rockhill, Haycock, Milford, Nockamixon, Springfield, Bedminster, and West Rockhill Townships, and Perkasio, Quakertown, Richlandtown and Trumbauersville Boroughs. Please refer to Figure 1 for a visual representation of the Upper Tohickon Creek Watershed Study Area.

1.2 Watershed Area

The entire watershed of the Upper Tohickon, beginning at the Lake Nockamixon dam and extending to all of the stream's headwaters throughout Upper Bucks County, covers an area of 73.7 square miles or 47,170 acres. Although this area includes 12 municipalities, the majority of the area lies within Haycock, Richland, and East Rockhill Townships. In addition, both Richlandtown Borough and Quakertown Borough fall entirely within the watershed. The character of the watershed is largely rural, with the majority of the watershed composed of either agricultural lands or forest. Yet within Quakertown Borough and along the Rt. 309 corridor that borders the western edge of the watershed, development is more concentrated and the rural character is replaced by dense residential development, extensive commercial facilities, and the associated traffic of a major thoroughfare.



View of Lake Nockamixon

1.3 Topography

The Upper Tohickon watershed spans two distinct landscape features: a central flat section around Richland Township and Quakertown Borough, and the surrounding region with extensive hills, ridges, and peaks of moderate height (see Figure 2). This separation in topography closely

follows the two distinct geologic formations within the watershed, where the central Brunswick formation has been more rapidly eroded to create the central plateau region while the more resistant Diabase formation has developed into the hills and ridges to the east and west of this central region. The topographic relief is most pronounced at three minor peaks within the watershed: The Lookout in the northeastern corner (911 ft above sea level); Rock Hill in the south-central portion of the watershed (850 ft above sea level); and Haycock Mountain in the northeastern portion of the watershed (970 ft above sea level). All of these small peaks are the highest remaining extensions of the Diabase intrusions within the Brunswick shales. At the other extreme, the Tohickon Creek cuts a moderately deep channel into the surrounding landscape, part of the reason that the Lake Nockamixon site was chosen for a large reservoir. At the downstream outlet to the lake, below the dam and spillway, the elevation along the Tohickon Creek channel is just over 300 ft. above sea level. This is the lowest elevation within the watershed and illustrates the moderately strong relief in the watershed, especially considering that the highest point in the watershed (Haycock Mountain) is just 2 ½ miles away from this lowest elevation.

1.4 Major Tributaries

Within the Upper Tohickon Creek watershed, there are eight major tributaries that drain the watershed's landscape (see Figure 3). These tributaries and their associated watershed serve as the structural template upon which this Rivers Conservation Plan is organized, and are thus central to the structure of the following sections and to the watershed recommendations. These eight tributaries are:

- Haycock Creek: This stream drains the most easterly section of the watershed and joins the Upper Tohickon within Lake Nockamixon near the outlet to the reservoir.
- Kimples Creek: This stream drains the north-central portion of the Upper Tohickon watershed and includes the Lake Towhee county park and its headwaters (Note: the stream is called Dimple Creek on many maps).
- Dry Branch Creek: Dry Branch Creek is one of the smaller sub-watersheds within the Upper Tohickon and also drains the north-central portion of the larger watershed.
- Upper Tohickon: The headwaters to the main stem of the Tohickon Creek cover a large area in the far northwestern corner of the watershed and drain the area immediately north of Quakertown.
- Beaver Run (Quakertown): Beaver Run and its northern tributary drain the far western section of the Upper Tohickon watershed; these two streams carry nearly all the runoff associated with Quakertown Borough.
- Morgan Creek: This tributary drains an elongated section of land in the southwestern portion of the Upper Tohickon watershed immediately to the south of Beaver Run and Quakertown.
- Bog Run: Bog Run is appropriately named as it drains the extensive area of Quakertown swamp in the south-central portion of the watershed immediately southeast of Morgan Creek.
- Threemile Run: This final major tributary of the Upper Tohickon extends across the most southern portion of the watershed and drains directly into Lake Nockamixon near the point where Tohickon Creek itself enters the lake.

A number of smaller tributaries also feed directly into Lake Nockamixon and are considered together as part of the Lake Nockamixon sub-watershed. In addition, the central portion of the Tohickon Creek above Lake Nockamixon (into which flow most of these major tributaries) serves

as a separate and unique management unit. A limited number of very small unnamed tributaries join this portion of the Tohickon Creek within this central sub-watershed.

1.5 Land Cover

The Upper Tohickon landscape is dominated by forested land cover. For the entire watershed, 66% of the land remains forested. In the Bog Run, Haycock Creek, Kimples Creek, and the middle Tohickon sub-watersheds, the extent of forest cover approaches or exceeds 80%. This dominance is clearly seen in both the land cover map (Figure 4) and the aerial photograph (Figure 1) of the Upper Tohickon watershed. The geologic map (Figure 5) demonstrates the close association between the forested land and the Diabase bedrock, which provide little opportunity for viable agricultural production. In total, 29,876 acres remain in forest and 1,066 acres remain in forested wetlands. Together, this broad extent of forested land exceeds the entire area within the Lower Tohickon Creek watershed (24,000 acres).

Within the remainder of the watershed, the only land cover that exceeds 10% of the watershed's area is the 26% of land that is categorized as agricultural land (11,083 acres for row crops; 1,015 acres for hay/pasture). This agricultural land, like the forested land, is closely associated with a single geologic formation (Brunswick shale) because of the topography and soils that developed over this bedrock. With the Brunswick belts extending through the central section of the watershed and along the southeastern and northeastern borders, the active agricultural land is likewise confined almost exclusively to these watershed areas. Because of the differences across the watershed, the sub-watersheds for each major tributary have distinct patterns of agricultural development, reaching maximums of 50% in the Dry Branch Creek sub-watershed and 51% in the Morgan Creek sub-watershed.

Intensively developed land constitutes a very small fraction of the entire watershed, with just 1,985 of the 47,000 watershed acres (4% of watershed area) classified as either low-density or high-density development. Based on this small fraction across the watershed, the influence of the developed lands might be expected to be minimal for the watershed as a whole. However, as Figure 4 illustrates (see also Figure 1), the developed land is concentrated in the area around Quakertown and, to a lesser extent, along the Rt. 309 corridor in the eastern portion of the watershed. As a result, the Beaver Run watershed is highly affected by this urbanization, with over 30% of the watershed area within these two development classes (high-density or low-density). The relatively small total area of urbanized land cover therefore has a disproportionately high effect for this one headwater tributary, at a minimum, and this concentrated impact is likely propagated to all downstream receiving water bodies, especially Tohickon Creek.

Finally, the area of cover categorized as "water" is nearly as large as the land classified as



View of The Lookout demonstrates the mix of agriculture in valleys and forests in the Diabase hills and ridges.

developed, with 4% of the watershed (1,897 acres) occupied by surface water bodies (lakes, ponds, and open-water wetlands). Together, the land cover data portrays a clear picture of the status and existing development of the Upper Tohickon Creek watershed. Forests now cover a large majority of the watershed, with agriculture the only other major land cover classification still existing within the watershed. Yet even with a small fraction of overall land coverage, the concentrated development around Quakertown has created an island of unique changes to the landscape in this area, with these urban effects magnified because such a small portion of the watershed bears the majority of the environmental burden from this type of land transformation.

1.6 Land Use Planning within the Watershed Area

The purpose of planning is to protect the public health, safety, and welfare. In Pennsylvania, municipalities are empowered to plan and guide their development through the use of comprehensive plans, Zoning Ordinances, subdivision and land development Ordinances, and other methods by the Pennsylvania Municipalities Planning Code (MPC). The MPC specifically lists the promotion of the preservation of the Commonwealth's natural (and historic) resources as one of its purposes.

The following subsections discuss the methods in which Bucks County and the municipalities within the watershed of the Upper Tohickon Creek use the powers given to them by the MPC to regulate and protect the natural resources of the watershed.

1.6.1 County-Wide and Regional Planning Efforts

The Upper Tohickon watershed, in its entirety, is located in Bucks County, Pennsylvania. Therefore, the planning and implementation efforts of the Bucks County government have, and continue to have a great effect on the management of the watershed. One such document; which is based on the single goal of promoting "the health, safety, and welfare of the county and its communities," is the Bucks County Comprehensive Plan. Prepared by the Bucks County Planning Commission, the Bucks County Board of Commissioners adopted the Plan in December of 1993.

The purpose of the County's Comprehensive Plan is, "to ensure that Bucks County government provides guidance to its agencies, municipalities, and the general public in the planning, development, and management of the county's natural and built resources." The plan contains, "policy recommendations and guidelines to assist municipalities with managing growth, developing comprehensive plans and related documents, and evaluating development proposals." The plan, "expresses goals, objectives, policies, and strategies, which will guide decisions on future growth, development, and the conservation of resources through the year 2020." The Plan focuses on measurements of growth, housing and economic activity, resources and recreation, infrastructure and basic services, growth management, and implementation strategies.

Because there are 54 municipalities within Bucks County, the Comprehensive Plan is very broad based. Goals and policies are general and make no mention of specific areas, such as the Upper Tohickon watershed. In providing demographic data and growth management strategies, however, the plan separates the County into regional planning areas. The watershed for the Upper Tohickon is located in what is termed the "Upper Bucks County Region".

In the Upper Bucks County Region, a number of the communities within the watershed are participants in regional planning committees. The Quakertown Area Planning Committee (QAPC) consists of Haycock Township, Milford Township, Richland Township, Richlandtown Borough, Quakertown Borough and Trumbauersville Borough. The Pennridge Area Coordinating Committee consists of East Rockhill Township, West Rockhill Township, Bedminster Township, and Perkasio Borough with in the limits of the Upper Tohickon Creek Watershed as well as Hilltown Township and Silverdale Borough outside of the limits of the Upper Tohickon Creek Watershed. The following subsections note where documents prepared by the committees are utilized by the individual municipalities. They also mention instances in which the municipality has chosen to prepare its own document, addressing its specific issues.

1.6.2 Comprehensive Planning Efforts

The Comprehensive Plan is one of the planning tools that municipalities use to guide development and protect the resources of its community. Comprehensive Plans generally contain specific studies of land use, housing, transportation, community facilities, natural, cultural, and historic resources, and utilities specific to the municipality and/or regional planning area. These studies typically include an inventory, goals, objectives, and implementation strategies, as well as a discussion of the interconnectiveness of the plan with the county, region and surrounding municipalities.

The following is a discussion of the Comprehensive Planning efforts of the municipalities within the Upper Tohickon watershed, as taken from the adopted Comprehensive Plans in each Township and/or Borough.

Bedminster Township

The Bedminster Township Comprehensive Plan was adopted eight years ago, and contains twelve elements. Although all twelve elements influence watershed resources, the agricultural, natural resources and cultural/heritage resource elements are particularly pertinent to the Upper Tohickon Creek Watershed Conservation Plan.

With regard to agriculture, the plan states that beyond its historical value, Bedminster farmland is a productive resource that contributes to the local economy and provides scenic open space valued by residents. The plan recommends a package of techniques to preserve farms and enhance the economic viability of agriculture in the Township. The Bedminster Township plan also contains a strong natural resource protection element and notes that a high quality environment is an important goal for the Township. It further states that development without concern for the natural limitations and amenities of land can be costly for people, as individuals and as taxpayers in the community. The plan also describes the wealth of historic, even pre-historic, resources in the Township and the need to protect them, as they are essential to understanding past settlement patterns and providing insight into Bedminster=s heritage.

The following goals are included in the Bedminster Township Comprehensive Plan and are supportive of watershed conservation efforts currently underway in the Upper Tohickon Creek Watershed area:

- Protect and conserve agricultural land and support the agricultural industry in Bedminster Township.
- Protect the people's constitutional right to clean air, pure water, and other natural, scenic and aesthetic natural resources and features that create the character and environment of the Township.
- Retain the character and qualities of the villages that play an important role in Bedminster Township.
- Recognize and protect the cultural heritage, natural resources, and character of Bedminster Township so that landmarks are preserved for future generations.

East Rockhill Township

The Comprehensive Plan of East Rockhill Township was prepared by the Bucks County Planning Commission and adopted on May 31, 1987. The Plan is very detailed, containing community goals and objectives, and inventory and analysis of population, housing, employment, land use, villages, natural resources, community facilities and services, transportation, and municipal finances. Using the information collected, the Plan includes policies and recommendations that are discussed in the plan concepts and implementation considerations.

The following are some of the policies that serve as the Township's principals for preservation, conservation, land use, and development. These goals and objectives relate to the purpose of this Rivers Conservation Plan:

- Ensure that development is compatible in scale and location with sensitive natural resources, such as floodplains, forests, steep slopes, poor soils and limited groundwater.
- Protect the character and qualities of the historic villages and rural countryside through land use regulations.
- Evaluate the impact of all planning, zoning, and development decisions and to minimize adverse environmental impacts through sound design and planning.
- Utilize the development district concept as a means to protect the environment while still allowing opportunities for growth.

The recommendations contain a plan concept, which separates the Township into 'Planning Areas'. The majority of the areas within the Upper Tohickon watershed are considered a "Resource Protection Area". However, based on the availability of utilities, and current growth patterns, portions of the Three Mile Run watershed are Agricultural Areas, Residential Areas, and Suburban Areas. In implementing these planning areas, the Plan identifies the planning tools that need to be updated. The Zoning Ordinance is one such document. The Plan indicates that the inclusion of natural resource protection standards is of particular importance.

In June of 2005 East Rockhill Township adopted a municipal Comprehensive Plan. The new Comprehensive Plan addresses goals and recommendations specific to East Rockhill Township including revisions to the local Zoning and Subdivision Ordinance, identification of areas that can accommodate growth and areas that should be preserved, and the continuation of improvements to traffic issues within the Township. The Plan encourages continued open space preservation efforts to prevent species habitat

destruction and a reduced quality of life and cooperation with other agencies.

Haycock Township, Milford Township, Richland Township, Quakertown Borough, Richlandtown Borough, Trumbauersville Borough and Quakertown Community School District

Haycock Township, Milford Township, Richland Township, Quakertown Borough, Richlandtown Borough, and Trumbauersville Borough are all partners in the Quakertown Area Planning Committee (QAPC), which prepared the Quakertown Area Comprehensive Plan of 1978. An update was completed in 1992 and was adopted by each of the municipalities that same year. All of the municipalities, with the exception of Richland Township, have utilized this plan as their municipal comprehensive plan. The following discussion includes portions of the analysis, goals, and objectives contained in the 1992 update that are relevant to the study of the Upper Tohickon watershed. It should be noted that the update was to serve the partnering municipalities until the year 2000. The QAPC has begun the process of reviewing the plan to address Growing Greener concepts.

The plan utilizes the Development Area concept for land use in which new construction efforts are to be focused in areas that are designated as “development areas”. “Resource Protection Areas” have significant environmental limitations and are, therefore, deemed inappropriate for development.

The implementation methods that are outlined in the plan include a citizen involvement component. Specifically listed under this heading are the number of additional studies that will need to be completed in order to address items such as groundwater recharge, open space, and environmental protection. These will all be addressed, with the help of volunteers, in the Upper Tohickon Rivers Conservation Plan.

Community development goals and objectives that specifically addressed the goals of the watershed planning efforts include:

- Planning efforts shall protect the (rural or semi-rural) character while providing for anticipated new development in appropriate locations.
- To protect specific natural features of the landscape through natural resource standards incorporated in zoning and subdivision / land development Ordinances.
- To conserve the Quakertown Area’s groundwater supply through sewage facilities planning, water resources planning, effective stormwater management, enforcement of sound development standards, and promotion of proper site design.
- To support state and local programs that result in the continuation of open spaces in the municipalities.
- To encourage use of cluster and mixed of residential forms of development to protect vulnerable natural features and provide for open space.
- To require high standards to control nuisances.
- To provide for recreational opportunities, including active and passive recreation facilities, for municipal residents of all ages.

Nockamixon Township

The Nockamixon Township Comprehensive Plan was adopted in 1988. The Plan is a regional approach to planned development, with the Township recognizing in its statement of community objectives, “the importance of taking into consideration the natural features and resources in land use planning”. In conjunction with this, the Township endorses natural resource protection policies which should be reflected in land use decisions and in the zoning and Subdivision Ordinance of the Township. Nockamixon Township is currently in the process of updating the Comprehensive Plan.

The following policies are related to natural resources and reflect the goals and objectives of the rivers conservation plan:

- Woodlands - Encourage protection of woodlands through protection standards. Zoning provisions should specify the amount of woodland area which must be preserved during the development process. Woodland areas in the eastern portion of the Township should be protected through low density zoning.
- Wetlands - Require the protection of wetland areas by incorporating wetland protection standards into the Zoning Ordinance and by working with regulatory agencies. Any areas which are designated as hydric soils will require further investigation by the landowner to show that no wetlands will be disturbed.
- Water Supply and Use - Provide for adequate water supply and careful balancing of competing water demands. The Township Subdivision Ordinance should require developers of large tracts of land to conduct water supply studies to ensure that an adequate supply of ground water exists and that the new development will not adversely affect the existing wells.
- Water Quality - Protect ponds and shorelines through zoning regulations; revise zoning regulations to require municipal review of proposed community wastewater systems. The Township has a responsibility to protect the quality of the water in its streams and waterways, not only for the protection of its own residents but for those who live downstream.
- Restrictive Soils - Require the identification of wet, erodible, prime agricultural and other restrictive soils on development plans.
- Steep Slopes - Restrict development of steep slopes through zoning regulations to avoid erosion and stormwater problems.
- Floodplain Areas - Restrict development in floodplain areas and on alluvial soils through zoning regulations.

Richland Township

As a partnering municipality in the Quakertown Area Planning Committee, the Township adopted the update of the Quakertown Area Comprehensive Plan on June 15, 1992. However, Richland Township has chosen to provide special attention to its needs in the preparation of its own Comprehensive Plan. Richland Township’s Comprehensive Plan, prepared by Thomas Comitta Associates, Inc., was adopted on May 12, 1997. The Plan provides goals and objectives to guide and direct development through the year 2010. It also contains an introduction, an inventory of existing conditions, analysis of growth, and specific plans for land use, housing, circulation, community facilities, and utilities. Moreover, it discusses plan interrelations, implementation strategies, and regional

relationships.

Pertinent to the preservation efforts of Upper Tohickon Rivers Conservation Plan are the inventory of natural features and constraints to development, goals for open space preservation and recreational facilities, and a plan for land use. The Comprehensive Plan notes that Richland Township has a significant number of wetlands and ponds associated with the Tohickon Creek, Morgan Creek, Beaver Run and their tributaries. An even greater amount of land is designated as floodway and floodplain of the same waterways. The plan includes two of the following goals:

- Develop a sound basis for decision-making for future land use and the protection of natural resources, based on the requirements of the Pennsylvania MPC; and,
- Preserve and conserve the agricultural, open space, and natural lands of Richland Township.

Richland Township, through many municipal efforts, including those of its Preservation Board, has been working to implement the following objectives and strategies listed in the Comprehensive Plan:

- Establish a low intensity land use theme outside the Route 309 Corridor, in order to retain the rural character of the Township, in the eastern half of Richland.
- Direct development outside of floodplains, wetlands, steep slopes, and woodlands.
- Establish setback requirements within stream corridors, especially: Tohickon Creek, Morgan Creek and Beaver Run, and for the Quakertown Swamp Area.
- Designate an open space “corridor” along major creeks (Tohickon and Morgan Creeks and Beaver Run), and minimize encroachment of expanses of paving within the “corridor”.
- Promote an open space and recreational network along the Tohickon and Morgan Creeks and Beaver Run.
- Advocate the use of incentives to preserve historic buildings and properties.
- Promote the establishment of an Environmental Education Center within the Quakertown Swamp Area located in the southern portion of the Township.

Springfield Township

The Springfield Township Comprehensive Plan was prepared by the Springfield Township Comprehensive Planning Committee with technical assistance from the Bucks County Planning Commission and adopted in December 2002. The plan contains a detailed list of community goals and objectives and provides a historical overview. The plan also provides an inventory and an analysis of the following topics: demographics and socioeconomic trends, land use characteristics and development trends, natural resources, open space and farmland preservation, historic, recreational, and scenic resources, residential development, nonresidential development, community facilities, transportation and circulation, wastewater and water issues, stormwater management, solid waste management, future land use and growth management, and Township finances and budgeting. Implementation strategies summarize the detailed information and recommendations provided throughout the report.

The Springfield Township Comprehensive Plan contains information on surface water resources. In this section of the report, the Plan specifically mentions the watershed conservation plan for the Upper Tohickon Creek and states that Richland Township has requested the participation of Springfield Township for the, “overall success of the watershed planning programs and activities.”

The following is a brief summary of the implementation strategies that are related to the goals of the Rivers Conservation Plan:

- Revise the riparian buffer regulations in the Zoning Ordinance to provide performance standards for the protection of the Township’s waterways.
- Utilize the volunteer citizen efforts of the Springfield Township Environmental Advisory Committee (EAC) to address issues of environmental concern.
- Develop strategies to reduce invasive species that threaten native plant communities.
- Adopt Ordinances designed to preserve existing vegetation, minimize grading impacts, and provide additional plantings to maintain and enhance scenic views and vistas.
- Maintain high standards that control nuisances such as objectionable noise, odors, smoke, and hazardous materials in local Ordinances. Identify areas experiencing flooding problems in the Township and determine if remediation measures are feasible.

West Rockhill Township and Perkasio Borough

Until recently, West Rockhill Township and Perkasio Borough, partners in the Pennridge Area Coordinating Committee, utilized the Pennridge Area Comprehensive Plan, prepared by the now defunct Pennridge Joint Planning Commission with assistance from the Bucks County Planning Commission and adopted in June of 1974. The Plan was a regional approach to planned development with special attention to, “the protection of natural resources to ensure ecologically sound development.” The Comprehensive Plan utilized Development District Planning Principles. Therefore, many of the Plan’s goals, objectives, and recommendations were not specific to West Rockhill Township or Perkasio Borough.

The Natural Resources chapter of the Comprehensive Plan discussed in detail the separation of the regional area into “natural planning areas” based on the watershed boundary lines. Three Mile Run, one of the planning areas, is a significant feature of the Upper Tohickon watershed. The Plan described this area as follows, “It is characterized by steep slopes at its outer edge with moderate slopes to gentle slopes within. Soils have very poor permeability except in small woodlots scattered throughout. With sewers, this land is moderately well-suited for development.” The goals and objectives further indicated that, “development where public sewers are available will be encouraged. Standards outside the sewered areas will be strict.”

In March of 2005 West Rockhill Township adopted a municipal Comprehensive Plan. The new Comprehensive Plan addresses goals and recommendations specific to West Rockhill Township including revisions to the local Zoning and Subdivision Ordinance,

identification of areas that can accommodate growth and areas that should be preserved, and continuation of improvements to traffic issues within the Township. The Plan encourages continued open space preservation efforts and cooperation with other agencies. In regard to natural resource protection, the Plan recommends stricter protection standards for land located along the East Branch of the Perkiomen Creek and areas north of Ridge Road.

1.6.3 Zoning

The Zoning Ordinance is typically the most important regulatory tool that a municipality can use to control land use and development. By creating different 'zoning districts', the municipality can specify the uses permitted, the area and bulk requirements for buildings appropriate for each district based on the character of the land. Further, the Zoning Ordinance can regulate other aspects of land development such as natural and historic resource protection.

The information contained below is taken from the Zoning Ordinances of each of the municipalities within the watershed of the Upper Tohickon Creek. A summary of the zoning districts within the watershed is provided as well as additional regulations specific to each of the municipalities. A copy of each of the municipal zoning maps can be found in Section 10, Appendix I of this report.

Bedminster Township

The Bedminster Township Zoning Ordinance (Bedminster Township, August 14, 2002) indicates that within the watershed, a majority of the land is zoned Agricultural Protection (AP). Section 405 of the Ordinance indicates that land zoned AP is intended for the production of agricultural, horticultural, arboricultural, viticulture, apicultural, and dairy products. Permitted uses also include the keeping of livestock, poultry, and other similar creatures raised for human use or profit. The AP zoning district is further separated into general farming, nursery, intensive agriculture, industrial animal production, commercial kennel, noncommercial kennel, equestrian, agricultural retail, and forestry uses. Minimum lot areas (range 32,000 square feet - 25 acres), set backs, structural, and impervious surface restrictions vary based on the sub classification.

The other zoning district within the watershed area is the Village Residential-2 District (VR-2). The purpose of this district is to recognize and preserve the unique residential character of all or portions of the Township's villages. Permitted uses include agricultural, residential, and commercial. Minimum lot areas (range 20,000 square feet – 40,000 square feet), set backs, structural, and impervious surface restrictions vary based on the sub classification.

In addition to the establishment of zoning districts and use regulations, Section VI of the Bedminster Zoning Ordinance contains performance standards addressing a variety of measures to protect water quality, floodplains, open space and other resources. These are briefly listed below.

- **Environmental Performance Standards (Section 601)** - The developer is required to determine the presence of environmental or natural features on the site.
- **Floodplain Performance Standards and Floodplain Soils (Section 613-620)** - This section includes floodplain definitions and area descriptions and prohibits development in the one-hundred year floodplain except with design approval from PADEP. It allows limited alteration of existing structures, requires notification of changes in delineations, and regulates dispute procedures. It sets design and construction standards for construction in the floodway, flood fringe and floodplain areas above the one-hundred year flood elevation, and for storm drainage facilities, utilities, streets, storage, and anchoring.
- **Steep Slopes [Section 601-(3)]** - No more than 30% of areas with 15-25% slopes may be developed, regraded, or stripped of vegetation except for 10 acre parcels in the AP District. For these areas, no more than 75% may be developed, regraded, or stripped of vegetation. No more than 15% of areas with >25% slopes may be developed, regraded, or stripped of vegetation, with certain exceptions in the AP District. For these areas, no more than 70% may be developed, regraded, or stripped of vegetation.
- **Woodlands [Section 601-(4)]** - No more than 20% of woodlands in environmentally sensitive areas (floodplains, floodplain soils, steep slopes, wetlands, wetland margins, lake/pond shorelines) may be altered, re-graded, cleared or built upon. No more than 50% of woodlands not located in environmentally sensitive areas may be altered. In AP District (parcels 10 acres or more) no more than 75% of woodlands (not in sensitive areas) may be altered, regraded, or built upon.
- **Lakes, Ponds, Wetlands, Swales & Streams [Section 601-(5)]** - Such areas may not be altered, regraded, developed, or filled. Roads may cross them with design approval from PADEP or USEPA permits.
- **Lakes and Pond Shorelines [Section 601-(6)]** – From the landside edge of a lake or pond extending outward for a distance of 100 feet shall constitute a lake or pond shoreline. No more than 30% may be altered, regraded, filled, etc. No more than 10% may include impervious surfaces.
- **Wetland Margins [Section 601-(7)]** - Defined as 100'. No more than 20% may be altered, regraded, filled etc.
- **Prime Farmland/Agricultural Soils in AP District [Section 601-(8)]** - On tracts with ten acres or more, no more than 40% of prime farmland or farmlands of statewide importance may be developed.
- **Stormwater [Section 601-(9)]** - Compliance with SLDO and state stormwater management act required.
- **Soil Erosion & Sedimentation [Section 601 (10-12)]** - Compliance with Chapter 102 and E&S plans at preliminary stage required for areas < 25 acres. Permanent removal of topsoil and subsurface solids prohibited (2 exceptions).
- **Riparian Buffer [Section 601(13)]** - No land disturbance in riparian buffer (75') and two distinct zones of use. Zone 1 (buffer edge + 25') allows for open space uses. Zone 2 (edge of Zone 1 + 50') allows for open space uses. Prohibited uses in both zones include clear cutting, selective cutting, hazardous waste storage, roads/driveways, parking lots, and subsurface sewage disposal. Replanting of streambank buffer required where there is little or no streambank vegetation.

- **Site Capacity Calculations (Section 602)** - Requires determination of appropriate intensity of use for watercourses, floodplains, floodplain soils, wetlands, lakes/ponds, riparian buffer, wetland margin, land/pond shoreline, steep slopes, and woodlands in all zoning districts. Requires determination of above plus prime farmland, farmlands of statewide importance, and farmland of local importance.
- **Buffer Yards (Section 603)** - Requires 3 step process for determining buffer yard class, selection of planting options, and selection of planting materials for all existing land uses. Buffer yard classes range from 25' to 45' wide. Suggested list contains native and non-native flora.
- **Noise & Vibration Ordinances (Section 604-05)** - Ordinance intended to protect citizens and requires inspection and testing and establishment of noise sensitive zones with associated general sound standards.
- **Air Pollution (Section 606)** - Regulations setting PADEP limitations upon fugitive, particulate matter, and sulfur compound emissions.
- **Toxic & Noxious Matter (Section 607)** - Offensive odors beyond the ASTM odor threshold limits are prohibited. Industrial Districts shall comply with odor threshold concentrations from ground level to 40' from ground level.
- **Water Quality (Section 612)** - No surface water withdrawals without DRBC permission or in cases of emergencies (e.g. fire ponds). Stream discharge limitations (e.g. heat, metal oil, suspended matter, etc.) per PADEP.
- **Open Space Provisions (Section 621-626)** - Requirements for residential developments (B2 & B3 Uses) including layout (best principles for site design), site plan designation (use & maintenance), stormwater management area allowances, open space performance bond requirements, ownership and dedication methods and associated requirements, and deed restrictions.

East Rockhill Township

The East Rockhill Township Zoning Ordinance was adopted April 18, 2000 and amended through November 11, 2002. The predominant zoning for the watershed area within East Rockhill Township is zoned Rural Residential (RR) and Resource Protection (RP).

The purpose of the Rural Residential Zoning District is to “promote the preservation of agriculture as a primary use of undeveloped land outside of the development area”. This use allows for provisions of a large variety of agricultural uses, as well as some residential, institutional and recreational uses. While single family detached units require a minimum lot area of 1.8 acres, cluster subdivisions have been developed with a minimum lot area of 10,000 square feet in portions of the Township. However, the portion of the Township within the watershed area, has not seen any development utilizing this option.

The purpose of the Resource Protection Zoning District is to, “protect areas containing sensitive natural features and areas of natural scenic beauty.” Agricultural and low-intensity residential uses are permitted with standards and densities designed to encourage preservation of natural resources. Similar to the Rural Residential Zoning District, the Resource Protection District allows for provisions of a large variety of agricultural uses, as well as some residential, institutional and recreational uses. While single family detached units require a minimum lot area of 1.8 acres, cluster subdivisions

may be developed with a minimum lot area of 20,000 square feet. However, cluster development has not occurred within this district. The majority of land within the Resource Protection District consists of single family detached dwelling units on large lots, park and recreation areas, and vacant lands.

Other zoning districts within the watershed area of East Rockhill include:

- Agricultural Preservation (AP)
- Commercial - Office (C-O)
- Extraction (E)
- Industrial - 1 (I-1)
- Industrial - 2 (I-2)
- Residential -1 (R-1)
- Suburban (S)
- Village Commercial (VC)
- Village Residential (VR)

The above noted districts are intended to serve as areas for both preservation of environmental features as well as areas for future development. While development can not be stopped, the regulations within these districts help to better manage and control the areas of growth. In conjunction with individual district regulations, natural resource protection standards, site capacity calculations, open space standards and buffer regulations have been established to further control growth and protect environmental features. A brief summary of the most relevant regulations is included herein:

- **Nuisance Standards (Sections 1800-1807)** These sections regulate noise, smoke, fumes, heat, odor, glare, vibrations and storage and waste disposal in order to protect the public.
- **Natural Resource Protection Standards (Section 1900)** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain - all such areas shall not be altered, regraded, filled or built upon except in conformance with section 1902 - Floodplain Regulations; Floodplain Soils - all such areas shall not be altered, regraded, tilled or built upon except in conformance section 1902 - Floodplain Regulations; Steep Slopes, 15-25% - no more than 30% shall be disturbed except for tracts that are 10 acres or larger within the AP District where no more than 75% shall be disturbed, 26% or greater - no more than 20% of such areas shall be disturbed except of tracts that are 10 acres or larger within the AP District, where no more than 70 shall be disturbed; Woodlands- protection ratios from 20% to 75% depending on zoning district and tract size; Mature Trees - 40% protection ratio within the R-1, C-O, E, I-1, and I-2 zoning districts; Streams, Watercourses, Lakes or Ponds - shall remain undisturbed except that roads and utilities may cross streams and watercourses; Lake or Pond Shorelines - no more than 20% of such areas shall be disturbed; Wetlands of one acre or more - shall remain undisturbed except for road and utility crossings; Wetland Margin - no more than 20% disturbance; Riparian Buffer Zone - shall remain preserved except for road and utility crossings; Prime Farmland of 10 acres or more - within the AP district no more than 40% disturbance.

- **Contiguous Building Envelope (Section 1901.a)** Establishes a minimum clear area on each lot to provide sufficient area for construction activities, while meeting the natural resource protection standards and minimum setback requirements.
- **Site Capacity Calculations (Section 1901.b)** The Site Capacity Calculations are a ten (10) step process completed prior to the design of any site that yields the net buildable site area, the maximum number of dwelling units and the maximum impervious surface area. The calculations are based on the base site area and the area of the site that is resource (floodplain, soils, steep slopes, woodlands, wetlands, lakes and ponds) protected.
- **Floodplain Regulations (Section 1902)** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a floodway (the area identified as “Floodway” in the AE Zone of the Flood Insurance Study (FIS) prepared by FEMA), flood fringe (the remaining portions of the 100 year floodplain in those areas identified as an AE Zone in the FIS where a floodway has been delineated), general floodplain area (the areas identified a Zone A in the FIS for which no 100 year flood elevations have been provided), and floodplain soils. It lists the methods for determining the floodplain as well as general regulations of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include; agriculture, public and private recreation, residential yard areas, garden play areas, and pervious parking, and accessory industrial and commercial uses such as yard areas pervious parking and loading areas and airport landing strips. Uses permitted by Special Exception include utilities and public facilities, water related uses, extraction of sand gravel and other materials, temporary uses, storage of materials and all uses, activities and structural developments. The section further regulates manufactured homes, existing structures, anchoring/flood proofing, design and construction standards, prohibited activities and variances within designated floodplain areas.
- **Open Space Regulations (Section 1903)** Requires the provision of open space, a portion of which must be utilized as recreation area, in detached dwelling developments, detached dwelling cluster subdivisions, performance standard subdivisions and mobile home park developments. This section regulates layout requirements, designation requirements, ownership, and maintenance.
- **Buffer Yards (Section 1905)** Provides for screening between conflicting land uses. In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list. General requirements provide provisions for the location, maintenance, design, and placement of the buffer yard.

Haycock Township

The Haycock Township version of the Quakertown Area Zoning Ordinance of 1975 was amended as of May 3, 1999.

The predominant zoning for the watershed area within Haycock Township is Resource Protection District (RP). Its purpose is, “to protect areas consisting largely of sensitive natural features such as woodlands, steep slopes, scenic areas, wetlands, floodplains, and

lakes and ponds.” This restrictive district permits low intensity agricultural uses, single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Detached dwellings have a two (2) acre minimum lot size.

Another predominant district within the watershed area is the Rural Agricultural District (RA). The purpose of this district is to, “provide standards for low-density development in rural areas until these areas are needed for development and provided with utilities.” This district allows for the provision of all agricultural uses as well as single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Although a single-family detached unit requires a two (2) acre minimum lot size, a “cluster” option with a minimum average lot size of 30,000 square feet is permitted. The majority of land within Haycock Township may be classified as either single family detached dwelling units on large lots, recreational land or as an agricultural use.

Other zoning districts in the watershed area of Haycock Township include the following:

- Planned Commercial (PC)
- Planned Industrial (PI)
- Select Commercial (SC)
- Suburban Residential High (SRH)
- Village Center-1 (VC-1)

The PC, PI, SC, SRH and VC-1 zoning districts are intended to serve as the development areas within the Township and were established to accommodate the anticipated growth of the Quakertown Area in accordance with the provided services and utilities.

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of performance standards (Article V) which include: site capacity calculations for determining the developable area of a site, density, and open space; environmental and resource protection standards, including those for the floodplain; number, type, and location of landscape materials and buffer yards; nuisance standards; and, dimensional requirements. A brief summary of the most relevant regulations is included herein:

- **Site Capacity Calculations (Section 501).** The Site Capacity Calculations are a twelve (12) step process completed prior to the design of any site that yields the net buildable site area, the maximum number of dwelling units, the minimum required open space and recreation area, as well as the maximum impervious surface area. The calculations are based on the base site area and the area of the site that is resource protected, i.e. floodplain, soils, steep slopes, woodlands, wetlands, lakes and ponds.
- **Table of Performance Standards (Section 502).** This section includes, by zoning district and use, the minimum open space, maximum density, and maximum impervious surface ratios, to be used in completing the site capacity calculations of Section 501, as well as the minimum site area and minimum lot areas.
- **Area and Dimensional Requirements (Section 503).** For each of the zoning districts, this section provides the minimum lot width, minimum yards, maximum floor area ratio (FAR), and maximum building height.

- **Environmental Performance Standards (Section 504).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain, to remain undisturbed except for minor road crossings; steep slopes, 8-15% slope, no more than 40% disturbance, 15-20% slope, no more than 30% disturbance, 25% or steeper slope, no more than 15% disturbance; woodlands, no more than 20% disturbance; lakes, ponds, watercourses, to remain undisturbed except for minor road crossings; lake shore areas, no more than 10% impervious and 30% disturbance; pond shore areas, no more than 10% impervious and 20% disturbance; wetlands greater than one acre are to remain undeveloped except for minor road crossings; wetlands less than one acre are to remain undisturbed.
- **Buffer Yards (Section 505).** In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list. General requirements provide provisions for the location, maintenance, design, and placement of the buffer yard.
- **Floodplain Regulations (Section 507).** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a floodway (the watercourse channel and adjacent land required to carry 100-year flood), flood fringe (portion of floodplain outside floodway), 100-year floodplain boundary, and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include agriculture, public and private recreation, residential yards, and temporary uses. Uses permitted by Special Exception include utilities and public facilities, water related uses, storage of materials and pervious parking areas. The section further regulates existing structures, mobile homes, prohibited activities, and special exceptions and variances within designated floodplain areas.
- **Nuisance Standards (Sections 508 - 515).** These sections regulate noise, smoke, fumes, vapors, heat, odor, glare, vibrations, storage and waste disposal, and radioactive and electrical disturbances in order to protect the public.
- **Open Space in Residential Developments (Sections 530-535).** Requires the provision of open space in single-family, detached cluster developments, performance standard subdivisions, mobile home parks, and planned residential developments, a portion of which must be utilized as a recreation area. Section 531 regulates how the open space will be designated on the plans and Section 532 provides the design standards, such as landscape and recreation requirements. Sections 533 through 535 provide the guidelines for how the open space is to be bonded, owned, and maintained.

Milford Township

The Milford Township Portion of the Quakertown Area Zoning Ordinance was enacted on July 18, 1995 and last revised through June 17, 2003.

Only small portions of Milford Township are located in the watershed area. The portions that are located with the watershed area consist of three (3) different zoning districts; Rural Agricultural (RA), Rural Development (RD) and Suburban Residential Low (SRL).

The purpose of the RA district is to, “provide standards for low-density development in rural areas until these areas are needed for development and provided with utilities.” This district allows for the provision of all agricultural uses as well as single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Although a single-family detached unit requires a two (2) acre minimum lot size, a “cluster” option with a minimum average lot size of 30,000 square feet is permitted.

The purpose of the RD district is to, “provide for limited, low density residential development in areas which are not now served with public sewers or for which a need for higher intensity development does not exist.” This district allows for the provision of all agricultural uses as well as single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Although a single-family detached unit requires a one (1) acre minimum lot size, a “cluster” option with a minimum average lot size of 20,000 square feet is permitted.

The purpose of the SRL district is to, “provide for low intensity residential development.” This district allows for the provision of agricultural uses as well as a variety of residential dwelling units, medical offices, and specific institutional and recreational uses. Although a single-family detached unit requires a 20,000 square foot minimum lot size, a “cluster” option with a minimum average lot size of 12,500 square feet is also permitted. In addition, a performance standard subdivision could permit lots as small as 2,000 square feet.

The majority of land within the watershed area of Milford Township may be classified as either single family detached dwelling units on large lots or as an agricultural use.

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of performance standards (Article V) which include: site capacity calculations for determining the developable area of a site, density, and open space; environmental and resource protection standards, including those for the floodplain; number, type, and location of landscape materials and buffer yards; nuisance standards; and, dimensional requirements. A brief summary of the most relevant regulations is included herein:

- **Site Capacity Calculations (Section 501).** The Site Capacity Calculations are a twelve (12) step process completed prior to the design of any site that yields the net buildable site area, the maximum number of dwelling units, the minimum required open space and recreation area, as well as the maximum impervious surface area. The calculations are based on the base site area and the area of the site that is resource (floodplain, floodplain soils, steep slopes, woodlands, wetlands, lakes and ponds, lake and pond shore areas, and watercourses) protected.
- **Table of Performance Standards (Section 502).** This section includes, by zoning district and use, the minimum open space, maximum density, and maximum impervious surface ratios, to be used in completing the site capacity calculations of Section 501, as well as the minimum site area and minimum lot areas.
- **Area and Dimensional Requirements (Section 503).** For each of the zoning districts, this section provides the minimum lot width, minimum yards, maximum

- floor area ratio (FAR), and maximum building height.
- **Environmental Protection Standards (Section 504).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain, to remain undisturbed except for minor road crossings; steep slopes, 8-15% slope, no more than 40% disturbance, 15-20% slope, no more than 30% disturbance, 25% or steeper slope, no more than 15% disturbance; woodlands, no more than 20% disturbance; lakes, ponds, watercourses, to remain undisturbed except for minor road crossings; lake shore areas, no more than 10% impervious and 30% disturbance; pond shore areas, no more than 10% impervious and 20% disturbance; wetlands greater than one acre are to remain undeveloped except for minor road crossings; wetlands less than one acre are to remain undisturbed. Wetland margins are to be provided for wetlands greater than 1 acre, extending 25 feet from the limits of wetlands or to the limits of hydric soils; whichever is less. No more than 20% shall be disturbed.
 - **Buffer Yards (Section 505).** Provides for screening between adjacent land uses for subdivisions and land development.
 - **Floodplain Regulations (Section 507).** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a floodway (the watercourse channel and adjacent land required to carry 100-year flood), flood fringe (portion of floodplain outside floodway), 100-year floodplain boundary, and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include agriculture, public and private recreation, residential yards, and temporary uses. Uses permitted by Special Exception include utilities and public facilities, water related uses, storage of materials and pervious parking areas. The section further regulates existing structures, mobile homes, prohibited activities, and special exceptions and variances within designated floodplain areas.
 - **Nuisance Standards (Sections 508 - 515).** These sections regulate noise, smoke, fumes, vapors, heat, odor, glare, vibrations, storage and waste disposal, and radioactive and electrical disturbances in order to protect the public.
 - **Open Space in Residential Developments (Sections 530-535).** Requires the provision of open space in single-family, detached cluster developments, performance standard subdivisions, mobile home parks, and planned residential developments, a portion of which must be utilized as recreation area. Section 531 regulates how the open space will be designated on the plans and Section 532 provides the design standards, such as landscape and recreation requirements. Sections 533 through 535 provide the guidelines for how the open space is to be bonded, owned, and maintained.

Nockamixon Township

The Nockamixon Township Zoning Ordinance was adopted in December 2002. The predominant zoning for the watershed area within Nockamixon Township is zoned Residential/Agricultural (RA).

The purpose of the Residential/Agricultural Zoning District is to “provide for residential uses in areas of the Township where there are fewer limiting natural features, where

agricultural activities now exist and where this district can serve as a transition zone between higher density uses and the state park”. This use allows for provisions of a large variety of agricultural uses, as well as some residential, institutional and recreational uses. While single family detached units require a minimum lot area of 2 acres, it appears that in portions of the Township, cluster subdivisions have been developed with a minimum lot area of 30,000 square feet. The majority of land within the Residential-Agricultural District may be classified as either single family detached dwelling units on large lots or as an agricultural use.

Other zoning districts within the watershed area of Nockamixon Township include:

- Commercial (C)
- Open Space Management (OSM)
- Residential (R)
- Village Center-1 (VC-1)

In conjunction with individual district regulations, natural resource protection standards, site capacity calculations, open space standards and buffers regulations have been established to further control growth and protect environmental features. A brief summary of the most relevant regulations is included herein:

- **Buffer Yards (Section 30)** Provides for screening between adjacent land uses for subdivisions and land development.
- **Performance Standards (Section 35)** This section regulates smoke, ash, dust fumes vapors, gas, noise, glare, heat, radioactivity or electrical disturbances and outdoor storage and waste disposal in order to protect the public.
- **Environmental Protection Standards (Section 36)** This section requires that five (5) step site capacity calculations be performed in order to determine site development potential. As part of these calculations, the Ordinance requires that the natural resources be protected as follows: Floodplain and Floodplain Soils - all such areas shall remain undisturbed except as permitted in the Floodplain regulations (Section 51); Lakes and Ponds - all areas shall remain undisturbed; Wetlands - shall remain undisturbed except for roads, dams, culverts, bridges, storm or sanitary sewer facilities, water facilities or any other public utility where approval is obtained; Streams and Watercourses - shall remain undisturbed; Steep Slopes, 15-24% - no more than 30% of such areas shall be disturbed, 25-30% - no more than 20% of such areas shall be disturbed, 30%+ - no more than 15% of such areas shall be disturbed; Woodlands - disturbance ratios between 10% and 50%, depending on zoning district.
- **Open Space Regulations (Section 37)** Contains provisions for open space within subdivision. In addition, this section establishes design standards, maintenance and ownership of open space and recreational areas.
- **Floodplain Regulations (Section 51)** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a Floodway District (the area within the floodplain intended to carry 100-year flood), Flood Fringe District (portion of floodplain outside floodway district), General Floodplain District (the floodplain area for which no detailed flood profiles or elevations are provided), and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the

floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include agriculture, public and private recreation, residential yards areas, garden play areas and pervious parking, and accessory industrial and commercial uses such as yard areas pervious parking and loading areas, and airport landing strips. Uses permitted by Special Exception include utilities and public facilities, water related uses, temporary uses, storage of materials and similar uses. The section further regulates existing structures, prohibited activities/uses, special exceptions and variances and flood proofing within designated floodplain areas.

Perkasie Borough

The Perkasie Borough Zoning Ordinance was adopted on December 16, 1985 and last revised through February 2004. The portion of Perkasie Borough which is located within the watershed area is zoned Planned Industrial (I-1).

The purpose of the I-1 district is to, “provide for the requirements of modern industrial development which are appropriate in selected areas”. This district allows for the provision of agricultural, recreational and various commercial/industrial uses. The minimum lot area required for this district is 43,560 square feet.

In conjunction with individual use regulations, site capacity calculations, environmental performance standards and buffers regulations have been established to further control growth and protect environmental features. A brief summary of the most relevant regulations is included herein:

- **Nuisance Standards (Sections 47 - 53).** These sections regulate noise, smoke, fumes, heat, odor, glare and vibrations in order to protect the public.
- **Buffer Yards (Section 54).** In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list.
- **Site Capacity Calculations (Section 56).** The Site Capacity Calculations are a five (5) step process completed prior to the design of any site that yields the minimum required open space, net buildable site area and the permitted number of dwelling units; excluding sites located in the I-1 district as well as sites less than 5 acres in the R-1A and R-1B districts. The calculations are based on the base site area and the area of the site that is resource (floodplain, soils, lakes or ponds, natural retention areas, steep slopes, wetlands and woodlands) protected.
- **Environmental Performance Standards (Section 57).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain - all such areas shall remain undisturbed except for road and utility crossings; Floodplain Soils - all such areas shall remain undisturbed except for minor road crossings; Steep Slopes - 8-15% shall remain 60% preserved, 15-25% shall remain 70% preserved, greater than 35% shall remain 85% preserved, when having a slope greater than 15% and being part of a woodland area shall be preserved so that 80% of such slope shall remain in natural cover and as permanent open space; Lakes and Ponds shall remain undisturbed; Natural Retention Areas - shall remain undisturbed; Wetlands - shall remain as

permanent open space, except for road crossings; Wetland Buffers – shall measure 100 feet from the limits of wetlands or to the limit of wetlands soils, whichever is less. A maximum of 20% disturbance is permitted within the wetlands buffer area. Woodlands - shall remain 50% preserved.

- **Floodplain Regulations (Chapter 94).** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. However, it should be noted that the portion of Perkasio Borough that lies within the boundaries of the Upper Tohickon Creek Watershed does not contain any floodplain areas.

Quakertown Borough

The Quakertown Borough Zoning Ordinance was enacted on March 4, 2003.

Quakertown Borough is located entirely within the watershed area. The predominant zoning districts in Quakertown Borough are zoned Medium Density Residential (MR) and High Density Residential (HR).

The purpose of the MR district is to, “provide for moderate density residential areas which are protected from incompatible land uses so as to maintain these areas as attractive living environments and to promote the orderly development of the Borough”. This district allows for the provision of agricultural, single-family dwelling units, institutional and recreational uses. This district allows for single family detached lots to be a minimum of 7,500 square feet; single family semi-detached lots to be 5,250 square feet and all other uses to be a minimum of 43,560 square feet.

The purposes of the HR districts are to, “provide for a variety of housing types and densities on residential areas which are protected from incompatible land uses and are near the commercial uses and community facilities so as to maintain these areas as attractive living environments and to promote the orderly development of the Borough”. This district allows for the provision of agricultural, a variety of dwelling unit types, institutional and recreational uses. This district allows for dwelling unit lots to be a minimum of 2,500 square feet.

Other zoning districts in the watershed area of Quakertown Borough include the following:

- Low Density Residential (LR)
- Town Center (TC)
- Neighborhood Commercial (NC)
- Highway Commercial (HC)
- Office/Business (OB)
- Hospital (H)
- Light Industrial (LI)

Quakertown Borough Ordinances do not appear to specifically regulate environmental protection standards or natural resources restrictions.

Richland Township

The Richland Township Portion of the Quakertown Area Zoning Ordinance was adopted on March 29, 1999. However, the Ordinance is currently being revised and updated to reflect Growing Greener land use principles. The narrative contained herein, however, references the current Ordinance.

The predominant zoning for the watershed area within Richland Township is Rural Agricultural (RA). The purpose of this district is to, “provide standards for low-density development in rural areas until these areas are needed for development and provided with utilities.” This district allows for the provision of all agricultural uses as well as single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Although a single-family detached unit requires a two (2) acre minimum lot size, the majority of development has been classified as a “cluster” and has a minimum average lot size of 30,000 square feet. Since the adoption of the Ordinance, this zoning district has seen significant residential development in the area south of Quakertown Borough.

Another predominant district within the watershed area is the Resource Protection District (RP). Its purpose is, “to protect areas consisting largely of sensitive natural features such as woodlands, steep slopes scenic areas, wetlands, floodplains, and lakes and ponds.” This restrictive district permits low intensity agricultural uses, single-family detached dwelling units, medical offices, and specific institutional and recreational uses. Detached dwelling have a five (5) acre minimum lot size.

Other zoning districts in the watershed area of Richland Township include the following:

- Suburban Residential Conservation (SRC)
- Suburban Residential Low (SRL)
- Suburban Residential Medium (SRM)
- Suburban Residential High (SRH)
- Planned Commercial (PC)
- Planned Industrial (PI)
- Extraction (EXT)
- Arterial Corridor Overlay (AC)
- Age Qualified Overlay (AQ)

The SRC, SRL, SRM, SRH, PC, and PI zoning districts are intended to serve as the development areas within the Township and were established to accommodate the anticipated growth of the Quakertown Area in accordance with the provided services and utilities. The EXT district is a special purpose district to provide for the continuation of existing extractive operations and other uses that would otherwise interfere with the development of other land uses.

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of performance standards (Article V) which include: site capacity calculations for determining the developable area of a site, density, and open space; environmental and resource

protection standards, including those for the floodplain; number, type, and location of landscape materials and buffer yards; nuisance standards; and, dimensional requirements. A brief summary of the most relevant regulations is included herein:

- **Site Capacity Calculations (Section 501).** The Site Capacity Calculations are a twelve (12) step process completed prior to the design of any site that yields the net buildable site area, the maximum number of dwelling units, the minimum required open space and recreation area, as well as the maximum impervious surface area. The calculations are based on the base site area and the area of the site that is resource (floodplain, soils, steep slopes, woodlands, wetlands, lakes and ponds) protected.
- **Table of Performance Standards (Section 502).** This section includes, by zoning district and use, the minimum open space, maximum density, and maximum impervious surface ratios, to be used in completing the site capacity calculations of Section 501, as well as the minimum site area and minimum lot areas.
- **Area and Dimensional Requirements (Section 503).** For each of the zoning districts, this section provides the minimum lot width, minimum yards, maximum floor area ratio (FAR), and maximum building height.
- **Environmental Protection Standards (Section 504).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain, to remain undisturbed except for minor road crossings; steep slopes, 8-15% slope, no more than 40% disturbance, 15-20% slope, no more than 30% disturbance, 25% or steeper slope, no more than 15% disturbance; woodlands, no more than 20% disturbance; lakes, ponds, watercourses, to remain undisturbed except for minor road crossings; lake shore areas, no more than 10% impervious and 30% disturbance; pond shore areas, no more than 10% impervious and 20% disturbance; wetlands greater than one acre are to remain undeveloped except for minor road crossings; wetlands less than one acre are to remain undisturbed.
- **Buffer Yards (Section 505).** In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list. General requirements provide provisions for the location, maintenance, design, and placement of the buffer yard.
- **Floodplain Regulations (Section 507).** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a floodway (the watercourse channel and adjacent land required to carry 100-year flood), flood fringe (portion of floodplain outside floodway), 100-year floodplain boundary, and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include agriculture, public and private recreation, residential yards, and temporary uses. Uses permitted by Special Exception include utilities and public facilities, water related uses, storage of materials and pervious parking areas. The section further regulates existing structures, mobile homes, prohibited activities, and special exceptions and variances within designated floodplain areas.
- **Nuisance Standards (Sections 508 - 515).** These sections regulate noise, smoke, fumes, vapors, heat, odor, glare, vibrations, storage and waste disposal,

- and radioactive and electrical disturbances in order to protect the public.
- **Open Space in Residential Developments (Sections 530-535).** Requires the provision of open space in single-family, detached cluster developments, performance standard subdivisions, mobile home parks, and planned residential developments, a portion of which must be utilized as a recreation area. Section 531 regulates how the open space will be designated on the plans and Section 532 provides the design standards, such as landscape and recreation requirements. Sections 533 through 535 provide the guidelines for how the open space is to be bonded, owned, and maintained.
- **Stormwater Management (Ord, 187).** This Ordinance provides specific regulations for the calculation, design and maintenance of stormwater management systems.

Richlandtown Borough

The Richlandtown Borough Zoning Ordinance was enacted on April 10, 1972.

Richlandtown Borough is located entirely within the watershed area. The predominant zoning for the watershed area within Richlandtown Borough is zoned Residential Subdivision District (RS). Two additional zoning districts are located within Richlandtown Borough, and are within the Village Center District (VC) and the Highway Commercial District (HC).

The purpose of the RS district is to, Aestablish areas composed of residential properties of a suburban character on lands in the Borough most logically suited for this type of development; both physically and locationally@. This district allows for the provision of single-family detached, two-family attached dwelling units and single-family attached dwelling units. This district allows for single-family detached lots to be a minimum of 12,000 square feet, with single-family attached units having a minimum lot area of 4,000 sf; with end units having a minimum lot area of 6,000 sf.

The purpose of the VC district is to; Aaccommodate higher density residential uses and those retail sales and services that are considered to be essential to the functions of residential neighborhoods@. This district allows for the provision of single-family detached and single-family attached dwelling units. This district allows for single-family detached lots to be a minimum of 12,000 square feet, with single family attached units having a minimum lot area of 4,000 sf; with end units having a minimum lot area of 6,000 sf.

The purpose of the HC district is to Aaccommodate those retail and business activities that serve a regional market and are not normally part of a shopping center development and those activities that require merchandising oriented to the highway user.@ This district allows for a variety of commercial uses with a minimum lot area of 20,000 sf.

In conjunction with individual district requirements, environmental performance standards and buffer regulations have been established to further control growth and protect environmental features. A brief summary of the most relevant regulations is included herein:

- **Wetlands (Section 228).** Requires an onsite assessment by a professional soil scientist when a site contains hydric soils. In addition, a wetlands margin should extend around the outer limit of wetlands for a distance of 75 feet or to the limit of hydric soils; whichever is less. Wetland margins shall remain undisturbed.
- **Nuisance Standards (Sections 601 - 607).** These sections regulate noise, smoke, fumes, heat, odor, glare and vibrations in order to protect the public.
- **Buffer Yards (Section 610).** Requires a 50 foot buffer yard in the HC district along district boundaries between themselves and residential districts through the use of screen plantings.

Springfield Township

The Springfield Township Zoning Ordinance was adopted on August 28, 1990 and amended through April 2005. The portion of Springfield Township which is located within the watershed area is predominantly zoned Resource Protection (RP) and Rural Residential (RR).

The purpose of the RP district is to, “protect areas consisting largely of natural features such as forests, steep slopes, scenic areas, wetlands, streams, floodplains and ponds including those identified in the Bucks County Natural Resource Plan. Intensities are such as to insure that these resources are preserved, while providing for residential development with suitable sewage disposal.” This district allows for the provision of several agricultural uses as well as single family detached residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a three (3) acre minimum lot size, a “cluster” option with a minimum lot size of 0.5 acre is also permitted when an approved public or private centralized water system and public sewer system are provided.

The purpose of the RR district is to, “preserve the rural character of the Township and to prevent haphazard, scattered development characterized by urban sprawl. It is intended that this district provide a place for residential growth and minimize health risks from on-site sewage failure.” This district allows for the provision of several agricultural uses as well as single family detached residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a two (2) acre minimum lot size, a “cluster” option with a minimum lot size of 0.75 acre is also permitted.

Other zoning districts within the watershed area of Springfield Township include:

- Development District (DD)
- Highway Commercial (HC)
- Planned Industrial (PI)
- Village Commercial (VC)
- Village Residential (VR)
- Scenic District Overlay

The Scenic Overlay District is a special purpose district to protect the unique visual character of the Township by setting standards for the visual impact of development on views from the roads.

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of general provisions (Article 5) which include: dimensional requirements, buffer yards, performance standards, environmental protection standards, site capacity calculations and open space standards. A brief summary of the most relevant regulations is included herein:

- **Buffer Yards (Section 503).** Provides for screening between adjacent land uses for subdivisions and land development. The Ordinance establishes standards for the required plant material based on the extent of improvements that are proposed.
- **Performance Standards (Section 508).** This section regulates smoke, ash, dust, fumes, vapor, gases, noise, glare, heat, outdoor storage, waste disposal, industrial waste and storage and electrical, diesel, gas or other power in order to protect the public.
- **Environmental Protection Standards (Section 509).** This section regulates the disturbance of natural resources within the Township. The Ordinance does not have a standard disturbance ratio for each resource in the entire district, but rather each resource is regulated separately in each district. These resources include: floodplain, floodplain soils, lakes and ponds, land and pond margins, wetland, wetland margins, streams and watercourses, stream and watercourse margins, steep slopes, and woodland and carbonate geology areas.
- **Site Capacity Calculations (Section 510).** The Site Capacity Calculations are a multi step process completed prior to the design of any site that yields the base site area, resource protected land, unrestricted land, total recreational land, total open space, net buildable site area, allowable impervious surface area and allowable number of dwelling units. The calculations are based on the base site area and the area of the site that is resource protected i.e. floodplain, floodplain soils, lakes and ponds, land and pond margins, wetland, wetland margins, streams and watercourses, stream and watercourse margins, steep slopes, and woodland and carbonate geology areas.
- **Open Space in Residential Developments (Section 512).** Requires the provision of open space in developments, a portion of which must be utilized as recreation area. This section also provides the guidelines for the layout, designation, how the open space is to be bonded, owned, and maintained.

Trumbauersville Borough

The Trumbauersville Borough Zoning Ordinance was adopted on 1975 and last revised in 1996. The portion of Trumbauersville Borough which is located within the watershed area is zoned Suburban residential Low (SRL) and Suburban Residential Medium (SRM).

The purpose of the SRL district is to, “provide for low intensity residential development.” This district allows for the provision of agricultural uses as well as a variety of residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a 20,000 square foot minimum lot size, a “cluster” option with a minimum average lot size of 12,500 square feet is also permitted on lots with a minimum site area of 4 acres. In addition, a performance standard subdivision could permit lots as small as 2,000 square feet.

The purpose of the SRM district is to, “provide for medium intensity residential development.” This district allows for the provision of agricultural uses as well as a variety of residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a 15,000 square foot minimum lot size, a “cluster” option with a minimum average lot size of 10,000 square feet is also permitted. In addition, a performance standard subdivision could permit lots as small as 2,000 square feet.

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of performance standards (Article V) which include: site capacity calculations for determining the developable area of a site, density, and open space; environmental and resource protection standards, including those for the floodplain; number, type, and location of landscape materials and buffer yards; nuisance standards; and, dimensional requirements. A brief summary of the most relevant regulations is included herein:

- **Site Capacity Calculations (Section 501).** The Site Capacity Calculations are a twelve (12) step process completed prior to the design of any site that yields the net buildable site area, the maximum number of dwelling units, the minimum required open space and recreation area, as well as the maximum impervious surface area. The calculations are based on the base site area and the area of the site that is resource (floodplain, soils, steep slopes, woodlands, wetlands, lakes and ponds) protected.
- **Table of Performance Standards (Section 502).** This section includes, by zoning district and use, the minimum open space, maximum density, and maximum impervious surface ratios, to be used in completing the site capacity calculations of Section 501, as well as the minimum site area and minimum lot areas.
- **Area and Dimensional Requirements (Section 503).** For each of the zoning districts, this section provides the minimum lot width, minimum yards, maximum floor area ratio (FAR), and maximum building height.
- **Environmental Protection Standards (Section 504).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain, to remain undisturbed except for minor road crossings; steep slopes, 8-15% slope, no more than 40% disturbance, 15-25% slope, no more than 30% disturbance, 25% or steeper slope, no more than 15% disturbance; woodlands, no more than 20% disturbance; lakes, ponds, watercourses, to remain undisturbed except for minor road crossings; lake shore areas, no more than 10% impervious and 30% disturbance; pond shore areas, no more than 10% impervious and 20% disturbance; wetlands greater than one acre are to remain undeveloped except for minor road crossings; wetlands less than one acre are to remain undisturbed; wetland margins - for wetlands greater than 1 acre, a minimum of 80% shall remain preserved.
- **Buffer Yards (Section 505).** Provides for screening between conflicting land uses. In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list.
- **Floodplain Regulations (Section 507).** Regulations in this section regulate and

restrict uses, activities, and development on areas subject to flooding. It establishes a floodway (the watercourse channel and adjacent land required to carry 100-year flood), flood fringe (portion of floodplain outside floodway), 100-year floodplain boundary, and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts. Uses that are permitted include agriculture, public and private recreation, residential yards, and temporary uses. Uses permitted by Special Exception include utilities and public facilities, water related uses, storage of materials and pervious parking areas. The section further regulates existing structures, mobile homes, prohibited activities, and special exceptions and variances within designated floodplain areas.

- **Nuisance Standards (Sections 508 - 515).** These sections regulate noise, smoke, fumes, vapors, heat, odor, glare, vibrations, storage and waste disposal, and radioactive and electrical disturbances in order to protect the public.
- **Open Space in Residential Developments (Sections 530-535).** Requires the provision of open space in single-family, detached cluster developments, performance standard subdivisions, mobile home parks, and planned residential developments, a portion of which must be utilized as recreation area. Section 531 regulates how the open space will be designated on the plans and Section 532 provides the design standards, such as landscape and recreation requirements. Sections 533 through 535 provide the guidelines for how the open space is to be bonded, owned, and maintained.

West Rockhill Township

The West Rockhill Township Zoning Ordinance was adopted in 1996. The portion of West Rockhill Township which is located within the watershed area is predominantly zoned Residential Agricultural (RA) and Residential Conservation (RC).

The purpose of the RA district is to, “promote rural residential development and agricultural use of lands which do not possess the accessibility and natural development restrictions of the resource protection areas of the RC District. Requirements of the RA district are designed to protect and stabilize the intrinsic character of the land, to encourage the continued use of land for agricultural purposes and to promote and encourage a suitable and safe environment for family life.” This district allows for the provision of all agricultural uses as well as single family detached residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a one (1) acre minimum lot size, a “cluster” option with a minimum average lot size of 30,000 square feet is also permitted.

The purpose of the RC district is to, “promote low intensity rural development in resource protection areas where major physiographical problems restrict development, where accessibility is difficult and in areas of unique natural features.” This district allows for the provision of all agricultural uses as well as single-family detached residential dwelling units, and specific institutional and recreational uses. Although a single-family detached unit requires a two (2) acre minimum lot size, a “cluster” option with a minimum average lot size of one (1) acre is also permitted.

Other zoning districts within the watershed area of West Rockhill Township include:

- Mobile Home Park (MPH)
- Neighborhood Commercial (NC)
- Planned Commercial (PC)
- Planned Industrial (PI)

In addition to the community goals and objectives, the establishment of zoning districts, and the use regulations, the Zoning Ordinance contains a number of performance standards (Article V) which include: natural resource standards, site capacity calculations, open space standards and buffers. A brief summary of the most relevant regulations is included herein:

- **Natural Resource Standards (Section 500).** A maximum alteration or disturbance permitted for each of the following standards is set: Floodplain, to remain undisturbed except in conformance with Section 503 Floodplain Regulations; Floodplain Soils - all such areas shall remain undisturbed except for roadway crossings; steep slopes, 10-15% slope, no more than 40% disturbance, 16-25% slope, no more than 30% disturbance, 26% or steeper slope, no more than 15% disturbance; forest - no more than 40% may be disturbed, this standard does not apply to sites within the PC, PI and IS zoning districts; lakes, ponds, watercourses, to remain undisturbed except for minor road crossings; lake and pond shore areas - no more than 30% disturbance.
- **Contiguous Building Envelope (Section 501.a)** Establishes a minimum clear area on each lot to provide sufficient area for construction activities, while meeting the natural resource protection standards and minimum setback requirements.
- **Site Capacity Calculations (Section 501.b).** The Site Capacity Calculations are an eight (8) step process completed prior to the design of any site that yields the unrestricted land, total recreational land, total open space, net buildable site area, allowable dwelling units, and allowable impervious surface. The calculations are based on the base site area and the area of the site that is resource (floodplain, soils, lakes or ponds, wetlands, steep slopes, forests, pond and lake shore) protected.
- **Table of Performance Standards (Section 502).** This section includes, by zoning district and use, the minimum open space, maximum density, and maximum impervious surface ratios, to be used in completing the site capacity calculations of Section 501, as well as the minimum site area and minimum lot areas.
- **Floodplain Regulations (Section 503).** Regulations in this section regulate and restrict uses, activities, and development on areas subject to flooding. It establishes a floodway, flood fringe, 100-year floodplain boundary, and floodplain soils. It lists the methods for determining the floodplain as well as general provisions of the floodplain, such as the floodplain is to be an overlay to the existing underlying zoning districts.
- **Open Space in Residential Developments (Section 504).** Requires the provision of open space in single-family, detached cluster developments, performance standard subdivisions, mobile home parks, and planned residential developments, a portion of which must be utilized as recreation area. This

section also provides the guidelines for how the open space is to be bonded, owned, and maintained.

- **Buffer Yards (Section 505).** Provides for screening between conflicting land uses. In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list.
- **Nuisance Standards (Sections 600 - 607).** These sections regulate noise, smoke, fumes, vapors, heat, odor, glare, vibrations, storage and waste disposal, and radioactive and electrical disturbances in order to protect the public.

1.6.4. Subdivision and Land Development

The Subdivision and Land Development Ordinance (SLDO) is a common planning tool used to specifically regulate the creation of new property lines (subdivision) and the construction of buildings, utilities, and other improvements (land development). The following subsections outline portions of the Subdivision and Land Development Ordinances of each of the participating municipalities that are most closely related to the natural, cultural, and historic preservation goals of this report.

Bedminster Township

The most recent Bedminster Township Subdivision and Land Development Ordinance (SLDO) was adopted November, 2002. The Ordinance contains seven articles, eight appendices, and two stand-alone Ordinances. Although all sections within the SLDO (e.g., submission procedures, traffic impact studies, street standards) are pertinent to natural and cultural resource protection, the most related are as follows:

- **Traffic Impact Studies (Section 406)** - Regulations enable the municipality to assess the impact of proposed development to the existing transportation system. The section requires a traffic impact study for all subdivisions and land development proposals in residential (>20 dwelling units or lots), non-residential (>10 lots), commercial (> 25, 000 square feet), office (> 25,000 square feet), industrial (> 10 lots, > 50,000 square feet, > 75 employees) and institutional (> 25,000 square feet) zoning districts.
- **Sewage Facilities and Sanitary Sewage Disposal (Sections 407 & 520)** - PADEP requirements must be met. The Township is required to review all planning modules and proof of soil suitability to Township via the BCDOH. Requires standard sanitary disposal language for public and on-lot disposal systems.
- **Water Resources Impact Study and Water Supply (Sections 408 & 519)** - DRBC approval required for projects withdrawing 10,000 gpd of groundwater or surface water. DRBC submissions must also be provided to the Township. All other withdrawals must be reviewed by the Township. Where public water is not provided, a water resources impact study shall be completed. The study is required for all zoning districts (e.g., residential subdivisions with 3 or more proposed lots). Site-specific investigations are required. Standard community and on-lot water supply language for public, private and on-lot wells.
- **Wetland Delineation (Section 409)** - Sites showing wetlands (NWI Mapped) or hydric soils require an on-site investigation and must be approved by the

- municipality. Delineation must be validated by ACOE.
- **Ground Water Resources (Section 410 & 411).** These sections provide standards and regulations for wellhead protection areas and well drilling.
 - **Landscaping and Street Trees (Section 515)** - Street trees (native and non-native list) are required for all land developments where street trees are not present. Off-street parking areas and detention basins must be landscaped at a specified density.
 - **Stormwater Management (Section 516)** - Facilities must convey flow of stormwater runoff (rate limitations shall not exceed pre-construction, 2-100 year calculations) from the development site. Easements shall be dedicated to the Township, owner is responsible for maintenance, and maintenance agreement required. No water quality treatment requirements.
 - **Excavation and Grading (Section 517)** - No excavation or fill steeper than 3:1 ratio (exceptions provided). Temporary crossings for live streams with PADEP, BCCD & Township approval.
 - **Erosion and Sedimentation (E&S) Control (Section 518)** - E&S plan must be submitted with all applications. Standard Chapter 102 language incorporated.
 - **Recreational Facilities (Section 525)** - Public dedication of land required for active park and recreation (athletic fields, tot lots, courts) purposes (>25 lots and >20 dwelling units). Consolidation options are included. (No passive recreation options included in this section).

East Rockhill Township

East Rockhill Township adopted its Subdivision and Land Development Ordinance on December 20, 1994 and amended through November 11, 2002. The Ordinance contains eight (8) parts and five (5) Appendices. Parts 5 and 6, which contain the General Design Standards and Required Improvements, are most applicable to the goals and objectives of the Upper Tohickon Rivers Conservation Plan. The following is a partial list of those sections, which contain preservation standards:

- **Landscaping and Street Trees (Section 515)** Requires the installation of street trees, off-street parking area landscaping, and plantings within stormwater management facilities. This section also establishes standards for plant material specifications and for the protection of existing vegetation.
- **Stormwater Management (Section 516).** The Ordinance contains specific regulations for the design and maintenance of the stormwater facilities, including water quality requirements, groundwater recharge standards, BMP's for runoff control measures and infiltration, detention and retention basin design, and drainage structures and pipes.
- **Erosion and Sedimentation Control (Section 518).** An erosion and sedimentation control plan shall be submitted with all applications wherein excavation, placement of fill and/or grading activities are proposed. Measures used to control erosion and reduce sedimentation during construction activities shall strictly conform to the standards and specifications of the BCCD.
- **Public Water Supply Systems and Centralized Water Supply and Distribution Systems (Section 519).** If water is not provided by the Township, a centralized water supply shall be provided for all residential subdivisions of 15 lots or more; all residential subdivisions of 5 lots or more with a density of 1.8

dwelling units; and for all nonresidential subdivisions of three (3) lots or more or non-residential buildings. All systems to be designed to requirements of applicable authority or water department and shall be offered for dedication to Township or authority having jurisdiction in the area of the subdivision. Minimum pressure of 35 pounds per square inch. Fire hydrants to be provided.

- **Sanitary Sewage Disposal (Section 520).** This section contains specific requirements for the types and locations for public and private on-lot systems; in accordance with the Pennsylvania Sewage Facilities Act (Act 537).
- **Recreational Facilities (Section 525).** The Ordinance contains specific requirements for the types and quantities of facilities that are required to be provided. All residential subdivisions of 25 or more dwelling units shall be provided with recreational facilities, unless waived by the Board of Supervisors. These facilities shall be constructed on open space within detached clustered subdivisions and performance standards developments.

Haycock Township

Although a partnering municipality within the Quakertown Area Planning Committee (QAPC), Haycock Township adopted its own, separate Subdivision and Land Development Ordinance on June 19, 2000, last amended August 7, 2000. The Ordinance contains eight articles and nine appendices, all of which are related to protecting the future growth and development of the Township. The following sections, however, are most directly related to the protection of natural and cultural resources in the watershed:

- **Water Resources Impact Study (Section 408).** Requires all projects withdrawing 10,000 gpd or greater of groundwater, surface water, or both to obtain a permit from DRBC, with copies of applications to be sent to the Township. Projects not under DRBC jurisdiction to be reviewed by the Township. Water Impact Study required when development is not served by public water. Requirements of study included in Ordinance.
- **Wetlands Delineation (Section 409).** Sites showing mapped wetlands, hydric soils, or a predominance of wetlands vegetation require an on-site investigation and must be approved by the municipality. Delineation must be validated by ACOE.
- **Landscaping and Street Trees (Section 515).** Street trees shall be planted along all existing and proposed streets within any land development or major subdivision. Required placement of vegetation is outlined and suggested tree lists are included. The Ordinance also outlines other planting requirements and specific methods for the protection of existing plant material during the planning, design, and construction of the site.
- **Stormwater Management (Section 516).** All subdivisions and land developments are subject to Haycock Township Stormwater Management Ordinance; Ordinance No. 91 adopted October 7, 2002 in addition to Section 516. Lots to have a minimum 2% positive drainage. No alteration to affect normal flow of stream or watercourse without approval by the PADEP or Township approval. No alteration of existing drainage onto adjacent property. Ordinance contains requirements for storm drainage systems and collection system design, including swales, easements, inlets, piping, and gutters.

- **Excavation and Grading (Section 517).** No excavation of fill with face greater than 3:1 slope except as permitted with conditions. Need approved grading and erosion/sedimentation control plan. Topsoil not to be removed from site.
- **Erosion and Sedimentation Control (Section 518).** Erosion and sedimentation control plan shall be submitted where excavation, fill and/or grading activities are proposed. Plan to be approved by Bucks County Conservation District.
- **Water Supply, Distribution Systems, and Fire Protection (Section 519).** All lots in a subdivision or land development shall have either connection to centralized/public water (all residential subdivisions of 15 lots or more where average lot size is less than 2 acres; all non-residential land developments) or on-lot water. Water quality to conform to PADEP and BCDH standards. Well certification and permit required.
- **Sanitary Sewage Disposal (Section 520).** System to be in accordance with PA Sewage Facilities Act (Act 537), Township Sewage Facilities Plan, and Chapter 71 of PADEP Regulations.

Milford Township

Milford Township adopted its Subdivision and Land Development Ordinance on August 6, 2002. On September 17, 2002 it was amended and readopted to its most recent version. The Ordinance contains ten Articles and three Appendices. Articles V and VI,, which contain the Design Standards and Required Improvements, are most applicable to the goals and objectives of the Upper Tohickon Rivers Conservation Plan. The following is a partial list of those sections, which contain preservation standards:

- **Erosion and Sedimentation Control (Section 511).** No subdivision or land development plan is to be approved unless an Erosion and Sedimentation Control Plan is approved by the Township and BCCD and escrow is posted. Must meet PADEP and BCCD standards. All disturbed areas are to have temporary erosion control measures in place. No excavation greater than 3:1 slope.
- **Stormwater Management (Section 512).** Similar in context to the recently adopted Quakertown Borough Stormwater Management Ordinance, the Milford Township SLDO contains detailed requirements for stormwater management. Stormwater Management Plans must be submitted and approved by the BOS prior to final land development or subdivision approval. The Ordinance contains specific regulations for the design and maintenance of the stormwater facilities, including water quality requirements, groundwater recharge standards, BMP's for runoff control measures and infiltration, detention and retention basin design, and drainage structures and pipes.
- **Landscaping (Section 520).** Installation of street trees prior to issuance of occupancy permit. Ordinance outlines tree specifications, spacing, location, and installation. Buffer yards are based on the adjacent land uses and are categorized as "A" through "C" with specific widths and planting options. Plant materials lists are also included. Plantings are required for the delineation between private lots and open space; screening is also required where private lots abut or are within 30 feet of open space.
- **Tree Protection Standards (Section 521).** Tree Protection Zone required on development plans to be delineated on the site prior to construction. The area

within Zone shall not be built. Retaining wall required when grade in Zone cannot be maintained. Ordinance provides pruning, fertilization, and tunneling and trenching methods to be implemented.

- **Open Space Standards (Section 522).** All major residential and all non-residential subdivisions/land developments shall meet open space requirements of the ZO. Section 522 provides a four-step design process for delineating open space, locating buildings, aligning infrastructure and the design of lots. The design of the open space is to be based on the natural resources protection standards outlined in the ZO and other items such as historic sites, agricultural areas, and trails.
- **Public Water Supply Systems and Centralized Water Supply and Distribution Systems (Section 611).** If water is not provided by the Township, centralized water supply to be provided for more than 12 dwellings or non-residential buildings. All systems to be designed to requirements of the Township, DRBC, and the Milford Township Water Authority and shall be offered for dedication to the Township. Minimum pressure of 40 pounds per square inch. Fire hydrants to be provided.
- **Sanitary Sewage Disposal (Section 613).** This section contains specific requirements for the types and locations for public and private on-lot systems; in accordance with the Pennsylvania Sewage Facilities Act (Act 537) and the Individual Sewage Disposal System application and certification procedure for Bucks County.
- **Special Drainage Problems Floodplain Areas (Section 620).** The Board of Supervisors is able to prohibit subdivision within a floodplain. Ordinance gives provisions for the development of drainage, sewer facilities, water facilities and other utilities.

Nockamixon Township

The Subdivision and Land Development Ordinance for Nockamixon Township was adopted on May 18, 2004. The Ordinance consists of eight Articles, however, Article 5, Design Standards, most specifically addresses the protection standards that are needed in order to preserve the natural and cultural resources of the Upper Tohickon Watershed. The following is a portion of these standards:

- **Landscape Regulations (Section 515).** All land developments and major subdivisions require the provision of street trees at intervals of no less than 40 feet along all streets. Minimum street tree trunk diameter is 2.5 inches. Buffer yards for industrial uses shall be 50 feet; all other uses, 30 feet. Buffer plantings required. Dumpsters are required to be screened from view. Ordinance contains a specific approved planting list.
- **Tree Protection Standards (Section 515).** Tree Protection Zone required on development plans to be delineated on the site prior to construction. Area within Zone shall not be built. Retaining wall required when grade in Zone cannot be maintained. Trees and roots damaged during construction shall be protected from further damage.
- **Stormwater Management (Section 516).** The Ordinance contains the methodology for calculating and controlling stormwater runoff, including those for detention basins, storm sewers, inlets, and swales.

- **Soil Erosion and Sediment Controls (Section 518).** Erosion and Sedimentation Control Plan shall be submitted, reviewed by Township Engineer, and approved by BCCD prior to any changes in the land and approved by Township prior to approval of subdivision or land development plans. Improvement bond is required.
- **Recreational Facilities (Section 525).** Requires that developments provide suitable land and facilities for recreation.
- **Sanitary Sewage Disposal (Section 520).** This section contains specific requirements for the types and locations for private on-lot systems; in accordance with the Pennsylvania Sewage Facilities Act (Act 537).
- **Water Supply (Section 519).** All wells are required to meet the standards of the Township Well Ordinance prior to preliminary plan approval. Water supplied by other means needs to be approved by Board of Supervisors in accordance with Nockamixon Township Water Supply Ordinance 62.

Perkasie Borough

Perkasie Borough adopted its Subdivision and Land Development Ordinance on December 16, 1985, as amended through February 2001. The Ordinance contains five (5) Articles. Articles III and IV, which contain the Design Standards and Specifications and Required Improvements, are most applicable to the goals and objectives of the Upper Tohickon Rivers Conservation Plan. The following is a partial list of those sections, which contain preservation standards:

- **Natural Features (Section 17).** Requires the preservation of trees, groves, waterways, scenic points, historic points or other community assets and land marks to be preserved to the fullest extent possible.
- **Hazardous Lands - Flood-prone Areas (Section 18).** Requires that land subject to flooding or other hazards to life, health or property and land deemed to be topographically unusable, not be subdivided or developed for residential occupancy.
- **Storm Sewage and Drainage (Section 33).** Requires that storm sewage shall be designed and constructed in accordance with the Borough Standards and the standards of the Pennsylvania Department of Environmental Protection and be subject to approval by the Borough Engineer.
- **Planted Buffers (Section 35)** In order to determine the required buffer yard, applicants must determine use and adjacent uses, select the required planting option for the required class of buffer yard, and select plant material from the provided list.
- **Site Capacity Calculations (Section 40).** The Site Capacity Calculations are a five (5) step process completed prior to the design of any site that yields the required open space, net buildable site area, the maximum number of dwelling units; excluding sites located in the I-1 district as well as sites less than 5 acres in the R-1A and R-1B districts. The calculations are based on the base site area and the area of the site that is resource protected i.e. floodplain, soils, steep slopes, lakes and ponds, natural retention areas, wetlands and woodlands.
- **Environmental Protection (Section 41).** This section establishes the standards for resource protection in accordance with the following summary: Floodplains - areas shall remain undisturbed except for road and utility crossings; Floodplain

Soils - areas shall remain undisturbed except for road and utility crossings; Steep Slopes - 8-15% no more than 40% disturbance, 15-25% no more than 30% disturbance, 25% or more no more than 15% disturbance, Steep slopes greater than 15% and being located in a woodland area shall exceed 20% disturbance; Lakes and Ponds - shall remain undisturbed; Natural Retention Areas - shall remain undisturbed; Wetlands - shall remain undisturbed, in addition, a 100 foot buffer shall be provided with no more than 20% disturbance within the buffer; Woodlands - no more than 50% disturbance.

- **Tree Protection Standards (Section 41.1).** Tree Protection Zone required on development plans to be delineated on the site prior to construction. Area within Zone shall not be built. Retaining wall required when graded in the Zone cannot be maintained. Ordinance provides pruning, fertilization, and tunneling and trenching methods to be implemented.
- **Sanitary Sewage Disposal (Sections 56 and 57).** Sanitary sewage services shall be in accordance with Perkasio Borough standards and if applicable, the Individual Sewage Disposal Code for Bucks County, Pennsylvania, adopted by the Bucks County Board of Health on November 12, 1955 and any amendments thereto made.

Quakertown Borough

Although a partnering municipality in the Quakertown Area Planning Committee, and a participant in the preparation of the Quakertown Area Subdivision and Land Development Ordinance, Quakertown Borough did not adopt the Quakertown Area Subdivision and Land Development Ordinance. Instead, the Borough utilizes the Quakertown Subdivision Regulation Ordinance of 1964. The Ordinance contains eight Parts, the last of which, the Stormwater Management Plan, was added to the Plan in August of 2002. The Ordinance of 1964 is vague in its design standards, indicating only that systems are to be designed, submitted, approved, and built by the developer. There is little verbiage as to any specifications with the exception of the stormwater systems, which is quite detailed.

The Stormwater Management Plan aims to control stormwater runoff and manage development in the Tohickon Creek Watershed. It contains general provisions, definitions, stormwater management requirements, site plan requirements, inspections, fees and expenses, maintenance responsibilities, and enforcement.

Richland Township

Richland Township utilizes the Quakertown Area Subdivision and Land Development Ordinance, prepared in 1979. The Richland Township Board of Supervisors has adopted a significant number of separate Ordinances throughout the years, which makes the SLDO unique to Richland. The following is a summary of the sections of this Ordinance which pertain to the goals and objectives of preserving the natural resources within the Upper Tohickon Watershed:

- **Dedication of Land, or Payment of Fees in Lieu Thereof for Park, Recreation, and Open Space Use (Section 503).** Residential subdivision and/or land development plans must meet provisions for providing suitable lands.

Planning Commission to review plans. Ordinance contains specific amount of land to be provided based on number of units to be served as well as dedication methodology and design standards of land to be provided. Provides for fee-in-lieu of land dedication of \$1,500. (*Note: this amount is reviewed annually and has recently been increased*).

- **Erosion and Sedimentation Control; Stormwater Management (Section 512).** Subdivision and land development plans must have erosion and sedimentation control plan approved by the Planning Commission. Improvement bond/escrow must be posted. Proposed measures must meet BCCD and PADEP standards, approved by Municipal Engineer. All disturbed areas are to have temporary erosion control measures in place. No excavation greater than 3:1 slope. Permanent retention/detention basins shall be provided; location and design shall be approved by Planning Commission and the Township Engineer.
- **Planting (Section 519).** Street trees to be provided at 45-foot intervals within any subdivision over 10 lots. Minimum street tree trunk diameter is 2.5 inches. Buffer yard plantings shall be minimum of 4-foot high.
- **Public Water Supply Systems and Centralized Water Supply and Distribution System (Section 612).** Connection to a public or private centralized water supply is required where the average lot size is one acre or less and more than 12 units are to be provided. Municipal approval and maintenance agreements are required. Pressure to be between 30 and 60 pounds per square inch. Adequate fire protection to be approved by Municipal Engineer.
- **Sanitary Sewage Disposal (Section 614 and 615).** Sanitary sewage services shall be in accordance with the standards and specification of the Municipal Authority and if applicable, the Individual Sewage Disposal Code for Bucks County, Pennsylvania, adopted by the Bucks County Board of Health on March 24, 1971 and any amendments thereto made.

Richlandtown Borough

Richlandtown Borough adopted its Subdivision and Land Development Ordinance on June 11, 1979. The Ordinance contains ten (10) Articles. Articles V and VI, which contains the Design Standards and Required Improvements, are most applicable to the goals and objectives of the Upper Tohickon Rivers Conservation Plan. The following is a partial list of those sections, which contain preservation standards:

- **Plantings (Section 521)** Requires the installation of street trees and buffer plantings between conflicting land uses.
- **Stormwater Management (Section 524).** The Richlandtown Borough SLDO contains detailed requirements for stormwater management. The Ordinance contains specific regulations for the design and maintenance of the stormwater facilities, including water quality requirements, groundwater recharge standards, BMP's for runoff control measures and infiltration, detention and retention basin design, and drainage structures and pipes.
- **Erosion and Sedimentation Control (Section 526).** An erosion and sedimentation control plan shall be submitted with all applications wherein excavation, placement of fill and/or grading activities are proposed. Plans shall include a construction staging narrative indicating the sequence of earthmoving activities and proposed erosion and sedimentation control procedures. Measures

used to control erosion and reduce sedimentation during construction activities shall strictly conform to the standards and specifications of the BCCD and sequence of earth moving activities.

Springfield Township

Springfield adopted its Subdivision and Land Development Ordinance on April 9, 1996 and has been amended through May 13, 2003. The Ordinance contains seven Articles and seven appendices. Articles V and VI, which contains the General Design Standards and Required Improvements, are most applicable to the goals and objectives of the Upper Tohickon Rivers Conservation Plan. The following is a partial list of those sections:

- **Landscaping and Street Trees (Section 515)** Requires the installation of street trees, trees in off-street parking areas, landscaping and plantings within stormwater management facilities. This section also establishes standards for plant material specifications and for the protection of existing vegetation.
- **Stormwater Management (Section 516).** The Ordinance contains specific regulations for the design and maintenance of the stormwater facilities, including water quality requirements, groundwater recharge standards, BMP's for runoff control measures and infiltration, detention and retention basin design, and drainage structures and pipes.
- **Erosion and Sedimentation Control (Section 518).** An erosion and sedimentation control plan shall be submitted with all applications wherein excavation, placement of fill and/or grading activities are proposed. Measures used to control erosion and reduce sedimentation during construction activities shall strictly conform to the standards and specifications of the BCCD.
- **Water Supply, Distribution Systems and Fire Protection (Section 519).** Requires all properties that abut a public water system to make a connection to that system. All systems to be designed to the requirements of the applicable authority or water department and shall be offered for dedication to the Township or authority having jurisdiction in the area of the subdivision. Minimum pressure of 35 pounds per square inch. Guidelines are also offered for private individual water supply systems. Fire hydrants to be provided.
- **Sanitary Sewage Disposal (Section 520).** This section provides regulations for sewage facilities in accordance with the Township's Official Plan for Sewage Facilities and in accordance with the Pennsylvania Sewage Facility Act, Act 537.
- **Recreational Facilities (Section 525).** The Ordinance contains specific requirements for the types and quantities of facilities that are required to be provided. All residential subdivisions of 25 or more dwelling units shall be provided with recreational facilities, unless waived by the Board of Supervisors. These facilities shall be constructed on open space within detached clustered subdivisions and performance standards developments.

Trumbauersville Borough

Trumbauersville Borough adopted the Trumbauersville Borough Subdivision and Land Development Ordinance on October 2, 2003. It contains nine Articles and one Appendix. Articles V and VI contain the design standards and the required improvements respectively. Although the entire Ordinance is aimed at promoting the, "orderly and

efficient development of land”, the following excerpt highlights the sections of the Ordinance most closely related to the preservation goals of the Upper Tohickon Watershed:

- **Planting (Section 518).** Street trees are required along all streets where suitable trees do not exist at intervals of forty-five feet. List of approved street trees is included in the Ordinance. Evergreens with a minimum height of 4 feet are to be planted where a screen planting is required within a buffer yard. Tree Protection Zone is defined.
- **Stormwater Management Requirements/Stormwater Management Facilities (Sections 523 and 610).** All subdivisions and land developments are to comply with the Borough’s Stormwater Management Ordinance in addition to the requirements of this Section. Lots to have a minimum 2% positive drainage away from buildings. No alterations of existing drainage onto an adjacent property. Ordinance contains requirements for storm drainage systems and collection system design, including swales, inlets, piping, and gutters. Bridges and culverts are to be designed to PADOT construction standards.
- **Excavation and Grading (Section 524).** No excavation or fill greater than 3:1 slope; conditional exceptions. Topsoil is not to be removed from the site.
- **Erosion and Sedimentation Control (Section 525).** An erosion and sedimentation control plan is to be submitted with all applications and meet with BCCD standards. Disturbed earth shall not be exposed for more than 20 days. Responsibility of developer to install and maintain controls on plan.
- **Special Drainage Problems – Floodplain Areas (Section 620).** The Governing body may prohibit subdivision within a floodplain. Provisions are provided in the Ordinance for the design of storm drainage facilities, sewer facilities, water facilities, and other utilities.
- **Water Resources Impact Study (Section 623).** Permit required from DRBC for all projects withdrawing 10,000 gpd or greater of surface and/or ground water. Copies of applications sent to Borough. Water resources Impact Study, prepared by professional engineer / geologist, required when development not served by municipal water.
- **Wetlands Delineation (Section 624).** Wetlands delineation required if NWI maps indicate wetlands or site contains hydric soils or area with wetlands vegetation. Delineation to be validated by US Army Corps of Engineers.
- **Sanitary Sewage Systems (Sections 613 and 614).** Provides regulations for public systems in accordance with the Milford Trumbauersville Area Sewer Authority and for private systems in accordance with the Pennsylvania Sewage Facilities Act, Act 537 as well as the Bucks County Department of Health Rules and Regulations Governing Individual and Community On-Lot Sewage Disposal Systems, approved November 9, 1995, by Bucks County Board of Health, as amended.

West Rockhill Township

The West Rockhill Subdivision and Land Development Ordinance was adopted on May 23, 1995. It contains eight Articles and four Appendices. The following sections of the Ordinance are most closely related to the goals and objectives of this report:

- **Landscaping and Street Trees (Section 515).** Trees to be planted at 40 foot intervals along all streets where no suitable trees exist. Minimum of 10% of any parking lot over 2,000 square feet shall be landscaped. Detention basins must be planted with one of the Ordinance specified seed mixtures. Landscape requirements may be waived for existing vegetation. Ordinance contains requirements for the preservation of existing plant materials as well as trees damaged during construction.
- **Stormwater Management Requirements (Section 516).** The stormwater management Ordinance is very detailed in its contents for the calculation methods of runoff, storm drainage system requirements (including easements, storm sewers, culverts, detention facilities, etc.), and collection system design. The Township has also Ordinance 153 which provides additional regulations.
- **Excavation and Grading (Section 517).** No excavation or fill steeper than 3:1 slope. Edges of slopes to be five feet from property line. All lots graded with positive drainage away from building. No equipment to cross live streams.
- **Erosion and Sedimentation Control (Section 518).** An erosion and sedimentation control plan is to be submitted with all applications and meet with BCCD standards. Disturbed earth shall not be exposed for more than 20 days. Responsibility of developer to install and maintain controls on plan.
- **Water Supply, Distribution Systems and Fire Protection (Section 519).** All lots/units to have adequate water supply with either connection to centralized/public water (all residential subdivisions of 15 lots or more with density of 1 du per acre; all non-residential land developments of 3 or more lots) or on-lot water. System to be designed for capacity of fire fighting purposes. Water quality to conform to PADEP and BCDH standards. Well certification and permit required.
- **Sanitary Sewage Disposal (Section 520).** This section provides regulations for sewage facilities in accordance with the Township's Official Plan for Sewage Facilities and in accordance with the Pennsylvania Sewage Facility Act, Act 537.
- **Recreation Facilities (Section 525).** Recreational facilities to be provided in all residential subdivisions of 25 or more lots. Connection between open space requirements of ZO and recreation. Recreational facilities to be accessible to all residents. The Developer is required to improve recreation land. Ordinance contains requirements for tot lots, playfields, basketball and tennis courts, and swimming pools. Further it contains minimums for the amount of land to be utilized and the consolidation of facilities.

1.6.5. Additional Planning Efforts

In addition to Comprehensive Plans, Zoning Ordinances and Subdivision and Land Development Ordinances, a number of the municipalities within the watershed have prepared additional planning documents such as Open Space Plans, Park and Recreation Plans, and Stormwater Management Plans. Although only a few of the municipalities have submitted their open space reports for inclusion in this document, it is appropriate that their open space planning efforts be highlighted. The following is a brief summary these plans.

In response to an open-space funding program initiated by Bucks County, all of the municipalities in the region prepared Open Space Plans to identify parcels of land

appropriate for protection. The plans vary based on the municipal goals and objectives, but typically include an inventory of existing open spaces and natural resource areas, current planning activities, selection criteria/prioritization, future open space programming, as well as goals and objectives for each open space plan.

The Pennridge Water Resources Plan is a comprehensive water resources plan for eight municipalities in Bucks County known as the Pennridge Area. This area includes Bedminster, East and West Rockhill Townships, and Perkasio Borough, all of which are partners in the Upper Tohickon Rivers Conservation Plan. The Plan is part of an overall effort to manage growth for long term land use, environmental, and water resource sustainability in the Pennridge municipalities. The implementation of the recommendations of the Plan are being coordinated with municipal land use planning documents with the goal of providing the Pennridge Area's fair share of development while maintaining the long term availability of water resources upon which the region depends. Many of the recommendations of the Plan are currently being implemented, including; the development of model water resource Ordinance language and source water protection programs for six of the area's water suppliers. More information about the Plan can be found on the Pennridge Area Coordinating Committee's link on Hilltown Township's web site at <http://hilltown.org/pacc>.

In addition, there are other regional planning documents such as the Highlands Initiative, the Pennridge Greenway Plan and the Lower Tohickon Rivers Conservations Plan which outline and provide suggested guidance for the preservation of natural, historical and scenic resources as well as areas for open space and recreation. These documents are an important part of the area's regional planning efforts and help reinforce the goals and objectives of this plan.

1.7 Population Information

Population figures from the 1990 and 2000 censuses have been provided in order to describe the demographic composition of the watershed area. Table 1.1, entitled, "1990-2000 Population Comparison", indicates the increase or decrease in populations of the twelve (12) municipalities within the watershed boundaries. Note, however, that these population figures are for the entire municipality not specifically for the portion of that municipality within the Upper Tohickon Creek watershed. The census data was gathered and compiled from the web site of the Pennsylvania State Data Center, operated by Penn State.

Table 1.1
1990-2000 Population Comparison

Municipality	1990 Population	2000 Population	Increase/Decrease	Percent Change
East Rockhill Township	3753	5199	+ 1446	+38.53%
Bedminster Township	4,602	4,804	+202	+4.39%
Haycock Township	2165	2190	+25	+1.16%
Milford Township	7360	8810	+1450	+19.70%

Nockamixon Township	3329	3517	+188	+5.64%
Perkasie Borough	7878	8828	+950	+12.06%
Quakertown Borough	8982	8931	-51	-0.57%
Richland Township	8560	9920	+1360	+15.89%
Richlandtown Borough	1195	1283	+88	+7.36%
Springfield Township	5177	4963	-214	-4.13%
Trumbauersville Borough	894	1059	+165	+18.46%
West Rockhill Township	4518	4233	-285	-6.31%

Source: US Census Data, PA State Data Center Web Site

Based on the most recent population counts, and as seen in Table 1.1, Richland Township has the largest municipal population within the watershed area and Trumbauersville Borough has the lowest. Table 1.1 shows that East Rockhill Township had the largest increase in population as well as the largest percent increase. Haycock Township had the lowest increase in population as well as the lowest increase in percentage of population. Quakertown Borough, Springfield Township and West Rockhill Township all had decreases in population, with West Rockhill having the largest percentage decrease.

Although the comprehensive plans of the municipalities in the watershed area do not reflect the 2000 census data, most of the municipalities expected an increase in population based on population projections using 1990 and older census data. As noted in Section 1.6.1 of this document, the Bucks County Comprehensive Plan takes a very broad approach for the region and does not focus on specific areas. It breaks the County down into three County Regions and Planning areas; Upper, Central and Lower. The Upper Tohickon Creek Watershed Area is completely within the Upper County Region and Planning Area. According to the Bucks County Comprehensive Plan, the projected increase in population for this area from 1990 to 2020 is 58,011 people, an increase of 67.71%. The Comprehensive Plan indicates that this is population projection is the highest estimate for these years.

1.8 Transportation Facilities

Access into the Upper Tohickon Creek watershed is possible via a variety of routes. Major arterial access roads within the watershed area include: Route 309, Route 313, Route 663, Route 611, Route 563, and Route 412. There are also numerous minor collector, primary and secondary roads that criss-cross the watershed, providing drivers with scenic views of agricultural and recreational lands, historic villages and environmentally sensitive areas.

The rural nature of the watershed is characterized by the minimal extent of public improvements to the roadways such as curbs, sidewalks and street lights. These improvements appear only in the more developed sections of the watershed, where major commercial and residential development occurs. As a result of the importance of these rural roads within the watershed, Springfield Township has implemented a scenic overlay district which requires developers to maintain scenic view sheds. Old Bethlehem Pike in Springfield Township is an example of one of these roads within the Upper Tohickon Watershed.

1.9 Employment Sources

Due to the rural nature of the Upper Tohickon Creek Watershed, there are limited areas of commercial and industrial developments to provide employment opportunities that could be sought. Fortunately, the areas that are available to commercial and industrial development are relatively small and somewhat clustered together. While there are individual small pockets of commercial areas that are scattered throughout the watershed area, the largest groupings are located along the major arterial roads of Routes 309, 313 and 663 in Richland Township and Quakertown Borough. Although limited, the types of employment opportunities that exist within these areas include: manufacturing, tourism, retail, farming, government, and service sector employment.

A listing of the top 50 employers in Bucks County has been included in Appendix II for reference.

1.10 Outstanding or Unique Features

The Upper Tohickon Creek Watershed possesses a wealth of outstanding scenic and unique natural and man made features. The Bucks County Naturals Areas Inventory, a scientific study listing natural features worthy of protection (Rhoads & Block 1999), designates several sites within the watershed area as Priority 1 sites, Priority 2 sites, Priority 3 sites and Priority 4 sites. The following is a list of the sites that are located within the Upper Tohickon Creek Watershed Area:



Nockamixon Tributary Passing Historic Stone Wall

Priority 1 Sites

- Haycock Mountain (State Game Lands 157) and Nockamixon State Park - Haycock, Bedminster and Nockamixon Townships
- Quakertown Swamp - East Rockhill, Richland and West Rockhill Townships

Nockamixon State Park and State Game Lands 157 together make up the largest expanse of protected open space in the county, with over 7,000 acres. Less than a mile separates this site from the Kimples Creek/Lake Towhee (Priority 2 Site). Haycock Mountain rises 970 feet above sea level and approximately 560 feet above the level of Lake Nockamixon.

The Quakertown Swamp is the largest inland wetland in Bucks County. It contains diverse natural communities ranging from open water to shrub swamp, cattail marsh, tussock sedge marsh and swamp forest and comprises approximately 400 acres. The Audubon Society has

designated the swamp as an Important Bird Area, known to provide habitat for 91 bird species, including 14 rare breeds.

Priority 2 Sites

- Cressman Hill and Contiguous Forested Area – Springfield Township
- Dimple (Kimples) Creek/Lake Towhee - Haycock Township
- Dimple (Kimples)Creek – Meadow at the Mouth - Haycock Township
- Rock Hill – East Rockhill Township and Richland Township
- The Lookout - Springfield Township
- Top Rock Trail Road - Haycock Township

Priority 3 Sites

- Morgan Run - Richland Township
- Sellersville Catch Basin and Vicinity – West Rockhill Township
- Tohickon Creek (Camp Tohikanee) - Haycock Township
- Tohickon Creek (Vicinity of West Thatcher Road) - Richland Township

Priority 4 Sites

- Beaver Run Woods - Richland Township
- Route 309 Woods (Vicinity of East Pumping Station Road and Route 309 Intersection) - Richland Township

All of the sites that are listed in this report are sites that are worthy of protection, with the Priority 1 Sites containing an exceptionally high quality of natural resources/elements; requiring the highest attention for preservation efforts.

In Section 5.4, of this document, there is a detailed list of the notable features from the Natural Areas Inventory of Bucks County, PA along with a PNDI (Pennsylvania Natural Diversity Inventory) list of all species and ecological communities of special concern within the Upper Tohickon Creek Watershed. The presence of rare species in the watershed is an excellent indicator of the quality of the habitats present in the watershed.

Volunteer watershed assessors identified other significant historical and scenic elements present within the watershed. These features are identified in Sections 6 and 7 of this document.

Section 2. Identify Issues, Concerns, Constraints, and Opportunities through Public Participation

2.1 The Public Participation Process

Public participation has been widespread and enthusiastic for this watershed study. Citizens and officials have raised concerns, offered suggestions and volunteered time towards the effort of the identified issues, concerns, constraints and opportunities.

It is important to identify the issues and concerns of the land owners, elected officials, citizens and agency personnel in any watershed. The job of a plan advisory committee is to ensure that the planning process proceeds efficiently, that the public is involved throughout the planning process and that a variety of public participation strategies are implemented.

Even before consultant contracts were signed, a Plan Advisory Committee (PAC) was organized. This committee developed strategies intended to involve as many citizens as possible throughout the duration of the project. One goal was to generate public discussions and participation. Since it is often difficult to get public input, several strategies for doing so were implemented early in the planning process. These strategies included the following outreach efforts:

- Assuring that the Plan Advisory Committee was well rounded.
- Advertising and holding public meetings.
- Holding frequent Plan Advisory Committee work sessions.
- Circulating questionnaires and compiling questionnaire responses.
- Completing a watershed and creek corridor tour.
- Writing articles and press releases.
- Inviting volunteer participation in a corridor and watershed assessment process.

The following subsections of this plan provide an overview of the methods used to involve the public and the information resulting from those efforts

2.2 The Plan Advisory Committee

The public must be involved in any planning project in order to determine watershed needs and to identify the attributes, attitudes, beliefs and behaviors of community residents. A crucial part of the Upper Tohickon Creek Watershed was the formation of a Plan Advisory Committee (PAC) which provided a forum for community residents and leaders to voice their opinions and to develop a framework for completion of key phases of the plan. The groups represented in the PAC included the following organizations: Richlandtown Borough, Milford Township, Bucks County Conservation District, Pennridge High, Heritage Conservancy, Tinicum Conservancy, Richland Township, Nockamixon, Quakertown, Nockamixon State Park and West Rockhill Township.

2.3 Public Meetings

The first meeting was held on April 29, 2004 at the Richland Township Building. This meeting was intended to introduce the newly appointed Plan Advisory Committee members to the public and familiarize the public with the project. Approximately 13 people attended the initial meeting. The 2 hour meeting included an introduction to the PAC members and an overview of the goals

and objectives of the Rivers Conservation Plan. Interaction between the PAC members and the attendees included discussions on the importance of public input for the plan as well as public participation with collecting data for the plan. Additionally, during the discussions the following questions were asked of the attendees, in order to determine what areas of interest that there may be from the general public. They are as follows:

- What do you like best about the Watershed?
- What do you like least about the Watershed?
- What are you doing now in the Watershed?
- What would you like to do in the Watershed?

The overall reaction to the above questions indicated that the residents like the scenic rural character of the area; and that increases in development and stormwater management were the areas of biggest concern. The residents also enjoyed the recreational opportunities such as fishing, hiking and other natural activities that the rural character of the area provided the residents. Additional recreational opportunities, education and restoration of streams summarized what the residents would like to see happen in the future. Water quality was voted as the most important issues facing the stream, followed by: sustainability for future generations, water quantity, conservation, education and open space/recreational use development.

The second public meeting was held on July 27, 2005 at the Richland Township Building. The purpose of this meeting was to update the public on the status of the project as well as present the draft goals and objectives that the PAC established as part of this report. In addition, a brief overview of the watershed and the land uses within the watershed were also presented to the public. The presentation was followed by a question and answer period in which residents expressed their concerns over water quality, erosion control, flooding and how the general public can get more involved in projects. It was noted to the public that this report was a tool that could be used by Municipalities, coalitions and groups to identify and complete projects that would improve the overall quality of the watershed. In addition, it was noted that this report could be used to try to secure funding to complete these projects.



Flooding such as this on Dry Branch Cr. at Raub Rd. was a primary concern identified by the public.

As part of the public meeting process, the PAC received comments both from residents that attended the meeting as well as from participating municipalities. These comments were incorporated into the draft report.

An additional meeting is scheduled to occur in the late fall of 2005, to present the final copy of this report to the public. It is anticipated that before this meeting, the report will be issued to all of the participating municipalities for adoption by resolution.

2.4 Plan Advisory Committee Work Sessions

The Plan Advisory Committee members communicated frequently at scheduled meetings, in the field and through phone and email conversations. During the first meeting, a general overview of the goals and objectives of the project were discussed. Defining the limits of the study as well as the establishment of a Project Advisory Committee was also discussed. Finally the establishment of data gathering tasks, the assigning of specific tasks and the establishment of a time frame for the completion of these tasks was also discussed. Overall, the first meeting was an important first step in the process for laying the ground work for future meetings and undertaking the watershed study.

Subsequent work sessions were held to develop a watershed and corridor questionnaire, evaluate questionnaire responses, develop watershed amenity and watershed problem area maps, evaluate research findings and Geographical Information System (GIS) maps, prepare for public meetings and to review draft and final versions of the Upper Tohickon Creek Watershed Plan. These meetings continued throughout the watershed study process to help guide the PAC in the completion of the study.

2.5 Volunteer Watershed and Corridor Assessment

In the fall of 2003, the watershed consultant (Princeton Hydro, LLC) utilized the Stream Visual Assessment Protocol to establish the program and techniques that the members of the PAC and other volunteers would use in the assessment of the watershed areas. It was determined that these visual assessments would be started in March of 2004 when weather conditions were more favorable to assessing the watershed.

On March 27, 2004, the first training session was held at Lake Towhee. The purpose of this training session was to introduce the volunteers to the different aspects of the watershed and which tools they could implement in the study of their respective areas. During the spring, summer and fall of 2004 and through the spring of 2005, PAC members and other volunteers worked together to complete the watershed, sub watershed and corridor assessments. Volunteers were recruited at public meetings and in response to mailed questionnaires and newsletter articles. This information was utilized to augment resource sections of this plan (Section 3 to 6) and to identify watershed and corridor areas that could benefit from management attention (Section 7). Examples of significant natural features identified during the field assessments include: wetlands, geologic features, forested habitat, scenic vistas and threatened or endangered species. Significant cultural historical and scenic features noted include: historic villages and historic structures, including houses, mills, and barns. Problem areas within the watershed are relatively minor, but include: failing septic systems, abandoned vehicles, eroded banks, litter, lack of riparian buffer and water flow obstructions, agricultural runoff and deer browse.

The information gathered from the volunteer field assessments and from public involvement will benefit the plan. Public involvement and education promotes greater awareness of the important resources and amenities of the watershed and a more widespread desire to protect the watershed

and to help solve its problems.

2.6 Other Public Participation and Outreach Efforts

The PAC realized that not everyone is comfortable attending or voicing opinions at public meetings. Therefore, the PAC and its consultants used other means to reach people and to obtain their input. In addition to meetings, public involvement was also encouraged by:

1. Press Releases
2. Public Notices
3. Meeting Invitations and Mailings
4. Newsletter Articles
5. One on One discussions

Invitations to attend the public meetings along with agendas and handouts were provided to municipal supervisors, appointed chairs (e.g., planning and environmental commissions) and agency directors (e.g., County Planning Commission, County Park and Recreation Department, DCNR Parks) before the public meetings.

Newsletter articles and updates on the planning process appeared in Municipal and Conservancy newsletters. This provided an alternate method for Townships residents to read about the progress on the Upper Tohickon Creek Watershed Study. This was an easy way to inform the most active, concerned and influential people in the Townships and to promote their support through volunteer hours. Some of these articles can be found in Appendix III.

Section 3. Water Resources of the Upper Tohickon Creek Watershed

3.1 Introduction

Water is our fundamental resource, required by all living things, but water serves as one of the most valuable resources for maintaining quality of life and satisfying the broader needs of the people living within the Upper Tohickon Watershed. Lakes and ponds provide multiple recreational opportunities regardless of age, gender, nationality or heritage. Streams and rivers, in addition to their recreational value, give insight into the connections among people and places; they provide a soothing source for measuring time; they give context and add perspective to the rigors of everyday life. The re-emergence of life from wetlands, vernal pools, and swamps each spring is among the most striking reminders of the power of the living world. The energetic diversity of life at all times of day or night in wetlands humbles human arrogance and reminds people that their responsibility within the landscape is to coexist with the species of plants and animals that have thrived in this landscape for untold generations.

From these aquatic environments, insight can be extracted about our success in utilizing the land's resources and managing the multiple demands on the various water resources. Because the quality of water in lakes, streams, and the groundwater aquifers is fundamentally related to the condition of the surrounding lands, measurements of water quality give a comprehensive assessment of the entire watershed and identify how and where human uses have exceeded the capacity of the land to absorb and ameliorate human impacts. As a result, the monitoring of watershed conditions largely focuses on aquatic communities and water quality. In addition, the water quality of these systems can serve as an attainable and easily recognized "endpoint" for improved use of the land and water. By setting defined goals for water quality (e.g., water temperature in streams not exceeding 70° F), various land uses can be evaluated for the way in which they help or hinder attainment of these specific and measurable goals. The appropriate actions, then, for attaining the goals become much clearer.

The value of the Upper Tohickon's water resources is multifaceted and far-reaching. The condition and quality of these resources touch the lives of every person in the watershed. An understanding of these resources and an assessment of their quality thus becomes a unifying focus for the management of the Upper Tohickon Watershed. This section of the Rivers Conservation Plan provides a detailed account of the aquatic resources and a compilation of data on their quality.

3.2 Watersheds within the Upper Tohickon Creek Watershed

A watershed is a contiguous section of land from which all surface water ultimately drains to the same point, typically a stream or lake. Watersheds serve as vital units from which to examine characteristics of water resources and the impacts on them. Because the surface water quality at the exit point from the watershed is the net result from all upstream activities, working at the watershed unit leads to identification of important features and impacts and thus to a natural prioritization of these features from the standpoint of the watershed's ultimate water quality. For the Upper Tohickon Rivers Conservation Plan, a total of 10 distinct watershed units have been used to organize information and set priorities across the larger Upper Tohickon Creek watershed.

These watersheds are delineated and identified on Figure 1, with the streams themselves mapped on Figure 3. They consist of eight headwater watershed units, one central receiving trunk watershed on the Upper Tohickon, and then finally the ultimate recipient of all surface runoff, a

Lake Nockamixon unit.

3.2.1 Major Tributaries to the Upper Tohickon Creek

Within the Upper Tohickon Creek Watershed, there are eight major tributaries that drain the landscape and that ultimately determine the characteristics and quality of the Tohickon Creek in this upper section. These eight tributaries are:

- Haycock Creek: This stream drains the most easterly section of the watershed and joins the Upper Tohickon within the lake basin near the outlet to the reservoir. The total area for this tributary's sub-watershed is 6,207 acres (13% of the entire watershed).
- Kimples Creek: This stream drains the north-central portion of the Upper Tohickon watershed and includes the Lake Towhee county park and its headwaters (many maps refer to this stream as Dimple Creek). The Kimples Creek watershed drains a total of 4,680 acres (10% of the watershed).
- Dry Branch Creek: Dry Branch Creek is one of the smaller sub-watersheds within the Upper Tohickon and also drains the north-central portion of the larger watershed. This stream's sub-watershed includes a total of 2,530 acres (5% of the watershed).
- Upper Tohickon: The headwaters to the main stem of the Tohickon Creek cover a large area in the far northwestern corner of the watershed and drain the area immediately north of Quakertown. These headwaters for the Tohickon Creek consist of 8,789 total acres (18.5% of the watershed).
- Beaver Run (Quakertown): Beaver Run, and its similarly sized northern tributary, drain the far western section of the Upper Tohickon watershed and carry nearly all the runoff associated with Quakertown Borough. The acreage of this subwatershed is 3,074 acres (6.5% of the watershed).
- Morgan Creek: This tributary drains an elongated section of land in the southwestern portion of the Upper Tohickon watershed immediately to the south of Beaver Run and Quakertown. Morgan Creek's sub-watershed encompasses 2,964 total acres (6% of the watershed).
- Bog Run: Bog Run is appropriately named as it drains the extensive area of Quakertown swamp in the south-central portion of the watershed immediately southeast of Morgan Creek. The area of the Bog Run sub-watershed is 3,125 acres (7% of the watershed).
- Threemile Run: This final major tributary of the Upper Tohickon extends across the most southern portion of the watershed and drains directly into Lake Nockamixon near the entrance to the Tohickon Creek itself. The Threemile Run sub-watershed spans an area of 5,101 acres (11% of the watershed).

A number of smaller tributaries also feed directly into Lake Nockamixon and are considered together as part of the Lake Nockamixon subwatershed (7,837 acres, 17% of watershed). Lastly, the central portion of the Tohickon Creek above Lake Nockamixon (into which flow most of the major tributaries above) serves as a separate and unique management unit, with a total acreage for this central section of 2,860 acres (6% of the entire watershed). A limited number of very small unnamed tributaries also join this central portion of the Tohickon Creek within this central sub-watershed.

3.2.2 Surface Water Quality Protection of the Tohickon Creek and its Tributaries

Surface waters within Pennsylvania (i.e., streams, lakes, rivers) are classified according to designated “uses” (Water Quality Standards, PA Code, Title 25, Chapter 93). These “uses” correspond to the types and quality of biological communities, water supplies, and recreation that exist or are expected to exist for a given stream or lake. In addition to selecting a “use” for each surface water body, Pennsylvania then evaluates the water quality of each surface water body to determine whether the designated uses of a given water body is attained through detailed chemical and biological sampling from these streams and lakes. Thus, for surface water features in Pennsylvania, one can determine the value and quality of that stream or lake by first determining its designated use and then checking whether full or partial attainment of that designated use has been achieved.

Within the Upper Tohickon Creek watershed, all streams and lakes are given a “use” designation of “Trout Stocking Fishery” (above and beyond the standard designated uses given to all surface waters of the Commonwealth; see Table 3.1). This designation protects use of these surface waters for the “maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat”. Thus, low water temperatures throughout the spring and early summer are expected in these waters, with a transition to warmer conditions and an aquatic community characteristic of warmer habitats during the end of summer and the remainder of the year.

The State of Pennsylvania has also enacted Anti-degradation Requirements for all surface water bodies in the State. Under these policies, the water quality of streams and lakes is protected from any alteration that would degrade the stream below the *existing* use (not the designated use), although stricter anti-degradation standards exist and are enforced for streams with Special Protections (i.e., designated either High Quality [HQ] or Exceptional Value [EV]). For the streams of the Upper Tohickon Creek watershed, the primary anti-degradation standards are limited to the existing uses because no stream in the Upper Tohickon has either of these Special Protections. As a result, as long as an activity or discharge does not degrade the quality of the stream or lake such that the established uses are no longer possible or prohibited, that activity or discharge is consistent with the State’s anti-degradation standards for a Trout Stocking Fishery such as the streams of the Upper Tohickon Creek.

3.2.3 Surface Water Quality in the Upper Tohickon Creek Watershed

An important component of the watershed assessment and characterization conducted as part of a Rivers Conservation Plan is the collection and compilation of data about the existing water quality for the streams and lakes of the watershed. This review of existing data revealed that extensive stream assessment data was collected in the Upper Tohickon Creek streams during the spring and summer of 2001 by the Pennsylvania Department of Environmental Protection, Water Quality Assessment and Standards unit. A total of 21 stations throughout the watershed, including all 10 of the sub-watersheds used in this Rivers Conservation Plan, were sampled and assessed by the Pennsylvania DEP biologists. These assessments focused on the collection and identification of insects and other invertebrates that live in these streams, and the interpretation of the data from the perspective of water quality and ecological health. Because such stream invertebrates are

long-lived (often 1 year or more to complete their life cycle) and because most move relatively slowly in their aquatic stages, the community of invertebrates at a site reveals an integrated picture of the water quality at that site through multiple seasons and across multiple stressor events. Moreover, important characteristics of the invertebrate community remain relatively constant across stream size and across watershed boundaries, providing a powerful tool to compare water quality among watersheds and sub-watersheds. Thus, the extensive data collected recently by the Pennsylvania DEP for the Upper Tohickon Creek watershed provide the clearest insight into the current quality of these streams. This data, organized by each of the 10 sub-watersheds, is therefore discussed in detail below.

A measure of water quality in the watershed's streams achieves only the first part of an overall assessment of these surface water resources. In order to maintain and improve water quality, a broader approach that identifies point-source and non-point source impacts to streams as well as habitat degradation and riparian integrity is needed in order to determine the likely causes of impairment and health in the biological community at any particular site. To achieve this latter goal, residents within the Upper Tohickon Creek watershed worked with the Project Advisory Committee to conduct a complete survey of all mapped streams within the watershed, assessing critical components of riparian structure, in-stream habitat, and direct pollutant loading into the streams. This data that begins the causal assessment of the existing water quality conditions is discussed in greater detail under Section 7, linking the water quality assessments below to the sources of any measured impairments.

In reviewing the current status of the Upper Tohickon watershed, it is also important to understand the past use of the land and the current trajectory of this land use (see Land Resources section below for a detailed account). In particular, because of the historical clearing of all forests in the watershed, the intensive agriculture that has been practiced, and the more recent conversion of this land back to forest, meadows, and preserved open space, the waters of the Upper Tohickon are generally now improving rather than deteriorating. The implementation of improved wastewater treatment, particularly the tertiary treatment used at the Quakertown Wastewater Treatment Plant, has likewise resulted in improved water quality over the past 30 years.

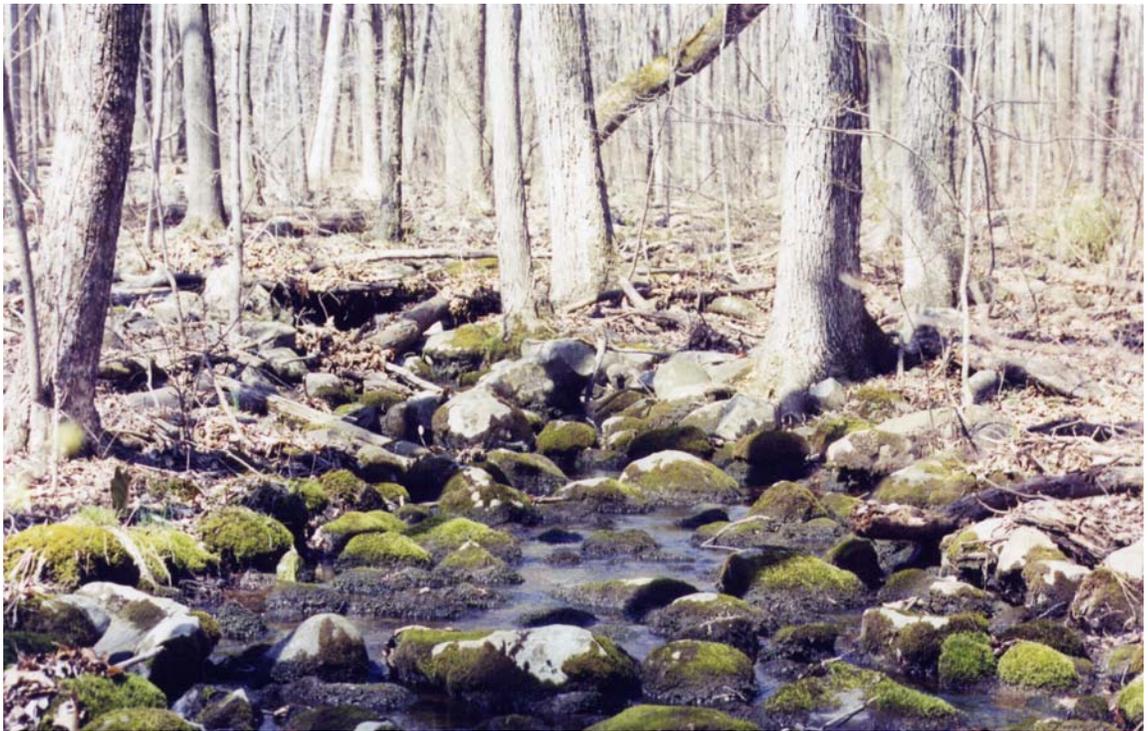


Sediment-laden section of Threemile Run

Because of the long legacy of land alteration, measurements of the current conditions of these streams and lakes are, in large part, a measure of the past abuses of the watershed. The erosion of stream banks, the channelization and down-cutting of channels, and the filling of channels with fine sediments have all resulted from the historical use of the land. As ecologically intact riparian corridors for the streams are re-established, the streams themselves will re-evolve toward their historical state and will lead to continual improvements in the stream channel. But this natural evolution and restoration of the stream channels will occur slowly, and the historical negative impacts will be felt and measured far into the future. Although human intervention can accelerate the restoration of these streams, the broad extent of the land abuses makes intervention impractical at all points in the watershed. Instead, simple efforts to protect riparian buffers and allow natural processes to do the majority of this restoration work will lead to the most effective and complete restoration of these riverine systems.

Haycock Creek Watershed

Haycock Creek was sampled mid-distance up its watershed from Lake Nockamixon in June 2001. The collected invertebrate community revealed a near-pristine assemblage of aquatic insects and a small population of crayfish. Among the notable aquatic insects were four families of each of the most sensitive groups, the mayflies, stoneflies, and caddisflies, for a total richness of 12 families across these three sensitive groups. Although the moderately tolerant Hydropsychidae caddisflies were the dominant family at this site, the diversity across these three sensitive groups clearly documents the high water quality and excellent habitat conditions at this site. Indeed, the invertebrate community at this site was the most diverse and closest to a pristine community among



Tributary to Haycock Creek draining the Diabase of Haycock Mountain

the 21 sites sampled in 2001 in the Upper Tohickon Creek watershed. Based on this assessment, all of the primary streams in the Haycock Creek watershed were assessed as “attaining” their designated uses (see Table 3.1; note that two small tributaries draining directly to the lake were “unassessed”). The only comment from the biologists who collected this data was that the habitat scores were not ideal at this site, with somewhat low scores across the “condition of banks” and “bank vegetation” criteria. These issues of habitat quality obviously did not lead to substantial impairment of the biological community within Haycock Creek, and the habitat within this sub-watershed is considered more fully in Section 7 below.

Kimples Creek (aka, Dimple Creek)

The main stem of Kimples Creek (listed on the USGS Quakertown quadrangle as Dimple Creek) was sampled for benthic macroinvertebrates at three locations within the watershed in June and July of 2001. The first site was in the upper headwaters near the State Game Lands 157; the next site was immediately downstream of Lake Towhee (a 50-acre on-line impoundment of Kimples Creek); and the third site was located 50 meters upstream from the confluence between Kimples Creek and Tohickon Creek in the most downstream reaches of the watershed. At the upper headwaters station, a diverse and evenly distributed community of insects and invertebrates was collected, with high diversity among the mayflies, stoneflies, and caddisflies similar to that seen at the single Haycock Creek site. In addition, no high dominance by any invertebrate was observed at this Kimples Creek headwater site, showing some signs superior to the Haycock Creek site. Thus, the headwater sites in Kimples Creek, particularly those near the state game lands, have outstanding water quality and are characterized by a diverse and healthy ecological community.

At the lower two stations within Kimples Creek, however, the invertebrate community showed many signs of moderate impairment.

A lower total diversity was seen at both sites, and both a lower diversity and lower densities of sensitive invertebrate groups were collected both below Lake Towhee and near the Tohickon Creek confluence. Moreover, pollution-tolerant groups begin to gain increasing dominance at these two sites, including the Simuliidae black flies, Amphipoda scuds, and Asellidae isopods. The



Intermittent Channel on Kimples Creek

PADEP biologists who collected these samples acknowledged the expected shift in the invertebrate community immediately below Lake Towhee where higher water temperatures and an altered food base will invariably occur below a shallow, productive lake such as Lake Towhee. However, despite good habitat quality in Kimples Creek below Lake Towhee (see Section 7), the invertebrate community does not recover from the changes brought on by Lake Towhee, an artificial impoundment of Kimples Creek. The water quality is still substantially better than many of the Upper Tohickon's streams, and the PADEP biologists assessed the community as "unimpaired" (see Table 3.1). Yet it is apparent by comparing the headwater site to these two lower sites that the invertebrate community has been strongly altered by the presence of Lake Towhee and that the diverse and healthy ecological community present above Lake Towhee does not exist at either of the downstream stations.

Together, the data from these three sites indicates that the headwaters of the Kimples Creek watershed maintain high water quality, but that the lower sections of the stream have somewhat impaired water quality, at least in part because of the stream's transformation through Lake Towhee.

Dry Branch Creek

Two sites on the Dry Branch Creek main stem were sampled for stream invertebrates in July 2001. The first site was located mid-distance up into the western main tributary at Union Ave., and the second site was located downstream, below the confluence of the two main branches, at Erie Rd. At the more upstream site, a moderately diverse invertebrate assemblage was present, but this community was dominated by groups that can tolerate poor water quality and habitat conditions. At the more downstream site, both the diversity and abundance of invertebrates was truncated, with nearly all invertebrate groups tolerant of impaired water quality. Both sites on Dry Branch Creek were therefore assessed as "impaired" by the PADEP biologists (see Table 3.1), with additional notes that there was both poor in-stream habitat, a poor riparian corridor, and poor bank conditions.

Based on these results, Dry Branch Creek demonstrates poor overall water quality and moderate to severe impairment as a result of human activity in the watershed. Because of these impairments, the PADEP will need to identify the causes of impairment and develop a Total Maximum Daily Load (TMDL) for this watershed based on the Clean Water Act. With the accurate characterization of the causes of impairment and the implementation of a TMDL, the conditions in Dry Branch Creek should improve and lead to attainment of the "Trout Stocking Fishery" designated use for this stream.

Tohickon Creek - Upper Headwaters

The headwaters of Tohickon Creek were sampled at 5 locations during June and July of 2001. Four of these locations were at or upstream from Pumping Station Rd. in the headwaters of the stream, with the final station located downstream near the confluence with Dry Branch Creek at Erie Rd. The four upstream stations were generally characterized by a diverse assemblage of both insect and non-insect invertebrates, with both a high density and a large number of distinct pollution-sensitive groups. The eastern headwater tributary was characterized by a slightly more pristine invertebrate fauna and

appears to have higher water quality than the western tributary. This may be related to the western tributary's passage along and under Rt. 309 for much of its length and the likely water quality stresses that this busy road will place on a neighboring stream. Nevertheless, the invertebrate community within both headwater branches is exemplary, if not pristine, and demonstrates the generally high water quality seen throughout the headwater tributaries for the Upper Tohickon Creek sub-watershed. As a result of this high quality, the State has determined that all of these headwater tributaries are "attaining" their designated use classification (see Table 3.1).

The invertebrate fauna at Erie Rd. is distinctly different from that in the headwater tributaries, reflecting important changes in the habitat and water quality at this more downstream site. Although a broad diversity of invertebrate groups are present at this lower station, an absence of the sensitive stonefly groups indicates either distinct impairments to water quality or elevated water temperatures (or both) in the stream. In addition, the sensitive caddisfly group likewise undergoes a severe contraction at this station, with only a single caddisfly taxon (the moderately tolerant Hydropsychidae) collected in July of 2001. Combined, this data indicates that some negative changes have occurred in the Upper Tohickon Creek between Pumping Station Rd. and Erie Rd., with the result that the State has listed this stretch of stream as "impaired" and not attaining its designated uses (see Table 3.1).

Combined, the data from the five invertebrate sampling sites on the Upper Tohickon sub-watershed suggest that the headwaters have remained in excellent condition and have resulted in high water quality. Below Pumping Station Rd., however, rapid declines in water quality occur and the water quality in the Tohickon Creek is substantially impaired by the time it reaches Erie Rd.

Beaver Run

Two stations on Beaver Run and its tributaries were sampled in July 2001 to assess the water quality of these streams. The upper station was located on the northern tributary at Nedig Elementary School in Quakertown Borough, while a lower station was located just downstream of Broad St (Rt. 313) on the main stem but adjacent to the confluence with its northern tributary. At Nedig Elementary School, extremely low abundances of invertebrates were noted, with a very narrow diversity of invertebrates (only 5 groups collected). The habitat quality was very poor at this site, particularly the lack of a riparian corridor around the stream. At the Broad St. site, both a broader diversity of invertebrates as well as a greater overall abundance was identified, although the invertebrate community at this site continued to be dominated by groups tolerant of pollution. As a result of the poor invertebrate communities at each site, as well as the poor overall habitat conditions, both sites were classified as "impaired" by the PADEP biologists who sampled these sites. Although some sections of Beaver Run were not adequately assessed and thus remain in the "unassessed" category, nearly all streams in the Beaver Run watershed draining Quakertown Borough are currently on the "impaired" list of surface waters in the state. Furthermore, the conditions at these two sites were at least as degraded as any other site within the Upper Tohickon watershed area, and may represent the worst water quality and habitat conditions for the Tohickon Creek watershed above Lake Nockamixon Dam.

Table 3.1. Summary of Sub-Watersheds and Streams within the Upper Tohickon Creek Watershed

SUB-WATERSHED	WATERSHED AREA		DESIGNATED USE ¹	INTEGRATED WATER QUALITY STATUS ²
	sq. miles	%		
Haycock Creek	9.7	13%	TSF	Attaining (all sections above the lake); Unassessed (tributaries now draining to the lake)
Kimples Creek	7.3	10%	TSF	Attaining (all stream segments); Unassessed (Lake Towhee)
Dry Branch Creek	4.0	5%	TSF	Impaired (all streams)
Tohickon Cr. - headwaters	13.7	18.5%	TSF	Attaining (all headwater streams); Impaired (lower central stem to Dry Br. Cr.)
Beaver Run	4.8	6.5%	TSF	Impaired (north trib. and headwaters); Unassessed (southern main stem)
Morgan Creek	4.6	6%	TSF	Attaining (unclear which sections); Impaired (unclear which sections)
Bog Run	4.9	7%	TSF	Attaining (all sections)
Threemile Run	8.0	11%	TSF	Attaining (most of stream and trib.); Impaired (headwaters of main stem); Unassessed (upper central main stem)
Tohickon Cr. - middle	4.5	6%	TSF	Attaining (all tributaries); Impaired (main stem from Bog Cr. to lake)
Lake Nockamixon	12.3	17%	TSF	Attaining (most unnamed tribs. to lake); Impaired (Lake Nockamixon); Unassessed (small eastern and southern tribs.)

¹ Designated Use identifies the standards for the ecological community and the water quality of a given stream, and the extent of environmental protections afforded to that stream.

² Integrated List Status is based on the 2004 *Pennsylvania Integrated Water Quality Monitoring and Assessment Report* and includes whether the designated use is attained and which sections of the watershed have achieved what status.

Morgan Creek

Two sites were sampled on Morgan Creek in July and August 2001. The first site was just downstream from the Old Bethlehem Pike Bridge near the headwaters of this creek, while the second site was just downstream of Rt. 313 near the confluence of Morgan Creek with the Tohickon. At both sites, overall abundance was low and diversity was limited to a narrow group of mostly pollution tolerant taxa. At the upper site, near Old Bethlehem Pike, a few invertebrate representatives from the mayflies and damselflies appear, suggesting slightly higher water quality than downstream. In addition, the PADEP biologists make specific note of the low-gradient nature of Morgan Creek between these sites, with emphasis on the forested wetlands adjacent to the stream throughout this section and the lack of suitable substrate (perhaps naturally) that could be colonized by a more typical stream invertebrate fauna. Thus, the apparently poor water quality at these two sites may simply reflect the natural character of Morgan Creek, or may represent a combination of some water quality impairments combined with a unique set of habitats that limit the abundance and diversity of invertebrates at these sites. As a result of this ambiguity, the State has listed most or all of Morgan Creek as “impaired” on the 2004 Integrated List while also listing a smaller section as “Attaining for at least 1 parameter” (sublist 2), apparently the section nearer the Tohickon Creek confluence (see Table 3.1). Morgan Creek is listed in the Bucks County Natural Areas Inventory as having a unique suite of emergent vegetation and a broad floodplain forest. The net result of this ambiguous data and multiple classifications is a poor understanding of the natural condition of Morgan Creek and the extent to which the water quality and stream habitats have been impaired by human activity in the watershed.

Bog Run

A single site was surveyed for benthic invertebrates on Bog Run in July 2001. This site was located near Axe Handle Rd. downstream from and to the north of Rt. 313. As with Morgan Creek, the PADEP biologists make specific note about the unique water chemistry at this site and the apparently natural but unproductive habitats in the stream. They indicate that the gradient is very gentle and that the substrate is dominated by clays and silts, thus precluding colonization by many invertebrate groups. Given the extensive area of forested wetland upstream (the Quakertown Swamp), the State biologists indicate that water quality is unimpaired at this site even though there is low invertebrate diversity and a general absence of the sensitive invertebrate groups (see Table 3.1). These observations and conclusions are consistent with the fact that much of this upstream area remains protected by local or state preservation programs, with part of the Quakertown Swamp preserved by the Heritage Conservancy and part included within State Game Lands #139. Thus, although a limited diversity of stream invertebrates was collected on Bog Run and the water chemistry of the site was atypical for the watershed, the broader knowledge of the watershed suggests that these conditions result from natural processes within the watershed that create a unique and valuable set of aquatic habitats.

Threemile Run

Threemile Run and its tributaries were sampled at two locations in June and July of 2001. The first site was located mid-distance up the watershed on the main stem of Threemile Run at the Schwenk Rd. Bridge. The second site was on the former tributary to

Threemile Run that now enters Lake Nockamixon directly; this tributary was sampled at Threemile Run Rd. At both sites, a broad diversity of sensitive invertebrate groups were present, with the main stem site on Threemile Run exhibiting a higher overall diversity than the smaller tributary. Both sites have few pollution-tolerant invertebrate groups, and both sites were assessed as “attaining” their surface water classification (see Table 3.1). The 2004 Integrated List provides a perplexing story, however, in light of these invertebrate assessments. This Integrated List places the State’s surface waters into 5 categories, ranging from Category 1 (meeting water quality standards) to Category 5 (impaired and required a modeling study of the impairments). Most of the Threemile Run watershed is listed as Category 2, indicating that at least one designated use is “attained”. However, one section of the upper main stem is determined to be “unassessed”, one headwater branch of Threemile Run is assessed at “impaired”, while an adjacent branch is assessed as “attaining”. The rationale for these categories is not apparent, and the condition of the headwaters of Threemile Run is best considered uncertain at this time. Nevertheless, the lower sections of Threemile Run and the large former tributary (now entering directly into Lake Nockamixon) have both been sampled and been assessed as “attaining”. As a result, it is clear that the water quality in these lower sections of Threemile Run and its tributaries is relatively high with little impairment of the water quality affected by human activities.



Tohickon Creek - Central section above Lake Nockamixon

Shale-dominated section of Threemile Run

A single site was surveyed in the central section of the main stem Tohickon Creek during 2001. This site was located near the Weisel Youth Hostel within Nockamixon State Park. The invertebrate community at this site was moderately diverse, with good abundances of two net-spinning caddisfly groups and the continued presence of the fishfly, *Nigronia*, which is very sensitive to pollution. But many of the invertebrates collected at this site are more tolerant of pollution and degraded habitats, and the overall assessment of this site was “impaired” (see Table 3.1). Furthermore, the entire length of the Tohickon Creek from the confluences of Dry Branch Creek, Beaver Run, and Morgan Creek down to Lake Nockamixon has been assessed as “impaired” in the 2004 Integrated List (PADEP 2004). Note, however, that all unnamed tributaries to the Tohickon Creek are assessed as “attaining” their designated uses. Given the impaired status of the major

tributaries to the Tohickon by the time they join together just east of Quakertown, and the apparently degraded water quality of Kimples Creek just upstream from the Tohickon Creek confluence, this designation of the entire main stem of the Tohickon Creek upstream from Lake Nockamixon and extending to Quakertown suggests that the impairment of Tohickon Creek in the Middle Tohickon sub-watershed is the direct result of the impairments of the headwater tributaries. Thus, although much of the sub-watershed is forested (see Figure 4), the degradation occurring upstream leads to impairment within the main stem even in the context of moderate or good overall habitat conditions. It should be noted, however, that the biological community in the Tohickon adjacent to the Weisel Youth Hostel is neither severely truncated nor devoid of large invertebrate populations. Rather, there appears to have been a shift in this community away from cold-water, sensitive groups in favor of invertebrates that can tolerate both higher pollutant loadings as well as elevated stream temperatures and degraded habitats. Thus, a moderately diverse biological community persists in Tohickon Creek in at least some sections, and the potential exists to recover this community to an even healthier state.

Lake Nockamixon

Lake Nockamixon itself has been extensively studied over the past 20 years, and has been determined to be impaired by excessive phosphorus loading and concentrations as a result of this research (see Lake & Pond section below). However, the two unnamed tributaries that drain directly into Lake Nockamixon, which have been sampled for stream invertebrates, indicate that these small tributaries to the Lake are generally of high water quality and unimpaired conditions. Although both of these two northwestern tributaries that have been sampled contain a somewhat narrow group of invertebrates (total taxa richness ranges from 10 to 13), both communities contain sizable populations of the sensitive invertebrates including both stoneflies and caddisflies. Thus, the streams within the immediate Lake Nockamixon sub-watershed appear to have high water quality with little evidence of impairment. This data therefore suggests that the impaired water quality status of Lake Nockamixon arises from the pollutant loading along the main stem of the Tohickon Creek upstream of the Lake and those tributaries in the upper watershed with excessive point-source and non-point-source loads.

3.2.4 Ground Water Quality and Quantity of the Upper Tohickon Creek Watershed

The groundwater resources within the Upper Tohickon Creek watershed serve as important resources for both the human population as well as the ecological systems that are sustained by these groundwater sources. Although public water supplies are available within several areas of the Upper Tohickon Creek Watershed Study Area, most of the residents obtain their potable water from groundwater wells (see Figure 3). Of the more than 500 water supply wells in the watershed that are tracked by the State of Pennsylvania, most have low water yields. Typical water yields range from 10 to 25 gpm and most wells are located within either the Brunswick Formation or the Diabase and Metadiabase formations at depths of between 90 to 240 feet.

Groundwater quality is as important as the quantity of water available. The long residence times of groundwater aquifers makes contamination of groundwater sources

pernicious and difficult to remedy. As a result, the monitoring of groundwater quality and the protection of recharge zones for wells (known as wellhead protections) have become vital to ensuring that these vital groundwater resources are available and of sufficient quality for use by the mostly rural population of the Upper Tohickon watershed. Results from the groundwater monitoring studies provide a broad picture of the existing conditions within the available aquifers of the region. For wells within the Brunswick formation, alkalinities are higher (median alkalinity=160 mg/L as CaCO₃) with the resulting pH of these waters slightly basic (median pH=7.9). Nutrient concentrations in the Brunswick formation were quite variable, however, with some wells showing elevated levels of both phosphorous and nitrogen (e.g., 0.04 mg/L phosphorus and 5.7 mg/L nitrate) while others showed little or no elevation, or elevated levels for only one of these two limiting nutrients. For wells within the Diabase formation, alkalinities were markedly lower (median alkalinity=66 mg/L as CaCO₃) and these waters were therefore neutral in their pH (median pH=6.9). As with the Brunswick formation, nutrient concentrations were variable among wells, with some showing elevated levels for nitrogen, phosphorus, or both, while other wells had low concentrations for both nutrients. Thus, there is distinct differences among groundwater quality across the watershed. Much of the variation is related to the geology of the parent aquifer, but the large variation in nutrient concentrations suggests that variable use of the land, particularly in wellhead areas, has led to some contamination of groundwater with excess nutrients while other wells remain relatively unaltered.

3.3 Wetlands of the Upper Tohickon Creek Watershed

Wetlands are unique and valuable features of the landscape. Where water is present for extended periods of time within and above the soil, suites of plants, animals, and microorganisms characteristic of these habitats develop. These wetland communities provide some of the most valuable ecological services of any natural habitat, serving to cleanse the water flowing through the wetlands, capturing floodwater and thus preventing damage in downstream areas, and serving as hotspots for ecological diversity and recreation.

In Pennsylvania, freshwater wetlands are regulated at both the State and Federal levels of government: the Army Corps of Engineers under the Clean Water Act at the Federal level; and under Chapter 105 of the Dam Safety and Waterway Management Act at the State level. Both officially define wetlands as:

"Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

The Army Corps of Engineers regulates the filling of "Waters of the United States" in accordance with Section 404 of the Clean Water Act. This includes not only the filling of wetlands but also any filling associated with streams, lakes, impoundments, or intermittent drainage areas. Both the definition of what constitutes a "wetland" and the regulations governing the filling of wetlands play critical roles in the human development of the landscape, with the nature and extent of landscape alteration often dictated exclusively by the distribution of official "wetlands" and the ability to modify or fill those wetlands for a given development.

Within the Upper Tohickon watershed, a broad variety of wetlands exists across the landscape, from forested and open-water wetlands in the headwaters to riparian floodplain forests along the main stem of the Tohickon Creek. A large fraction of the wetland area within the watershed has received official protection through either efforts by the State of Pennsylvania or through private efforts to preserve outstanding wetland areas. This is most evident in the Quakertown Swamp, an extraordinary area of wetlands extending throughout the Bog Run watershed. In this area, the Heritage Conservancy has preserved a number of land parcels of the Quakertown Swamp. In addition, the multiple units that compose State Game Lands #139 include a large portion of the swamp and provide strong protections for activity within the swamp. Quakertown Swamp is known as the largest inland freshwater marsh in southeastern Pennsylvania and has been recognized at the local, county, state and federal levels as an important resource for the maintenance of both plant and animal biodiversity within the region. A large number of rare bird species nest within the Quakertown Swamp, including the largest known Great Blue Heron rookery in eastern Pennsylvania. In addition, the swamp harbors an outstanding diversity of plant species in the various wetland habitats, ranging from open water wetlands to tussock sedge marsh, shrub wetland, and forested swamp.



Section of the Quakertown Swamp showing the diversity of wetland habitats.

Throughout the remainder of the Upper Tohickon watershed, wetlands are more broadly distributed, with isolated patches of wetlands occurring in all of the sub-watersheds identified through this RCP. The greatest concentration of wetlands outside the Quakertown Swamp occurs as riparian wetlands along the streams of the watershed (see Figure 3). With the exception of the highly developed Beaver Run streams around Quakertown and the central portions of Dry Branch

Creek with extensive agriculture use, all of the major tributaries to the Tohickon, as well as the Tohickon Creek itself, have consistent riparian wetlands associated with their stream channels. These riparian wetlands serve as mutually beneficial associations with the stream channels, where the streams provide strong water supply to the wetlands and maintain the saturated soil conditions while the wetlands provide vital vegetative cover in the riparian corridor, stability of the stream banks, and both water purification and flood storage capacity for the streams. Thus, the extensive wetlands throughout the watershed along these stream corridors is an important factor in the maintenance of the water quality in the Tohickon Creek watershed and is a central reason why the streams of the watershed are in relatively good or only moderately impacted condition and have not been decimated by the long history of human use of land within the watershed.

3.4 Floodplains of the Upper Tohickon Creek Watershed

Floodplains are the low lying areas adjacent to streams, ponds, and lakes that are subject to flooding during large precipitation or snowmelt events. These floodplains serve a number of critical functions within the watershed, including flood water storage, groundwater recharge, and maintenance of water quality, functions which are similar to those of wetlands. Indeed, floodplains are frequently associated with riparian wetlands, although the floodplain commonly extends beyond the official line separating wetlands from the surrounding upland habitats. When the riparian wetlands and floodplains are protected from alteration as the surrounding landscape is developed, or as these riparian zones are allowed to restore themselves following short-term or long-term disturbance, the ecological functions of these systems are maintained, and these corridors become an important corridor or greenway linking the watershed from headwaters to the most downstream outlet points.

Among the most critical functions of the floodplain, beyond those functions associated with the wetlands themselves, is the ability to capture and store large volumes of water during storm events and snowmelts. This floodplain storage is vital to moderating the pulse of storm water seen during these events and thus decreases considerably the magnitude of flooding. When floodplains are maintained in an undisturbed state, expensive flood control structures are unnecessary. The Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) have implemented measures to regulate development upon floodplains. Maps produced by FEMA define and delineate floodways and flood fringe areas. The NFIP states that there shall be no new construction or substantial improvements in floodways and that all new construction must be above the base flood elevation.

Although these Federal efforts to limit development within floodplains have helped to maintain the integrity of floodplains throughout the nation, the NFIP acknowledges that their guidelines are minimum standards and that local governments have the power, right, and responsibility to implement more stringent guidelines and regulations in order to achieve greater protection of these floodplains and thus to more completely prevent unnecessary flooding, flood damage, and the disturbance that flooding causes to the ecological systems they affect. Central to such efforts is the idea of “No Adverse Impacts” whereby any activity further upstream in the watershed is charged with the responsibility of being conducted in such a manner that no downstream change in flood potential and stream flows can be expected. Thus, although the Federal government plays an important role in maintaining floodplains and preventing additional flooding as the landscape is altered by human use, much of the responsibility falls on local governments to examine the risks and implement guidelines that further minimize flooding risk and the negative consequences associated with flooding.

Within the Upper Tohickon Creek watershed, 100-year floodplains occur throughout the basin and are closely associated with the stream channels of the major tributaries, particularly in areas with flat topography and shallow stream gradients (see Figure 6 and Figure 2). Although these floodplains are broadly distributed, it is clear that the junction of the four major tributaries in the upper part of the watershed near Thatcher Road and just east of Quakertown is an area with a particularly extensive area of floodplains. The combination of concentrated water volumes at this point with a shift to steeper topography as the Tohickon moves into the Diabase belt lead to high flood potential, an extensive floodplain, and (as discussed further in later sections of this document) stress of the human functions and use of the watershed in this area.

3.5 Lakes and Ponds

Substantial areas of standing water that would be characterized as lakes or ponds are lacking in most of the Upper Tohickon Creek Watershed. The absence of lakes and ponds is a result of the absence of glacial activity within the region over the recent geologic past (i.e., 1 million years). Firm evidence shows the Illinoian glacial maximum limited to areas immediately north of the watershed in the areas around Hellertown within the Lehigh watershed. As a result, nearly all large standing water bodies within the watershed are the result of human activity and human alteration of the natural hydrology. Two general types of human intervention occur in the Upper Tohickon watershed. First, a large number of small surface excavations have been made in all parts of the watershed, creating the small farm ponds, quarry ponds, stormwater basins/ponds, and other small ponds that dot the landscape. These numerous smaller surface water bodies are too numerous to discuss in detail but generally have similar characteristics of shallow water depth, warm summer water temperatures, high biological productivity, and localized importance for biological diversity and recreation. The second type of human intervention is the impoundment of streams in the watershed to create reservoirs of varying size. One of the dominant features of the watershed, Lake Nockamixon, is such a reservoir that was created in 1973. Another large water body within the watershed is also a reservoir, Lake Towhee, while numerous small dams on streams throughout the watershed create large numbers of on-stream impoundments, typically considered ponds rather than lakes (an oft-cited distinction between these is that one may throw a stone across the width of a pond). The only remaining pond or lake of moderate size and significant ecological importance is the Sellersville Catch Basin in the headwaters of Threemile Run in the very southwestern corner of the watershed.

Thus, Lake Towhee and Lake Nockamixon are the primary lakes in the watershed. Lake Towhee is a small lake (50 acres) located within Lake Towhee County Park, a 550 acre park owned and operated by the Bucks County Department of Parks and Recreation. The lake was created as an impoundment to Kimples Creek in the central portion of the Kimples Creek sub-watershed near the confluence of the two primary headwater streams that form Kimples Creek. The lake is broad and shallow, with extensive coverage by various native and exotic species of aquatic plants during the summer months. The extensive plant cover limits recreation on the lake but nevertheless provides excellent habitat for aquatic invertebrates and fish. The overall water quality of the lake is good, as evidenced by the good water clarity and the dense macrophyte growth, but a comprehensive study of the lake has not been conducted. In addition to fishing, the park offers a broad array of recreation opportunities ranging from camping and athletic field activities to winter ice skating and year-round hiking in the varied ecological habitats around the lake and along Kimples Creek upstream and downstream of impoundment.



Lake Towhee

The land surrounding Lake Nockamixon constitutes one of the largest State Parks in southeastern Pennsylvania (5,300 acres), with the lake itself being the largest lake in the region (1,450 acres). The Park and Lake therefore provide for extensive recreational opportunities and serve as a regional focus for public recreation, including sport hunting. Four boat launching sites are maintained at the park for boating access to the lake, with a central marina and dry storage area also providing long-term access to the lake for boating enthusiasts. Although swimming is not permitted in the lake itself, a large recreational swimming pool is available during summer months. Fishing within the lake covers a broad range of warm-water game fish, from bass (largemouth, smallmouth, striped) and sunfish to muskellunge, pickerel, and walleye. Hiking, biking, and horseback riding are also common activities across the extensive trail system, with these trails being open to cross-country skiing and snowshoeing during winter months. Although no camping is available within the park, 10 cabins are available for rental year-round.

The ecology and water quality of Lake Nockamixon has received extensive study over the past 20 years. Even with extensive efforts to improve the water quality in the lake, the results from this research consistently indicates that the lake maintains high nutrient concentrations and is thus classified as either eutrophic or hypereutrophic. These terms indicate that biological productivity in the lake is very high and is not strongly constrained by limiting nutrient levels. Eutrophic lakes typically have large quantities of planktonic algae that can result in nuisance algal blooms. Indeed, much of the research at Lake Nockamixon has been in response to the presence and

overabundance of algae within the lake. This extensive research led to substantial improvements upstream within the Upper Tohickon watershed in an effort to limit the loading of nutrients and sediments into Lake Nockamixon. Among these improvements was the implementation of important Best Management Practices (BMPs) in those areas of the watershed where farming was a dominant land use. In addition, and to complement the efforts at reducing the non-point source pollutants arising from land use, the single dominant point source within the watershed (the Quakertown Wastewater Treatment Plant) improved its wastewater facility to a tertiary plant and reduced its effluent phosphorus concentration to 0.5 mg/L. This single action resulted in a very large reduction in the phosphorus loading to Lake Nockamixon, and combined with the agricultural BMPs, led to improved water quality conditions for the lake (and for the Tohickon Creek itself).

Nevertheless, through the early 1990s, algal blooms persisted in the lake despite the focused efforts to reduce nutrient loading. As a result, the State of Pennsylvania added Lake Nockamixon to its list of impaired water bodies, the 303(d) list, in 1996. By listing Lake Nockamixon on this list of impaired water bodies, the state was then obligated to complete a Total Maximum Daily Load analysis (TMDL) for those parameters that were suspected of causing the water quality impairment. In the case of Lake Nockamixon, the suspected parameters were the limiting nutrient, phosphorus, as well as total suspended solids. The TMDL analysis for Lake Nockamixon was completed in 2003 and focused on reducing non-point source phosphorus loading (Tetra Tech 2003). Apparently, this focus on non-point source loading was the result of the large point-source discharger (Quakertown WWTP) having already upgraded to a tertiary treatment system with low effluent thresholds. With the focus on non-point sources of phosphorus, the TMDL analysis identified load reductions that would be needed to move the Lake Nockamixon system from a eutrophic status (>10 $\mu\text{g/L}$ Chlorophyll a as a measure of algal biomass) to an improved status of “mesotrophic” (10 $\mu\text{g/L}$ Chlorophyll a). These reductions were set at 47% for all sources that could be controlled (i.e., excluding groundwater and natural forests), with the one exception that 80% reductions in total phosphorus loading be attained from cropland. Thus, the TMDL placed a clear focus and almost all responsibility for reducing phosphorus loading on farmers involved in cropland production (based on total loads, 86% of the load reduction will need to be obtained from cropland). These goals will be quite challenging to obtain and will require innovative approaches in order to obtain the load reductions while maintaining the viability of these farming operations. Should these goals be achieved, the benefits to the entire Tohickon Creek watershed as well as Lake Nockamixon will be remarkable. Specifically, the reduction of phosphorus will require the reduction in suspended sediments since most of the phosphorus carried in surface waters is adsorbed to sediment particles. The combined reduction in suspended sediments and nutrients will address some (but not all) of the specific stresses that have been identified as the likely causes of impairment to the streams within the Tohickon Creek watershed.

Section 4. Land Resources

4.1 Introduction

The lands of the Upper Tohickon watershed are the primary stage upon which human activity occurs, and because this activity both directly and indirectly affects the overall quality of the watershed and the specific quality of the lakes, streams, and wetlands, a firm understanding of the natural land resources is integral to a broad watershed assessment. This includes examinations of the current human influence on the land, the underlying geologic forces that have shaped the landscape, how the natural processes have created the landscape now evident within the Upper Tohickon watershed, and finally what efforts are likely to shape these lands into the future.

4.2 Land Ownership

With the existence of a State Park, State Game Lands, a County Park, and the numerous municipally owned lands, much of the Upper Tohickon watershed is publicly owned and accessible (see Figure 7, Figure 8). The State Game Lands occupy 2,298 acres of land across the #139 and #157 Game Land parcels, which is 5% of the total land area of the watershed (compare this to the primary land cover types - Figure 4). The State and County Parks cover an even greater extent, with 8,927 acres (19% of the watershed) under State and County control and accessible to the public. Although data on public lands held by municipalities were not available digitally, these smaller parcels contribute to the total holdings by various public agencies, more than 11,000 acres altogether or about one quarter of the total watershed area. Such high public ownership is very unusual for a moderately large watershed, especially in the context of the high percentage of land typically held as private property in Pennsylvania and throughout both the Mid-Atlantic Region and northeastern states. Combined with the diversity, scenic qualities, and uniqueness of these public lands, the Upper Tohickon watershed serves as a focal point for public recreation and rejuvenation within the region.

4.3 Geologic Characteristics

The Upper Tohickon Creek watershed has a broad diversity of geologic formations including constituents of two of the three major geologic groups: igneous and sedimentary. These constituents are realized in the Diabase Suites and the Brunswick/Locokatong formations, respectively. The watershed is dominated by two of these formations, both of the Triassic Period (205-250 million years ago; see Figure 5). The Diabase belts within the watershed have had perhaps the most profound effect on the development of the watershed, precluding most agriculture and providing extensive areas for modern deciduous forests. Diabase is a dark gray to black, dense igneous rock formation that intruded into overlying formations and formed dikes, sheets, and small flows within these broader geologic formations. Because they are highly resistant to erosion, Diabase formations are typically associated with ridges and promitories. In the Upper Tohickon watershed, this is evident by the broad intrusion/sill of Diabase forming Rock Hill and extending northeastward to Haycock Mountain. Additional Diabase intrusions are also present in the northwestern section of the watershed that leads northward out of the watershed to the local promontory known as The Lookout. In total, these Diabase intrusions outcrop in 44% of the watershed's area, but may underlie more extensive portions within the other formations. Because it has no primary porosity, Diabase serves as a poor groundwater source with flow occurring exclusively through fractures (secondary porosity) within the bedrock. The poor weathering of Diabase provides a unique and highly valued recreational resource

within the Upper Tohickon watershed. At Haycock Mountain, extensive fields of exposed and contiguous Diabase boulders have earned this area the reputation as one of the outstanding recreational climbing destinations within the region. Because these Diabase sheets and dikes are unusual and form striking features in the landscape, they are also often recognized for their importance within the Commonwealth's diverse suite of natural resources. Within the Tohickon watershed, at least two Diabase promontories (The Lookout and Rock Hill) are recognized as Outstanding Scenic Geologic Features of Pennsylvania.

The primary formation within the Upper Tohickon Creek watershed is the Brunswick Formation. 54% of the watershed is underlain by this parent bedrock. It consists primarily of reddish-brown shale, siltstone, and mudstone with limited shale and argillites interbeds near its base. Erosion within this formation creates broad valleys with gently rolling hills and ridges parallel to the strike of the beds. Because the shales of the Brunswick formation are highly fractured, they form relatively productive groundwater aquifers and thus serve as moderately strong sources for human use, especially in comparison to the Diabase formation. The differences between the Brunswick and Diabase formations have created such distinct uses of the land that their approximate boundaries are easily discernable in the aerial photograph of the watershed (see Figure 1 and Figure 5). In areas underlain by the Brunswick formation, deep soils suitable for productive agriculture has developed, with agriculture and dense human settlement occurring almost exclusively within this zone. By contrast, the Diabase regions within the watershed continue to be sparsely settled and have become reforested due to the limited human use of these areas.

The Lockatong Formation is the final geologic unit lying within the watershed, although it is limited to peripheral areas along the southeastern edge and in the far northeastern edge of the watershed. Only 2% of the watershed is underlain by this formation. The Lockatong Formation is distinguished by the dominance by argillite, a material similar to sedimentary shales of the Brunswick Formation but bound by silica. The Lockatong does contain some zones of thin-bedded shales as well as thin layers of impure limestone and calcareous shales. The Lockatong Formation has a water-bearing capacity only slightly better than Diabase and thus tends to be a relatively poor source of ground water. The rock comprising this formation has no primary porosity or permeability and virtually all groundwater is transmitted through widely spaced, poorly interconnected and relatively tight fractures and joints.

A dominant geological force throughout northern sections of the United States is the advance of glacial ice sheets during the last 1 million years. These glaciers transformed the topography, soils, and drainage systems throughout much of Pennsylvania, and the possible effect from glaciers is central to any historical evaluation of the landscape. The data suggests that the most relevant glacial maximum to consider is the Illinoian Ice Sheet. Detailed mapping of this glacial advance indicates that its maximum reach ended immediately to the north of the of the Upper Tohickon watershed within the Lehigh drainage around Hellertown (Geologic Map of Pennsylvania 1980). As a result, distinct differences in land forms and soils exist between the Tohickon watershed and those glacially-influenced watersheds immediately north, with the Tohickon watershed's primary influences over the recent geological past coming primarily from faulting and long-term weathering.

4.4 Soil Characteristics

Soil characteristics such as fertility, depth to bedrock, depth to seasonal high water table and slope strongly influence land use. Historically, relatively flat to gently sloping fertile soils in the Tohickon Creek watershed were in row crop production, while land that was too steep, or poorly drained, was used for grazing or woodlots. As the population of Upper Bucks County increased over the past several decades, some of the fertile farmland was converted to residential and commercial uses. The best land for development having been used, lands with constraints such as steep slopes and high water tables will be under greater development pressure in the future. However, soils with specific constraints such as steep slopes, shallow depth to bedrock or shallow depth to groundwater as well as soils associated with sensitive resources (hydric or alluvial soils) limit the type and the density of development.

The soils of the Tohickon Creek watershed consist of fine textured silt loams and silty clay loams,

weathered from shale and sandstone. The physical limitations associated with some of them may prohibit the downward entry of water into soil surface (*infiltration*), the movement of water through soil layers (*percolation*), the ability of the soil to transmit water (*permeability*), and the extent to which soils wear away from the land surface by wind, running water and other physiographic agents (*erodability*). These four qualities (*infiltration*, *percolation*, *permeability*, and *erodability*) of soils



Hay and corn production on the productive agricultural soils

determine the acceptability and types of on-lot sewage treatment systems. Soils also affect land development and the construction techniques required to implement a development project. Soil characteristics related to steep slopes, depth to bedrock, the presence of hydric soils, and alluvial soils can significantly impact land development and construction methods.

The most common soils across the Upper Tohickon watershed are the Croton, Mount Lucas, Neshaminy, and Towhee Series, as well as the Towhee-Glenville Complex (see Map 8 and Maps 10-19). In addition, areas now dominated by urban development and the associated urban soil characteristics make up 7% of the watershed, primarily in the Upper Tohickon (1,025 acres) and the Quakertown/Beaver Run (1,527 acres) watersheds. The distribution of these dominant soils varies strongly across the watershed based on the underlying parent geology (see Figure 5 and Section 4.3 above), weathering environments, depositional environments, and landforms. The Croton soil series, for example, covers 14% of the Tohickon watershed (6,434 acres), but reaches a maximum of 43% (1,091 acres) in the Dry Branch Creek sub-watershed and a minimum of

0.4% (13 acres) in the Bog Run sub-watershed.

The chief soil constituents of the Tohickon Creek watershed tend to be well-drained and shallow in both the uplands and steep slope areas, to poorly-drained and moderately deep in level or depressional areas. The landforms associated with each soil type in turn dictate the characteristics of the soil.

In undisturbed soils, the weathering of parent geologic formations dictate the physical mineral and grain-size content of the soils, thereby affecting the four major soil qualities as indicated above. Materials weathered from the shales of Brunswick formation tend to have high fine-grained contents (silt, clay) and will therefore have high runoff rates and low infiltration, percolation, and permeability rates. The possibility of increased erosion rises with increased runoff. The Erodible Soils map (see Figure 10) depicts the propensity for soils to erode under wind and water load if those soils are undisturbed.

In addition to the physical makeup of the soil, the land cover and land use of the ground affects the overall erodability of soils. In reference to Figure 10, the areas that are indicated as “highly erodible soils” may become excessively erodible if the current land cover protections are removed and the land uses are modified. Conversely in areas that are mapped as just “potentially highly erodible soils”, the soils may begin exhibiting characteristics of “highly erodible soils” where landcover protections have been removed for farming or development.

Prime farmland is land best suited to and available for producing food, feed, forage, fiber, and oilseed crops. Prime farmland soils exhibit the quality, growing season and moisture required to produce economically viable and sustained high yield. In Bucks and Philadelphia Counties, there are twenty-eight soils that qualify as prime farmland. Of these, ten soils in seven series are found in the Upper Tohickon Creek watershed (Table 4.1 below).

Table 4.1
Upper Tohickon Creek Watershed Plan
Soil Mapping Units That Qualify as Prime Farmland in Tohickon Creek Watershed

Soil Series Symbol	Soil Series Name
ArB	Ardentsville gravelly silt loam
BrB	Brecknock channery silt loam
LmA, LmB	Lehigh channery silt loam
MIA, MIB	Mount Lucas silt loam
NbB	Neshaminy silt loam
PeA, PeB	Penn silt loam
ReA	Readington silt loam

Source: USDA Supplement

Additional Farmland of Statewide Importance

Additional Farmland of Statewide Importance is defined in Pennsylvania, as being comprised of Class II and Class III soils that do not qualify as prime farmland. In general, farmland of statewide importance is land, other than prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage and oilseed crops. In Bucks and Philadelphia Counties, there are thirty-two soils that qualify as Additional Farmland of Statewide Importance. Of these, 25 soils in 16 series are found in the Upper Tohickon Creek watershed (Table 4.2).

Table 4.2
Upper Tohickon Creek Watershed Plan
**Soil Mapping Units That Qualify as Additional Farmland of
Statewide Importance in the Tohickon Creek Watershed**

Soil Series Symbol	Soil Series Name
AbA, AbB, AbC	Abbottstown silt loam
AmA, AmB	Amwell silt loam
ArC	Arendtsville gravelly silt loam
BeC	Bedington silt loam
BrC	Brecknock channery silt loam
BwB	Buckingham silt loam
CyB, CyC	Culleoka-Weikert channery silt loam
Ha	Hatboro silt loam
K1B	Klineville very channery silt loam
LmB	Lehigh channery silt loam
MIC	Mount Lucas silt loam
NbC	Neshaminy silt loam
NkA, NkB, NkC	Nockamixon silt loam
PkB, PkC	Penn-Klinesville channery silt loam
ReB	Readington silt loam
RIA, RIB, RIC	Reaville channery silt loam

Source: USDA Supplement

4.5 Land Preservation Programs and Preserved Land

Although much of Bucks County has been subject to urban sprawl, only small portions of the Upper Tohickon Creek Watershed Area have experienced this problem. Communities such as Quakertown Borough, Richlandtown Borough and Trumbauersville Borough have seen their areas just about reach their development potential. Milford Township and Richland Township are currently experiencing a great deal of development pressure from both residential and commercial developments. This development is coming at the expense of agricultural land, since the best properties for farming typically possess the topography and soils desirable for real estate development (e.g., flat to gently sloping, well drained and proximate to water bodies). In order to help maintain the rural character of Bucks County communities and preserve historically valuable farmlands, a variety of initiatives have been developed to preserve farmlands and other important land areas.

The Bucks County Agricultural Land Easement Program, established in 1990 as part of the Pennsylvania Farmland Protection Program, provides funds for agricultural conservation easement purchases. These easements limit the use of the land to agricultural operations in perpetuity. Limited numbers of farms can be preserved under this program, though interest among farmers is high. Although the process is time-consuming, several farms within the Upper Tohickon Creek Watershed met the criteria of the Bucks County Agricultural Preservation Program and have been preserved. As noted in Section 2 of this plan, residents of the watershed feel that additional measures are needed in order to preserve additional agricultural land in the watershed and to enhance the economic viability of agriculture.

The Bucks County Open Space Program

The Bucks County Municipal Open Space Program was created to assist municipalities within Bucks County to acquire and preserve open space. Started as part of the Bucks County Commissioners' Open Space initiative in 1997, \$20 million of a \$59 million bond was set aside to provide municipalities with the required funding. The monies available through the program first provided assistance for municipal governments to prepare the required Open Space Plans. Once the plans were written and approved, the monies were used for the acquisition of land to "permanently protect natural areas, preserve farmland, or provide park and recreation areas."¹ The initial program made funds available until December of 2001. The program was very successful in certain communities and unused funding was made available after the program deadline.

Other public and private land preservation organizations operate in Bucks County, including the Heritage Conservancy, National Lands Trust, Tinicum Conservancy and the Bedminster Land Conservancy. Some of the land preserved through these programs is shown in the Quakertown Swamp region (Figure 8). The Heritage Conservancy is a non-profit organization, concerned with the rapid loss of open space in Bucks County. It is dedicated to preserving the natural and historic heritage of the County. Through a planned giving program that helps donors and friends to plan estates, Heritage Conservancy has preserved 113 acres within the Upper Tohickon Creek Watershed (see Figure 8 for areas surrounding the Quakertown Swamp and Bog Run; Heritage Conservancy, personal communication).

¹ Bucks County Municipal Open Space Program, Land Acquisition Grant Guidelines, August 2000

4.6 Potential Hazard Areas

The United States Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (DEP) monitor hazardous waste facilities. Areas of environmental concern include EPA Superfund Sites, Resource Conservation and Recovery Act (RCRA) Inspection Sites, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) landfills and other areas. The permit process assures that the public and the environment are protected. DEP reserves the right to conduct random inspections of these facilities both during construction and throughout their existence. If there is a failure in compliance, the DEP reserves the right to shut down a hazardous waste facility.

From current research, it appears that two (2) superfund sites have been/are currently located within the Watershed area. The first site is located in Quakertown Borough. This site was listed on the Hazardous Site Cleanup list on March 9, 1996 and through cleanup activities, this site was removed from that list on July 5, 2003. This site is the current location for the Upper Bucks County Free Library. The second site is an active superfund site known as the Watson Johnson Landfill. This site was added to the National Priorities List on September 13, 2001. The EPA is currently conducting a comprehensive site study, known as a remedial investigation, to be completed in 2004. Data from this study will determine the nature and extent of the contamination and will be used to develop a cleanup plan.

Sinkholes and Quarries

Sinkholes are common where the rock below the surface is limestone, carbonate rock, salt beds or rocks that can naturally be dissolved by groundwater circulating through them. As the rock dissolves, spaces and caverns develop underground. When underground support becomes inadequate, sudden dramatic collapses of land surface may occur. Although carbonate geologic formations occur elsewhere in Bucks County, they do not exist in the Upper Tohickon Creek watershed area.

Most of the quarries present in the portion of the Delaware River Basin in Upper Bucks County are for crushed stone including, Triassic red or black sandstone, argillite and shale, Triassic grey to black shale and Triassic Diabase. Only one quarry has been located within the watershed area.

The quarry, located in East Rockhill Township, is not active and has been abandoned.

Several additional areas within Richland Township were evidently once used as gravel, sand, clay or borrow pits. These excavations are not currently being utilized for extraction of raw materials and have since filled with water and would be considered abandoned.

Section 5. Biological Resources

5.1 The Landscape of the Upper Tohickon Creek Watershed

The biological features and resources within the Upper Tohickon watershed are determined to a large degree by the watershed's landscape and climate. Although the distinct features of the watershed have been considered previously in Sections 1.10, 3 & 4, a synthetic overview may help to understand the setting for the myriad of species that have colonized and persisted within the Upper Tohickon watershed.

The dominant landscape feature for the biological community is the parent geology within the watershed. The age of the bedrock throughout the basin (Triassic Diabase and Brunswick shales at 205-250 million years old) combined with the lack of any recent glacial ice sheets within the watershed has provided an extended weathering period for these parent rocks materials and permitted the formation of relatively complete soils for each bedrock type (see Figure 5 and Figures 11 to 20). Strong



Diabase Slope Near Haycock Mountain

contrasts between the sedimentary Brunswick Shales and the igneous Diabase, when combined with their long history of weathering, have created many of the topographic features within the watershed (see Figure 2). For example, in the upper central basin of the Tohickon near Quakertown, the more rapid weathering of Brunswick shale has led to a broad, flat region with deep soils. Similar soils and topography can also be found in the southeastern and northeastern sections of the watershed also dominated by Brunswick geology. Along the ridge between Lake Nockamixon and Quakertown, as well as in the headwaters of many of the streams, the resistance to weathering by Diabase has produced an extensive hilly terrain with substantial topographic relief, as well as thin soils containing extensive boulder fields. The parent geology and the subsequent differential weathering of these geological formations has therefore created the topography, soils, and landscape template upon which both ecological and human transformation of the landscape has occurred.

Ecologically, this varied landscape of gentle topography with deep soils in the central portion of the watershed, surrounded by rocky, thin soils within a more hilly terrain has produced distinct biological communities across the landscape. In the central region, gentle streams with wide floodplains and a stronger connection between the stream channel and the surrounding riparian zone developed. In the Diabase uplands, streams generally maintained steeper slopes and coarser substrates, although more extensive floodplains and even extensive wetland systems, such as the Quakertown Swamp, developed on sediment-filled plateaus and former stream sections within this geologic formation.

Post-European settlement of the watershed also conformed strongly to the natural shape and character of the landscape. The deeper soils and more gentle topography of the central, southeastern, and to lesser extent northeastern regions of the watershed provide suitable conditions for intensive agriculture. The land was cleared of its original hardwood forest, and much of this land has remained in agricultural production for 100-200 years, or more. In the hilly Diabase areas, however, the land was unsuitable for most agriculture. As a result, this land was used to a greater extent as wood lots for fuel and timber. Although the entire forest of the Diabase sections was cleared over time and no old growth forest stands remain, the lack of continued disturbance, coupled with development and utilization of different fuel sources, provided an opportunity for the deciduous forests to reinvade these regions and re-establish a dynamic tapestry of forest and cleared land even as the forests continued to be more lightly utilized by the rural population. The combination of agricultural use and successional forests continues to dominate the landscape, with 90% of the watershed area (excluding open waters like Lake Nockamixon) classified as either Forest or Agricultural (see Figure 4).

More recently, the globalization of agriculture and the shifting priorities of younger generations have provided less demand for agricultural land throughout the northeastern United States, Pennsylvania, and particularly Bucks County. As a result, former agricultural land has become available for development and the human alteration of the landscape has entered a transitional period. The most dominant force shaping this transition is the “suburbanization” of formal rural areas, with extensive tracts of land being converted from open space to residential use. Such transformation permanently changes the land and solidifies the human imprint on the watershed. A second force shaping this transformation of agricultural land, which has been in part a response to the expansion of suburban areas, has been the drive to preserve open space. These open space efforts have occurred through state, county and local governments, but have also been sustained through considerable efforts and successes by non-profit groups. The combination of these two transitional forces (suburbanization, open space preservation) has resulted in a watershed pulled in two directions. On the one hand, the conversion of intensive agricultural land to preserved open space has typically led to a reduction in the disturbance of the land and improvements in riparian corridors, wildlife habitat, and both surface water and ground water quality. Moreover, the continued progress in agricultural research and the increased implementation of advanced agricultural practices have decreased impacts from agriculture, thus improving water quality while maintaining agricultural production. The building of residential housing, on the other hand, has changed the human impact to issues of impervious cover, stormwater management, the lack of groundwater recharge, and the alteration of both groundwater and surface water hydrologies. Thus, as portions of the agricultural land within the Upper Tohickon watershed have been removed from agricultural production, the human imprint on the landscape has begun to change in both positive and negative ways. Together, these natural and human histories within the watershed have led to the current patterns of biological communities across the Upper Tohickon landscape, and have set the stage for the continued changes that will occur across this landscape into the future.

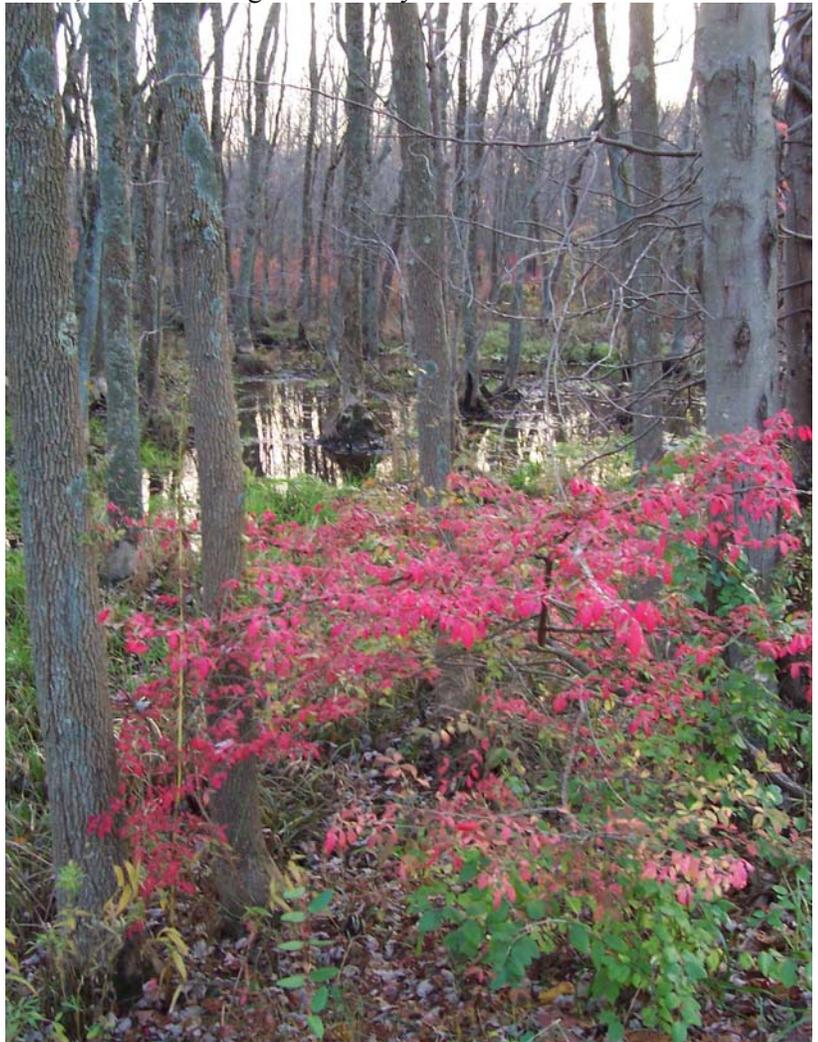
5.2 Flora and Fauna

5.2.1 The Flora of the Upper Tohickon Creek Watershed

Bucks County has a greater diversity of plants than any other county in the state. This is partly related to the transformation from upland to coastal plain in the southern part of the county. However, a large and diverse array of plant species and associations occurs within the Upper

Tohickon watershed. This diversity has resulted both from the varied natural habitats, ranging from swamps and pocket wetlands to different forest associations, and from human transformation of the land and the accompanying changes to vegetation.

At the broadest scale, the Upper Tohickon watershed falls within the eastern broadleaf forest ecoregion, and the primary vegetation associations that develop on undisturbed sites will be the deciduous forest types common in this region. This is evident in the Upper Tohickon watershed today, with the Diabase areas having reduced disturbance and therefore extensive tracts of forest (65% of the watershed is classified as either Forest or Forested Wetlands - see Figure 4). These upland forests are dominated by red oak-mixed hardwood forests and tuliptree-beech-maple forests, with the latter particularly common throughout the diabase areas. In addition, in areas such as Haycock Mountain and Nockamixon State Park, limited areas of birch-blackgum rocky slope woodlands occur. This plant community is of regional rarity and significance (Rhoads and Block 1999). In areas with poor drainage, the forests shift to oak-hardwood palustrine types that are composed of pin oak, swamp white oak, elm, and shagbark hickory. Coniferous trees are limited in the watershed and occur primarily on north and west-facing slopes. Eastern hemlock occurs frequently in this region, although it is primarily limited to areas around streams. Throughout both upland and bottomland forests, the vertical structure of the forests has been altered considerably because of elevated whitetail deer populations that eliminate much of the understory layer. As a result, sugar maple and a number of invasive species (e.g., raspberries, honeysuckle) dominate the understory and limit habitat diversity in the forest. Regeneration of these mature forests is threatened because most young trees are absent in the understory and will thus not replace the aging trees of the canopy (Rhoads and Block 1999). The herbaceous layer in the forests, however, has maintained some of its diversity and integrity, even with the excessive grazing pressure from deer. This herbaceous layer undergoes strong seasonal changes, with plants such as trout lily, mayapple, red trillium, and Dutchmans' breeches dominating through the spring. A diverse



Diverse Vegetation of Bog Run and the Quakertown Swamp

community of ferns become established and thrive under the forest

canopy layer from spring to fall. As fall approaches, species such as wood aster and wood goldenrod appear and usher in the final transition among the non-woody understory plants.

Agricultural land has continued to be taken out of production and left fallow. The resulting “old fields” become important sites for a number of grassland plants and will eventually begin the successional cycle toward mature forests if left unmanaged. The succession begins with a suite of annual and perennial grasses, wild flowers, and weeds and is followed by the colonization of ash, black cherry, and eastern red cedar. Through time, these successional forests are then colonized by species from the surrounding mature forests and eventually succumb to the dominance of these late-succession trees. The active agricultural land likewise plays a role in the overall plant diversity of the region, especially along hedgerows and wind breaks. These small features can be important corridors for dispersal and can harbor unusual diversity among various plant and animal groups.

The varied wetland communities within the Upper Tohickon watershed provide an additional diverse suite of species to the flora of the watershed. The Quakertown Swamp is the most well-known of these and harbors an outstanding diversity of plants across open water, shrub swamp, cattail marsh, tussock sedge marsh, and swamp forests (Rhoads and Block 1999). Although a number of invasive species have colonized the swamp (e.g., common reed, purple loosestrife), the large contiguous nature of the swamp provides excellent overall conditions across these wetland communities. The Diabase zones throughout the watershed also provide a broad array of smaller wetland types, including vernal pools and moist meadows. These harbor such rare species as prairie phlox, pineland pimpernel, slender blue iris, Mead's sedge, and brown sedge. Other vernal pool habitats occur along Beaver Run, and a number of unique plant communities such as water willow-smartweed riverbed community, black willow scrub/shrub wetlands, and populations of shellbark hickory occur along Morgan Run and the central sections of Tohickon Creek.

5.2.2 The Fauna of the Upper Tohickon Creek Watershed

The diverse array of terrestrial, wetland, and aquatic habitats within the Upper Tohickon watershed provide for a broad diversity of invertebrate and vertebrate animal life. Combined with the extensive forest coverage and the corridors among many of the natural forested areas, the Upper Tohickon watershed serves as an important component to the relatively large extent of natural areas that exist in eastern Pennsylvania and western New Jersey around the Delaware River corridor.

Among the mammals, large populations of common eastern species are present throughout the watershed (e.g., gray squirrels, groundhogs, opossums, raccoons). The watershed also maintains sizable populations of red squirrels and flying squirrels, while fur-bearers such as the weasel, mink, and ermine are much less common but still present (Rhoads and Block 1999). Among the larger mammals, black bear are not believed to be resident within the watershed but do periodically enter it, particularly in the area around Haycock Mountain. In addition, coyote are at times found within this region of upper Bucks County, and both the introduced red fox and the native gray fox occur within the watershed.

The bird fauna is particularly diverse in this region and has been well-studied. In the Quakertown Swamp alone, 91 species of birds have been documented, including 14 rare breeders, while the Haycock Mountain/Nockamixon State Park complex have 5 rare breeders and at least 47 species of birds (Rhoads and Block 1999). Among the rare birds found in the watershed, the existence of

sora rail and Virginia rail within the wetlands of the watershed is particularly noteworthy. The mix of agricultural lands, abandoned agricultural fields, mature forest, and wetlands is important in maintaining the diversity of the bird fauna. For instance, many rare bird species in the region are dependent on the shifting mosaic of old fields and meadows in areas formerly used for agriculture. If these fields are not maintained at periodic intervals, they eventually shift toward forested habitats and the communities of birds (and other animals) that depend on the meadow habitats are lost from the system. This includes birds such as grasshopper sparrow, bobolink, northern harrier, and woodcock. Thus, for the bird fauna, the combination of natural wetlands and forest with old fields, meadows, and open water habitats created by humans sustains a broader diversity of bird species within the Upper Tohickon watershed than would likely be found if the watershed were to revert to contiguous forest.

The reptiles and amphibians, including snakes, lizards, turtles, frogs, and salamanders, are well-represented in the Upper Tohickon watershed. Common groups include eastern box turtles, green frogs, and water snakes, while wood turtles, spotted salamanders, and copperheads are less commonly encountered and presumably have smaller populations within the watershed. As with the Lower Tohickon watershed, it is believed that 30 or more species of these reptiles and amphibians are resident within the Upper Tohickon watershed. Of particular note among these is the bog turtle, a small turtle that is rapidly declining across its range. As a result, the bog turtle is federally listed as “threatened” and State listed as “endangered” (see Section 5.3 below). Although the distribution of bog turtles within the Upper Tohickon watershed is not well known, populations are believed to exist and multiple sites with suitable habitat are known within the watershed.

A diverse suite of native and introduced species of fish are present within the watershed as a result of combined natural riverine habitats and the artificial lakes and reservoirs. In the streams, a moderately diverse group of Atlantic slope species inhabit the watershed. These include fall fish, blacknose dace, bluntnose dace, tessellated darters, and white suckers. In the lakes and ponds are a broad variety of species which, although native to eastern North America and historically present within the Delaware River drainage, probably did not occur within the Upper Tohickon watershed prior to European settlement. Such species include largemouth bass, striped bass, muskellunge, walleye, and channel catfish. Thus, the assemblage of fishes has been significantly augmented by the creation of additional habitat within the watershed and the subsequent stocking of these habitats with non-native fishes.

Among invertebrate groups, very little research has been conducted to identify and map the distribution of rare and at-risk species. Given the broad variety of habitats within the watershed and its rural nature, it is likely that a number of at-risk species of butterflies, moths, dragonflies, and damselflies reside within the watershed. The one group of invertebrates that have received substantial attention is the freshwater mussels (family Unionidae). The Unionidae mussels are native clams that have their greatest concentration of species within North America. Populations of these mussels have undergone rapid declines in North America, with 35% of species either extinct or at-risk of extinction. In fact, the majority of the native mussel species in the U.S. continues to undergo rapid population declines. Many Unionid specialists have emphasized the need to stabilize and monitor all native mussel populations. Within Bucks County, at least 4 species of native Unionidae mussels have been recently identified; although 2 species are historically known to occur within the county could not be found and may have been extirpated (Rhoads and Block 1999). Within the Tohickon Creek watershed, at least 3 species of mussels have been found: the eastern floater, the eastern *Elliptio*, and the yellow lampmussel.

Maintenance of these populations (and potentially other undiscovered mussel populations) will occur only through careful management of the watershed's resources, with particular needs to maintain or improve water quality conditions, the natural sediment flows in streams, and the natural hydrologic conditions of these waterways.

5.3 Endangered and Threatened Species in the Upper Tohickon Creek Watershed

As a result of the Federal Endangered Species Act of 1973, individual species have been given the opportunity to gain legal protection if their populations become threatened and if this threat can be translated into a "listing" of that species under the Act. States have also taken action to provide state-wide protections for species whose populations may be at risk at a more local level and which would not receive protection at the Federal level. In Pennsylvania, a joint partnership between the Department of Conservation and Natural Resources (DCNR), The Nature Conservancy, and the Western Pennsylvania Conservancy has coordinated efforts to identify populations of rare and endangered species within the Commonwealth and to manage the resulting information as a means of protecting these species and enhancing their chances for long-term survival. These joint efforts have been brought together through the Pennsylvania Natural Heritage Program, and requests for information about these at-risk species is managed through their database, known as the Pennsylvania Natural Diversity Inventory (PNDI). Although specific information about the location, extent, and size of individual at-risk populations is carefully guarded, requests for more general information can be fulfilled through the PNDI database.

A broad search of the PNDI database for threatened, endangered, and other at-risk species was conducted for the entire Upper Tohickon watershed. The results from this search further document the outstanding resources of the Upper Tohickon watershed, with 12 plant species of special concern found within the boundaries of this watershed (see Appendix VII). In addition, two ecological communities exist within the watershed are also listed because of their rarity or the declining extent of these habitats within Pennsylvania. Requests to the Pennsylvania Fish & Boat Commission, the Pennsylvania Game Commission, and the U.S. Fish and Wildlife Service about vertebrate and invertebrate animal species provided no specific information about the Upper Tohickon Watershed. Instead, the information provided by these agencies addresses possible species of special concern in the region or throughout Bucks County (see Appendix VII). However, populations of great blue heron and bog turtle have been documented within the Upper Tohickon Watershed.

Among the plants, most are associated with wetland habitats, including the two species listed as "endangered" by Pennsylvania, while the others are primarily associated with grassland habitats. These patterns reinforce the need to conserve wetland habitats and maintain the diversity of ecological associations across the watershed, including artificial maintenance of grassland habitats by periodic mowing or controlled burns. Among the animals, the broad list of at-risk species includes groups from all habitat types, from wetlands to successional grasslands to upland forest. Many of these animals, although listed by Pennsylvania, have sizable and stable populations across other parts of their range. However, a number of the species also listed at the Federal level are undergoing broader declines and require more concerted efforts in all areas to reverse the declines and ensure the long-term existence of these species.

5.4 The Bucks County Natural Areas Inventory

Recently, a single comprehensive assessment of the natural areas and at-risk species within Bucks County was performed through a cooperative effort led by Ann Rhoads and Timothy Block at the Morris Arboretum. Through this research, a summary publication of the collected data was produced entitled “Natural Areas Inventory of Bucks County, Pennsylvania” (Rhoads and Block 1999). This study was charged with reviewing existing data, surveying priority sites within the county, and then identifying both the unique sites of state and regional importance as well as prioritizing the preservation of these areas based on the integrity, diversity, and uniqueness of the flora, fauna, and habitats at the various sites. In total, 115 priority sites were identified across the county and placed in four priority levels, with 19 sites identified as “Priority 1” with clear state-wide and county-wide significance.

The Upper Tohickon watershed, spanning a broad section of northern Bucks County, consists of 74 square miles of the 610 square miles for the entire County (12%). Of the 115 priority sites identified in the Natural Areas Inventory, 14 are found partly or wholly within the Upper Tohickon watershed, including two Priority 1 sites, six Priority 2 sites, four Priority 3 sites, and two Priority 4 sites. These sites, and their priority level, are given below. For a more comprehensive understanding of these natural areas, please refer to the Natural Areas Inventory, an outstanding source of information, with a large number of detailed maps showing the areas of these prioritized sites and broad descriptions of the habitats and some of the unique species that can be found within each site (Rhoads and Block 1999).

- Haycock Mountain & Nockamixon State Park - The broad expanse of these two protected areas covers over 7,000 acres of forests, old fields, boulder fields, rocky streams, forested wetlands, and a 1450 acre reservoir (Priority 1).
- Quakertown Swamp - This extensive swamp includes open water, shrub swamp, cattail marsh, tussock sedge marsh, and swamp forests (Priority 1).
- Cressman Hill - A large area of forested slopes and flat uplands that is contiguous with the forests of Lake Towhee County Park (Priority 2).
- Dimple Creek (Kimples Creek) and Lake Towhee Park - This relatively pristine stream (at least in its headwaters) and the parklands associated with it and Lake Towhee form a central part of the contiguous forest in the Diabase region with a diverse suite of aquatic and wetland habitats (Priority 2).
- Dimple Creek (Kimples Creek) meadow - A valuable meadow with a number of unique plant species is located along Dimples Creek in its lower reaches (Priority 2).
- Rock Hill - This Diabase hill maintains extensive forest cover as well as historical and cultural remnants (Priority 2).
- The Lookout - Like Rock Hill, this Diabase hill maintains an outstanding mixed deciduous forest and also includes vernal pools and a well-developed understory herbaceous layer (Priority 2).
- Top Rock Trail Meadow - This moist meadow near Haycock Mountain harbors a broad diversity of plants including at-risk species (Priority 2).

- Morgan Run - This low-gradient stream maintains broad, shallow stream channel that contains a unique suite of emergent vegetation and a broad floodplain forest (Priority 3).
- Sellersville Catch Basin - The small dam on this Threemile Run headwater contains both the reservoir and an excellent example of surrounding forest within the Diabase ridge (Priority 3).
- Tohickon Creek near Camp Tohikanee - This section of the Tohickon Creek contains extensive forested slopes surrounding the stream as well as adjacent floodplain forests (Priority 3).
- Tohickon Creek near Thatcher Rd - This section of stream maintains both a broad floodplain forest as well as a diverse group of emergent aquatic plants (Priority 3).
- Beaver Run Woods - The riparian zone along Beaver Run contains both seasonally wet woods and vernal pond habitats (Priority 4).
- Route 309 Woods - The site consists of wet forested areas with a diverse herbaceous understory (Priority 4).

Section 6. Historic, Cultural, Scenic, and Recreational Resources

6.1 Introduction

The area of the Upper Tohickon watershed has many unique resources. These resources come as scenic vistas, pristine woodlands, bodies of water, open space, recreational areas, historic structures, villages, and cultural opportunities.

While many of the open spaces and significant environmental resources are listed in other portions of this report, this section focuses on the recreational and historical resources found in the watershed, and its immediate surrounding areas which have a direct link to the Tohickon Watershed area and its inhabitants. Cultural and historic resources are essential in understanding an area's past settlement patterns and heritage. When protected and preserved, they can also make a significant contribution to the character of a community. Recreational resources provide a community, its residents, and visitors, with active and passive opportunities to improve their overall quality of life. The historic, cultural and recreational resources of the Upper Tohickon watershed are exceptional in their number and quality and provide for a unique experience.

6.2 Historic Overview

The Tohickon Creek is the second largest stream in the county, next to the Neshaminy Creek. For many years it has been noted for its large mill dams and imported grist mills. Most of Bucks County, including the Upper Tohickon watershed was originally inhabited by the Lenni Lenape Indians, as long ago as 3000 BC. Tohickon is an Indian place name, changed only slightly from the Indian word "To-hick-han" or "To-hick-hanne". Heckewelder interprets this word to mean 'stream over which we pass by means of a bridge of drift wood,' but more recent students of the Indian tongue take exception to this definition and say it means 'Deer Bone Creek'. The Lenape lived amicably with European settlers until the mid-1700s. Welsh and English Quakers are believed to be the first white, English-speaking settlers to the area. However, German-speaking immigrants arrived in the early 1720's and the population grew quickly. Groups of Irish settlers were also known to have moved here about the same time. The new settlers built homesteads and cultivated crops and livestock. The manufacturing of pottery from the abundant red clay was the first major industry of the area. Mills also were abundant in the area due the number of bodies of water. Trade businesses grew in the local villages and by the 1800's, Township boundaries had formed. Sites sacred to these cultures are located in the watershed. Settled villages and hamlets date from the 1700s. Place names reflect these early settlers. The watershed boasts many historic buildings and districts on the National Register.

6.3 Cultural and Historic Areas, Villages and Structures

There are still over one hundred identifiable villages remaining in Bucks County, but many have been lost or overshadowed by growth and development. Historic structures found both within and outside of the historic villages give a glimpse of the period architecture as well as lifestyles of the past residents of the area. These historic commodities are a unique resource, and once they are lost, are irreplaceable. The following is a summary of each municipality's formation, development, and historic villages and structures. The information has been collected from municipal comprehensive plans, open space plans, recreation plans, and municipal web sites.

- **Bedminster Township** – The area was organized in 1742 and named after the town of

Bedminster near Bristol, England. The first settlers were Irish, although most of the original settlers soon left the area. Mennonites were the next group of settlers in the early 19th century. The area was, and still remains, largely agricultural. However, villages were critical to providing the specialty services of the community. Bedminster contains four villages, one of which is located within the Upper Tohickon Watershed. In addition, there are many historical structures located throughout the Township, most of which are not located within the limits of the Upper Tohickon Creek Watershed.

1. Keelersville Village. Also divided by the Township line with East Rockhill, Keelersville is located in the northwest corner of the Township near Lake Nockamixon. It was a residential community with a riding stable and club as commercial uses. The village was named after the Keeler family. The original section of Keelersville is along Old Bethlehem Road north of Ridge Road. During the start of the 20th century, Keelersville consisted of a store, hotel, shops, a large tannery, and a leather factory. The Tohickon Union Church was originally built of log in 1745 on the East Rockhill Township side of Old Bethlehem Road. In 1837 the church was rebuilt in Bedminster Township where it remains the primary landmark of the village. Two historic one-room schoolhouses are also found in the village.

- **East Rockhill Township** – During the early days of the county’s history, William Penn had reserved the lands of East Rockhill and neighboring West Rockhill Township for the future home of indentured servants. In fact, the area was also known as “Servants.” Named after its rocky and uneven landscape, Rockhill Township initially encompassed both East and West Rockhill Townships. It was established as a result of a petition by Richland Township residents who argued that roads in the unincorporated territory to the southeast were inadequately maintained and in poor condition. Rockhill Township was created by court order in 1740, and a road supervisor and constable were appointed soon after. In 1870, Rockhill Township was the largest Township in Bucks County with a land area of 19,168 acres and population of 3,369. During this time, Sellersville, Perkasio, and Telford were also included within the boundaries of Rockhill Township. Early industries included sgraffito pottery, brickyards, hand-made cigars and cigar boxes, and gunsmiths. Rockhill Township was officially divided into East and West Rockhill Townships on December 24, 1890.

Sheard’s Mill Covered Bridge, built in 1873, spans the Tohickon Creek. Located along Covered Bridge Road through East Rockhill and Haycock Townships, the bridge is 130 feet long and 15 feet wide.



Tohickon Creek at the Sheards Mill Covered Bridge

Built in 1846, the Hager House, on Old Bethlehem Road serves as a classic example of an early Bucks County farmhouse. Another significant historic resource in the Township is the Sheard's–Clymer's Grist Mill. The mill used water power to grind grain into meal for either local farmers or for general public sale. While it is not certain when the mill was built, the earliest deeds date back to 1798. The mill ceased operation in 1971; however, apple cider was sold there until 1985. In 2004, the Heritage Conservancy applied for listing on the national historic register for Sheard's–Clymer's Gristmill.

East Rockhill encompasses four villages: Hagersville, Keelersville, Rockhill Station and Rich Hill; of which only three are located within the Upper Tohickon Creek Watershed.

1. Keelersville Village. Named after the Keeler family, the village is located in both East Rockhill and Bedminster Townships. (*see Bedminster Township for description*)
2. Rockhill Station. Rockhill Station takes its name from the mountainous ridge that extends across the northwestern parts of East and West Rockhill Townships. Rockhill Station is the only village in the Township not located at a road intersection, and it is the only one that is not partially located in another municipality. Rockhill Station boasts the only confirmed discovery of gold in Bucks County. The original homes in Rockhill Station were wood-frame and masonry structures. Although none of the buildings are architecturally significant, together they offer consistency and scale that gives the village a uniform character. The woods, quarry, and railroad tracks surrounding these homes form distinct boundaries.
3. Rich Hill Village. Rich Hill is located on the border of East Rockhill, West Rockhill and Richland Townships. Rich Hill was developed along Old Bethlehem Pike and was bypassed when PA Route 309 was built. The village has remained a small, residential community consisting of a few houses at the crossroad of Rich Hill Road and Old Bethlehem Pike. The stone houses found at the intersection are quite large and have been well maintained over the years. Large shade trees enhance the setting of the picturesque village.

- **Haycock Township.** The Township was founded in 1762 after the boundaries of many of the surrounding villages and Townships were already formed. Haycock Township has two villages, Applebachsville and Strawtown, and a hamlet of Thatcher. The first settlers to the area were Irish and German and arrived in the 1740's. Farming was difficult due to the rough and rocky terrain. Lumbering and pottery were



Church in Village of Applebachsville

among the first industries in the area. The Township name is taken from Haycock Mountain which resembles a series of hay cocks (hay raked into piles prior to being loaded on wagons).

- **Milford Township** – It is believed the name Milford arose from the large number of mills and fords located on the several streams of the Township. The area's first settlers, aside from the Indian tribes, were Mennonites who came here around 1712 or earlier from Germany. The Township is comprised of seven villages: Brick Tavern, Finland, Geryville, Milford Square, Mumbauersville, Spinnerstown and Steinburg. None of these villages are within the Upper Tohickon Creek Watershed.
- There are a number of significantly historic structures in Milford Township that are still in existence today, most of which are not located within the limits of the Upper Tohickon Creek Watershed.
- **Nockamixon Township.** The name Nockamixon is of Indian origin, meaning "place of soft soil." The area of what is currently Nockamixon Township was originally settled by the English in the 1700's but the later settlers were primarily German. The Township was formed in 1742 and included the area of Bridgeton. Bridgeton became its own separate municipality in 1890.

Nockamixon has three primary villages. Ferndale, Kintnersville and Bucksville; none of which are located within the Upper Tohickon Creek Watershed.

- **Perkasie Borough.** The Manor of Perkasie was one of several in Bucks County and contained 11,462 acres. It was laid out and surveyed in 1708. This survey embraced most of the current Hilltown and Rockhill Townships. The North Pennsylvania Railroad Company made a survey and built their railroad over and across this tract of land. In 1853 the railroad only extended from Philadelphia to Fort Washington. It was then decided to extend the line to Bethlehem, and they began building the tracks on both ends concurrently. Because of so many Irish immigrants working on the railroad, Rev. F.X. George of the Haycock Catholic Church started a Mission at Sellersville. In 1856, only a single track was finished north to the tunnel and from the tunnel north to Bethlehem. It wasn't until 1858 that trains could travel from Philadelphia through to Bethlehem. Then at last, the village was accorded railroad station facilities, it was christened "Perkasie" after an old historic name, Perkasie Manor, a tract of land owned by John Penn, from which also the Mennonite Meeting House near Blooming Glen derived its name.

In 1871, proper roads were also opened to the neighboring towns and the Perkasie and Bridgetown Turnpike was laid out. From then on, Perkasie improved gradually until it was incorporated as Borough in 1879, when its real progress began. Merchants, dealers, and farmers, within 15 miles eastward, made it a trade center, and year-after-year, the railroad business increased, until the business transacted at Perkasie was the third largest of the stations along the North Penn rail line. In 1892 the first of many cigar factories was opened in Perkasie. Perkasie began the 20th century by gaining telephones, a police department, an organized fire company, a water and sewer company, electric light plant, most of the row houses in town, two schools, the rise of the cigar industry and much more.

Many of the historic buildings and structures of Perkasio still remain. However none of these resources are located within the Upper Tohickon Creek Watershed.

- **Quakertown Borough.** Welsh and English Quakers were the first to settle in the area. German immigrants settled around the Quakers and referred to the English-speaking area as “Quaker Town”. A bilingual school was formed, the Richland Library was started in 1785, and the “Quaker Town” Post Office was created in 1803. The North Pennsylvania Railroad was completed in 1855; the same year that Quakertown Borough was established within the limits of Richland Township.

Historical structures within the Borough, listed on the National Register of Historic Places, include: Liberty Hall, the Quakertown Passenger and Freight Station, and the Enoch Roberts House. The Borough has a number of other historically significant places and structures which have not been listed at present date, such as the Center for the Arts on Main, and the Friends Meeting House.

- **Richland Township.** In late 1703, English surveyors laid out a tract of 10,000 acres to be called the Manor of Richland. In 1735 the Manor was resurveyed. The area was settled by the Germans who cultivated the area. Because of high surface water, the area was referred to as the “Great Swamp”. In 1723, the first Friends Meeting House was built. In 1734, Richland was incorporated as a Township and the first post office was established in 1803. The population of the Township was growing, primarily in the village of Quakertown, which separated from Richland in 1854 and incorporated as a Borough.

Some of the earliest sites and structures in Richland Township still exist today, although none of these places are listed locally or nationally. The Shelly One Room Schoolhouse located on Richlandtown Pike is home to the Richland Historical Society.

- **Richlandtown Borough.** Considered a Village of Richland Township, Richlandtown Borough incorporated in 1890. It is approximately 0.3 square miles in size. The first frame house was built here in 1804, and the community soon grew to around 60 homes. Today there are over 400 homes in the Borough, with a population of about 1,300 residents.
- **Springfield Township.** The first visitors to the area were the English and Scotch-Irish. They were soon joined by the Germans who settled throughout the area. In 1743 the area residents petitioned for and obtained incorporation. The Township was and remains primarily agricultural. Villages developed throughout the Township; however, none of these are located within the Upper Tohickon Creek Watershed.

The Township has a number of significant historic resources most of which are not located within the limits of the Upper Tohickon Creek Watershed.

- **Trumbauersville Borough.** Originally a village within Milford Township, the Borough incorporated itself in 1908. There are a number of historically significant structures in the Borough, although none have been added to the National Register of Historic Places.
- **West Rockhill Township** – German speaking immigrants were the first settlers to the

area. Due to the large number of bodies of water found in West Rockhill Township, agricultural and mills played a large party in the historic development of the area. West Rockhill has a number of small villages with historic backgrounds including, Derstine, Almont, Rich Hill, Ridge Valley, and Naceville.

Although not registered, there are a number of historically significant mills located throughout the Township; most of which are not located within the limits of the Upper Tohickon Creek Watershed.

6.4 Scenic, Natural and Recreational Resources

The plentiful scenic, natural, and recreational resources found in the Upper Tohickon watershed, and its immediate surrounding areas, which have a direct link to the Tohickon Watershed area and its inhabitants, provide both active and passive recreation as well as educational opportunities. State and county owned parks provide large scale recreational facilities, amazing views and vistas and vast open spaces. Municipal resources are found in municipal parks, permanently preserved open spaces, natural resource protected areas, ball fields and walking trails. Privately owned recreation includes golf courses, hunting and fishing areas, campgrounds, and swimming facilities. Regionally significant natural features, such as the Quakertown Swamp, encompass public and private entities but provide scenic, natural, and recreational resources for all.

From the examination of state and county web sites, municipal open space plans and recreation plans, an inventory of open spaces in the Upper Tohickon watershed has been compiled. Although not every open space can be accounted for, the following list is a comprehensive list detailing the types of scenic, natural, and recreational resources of the watershed.

State Areas

- Nockamixon State Park is the largest active and passive recreation area in the watershed. Located just off Route 563, the park is approximately 5,280 acres in size and surrounds the beautiful Lake Nockamixon. Recreational activities include boating (the park is equipped with four public launch areas and a marina), fishing, hunting, bicycling (2.8 mile trail), equestrian riding (over 20 miles of trail provided), swimming (outdoor pool complex) and picnicking. In the winter, recreational activities include ice skating, ice fishing, cross-country skiing, and sledding. Cabins and a youth hostel are available for lodging.
- State Game Land 157 is located adjacent to Nockamixon State Park. Hunting, hiking, and the rifle range are the most popular recreational activities to take place on the Game Land's 2,010 acres.
- State Game Land 139 is located in Richland and East Rockhill Townships and has approximately 130 acres. The lands are used primarily for hunting and bird watching..

County Areas

- Lake Towhee County Park. The 549 acre park, operated by Bucks County, is located in Haycock Township. The park has facilities for numerous activities including: picnicking,

hiking, horseback riding, fishing, boating, camping, ice skating. There are also ball fields, nature areas, and playgrounds.

Municipal Areas

- **Bedminster Township.** The two major recreational facilities in the Township include Nockamixon State Park and the County-owned Stover-Myers Mill. Outside the open space and recreational areas provided by developers within residential subdivisions, the Township does not provide additional recreational facilities.
- **East Rockhill Township.** The Township owns and operates two primary recreation areas for residents to enjoy – Willard H. Markey Centennial Park and the Mervin C. Bryan Walking Path and Athletic Fields. The park contains a pavilion with picnic tables, a driving range, a sand volleyball court and basketball courts. The walking path is not located within the Upper Tohickon Creek Watershed.

The Township has also acquired a tract of land on Three Mile Run Road near the intersection of Schoolhouse Road for passive open space as part of its park system. It consists of approximately 87 acres of woodland. In addition, the Township is in the process of establishing a Municipal Golf Course, near the intersection of Route 536 and Route 313, the first of its kind in the area.

- **Haycock Township.** The Township contains acreage of Nockamixon State Park, PA State Gameland, and Lake Towhee County Park. However, no additional recreational facilities are provided by the Township. It should be noted that additional open spaces are owned by the Heritage Conservancy and the school district.
- **Milford Township.** The Township owns and maintains a variety of recreational parks. However, none of these are located within the Upper Tohickon Creek Watershed.
- **Perkasie Borough.** The Borough Parks and Recreation Department oversees the many park facilities throughout the Borough. However, none of these facilities are located within the Upper Tohickon Creek Watershed.
- **Quakertown Borough.** Memorial Park, located in both Richland Township and Quakertown Borough (although operated and maintained by the Borough), is approximately 109 acres and consists of softball, soccer, football, and baseball fields, basketball and tennis courts, as well as a swimming pool complex. A large playground area and pavilion area is also located in the park. The Borough also maintains a number of other smaller recreational areas (Main Street and Cedar Grove Parks) which includes a skate park, basketball courts, and other ball fields. School facilities within the Borough also provide additional recreational opportunities for Borough residents.
- **Richland Township.** The Township Park, located adjacent to the Municipal Building on California Road is approximately 32 acres in size. Facilities at the park include a nature trail with interpretive signage, tennis courts, basketball courts, baseball/softball field, multi-purpose fields, a pavilion with grill, picnic area, and a playground.

In the last five years, the Township has obtained six hundred and seventy (670) acres of

open space through acquisition, for a total of nine hundred and sixty (960) acres, as a part of the Buck's County Open Space Program and thorough developer dedication as a portion of the land development process. Although the Township currently has only one park, a number of park and recreational areas are planned for development within residential neighborhoods. Passive recreation is also planned for a number of preserved open space parcels and environmentally sensitive areas. The Township is also in the process of developing a 24.8 acre municipal park; which is proposed to contain 6 softball fields, 2 multi-use fields, a tot-lot, a pavilion area, parking areas and walking trails.

- **Richlandtown Borough** is home to the 11 acres that is occupied by Benner Memorial Hall. Other recreational opportunities in the Borough are provided privately.
- **Springfield Township.** Using monies from the Bucks County Open Space Program in 2002, Springfield Township was able to acquire a 45.3 acre parcel to be developed as a park. The remaining recreational opportunities are private.
- **Trumbauersville Borough.** The Borough has one municipally owned, public park, adjacent to Christ Reformed Church. The park is approximately 4.4 acres in size, and contains playground equipment, a basketball court, softball field, and a walking path. A 2.38 acre parcel was dedicated to the Borough as a portion of a subdivision. Other open space can be found on church sites, cemeteries, schools, and privately-owned lands.

West Rockhill Township. Open spaces in West Rockhill includes conservation easements, churches and cemeteries, open space and recreational areas within residential developments, schools, utilities, and a number of private facilities.

Other Open Spaces and Recreational Areas

- Little Red Barn Campgrounds contain approximately 20 acres of open space in Haycock Township for camping and other related activities
- Tohickon Family Campgrounds, located in Haycock Township, utilizes approximately 64 acres of land for use as a campground. It has over 200 individual camp sites and provides water, electric, and selected sewer. A store, laundromat, and shower/bathroom facility are also located at the campgrounds.
- Camp Tohikane is a 235-acre camp owned and operated by the Girl Scouts of America. It is located in both Haycock and East Rockhill Townships. A number of historic buildings and structures are located on the grounds. The Girl Scouts offer a variety of programs at the camp site but have an emphasis on horseback riding. Other recreation activities include swimming (outdoor pool), orienteering, miniature golf, pottery, hiking, maple sugaring, and field sports. Lodging takes place in historic buildings or cabins.
- Paletown Rod and Gun Club is located on 16.5 acres in Richland Township. The facility is equipped to handle black powder, pistol, rifle, and skeet shooting.
- Branch Valley Fish and Game in East Rockhill Township contains approximately 29 acres dedicated to swimming, fishing, ice skating, and trap shooting.

- The Upper Bucks YMCA is a not-for-profit organization established in 1968 to serve the local communities within the service area, encompassing the Pennridge, Palisades and Quakertown school districts. They provide a wide variety of programs and services offered at one of the three YMCA buildings as well as various other locations throughout the region. Support for the Upper Bucks YMCA comes from membership fees, program fees, and private and corporate donations and from the Bucks County United Way.

The facilities and programs offered are numerous and diverse and include the following: swimming, child care, racquetball, fitness and weight training, tennis, aerobics, gymnastics, basketball, babysitting services, family programming, locker rooms, showers, summer camp, and nursery school.

- North Penn Gun Club is located off Tollgate Road in Milford Township. The facility has a shooting range for pistols and rifles. It is also home to the Quakertown Slow Pitch Softball League and the Oaklane Quarter Midget Racing Club. The speedway used by the Racing Club was constructed in the late 1950's and is actually a portion of the Gun Club site.
- Quakertown Swamp. Located in Richland, East Rockhill and West Rockhill Townships, the Quakertown Swamp is a 518-acre wetland which is recognized as significant by the Pennsylvania Natural Diversity Inventory because it is a haven for a variety of wildlife species, including beaver and waterfowl. Quakertown swamp has been listed as a first priority site in the Bucks County Natural Areas Inventory (NAI) and is listed by the U.S. Fish and Wildlife Service as an all important wetland area. Heritage Conservancy was instrumental in securing cooperation from the United States Environmental Protection Agency for designation of the Quakertown Swamp through an Advanced Identification Program. Only seven other wetlands in the Mid-Atlantic region possess this status. More than 74 bird species nest in the swamp. In addition, the Pennsylvania Breeding Bird Census confirmed in the late 1980's the occurrence of Sora rail and marsh wren, two Pennsylvania Species of Special Concern.

Section 7. Watershed Assessment and Creek Corridor Inventory

7.1 Introduction

Although a broad array of existing data was available for the Upper Tohickon watershed (e.g., GIS data layers, PADEP stream assessments, USGS water quality data), the Project Advisory Committee determined that data was lacking on the condition of the stream channels and stream corridors throughout the watershed. Such data was needed for a number of reasons. First, the data collected on the channels and corridors could cross-validate the other water quality and stream assessments conducted by other groups. Second, these field surveys could provide insights into the likely causes of impaired streams and thus prioritized solutions for correcting these causes of impairments. Third, such data would represent actual observations of the streams rather than less tangible numbers collected by another group or even by automated sampling devices. Finally, the process of training and collecting this data would provide a unique opportunity for the residents and stakeholders from within the watershed to interact with each other and with the primary focus of this Rivers Conservation Plan, the Upper Tohickon Creek and its tributaries.

7.2 Assessment Protocol

To achieve these objectives, a Stream Visual Assessment methodology was developed by the Project Advisory Committee that would meet the data needs for this Upper Tohickon study. The protocol was based on a subset of the USDA Natural Resource Conservation Service's (NRCS) assessment protocols that best matched the needs and intensity of this volunteer-based program (USDA 1998). Five components were selected for inclusion in the Upper Tohickon Stream Visual Assessment:

1. Channel Condition
2. Hydrologic Alteration
3. Riparian zone Condition
4. Bank Stability
5. Canopy Cover

These five components were then synthesized into a single Stream Visual Assessment packet that could be used by each volunteer in assessing the conditions of the watershed's streams (see Appendix IV). The packets included both the final ratings tables for the streams as well as broad descriptions of the assessment components to ensure comparability among volunteer groups, photographs to guide volunteers in matching their observations to the characteristics being evaluated, and both road and GIS maps to guide volunteers in assessing their stream segment.

Scores for each of the five components ranged from 1 to 10, with scores of 1 indicating extremely poor condition and scores of 10 indicating excellent or natural condition. An integrated site score could then be calculated as a simple average across the five assessment components. The following scale was provided to guide volunteers on the implications of their individual and collective scores for these visual assessments:

<u>Score</u>	<u>Assessment</u>
< 6.00	Poor
6.0 - 7.49	Fair
7.5 - 8.99	Good
≥ 9.00	Excellent

Each assessment packet was then targeted to a specific section of the Upper Tohickon watershed. The watershed area was circumscribed by a rectangular grid of 156 cells each measuring 1 mile by 1 mile. Of these 156 grid cells, 79 cells fell within the watershed boundary and had at least one USGS blue-line stream within each of their boundaries. Each Stream Visual Assessment packet then target one of these 79 watershed grid cells, with a GIS-based map for that grid cell included in the packet. The map included a recent color aerial photograph layer, labeled roads within the grid, and then the locations of streams mapped on USGS 1:24,000 quadrangle maps. A boundary on this map indicated the extent of streams needing assessment in order to complete the visual assessment for that packet.

7.3 Volunteer Training

A single training session was held for project volunteers on March 27, 2004, at the Lake Towhee County Park in Haycock Township, Bucks County. The training extended for 2 hours and was attended by approximately 50 people from the surrounding communities. The training session was led by staff from Boucher & James, Inc. and Princeton Hydro, and combined an overview of the whole Upper Tohickon Creek Rivers Conservation Plan with detailed training on the Stream Visual Assessment protocol developed for this project. Volunteers selected a watershed packet and grid, and the assessment protocols



Volunteer Kathy Michener assessing an unnamed tributary to Nockamixon Lake

were reviewed in terms of the technical parameters being evaluated as well as the importance of each parameter for the overall assessment for the watershed. Following the training and the subsequent question and answer period, a small group of volunteers and trainers proceeded to Kimples Creek below the Lake Towhee dam to review the assessment methodology in the context of a specific stream segment. In addition, the technical staff from Princeton Hydro and Boucher & James, Inc. provided contact information and fielded additional questions throughout the following 9 months while volunteers continued to conduct the stream assessments.

7.4 Assessment Results

Of the 79 volunteer packets for the volunteer assessments, a total of 53 were returned and completed by the volunteers. This represents a return of 67% of the total packets needing

completion, a very high return rate for a volunteer monitoring program. In addition, because some grid cells overlapped sub-watershed boundaries (e.g., a grid cell covered part of both Dry Branch Creek and Kimples Creek watersheds), a total of 59 final assessments were conducted across the watershed. These 59 independent stream assessments were distributed among the sub-watersheds as follows:

<u>Sub-Watershed</u>	<u>Number of Stream Assessments</u>
Beaver Run	4
Morgan Cr	3
Dry Branch Cr	8
Tohickon Cr - middle	2
Tohickon Cr - headwaters	11
Haycock Cr	7
Threemile Run	9
Lake Nockamixon	9
Kimples Cr	6
Bog Run	1

The middle section of Tohickon Creek received only 2 completed assessments, and Bog Run received only a single quantitative assessment, too low a sample size for a quantitative assessment of the individual or collective assessment scores for these sub-watershed units. Morgan Creek likewise had a low number of completed assessments, but because the watershed was relatively small, the 3 completed assessments represented a 50% return rate for this sub-watershed. Consequently, the results from Morgan Creek are presented and discussed with the caveat that these results are somewhat preliminary because of the incomplete nature of the data. Finally, Bog Run was not assessed using the quantitative protocols because the volunteers responsible for these grids conducted the field work and determined that these standard stream measures were largely not applicable to the braided and ill-defined channels running through the Quakertown Swamp, which constitutes the majority of Bog Run's channel. As a result, a more qualitative narrative description was provided for this sub-watershed (see Appendix V, Appendix VI).

The data was analyzed by separating assessments according to watershed management units. In this way, if a single grid contained streams that drained to different watersheds, the assessments for those streams within that grid would be incorporated into their respective watershed units. The multiple assessment scores within a grid for each watershed unit were then averaged using a simple arithmetic mean. Because the typical conditions within a watershed unit were sought, a median (rather than an arithmetic mean) of these scores was then computed across all assessment grids within a watershed unit. The median is less influenced by extreme data points, and in this way the median provides a more accurate picture of the typical conditions. The final data is presented in Table 7.1.

The summary data in Table 7.1 shows that substantial differences exist in the channel and riparian condition of the watershed's streams, and the sub-watersheds group into 3 relatively distinct clusters based on the Average Site Assessment score. First, Beaver Run, Morgan Cr., and Dry Branch Cr. all have overall scores between 6.8 and 7.1 indicating only a "fair" condition based on the NRCS assessment protocols. The second group had slightly higher scores (range of 7.9 to 8.5) within the "good" conditions; these sites included Tohickon Cr. headwaters, Haycock Cr.,

Threemile Run, and Lake Nockamixon streams. Finally, only Kimples Cr. attained the status of “excellent” with an overall score substantially higher than the other sub-watershed.

Table 7.1 Median Grid Scores for Each Sub-Watershed of the Upper Tohickon Creek Watershed (scores range from 1 for poor condition to 10 for excellent condition).

Sub-Watershed Unit	Channel Condition	Hydrologic Alteration	Riparian Zone	Bank Stability	Canopy Cover	Median Site Assessment
Beaver Run	6.4	6.9	6.2	7.6	6.6	6.8
Morgan Cr.	7.5	7.0	6.5	6.5	5.0	6.9
Dry Branch Cr.	8.0	8.2	6.7	7.0	5.7	7.1
Tohickon Cr - headwaters	8.0	7.7	9.0	7.2	7.3	7.9
Haycock Cr.	9.0	9.0	8.5	8.0	8.1	8.2
Threemile Run	9.5	9.3	9.6	7.8	8.5	8.3
Lake Nockamixon	8.3	7.0	9.9	9.4	8.8	8.5
Kimples Cr.	9.5	9.5	9.8	9.3	10.0	9.5

These channel and stream corridor ratings compare well to the biological assessments conducted by the PADEP within the watershed. The lowest scoring streams in both data sets were Beaver Run, Morgan Cr., and Dry Branch Cr. and suggest that the poor ecological condition of these streams stems, at least in part, from the poor condition of the stream channel, the limited riparian zone, and the instability of the stream banks. The remainder of the sites were all assessed as “unimpaired” in at least some sections of the sub-watershed, and this matches the higher channel and stream corridor assessment scores for these sub-watersheds.

The one notable mis-match in the rankings is that the Stream Visual Assessments assigned Kimples Cr. the highest overall score and an “excellent” rating while the biological surveys on Kimples Cr. suggest that the invertebrate community is severely truncated below the Lake Towhee dam. This mis-match suggests that, although the stream channel and riparian corridor remain in an desirable state through much of the Kimples Cr. sub-watershed, the presence of Lake Towhee may cause the biological community to be relatively poor in quality when the habitat scores would suggest a more pristine



Accumulated soil and sediment within a Haycock Cr tributary

community should be present.

Each individual score among the five assessment components likewise reveals important patterns in the upper Tohickon Cr. watershed. Specifically, Threemile Run scores well in four of five categories, but receives a relatively low score for bank stability. This indicates that restoration and preservation work in this watershed would be achieved through stream bank stabilization measures, and that other preservation and restoration measures may not be as high a priority. A similar pattern is seen in the Haycock Cr. sub-catchment, with both lower bank stability and canopy cover scores that reflect the intensive clearing that has occurred in the northern areas of this sub-watershed (see Figure 1 aerial photograph). For this sub-watershed, both of these conditions should be addressed in order to maintain the relatively diverse biological community in this stream and to prevent any further degradation both water quality and ecological integrity.

For both Dry Branch Cr. and Morgan Cr., a similar lack of forested canopy results in poor ratings for these streams. In fact, the canopy cover in these two sub-watersheds received the lowest scores among all monitoring components, and this occurred even though the riparian corridor was not ranked quite as low. This suggests that some degree of natural riparian vegetation has re-colonized the stream corridor in this sub-watershed but that a true riparian forest with high levels of stream shading and leaf-litter inputs have not yet developed. A re-forestation effort within the riparian corridor would therefore be recommended as a priority activity for future management in these areas.

Finally, the volunteers' written narratives while conducting the visual assessments provide a deeper and more complete view of the unique features of the watershed (see Appendix V, Appendix VI). Two patterns emerge from these notes. First, many aspects of the watershed's streams remain in a relatively healthy condition in those areas where a forested canopy has either remained or has re-established itself. Thus, sections of the most sub-watersheds maintain an extensive, established native forest along the streams that contribute to their relatively good condition of these streams. For these areas, maintaining the riparian forest on both sides of the stream to a distance of between 50 and 300 feet will be an important component of ensuring high water quality and diverse, healthy ecological communities far into the future. Second, throughout nearly all sub-watersheds, numerous specific problem areas exist which together contribute to the "impaired" condition of a number of the watershed's streams, as well as to the "impaired" condition of Lake Nockamixon. Thus, the Stream Visual Assessment results indicate that there are priority areas for nearly all types of stream restoration and preservation in each sub-watershed. Bank instability plagues sections of the small Lake Nockamixon tributaries as much as it does areas of Dry Branch Creek. Poor riparian coverage is an issue for much of the Haycock Cr. and the Dry Branch Cr. sub-watersheds even though the former is assessed as "attaining" while the latter is assessed as "impaired". The impaired condition of Lake Nockamixon thus results from a broad array of water quality and habitat degradation from nearly all areas in the watershed, and improvements to the upper Tohickon Cr. watershed and thus to Lake Nockamixon will be attained only through an integrated program to address the causes of degradation in all areas of the broader watershed.

Section 8. The Conservation Management Plan

8.1 Introduction

The final objective for the Upper Tohickon Creek Rivers Conservation Plan was to identify the opportunities to affect positive change for both the aquatic resources of the watershed and the human communities living within this watershed. Clearly, there are many challenges to protecting and restoring the conditions within the Upper Tohickon Creek basin, and substantive improvements will require concentrated efforts along many fronts over long periods of time. The diverse perspectives among the citizens, municipal representatives, and Plan Advisory Committee members were invaluable in synthesizing the needs for the watershed and then identifying both the broader goals to be addressed as well as the specific objectives needing attention in order to fulfill the broader goals.

The interactive process of setting long-term needs for the watershed and then identifying possible activities to address those needs resulted in 9 goals being identified and articulated below for addressing the current and future health of the Upper Tohickon Creek watershed. Within each goal, many specific objectives are listed to further specify the projects and activities needing work in order to meet these goals. This combined list of goals and objective will hopefully achieve its purpose: directing watershed management and community development within the Upper Tohickon Creek watershed through the foreseeable future.

8.2 Goals, Recommendations and Objectives for the Upper Tohickon Creek Watershed

Goal 1 - Coordinate the goals and outcomes of the Upper Tohickon Rivers Conservation Plan with those of the Lower Tohickon Creek Watershed Conservation Plan, the Delaware River Basin, and the Highlands Region.

- a) Create opportunities for communities within the Upper and Lower Tohickon Creek Watersheds to share information, resources, and data.
- b) Coordinate implementation of Upper Tohickon projects to avoid conflict with other regional projects so efforts are not counterproductive.
- c) Expand upon the Lower Tohickon Creek Watershed's Important Bird Area.
- d) Create a Watershed Association/Coalition.

Goal 2 - Protect and Improve Surface Water Quality to Improve Quality of Life for the Current and Future Inhabitants of the Watershed.

- a) Identify and map all intermittent and perennial headwater streams, particularly those not appearing on either USGS 15-minute quadrangles or Soils Conservation Service maps.
- b) Advocate for permanent monitoring stations to monitor critical water quality parameters during base flows and storm flows, including the addition of the Upper Tohickon Creek as a permanent hydrological and water quality monitoring station by the USGS.
- c) Identify and implement effective goose control measures throughout the watershed.
- d) Educate homeowners about fertilizer application. Advocate fertilizer application based on yearly soils tests (available through the Penn State Cooperative

- Extension in Bucks County; 215-345-3283), as well as the transition from phosphorus-based fertilizers to fertilizers with minimal or no phosphorus for residential lawn care.
- e) Advocate for the transition from nitrogen based nutrient management plans to phosphorus based nutrient management plans in the agricultural community.
 - f) Identify, quantify, and then reduce sediment and phosphorus loading in the watershed from both point-sources and non-point sources.
 - g) Advocate for conservation plans on all agricultural land provided by the Natural Resource Conservation Service.
 - h) Implement stream-bank restoration projects in areas with severe bank instability and erosion.
 - i) Reduce the impact from deer overpopulation on the health of both terrestrial and aquatic systems.
 - j) Engage in creative discussions with representatives of the Quakertown Wastewater Treatment Plant to reduce the loading of environmental pollutants through the beneficial re-use of treated wastewater and additional treatment mechanisms.
 - k) Identify existing on-lot sewage disposal systems, and quantify potential pollutant load from these systems.
 - l) Reduce nutrient loading to streams and lakes from on-lot sewage disposal systems, in part through an active maintenance plan to ensure functionality of these systems and/or upgrades to systems not meeting their current demands.
 - m) Identify high-quality streams with cold summer water temperatures and suitable public access to re-implement trout stocking within the watershed.
 - n) Expand trout stocking programs, as water quality improves for all streams, to include all suitable streams with public access.
 - o) Identify high-quality streams with suitable public access to re-implement warm water fish stocking within the watershed, and work to improve both the habitat for warm-water fish as well as the access to these fishery resources.

Goal 3 – Environmental Protection

- a) Encourage municipalities to enforce existing regulations and/or establish new regulations for natural resources that maintain and enhance biodiversity and support water quality objectives; to include the following resources:
 - i) Floodplains
 - ii) Steep Slopes
 - iii) Natural Areas Inventory Areas
 - iv) Groundwater Supply and Recharge Areas
 - (1) Research and map critical recharge areas within the watershed.
 - (2) In critical recharge zones, limit development of impervious surfaces, and require no net change in infiltration for any development activity.
 - (3) Identify well-head protection zones and implement well-head protection Ordinances in each Township.
 - v) Wetlands
 - vi) Forests
 - vii) Hydric Soils
 - viii) Ponds, Lakes and Streams

- ix) Riparian Buffers
 - x) Agricultural Soils
 - xi) Link Corridors and Greenways for Animal Transit
 - xii) Native Plant Species
 - xiii) Endangered Plant Species
- b) Protect and Restore Riparian Buffers
- i) Encourage residents and municipalities to re-vegetate the riparian corridors around all streams, focusing on re-forestation in all possible settings with native flora.
 - ii) Implement riparian buffers off all surface waters and wetlands in municipal Ordinances.
 - iii) Construct detailed maps of riparian buffer widths on all mapped streams.
 - iv) Develop funding and distribution system for native trees to be used by residents, non-profit organizations, and municipalities in riparian re-vegetation.
- c) Encourage municipalities to develop regulations to limit adverse impacts to the Quakertown Swamp and the entire Bog Run watershed.
- d) Encourage and promote preservation/conservation easements on privately owned lands.
- e) Encourage and support legislation to foster preservation/conservation.
- f) Consider the use of “purchase of development rights”(PDR’s) and other methods of funding to preserve riparian areas.
- g) Encourage/advocate the use and protection of native species of plants.
- h) Develop working relationship with Park Services and Game Commission to enforce natural resource protection standards.

Goal 4 – Effectively Manage Stormwater to Protect Natural Resources and Properties

- a) Aggressively pursue structural and non-structural BMP’s within the watershed to encourage infiltration and improve water quality.
- b) Include recharge as a critical component for any new development.
- c) Retrofit existing stormwater infrastructure to reduce pollutant loading, increase infiltration, and more closely simulate natural flow regimes.
- d) Identify and minimize areas of combined sewer systems, and aggressively pursue work to eliminate infiltration and inflow (I and I) to the infrastructure serving the wastewater treatment plant.
- e) Develop and implement model stormwater Ordinances within each municipality to better manage these water resources.
- f) Identify areas within the watershed where innovative paving options could be utilized to facilitate infiltration.
- g) Implement innovative stormwater management on municipal and school-district lands to demonstrate the design and function of cutting-edge stormwater management.
- h) Develop and implement stormwater design and maintenance guidelines for developed and developing properties.
- i) Implement cooperative stormwater maintenance capabilities and regularly service existing stormwater facilities within both the public and private domain.

Goal 5 - Protect Cultural Resources to Enhance the Link Between the Present and the Past

- a) Create an inventory of Natural, Cultural, Historic, Scenic and Recreational Resources within the watershed and develop preservation programs.
 - i) Historic Bridges
 - ii) Scenic Viewsheds
 - iii) Public Parks
 - iv) Historic Villages
 - v) Historic Buildings
 - vi) Native American Sites and Artifacts
- b) Purchase and restore Historic Buildings that have fallen into dis-repair.
- c) Establish a system/network to reuse, reclaim and preserve: lumber, windows and materials from historic structures that are not able to be preserved or restored.
- d) Encourage and promote open space acquisition for farmland protection, natural resource protection and to preserve the rural character of the area.

Goal 6 – Provide Educational Awareness and Recreational Opportunities to Improve the General Health, Welfare, and Quality of Life of the Community.

- a) Provide increased access to waterways in desirable locations.
 - i) Develop hiking trails and interpretive paths along the streams of the watershed.
- b) Continue efforts to obtain open-space acquisitions and/or easements throughout the watershed, particularly along streams, lakes, and wetlands.
- c) Integrate educational awareness of local watershed issues.
- d) Include watershed information and education materials on municipal, park, business, and non-profit organizations' web sites.
- e) Develop contingent of volunteer monitors for the watershed, and implement a volunteer monitoring program.
- f) Work closely with the State and County parks on environmental education activities, including specific programs about the Upper Tohickon Watershed.
- g) Distribute information to residents, businesses, and organizations about the importance of riparian buffers, stable stream-banks, and headwater streams for the quality of streams and lakes in the watershed.
- h) Expand educational efforts (public meetings, mailings, workshops, programs) with particular focus on private land owners next to the creeks and tributaries.
- i) Include regular cycles of educational programs for decision-makers within municipal and county governments.
- j) Install signs at road crossings of the watershed's streams to identify both the stream being crossed and the fact that this stream lies within the Upper Tohickon Watershed.
- k) Initiate an educational program that links land use and water quality and quantity impacts.
- l) Circulate and communicate the information contained in this study.
- m) Demonstrate innovative stormwater management on municipal and school-district lands to demonstrate the design and function of cutting-edge stormwater management.

- n) Establish a volunteer network for trail maintenance and litter removal in the parks.

Goal 7 – Explore impacts of flooding and minimize human-induced flooding hazards throughout the watershed

- a) Identify anthropogenic (man-made) constriction point along stream courses that could exacerbate flooding issues within the watershed.
- b) Study the geomorphology of the stream channels in areas with problematic flooding to determine the location and extent of the pre-colonial streambed, especially near Thatcher Road, and implement the recommended restorations of these stream channels to handle the volumes of runoff generated by large storms.
- c) Retrofit or replace bridges, culverts, roads, and other infrastructure to effectively pass the 100-year storm, where possible, and maximize the use of pedestrian circulations systems during these infrastructure projects.
- d) Re-map 100-year floodplains for the entire watershed based on updated precipitation estimates for extreme events from the National Weather Service.
- e) Incorporate properties subject to natural flooding into open-space acquisition efforts.
- f) Work with Federal, State, County, and Municipal governments to implement a balanced approach to stream clearing that minimizes features that cause unnecessary flooding while maintaining the diversity of habitats and structures within the stream channel.
- g) Re-locate structures adversely impacted by floods outside the 100-year floodplain, where feasible.
- h) Re-connect the stream channels to their floodplains in areas where human structures will not be affected.
- i) Encourage the study of the historical, economical, and environmental significance of existing dams and the development of management plans for dams.

Goal 8 - Minimize the negative impacts while maximizing the positive impacts of land uses on watershed resources

- a) Study/Promote links between specific land uses and their effects on water quality and quantity, to include the following uses:
 - i) Agricultural
 - (1) Encourage the use of BMPs on farms.
 - (2) Encourage organic farming and livestock management practices.
 - (3) Encourage the location of livestock areas to be away from streams and wellhead protection areas.
 - (4) Encourage education on proper vaccination/medication for livestock.
 - ii) Industrial, Commercial, Institutional
 - (1) Monitor point source discharges.
 - (2) Monitor implementation of NPDES regulations.
 - (3) Encourage proper disposal of hazardous waste.
 - (4) Encourage business operations to use new technologies for environmental remediation.

- (5) Encourage the use of environmentally responsible alternatives to industrial products.
- (6) Encourage low impact developments.
- (7) Promote the use of rain gardens.
- (8) Advocate the use of environmentally sensitive lawn care services.
- iii) Residential - Encourage residents to implement home maintenance practices to protect the watershed, including (but not limited to):
 - (1) Limit lawn areas and maintain proper mowing heights.
 - (2) Use of rain barrels.
 - (3) Proper disposal of hazardous wastes.
 - (4) Use of slow-release organic fertilizers.
 - (5) Regular septic system maintenance.
 - (6) Encourage organic gardening practices.
 - (7) Encourage the use of environmentally responsible alternatives to household cleaning products.
 - (8) Promote the use of rain gardens.
- iv) Recreational - Encourage recreational users to “leave no trace” of their activities in the outdoors.
 - (1) Provide trash and recycling receptacles at all parks trails and access ways.
 - (2) Establish systems to enable reporting of abuses to natural areas.
- v) Government and Community Services - Encourage municipalities to set an example for the community by managing their own properties to illustrate the goals of this plan.

Goal 9 – Encourage commitment of resources from the public and private sectors to implement the goals of this plan

- a) Identify potential contributors and seek commitments in terms of:
 - i) Financing
 - ii) Materials
 - iii) Labor
 - iv) Administrative Support
 - v) Other Resources
- b) Explore future public funding sources through Local, County, State and Federal Grant Programs as well as non-governmental agencies.
- c) Explore the use of Municipal Bonds for improved access and recreational opportunities.
- d) Encourage/Promote/Facilitate groups/organizations/coalitions/partnerships of stakeholders to champion the goals and objectives of this plan.
 - i) Encourage behavioral changes through the establishment of annual awards for implementation of the goals of this plan within the watershed such as:
 - (1) Grants
 - (2) Scholarships
 - (3) Fellowships
 - (4) Plaques
 - (5) Certificates

- ii) Establish a foundation that creates funding sources.
- iii) Coordinate efforts for protection and improvement of the water resources.
- iv) Provide guidance and coordination on complex issues that cross municipal boundary lines.
- e) Encourage municipalities and non-profits to provide dedicated funding for watershed issues.
- f) Develop partnerships in watershed planning and protection among citizens, local, and regional businesses, and governmental institutions.
- g) Empower citizens to make positive contributions to watershed protection, preservation, and restoration within and outside the organizational structures in the community.
- h) Encourage completion of fieldwork for grids that have not yet been completed.

Section 9. References Cited, Contacts & Electronic Resources**References Cited**

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Pennsylvania State Data Center. [available at www.pasdc.hbg.psu.edu]

Princeton Hydro LLC. 2002. The Lower Tohickon Creek Watershed Conservation Plan. Final report submitted to Tincum Conservancy and the Pennsylvania Department of Conservation and Natural Resources. 146 pp. [available on the Rivers Registry at www.dcnr.state.pa.us/brc/rivers/riversconservation/registry]

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Tetra Tech, Inc. 2003. Total Maximum Daily Load of Nutrients for Lake Nockamixon in Buck County, Pennsylvania. Final report to the U.S. Environmental Protection Agency. 91 pp [available at www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/tmdl/LakeNockamixon_TMDL.pdf]

USDA - NRCS. 1998. Stream Visual Assessment Protocol. National Water and Climate Center Technical Note 99-1. 42 pp. [available at www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf]

Bucks County Planning Commission. 1999. Bucks County Natural Resources Plan

Pennridge Area Coordinating Committee. 2000. Pennridge Area Greenway Plan

Contacts & Electronic Resources

Internet-Based
Environmental Mapping Pennsylvania Department of Environmental Protection's "eMapPA"
www.emappa.dep.state.pa.us/emappa/viewer.htm

Soil Testing Penn State Cooperative Extension, Bucks County Office (215-345-3283)
www.extension.psu.edu; www.aasl.psu.edu/SSFT.HTM

Section 10. Appendices and Figures

Appendix I. Zoning Maps

Appendix II. Top 50 Employers List

Appendix III. Press Releases and News Articles

Appendix IV. Stream Visual Assessment Packet

Upper Tohickon Creek Watershed Conservation Plan Stream Visual Assessment

Thank you for helping to assess the aquatic resources of the Upper Tohickon Creek Watershed. This volunteer-based study is primarily a visual assessment of the overall condition of the watershed and encompasses the Tohickon Creek upstream of the Lake Nockamixon Dam, and all associated streams, including Dry Branch, Kimples, Haycock, Morgan, Bog, and Three Mile Creeks and their mapped tributaries. Results of this assessment will be incorporated into the Pennsylvania Dept. of Conservation and Natural Resources (DCNR) Funded Upper Tohickon Creek Watershed Conservation Plan. The end product will be a planning tool for local municipalities to assess areas within the watershed in need of restoration or preservation; areas where recreational opportunities may be enhanced, identify sources of water quality degradation, and to identify areas of concern for landowners and citizens within the watershed.

The goal of this volunteer packet is to create a user-friendly assessment that anyone can use. Don't let the terms intimidate you. If you don't understand something, just use your best judgment and note any comments in the "comments/suggestions" area provided.

What you will need to perform this assessment

- Waders are helpful as you may need to cross stream(s)
- Camera, if possible, to photograph areas of concern, aesthetic areas, historic places, mills, springhouses, etc. (photos will be used in final report)
- GPS unit, if possible (if not, write down adjacent landmarks)
- Partner, safety comes first! Don't enter fast moving water, cold water or water too deep to wade into. No data is worth injury or even worse.
- Pen or Pencil
- Clipboard

If you find hazardous material, illegal dumps, see a spill impacting surface water,
etc. call the DEP hotline:

1-610-832-6000.

Upper Tohickon Creek Watershed Conservation Plan Watershed Assessment Protocol

Volunteer: _____ **Date:** _____ **Time:** _____

Management Unit _____ **GPS Coordinates** _____

Stream Name _____ **Grid Number** _____

Applicable Reference (Notable Feature Within Vicinity of Assessment Area)

Assessment Scores (1-Poor – 10-Excellent, Refer to Assessment Guide Provided)

Channel Condition _____

Hydrologic Alteration _____

Riparian Zone: Left _____ **Right** _____

Bank Stability: Left _____ **Right** _____

Canopy Cover _____

Overall Score (Total Divided by Number Scored)		
_____	<6.0	Poor
	6.1-7.4	Fair
	7.5-8.9	Good
	>9.0	Excellent

Streamside Land Use:
 (Within 50 Ft. of top of Bank)
Check All That Apply

Land Use Category	Left Bank	Right Bank
Forest		
Field/Pasture		
Agriculture		
Residential (Multi-Family)		
Res. (Single Family Detached)		
Commercial		
Industrial		
Other		

Assessment Guide

Each Assessment element is rated with a value of 1 to 10. Rate only those elements appropriate to the stream. Using the Stream Visual Assessment Protocol Worksheet and the definitions at the end of this section, record the score that best fits field observations based upon the narrative descriptions provided. Descriptions are provided in intervals of three (3). You may record values intermediate to those listed. The length of assessment reach should be approximately 12 times the channel width.

Channel Condition

Natural Channel; no structures, dikes. No evidence of down cutting or excessive lateral cutting	Evidence of past channel alteration, but with significant recovery of channel and banks (Photo A)	Altered channel with less than 50% of reach with riprap or channelization (Photo B)	Channel is actively down cutting or widening. Greater than 50% of the reach with riprap or channelization
10	7	3	1

What to look for: Signs of channelization or straightening of the stream may include an unnaturally straight section of the stream, high banks, and dikes or berms. In newly channelized reaches, vegetation may be missing or appear very different (different species, not as well developed) from the bank vegetation of areas that were not channelized. Older channelized reaches have little or no vegetation or have grasses or woody vegetation. Drop structures (check dams), irrigation diversions, culverts, bridge abutments, and riprap also indicate changes to the stream channel.

Hydrologic Alteration

No dams, no water withdrawals, no dikes or other structures limiting the stream's access to the flood plain. Channel is not incised	Limited channel incision or withdrawals, although present, do not affect available habitat for biota	Channel deeply incised or withdrawals significantly affect available low flow habitat for biota	Channel deeply incised or structures (e.g. riprap) prevent access to flood plain or dam operations prevent flood flows (Photo C)
10	7	3	1

What to look for: Bankfull flows, as well as flooding, are important to maintaining channel shape and function and maintaining the physical habitat for animals and plants. High flows scour fine sediment to keep gravel areas clean for fish and other aquatic organisms. Evidence of flooding includes high water marks (such as water lines), sediment deposits, or stream debris. Look for these on the banks, on the bankside trees or rocks.

Riparian Zone

Natural vegetation (trees & shrubs) extends at least two channel widths from sides (Photo D)	Natural vegetation extends one channel width	Natural vegetation extends half of the channel width	Natural vegetation less than a third of channel width (Photo E)
10	7	3	1

Grasses or pasture do not constitute “natural vegetation”. A healthy riparian vegetation zone is one of the most important elements for a healthy stream ecosystem. The quality of the riparian zone increases with the width and complexity of the woody vegetation within it. Riparian zones reduce the amount of pollutants that reach the stream in surface runoff, help control erosion, provide cooler microclimates in summer for aquatic organisms, provide fish habitat, provide organic material for stream biota, dissipate energy during flood events, and provide movement corridors for terrestrial animals.

Bank Stability

Banks are stable, banks are low (at elevation of active flood plain), 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base flow elevation	Moderately stable, banks are low (at elevation of active flood plain), less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the base flow elevation (Photo F)	Moderately unstable, typically high banks, outside bend actively eroding, some mature trees falling into streams	Unstable, inside and outside bends eroding, many mature trees falling into streams, some straight reaches, numerous slope failures apparent (Photo G)
10	7	3	1

What to look for: This element is the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. Some bank erosion is normal in a healthy stream. Signs of erosion include unvegetated stretches, exposed tree roots, or scalloped edges. Evidence of construction, vehicular, or animal paths near banks or grazing areas leading directly to the water’s edge suggests conditions that may lead to the collapse of banks.

Canopy Cover (Do not assess if channel width is greater than 50 ft.)

Greater than 75% of water surface shaded and 2 to 3 miles upstream generally well shaded (Photo P)	Greater than 50% shaded in reach or greater than 75% but 2 to 3 miles upstream poorly shaded	20 to 50% water surface in reach shaded (Photo O)	Less than 20% water surface in reach shaded (Photos N & Q)
10	7	3	1

What to look for: Shading of the stream is important because it keeps water cool and limits algal growth. Cool water has a greater oxygen holding capacity than does warm water. Decreased oxygen level is a major contributing factor to the decrease in trout from many streams that historically support trout. When streamside trees are removed, the stream is exposed to the warming effects of the sun causing the water temperature to increase for longer periods during daylight hours. Try to estimate the portion of the water surface area

for the whole reach that is shaded by estimating areas with no shade, poor shade, and shade. Time of the year, time of the day, and weather can affect your observation. Therefore, relative amount of shade is estimated by assuming that the sun is directly overhead and the vegetation is in full leaf-out.

Note the Following if Applicable: Outfall Pipes

Outfall Pipe 1: (Photograph # ____ and mark on site diagram)

GPS Coordinates _____
Diameter _____ in.
Headwall: Yes / No
Pipe Material: Steel / Concrete / PVC / Clay / Other _____
Location: In Stream / Top of Bank / Behind Bank / Other _____
Pipe Comes From: _____
Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other _____

Outfall Pipe 2: (Photograph # ____ and mark on site diagram)

GPS Coordinates _____
Diameter _____ in.
Headwall: Yes / No
Pipe Material: Steel / Concrete / PVC / Clay / Other _____
Location: In Stream / Top of Bank / Behind Bank / Other _____
Pipe Comes From: _____
Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other _____

Outfall Pipe 3: (Photograph # ____ and mark on site diagram)

GPS Coordinates _____
Diameter _____ in.
Headwall: Yes / No
Pipe Material: Steel / Concrete / PVC / Clay / Other _____
Location: In Stream / Top of Bank / Behind Bank / Other _____
Pipe Comes From: _____
Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other _____

Outfall Pipe 4: (Photograph # ____ and mark on site diagram)

GPS Coordinates _____
Diameter _____ in.
Headwall: Yes / No
Pipe Material: Steel / Concrete / PVC / Clay / Other _____
Location: In Stream / Top of Bank / Behind Bank / Other _____
Pipe Comes From: _____
Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other _____

Outfall Pipe 5: (Photograph # ____ and mark on site diagram)

GPS Coordinates _____
Diameter _____ in.
Headwall: Yes / No

Pipe Material: Steel / Concrete / PVC / Clay / Other_____

Location: In Stream / Top of Bank / Behind Bank /
Other_____

Pipe Comes From: _____

Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other_____

Outfall Pipe 6: (Photograph # _____ and mark on site diagram)

GPS Coordinates _____

Diameter _____ in.

Headwall: Yes / No

Pipe Material: Steel / Concrete / PVC / Clay / Other_____

Location: In Stream / Top of Bank / Behind Bank / Other_____

Pipe Comes From: _____

Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other_____

Outfall Pipe 7: (Photograph # _____ and mark on site diagram)

GPS Coordinates _____

Diameter _____ in.

Headwall: Yes / No

Pipe Material: Steel / Concrete / PVC / Clay / Other_____

Location: In Stream / Top of Bank / Behind Bank /
Other_____

Pipe Comes From: _____

Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other_____

Outfall Pipe 8: (Photograph # _____ and mark on site diagram)

GPS Coordinates _____

Diameter _____ in.

Headwall: Yes / No

Pipe Material: Steel / Concrete / PVC / Clay / Other_____

Location: In Stream / Top of Bank / Behind Bank / Other_____

Pipe Comes From: _____

Flow Appearance: Clear / Turbid / Oily / Foamy / Colored / Other_____

Baseflow: The portion of streamflow that is derived from natural storage, average stream discharge during low flow condition

Boulders/Cobble: Boulders are rounded stones more than 10 inches in diameter or large slabs more than 10 inches in length; cobbles are stones between 2.5 and 10 inches in diameter

Channelization: Straightening of a stream channel to make water move faster

Degradation/Down cutting: Geologic process by which a stream bottom is lowered in elevation due to the net loss of substrate material

Dikes: An embankment or dam made to prevent flooding

Flood Plain: The flat area of land adjacent to a stream that is formed by flood processes

Incised Channel: A channel with a streambed lower in elevation than its historic elevation in relation to the flood plain

Isolated/Backwater Pools: Areas disconnected from the main channel characterized by a lack of flow except in periods of high water

Macrophyte Bed: A section of stream covered by a dense mat of aquatic plants

Outfall Pipe: Outlet of a water source or point source into the stream channel, usually a pipe

Pool: Deeper area of stream with slow moving water

Riffle: Area characterized by broken water surface and a swift current caused by water movement over a shallow portion of the stream channel

Riparian: the vegetated zone adjacent to a stream or water body

Riprap: Rock material of varying size used to stabilize streambanks and other slopes

Scouring: The erosive removal of material from the stream bottom and banks

Substrate: The mineral or organic material that forms the bed of the stream; the surface on which aquatic organisms live

Turbidity: Murkiness or cloudiness of water caused by particles such as fine sediments and algae

Undercut Banks: Eroded areas extending horizontally beneath the surface of the bank forming underwater pockets used by fish for hiding and protection

Withdrawal: Taking surface water from the stream for irrigation or industry

Appendix V. Stream Visual Assessment Narrative Results

Appendix V. Stream Visual Assessment Narrative Results

(Note: pictures and maps referred to in this appendix are not related to the pictures and maps in the Upper Tohickon Rivers Conservation Plan; they refer to information in the Volunteer Packets)

Grid Number: A-8

Notable Feature:

3223 Mink Road

Comments: *No comments*

Grid Number: A-9

Notable Feature:

- *Start Point* – Gravel Bed with larger boulders throughout. Canopy trees: Beech/Hickory/Maple/Oak/some brambles here and there Skunk Cabbage, Lesser Celandine, Christmas fern, Spring Beauty, unknown purple flower.
- *School Road Point* – This part of the stream runs under School Road. No bridge, just a pipe with water running through it. School Road over top. Few man-made boulder dams
- **Starting Approximately 300 yards above School Road point and beyond –**
Healthy riparian zone. Mature trees: Maple/Hickory/Oak/Ash
Spring ephemerals – Skunk Cabbage/Trout Lily, Lesser Celandine (exotic)
Stream bed has **many** more boulders.
- Picked up a plastic bag worth of trash at this point. But over all, not much litter along this stream. Great!
- Boulder Dam, slight flooding upstream, some trees cut down. Picnic area: Tables, fire pit trash bin.
- The only pipe that was noticed in the entire stream was under School Road. It looks like when they built School Road they didn't build a bridge, they just laid concrete pipe in the Haycock Stream and packed dirt and gravel around it. Haycock Creek is a very small stream.

Comments: *No Comment*

Grid Number: A-10

Comments: *No Comment*

Grid Number: B-3

Notable Feature:

Rocky View Road on left “Columbia Gas System” (Pipeline)

Grid Number: B-8

Comments:

Assessed stream site #1; Stream #2 inaccessible

Grid Number: C-1

Notable Feature:

3175 Old Bethlehem Park, Zion Hill

Grid Number: C-3

Notable Feature:

Keystone 500,000V R.O.W. splits into two

Comments:

The area under consideration is bound in the main, by the 500,999 Keystone Power line right of way.

I have evaluated the canopy cover over these areas as a 10 for the following reasons:

1. On the South line there is dispersion into a marshy area that is covered so thickly in briar and other plants that it is virtually impassable until it approaches the wooded area to the south. It is also strewn with very large basalt boulders that make walking in the area hazardous at best, especially for the inexperienced.
2. This open space provides an ideal environment for plants that thrive in transition areas between forest and open, some of which are threatened in the wild. It also provides as a food source for a variety of wildlife including raptors.
3. On the North lines the low area between the two branches shown on the grid is marsh. The open area has bulrushes (cattails) seven or more feet in height, and water over my knee high boots in many places. This provides a transition environment as noted above, but wetter.
4. Of note is the fact that when a strong freeze occurs, the stream level drops, indicating that the source is near the surface.

South of Povenski Road, the stream cuts through a field of boulders and natural rip rap that stabilize the banks. The flood zone for that area extends for more than a hundred feet on either side in places and becomes very marshy in character (both sides of the stream, but most notably on the North) just before crossing into the Keystone ROW. The feeder streams are sometimes hidden from view below the rocks. Skidder tracks that I know to be 35 years old are still visible north of the stream.

Grid Number: C-7

Notable Feature:

- Upstream of crossing on Hickory Lane
- Downstream from Hickory Lane Bridge
- Check aerial photo – Site #3 Downstream of Hickory Lane Bridge

Comments:

No comment

Grid Number: C-8

Comments:

No comment

Grid Number: C-13

Notable Feature:

- This reach runs under Tower Road

Comments:

This short stretch runs through a pipe under a driveway through thick brambles (no trees) under Tower Road into a brushy forest. This is low volume stream and so banks were stable.

Grid Number: D-2

Notable Feature:

- Intersects Clay Avenue
- Intersects Mine Road
- Intersects Bethlehem Park

Comments:

No comment

Grid Number: D-3

Notable Feature:

- California Dam
- California Dam (north of Hickon Road)
- California Dam (South of Hickon Road – North of Dam and Cherry Road)

Comments:

For the most part, the entire section is in the woods. Riparian zone on either side is 100' or greater. There is extensive flood plain on the western side 50' or more. There are signs of frequent flooding – the lower half, west side consists of boulders with the soil eroded away. With the exception of several hundred feet on either side of Hickon Road, the stream banks appear stable and the water is fairly clear. The stream on either side of Hickon Road is in a swampy open area with full natural grass coverage.

- Northern (200') swampy – small (5') channel.
- - All appear to have 50-100' flood plain and floods regularly.

Grid Number: D-4

Notable Feature:

- Hickon Road to California Road
- Keystone Road to California Road
- Keystone Road to California Road South
- South of California Road – Fields

Comments:

The west branch is generally completely in the woods. Complete canopy cover with a minimum 20' flood plain. There are some signs of flooding with lesser bank stability in the southern portion. The eastern branch has two areas in fields with no cover. Very little water present, small channel – northern portions appear like a dry creek. The entire area has former livestock and equipment damage – mostly recovered.

East – Dry Creek – southern part recovering from animals/equipment all very dry.

Grid Number: D-5

Notable Features:

- The left tributary seems to begin at a pond just south of Younken Road. This reach ends at Church Road.

*This stretch runs for the most part under a dense stand of brambles/thickets.

- This reach begins at Church Road ends at private pond. Due to lack of permission I was unable to assess the southern most forested part of this reach (Please see Map).
- This reach is the headwaters for the middle tributary into the left branch of Dry Branch Creek

Comments:

Assessment 1: This reach is overgrown with brush. I think scoring is a bit inflated because although it qualifies as having good riparian, canopy cover, bank stability, it doesn't seem like a healthy system. The next reach,

Assessment 2: Runs through a cattle pasture. It still meanders greatly but has extremely unstable banks.

Assessment 3: Begins beautifully through a forest and boulders but the land owner has dug out the creek and therefore there is a large track with very unstable banks coinciding with little canopy cover. There is also another stream that runs through this property and joins the creek just north of Church Street (see map) which is not on the aerial map. This stretch is reported to run dry naturally during the year.

Grid Number: D-7

Notable Feature:

- From west Sawmill Road South to Strawn Town Road (not shown on map)
- From West Sawmill Road North-East for approximately 1,200 yards.

Comments:

Although both of these streams appear dry in spots there was still noticeable water flow in most areas, and the general appearance of the streams seemed natural.

Enclosed photos 2A to 7A are of the Dry Branch Creek Management Area.
Photos 11A to 16A are of the Kimple Creek Management Area.

Grid Number: D-9

Notable Feature:

Starting at Sawmill Road and going upstream to pond. Except at driveways along Saw Mill Road, no pipe outfalls apparent—could not find outlet from pond.

Photo #1 Looking downstream along Sawmill Road.

Photo #2 Looking upstream along Sawmill Road with home in background.

Photo #3 Looking upstream, near house and side drainage ditch.

Photo #4 Of Ephemeral photos of house

Photo #6 At private pm line – looking upstream

Photo #7 At split/fork in channel, nearing pond – looking upstream

Photo 8 & 9 Right hand channel, swampy headwaters, near pond berm

Photo #10 View of Pond/surrounded by multiflora.

Photo 11 Contaminated water (?) = orange color, oil slick?

Photo 12 Random trees falling

Starting at Harrisburg/School Road near Twp. Building

Photos #1,2 Salt/Blacktop, Recycling @ Twp. Building

Photos #3,4,5 Headwater swamp at Township Building

Photo 6 Culvert under Harrisburg School Road

Photo 7 Stream “Disappears”

Photo 8 Old dam/road (?)

Photo 9 Stream “Reappears”

Photo 10 Fork Looking upstream

Photo 11 Fork Looking downstream

Photo 12 End Looking downstream

Photo 13 Culvert under Harrisburg School Road East of Township Building and Photo 6 culvert

Walked into woods off of S.E. corner of terminal package area in state game lands

Photo 1 Looking downstream

Photo 2 Looking upstream

Comments:

- ***Lake Nockamixon Management unit grid D-9***

Included three different headwater segments:

- N.E. corner – Headwaters in State Game Lands
- N.W. corner – Tributary to Kimples Creek along Sawmill Road
- South – Unnamed tributary off of Harrisburg School road across from Haycock Township Building.

Grid Number: D-10

Comments:

- Concrete block/slab (old roadway) water – 1” deep
- * Banks appear to have been unstable (very high exposed roots) but have recovered (lots of vegetation).
- **Bogs with leafy plants on either side at intervals

Grid Number: D-11

Notable Features

- Begins in swampy area close to Mt. View Drive, goes under Mt. View Drive through culverts; contributes water to migratory fowl resting pond near Tohickon Lane then empties into Lake Nockamixon. Swampy areas at its origin.

Comments:

Water is held to create the migratory fowl resting pond on Tohickon Lane within Nockamixon State Park. Water level changes seasonally. This type of land and wildlife management area could be used to show people what can be done with a lowland area. It would be a good educational site also.

Volunteer Notes:

1. Mouth of stream flowing from resting pond into Lake Nockamixon
2. Water release beneath Tohickon Lane.
3. Stream in “forested” area.
4. Stream origin in swamp area off of Mt. View Drive. Crosses under the road to head toward the lake.

Grid Number: D-12

Notable Feature –

- Tower Road and Fink Drive – Parking lot for park area at this corner; culvert beneath Fink Drive.
- “*Fleck Farm*”

Comments:

Fink Drive culvert under roadway – upper ¼ of this stream was silted; stream is very stable since bed is formed of slabs of horizontally – oriented bedrock; rocks are not covered (many exhibit colonies of moss) by water; small stream flow; can barely see the stream as it works its way through the Fleck Farm (heavy growth of small shrubs and weeds but no canopy trees).

Grid Number: D-13

Notable Feature:

Culvert under Foellner Lane access lane to park

Comments:

A Nockamixon Park access road is parallel to the stream and is built up above the stream level. Stream bed did not have a great deal of water in it. Appears to be stable for its pathway through horizontal rock layers.

Horse farms are numerous in this area, one is adjacent to the stream.

Stream continuing on Fleck Farm is very low in flow. Appears to be stable, small rubble in bed.

Volunteers Notes:

High concentration of horse farms in this section. Access road to state park runs by the side of stream (higher than the stream).

Grid Number: E-3

Notable Feature:

Cherry Road runs parallel to the creek from approximately 100 to 200 feet.

Comments:

The upper Tohickon Creek within Grid E-3 is in its original undisturbed condition under a heavy forest canopy except for a very short section adjacent to Grid E-4 at California Road. That portion passes through a single home residential area, however, the stream is very well maintained without damage to bank stability. There are open lawns extending to the stream banks on both sides in this very short area, and a couple of partial creek stone dams have been created to form small ponds of limited size and depth.

The overall impact on stream flow and condition appears to be none. (There are more pronounced impediments to stream flow from natural stone obstructions up-stream.

Grid Number: E-6

Notable Feature:

- This is the assessment for the left branch of Dry Branch on Grid E6 running from north of Meadow Road to Union Road.
- This is the assessment for the right branch of Dry Creek. This reach runs from just south of Beek Road until it crosses just north of intersection of Beck and Apple Roads.
- On the right branch of Dry Branch Creek from intersection of Beck and Apple Road to Apple Road.
- The Right branch of Dry Branch Creek from Apple Road to Union Road.

Comments:

Left Branch:

I was unable to observe the conditions where the town northern tributaries join. This area is inaccessible because of dense brush. The southern/western most tributary seems to be a very, straight shot behind property lines, maybe suggesting some past channelization. This is the same for the reach below where this tributary meets the main (left) branch to Meadow Road. This creek runs mostly through grasses and is reported to normally run dry in some seasons. The majority of this branch runs through agricultural fields with no riparian zone associated with it. The exception is one small area that runs through the edge of a rather large track of forest.

Right Branch:

The riparian zone for this branch is a little more extensive although characterized by very thin trees, brush and these occurring sporadically. There are many access roads, ponds and bridges crossing over this stretch, and a lot of residential use. This eastern branch is reported to run dry under normal circumstances especially the northern-most part.

Grid Number: E-7:

Comments:

Nearly 100 percent of this section of Kimples Creek has not been touched by any development. During heavy rain, the area maintains or has an adequate, flood plain. The area has an abundance of riparian zones. Nearly all of it is configured in an oxbow-type creek.

We live 1000' from Kimples Creek and have lived there for 17 years. Every year I walk significant portions of the creek for waterfowl and small game hunting. Because of that, I've acquired knowledge of the streams condition. Waterfowl along the stream is sparse, mostly black and an occasional wood duck. The area is very thick with vegetation, making walking difficult. Most of it is also located within the boundaries of the town's large farms – neither farm is working except for twice yearly hay cuttings. One farm, in section A and portions of C, has at most eight head of beef cattle, but the herd is not raised there every year. Another farm, within section C, has a small herd of angora sheep.

Grid Number: E-8:

Notable Feature:

- From the bridge on Roudenbush Road to the Dam at Lake Towhee.
Note: Under hydrologic alteration I did not include the Dam at Lake Towhee. From the bridge on Rouden Bush Road for about 1,000 feet south or down stream.
- From the bridge on Rouden Bush Road for about 1,000 feet south or down stream.
- From about 1,000 feet south (Down, Stream) from old Bethlehem Road to about 1,000 feet south of Rouden Bush Road.

Comments:

It appears this section of Kimple Creek is in a very natural condition. The enclosed photos are all facing upstream and are numbered with the page they refer to.

Grid Number: E-9:

Notable Feature:

- Two houses (yellow and white) visible, large boulders in stream bed from here to Deer Wood Lane on Left. 10-15 feet wide and very shallow.
- Just passed residence, emergent macrophytes, marshy.
- Water about one-foot deep, flow is wide, banks are low, shallow slope.
- Emergent macrophytes.

Comments:

The area is wooded with few residences visible from creek. The houses were >50 feet from the creek. Generally wide creek bed with very shallow slopes to the banks. The flow was not concentrated to one easily followed channel. Area was like wetland with very slow or standing water over large area >20 feet wide in some location emergent macrophytes. Kept us at slow pace. Several frogs were observed. Mosquitoes were quite abundant. The structures mentioned in your directions at top of this page were not

observed along the sites that we visited in grid E-9. Entire creek area in grid was not covered. Just from Deer Wood Lane up to Site 4.

Volunteer Notes:

GPS not available, map locations are approximate.

Grid Number: E-10:

Notable Feature:

Empties into east end of Lake Nockamixon Marina; two stream mouths; crosses under Mr. View Drive through Culvert.

Comments:

Water comes from a number of fresh and run off sources near Mt. View Drive (culverts).

The stream is within the boundaries of Nockamixon State Park. It is near an area that has been altered by man and is used as a "course" for friskee golf.

The stream is in a beautiful area for recreation.

Note: There are two streams which seem to be distinctive here. Only one stream was show on the grid.

Comments on Photos:

#1 Showing the streambed and some of the riparian buffer. This was taken close to the mouth of the stream where it's going to flow into Lake Nockamixon.

#2 Rocks were placed across the stream bed to form a small dam or slow the flow of the water into the stream valley.

#3 Fast moving water source flows beneath Mt. View Drive. This area has been highly altered. It is to the left of the larger culvert.

#4 Water flows beneath Mt. View Drive. It is to the right of the quickly moving water source. In this area many things have been altered.

Volunteer Notes: Picture #1 Near the mouth

Picture #2 Middle Area

Picture #3 & #4 at Mt. View Drive Sources.

Grid Number: F-5:

Notable Feature:

Assessment area lies between East Pumping Station Road (old access way) to Raub Road at the above coordinates.

Assessment area begins at Raub Road and ends just north of Erie Road.

This reach begins at the end of Highland Avenue and ends at the above coordinates at the Richlandtown Pike Bridge.

Assessment area lies just south of Union Road and ends at East Pumping Station Road (access way) which crosses and dams this stream at the above coordinates.

Comments:

Dry Branch Creek: Between Union and Raub Roads this creek is dammed by an old access way of East Pumping Station Road CPS coordinates: N40°27.581' WO 75° 18.853. There is an old culvert at N40° 27.559'

No Picture: flat bottom, sharp side, field drain, could not find drain pipe

Picture # 11: Flat bottom, sharp sides North end of F6.

Picture # 13,14,15: Girl Scout camp pond.

Picture # 16: Outlet of Girl Scout Pond

Comments:

The most damaging condition of the Dry Branch Creek is the bridge and culvert on Raub Road. Each of these man-made structures carries only a fraction of the water flow. The bridge carries less than 30% and the culverts (see map F5) carry only 16% of the flow.

Figure #1 A&B shows the flooding on May 10, 2002 which is the blue area shown on the F-6 chart. Dry Branch Creek is a major creek during a number of rain falls per year. The pictures of Figure # A&B show the water flow across Raub Road. The only thing keeping the road from washing away are the heavy woods that hold the erosion in check.

Grid Number: F-8

Notable Feature:

From Old Bethlehem about 1,000 yards North and about 1,000 yards south

Comments:

The Tohickon Creek area of Grid F-8 is very rocky with clear flowing water with minimal bank erosion Photos 8A to 10A.

The Lake Nockamixon area of Grid F8 North-West of old Bethlehem Road is no more than at present a dried up marsh area with little sign of water flow. See Photos 12A to 17A

The Lake Nockamixon area of Grid F-8 South-West of old Bethlehem Road starts as dried up marsh area but eventually turns into a flowing stream. See Photos 18A to 22A.

Grid Number: F-9

Notable Feature:

Lake Nockamixon to Route 563:

- (1) Rock Wall with water fall behind it
- (2) swamp like area of still water
- (3) running water past a collapsed wall of rock – canopy-excellent/stable banks.
- (4) small natural rock dam (tons of moss covered rocks; water is rapidly flowing through/past.
- (5) all boulders to 563; can hear the water running under then, can't see the water (essentially no banks at 563).
- (6) Cement Channel brings water under the road, running water to the lake @ 9:08 am

Route 563 upstream to fork:

- (1) Under bridge Route 563 above (2) Rock wall channel to water is flowing underneath, on heavy rains I have seen it flow over top of the wall - 5 feet high - behind the wall - swamp like body of still water.
- (2) R-bank (4) fallen trees in the water dense canopy

On the map, right fork in the stream – fallen tree (Beaver Dam?) Water behind is still (L) Bank (3) or (2) (R) bank (4) evidence of flowing under Pink and Blue tape on tree branches (Marked as Wetland Delineation) lining the creek banks R & L (all mud) – Flood Plain

L bend – a lot of silt in the creek bed (at the fork) very small (2' wide) – L&R bank (2) water is quite still 4-5 feet wide – really big boulders, quite deep along L&R banks. Water is running under and around the boulders, no banks, and acting as a dam in areas where debris has collected on the boulders. Very wide boulder field, (stream is very divergent through) Above the boulder field – 2 bank 2 R Bank #-More boulders on both sides of the creek (rock band) paint ball fence

Comments: *None*

Grid Number: F-10

Comments:

This study extended along the south east shore of Lake Nockamixon Lake beginning at Stovers Mill Road and continued to a point in line with Fairview Road (which does not extend to the lake). Overall the lake shore and land within 50 feet adjoining the lake showed as environmentally sound. There were no areas of erosion of the lake embankments. The fifty foot area from the lake shore is covered with heavy undergrowth or stands of Hemlock.

There are several areas, however, that need some attention. As you approach the lake down Stovers Mill Road there is a run off creek bed on the left side that carries water and drainage to the lake. Old tires and junk are in the bed. The run off showed signs of oil residue as it entered the lake (picture 1).

Going north east along the lake there are several feeder gullies to the lake and some small stretches of sandy beaches. There are stands of pines along the shore as seen in picture 2.

The lake bed is made up of small round rock ranging in size from golf ball to baseball. There are runoff gullies from the cabin area to the lake as seen in picture 3. There is some undercutting of the embankment along this area which makes for good fish habitat. Lichen covers the bank floor for 8-10 feet back. (picture 4)

Across from the fishing pier there extends a peninsula where a discarded barrel and a carp or bass carcass was found. (Picture 5). In the cove area the embankment is strewn with trash from fishermen or water fowl hunters. A decoy duck was found there also. (Pictures 6,7,8)

After rounding the peninsula the cove area showed signs of murkiness and foam and another fish carcass (picture 8a). Picture 9 shows a stand of trees along the cove area.

Around the power line area there appears to be some type of tanks with the letters B&S on them. There is about a 6 inch PVC pipe extended to the lake which has fluid flowing from it. There does not seem to be an odor from it.

There was evidence of foam along a good section of the shore line (Picture 10). A local fisherman said it was from the Quakertown Sewage Plant which overflows due to too little capacity for the population and growth.

Lily pads were profuse in June and provided good habitat for bass and other fish. (pictures 11,12)

The embankment is covered with low growth shrubs continuing along the lake. More evidence of foam sludge is shown in Picture 13.

The over all assessment of the area in grid F-10 I would assess as very good.

Grid Number: G-4

Notable Feature:

Just off Main Street. Riparian increases on right bank to 3 in part South of 9th street. Mill creek in this section is channelized, but not hardened except in a few sections. Miscellaneous trash and debris, some rip rap but not professionally placed. Same conditions apply south Hellertown Avenue.

- Senior Center
- Fiber Mark same until RR crossing/
- South of railroad crossing; south of Hellertown Avenue (212) conditions return to those on sheet 1.

Grid Number: G-5

Notable Feature:

This is the assessment for the Tohickon Creek from the Richlandtown Pike Bridge to Thatcher Road.

This reach lies between Ambler Road (bridge) to Erie Road Bridge at above coordinates. N40°26.698 – N40°26.627'

WO 75° 19.902 WO 75° 19.688'

This reach lies from Erie Road Bridge to just East of Knauss Dry Beef factory (See GPS for Erie Bridge).

Downstream of Knauss Dry Beef plant to the point where Lickin and Tohikon Creeks unite.

This is the retaining pond for the Quakertown wastewater treatment facility which feeds in Lickin Creek just west of Nick Luca Drive.

Assessment area lies from just south of 313 to merge with Tohickson Creek just before Thatcher Road

This assessment begins at Front Street Bridge and ends at the 313 Bridge.

Assessment area lies between just North of Stoneback farm to junction of Tohikon and Dry Branch Creeks.

Comment:

Tohickon Creek: The first reach of this creek assessment is marked by the historic ice house dam (N40° 26.795' WO 75° 19.647). This area has a rich history of recreational use. Information and documents are being compiled to supplement this evaluation. The creek is then subject to a utility road crossing and a reported over-flowing manhole before it crosses under the Erie Road Bridge (N40° 26.673' WO 75° 19.198'). Before converging with Dry Branch Creek (where there is a rock dam). The Tohickon Three creeks; Dry Branch, Lickin (Beaver) and Morgan converge with Tohickon in short distance just prior to crossing under the Thatcher Road bridge. Morgan Creek: Only assessed from just south of 313 bridge (see picture) to end of course at junction with Tohickon.

Grid Number: G-8

Notable Features:

Weisel Youth Hostel – Haskins Dam – This section is from Haskins Dam Downstream to the marked tributary.

Weisel Youth Hostel – Rosa Crucian Shrine – This section is the tributary that flows under Richlandtown Road into the Tohickon. The stream was visually inspected from a distance for upstream positions above Richlandtown Road and fully assessed downstream of Richlandtown Road due to private property concerns.

Lake Nockamixon, Route 563 High Bridge- This section is from Tributary (section 2) to Lake Nockamixon backwaters.

Comment:

This portion of the watershed is centered around the Weisel Youth Hostel, which is owned by the Commonwealth of PA and managed by Bucks County Parks and Recreation. This property is an old mill property and it includes a concrete dam known as Haskins Dam, with a run that flows east of the creek and returns to the Tohickon before the next tributary. That run is now a healthy channel and is similar to the main creek channel in quality of assessment criteria. The main problems with the Tohickon Creek along this section are: large sized refuse and debris items on the shores and an incredibly high level of sediment on the stream bottom and banks (particularly considering the presence of an upstream dam) which seems to indicate a large amount of run-off occurring upstream of this section of stream. The tributary that flows in from the east has even higher amounts of sediment, at times with no rocks of any size on the stream floor, and incredibly high banks or under cutting along much of the stretch that was assessed.

Grid Number: H-3

Notable Feature:

- Bethlehem Pike Bridge to house or building.
- Start of forested area
- Trumbauersville Road to Development
- End of Development to white slash
- Silt fences and bank modifications in place – should have been removed some time ago.
- End of right fork.
- Stream runs between development, stream disappears (wells) upstream wooded, stream returns
- Upstream of Development, left fork

Comments:

In Grid section H-3 most of the fields along the banks have been converted into developments.

Grid Number: H-4

Notable Feature:

- Route 309
- Housing developments start
- End housing developments
- Old Bethlehem Pike to Front Street

Comments:

Lots of trash and debris

Section 2: Stream splits and rejoins, many shopping carts with sticks/leaves restricting flow.

Section 3: Stream hidden, can't tell width, very shallow.

Grid Number: H-5

Notable Feature:

Old Bethlehem Pike

Comments:

Terrain in and around Morgan Creek virtually impassable – Study discontinued. All exactly the same (as far as we got – almost half-way).

Grid Number: H-8

Notable Features:

2450 Three Mile Run road next to “Three Mile Run Road” and Butler Lane intersection.

Sterner Mill Hiking area on left going South (563)

Grid Number: I-3

Notable Feature:

- Start of assessment: Bend of Yankee Road/Corresponds with Photos #1,2
- Wooded area – corresponds with photos #3,4

Comments:

Photo # 1,2 Concrete culvert pipe interior 3 by 4 feet. Creek through pasture livestock access to stream

Photo #3, 4, Downstream of pasture, wooded with cut banks and exposed roots

Photo #5,6 Downstream of wooded area north of field #2 abundance of invasive plants – Canary Reed, Honeysuckle, Multiflora Rose

Photo #7 North Field #3 successional woods both stream sides

Photo #8 Power line

Photo #9,10 Concrete footers moderately restricting flow 100 feet downstream second rock dam moderately impeding flow

Photo #11 West of School Road wooded floodplain 20 feet removed from both banks – abundance of invasive plants

Photo #12 School Road Bridge

Photo #13 East of School House Road

Volunteer Notes:

11.11.04 Photo Map #1-13

Grid Number: I-7:

Notable Feature:

Intersects West Rockhill Road off Sat. Map.

Comments: *None*

Grid Number: I-8:

Notable Features:

This stream enters Lake Nockamixon where the lake intersects Rt. 313 west of Rt. 113.

Note: There are two old dams on this section of stream. Both are in disrepair and don't have a major influence on the water flow. These dams are near the intersection of grids I7 and I8. It is possible that they are in grid I7. I had trouble locating the exact boundary between these grids using the map provided.

This section is located between Rt. 313 and Three Mile Run Road. Going from Rt. 563 towards Quakertown, the section is to your right.

Comments:

Section B

There is a large pond to the left of the stream. The stream doesn't feed into the pond. I didn't see any outlet from the pond into the stream.

At the down stream end of the pond there is a dump. The dump has an old stove, used tires, cans, bottles and old building material located in it. The dump is not into the stream bed, but is located within a few feet of the stream bank.

Grid Number: J-6

Notable Feature:

Rockhill Road (Bridge)

South on Three Mile Run Road just before overpass.

Grid Number: J-7

Notable Features:

Channeling on right bank, right side of bank upstream scoured out, Picture #2 left bank

Graveling on left side, slight stream bank erosion both sides Photo S gravel stream bank, Picture #6 & #7 multiflora rose, Picture 8 large gravel bed.

Very open, little canopy, many boulders in stream, Photo #10 upstream, Photo #11 damn, Photo #12 left bank, isolated backwater stream, natural pool, channel in middle of stream, Photo 14 & 15 foam in water, Photo #16 Lots of undergrowth, right bank multiflora rose, Photo #17

Stream facing upstream, duck trail, deer tracks, ripples, pool left side of bank, Photo #18 cement blocks undercut banks left side.

Channel 10,

Hydro 10

Rip left 10, right 10

Bank left 5 Right 8

Canopy 8

Boulders, left bank undercut, backwater stream

#19 Bridge looking downstream

Comments:

Any area beyond stream banks that was clear cut had multiflora rose.

Grid Number: K-4

Notable Feature:

Immediately south of Sellersville Reservoir on Catch Basin Road Map Location #1`

Map location #2 50 meters NW of Forrest Road.

Comments:

This small stream is the outfall of Sellersville Reservoir catch basin. No water was passing over spill wall at this time of survey. The entire length of stream in this grip was wooded.

Photos:

K-4-1 Sellersville catch basin location #1

K-4-2 Sellersville catch basin spillway

K-4-3 Location #1 looking S.E. note bricks in streambed.

K-4-4 Location #2 Looking S.E.

Grid Number: K-5

Notable Feature:

Crossing under road via culvert

Map location #1

Directly N.E. of Catch Basin Road

Map location #2: Directly N.E. of Mill Road

Map location #3: 50 meters S.W. of Culvert under Mill Road

Map location #4: Both sides of culvert under Bethlehem Pike

Comments:

Map location #4: Immediately S.W. of Bethlehem Pike. Roy-Ann Diner is located approximately 200 meters from creek. Diner has its own sewage treatment facility adjacent to creek. No pipe was observed emptying into creek. However, land near creek observed to be extremely boggy. May indicate seepage of effluent into creek. See Photo K-5-13

Photos:

- K-5-1 Location #1 Looking N.E.
- K-5-2 Location #2 Looking East
- K-5-3 Location #3 Looking East
- K-5-4 Location #3 Looking East
- K-5-5 Location #3 Looking West
- K-5-6 Location #3 Looking West
- K-5-7 Location #3 Looking Down
- K-5-8 Location #3 Looking Down
- K-5-9 Barn along Mill Road, New Location #2
- K-5-10 Location #4, Looking S.W.
- K-5-11 Location #4, Looking N.E. toward Bethlehem Pike
- K-5-12 Location #4, Looking S.W.
- K-5-13 Location #4, Working N.W. toward bog.

Grid Number: K-6

Notable Feature:

Start bridge over Three Mile Run Stream at eastern most extent of survey area end at bridge on Stone Edge Road West of starting point. The concrete bridge at starting point has a 20' long concrete pad that the stream flows over.

Start at bridge on Stone Edge Road. Heading west – end at dirt road's bridge. ½ way between Stone Edge Road and Hill Road. Muddy high water mark roughly two feet above existing water level. A

man-made rock dam serves as a demarcation between the narrower grass filled channel downstream from the wider channel above the dam.

Start at Dirt Road Bridge over Three Mile Run Stream. End at a point where Tunnel Road would intersect Three Mile Run Stream.

A few crayfish in the stream bottom among the rock bottom. Quite a few 3 feet, near vertical banks on both sides and lost of roots exposed.

Start 50 feet west of greenhouse. End at western boundary of K-6 Grid. The Park Avenue Bridge had concrete conduits allowing water to run of the road into 3 mile run stream. Saw brown sludge, just east of the Park Avenue Bridge, clinging to stream bed rocks. One active pump in field north of 3-mile run stream where discharge is into the stream.

Start at point where Tunnel Road, if it was extended, would cross 3-mile run , End at Bridge on Hill Road. This stream flows west to east.

Visible signs of human garbage along highwater floodplain.

Saw a few pools of brown “yuk” (like jello) hanging onto stream bed exposed rocks.

Start at bridge on Hill Road. End about 50 feet west of Greenhouse.

I noticed increase # of brown sludge groupings clinging to stream bed exposed rocks.

An outfall pipe behind a home with an above ground pool.

The greenhouse has three settling ponds close to the stream. The elevation of the settling pond closest to the stream could potentially be reached by 3-mile run stream if stream level rises substantially.

Grid Number: K-7

Notable Feature:

A on map - Top of stream – next (below) to lake

B on map – Mid length of stream

C on map – End of stream (Tunnel Road)

D on map – Lake at “Gun Club”

Comment:

This grid was very compact and had only one “lake” which we assume was man made due to the topography difference from the surrounding acreage. The outflow/overflow pipe from the lake formed the little “trickle” that we assessed. It was clean, not littered, inches deep if any water at all throughout. Some large trees along the stream had fallen over, leading us to believe the soft ground has been less supportive in the past.

Fieldnotes for Grids F7, G7, & H7

General Comment

The three grids H-7, G-7, and F-7 concern the center portion of the Middle Tohickon Management Area (MTMA). This south to north strip of land, lying due east of Richland Township, includes the western and central parts of the north-directed "spike" of East Rockhill Township (the eastern part occurs on Grids G-8 and F-8). Tohickon Creek is the boundary of the spike that separates East Rockhill from Haycock Township to the north and east. The entire water drainage of the Tohickon system from Richland Township passes through this strip of land on its way to Lake Nockamixon. Describing the three constituent grids in south to north sequence helps to understand the topography of each more easily and spotlights the importance of the MTMA in water conservation and management throughout the watershed.

Grid H-7

Lying entirely on the diabase this grid comprises wooded, boulder-covered slopes with relatively few houses or cultivated land. Its altitude ranges from a maximum of 720' in the SW corner (close to the peak of Rock Hill in Grid I-6) to a minimum of 520' in the other three corners. It is best described with reference to a man-made feature, Route 313 (a.k.a. Doylestown Pike, Swamp Road). Route 313 begins in the NW corner at an altitude of 320', rises to a cutting at 600' and descends to 320' in the SE corner. The grid contains parts of three management areas but field observations suggest that water runoff patterns do not coincide with their boundaries.

It is not clear whether 313 has a continuous storm drainage system: if it does, distribution of debris in ditches at the side of the roadway and sporadic erosion suggest that it is frequently overtaxed. There are numerous conduits of various sizes running S → N under the road bed. Water from the western side of the grid drains into Bog Run via a complex system of dry gullies traceable within the woodlands.

A surprising feature of 313 was conspicuous running water in roadside ditches within the cutting at 600' – flow was towards the NW and must derive from surface runoff and seepage from the slopes of Rock Hill. Despite its complex topography that had resulted from thousands of years of erosion, the wooded terrain towards the NE has copious wetlands and drainage contributes ultimately to Tohickon Creek (see later).

A small creek marked at the center, East of the grid that purportedly continued beneath Route 563 it could not be found. However the search revealed a surprising feature. The aerial photograph of the grid shows a conspicuous linear feature towards its southern aspect: according to posted signs, this seems to coincide with the path of a fiber optical cable. About 30' NW of where the cable passes under 313 there is a 30" conduit that carries water NNE, beneath the roadway. A gully runs approximately 100-150' NW of, but parallel to Route 563: for most of its course it lies in Grids H-8 and G-8 from whence it drains into Tohickon Creek just east of the southernmost portion of Richlandtown Rd. This gully runs across a plateau at an altitude of 540' before dropping to Creek level of approx 400' via a conspicuous cleft in the stony slopes. The location and direction of water flow throughout the SE corner of Grid H-7 seems to indicate only a minimal contribution to the Three Mile Run Management Area.

Grid G-7

A drive along the three inter-connected Richlandtown, Sterner Mill, Clymer, and Axehandle Roads (the eastern leg of the last-named confusingly posted as Axehandle DRIVE in East Rockhill Township)

reveals the complex topography of this grid with heights of 600' ranging down to 400'. There are however numerous plateaus with pasture and/or man-made ponds: the surrounding woodlands contain many wetlands regions that warrant future intensive study and mapping.

Each of three moderately conspicuous water courses has noteworthy characteristics.

In the SE corner, east of Clymer Rd a series of rock-lined gullies coalesce as a stream that fills two large ponds before passing under Richlandtown Rd to drain into Tohickon Creek on Grid G-8.

An even more extensive system – not marked on the original aerial photograph, or even on a USGS survey map – originates in the center of Grid G-7 north of Axehandle "Drive" and also passes under a small bridge on Richlandtown Rd to drain into Tohickon Creek, again on Grid G-8.

The two just-mentioned water courses are covered with foliage for most of the year. They are of interest because their paths can be so easily recognized by their effects on the contour lines. The fact that the first is featured as a water course on a USGS survey map while the second is not underscores the seasonality of surface water flow throughout the Tohickon Creek watershed system.

The third water course visible on the NW corner of Grid G-7 is a portion of Tohickon Creek itself: a tributary with only seasonal flow runs south to north from its origin near Sterner Mill Rd on Grid H-7.

Along this stretch Tohickon Creek has a substantial flood plain, some of which is still in pasture (to the West on Grid G-7). As detailed below, further downstream evidence of earlier tilling of this bottom land can still be discerned. The creek width is as much as 40-50' so that the center is not covered by foliage. The course of the creek is very tortuous and the banks vary greatly in height. Occasional large boulders occur and they increase in frequency as one walks downstream. Evidence of seasonal flooding is abundant – large trees and detritus occur at substantial distances from the water. Undercut banks on both sides of the creek, some opening into blind-ending "bayous" directed upstream, are probably natural – substantial seasonal flooding has seemingly carved the tortuous passage of the creek over the years. Greater bank stability is visible further downstream.

The NW corner of Grid G-7 includes part of the Girl Scouts of America property – Lake Tohikanee. Within its confines, on the western bank of the creek there are large man-made ponds associated with extensive wetlands that have been mapped. They have been considered in detail in the report on Grids G-6 and F-6 although a tiny portion is seen in the extreme SW corner of Grid F-7.

Grid F-7

The terrain may be simplified by noting that the aerial view shows the SE third of the grid to comprise rocky, wooded slopes descending from an altitude of 540' at the extreme SE corner towards Tohickon Creek (altitude 440'), while land covers the remainder to the north. Along this stretch the creek is always minimally 50' wide and greater in places. To the NW, along the creek banks it is apparent that gentle slopes house holiday cottages and others are visible within the sharp bend of the creek (center, east). At the north of Grid F-7, Thatcher Rd (wrongly labeled "Axehandle Rd" on aerial photo) runs almost east to west before showing a sharp bend in the extreme NW corner of the grid: further comments on Thatcher Rd are made below.

In the SW corner of F-7, Tohickon Creek passes beneath a substantial bridge on Richlandtown Rd. Downstream from the bridge the character of the creek changes dramatically: it is filled with very large boulders, some form "islands" while others form "permanent banks."

While both banks slope noticeably, the southern bank has masses of exposed boulders surrounded by patches of wetland. Trees on both banks vary in age up to circa 80+ years: numerous stone-lined "bubbling brooks" enter creek after running down slopes. Throughout the southern floodplain, "fences" of huge boulders – the make-work winter projects for the draft animals that used to work these bottom lands -- are scattered about.

Quite suddenly big boulders disappear from slopes and there is a return to wide wetlands because the banks are very low – here the "lake" is at its widest: lots of beaver activity

Below a small rapids are 3 subdivisions of creek, one seemingly associated with an old mill race. Through dense, boggy woodland Shard's Mill Covered Bridge can be seen. It lies at the bottom of fairly steep, north and south, 200' stretches of Covered Bridge Rd. The covered bridge itself sits next to Tohickon Camp Ground. The creek "break ups" on either side of road due to very large boulders, some accumulations of which are big enough to form islands with their own trees: the mill race (the southernmost of the "tributaries") was one of the original 'splits."

East of the bridge there are extensive meadows that were probably original bottom land: walking north to Thatcher Rd, then east along it, one finds the very slow-running Kimple Creek meeting the Tohickon within such bottom land on either side of Thatcher Rd. Where the two creeks join the overall ecology is very similar to land representing the Quakertown Swamp on Axehandle Rd. (Grid G-6).

Thatcher Rd from Grid F-7 to Axehandle Rd (Grid G-6): a General Evaluation and its Relation to Flood Control

North on Grid F-7 Thatcher Rd begins its up and down course westward towards Axehandle Rd. Beginning on high wooded slopes (F-7, NE) it descends to the bridge over Kimple Creek and rises again immediately towards the junction with Covered Bridge Rd. Continuing uphill, wooded slopes with occasional houses lie northwards while gentle slopes down towards Tohickon Creek are visible to the south.

Continuing generally west through a 90° right-hand bend, a dog-leg, and a 90° left-hand bend (NW corner Grid F-7) a sharp "dip" in Thatcher Rd just after third bend (E margin of Grid F-7) reveals a picture that is repeated later: a "dry gully" – water-filled when last visited – filled a large man-made pond on its descending course from the upland meadow. Largish boulders are scattered about.

After the sequence of bends Thatcher Rd runs NE → SW through Grids F-6 and G-6, i.e., parallel to the overall course of Tohickon Creek as seen in Grid F-7.

A walk in a SW direction along Thatcher Rd. shows land to the west (maximum altitude approx 550'): beyond that ridge the land "falls away" to the fertile central plain of Richland Township (the Dry Branch Management Area). East of Thatcher Rd., acres of arable land slope so gently (altitude 480' or less) towards Tohickon Creek that the fields often seem "flat."

Subsequently, all meadows on SE side of Thatcher Rd. hold so much surface water they could be described as "horizontal wetlands" with occasional boulders sticking out. Drainage ditches, oriented NW to SE obviously derive from "dry gullies" that, depending on elapsed time since the last rainfall may be full of running water as are ditches on both sides of Thatcher Rd.

The fact that boundaries demarcating property lines are so often occupied by "dry gullies" implies that while small ones may be covered up by arable fields leaving only areas where "concrete to liquid mud" transitions can occur with 60 hrs during the summer, the larger ones have historically served as property markers. This confirms observations made elsewhere in the eastern part of Richland Township. The tortuous pattern of several roads in this MTMA, e.g., Richlandtown and Axehandle, probably reflect their evolution over the past 500 years from trails on the margins of water courses to early farm roads to macadam surfaces in the mid 20th century. Thus, since colonial days, even though few wooded areas have remained uncut and many acres have been under continuous cultivation, the sub-soils have had opportunities to slowly regain equilibrium after disruption from their pristine state. The gradual establishment of road beds has been a factor in the process of achieving this equilibrium. Because flooding of local roads has been increasing steadily in extent and frequency over the past 20 years the relation between "permanently water logged fields" and existing roads should be born in mind in planning future development. There is a great need for an organized monitoring of flooding throughout the Tohickon watershed and such a study should be integrated with documentation of precipitation in different regions of the watershed over short periods throughout the year.

Fieldnotes Describing the Quakertown Swamp (Bog Run) from West to East with Reference to Nine Man-made Crossings of Bog Run enumerated (1) through (09)

General Introduction

Except for those concerning the origin (Note 0) of Bog Run (the central, permanently running waterway of The Quakertown Swamp and its eastern-most confluence with Tohickon Creek (Note 00), the following descriptions (01) – (09) allude to features lying to the east of the defined man-made crossings. All allusions to altitude are based on USGS Map >>>>>>> except where indicated.

(0) Notes on Land where Bog Run originates

Grid location – much of J4

Physical Description (especially altitude): An "amphitheater-shaped" portion \approx 0.56 sq miles in area, rocky and covered with mature trees, this land was probably never farmed. It comprises a network of "dry gullies" (some probably permanent year-round) circumscribed by Rich Hill Rd (N – altitude 570'), Whaland and Catch Basin Rds (W – 560') and Green Top Rd (S – 600'). South of the latter on grid J4 there is an unnamed, western "extension" of Rocky Ridge with a maximum altitude of 700'. Pasture and/or "lawns" associated with domestic dwellings are seen near roads. Where the gulleys meet to form Bog Run proper (see [01]) below, altitude is approx. 530' and gentle, upwardly inclined, rocky slopes covered with mature trees are visible to the west, north and south. Around the meeting of contributing "streams and gulleys" visible from roadside of exit ramp (01 below) wetlands comprise scrubby trees, with little ground cover in the very swampy land.

Comments: Mr Fried at end of Masi Rd spoke of extensive flooding from network of "dry gulleys" throughout his property and adjacent land: water runoff from auto junk yard accessible from Green Top Rd probably leaches into Bog Run system.

(01) Sellersville exit from Route 309 (Bethlehem Pike) southbound

Grid location – J4, north-east corner

Compass orient creek WSW \rightarrow ENE

Comments: Bog Run passes through a 10' wide passage beneath roadway of Sellersville exit. There is little of ecological interest around creek except for junk and debris that needs cleaning up.

(02) Route 309 and Bethlehem Road northbound

Distance from (01) 0.1 miles Distance from source tributaries 0.1 miles

Grid location – J4, north-east corner

Compass orient creek WSW \rightarrow ENE

Comments: The natural gas pipeline (running \approx west to east across northern aspect of Grid J4) has a "kink" in it that passes under the Sellersville exit ramp and these roadways. From hereon, along its path, an extensive growth of *Phragmites* follows Bog Run eastwards. Around the margins of a flat, *Phragmites*-covered floodplain there are scrubby trees. To both north and south, as elevation increases slightly over gentle slopes (visually very similar to comparable slopes on either side of Bog Run on Axehandle Rd – see [09] below) some more mature trees are present. A property owner told me that flooding of the entire flood plain occurred during the recent rains.

(03) Old Bethlehem Pike

Distance from (2) 0.2 miles Distance from source tributaries 0.3 miles

Grid location – J4, extreme north-east corner

Compass orient creek WSW → ENE, approx parallel to Rich Hill Rd to the north

Comments: *Phragmites* growth characterizes entire region eastwards with free-running stream occasionally visible on southern aspect. USGS map shows creek descending below 520' contour just beyond the roadway and this is confirmed by the very slight upward incline to swamp origin as one looks westwards towards highway. The flood plain becomes steadily wider as one moves eastwards and over the gentle slopes up through the private properties on Rich Hill Rd, *Phragmites* is replaced first by scrubby and then mature trees. At the western end of this stretch of Bog Run, Rich Hill Rd lies at ≈ 560' or lower, but at the eastern end roadway lies in the flood plain (≈ 510' altitude). To the south, rocky, tree-covered slopes are slightly steeper reaching a maximum altitude of 700' on Rocky Ridge.

About halfway along this stretch i.e., ≈ 0.1 miles east of Old Bethlehem Pike, the flood plain widens. North of Rich Hill Rd, rocky, tree-covered slopes are replaced by extensive lawns running fairly steeply from 540' altitude down to the floodplain that lies within a narrow corridor bounded by the 520' contour line. The natural gas pipeline, having crossed and recrossed the creek four times, finally swings southwards away from Bog Run. On private property on Rich Hill Rd, ≈ 0.4 miles from (03) the latter has been transformed into a large, "lawn encompassed", man-made (? 1950s) pond, surrounded by, and enclosing, large rocks: regular mowing has eliminated *Phragmites* from around the pond but this ecosystem follows the pipeline towards the Bethel Baptist Church lands on Rock Hill Rd. Evidence of much beaver activity in the scrubby trees surrounding the extreme eastern aspect of the pond. As the creek passes under a bridge on Rich Hill Rd (04 next), the rate of water movement is so slow that it can scarcely be discerned.

(04) Rich Hill Road

Distance from (03) 0.78 miles Distance from source tributaries 1.08 miles

Grid location – I5, south-east corner

Compass orient creek ≈ W → E, approx parallel to Rich Hill Rd to the south.

Comments: Bog Run, where visible, is difficult to access because north and south margins of the boggy floodplain are covered by scrubby small trees. As it emerges from beneath a small bridge on Rich Hill Rd., to the west a second, somewhat smaller man-made pond abuts scrubby swampland. When this second pond, also surrounded by water-logged "lawns" is left behind, the creek disappears into impenetrable, scrubby swampland. Within this the heronry is located: its "geopolitical address" is the North West corner of the intersection of Rich Hill Rd and Muskrat Rd. Looking due north from the southern end of Muskrat Rd. one sees a 0.34 mile stretch of swampland that lies within an expanded 520' contoured region: a moderate-sized pond (? Man-made) lies west of Muskrat Rd at the northern tip of the flood plain. Muskrat Rd floods regularly. Originating within the scrub-covered, impenetrable wetlands housing the heronry, three distinct "sub-divisions" of Bog Run can be identified as they enter culverts to run under the roadway.

(05) Muskrat rd

Distance from (04) 0.31 miles Distance from source tributaries 1.39 miles

Grid location – I5, south-east corner

Compass orient creek W → E

Comments On the eastern side of the roadway the three sub-divisions of Bog Run immediately reform similar impenetrable wetlands that are State Game Lands. To the south these are accessible from Muskrat Rd and one can walk through the substantial wooded area – albeit very swampy, to access a single body of open water that drains under the railroad line to the east. The railroad, running NNW atop

an elevated embankment forms the eastern constraining boundary of the State Game Lands: impenetrable wetlands lie all along the base of the embankment. The single bridge through which Bog Run passes eastwards produces an observable "main run" of the creek within which water movement is barely discernible.

(06) Railroad

Distance from (5) 0.19 miles Distance from source tributaries 1.58 miles

Grid location -- I6, west center

Compass orient creek – SSW → NNE

Comments Looking eastwards from the railroad embankment the general topography is somewhat similar to that just described except that patches of *Phragmites* are interspersed randomly among scrubby trees and small ponds. Looking beyond these wetlands (apparently the flood plain) one sees the gentle rise of the land to the northwest of Rocky Ridge Rd and to the south beyond Rich Hill Rd. Using the 520' contour lines as a defining periphery "the swamp" reaches maximal width along this stretch. To the east, Rock Hill Rd runs ≈ south to north at the base of Rock Hill itself whose steep, rocky, slopes covered with mature trees reaches a maximum altitude of 860'. On the western side of Rock Hill Rd, on several properties, the slightly gentler slopes (altitude less than 520') have been cleared and transformed into pasture and lawns. Residents state that within them extremely boggy tracts alternate with drier regions and the "dry gullies" responsible for this condition can be followed up the slopes of Rock Hill. In Summer and Fall, when those rocky slopes are relatively dry, the gullies – lacking free flowing or pooled water – can be identified by linear tracts of ferns and mosses.

(07) Rocky Ridge Rd

Distance from (06) 0.43 miles Distance from source tributaries 2.01 miles

Grid location – H6, south-west corner

Compass orient creek ≈ S → N then arching gently to NE – arch approx 2.0 miles

Comments: The impenetrable wetlands (≈ flood plain of Bog Run within 520' contour) described above continue northwards and traverse two State Game Lands lying south and north of Rocky Ridge. A discreet Bog Run can only be identified where it passes under the road. Similar to the description in (04) above, the general topography of the Swamp can be confirmed if one stands at the 90° bend (altitude 540') in Rocky Ridge Rd and looks eastward towards the Rockhill Rd intersection (altitude less than 520'): such a view spotlights the relationship between extended gentle slopes and lower wetlands.

This stretch of Bog Run runs roughly parallel to East Paletown Rd ≈ 0.3 - 0.4 miles to the west (see NW corner of Grid H6 and east of Grid H5). After Bog Run descends below the 500' contour line within the State Game Lands it runs in a narrow channel within an extensive plateau bounded by the 520' contour line. At its SW margin this plateau rises very gradually to 540' (the railroad cutting) then 560' further towards Rich Hill. At its NW end, along Route 313, there is a similar gentle rise to an altitude of 540+'. This sway-backed plateau is the south eastern margin of the erodable soils (Fig. 9) lying atop the Brunswick formation (Fig. 3) that drains into Bog Run by very steep slopes between the State Game Lands and Route 313. While domestic residences and fallow farmland line East Paletown Rd, the Bog Run flood plain – itself covered by scrubby trees -- is bounded by mature trees growing on steep rocky slopes that have probably never been farmed.

Away from "the swamp", to the east, there is a major "dry gully" with many associated tributaries forming a complex drainage system that runs roughly parallel to Rockhill Rd: it is not marked on some commercial maps and was not shown on Grid H6. It runs under Route 313 as a well-defined water course, about 800' east of the intersection with Rockhill Rd: it supplies water to several man-made ponds in the Paletown Fish and Gun Club and is the basis for several designated wetlands at approx 496' altitude at the eastern end of Axehandle Rd. Although this entire drainage system is quite separate from Bog Run *per se* in Grid H6, it makes a fairly major contribution to the extreme eastern end of the swamp.

(08) Route 313

Distance from (7) 2.00 miles Distance from source tributaries 4.01 miles

Grid location – G6 (Not allocated to PFAM, see Harris), center southern edge

Compass orient creek \approx S \rightarrow N

Comments: A well-defined water course as it passes under Route 313, Bog Run here reaches its lowest altitude. While the USGS map shows that within the State Game Lands north of Rocky Ridge Rd Bog Run descends below the 500' contour, a recent survey of contiguous private land shows its altitude to be 482' – a level it maintains until it joins Tohickon Creek (Grid G6, center right). Eastward from Route 313 Bog Run loses its identity immediately as it enters extensive reed-covered wetlands whose western portion belongs to Heritage Conservancy (north) and private property including the Paletown Fish and Gun Club (south). The USGS contour lines show increasing widening between the 500' contour lines north of Route 313 and edges that are moderately steep slopes down to the flood plain margin at 488'. The bottomland was farmed until 1916 when tractors replaced oxen and dray horses. Until a few years ago "the swamp" between Route 313 and Axehandle Rd contained numerous old growth trees many of which are now dead and falling. The recent demise of many tall trees within the flood plain may be attributed to restoration of the beaver population over the past 15 years.

On the south side, towards Axehandle Rd where it joins Route 313 at an altitude above 500' there are numerous extensive wetland areas and several man-made ponds (on the grounds of the Fish and Gun Club) that receive their water from a significant tributary arising from the slopes paralleling Rockhill Rd (see [07] above).

Towards the northern horizon tall mature trees that border the scrub trees within the flood-plain can be seen. Within that flood-plain Bog Run has a permanently running, meandering course that goes through to Axehandle Rd.

(09) Axehandle Rd

Distance from (8) 1.0 miles Distance from source tributaries 5.01 miles

Grid location – G6 (Harris) slightly east of center

Compass orient creek \approx W \rightarrow E

Comments: Visible only looking southward from Axehandle Rd are various wetlands. Most lie below 490', although some extend beyond the flood-plain boundaries. To the east and west they include various types of ecosystem ranging from restored woodlands (80+ years growth), replete with exposed boulders and a variety of slopes.

The east-south-eastern view along Axehandle Rd shows modest rocky slopes rising to 560'. West-south west, very gentle slopes rise to 560' at the intersection of East Paletown Rd and Route 313 covered by a variety of ecosystems. Adjacent to Bog Run there is scrubby woodland, but beyond lie arable land, pasture, "lawns", and a large man-made (1946) pond.

Looking eastwards from the two 30" conduits that carry Bog Run beneath Axehandle Rd – except during the frequent flooding of the roadway – Bog Run continues as a discreet waterway through private land north of the third, eastward-directed spur of Axehandle Rd.

The permanently-running water course is surrounded on either side by a mixture of mature, old growth trees intermingled with occasional scrubby inclusions. To the north a large field of permanent pasture lying within the flood plain has a large man-made pond beyond it: the flood plain pasture, and pasture lying "up the slope, above the pond" have several "dry/wet gullies" that are the basis for intermittent very soggy regions., i.e., truly "swampy" except after periods of extended drought. South of Bog Run, beyond the eastward extension of Axehandle Rd., wooded, boulder covered slopes rise to an altitude of 540-560' depending on the specific location.

(00) Where Bog Run joins TOHICKON CREEK

Distance from (09) 0.23 miles Distance from source tributaries 4.24 miles

Grid location: G6, center east

Compass orient creek: WSW → ESE

Comments: Over its last 0.23 miles, between Axehandle Rd and Tohickon Creek, Bog Run is a well-defined waterway that joins the eastern end of an inverted U-shaped bend in Tohickon Creek (center north on Grid G6). The latter lies below 480' and receives run-off from the pasture and arable land covering 1.0 miles of gentle slopes originating at an altitude of 540+' SE of the junction of Route 313 and East Paletown Rd.

The "bottom lands" thus defined are the meeting point of the entire Upper Tohickon Creek drainage system from the center and north of Richland Township, Bog Run, and the gentle slopes of the Mid Tohickon drainage system in Grid H7 that in fact receives its supply from the north western slopes of Rock Hill (altitude 860'). The specific location of the join between Bog Run and Tohickon Creek probably varies from year to year as flood waters continually bring debris from the north and north-west and damage the "banks".

Appendix VI. Bog Run Sub-Watershed Hydrology
submitted by Paul Maderson, Ph.D.

Appendix VI. Bog Run Sub-Watershed Hydrology *submitted by Paul Maderson, Ph.D.*

Introduction – Some Generalities

On Heritage Conservancy's latest map of The Quakertown Swamp (November 2004), its indicated boundaries approximate those of the Bog Run (= Bog Creek) Management Area: those boundaries derive from a joining of the known highest points on either side of Bog Run, the central drainage channel of "the swamp." Comparison of that map with a USGS map showing contour lines – even at 20' resolution – reveals a curious feature: lands that are customarily described as parts of the Quakertown Swamp lie at elevations ranging from below 480' above sea level (at the confluence of Bog Run and Tohickon Creek) to as high as 560' (at the source of Bog Run west of the Sellersville exit from Route 309). This confirms what many residents and land owners know – a unique feature of our Swamp is that it can get swampier as one moves uphill! An understanding of the reasons for this counter-intuitive phenomenon emerges from consideration of land topography and quality along the linear distance of 3.75 miles through which Bog Run meanders. Such an analysis facilitates an understanding of the increased flooding conditions that have occurred in the SE corner of Richland Township over the past 20 years and spotlights the type of further studies necessary to evaluate water management in the future.

Few, if any, parts of today's Quakertown Swamp have been unaffected by human actions over the past 350 years. There is reason to believe that accumulated perturbations have reached a critical threshold that, if ignored, could lead not only to damage to, even destruction of the Swamps' unique flora and fauna that warrant preservation for future generations, but also bring about irreversible future problems in flood management throughout Richland Township.

The key to understanding these issues is quite simple – it is reflected in a feature of Bucks County obvious to the most casual observer. The county's landscape comprises a continuous sequence of gently undulating slopes, the largest of which are rocky and tree-covered and alternate with regions of arable land and pasture now increasingly used for development. In fact, these "flat" arable/ pasture regions themselves vary significantly in altitude even if only by a few feet. The whole is covered by a network of watercourses that meander across the countryside. They vary in width from a couple of feet to 50+': some are permanent, some are prone to drying up after only a few weeks without precipitation.

Richland Township is a microcosm of this variously undulating landscape. Just beyond the northwestern and southeastern corners of the Township occur highlands ranging up to 700' whose rocky, tree-covered slopes directed respectively southeast and northwest, merge imperceptibly into a flat central region 200' lower. Across the latter run major waterways – Tohickon Creek and its tributaries drain lands in the northern quadrant, while Morgan Creek and Beaver Run drain those to the west and southwest. They are confluent with Bog Run in the east central portion of the Township after which the entire Tohickon Creek drainage system empties into Lake Nockomixon. However, on its final course, the system receives major contributions from the Rockhill highlands on either side of Route 313. Study of Bog Run (and the surrounding Quakertown Swamp) reveals that their size and area (small when compared in whole or part to the entire Upper Tohickon system) do not reflect their role in the dynamics of water drainage.

A More Detailed Assessment

The subsoil of the northwest and southeast corners of Richland Township comprises a fractured diabase rock covered only sporadically by thin topsoil as is observable in an old quarry at the intersection of Thatcher and Axehandle Rds (Grid G6). For three centuries, over the flat central plain, the soil atop Brunswick formation rock served as prime agricultural land. The meanderings of Tohickon Creek, Morgan Creek and Beaver Run across it reflect the continual pattern of soil deposition and erosion of the dense alluvial soils due to annual precipitation. Although less obvious to the casual observer, similar meanderings influence the sporadic topsoils of the north western and southeastern lands. Primarily documented via expression of erosion channels in the diabase rock, the effect of water drainage over tens of thousands of years has produced a tortuous pattern of contour lines. Long-term occupants of lands around the Quakertown Swamp know of surface features that reveal these erosion channels and that knowledge is amenable to formal analysis from whose results predictions can be made.

Ecosystems in and Around the Swamp Vary Greatly

The assumed central axis of the swamp is Bog Run even if it is not always recognizable as a discreet waterway. The surrounding flood plain is often covered by aquatic rushes or grasses including native or invasive immigrant species. It is presently uncertain whether such represents the primordial swamp as certain stretches today comprise impenetrable scrub woodlands where a free flowing Bog Run cannot be identified. Expressed as a function of axes at 90° to any segment of Bog Run, the width of the flood plain varies. Its edges presently comprise a diversity of ecosystems that reflect human interference. In fact, even the rush-covered flood plains of the eastern portions were, until recently "unnatural": in the absence of beavers, 80+ years of restoration following cessation of farming of the bottomlands in 1916, permitted growth of tall hardwoods. These are presently being "culled" by the expanding, reintroduced rodents.

Five ecosystems can be categorized on the periphery of the flood plain today:-

- (a) Mature 80+ years old woodlands, secondarily restored after cutting during the early 20th century.
- (b) Scrubby woodland, perhaps the first steps in forest renewal but equally possibly adaptive of extreme wetland conditions as such are often continuous with the flood plain vegetation.
- (c) Arable land – now confined to the extreme eastern portion of the swamp close to Tohickon Creek.
- (d) Man-made ponds – manifested in three different sub-types i) dug out within the primary water course e.g., where two ponds lie either side of Rich Hill Rd; ii) dug out within the margin of the flood plain so that wetlands may have emerged on the distal side, away from Bog Run e.g., on properties along Axehandle Rd; iii) dug out beyond the margin of the flood plain at a higher altitude e.g., Paletown Fish and Gun Club.
- (e) Pasture and/or "lawns" – such range from fallow arable land, through horse pastures, to "short green growth" to "typical American suburban lawns".

Among these variants, it is within Category (a) that a major feature of land surrounding the Quakertown Swamp is most readily recognized – what is known locally as a "dry gully."

A walk over wooded rocky slopes after a recent rainfall reveals many tiny streams running downhill: some or all of any one particular stream may have a permanent effect on the land surface – water runs between rocks or in a distinct, clay-lined channel. After a few days, a return visit may reveal a lack of running water and only discontinuous sporadic large and small pools. After a period of drought, neither running water nor pools may be discerned: fern and moss growth reveals "dry gullies." Examination of appropriate maps reveals that where there are stretches of "major dry gullies" – in fact sometimes continuously running streams – adjacent wooded slopes are covered by a tortuous network of such waterways and it is clear that the land around Bog Run, indeed Bog Run itself, has been carved from the diabase by erosion. Where large boulders are exposed beside streams or bounding pools one concludes that when the action of running water cannot be detected, it is possible that the water course is expressed beneath the sparse soil. This conclusion is supported by the existence of "downstream" pools and swampyness of leaf-mold covered areas within woodland. These observations suggest that the rocky,

wood-covered slopes throughout the south eastern corner of Richland Township and beyond act as an enormous sponge from which water resulting from all types of precipitation continually feeds the Quakertown Swamp.

For various reasons, identification of "dry gully" runoff patterns within categories (b) – (e) may be disguised. However, given awareness of the "dry gully phenomenon", there are different clues to their existence in all four.

In Category (b) sometimes conditions essentially similar to those readily discernible in mature woodlands can be detected. In other places and locations within scrub woodland regions as one walks parallel to Bog Run one encounters alternating regions of degrees of swampyness although several visits to one location are needed to reveal and confirm them.

In Category (c) fields may be delineated by drainage ditches that are modified dry gullies: walking across fields reveals alternating regions of soil of varying degrees of swampyness.

In Category (d) the margins of "spring-fed", man-made ponds, away from Bog Run, is most revealing of erstwhile "dry gullies." As one walks along them, or especially as one mows even with a light tractor, the alternating degrees of swampyness and the relation of their expression to recent rainfall is especially obvious.

However, when a pond is lacking, identifying these drainage patterns over pasture or "lawns" (Category [e]) is most difficult. Their identification requires frequent visits to a specific location at different times of the year and at different intervals after precipitation. Extreme drought will sometimes reveal a paucity of available water in specific places while only feet away the grass looks healthy. When and wherever I have asked property owners about the extent of "swampyness" on their lands they have confirmed my experience of my own land on Axehandle Rd.

Three Additional Features Warranting Consideration

First, no land anywhere in Richland Township is "flat" – local variations of 2 – 4' are the rule rather than the exception, so that, given the clay-like nature of most of our soils, there is everywhere a tendency for significant pooling of surface water that lasts hours, in some locations days after precipitation.

Second, in nearly all regions that have been cleared for agricultural use over the past 300 years, especially around the swamp, the topsoil is so shallow that exposure of large boulders, too large to be moved is a regular occurrence. Always a minor problem for homeowners during mowing, such boulders help identify the proximity of the rock base below the soil: when such are evident they provide good warning that any attempt to excavate trenches etc. could present major problems.

Third, because of the complexities of contour lines that reflect aeons of water erosion, evaluating potential patterns of runoff drainage necessitates consideration of land topography at points far distant from specific sites. There is a specific feature of land around East Paletown Rd where this is of concern with respect to preservation of the swamp. North and west in the direction of Morgan Creek, NNE towards Tohickon Creek and south and east towards Bog Run, the 500' contour line may be followed. Within its confines, at an elevation of 520' a plateau extending from Axehandle Rd in the north to Old Bethlehem Pike in the south can be discerned. Around the intersection of East Paletown Rd and Route 313 and just east of the railroad track, land reaches an altitude of 540+'. Because of the shape of the plateau with its undulating surface, the nature of its soil covering and the location of these two high points, substantial surface water accumulation occurs. Given the predictably shallow soil on this erstwhile farmed land, beneath which is an intrusion of the Brunswick formation, it is possible that major excavations such as those associated with installation of sewers and other facilities needed for housing developments would necessitate blasting of rock – an undesirable activity so close (0.1-0.2 miles) to Bog Run.

The Overall Problem

One hears it said that "Flooding follows heavy rain." It is often implicit that because we cannot control the rain, we can do nothing about flooding. The assertion is simplistic and the conclusion suspect.

While it is obvious that heavy rain or indeed any form of precipitation is a factor in flooding, there are several other causal factors that demand further documentation.

The situation suggested by presently available data, including new observations in this study concerning Bog Run and the Quakertown Swamp is as follows:

While apparently small in size relative to other management areas in the Upper Tohickon Creek system, special features of the topography and geology of land around Bog Run suggest that herein lie the clues to future flooding problems.

The land masses south and east of Paletown Rd act as enormous sponges: water from the surface may accumulate deep in the masses of fractured rock of the diabase. The degree of saturation of these lands at any time affects the ability of Bog Run – and therefore the Quakertown Swamp ecosystem in general -- to accommodate sudden severe storms. When such storms break only over the southern portion of Richland Township, especially if some days or weeks have passed since previous precipitation, sudden storms do not endanger the swamp. Obviously variations on these themes have been part of the history of the swamp since before European colonists came to Bucks County.

Since European immigration began, additional complicating factors have emerged. The most important of these has been the increased development over the past 15 years. The increase in impermeable surface area forces rainwater to enter other drainage systems throughout Richland Township and they all meet in one location on the eastern margin of the Township. Because the northwestern lands of the Township are similar to those of the southeast, depending on the degree of soil and sub-soil saturation, heavy rains there will release varying amounts of flood water into the Tohickon Creek and its tributaries. It is also possible that heavy rains could occur over the western part of the Township and such would magnify the effect.

In Fall 2003, when heavy rain fell over the entire Township and surrounding region, a neighbor who has known the Axehandle Rd conditions for the last 50 years observed something he had never seen before: the direction of water flow across the flooded roadway ran upstream in Bog Run. This suggests that for whatever reason, human intervention or natural changes, we have reached some sort of threshold in the dynamics of flow in the Tohickon system.

In the absence of appropriate data that permit an analysis of flooding conditions throughout the Township as a function of rainfall patterns it cannot be ruled out that factors other than increased development are at work. My own observations on land around Axehandle Rd over the past 20 years suggest that, even in the absence of any major disturbance, the "dry gullies" discussed above change dynamically: areas of land that once accumulated surface water and became excessively swampy no longer do so and vice-versa. While beaver activity has certainly changed the ecology of the stretch of Bog Run between Route 313 and Axehandle Rd, death of trees often cannot be attributed to direct damage and drowning of the roots may be involved: floral changes are occurring. A stretch of western Thatcher Rd just before the intersection with Route 313 that has flooded after every moderately severe rainfall for years has not been doing so recently. However, the very fact that we can discern potentially dangerous changes in drainage that could be attributed to natural events makes it imperative that any major human impact on land use should be approached with very great caution.

Appendix VII. Possible and Known At-Risk Species

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Plant Species and Associations of the Upper Tohickon Creek Watershed (obtained through a Pennsylvania Natural Diversity Inventory review)

Scientific Name	Common Name	State Status	Proposed State Status
<i>Carex buxbaumii</i>	Brown Sedge	Tentatively Undetermined	Rare
<i>Carex meadii</i>	Mead's Sedge	Tentatively Undetermined	Endangered
<i>Castilleja coccinea</i>	Scarlet Indian-paitbrush	Tentatively Undetermined	Threatened
<i>Iris prismatica</i>	Slender Blue-Iris	Endangered	Endangered
<i>Juncus biflorus</i>	Grass-leave Rush	Tentatively Undetermined	Endangered
<i>Leucothoe racemosa</i>	Swamp Dog-hobble	Tentatively Undetermined	Threatened
<i>Linum intersursum</i>	Sandplain Wild Flax	Endangered	Endangered
<i>Phlox pilosa</i>	Downy Phlox	Tentatively Undetermined	Endangered
<i>Ratibida pinnata</i>	Gray-headed Prarie Coneflower	Tentatively Undetermined	Extirpated
<i>Samolus parviflorus</i>	Pineland Pimpernel	Tentatively Undetermined	Endangered
<i>Trillium cernum</i>	Nodding Trillium	None	Tentatively Undetermined
Plant Community Associations			
	Highbush Blueberry-Sphagnum Wetland		
	Robust Emergent Swamp		

Vertebrate Species of Bucks County (obtained from the Pennsylvania Natural Heritage Program website: www.naturalheritage.state.pa.us)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Proposed State Status	Federal Status
<i>Acantharchus pomotis</i>	Mud Sunfish	G5	SX		PX	
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	G3	S1	PE	PE	LE
<i>Acipenser oxyrinchus</i>	Atlantic Sturgeon	G3	S1	PE	PE	LT,C
<i>Aphredoderus sayanus</i>	Pirate Perch	G5	SX		PX	
<i>Ardea herodias</i>	Great Blue Heron	G5	S3S4B,S4N			
<i>Bartramia longicauda</i>	Upland Sandpiper	G5	S1S2B	PT	PT	
<i>Cistothorus palustris</i>	Marsh Wren	G5	S2S3B		CR	
<i>Cistothorus platensis</i>	Sedge Wren	G5	S1B	PT	PT	
<i>Glyptemys (Clemmys) muhlenbergii</i>	Bog Turtle	G3	S1S2	PE	PE	LT, SAT
<i>Enneacanthus chaetodon</i>	Blackbanded Sunfish	G4	SX		PX	
<i>Enneacanthus obesus</i>	Banded Sunfish	G5	S1	PE	PE	
<i>Etheostoma fusiforme</i>	Swamp Darter	G5	SX		PX	
<i>Falco peregrinus</i>	Peregrine Falcon	G4	S1B,S1N	PE	PE	PS:LE
<i>Heterodon platirhinos</i>	Eastern Hognose Snake	G5	S3S4			
<i>Kinosternon subrubrum</i>	Eastern Mud Turtle	G5	SH		PX	
<i>Lepisosteus osseus</i>	Longnose Gar	G5	S3	PC	CR	
<i>Lepomis megalotis</i>	Longear Sunfish	G5	S1	PE	PE	
<i>Lontra canadensis</i>	Northern River Otter	G5	S3		CA	
<i>Myotis leibii</i>	Eastern Small-footed Myotis	G3	S1B,S1N	PT	PT	
<i>Myotis septentrionalis</i>	Northern Myotis	G4	S3B,S3N		CR	
<i>Notropis chalybaeus</i>	Ironcolor Shiner	G4	S1	PE	PE	
<i>Nycticeius humeralis</i>	Evening Bat	G5	SUB,SUN		CR	
<i>Pandion haliaetus</i>	Osprey	G5	S2B	PT	PT	
<i>Phoca vitulina</i>	Harbor Seal	G5	SNA			
<i>Phocoena phocoena</i>	Harbor Porpoise	G4G5	SNA			
<i>Protonotaria citrea</i>	Prothonotary Warbler	G5	S2S3B		CR	
<i>Pseudacris triseriata kalmi</i>	New Jersey Chorus Frog	G5T4	S1	PE	PE	
<i>Pseudemys rubriventris</i>	Redbelly Turtle	G5	S2	PT	CA	PS
<i>Rallus limicola</i>	Virginia Rail	G5	S3B			
<i>Rana sphenoccephala</i>	Coastal Plain Leopard Frog	G5	S1	PE	PE	
<i>Tyto alba</i>	Barn-owl	G5	S3B,S3N		CA	

Fish, Amphibian, Reptile, and Aquatic Invertebrate Species in Bucks County Regulated by the Pennsylvania Fish & Boat Commission.

Scientific Name	Common Name	PA Status
<i>Acantharchus pomotis</i>	Mud Sunfish	Believed extirpated
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	Endangered
<i>Acipenser oxyrinchus</i>	Atlantic Sturgeon	Endangered
<i>Alasmidonta heterodon</i>	Dwarf wedgemussel	Endangered
<i>Alasmidonta varicosa</i>	Brook floater	Rare
<i>Aphredoderus sayanus</i>	Pirate Perch	Believed extirpated
<i>Caecidotea pricei</i>	Price's Cave isopod	Imperiled / vulnerable
<i>Calopteryx aequabilis</i>	River jewelwing	Imperiled
<i>Glyptemys (Clemmys) muhlenbergii</i>	Bog Turtle	Endangered
<i>Enneacanthus chaetodon</i>	Blackbanded Sunfish	Believed extirpated
<i>Enneacanthus obesus</i>	Banded Sunfish	Endangered
<i>Etheostoma fusiforme</i>	Swamp Darter	Believed extirpated
<i>Heterodon platirhinos</i>	Eastern hognose snake	Vulnerable
<i>Kinosternon subrubrum</i>	Eastern Mud Turtle	Believed extirpated
<i>Lampsilis cariosa</i>	Yellow lampmussel	Vulnerable
<i>Lepisosteus osseus</i>	Longnose Gar	Candidate
<i>Lepomis megalotis</i>	Longear Sunfish	Endangered
<i>Leptodea ochracea</i>	Tidewater mucket	Believed extirpated
<i>Macromia alleghaniensis</i>	Allegheny river skimmer	Critically imperiled
<i>Notropis chalybaeus</i>	Ironcolor Shiner	Endangered
<i>Pseudacris triseriata kalmi</i>	New Jersey Chorus Frog	Endangered
<i>Pseudemys rubriventris</i>	Redbelly Turtle	Threatened
<i>Rana sphenoccephala</i>	Coastal Plain Leopard Frog	Endangered

Status Definitions Used in Appendix VII

GLOBAL RANK DEFINITIONS

Global ranks (i.e. range-wide conservation status ranks) are assigned at NatureServe's Headquarters or by a designated lead office in the Heritage/Conservation Data Center Network.

- GX Presumed Extinct - Believed to be extinct throughout its range. Not located despite intensive searches of historic sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
- GH Possibly Extinct - Known from only historical occurrences. Still some hope of rediscovery.
- G1 Critically Imperiled - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or stream miles (<10).
- G2 Imperiled - Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or stream miles (10 to 50).
- G3 Vulnerable - Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
- G4 Apparently Secure - Uncommon but not rare, and usually widespread. Possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.
- G5 Secure - Common, typically widespread and abundant. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

Variant Global Ranks

- G#G# Range Rank - A numeric range rank (e.g., G2G3) is used to indicate uncertainty about the exact status of a taxon.
- GU Unrankable - Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
- G? Unranked - Global rank not yet assessed.
- HYB Hybrid - Element represents an interspecific hybrid.

Rank Qualifiers

- ? Inexact Numeric Rank - Denotes inexact numeric rank.

- Q Questionable Taxonomy - Taxonomic status is questionable; numeric rank may change with taxonomy.
- C Captive or Cultivated Only - Taxon at present is extant only in captivity or cultivation, or as a reintroduced population not yet established.

Infraspecific Taxon Ranks

- T Infraspecific Taxon (trinomial) - The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species= basic rank (e.g., a G1T2 subrank should not occur). A population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T rank; in such cases a Q is used after the T rank to denote the taxon's questionable taxonomic status.
-

STATE RANK DEFINITIONS

- SX Extirpated - Element is believed to be extirpated from the "state" (or province or other subnational unit).
- SH Historical - Element occurred historically in the state (with expectation that it may be rediscovered), perhaps having not been verified in the past 20 years, and suspected to be still extant. Naturally, an Element would become SH without such a 20-year delay if the only known occurrences in a state were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, SH-ranked Elements would typically receive an S1 rank. The SH rank should be reserved for Elements for which some effort has been made to relocate occurrences, rather than simply ranking all Elements not known from verified extant occurrences with this rank.
- S1 Critically Imperiled - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer occurrences or very few remaining individuals or acres.
- S2 Imperiled - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically 6 to 20 occurrences or few remaining individuals or acres.
- S3 Vulnerable - Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences.
- S4 Apparently Secure - Uncommon but not rare, and usually widespread in the state. Usually more than 100 occurrences.

- S5 Secure - Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.
- S? Unranked - State rank is not yet assessed.
- SU Unrankable - Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible, the most likely rank is assigned and a question mark added (e.g., S2?) to express uncertainty, or a range rank (e.g., S2S3) is used to delineate the limits (range) of uncertainty.
- S#S# Range Rank - A numeric range rank (e.g., S2S3) is used to indicate the range of uncertainty about the exact status of the Element. Ranges cannot skip more than one rank (e.g., SU should be used rather than S1S4).
- HYB Hybrid - Element represents an interspecific hybrid.
- SE Exotic - An exotic established in the state; may be native in nearby regions (e.g., house finch or catalpa in eastern U.S.).
- SE# Exotic Numeric - An exotic established in the state that has been assigned a numeric rank to indicate its status, as with S1 through S5.
- SA Accidental - Accidental or casual in the state (i.e., infrequent and outside usual range). Includes species (usually birds or butterflies) recorded once or only a few times. A few of these species may have bred on the one or two occasions they were recorded. Examples include European strays or western birds on the East Coast and vice-versa.
- SZ Zero Occurrences - Not of practical conservation concern in the state because there are no definable occurrences, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long distance migrants whose occurrences during their migrations have little or no conservation value for the migrant as they are typically too irregular (in terms of repeated visitation to the same locations), transitory, and dispersed to be reliably identified, mapped, and protected. In other words, the migrant regularly passes through the subnation, but enduring, mappable Element Occurrences cannot be defined. Typically, the SZ rank applies to a non-breeding population in the subnation -- for example, birds on migration. An SZ rank may in a few instances also apply to a breeding population, for example certain Lepidoptera which regularly die out every year with no significant return migration. Although the SZ rank typically applies to migrants, it should not be used indiscriminately. Just because a species is on migration does not mean it receives an SZ rank. SZ only applies when the migrants occur in an irregular, transitory, and dispersed manner.
- SP Potential - Potential that Element occurs in the state but no extant or historic occurrences reported.
- SR Reported - Element reported in the state but without a basis for either accepting or rejecting the report. Some of these are very recent discoveries for which the program hasn't yet received first-hand information; others are old, obscure reports.
- SRF Reported Falsely - Element erroneously reported in the state (e.g., misidentified specimen) and the error has persisted in the literature.

SSYN Synonym - Element reported as occurring in the state, but state does not recognize the taxon; therefore the Element is not ranked by the state.

* S rank has been assigned and is under review. Contact the individual state Natural Heritage program for assigned rank.

Not Provided Species is known to occur in this state. Contact the individual state Natural Heritage program for assigned rank.

Breeding Status Qualifiers

B Breeding - Basic rank refers to the breeding population of the Element in the state.

N Non-breeding - Basic rank refers to the non-breeding population of the Element in the state.

Note A breeding status subrank is only used for species that have distinct breeding and/or non-breeding populations in the state. A breeding-status SRANK can be coupled with its complementary non-breeding-status SRANK. The two are separated by a comma, with the higher-priority rank listed first in their pair (e.g., AS2B,S3N@ or ASHN,S4S5B@).

Other Qualifiers

? Inexact or Uncertain - Denotes inexact or uncertain numeric rank. For SE denotes uncertainty of exotic status. (The ? qualifies the character immediately preceding it in the SRANK.)

C Captive or Cultivated - Element is presently extant in the state only in captivity or cultivation, or as a reintroduced population not yet established.

PENNSYLVANIA STATUS DEFINITIONS

Native Plant Status Codes and Definitions

Native Plant Species Legislative Authority: Title 17 Chapter 45, Conservation of Native Wild Plants, January 1, 1988; Pennsylvania Department of Conservation and Natural Resources.

PE Pennsylvania Endangered - Plant species which are in danger of extinction throughout most of their natural range within this Commonwealth, if critical habitat is not maintained or if the species is greatly exploited by man. This classification shall also include any populations of plant species that have been classified as Pennsylvania Extirpated, but which subsequently are found to exist in this Commonwealth.

PT Pennsylvania Threatened - Plant species which may become endangered throughout most or all of their natural range within this Commonwealth, if critical habitat is not maintained to prevent their future decline, or if the species is greatly exploited by man.

- PR Pennsylvania Rare - Plant species which are uncommon within this Commonwealth. All species of the native wild plants classified as Disjunct, Endemic, Limit of Range and Restricted are included within the Pennsylvania Rare classification.
- Disjunct Significantly separated from their main area of distribution
- Endemic Confined to a specialized habitat.
- Limit of Range At or near the periphery of their natural distribution
- Restricted Found in specialized habitats or habitats infrequent in Pennsylvania.
- PX Pennsylvania Extirpated - Plant species believed by the Department to be extinct within this Commonwealth. These plants may or may not be in existence outside the Commonwealth.
- PV Pennsylvania Vulnerable - Plant species which are in danger of population decline within Commonwealth because of their beauty, economic value, use as a cultivar, or other factors which indicate that persons may seek to remove these species from their native habitats.
- TU Tentatively Undetermined - A classification of plant species which are believed to be in danger of population decline, but which cannot presently be included within another classification due to taxonomic uncertainties, limited evidence within historical records, or insufficient data.
- N No current legal status exists, but is under review for future listing.

Wild Birds and Mammals Status Codes and Definitions

Wild Birds and Mammals Legislative Authority: Title 34 Chapter 133, Game and Wildlife Code, revised Dec. 1, 1990, Pennsylvania Game Commission.

- PE Pennsylvania Endangered - Species in imminent danger of extinction or extirpation throughout their range in Pennsylvania if the deleterious factors affecting them continue to operate. These are: 1) species whose numbers have already been reduced to a critically low level or whose habitat has been so drastically reduced or degraded that immediate action is required to prevent their extirpation from the Commonwealth; or 2) species whose extreme rarity or peripheralness places them in potential danger of precipitous declines or sudden extirpation throughout their range in Pennsylvania; or 3) species that have been classified as "Pennsylvania Extirpated", but which are subsequently found to exist in Pennsylvania as long as the above conditions 1 or 2 are met; or 4) species determined to be "Endangered" pursuant to the Endangered Species Act of 1973, Public Law 93 205 (87 Stat. 884), as amended.
- PT Pennsylvania Threatened - Species that may become endangered within the foreseeable future throughout their range in Pennsylvania unless the casual factors affecting the organism are abated. These are: 1) species whose populations within

the Commonwealth are decreasing or have been heavily depleted by adverse factors and while not actually endangered, are still in critical condition; 2) species whose populations may be relatively abundant in the Commonwealth but are under severe threat from serious adverse factors that have been identified and documented; or 3) species whose populations are rare or peripheral and in possible danger of severe decline throughout their range in Pennsylvania; or 4) species determined to be "Threatened" pursuant to the Endangered Species Act of 1973, Public Law 93205 (87 Stat. 884), as amended, that are not listed as "Pennsylvania Endangered".

N No current legal status but is under review for future listing.

Fish, Amphibians, Reptiles, and Aquatic Organisms Status Codes and Definitions

Fish, Amphibians, Reptiles, and Aquatic Organisms Legislative Authority: Title 30, Chapter 75, Fish and Boat Code, revised February 9, 1991; Pennsylvania Fish Commission.

PE Pennsylvania Endangered - All species declared by: 1) the Secretary of the United States Department of the Interior to be threatened with extinction and appear on the Endangered Species List or the Native Endangered Species List published in the Federal Register; or 2) have been declared by the Pennsylvania Fish Commission, Executive Director to be threatened with extinction and appear on the Pennsylvania Endangered Species List published by the Pennsylvania Bulletin.

PT Pennsylvania Threatened - All species declared by: 1) the Secretary of the United States Department of the Interior to be in such small numbers throughout their range that they may become endangered if their environment worsens, and appear on a Threatened Species List published in the Federal Register; or 2) have been declared by the Pennsylvania Fish Commission Executive Director to be in such small numbers throughout their range that they may become endangered if their environment worsens and appear on the Pennsylvania Threatened Species List published in the Pennsylvania Bulletin.

PC Animals that could become endangered or threatened in the future. All of these are uncommon, have restricted distribution or are at risk because of certain aspects of their biology.

N No current legal status, but is under review for future listing.

Invertebrates Status Codes and Definitions

Invertebrates Legislative Authority: No state agency has been assigned to develop regulations to protect terrestrial invertebrates although a federal status may exist for some species. Aquatic

invertebrates are regulated by the Pennsylvania Fish Commission but have not been listed to date.

N No current legal status but is under review for future listing.

PENNSYLVANIA BIOLOGICAL SURVEY (PBS) SUGGESTED STATUS DEFINITIONS

Note: the same PBS Status codes and definitions are used for all PNDI tracked species.

- PE Pennsylvania Endangered - Species in imminent danger of extinction or extirpation throughout their range in Pennsylvania if the deleterious factors affecting them continue to operate. These are: 1) species whose numbers have already been reduced to a critically low level or whose habitat has been so drastically reduced or degraded that immediate action is required to prevent their extirpation from the Commonwealth; or 2) species whose extreme rarity or peripherality places them in potential danger of precipitous declines or sudden extirpation throughout their range in Pennsylvania; or 3) species that have been classified as "Pennsylvania Extirpated", but which are subsequently found to exist in Pennsylvania as long as the above conditions 1 or 2 are met; or 4) species determined to be "Endangered" pursuant to the Endangered Species Act of 1973, Public Law 93 205 (87 Stat. 884), as amended.
- PT Pennsylvania Threatened - Species that may become endangered within the foreseeable future throughout their range in Pennsylvania unless the casual factors affecting the organism are abated. These are: 1) species whose populations within the Commonwealth are decreasing or have been heavily depleted by adverse factors and while not actually endangered, are still in critical condition; 2) species whose populations may be relatively abundant in the Commonwealth but are under severe threat from serious adverse factors that have been identified and documented; or 3) species whose populations are rare or peripheral and in possible danger of severe decline throughout their range in Pennsylvania; or 4) species determined to be "Threatened" pursuant to the Endangered Species Act of 1973, Public Law 93205 (87 Stat. 884), as amended, that are not listed as "Pennsylvania Endangered".
- PR Pennsylvania Rare - Plant species which are uncommon within this Commonwealth. All species of the native wild plants classified as Disjunct, Endemic, Limit of Range and Restricted are included within the Pennsylvania Rare classification.
- Disjunct Significantly separated from their main area of distribution
- Endemic Confined to a specialized habitat.

Limit of Range	At or near the periphery of their natural distribution
Restricted	Found in specialized habitats or habitats infrequent in Pennsylvania.
CP	Candidate Proposed - Species comprising taxa for which the Pennsylvania Biological Survey (PBS) currently has substantial information on hand to support the biological appropriateness of proposing to list as Endangered or Threatened.
CA	Candidate at Risk - Species that although relatively abundant now are particularly vulnerable to certain types of exploitation or environmental modification.
CR	Candidate Rare - Species which exist only in one of a few restricted geographic areas or habitats within Pennsylvania, or they occur in low numbers over a relatively broad area of the Commonwealth.
CU	Condition Undetermined - Species for which there is insufficient data available to provide an adequate basis for their assignment to other classes or categories.
PX	Pennsylvania Extirpated - Species that have disappeared from Pennsylvania since 1600 but still exist elsewhere.
DL	Delisted - Species which were once listed but are now cited for delisting.
N	No current legal status, but is under study for future listing.

FEDERAL STATUS DEFINITIONS

Native Plant and Animal Species Legislative Authority: United States Endangered Species Act of 1973: Public Law 93-205. U.S. Fish and Wildlife Service.

LE	Listed Endangered - A species which is in danger of extinction throughout all or a significant portion of its range.
LT	Listed Threatened - Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
LELT	Listed Endangered in part of range; listed Threatened in the remaining part.
PE	Proposed Endangered - Taxa proposed to be listed as endangered.
PT	Proposed Threatened - Taxa proposed to be listed as threatened.
PEPT	Proposed Endangered in part of range; proposed Threatened in the remaining part.
C	Candidate for listing.
E(S/A)	Treat as Endangered because of similarity of appearance.
T(S/A)	Treat as Threatened because of similarity of appearance.
XE	Essential Experimental population.
XN	Nonessential Experimental population.
"xy" (mixed status)	Status varies for different populations or parts of range.
"x" NL	Status varies for different populations or parts of range with at least one part not listed.

Appendix VIII. Watershed Figures/Maps

