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A RIVERS CONSERVATION PLAN FOR SUSTAINABLE WATERSHED MANAGEMENT:

A MODEL PROGRAM TO BALANCE WATER RESOURCES AND LAND DEVELOPMENT IN THE PIGEON CREEK AND STONY RUN WATERSHEDS OF CHESTER COUNTY, PA

Executive Summary

In order to define the term "sustainable" in the context of a watershed, one must consider the very different nature of the land and water systems which comprise the drainage area of a natural stream. The land resource is finite, subject to alteration by human activities and to a far lesser extent, by natural processes. The most significant of these processes is the movement of incident rainfall, over and through the land surface in its eternal path to the ocean. The activities of our species, be it for cultivation, transportation, or habitat, impacts both systems in countless ways, usually diminishing the *quality* of land and water. The great issue of our time is how to make use of and benefit from these resources, managing our activities by technical and legislative guidance, while sustaining their quality for future generations.

Thus, the purpose of this study is to conserve the land and water resources, both quality and quantity, of northern Chester County's Pigeon Creek and Stony Run. Included as well are a number of small tributaries of direct drainage to the Schuylkill River, an area some 35 square miles in total. These three watersheds are renown for their beauty, their exceptionally high quality water, the richness of their history and cultural resources. All of the six municipalities in Chester County which comprise these three watersheds are a part of the Federation of Northern Chester County Communities, and have planned together for over twenty years. While all of the involved individual municipalities have tried for decades to plan for the future, the issues surrounding growth patterns and overall water resources transcend municipal boundaries, and require analysis within a framework of land drainage elements. The area has been divided into some forty-eight such elements in this study, which provides the framework for detailed evaluation.

This Plan includes development of a Geographic Information System (GIS) data base for the Watersheds, documentation of generic water resource impacts resulting from new land development, delineation of the "Baseline Future" of the Watersheds, and development of a Rivers Conservation Plan based on the recently proposed Landscapes Plan by the Chester County Planning Commission. Also included here as an Appendix is the Model Stormwater Management Ordinance, as the first step in the Water Resources Ordinance Program, which will be completed during the Implementation Process in 1998 and 1999. This Rivers Conservation Plan is not a grand master plan for the region, but rather provides the framework for planning from a perspective of resource management, rather than resource exploitation.

A RIVERS CONSERVATION PLAN FOR SUSTAINABLE WATERSHED MANAGEMENT:

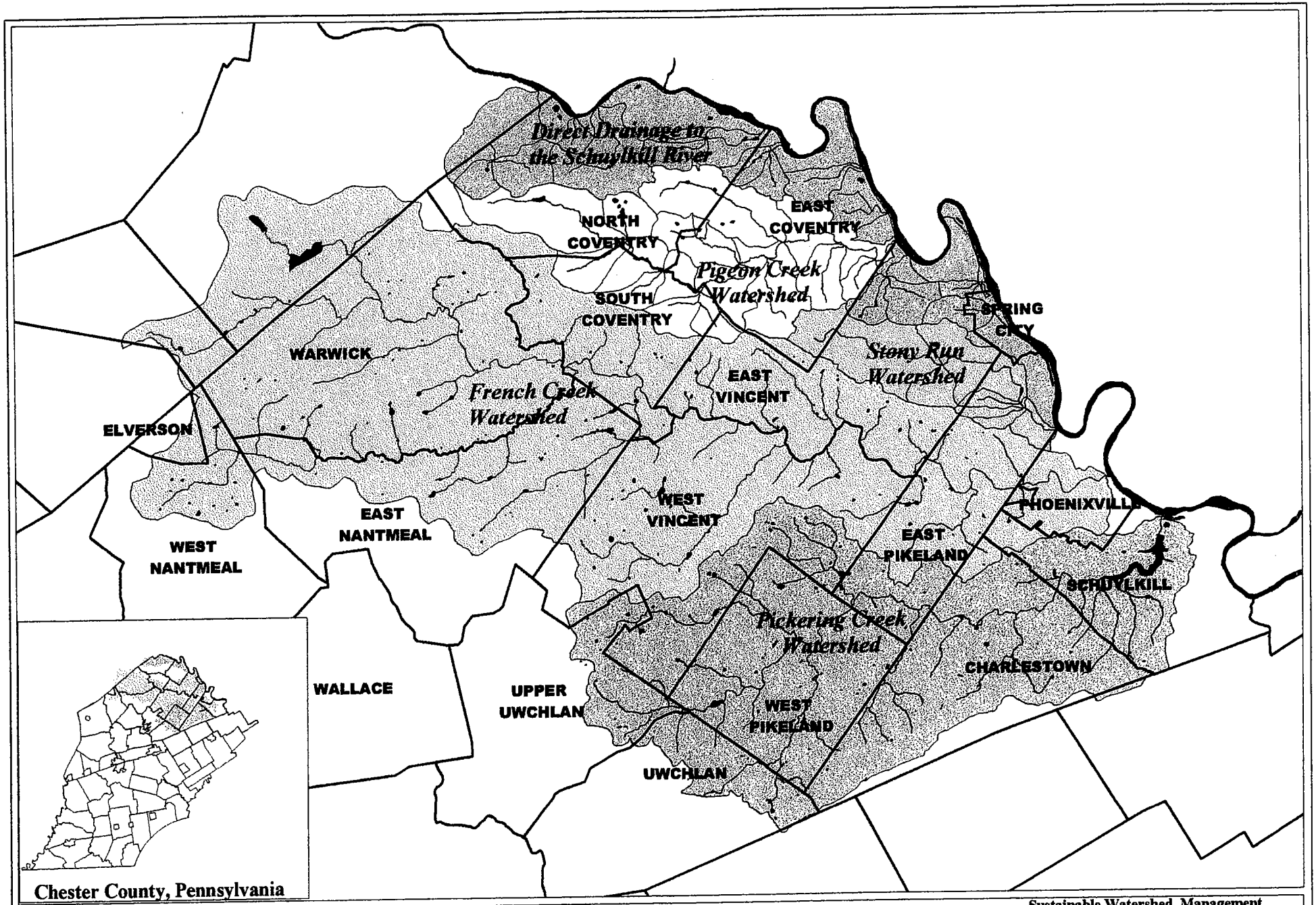
A MODEL PROGRAM TO BALANCE WATER RESOURCES AND LAND DEVELOPMENT IN THE PIGEON CREEK AND STONY RUN WATERSHEDS OF CHESTER COUNTY, PA

I. INTRODUCTION

The purpose of this study is to conserve the water resources, both quality and quantity, of northern Chester County's Pigeon Creek and Stony Run. The study area also included a number of small tributaries of direct drainage to the Schuylkill River, and totals some 35 square miles. Like the adjacent French Creek, these two watersheds are also renown for their beauty, their exceptionally high quality water, the richness of their history and cultural resources. Together with the larger French and Pickering Creeks (as well as Valley Creek, not shown), they complete the Schuylkill River tributary drainage in northern Chester County (Figure 1), and are hydrologically and politically linked. All of the municipalities that comprise these watersheds, are a part of the on-going Green Valley Association's (GVA) Sustainable Watershed Management Program.

Growth pressures are increasing faster in these watersheds than in other areas of Chester County, as development radiates from the urbanizing Philadelphia region to the southeast (Figure 2) as well as south from the Pottstown/ Montgomery County region along Route 422. This growth threatens to dramatically reduce the special values which make the Pigeon Creek and Stony Run so unique and which GVA has dedicated 31 years of effort to conserve. Those municipalities which straddle the French and adjacent Pigeon or Stony Creek watersheds are fully involved in the Rivers Conservation Process, and wish to complete that process by including the data gathering and analysis within these two additional watersheds. This remaining direct tributary drainage to the Schuylkill River gives closure to the program in northern Chester County.

All of the involved individual municipalities have tried for decades to plan for the future, and the Bibliography lists a number of important study efforts to protect both land and water resources in Northern Chester County. The conclusion reached in all of these prior efforts is that the issues surrounding growth patterns and overall water resources vastly transcend municipal boundaries. Although the PA Municipalities Planning Code enables water resources to be integrated into the overall land use management scheme, individual municipalities within the Pigeon Creek and Stony Run -- and elsewhere -- have not been able to technically cope with matters that extend beyond their respective jurisdictions. Thus the geographical scope of this project must be watershed-wide, including water quality and quantity, water supply, wastewater, stormwater -- all aspects of water resources. It is the objective of this Program to build on prior knowledge and formulate a resource management capability that truly sustains those resources for future use.



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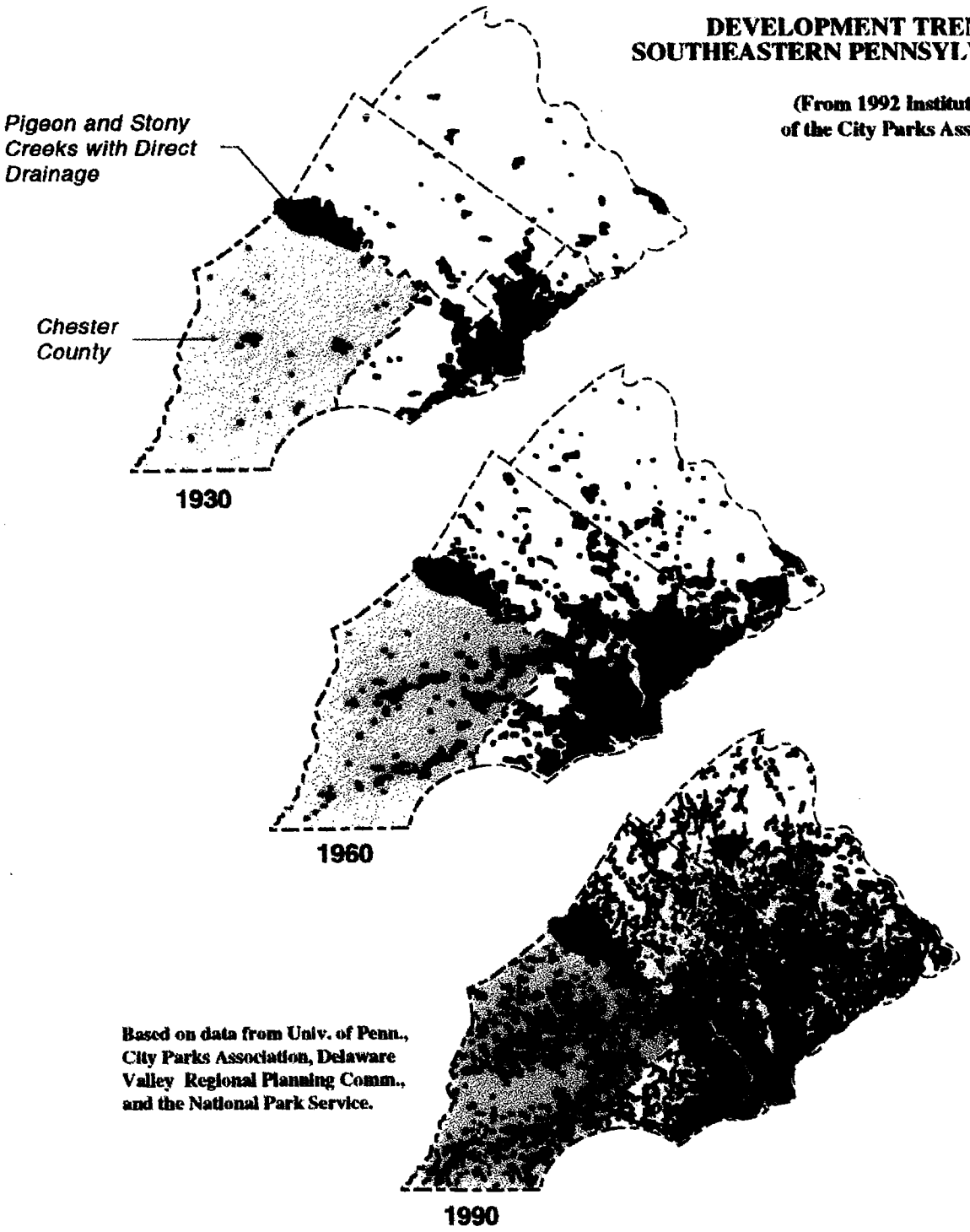


Figure 2. Urbanization Patterns in the Deleware Valley

II. BACKGROUND

Given the development of the Sustainable Watershed Management Program in the adjacent French and Pickering Basins during 1995 and 1996, the groundwork was laid for completing the same program in these remaining watersheds. The GIS data base was completed for the 34.2 square-mile Pigeon-Stony-Schuylkill drainage area during 1997 and 1998 (Figure 3), and the Water Balance Model applied and evaluated for the component sub-basins. The Implementation Program now under development for the French and Pickering watersheds will also be directly applicable to this area, since most of the municipalities are presently included in the regulatory evaluation. That is, the recommended changes and additions to the municipal zoning, land use and development criteria which evolves in the second phase of work during 1998 will include the Pigeon and Stony, as well as the French and Pickering watersheds. Thus the GVA's proposed Model Program will move ahead directly to the implementation phase for Pigeon Creek and Stony Run. In fact, the first step in this process, the development of a Model Stormwater Management Ordinance, has been completed as a prototype in this current planning effort and is included in this Plan.

The objectives of GVA's Model Program completed in this Plan include:

- Bringing together the various agencies and institutions, focusing particularly on the municipalities in the affected watersheds, which must cooperate and coordinate efforts to achieve water resource protection.

- Development of a Geographic Information System (GIS) database for the Watersheds, designed for application in Chester County and elsewhere in PA.

- Documentation of water resource impacts resulting from new land development.

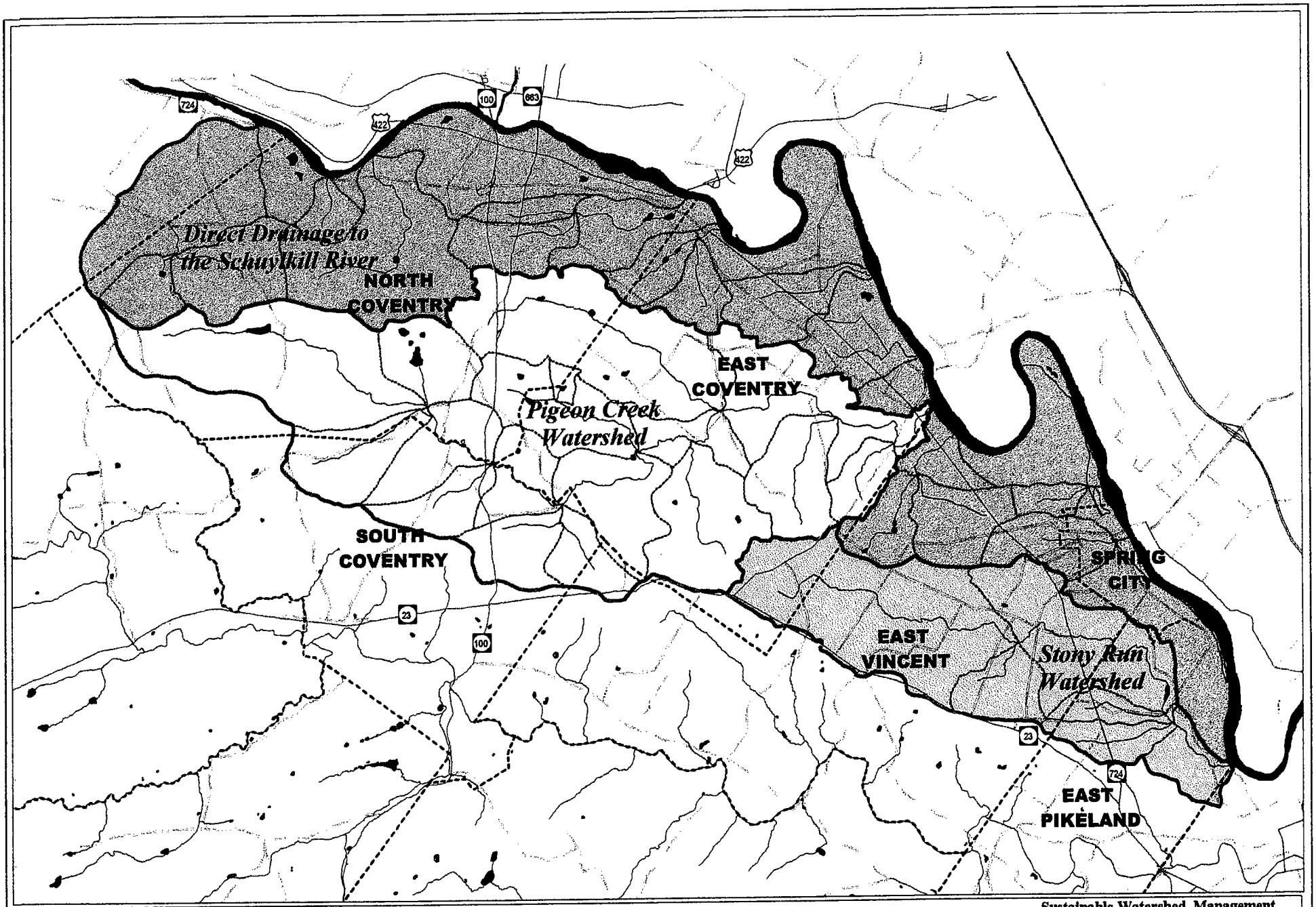
- Delineation of the "Baseline Future" of the Watersheds, defined by the existing municipal plans and zoning ordinances.

- Application of the above impact analysis to the "Baseline Future" for watershed municipalities, and recommend alternatives.

- Evaluation of the existing system that governs land development /water resources and identification of management gaps linked to water resource impacts.

- Development of a Model Stormwater Management Ordinance reflecting all of the sustainable site design concepts, for consideration by the municipalities.

- Development of a Rivers Conservation Plan which reflects the best current efforts to formulate a future for the region. The recently proposed *Landscapes* Plan by the Chester County Planning Commission completes the concept of a Rivers Conservation Plan.



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Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 3
Pigeon Creek, Stony Run, and direct Schuylkill Watersheds

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III. EXISTING CONDITIONS - Demographics

Chester County's Pigeon Creek and Stony Run are renown for their exceptional water quality, fisheries, natural beauty, history, and outstanding cultural resources. Both watersheds are relatively undeveloped, with pockets of urbanization along the Schuylkill River Valley into which both streams drain. Some of these small communities, such as Spring City, date back in history, and were part of the river corridor of commerce and transportation that flourished during the 19th century. Both watersheds are rated High Quality, and do not serve as water supply reservoirs for any of the river communities, such as occur in a number of other tributaries along the Schuylkill. As trout stocking fisheries, the value of the water resource is of great environmental importance in both stream systems. These tributaries also play an important part in improving and maintaining overall water quality in the Schuylkill River drainage, which is a vital water supply source for several million residents of the Delaware Valley.

However, growth pressures are increasing. Population projections for the five townships and one borough in the affected watersheds (Table 1) confirm that their rate of growth is expected to be significantly higher than much of Chester County, already one of Pennsylvania's fastest growing counties. Furthermore, this new development is occurring in patterns that are less dense and more land "consuming" than ever before. The result is that more and more watershed area is required for fewer and fewer people on a per capita basis. Figure 2 illustrated historical growth pressures radiating out from central Philadelphia over the past 60 years, with the Pigeon Creek and Stony Run highlighted. Though Year 2020 development was not shown in that Figure, the development projection for 2020--without changing current trends and management systems-- reveals dramatic development, literally overtaking these Watersheds.

TABLE 1

Municipal Population Projections (Chester County Planning Commission)

Municipality	Population 1990	Population 2000	Population 2020	Percent Growth (30 years)
North Coventry	7,506	8,190	8,950	19 %
South Coventry	1,682	1,820	1,950	16 %
East Coventry	4,450	4,980	6,030	35 %
East Vincent	4,161	4,850	6,860	65 %
East Pikeland	5,825	6,070	6,910	19 %
Spring City	3,433	3,470	3,510	2 %

Land Use

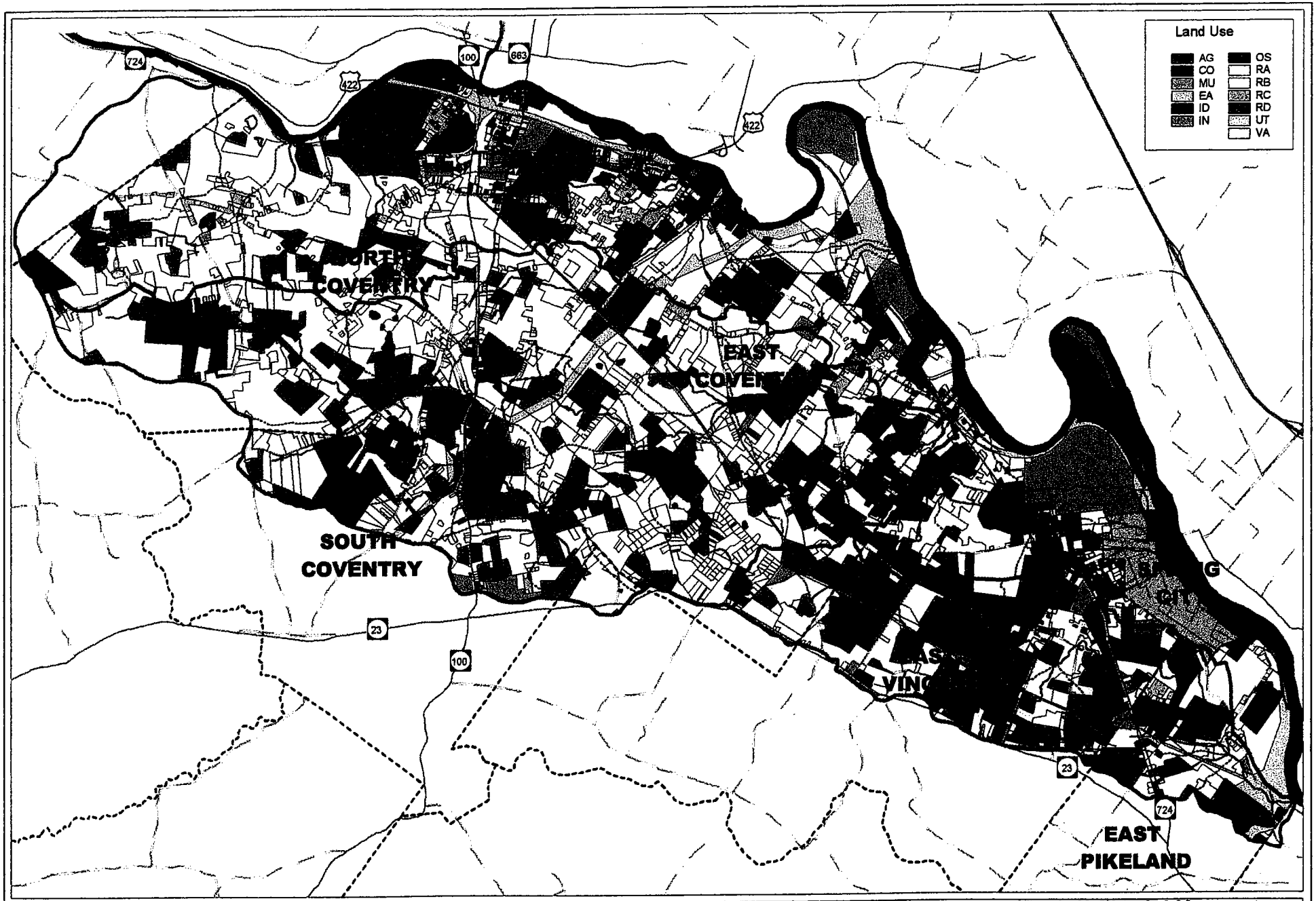
Figure 4 presents the existing land use patterns of the study area. The land use patterns indicate a predominant suburban/rural setting with significant agricultural and low residential communities. The major roadways through the watershed such as 422, 100 and 724 represent some commercial development corridors. Figure 5 summarizes the land uses sorted by major watershed with total area and percent of each land use category. For instance, Pigeon Creek Watershed is predominated by low-density residential land use with 3205 acres out of the total watershed area, which totals 9209 acres. This represents almost 35% of the watershed. The next two predominant land uses in the Pigeon Creek watershed are agricultural and vacant land (both categories can be considered for planning purposes as developable land). The combined area of developable lands in the Pigeon Creek watershed is almost 53%. It is future development that poses the largest challenge to the conservation of these watersheds.

A very similar situation is present in the Stony Run watershed where low density residential use predominates the land uses. Vacant and agricultural uses (developable lands) comprise 48% of the watershed. The Schuylkill River Direct Drainage watershed includes somewhat more balanced land use types but residential still predominates, with developable lands (vacant and agricultural) almost 43% of the watershed area.

Geology

The basic rock types of most of Chester County are crystalline meta-igneous and metamorphic rocks. However, Pigeon/Stony watersheds lie in the Schuylkill Valley Lowlands and are underlain by sedimentary rocks of Triassic age (Figures 6 and 7). They are comprised of sands and mud washed down from the highlands and deposited either in river or lake environments that once covered much of the county. Deposits eventually were cemented and hardened into rock.

The Triassic sedimentary series formed as almost flat beds with a slight slope towards the north and the Schuylkill River. However, uplift and compression of the beds has resulted in a series of relatively gentle folds heading east-northeast and forming a land formation of elongated ridges and valleys parallel to the folds. The Brunswick Group (approximately16,000 acres) covers the majority of the watershed area followed by the Hammer Creek Formation (approximately 5200 acres) which occurs as four finger-like features projecting into the watershed from west to east. The Lockatong Formation is limited to the southern and southeastern portion of the watershed, as well as two small bands within the small spit of land formed as an inside meander of the Schuylkill River just east of Pottstown. The Stockton Formation (approximately 65 acres) is limited to only the southeastern portion of the watershed.



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Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 4
Existing Land Use in the Watershed

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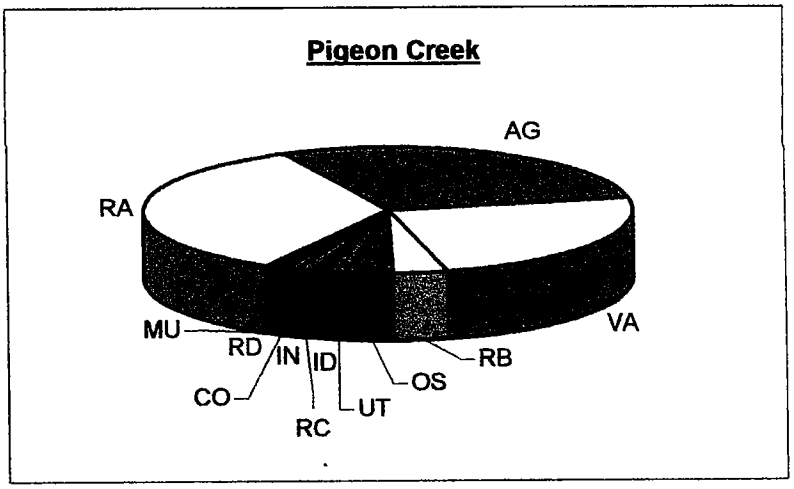
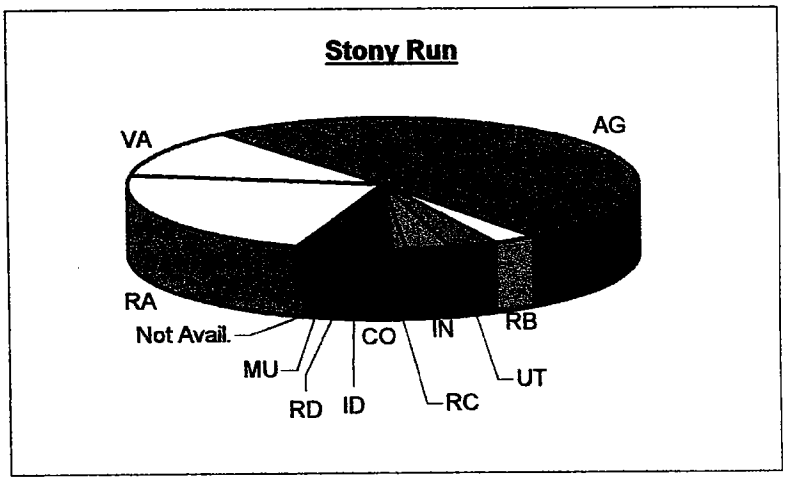
Pigeon Creek

Land Use	Acres	Percent
RA	3204.8	34.8%
AG	2664.5	28.9%
VA	2206.7	24.0%
RB	336.7	3.7%
OS	282.7	3.1%
UT	127.2	1.4%
ID	90.6	1.0%
RC	84.9	0.9%
IN	84.5	0.9%
CO	81.9	0.9%
RD	36.9	0.4%
MU	8.2	0.1%
	9209.6	100.0%



Stony Run

Land Use	Acres	Percent
RA	784.7	21.9%
VA	415.8	11.6%
AG	1820.9	50.9%
RB	102.1	2.9%
UT	106.2	3.0%
IN	104.0	2.9%
RC	24.4	0.7%
CO	73.6	2.1%
ID	47.9	1.3%
RD	53.2	1.5%
MU	28.3	0.8%
Not Avail.	18.5	0.5%
	3579.6	100.0%



Schuylkill River

Land Use	Acres	Percent
RA	2131.1	21.0%
VA	2059.1	20.3%
AG	1987.0	19.6%
IN	779.8	7.7%
RC	558.6	5.5%
UT	518.9	5.1%
RB	363.1	3.6%
CO	338.3	3.3%
OS	268.9	2.7%
RD	232.8	2.3%
ID	198.1	2.0%
MU	25.7	0.3%
Not Avail.	679.7	6.7%
	10141.1	100.0%

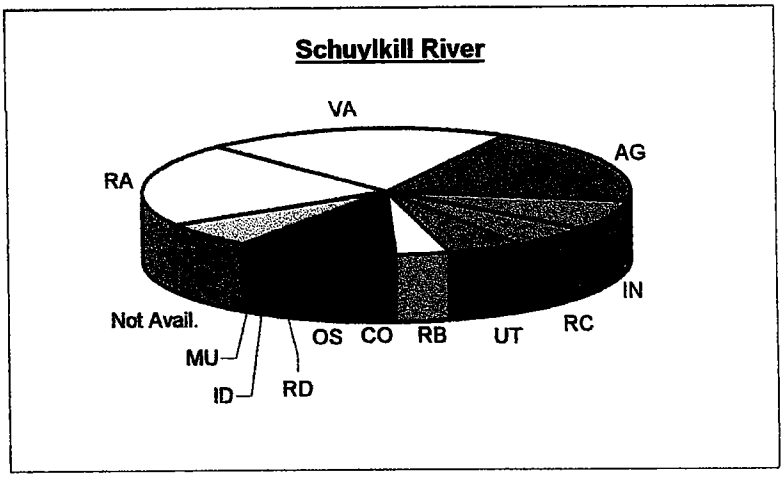
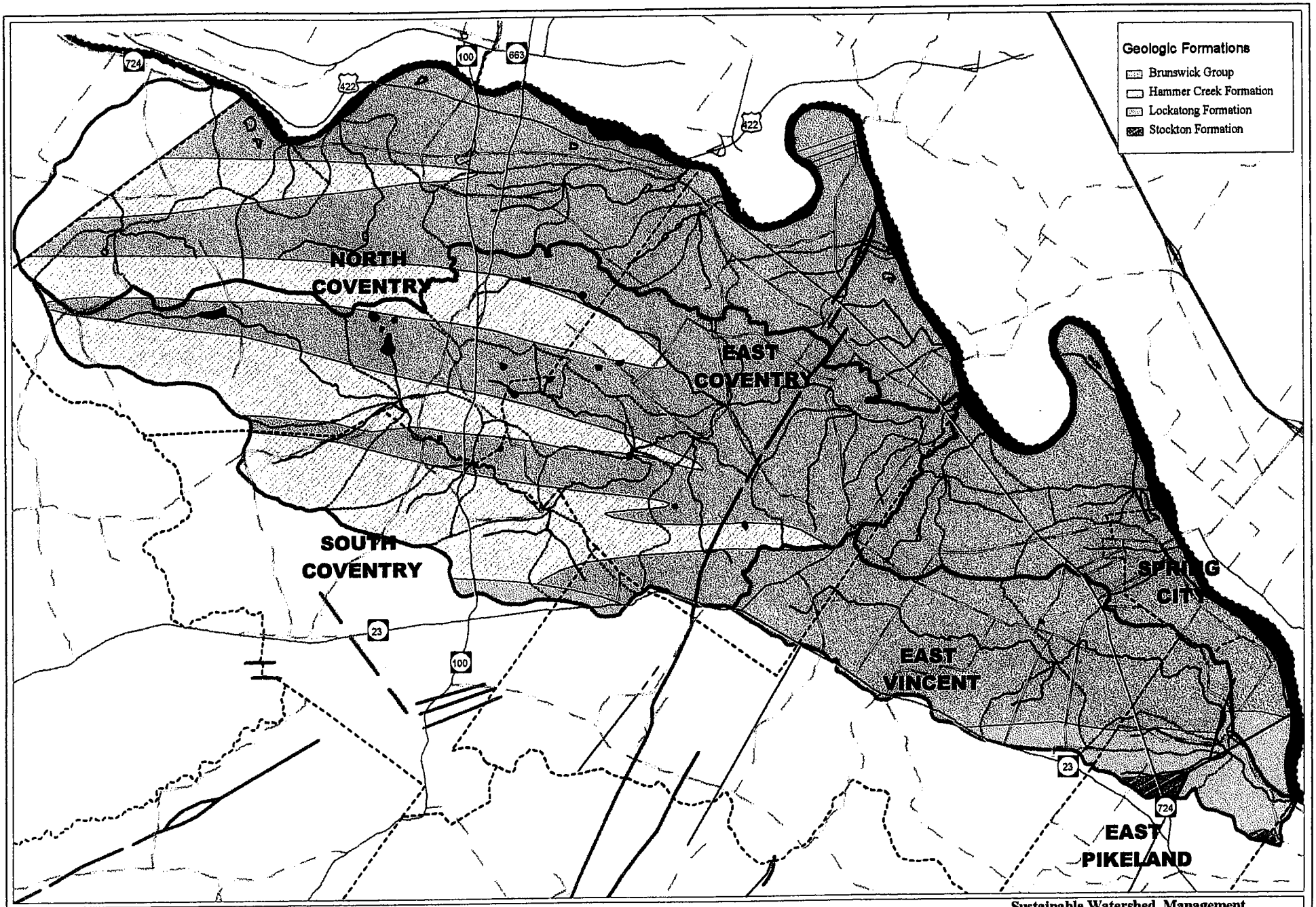


Figure 5. Existing Land Use - Pie Chart



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Pigeon Creek and Stony Run Watersheds

FIGURE 6
Geology in the Watershed

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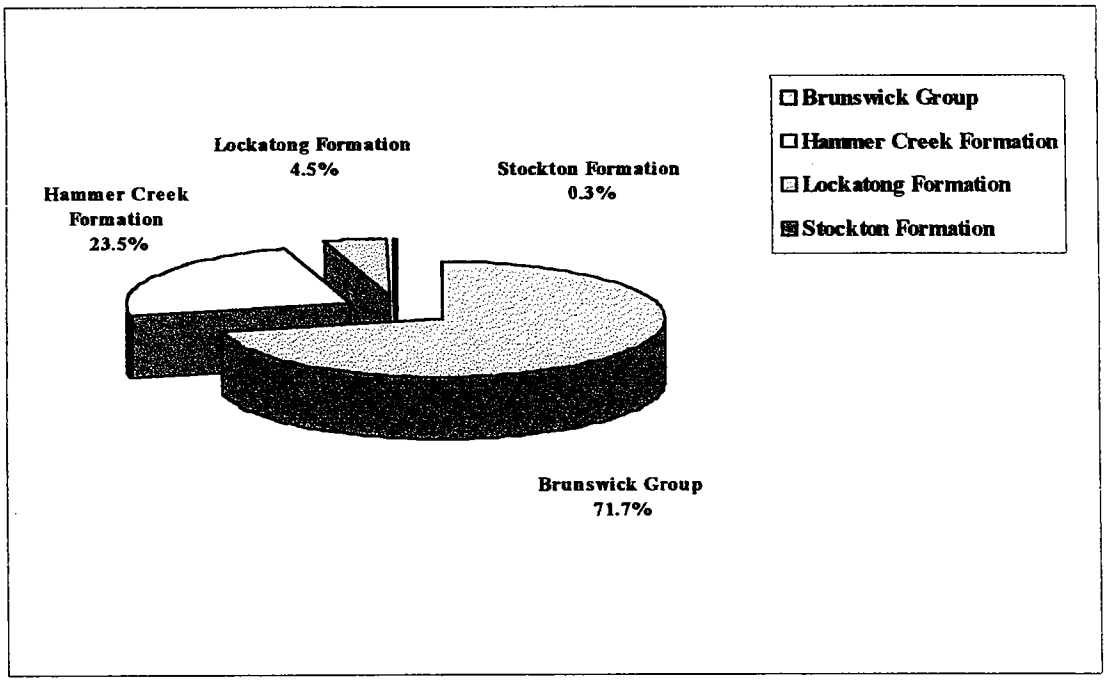


Figure 7. Geologic Composition within the Watersheds

The Brunswick Formation is comprised largely of soft red shale, inter-bedded with size grained quartzose sandstone. The formation occupies the largest aerial extent of these Watersheds included in this plan. This rock has no value as crushed or building stone. It is the source of a moderate ground water supply ranging from 20-40 gpm.

The Hammer Creek Formation is reddish-brown coarse-grained sandstone with interbeds of red shale and quartz-pebble conglomerate. This formation has a moderate ground water yield with a median of 66 gpm.

The Lockatong Formation is comprised of dark gray to black thick-bedded argillite with occasiional zones of thin black shale. Because of its hard impervious shale and fractures, ground water yields are poor, averaging only 10 gpm. However, along fault zones yields are sometimes as high as 100 gpm.

The Stockton Sandstone is comprised of layers of arkosic sandstone, siltstone and conglomerate interbedded with layers of red shales as well as fine-grained siliceous sandstones. Because of its ease of erosion, the Stockton formation forms gently rolling or relatively flat lowlands. The Stockton sandstone is the best source of ground water in Chester County. Yields will range from 100 to 300 gpm, averaging around 130 gpm of moderately soft water.

Topography and Landform

The combined area of the Pigeon Creek, Stony Run and Direct drainage tributaries to the Schuylkill River include an area of approximately 35 sq. miles. The Pigeon Creek Watershed drains in an easterly direction from headwater elevations of approximately 550 feet NGVD to the confluence with the Schuylkill River at approximately 110 feet NGVD. Stony Run flows in an east, southeasterly direction from headwater elevation of 310 feet to their confluence with the Schuylkill River at approximately 90 feet NGVD. The direct drainage tributaries flow from elevations (250- 200 Ft NGVD) north of the Pigeon creek and Stony Run watershed divide to their confluence with the Schuylkill River (elevation range from 90 to 120 ft. NGVD dependant on Schuylkill River mile).
Figure 8 Depicts the watershed landform and drainage pathways on a hill-shaded rendering, using USGS 7.5 minute Digital Elevation Model (DEM) data to create a surface with light simulating sun on the northern horizon casting shadows on the hills and valley to depict the existing landform.

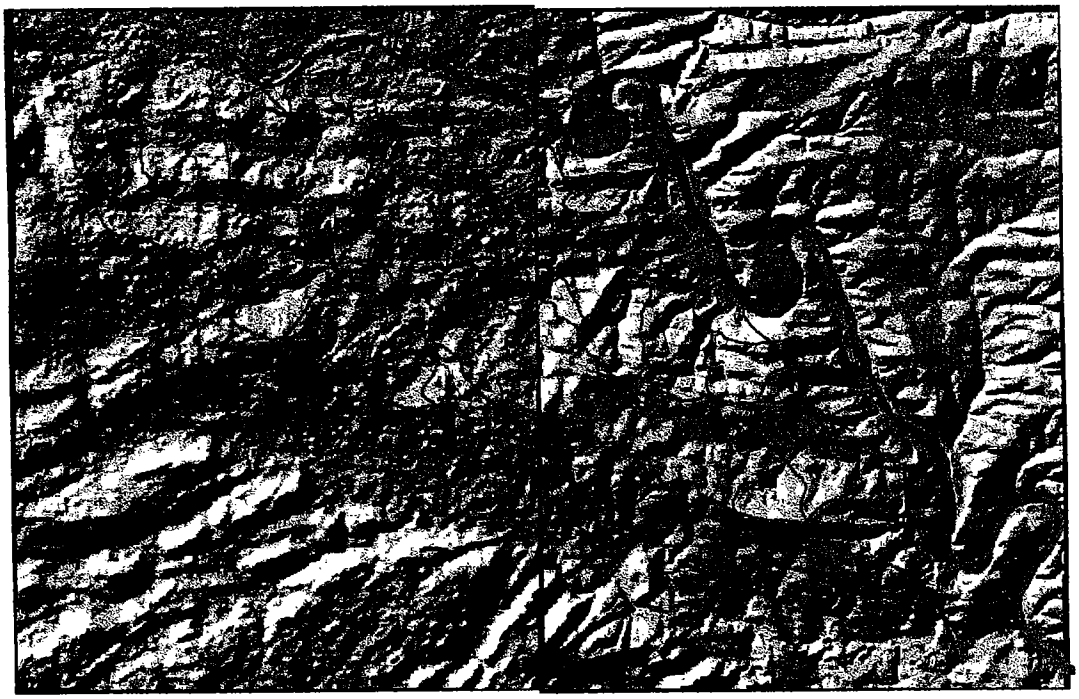
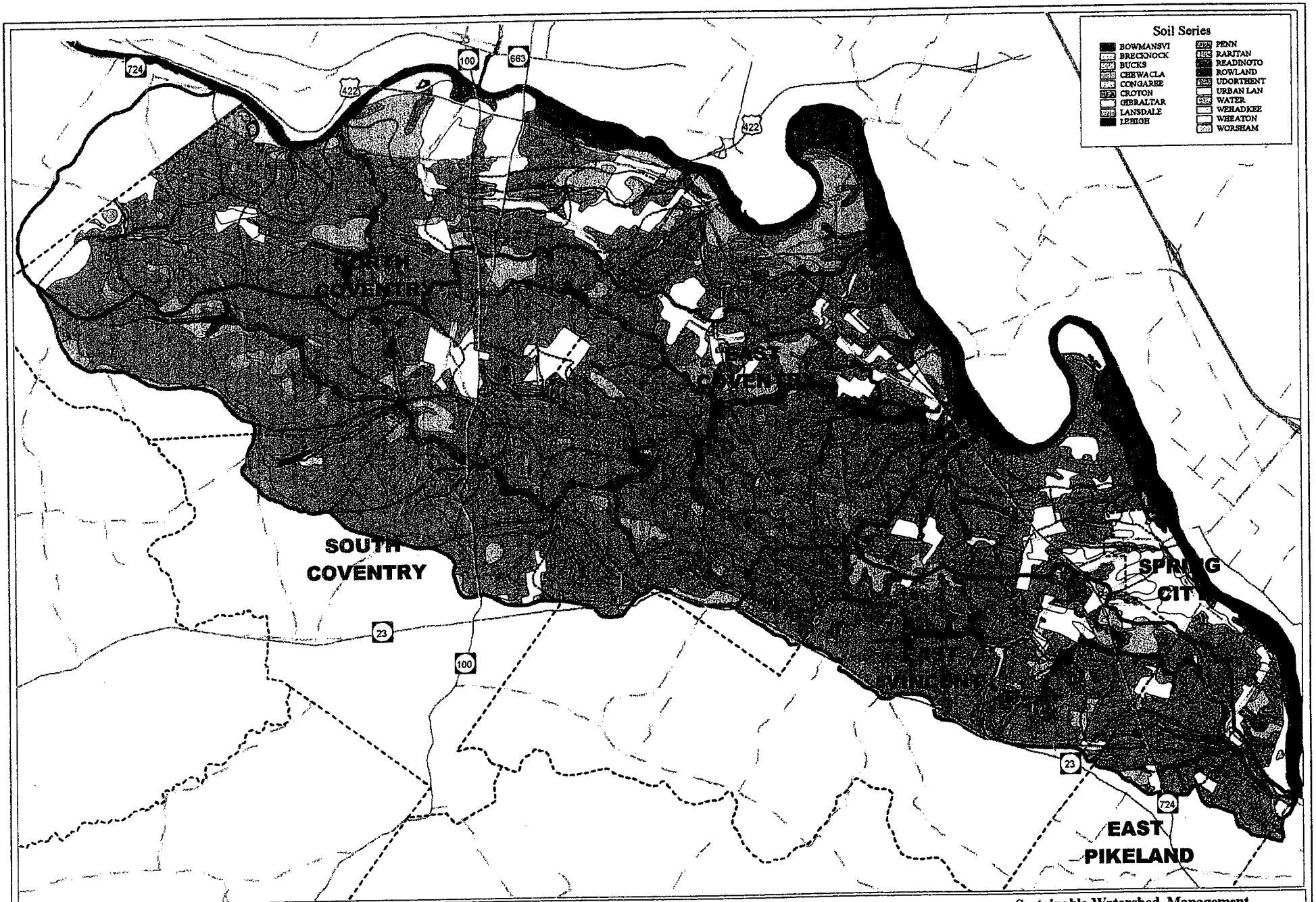


Figure 8. Hillshade View of the Pigeon Creek, Stony Run and Schuylkill River Valley



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Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 10
Soil Series in the Watershed

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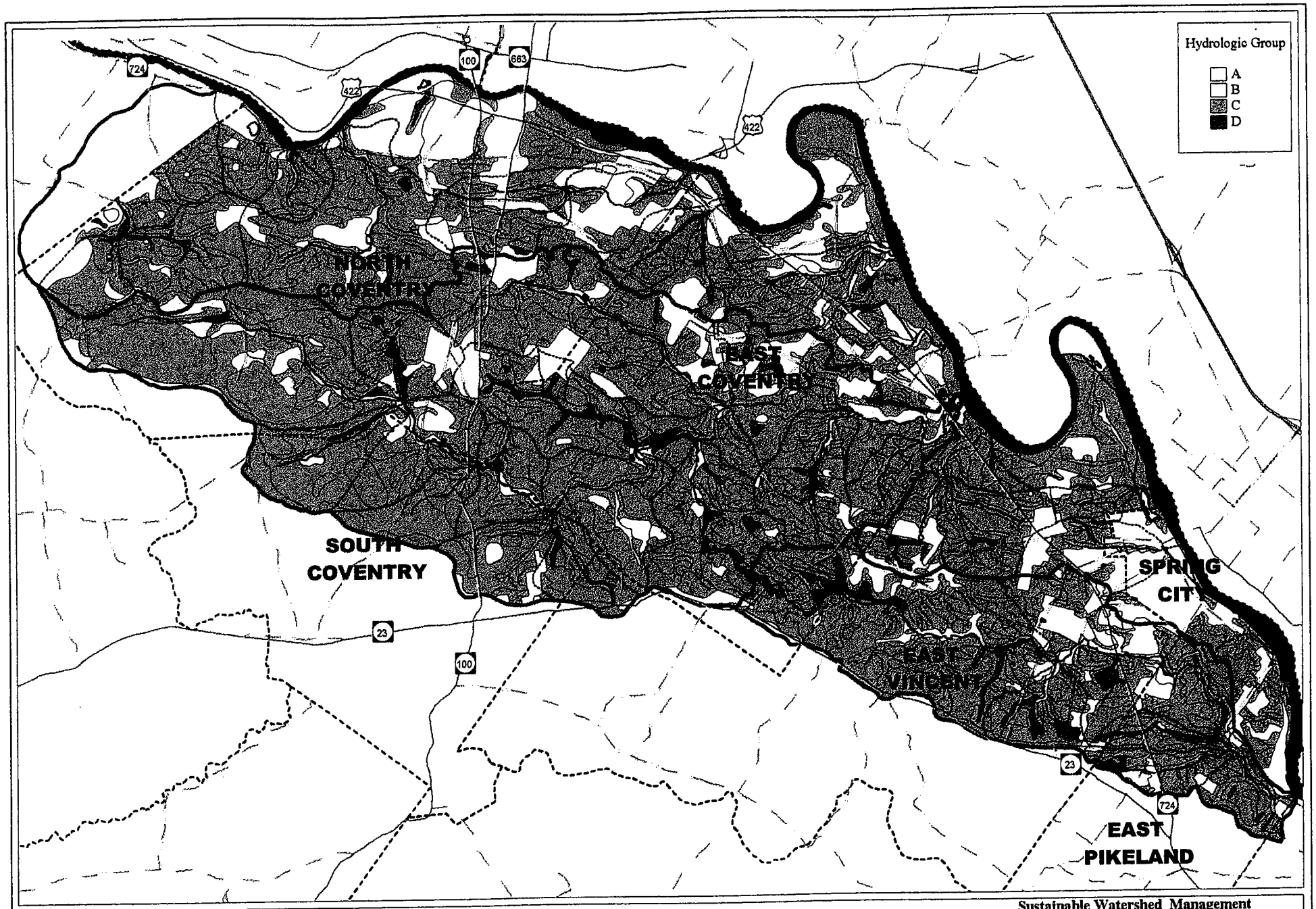
The hydrologic group (Figure 11) is important in explaining the relationship between water resources and land development impacts. Rated as A through D, this parameter describes the physical drainage properties of a soil series, including texture and permeability, as well as certain physiographic properties such as depth to bedrock and water table. Group A, which is not represented in the watershed, is well drained while Group D, usually a floodplain or hydric soil, is at the other end of the spectrum and drains poorly. The hydrologic group rating is also of importance in determining the feasibility of using infiltration or recharge-oriented Best Management Practices (BMPs) for stormwater management, as well as land based technologies for wastewater effluent application and recycling, all of which are critical here. As one can see in Figure 11, the majority of the combined watersheds is categorized as hydrologic group C. These soils demonstrate some constraints. For the dominant Penn soil series, the limitation is not in the permeability of the soil mantle but the relative depth of soil, usually in the range of three feet or less to weathered bedrock. This is a severe condition for conventional septic systems, but not so for stormwater infiltration design, which can be applied within or above the soil mantle.

Cultural Resources

The description of existing conditions in the watershed would not be complete without recognizing the richness of the region with respect to cultural resources. Numerous reports and studies (FNCCC, 1996; PEC, 1979; PADER (now DCNR), 1984) have documented the uniqueness of the region and the various historic structures and landmarks, scenic areas or overlooks (especially along the Schuylkill River corridor), and open space and recreation facilities. A great number of historic structures are located along the French Creek valley to the south. Within this study area, the use of the Schuylkill River as a primary transportation route and commercial corridor during the last century left a legacy of small river towns and a canal system which provide focal points for the community. Current plans to develop a Greenway (CCPC, 1987) and Heritage Corridor (SRGA, 1993) along the river and on-going efforts at a regional trail system will greatly enhance the appreciation of these resources.

While the Schuylkill River Valley has been the historic focus of development for the municipalities which occupy this portion of Chester County, the small stream systems which drain to the river, such as the Pigeon Creek and Stony Run, have formed their own communities of small villages along the streams. The southern ridge of the Pigeon Creek forms the boundary with the larger French Creek watershed, and has been a wagon trail, farm route and highway for over two hundred years, currently identified as PA Route 23. This high ground has also been a location for small clusters of buildings in all of the respective townships, and the current location for schools, churches and municipal buildings.



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Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 11
Hydrologic Soils Groups

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Hydrology

The Hydrologic Cycle

In order to put these particular Watersheds in perspective, it is necessary to first consider a more comprehensive basis for the movement of water through its complete natural system, or hydrologic cycle. The hydrologic cycle describes the various natural (and human influenced) steps which account for the movement of rainfall through the land system and back again into the atmosphere. It is important to note that there is a tremendous variability in this cycle over time, both on a seasonal basis and also from year to year.

For example, all regions experience periods of significant variability in precipitation, with hot and cold cycles of climate change impacting and controlling these patterns. In any given region, however, an estimate of the average conditions experienced in the hydrologic cycle can be developed, based on the record of rainfall and corresponding stream flow or runoff, if properly gaged. A recent study (Sloto 1994) proposed a set of values for an average Chester County hydrologic cycle, based on a record from 1975 to 1988. Other periods of record have suggested somewhat different values for some hydrologic components. Figure 12 illustrates a representative cycle specific to the Pigeon Creek Stony Run Watersheds, based on the long-term rainfall averages of meteorological stations in and around northern Chester County.

The hydrologic cycle begins with rainfall, and in order to assess the extremes of this cycle, drought and flood, the questions of how and where we measure rainfall becomes important. Although several meteorological stations operate in the general vicinity of the study area, of most interest is a rainfall record which distinguishes individual storm events over the period and collects bi-hourly (every two hours) rainfall data. For the purpose of this study the same rain gage station used in the French and Pickering study (Phoenixville and Glenmoore) will be referenced.

Base Flow Analysis

There are no continuous stream flow measurement and recording stations located on either the Pigeon Creek or Stony Run, nor on any of the small direct tributaries to the Schuylkill River, Over the past twenty-five years, a number of instantaneous flow measurements have been made in the Pigeon Creek by the USGS at four locations and in the Stony at two locations (Figure 13), with corresponding water chemistry and biota sampling (Lium, 1977; McGreevy and Sloto, 1977; Sloto, 1987; Moore, 1987, 1989). This partial flow record is of interest and value in developing a good understanding of probable base flow conditions for these ungaged watersheds. Given the fact that the predominant geologic units are Triassic in these watersheds, one might expect that the base flow conditions are different from the adjacent French Creek basin, which does not prove to be the case, as discussed below

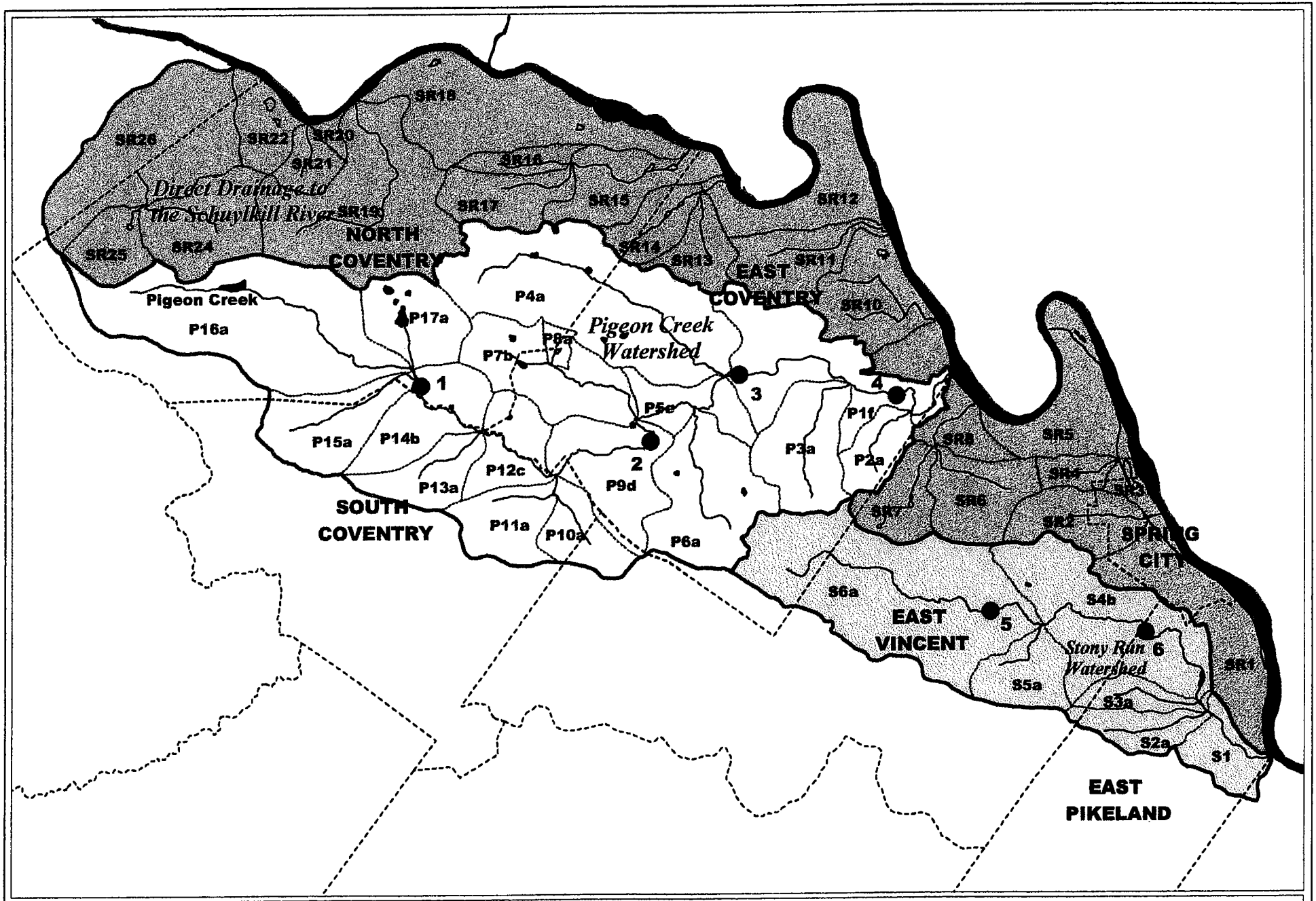

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FIGURE 13
USGS Sampling Stations and Sub-Basins

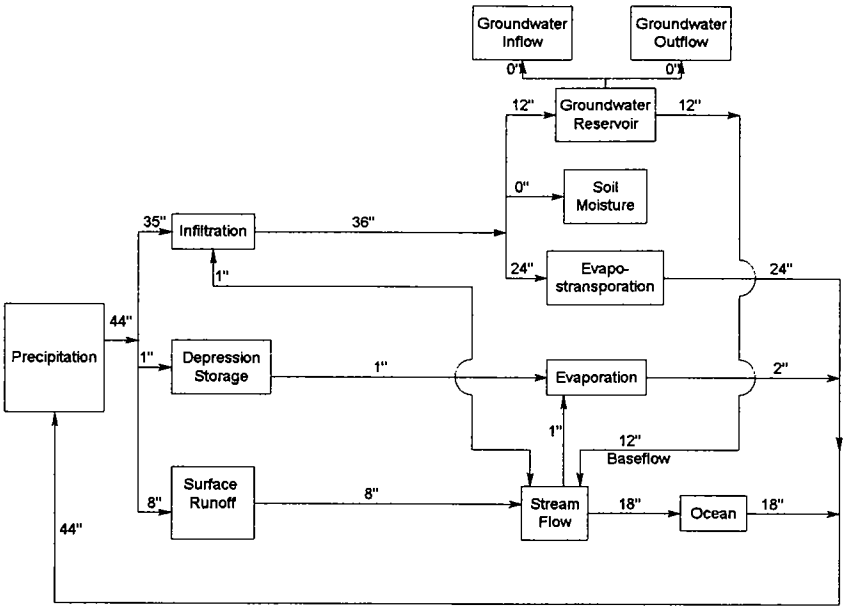

Figure 12. The Hydrologic Cycle in the Pigeon Creek and Stony Run

The continuous gage on the French Creek is located 7.3 miles above the mouth, operated by the USGS since 1966. Although flows measured here do not include the entire French Creek Watershed, the gage does reflect about 60 sq mi (80 percent) of the basin. This record is excellent for development of base flow statistics, as shown in Table 2. Table 3 summarizes the partial flow measurements for both the Pigeon Creek stations and the corresponding flow measurement for that date from the French Creek gage. The data is expressed in units of cubic feet per second per square mile (CFS/SM), so that the different stations can be compared. Assuming that any flow greater than 0.9 CFS/SM should not be considered as a base flow condition, the low flow records were analyzed (Figure 14), and a regression coefficient of 0.8 estimated. This suggests that the base flow record for the French Creek can serve as a representative statistic for these small adjacent watersheds.

Figure 13 also showed the division of the three watersheds into sub-basins for analysis in this study and the various models applied. These 48 sub-basins, averaging about 477 acres in size, will form the basic unit for all of the subsequent data presentations and discussions. By and large, most residents are not familiar with thinking in terms of the watershed in which they reside, let alone the sub-basin divided as shown here. Thus this figure or some form of it will provide a constant reference to the local parcels and roadway network for detailed discussion. The Pigeon Creek sub-basins are shown in

Recurrence Interval (Years)	Annual Base Flow (MGD/SM)	Annual Base Flow (Gal/day/acre)
2	0.589	920
5	0.455	711
10	0.288	450
25	0.254	397

Annual Base Flow Statistics: French Creek Watershed 1969 - 1985 (White and Sloto, 1990)

RECURRENCE INTERVAL	LOW FLOW (Q 7-10)			
(Years)	cfs	(cfs/sq mi)	(gpd/sq mi)	(gpd/acre)
1.01	35.48	0.600	387,790	606
1.25	22.69	0.384	248,186	388
2	17.34	0.293	189,370	296
5	13.10	0.222	143,482	224
10	11.26	0.190	122,800	192
20	9.91	0.168	108,581	170
50	8.57	0.145	93,716	146
100	7.76	0.131	84,667	132

Q 7-10 Base Flow Statistics: French Creek Watershed (unpublished data analysis by R. Helm, USGS)

Table 2. French Creek Low Flow Statistics

Table 3. Stream Flow Records for Pigeon Creek: Unit Area Basis

UNIT AREA FLOW COMPARISON										
DATE	Pigeon Creek nr Bucktown Flow, cfs	4.2 SM Unit Flow cfs/SM	Pigeon Creek at Porters Mill Flow, cfs	7.0 SM Unit Flow cfs/SM	Pigeon Creek nr Parker Ford Flow, cfs	12.0 SM Unit Flow cfs/SM	Pigeon Creek at Parker Ford Flow, cfs	13.9 SM Unit Flow cfs/SM	French Creek nr Phoenixvil	59.1 SM Unit Flow cfs/SM
11/14/69	1.3	0.31	2.4	0.34	4.2	0.35			21	0.36
2/19/70	4.2	1.00	8.8	1.26	12	1.00			93	1.57
5/5/70			8.3	1.19	12	1.00			104	1.76
9/29/70	1.5	0.36	2.7	0.39	3	0.25			23	0.39
5/4/71	4.5	1.07	8.8	1.26	14	1.17			61	1.03
9/28/71	6.2	1.48	12.3	1.76	19	1.58			67	1.13
10/9/72	3.6	0.86	7.1	1.01	11	0.92			47	0.80
10/21/80					2.6	0.22			12	0.20
4/7/81					8.1	0.68			53	0.90
8/13/81					6.4	0.53			20	0.34
8/20/81							4.2	0.30	9.8	0.17
9/19/81							9	0.65	49	0.83
10/16/81					3.1	0.26			12	0.20
10/20/81									19	0.32
9/17/82							6.2	0.45	24	0.41
9/23/82					5.8	0.48			35	0.59
10/29/82	1.5	0.36	2.44	0.35					34	0.58
10/21/83					25	2.08			24	0.41
10/22/84					16	1.33			29	0.49
11/20/84					5.1	0.43			35	0.59
4/26/85					7.1	0.59			28	0.47
5/21/85					8.6	0.72			33	0.56
6/20/85					5.8	0.48			20	0.34
10/11/85					6.6	0.55			30	0.51
6/3/86					7.7	0.64			33	0.56
9/16/86							3.5	0.25	11	0.19
10/10/86					3.36	0.28			14	0.24
11/13/87					29	2.42			106	1.79
7/12/88							6.9	0.50	23	0.39
10/14/88							3.8	0.27	19	0.32
11/9/88					5.4	0.45			26	0.44
10/11/89					10	0.83			39	0.66
10/4/90					3.9	0.33			24	0.41
7/10/91							6.7	0.48	27	0.46
8/7/91							4.3	0.31	20	0.34
9/9/91							3.5	0.25	26	0.44
10/8/91					3.62	0.30			18	0.30
10/13/92					5.5	0.46			24	0.41
10/8/93					4.17	0.35			16	0.27
10/31/94					4.33	0.36			195	3.30
11/22/95					10.7	0.89				

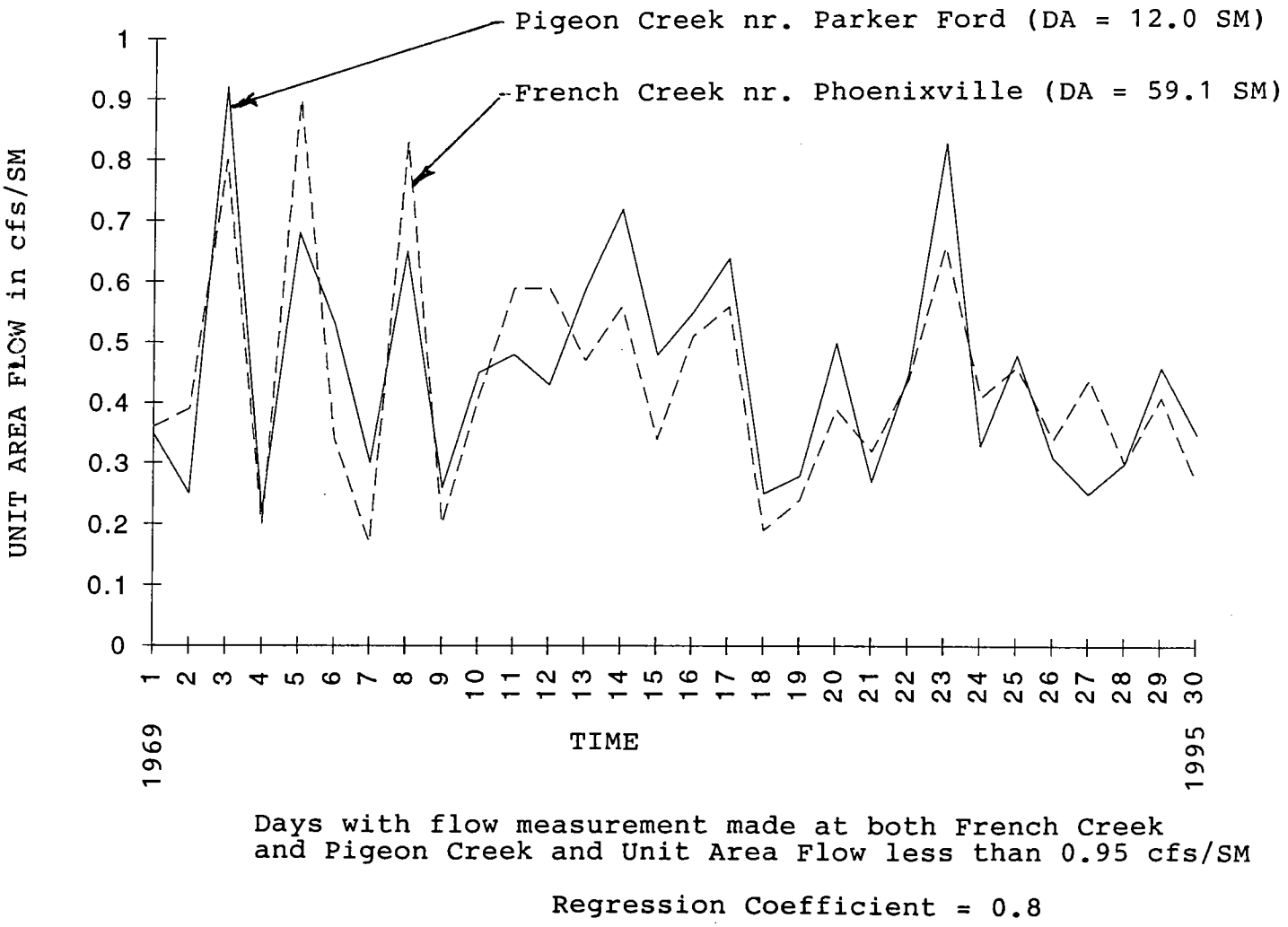

Figure 14. Comparison of Unit Area Flow Statistics for Pigeon and French Creeks

yellow with the prefix "P", the Stony Run with the prefix "S", and the direct drainage to the Schuylkill River with the prefix "SR".

First Order Streams

Those sub-basins with the suffix "a" are first order stream systems, and represent sub-basins in which only a single perennial surface stream has formed (Figure 15). ***These small streams provide the essential quantity and quality of the larger stream systems, and are most vulnerable to the impacts of land disturbance and development.*** As such, they form a distinct category of drainage elements, with special consideration given to the protective measures imposed or recommended in this study. It should be noted that the small streams which flow directly to the Schuylkill River, such as SR 11 or SR 21, have not been so classified as first order. The distinction is that these streams are classified as direct local drainage, and not as forming the headwaters of the stream systems which comprise the Schuylkill tributaries. The distinction may seem arbitrary, but in a hydrologic context recognizes the special importance of first order streams.

Water Quality

The available water quality record for the Pigeon Creek and Stony Run is fairly rich. These two small streams have been a part of the larger stream monitoring effort by the Chester County Water Resources Authority (CCWRA) and the USGS since 1972, and previous studies supported by the Northern Federation have considered this data (FNCCC/CCPC, 1991). This water quality record has been supplemented by sampling performed by the PADEP, the PA Fish Commission, the Chester County Health Department and local environmental groups, such as the GVA and related school programs. The summary of biota data developed by the USGS (Figure 16) is reflective of this record, which indicates a good to excellent condition in most portions of the two watersheds. Some enrichment problems are noted with elevated concentrations of both Nitrate(NO3) and Total Phosphorus (TP), largely attributable to agricultural activities but in some cases identified with malfunctioning on-site septic systems.

The spring sources which feed the base flow of these two small systems are the lifeblood of their high water quality, and maintain a healthy biota and fisheries habitat where the streams flow freely. Within both the Pigeon and the Stony several small impoundments have been constructed, which serve to trap the nutrient flux from cultivated lands and developed areas in the watersheds. Where the size of these ponds is sufficiently large to allow the in-flowing stream waters to remain for two weeks or more, the excessive nutrients, especially Phosphorus, trigger algae blooms in the warmer weather. This "nonpoint source pollution" severely degrades water quality both within the pond and downstream, as oxygen-depleted waters are released. Most of the transport of this nutrient flux from the watershed takes place during storm runoff, and so the long term management of water quality includes consideration of the nutrients applied to the landscape, on both farm fields and lawnscapes, as well as the control of increased stormwater runoff from these landscapes.

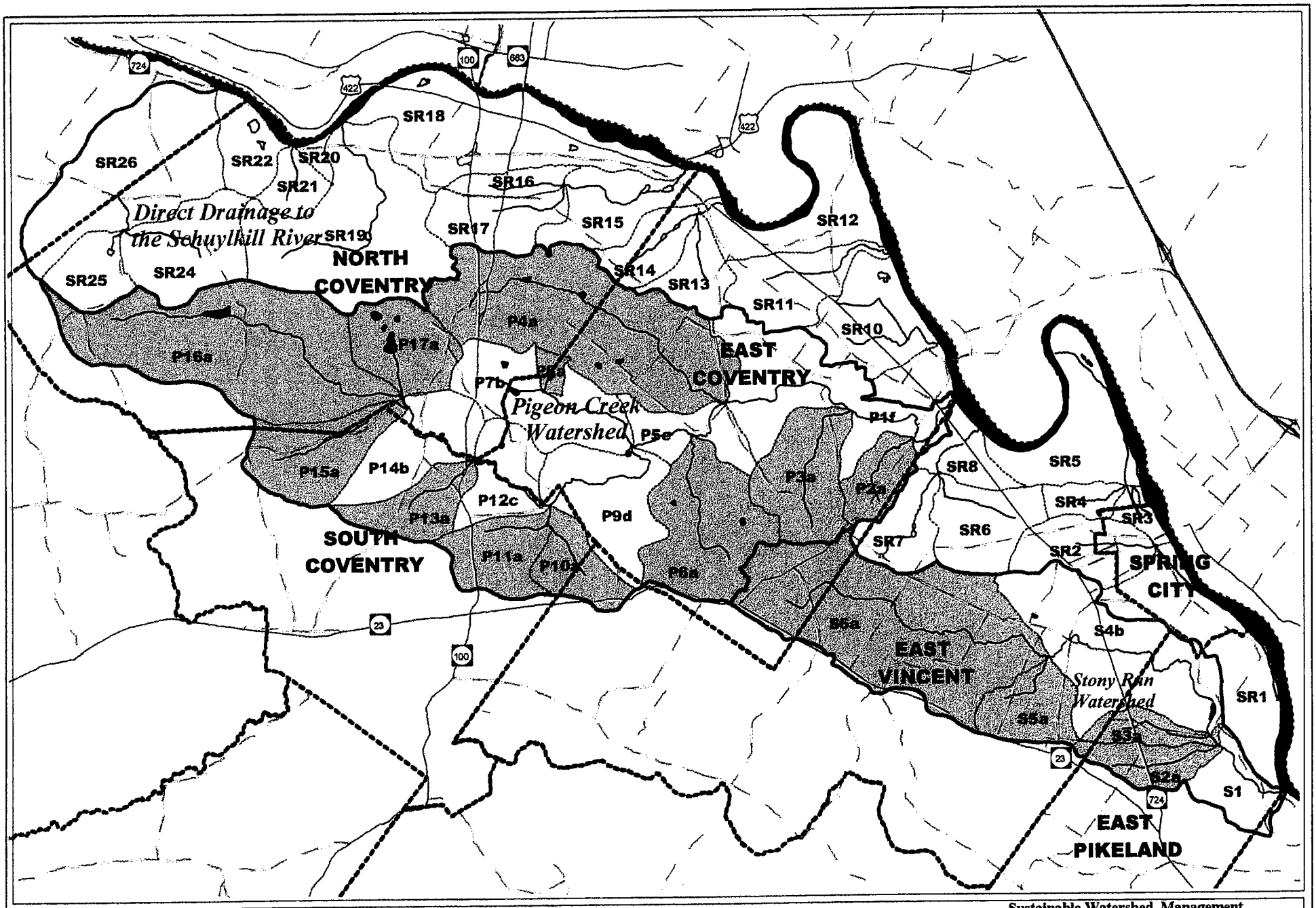

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FIGURE 15
First Order Streams

F:\APRS\Pigeon\Stony run-1st Order Waters

Site 10

Year	Total number of organisms	Total number of taxa	Brillouin's diversity index (H)	Maximum diversity (Hmax)	Minimum diversity (Hmin)	Evenness (E)
1970	104	8	2.45	2.80	0.45	0.85
1971	24	4	1.50	1.71	.57	.81
1972	548	15	1.88	3.89	.23	.45
1973	–	–	–	–	–	–
1974	–	–	–	–	–	–
1975	767	19	2.90	4.21	.22	.67
1976	880	26	2.62	4.72	.28	.53
1977	344	27	2.87	4.74	.63	.55
1979	32	10	2.15	2.87	1.35	.53
1980	620	19	3.19	4.24	.27	.74
1981	2,787	33	3.07	5.03	.13	.60
1982	1,686	30	3.39	4.86	.18	.69
1983	972	24	3.20	4.56	.23	.69
1984	1,492	29	3.50	4.83	.20	.71
1985	1,031	21	2.82	4.33	.19	.63
1986	1,121	24	3.35	4.59	.21	.72
1987	2,097	39	3.86	5.29	.20	.72
1988	2,400	31	3.57	4.93	.14	.71

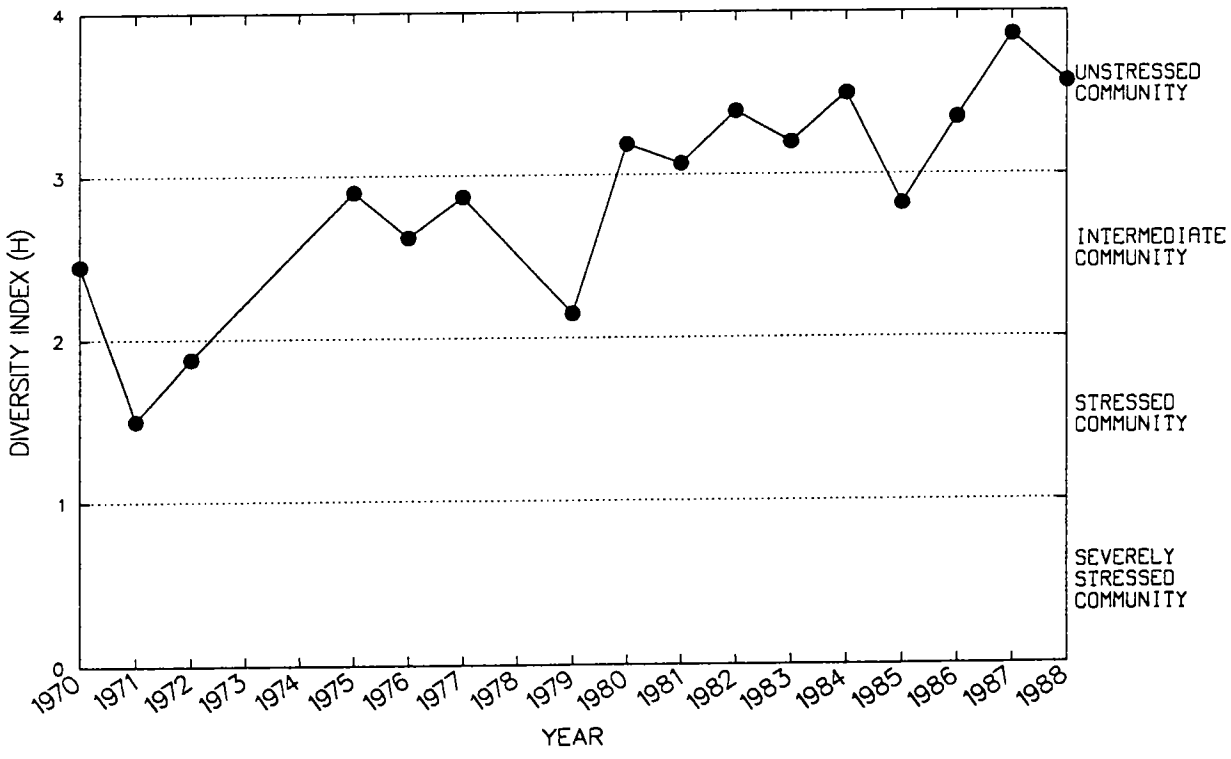

Figure 16. Water Quality Biota Indices in Pigeon Creek – Station 10 (USGS, 1992)

Existing and Planned Water Supply and Wastewater Systems

Although the Watersheds as yet are not extensively watered and sewered, some system infrastructure development has occurred and is shown in Figure 17. This information was collected and mapped in 1991 by the County Planning Commission and updated as part of the County's Water Supply Plan process in 1995. This information has been digitized as part of the GIS, so that the extent of the infrastructure can be related by sub-basins to the natural water resources and local demands. Additional information relating to expansion of existing facilities, actions already in planning, actions institutionally enabled (e.g., existing water supply franchise areas, State-granted surface water supply allocations, unutilized capacities, and so forth), has also been considered, and discussed in meetings with the respective municipalities.

Two water companies operate in northern Chester County. Table 4 is a summary for the Citizens Utilities Water Company serving the Spring City vicinity and portions of the two contiguous municipalities, East Pikeland and East Vincent. The table indicates supply to almost 2,000 households and 87 commercial and industrial connections as of 1991. This system has been extended further into the townships during the past seven years, and most recently has been proposed to serve a large residential parcel in the middle of the Stony Run watershed. The Pottstown system is derived from the Schuylkill River (6.0 MGD) and serves a portion of North Coventry Township along the Schuylkill River, estimated in 1990 at 1,173 county residents. Other small systems, all groundwater based, serve small clusters of mobile homes and other sites within the watershed, but by and large most existing residences use individual well withdrawals.

Table 4.

Citizens Utilities Water Company - 1990 Service in Chester County (CCPC, 1995)

Domestic	East Pikeland	East Vincent	Spring City	Total Chester Co.
Households Served	250	217	1,445	1,912
Population	725	586	3,323	4,634
Use (MGD)	0.046	0.04	0.265	0.35
Comm/Ind (MGD)	0	0.01	0.112	0.122
Other Use (MGD)	0.018	0.018	0.111	0.148
Total	**0.064**	**0.067**	**0.489**	**0.621 MGD**

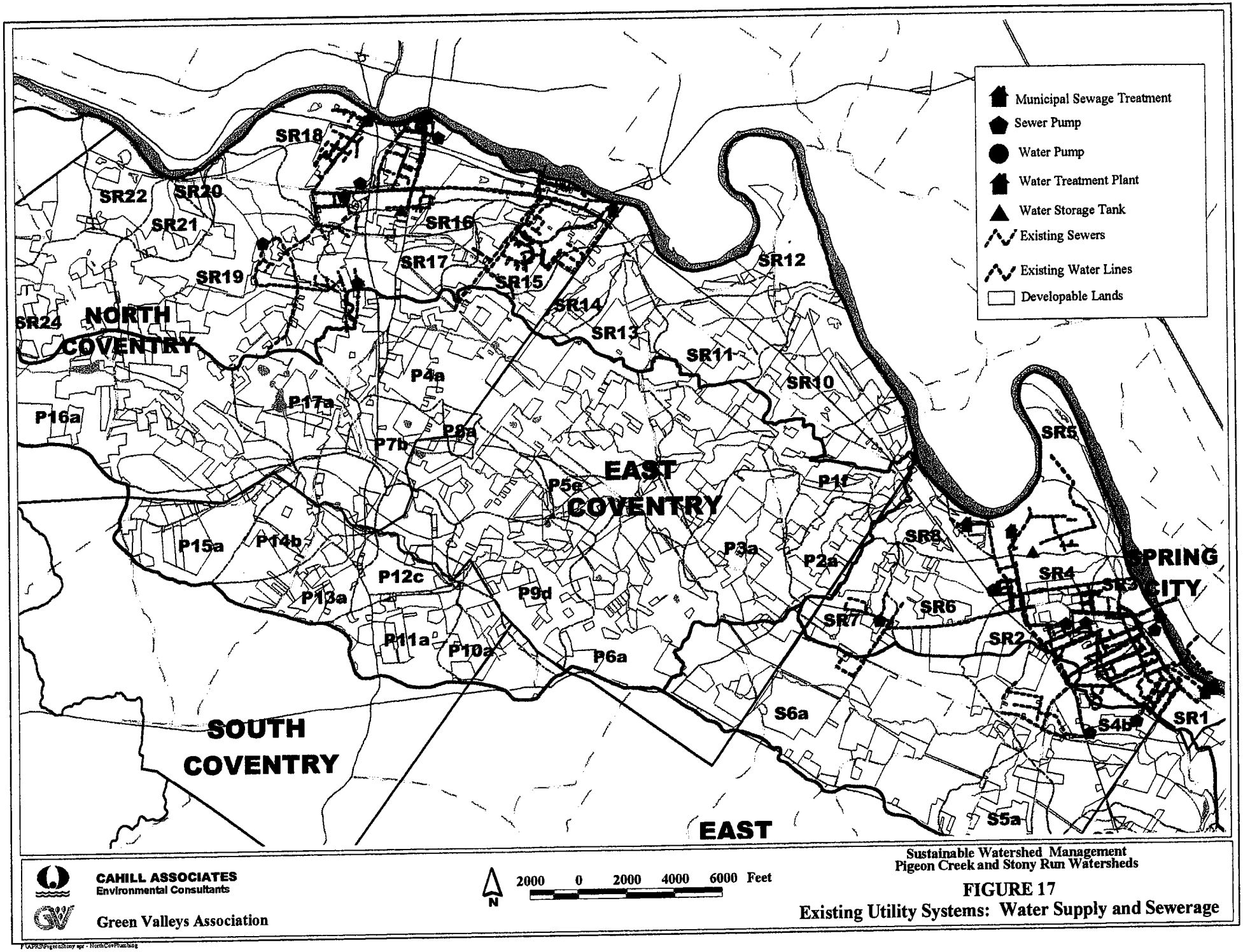

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FIGURE 17
Existing Utility Systems: Water Supply and Sewerage

Public sewer service is generally limited to those same communities contiguous to the river, with North Coventry and Spring City both providing treatment facilities (Table 5). As shown in Figure 18, the infrastructure elements of water and sewer service closely parallel each other in the developed areas, such as Spring City and vicinity. East Vincent purchased to former Pennhurst School STP in 1997 and now also provides service to portions of theTownship.

Table 5.
Public Wastewater Treatment Facilities in Northern Chester County
(1991 & 1996 for EVMA)

	North Coventry Township	Spring City Authority	East Vincent Municipal Auth.
Population Served	4,500	5,200	500
No. of Connections	1,600	1,854	211
System Service (MGD)	0.56	0.29	0.1
System Capacity (MGD)	0.6	0.35	0.5

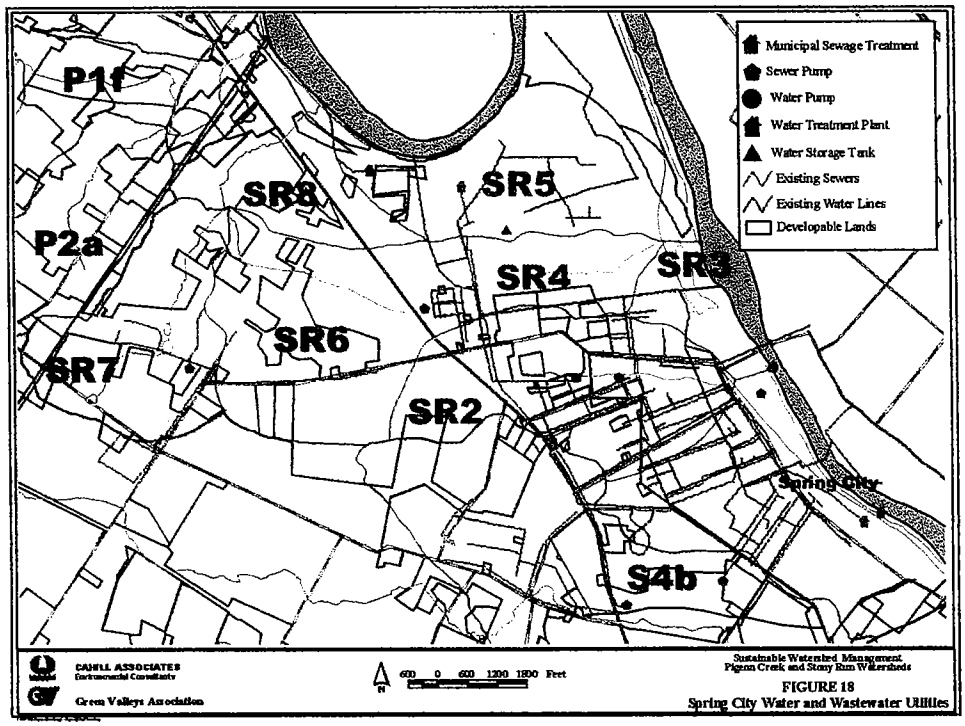


Figure 18. Water and Sewer Service in the Vicinity of Spring City

IV. LAND USE AND WATER REGULATION

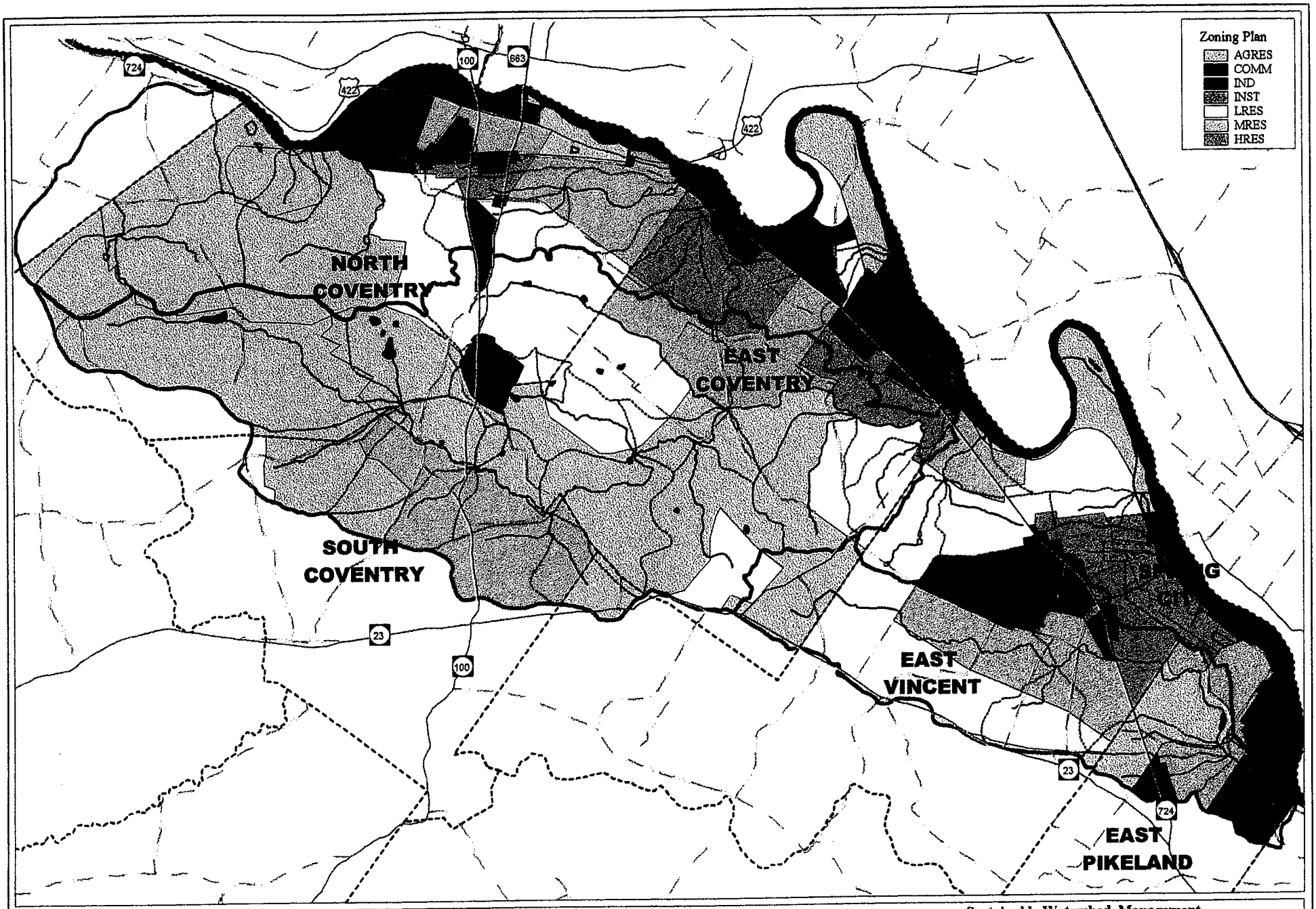
Municipal

Existing Zoning

The 6 municipalities (and small portions of two others) which in whole or part comprise the Pigeon, Stony and direct Schuylkill Watershed have created Zoning designations which are similar in form and structure. They are generally built on the patterns of land use created before zoning was instituted, with a preferred future use of land for large lot, single family residential purposes, outside of the Borough of Spring City. In anticipation of need or perhaps legal challenge, many of the municipalities have established zones for higher density and types of residential use, as well as relatively small commercial, industrial and other uses, frequently situated contiguous to existing similar uses or following transportation corridors and junctures. All of this zoning has been carried out with virtually no consideration of water resources, not out of a sense of neglect, but rather because the existing land form, topology, drainage and composition had little direct input into the zoning process, except where a municipal boundary is formed by a stream or a ridge line.

Certainly the original settlement patterns along the Schuylkill River valley as a transportation corridor, and other settlements at or near mill sites on the tributaries, created the basic skeleton of communities and interconnecting roadways. This land use was guided by the drainage system and the ridge lines which divide the small tributary watersheds, with gentle sloping valleys cultivated because of the richness of soil and topologic accessibility. As Zoning districts were imposed on this land form, however, it was applied in a flat, geometric pattern, defined by ownership lines and existing land use. Some streams became municipal boundaries, and therefore zoning boundaries, only because they offered definitive limits to land.

Within the 6 municipalities in the three watersheds, some 48 Zoning categories have been established, which create a patchwork quilt covering the watershed, if each zone is considered as distinct. In reality, these zones can easily be combined into seven general zoning categories, as shown in Figure 17 and Table 6. The zoning categories are not identical within the grouping, but are reasonably consistent across the category. The figure reinforces the controlling elements described earlier, with the urbanization patterns of higher densities extending south from the Pottstown area along Route 100, and to the west and north of Spring City. The largest portion of zoned land is large lot residential, reflecting the collective opinion of existing municipal governments that if development must take place, it be residential in form of the least density which can legally be justified.



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Pigeon Creek and Stony Run Watersheds

FIGURE 19
Current Zoning

F:\APRS\PigeonStony apr - Zoning

4		Zoning Designations		
5	Municipality	Mun_Symb	Uni_Symb	Description
6		R-1	LRES	Residential
7	East Coventry	FR	AGRES	Farm Residential
8		NC	COMM	Neighborhood Commercial
9		R-1	LRES	Residential
10		R-2	MRES	Residential
11		R-3	HRES	Residential
12		C	COMM	Commercial
13		LI	IND	Light Industrial
14		HI	IND	Heavy Industrial
15	East Pikeland	C	COMM	Commercial
16		HI	IND	Heavy Industrial
17		KR	COMM	Kimberton Retail
18		LI	IND	Light Industrial
19		R-1	AGRES	Farm Residential
20		R-2	MRES	Residential
21		R-3	HRES	Residential
22	East Vincent	C-1	COMM	Neighborhood Commercial District
23		R-1	AGRES	Rural Conservation District
24		R-2	LRES	Low Density Residential District
25		R-3	MRES	Medium Density Residential District
26		R-4	HRES	High Density Residential
27		C-2	COMM	General Commercial
28		I-1	IND	Professional Office/Research District
29		I-2	IND	General Industrial District
30	North Coventry	FR-1	AGRES	Farm Residential
31		FR-2	AGRES	Farm Residential
32		R-1	LRES	Single Family Residence
33		R-2	MRES	Single Family Residence
34		R-3	MRES	Single Family Residence
35		R-4	HRES	Multi-Family Residence
36		C1	COMM	Small Stores
37		C2	COMM	Large Stores
38		I1	IND	Offices & Laboratories
39		I2	IND	Industrial Park
40		I3	IND	Small Factories
41	South Coventry	AG	LRES	Agricultural
42		AG-RES	LRES	Agricultural-Residential
43		C	COMM	Commercial
44		C-I	COMM	Commercial-Industrial
45		CONS	AGRES	Conservation
46		H	VILL	Historic
47		RES	MRES	Residential
48	Spring City	R-1	HRES	Low Density Residential
49		R-2	HRES	Medium Density Residential
50		R-3	HRES	High Density Residential
51		PN	HRES	Planned Neighborhood
52		DC	COMM	Downtown Commercial
53		GC	COMM	General Commercial
54		I	IND	Industrial

Table 6. Municipal Zoning Classes and Related General Group

Subdivision Regulations

All of the municipalities in the watershed have adopted Land Development Ordinances, setting out specific criteria to be applied in the land development process. Most such guidance respects the sensitive land areas on a given parcel, such as flood plains and steep slopes, and all municipalities have some form of a stormwater management ordinance in place which requires that the post-development runoff peak not exceed the pre-development condition. A few of the townships have made this criteria more stringent by defining the pre-development condition as better vegetated than present existing conditions, or setting the pre- and post-development hydrology using storm events of different statistical frequency. The net result of these criteria is to require the building of larger detention basins. With respect to water and sewer criteria, all municipalities refer to County Health Department (and underlying PADEP) criteria for on-site septic systems and potable well construction, and require compliance with the municipal Act 537 Sewer Facilities Plan for any community or larger sewer system.

Virtually all technical guidance set out in the various municipal ordinances deals with related aspects of land development (impervious cover limits, earthwork criteria, etc.), but none of the municipalities have formulated specific guidance defining the limits of the water resource to support a given land use, or translated these limits into specific development criteria. Several municipalities recognize the importance of the aquifers in related planning documents, but for the most part the issue of water resource impacts is contained only in the allowance of higher densities where public water and sewer service is provided. No corresponding reduction is proposed where water resource limits are anticipated.

Comprehensive, Sewer and Open Space Plans

When a municipality elects to plan, it must conform to the Municipalities Planning Code (MPC), Act 247, the enabling state legislation in Pennsylvania for land regulation. Planning for sewer facilities (and the related land uses they serve or will serve) is required under state law (Act 537), and was intended to anticipate growth in a community and plan for the assumed to be needed infrastructure. The logic was to allow development to go forward in an orderly fashion while protecting the public health, safety and welfare (without crises created by malfunctioning septic systems), based on the assumption that wastewater was better managed by collection and treatment at the community level. The preparation of Open Space Plans has been supported by recent county funding of planning grants to each municipality in relatively small amounts (less than $15,000 in most cases), and has generated some very imaginative and creative planning documents which recognize the land and water resource planning issues. The collective impact of these various planning documents can best be considered by discussing selected municipalities and the specific plans developed in each jurisdiction. This is not a comprehensive overview of each municipality in the watershed, nor is it a complete inventory of each planning document.

East Coventry Township

The new Comprehensive Plan (1995) sets the stage nicely for the recommendations of this report, and the township clearly wishes to do the right thing. The first stated goal is environment protection. The plan advocates Planned Residential Development (PRD), with housing mix as well as clustering. The actual ordinances are weak, however, and although they have sound goal and policy statements, have not been implemented. The Comprehensive Plan contains some excellent discussion on aquifers, advocates stream buffers, and recommends quality protection of aquifers and headwaters. It also concludes that aquifers are satisfactory for low density development, but no rationale given.

East Pikeland Township

East Pikeland has made an ambitious start in making their management "tools" sensitive to water resources management concerns. Their stormwater requirements, for example, are remarkably advanced and consistent with Sustainable Watershed Management recommendations. The Open Space Plan Update (1993) constitutes their most recent and most sophisticated planning and establishes an excellent base for incorporating SWM recommendations. The Open Space Plan has a distinctly greater focus on conservation of natural resources; ....*Environmental resources can no longer be squandered or left unprotected. Municipalities that want to preserve their resources will have to take deliberate actions. Many, if not most, of these actions will require a regional planning and cooperative implementation. The preservation of streams, ground water resources, biotic resources, the rural character, the visual environment, and other resources must be considered in a regional context..*
The Plan also states .....*The impact of development in headwaters areas is critical to areas of East Pikeland and should be a regional concern.*

The objectives which are listed for each of the Plan goals comprise many of the recommendations which are made for sustainable watershed management.

East Vincent Township

East Vincent is an excellent example of a township confronted with substantial development pressures and striving to manage these pressures. Their recent management actions include the recently updated Comprehensive Plan (1994) and Open space Plan (1992). The Comp Plan addresses water resources, quality and quantity for both surface and groundwater resources extensively. This treatment reflects the level of sophistication developed in the Open Space Plan. Many of the basic themes of sustainable Watershed Management are in fact addressed in these documents. The inventory undertaken as part of these plans is more advanced than most other municipal plans. For example, headwaters stream watersheds are in fact designated. Statements of goals and objectives in these plans are quite comprehensive in terms of water resources management, as well as broader growth management issues. Protection of total natural resources as well as agricultural resources is stressed. The French Creek Watershed zone is singled out and

assigned the lowest density defined in the planning (Rural Conservation, which is consistent with the existing zoning classification of R-1 at an approximate 2-acre maximum limit). Under stormwater, recharge is established as required.

The major problem is that the resultant Future Land Use Plan delineates a large zone in the Stony Run where development is to be "directed," primarily through provision of public water and sewer facilities as well as other possible municipal incentives. The concept is quite typical and reminiscent of a transfer of development rights "sending" zone and "receiving" zone. Large homogeneous zones of higher density are defined in the "receiving" zone. The Rural Conservation "sending" zone is uniformly kept open. It is not clear how this concept differs from past planning--possibly not significantly. The problem is that not only does such a plan allow for greater density in the development area, but there is no mechanism provided for real protection of the conservation zone.

As has happened in the past, low density development with on-site facilities may be able to leapfrog into the conservation zone. Package wastewater treatment plants may occur as well. As well intentioned as these plans might be, such planning can simply become subservient to sewer and water line phasing. Imagine the situation 10 or 20 years down the line when the development zone is built out. At that point the development zone line must be extended to the south and west. Ultimately, the entire municipality is built out--really the antithesis of what East Vincent wants. A second point to make is that such broad zone designations are lacking in careful neighborhood and community building. The end result becomes large zones of suburban sprawl--not the kind of hamlet and village and town that offers water resource benefits and so many other types of benefits.

North Coventry Township

North Coventry lies within both the Pigeon Creek and the direct drainage Schuylkill River, with a small piece of the French Creek. The township is a vital part of the Northern Federation and active participant. The Comprehensive Plan (1988) is similar to the East Vincent plan in its approach to loading future growth in North Coventry. Broad zones of higher density where public facilities (sewer and water) are provided have been designated. There is discussion of importance of villages; however the Future Land Use plan shows us no villages. Furthermore, the provisions in the Plan addressing villages are not relevant to development of villages. Natural resources goals and objectives focus largely on zoning and SLDO provisions. Planning-related provisions developed for sustainable Watershed Management should be integrated.

A proposal has recently been made to franchise a private water company to serve portions of the Pigeon Creek drainage by groundwater withdrawals, with sewage conveyance to the municipal plant. The net result of this infrastructure would be a significant depletive loss of water from the sub-basins served, with corresponding depletion of base flow. A more complete discussion of this proposal, and the implications for water resources, is included in a subsequent section titled Case Studies.

County Regulatory Agencies

Chester County Health Department

The Chester County Health Department (CCHD) has regulatory responsibility and performs resource management for several key water resource laws and programs in the Watershed. Created under enabling State legislation in 1966, the CCHD has primary control over on-site sewerage systems, including both permitting and construction inspection. For larger Community On Lot Disposal Systems (COLDS), the DEP has oversight responsibility, and for most larger systems (greater than 10,000 GPD) the state assumes primacy in permit issuance, with the option of considering smaller systems of special concern. For single family residential systems, the CCHD is the only regulator, but for larger systems the division of responsibility is unclear and varies over time as agency programs are modified. In both of these programs, there is recognition that the application of septage has the potential to impact groundwater, and elevate concentrations of Nitrate above 10 mg/l, limiting local water supply withdrawals. For the larger onsite effluent application systems, testing of groundwater quality is now required, and in many cases continuing monitoring has been included in the permit. For the individual residential systems, however, only limited testing is required.

The planning process for community or regional wastewater system development has traditionally been implemented through the requirements of Act 537, the state law governing sewage facilities planning. The CCHD plays an important part in encouraging, supporting and reviewing the preparation of these plans and assuring compliance with them following adoption by the municipality, but the lead agency is the DEP. The on-going conflict between land use change and water quality is most apparent in these plans and their formulation, as both local government and county and state regulators have lacked the capacity to estimate future impacts of resource management. Issues of water balance exacerbated by basin transfers, sewage export and regional groundwater pollution are considered but seldom enter into the final plan development. The pressures created by existing system failures, new land development applications and other socioeconomic and political factors make the question of where to define the "end of the sewer" a very difficult issue.

Chester County Conservation District

The Chester County Conservation District (CCCD) plays a vital role in water resource management and the land development process from a regulatory perspective. Evolving from a traditional role as technical advisor to the farming community, the CCCD now implements Chapter 102 of the state water quality regulations concerning Erosion and Sediment Control for new development applications, and reviews the associated stormwater management controls designed for such developments. In many municipalities, ordinances have been enacted which parallel this role, with review and approval control mandated to the municipal engineer. In most cases, the management

controls are identical, with the primary design criteria of stormwater facilities being the attenuation of runoff peak flows.

The CCCD has become the lead technical agency in all aspects of stormwater management, providing guidance to the municipalities and promulgating the current guidance, standards and methods of the state. As an institution, the District is more comfortable in the role of technical advisor, and the occasional enforcement aspects of the E & S program are more difficult. Much of the good advice offered by the DEP and federal agencies with respect to stormwater management is directed through the District and the supporting federal agency, the Natural Resources Conservation Service (NRCS) formerly the Soil Conservation Service (SCS). Some of this guidance recognizes the basic resource management conflicts of allowing increased runoff at the cost of diminished groundwater recharge, but by and large the focus is on direct stormwater impacts.

Current Best Management Practices (BMPs) advocated by the District and NRCS recognize the importance of controlling Nonpoint Source (NPS) pollution, both before and after development. However, nothing in the current management guidelines requires recharge of stormwaters as a basic policy for both quantity and quality considerations, and the requirement of BMPs for new development, while recommended and encouraged, is not yet a part of the management system. That is, specific criteria for NPS load reduction have not yet been included in the design guidelines. The recent BMP Manual (Pa Assn. of Conservation Districts, 1997) does recommend a number of measures with positive benefits for water quality, but these guidelines have not yet found their way into regulatory form at the municipal level.

Chester County Planning Commission

The Chester County Planning Commission (CCPC) has long preached a gospel of land planning with resource protection, and all of their reports have reflected a sensitivity for the environmental quality which is held in great esteem within the county. The numerous documents prepared under various aspects of community support reflect this understanding and advocacy, and the current County Comprehensive Plan (1996), titled *"Landscapes"* and the related Draft Regional Land Use Plan (1996) prepared for the Northern Federation, continue to recognize the interrelationship between land and water resources. The recent inclusion of the Chester County Water Resources Authority (CCWRA) within the administrative framework of the CCPC should further reinforce this policy.

Given the inherent weakness of county government in Pennsylvania, much of this advice is not given adequate consideration by municipal governments, and does not find translation into specific ordinances, zoning changes or other management actions. To compensate for this lack of direct political control, the county provides financial support to municipalities to "do the right thing" in local planning efforts, supported technically by the CCPC. Some of these regional planning programs have been successful for Pennsylvania, and the 22-year old Federation of Northern Chester County Communities

(FNCCC) stands as a success story within the county for inter-municipal planning efforts. Current efforts by the CCPC to implement the concepts of the Landscapes Plan have taken the form of significant financial support to the municipalities (a maximum of $75,000 each) to revise planning, zoning and municipal plans to incorporate the substance of the County Plan. This effort could significantly improve the overall municipal land planning process.

The linkage between County planning and state regulation of water resources is very weak. The state may consider the various related planning documents as and when a water or wastewater permitting issue is specifically identified, but seldom uses the county programs as guidance for any type of comprehensive regulatory program. The future efforts by PADEP under federally-mandated Total Maximum Daily Load (TMDL) permitting for both point and non-point pollutant discharges may be influenced by future planning on a county or regional basis, but the current relationship is poor to non-existent.

Regional Agencies

Federation of Northern Chester County Communities

The Federation of Northern Chester County Communities (Northern Fed) is a consortium of nine municipalities in northern Chester County. It was formulated in 1974, with East Vincent, South Coventry, Warwick and West Vincent Townships, and expanded in 1982 to include North Coventry, East Coventry, Spring City, East Pikeland and East Nantmeal Townships. The original focus of the Northern Federation was the protection of water quality and quantity in the French Creek, a mission which still remains a key objective.

The Northern Fed has participated in and given final approval to several plans and planning studies undertaken by the CCPC on their behalf over recent years and which have major water resources management importance. The *Surface Water Runoff Study (1991)* recommended that Northern Fed municipalities pursue a more ambitious program for managing surface water resources. Many of the recommendations made in the *Surface Water Study* also pertain directly and indirectly to groundwater and total watershed management. These recommendations are directly supported by this study, and offers a mechanism to achieve the forward-thinking goals and objectives which already have been embraced by the Northern Fed municipalities. The technical task is to translate this guidance into specific changes and additions to the Zoning, Ordinances and Planning documents of each of the member municipalities. One such effort was included in this current program for the Pigeon and Stony basins, with a Model Ordinance developed for stormwater management. This ordinance proposes the use of groundwater recharge systems for stormwater management as the primary measure instead of conventional detention basins, and includes water quality mitigation for NPS reduction. A draft copy of the ordinance is included here as Appendix A.

Delaware River Basin Commission (DRBC)

Groundwater Protected Area

The Delaware River Basin Commission (DRBC) regulates development of new wells where well usage is expected to be large (100,000 gallons per day) based on average 30-day usage in all areas excepting the Special Groundwater Protected Area, where the 100,000 GPD threshold is reduced to 10,000 GPD. All of the Watershed is located within this Special Groundwater Protected Area. The DRBC permitting process requires much more complex technical evaluation, including more detailed hydrogeologic studies and pump test analysis of the new well being permitted, as well as an evaluation of the potential impacts on adjacent wells. However, until the current time, no specific quantity withdrawal limits have been imposed on any new well applicant, regardless of the current and future anticipated use of that aquifer, or the existing and planned wastewater effluent discharge programs, including the net impact of the export of wastewaters from a given basin.

The DRBC has long recognized the importance of maintaining base flow in stream systems, and the original reason for the establishment of the Groundwater Protected Area was a very important study of stream base flow, performed for the DRBC (Wright, 1981), titled *"Special Groundwater Study of the Middle Delaware River Basin, Study Area II"*. The Wright study considered available groundwater data for the middle portion of the Delaware basin, including the French and Pickering watersheds. The study considered a number of factors which influence well yield in various formations, such as lithology, topologic setting, degree of fracturing, and other conditions. It gave detailed consideration to the Triassic Formation, and the differences among major rock types, all of which are found in the northern portion of the French Creek watershed.

The development of data concerning possible depletion of base flow and subsequent de-watering of streams in the Delaware River basin during drought resulted in specific regulations by DRBC concerning development of new wells. In 1996 and as amended in 1997, the DRBC Groundwater Advisory Committee proposed amendments to the Groundwater Protected Regulations which would use the Average Annual Base Flow of 25-year frequency (Q 365-25) as a limit to withdrawals in the protected area. The pilot studies supporting these proposed regulations were performed in the Neshaminy basin, a watershed whose Triassic aquifers are substantially overdrawn by urban demands, with several major streams which dried up during the drought period of 1995.

It is the intention of the DRBC to extend the regulations to the entire Groundwater Protected Area following further study by the USGS during 1998, in developing base flow statistics. More importantly, the currently proposed rules allow local groups of municipalities (such as the Northern Federation) or Counties (such as Chester) to adopt more stringent withdrawal regulations where high quality stream systems have been designated. Thus these DRBC regulations can offer a technical support and regulatory

foundation for any effort to apply base flow limits to groundwater withdrawals in the study area.

Delaware Valley Regional Planning Commission

The potential role of the DVRPC in relating land use to water resources has significantly changed over the past decade, as diminished funding for water related planning has forced the agency to focus on transportation issues. During the 1970's, the agency played a key leadership role in formulating a series of studies of land and water in the Delaware Valley, under the Section 208 program of the Federal Clean Water Act (CWA). That work and the resultant guidance fell into disuse during the 1980's, as the DVRPC withdrew from any substantial role in local land use issues related to water resources. Potentially, they could reinforce the county planning effort in basins which include multiple counties, and should be included in the watershed planning process.

State of Pennsylvania

Water Resources Management

The PA Department of Environmental Protection (DEP) and its sister agency and former partner the Department of Conservation and Natural Resources (DCNR) have a great deal to do with water resource management in the watershed, but little to do with land use, except where lands are under the direct ownership or control of the state. Formerly combined as one institution created in the 1970's and separated in 1996, the regulatory functions fall largely with the DEP. Building on the original PA Clean Streams Law (1937), this agency implements all of the programs mandated under the Federal Clean Water Act, including the permitting of all wastewater discharges (NPDES), the Safe Drinking Water Act, and related environmental legislation, such as the Clean Air Act and other laws which give general control over most environmental pollution issues. As such, it is the primary water quality regulator, as well as the regulator of surface water quantity, and regulates groundwater in a qualitative sense (discharges and withdrawals). It has traditionally avoided any regulatory limits on groundwater quantity, a void which the DRBC regulations have partially filled. While the DEP has clearly recognized that land use is often the root cause of many of the water quality problems which it confronts, it has carefully avoided any direct intrusion into what is considered the exclusive domain of local government.

Many of the programs and laws which DEP currently enforces within the Pigeon-Stony-Schuylkill Watershed are partially or largely derived from or based on Federal legislation, and partially supported by Federal funding through USEPA. This funding support and the degree of control exercised by the EPA over DEP has varied over time, with the current cycle characterized by reduced funding and lessened control. Without attempting to document each and every specific program, those aspects of key programs which have direct bearing on the land and water resource management issues identified here will be considered. Perhaps most prominent is Pennsylvania's Environmental Amendment to the State Constitution, Article I, Section 27. More specifically, the Clean

Streams Law (Act 394 of 1937; P. L. 1987) has been enacted *"...to preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for industrial consumption, and for recreation."* (Preamble to Act 394).

In Section 4. Declaration of Policy, the Legislature has specified several objectives of the Clean Streams Law which are supported and furthered by the proposed management program here (an exclusive focus on water quality notwithstanding):

> *"(1) Clean, unpolluted streams are absolutely essential if Pennsylvania is to attract new manufacturing industries and to develop Pennsylvania's full share of the tourist industry;*
> *(2) Clean unpolluted water is absolutely essential if Pennsylvania are to have adequate out of door recreational facilities in the decades ahead;*
> *(3) It is the objective of the Clean Streams Law not only to prevent further pollution of the waters of the Commonwealth, but also to reclaim and restore to a clean, unpolluted condition every stream in Pennsylvania that is presently polluted;*
> *(4) The prevention and elimination of water pollution is recognized as being directly related to the economic future of the Commonwealth; and*
> *(5) The achievement of the objective herein set forth requires a comprehensive program of watershed management and control."*

Furthermore, Section 401 of the Clean Streams Law states:

> *"It shall be unlawful for any person or municipality to put or place into any waters of the Commonwealth, allow or permit to be discharged from property owned or occupied by such person or municipality into any waters of the Commonwealth, any substance of any kind or character resulting in pollution as here defined. Any such discharge is hereby declared to be a nuisance."*

Although this language appears to be far-reaching in its scope, the specific programs enacted for pollution control have not been as encompassing. Over time, the implementation of the Clean Streams Law and subsequently the Federal CWA has focused almost exclusively on the direct discharge of wastewaters to surface streams, as currently implemented under the NPDES program. Only two such permits are currently in place within the Watershed, and virtually all wastewaters generated within the watershed are collected and discharged directly to the Schuylkill River.

In addition to the NPDES program and the Chapter 102 E&S program enforced by the CCCD, the state does have various specific laws and regulations related to water resources, including the Stormwater Management Act, the Floodplain Management Act, Dam Safety and Encroachments Act, Wastewater Facilities Plan Act, and others, which are in various ways furthered by land and water resource management. Sustainable Watershed Management provides a mechanism to achieve the goals and objectives which have been adopted on the state level for most of these laws, but the existing laws presently have little bearing on land use.

Special note should be made of the concept of antidegradation on the state level. The federal government requires that states develop and implement programs for antidegradation of streams which enjoy high quality, exceeding existing water quality standards. Pennsylvania's program of antidegradation has been controversial and in fact has been litigated, with a variety of parties contending that current program elements are inadequate. PADEP has promulgated a *Special Protection Waters Implementation Handbook (1992)* which identifies a variety of measures to be implemented in order to properly protect and conserve stream values. To date, most attention for special management has been in the area of point source control, although the *Handbook* does identify other actions beyond point source management which should be considered for Special Protection Waters management in order to prevent significant degradation. The management actions proposed here constitute a significantly more rigorous approach to antidegradation and could provide a potentially useful model for management of these special resources across the state.

Land Use Planning - State Law

With respect to the laws which regulate land use at the state level, the *Pennsylvania Municipalities Planning Code* (MPC) provides the legal framework for land use planning and management for all levels of government in Pennsylvania. Recent amendments (Act 170) to the MPC added several water-related provisions:

> *603. Zoning ordinances may permit, prohibit, regulate, restrict and determine: (1) uses of land, water courses and other bodies of water. (5) protection and preservation of natural resources and agricultural land activities. (d) Zoning ordinances may include provisions regulating the siting, density and design of residential, commercial, industrial and other developments in order to assure the availability of reliable, safe and adequate water supplies to support the intended land uses within the capacity of available water resources.*
>
> *604. (1) The provisions of zoning ordinances shall be designed: To promote, protect and facilitate any or all of the following...the provision of a safe, reliable and adequate water supply for domestic, commercial, agricultural or industrial use, and other public requirements; as well as the preservation of the natural, scenic and historic values in the environment and preservation of forests, wetlands, aquifers and floodplains.* (MPC, Reenacted and Amended December 21, 1988 by P. L. 1329, No. 170)

The implications of these water-related provisions in most cases are not totally clear and certainly have not been court-tested. Nevertheless, the water resource management concepts proposed in this study are consistent with these new provisions. It is worthy of note that in most cases the MPC water-related provisions <u>enable</u>, but do not <u>mandate</u>, municipalities to take into account these water concerns in their overall planning.

Federal - USEPA

The Federal Clean Water Act, Safe Drinking Water Act, and other legislation which is implemented within the state by DEP is limited to environmental protection of water resources, and has little or nothing to do with land use directly. The only exception to this is the Federal Wetlands Protection Act, which specifically prevents the disturbance of land which meets specific criteria defined (and redefined) in guidance developed by the Corps of Engineers, aided by EPA and US Fish and Wildlife. While the methodology to define a "regulated wetland" has been debated and litigated over the past decade, the end result has been to avoid, to a large degree, any significant further loss of wetlands in most watersheds. In terms of land use policies, the reality of land development applications has come to include a careful delineation of regulated wetlands as a part of every such application before a municipality, with no actual filling or development proposed or allowed on these lands. Those lands so identified within the watershed can expect to remain undisturbed for the foreseeable future.

Delaware Estuary Comprehensive Management Plan

Over the past five years, the Region III office of USEPA has directed significant funding into the Delaware Estuary program, funded under the CWA. The thrust of this program is to recognize the regional implications of water quality management within the Estuary and its associated drainage, with a portion of the lower tributary area identified as the planning region of concern. Within this drainage, which includes the French, Pickering, Pigeon, Stony and other tributaries of the Schuylkill River, the importance of reducing pollutant inputs from nonpoint sources has been recognized, and the issue of land use management is clearly identified as one of the most important elements of the program to restore and maintain water quality in the Estuary.

Having incorporated these ideas into the program, the Federal agencies which are guiding this effort with support from state (PA, NJ and DE) and regional agencies (DRBC) are extremely cautious to venture into the area of land use controls. Clearly the objectives of the Estuary program cannot be implemented without land use management programs which substantially reduce the discharge of NPS pollutants from existing agricultural and urban land. Actual implementation of the *Management Plan for the Delaware Estuary* (EPA, 1996) must develop strategies which prevent such inputs during future land use change, which is generally from agricultural to urban, as the regional population spreads further and further into the surrounding counties. Projects such as this GVA program are receiving close scrutiny by the EPA to determine if the linkage between water resources and land use can be defined sufficiently to alter and influence land use management.

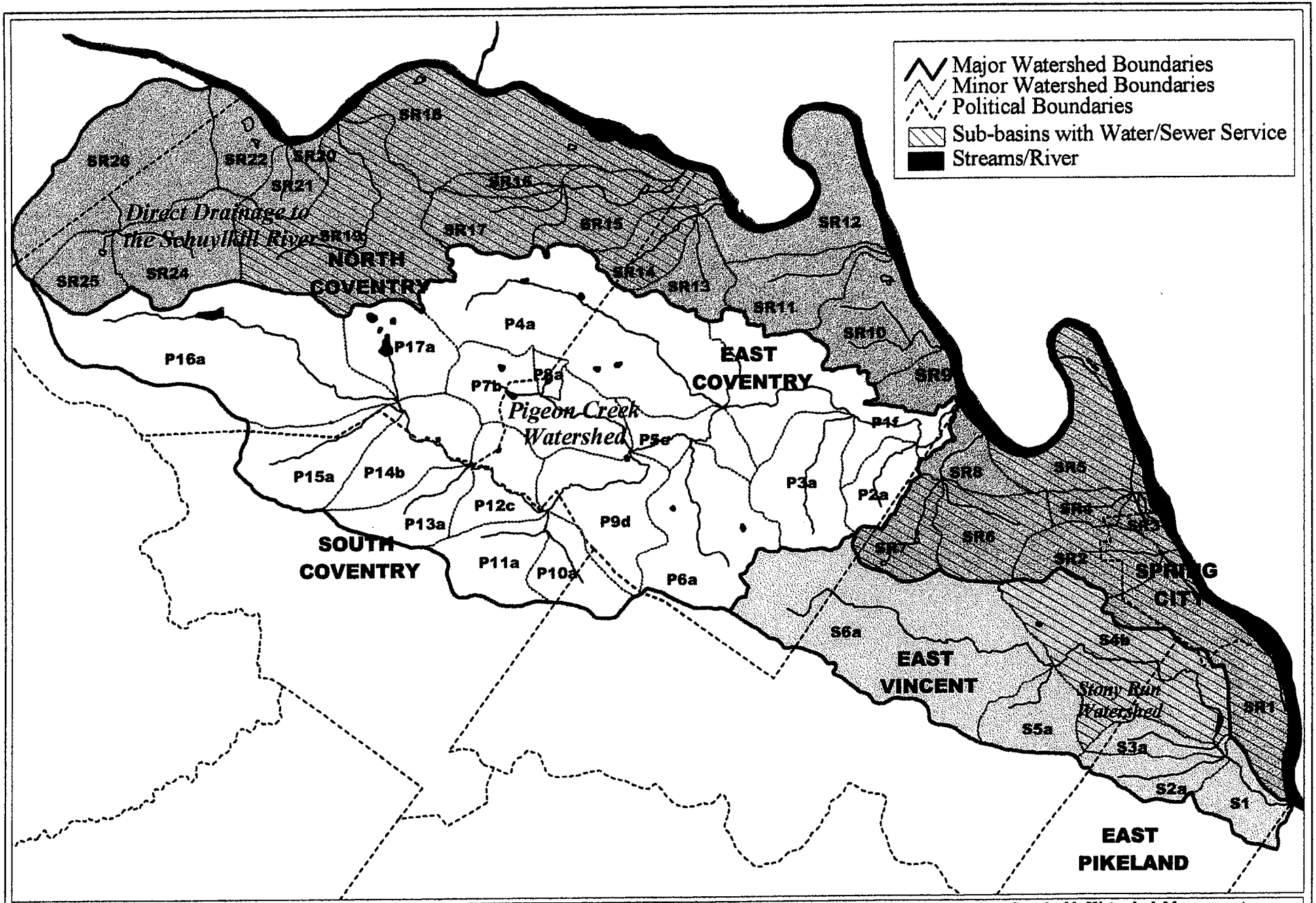
V. WATER BALANCE MODEL

Conceptual Framework

The technical analysis of land and water resources within the study area begins with a careful measurement of both, making use of the Geographic Information System (GIS) files created for this purpose and which cover the full study area. Since three distinct drainage basins comprise the 23,930-acre (35.83 SM) study area, the delineation of first order streams and larger catchments within these basins was required for analysis, as discussed previously. As was shown in Figure 13 and repeated here as Figure 20, the Pigeon Creek has been divided into 17 sub-basins, the Stony Run into 6 sub-basins and the direct Schuylkill River drainage into 25 sub-basins. These areas vary significantly in size, but average about 477 acres for the 48 sub-basins.

Analyzing the existing and potential future hydrologic balance in each of these sub-basins required the application of what is referred to here as the Water Balance Model (WBM). On a conceptual basis, the model considers the dynamics of water movement from incident rainfall through the soil into the groundwater reservoir, with gradual discharge as stream base flow (see Figure 12). It is the stream base flow which is taken as the net result of all intervening processes, including evaporation, transpiration and human intervention, so that existing uses and conditions are all reflected in this statistic. The model can consider base flow variability by each geological structural element (which in this study area has been shown to be insignificant, see French & Pickering Study, 1997), surface yield and subsurface withdrawals, with hydrologic analysis for wet, dry and average years. The WBM can be thought of as a bookkeeping process which accounts for the dynamics of the water cycle by considering each catchment under stress conditions which test the specific resource impact; drought periods of base flow for water supply (Q7-10 = 192 GPD/acre), dry year cycles (Q365-10 = 445 GPD/acre) for groundwater contaminants such as Nitrate (NO3), and storm periods (based on annual runoff) for estimates of potential pollutant runoff from future urbanized lands.

Of course any such fixed analysis of the hydrologic cycle ignores the dynamic nature of the process, with the water in constant movement. All elements of the cycle vary with time and seasonal change. Patterns of incident rainfall, as documented by the climatological record in terms of seasonal variability and event probability, changes in the evaporative and transpirational losses as a function of temperature and vegetative land cover, changes in the net withdrawals from the aquifers by wells and additions by wastewater effluent of on-site systems, and the resultant impact on storm and dry weather stream flows which are produced by land surface alteration, all contribute to the dynamic nature of this process. The WBM has been applied and aggregated to reflect the total watershed balance and variability within each basin for planning purposes, and to allow us to identify potential stress conditions in the system so that we may prevent or intervene to protect the resource.


Major Watershed Boundaries
Minor Watershed Boundaries
Political Boundaries
Sub-basins with Water/Sewer Service
Streams/River
Direct Drainage to the Schuylkill River
NORTH COVENTRY
EAST COVENTRY
SOUTH COVENTRY
Pigeon Creek Watershed
Stony Run Watershed
EAST VINCENT
EAST PIKELAND
SR26
SR22
SR20
SR21
SR18
SR16
SR17
SR15
SR12
SR25
SR24
SR14
SR13
SR11
SR10
SR9
P16a
P17a
P4a
P8a
P7b
P4f
P5e
P15a
P14b
P3a
P2a
P12c
P13a
P9d
SR8
SR5
SR4
SR3
SR7
SR6
SR2
P11a
P10a
P6a
S6a
S4b
S5a
S3a
SR1
S2a
S1
2000 0 2000 4000 6000 Feet
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CAHILL ASSOCIATES
Environmental Consultants
Green Valleys Association
Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds
FIGURE 20
Watershed Sub-basins

Water Use Based on Existing Conditions

Each of the 48 sub-basins experience some amount of water use at present, primarily based on residential use or the equivalent use of other land activities expressed in "equivalent dwelling units" (EDUs). The demands of agriculture are not included in this estimate, since the future land use scenarios all assume that the lands zoned agricultural and used as such at present will provide the developable lands (excluding those parcels under permanent easements or protective covenants). For a more accurate estimate, the individual agricultural parcels could be evaluated and a current demand estimated, but this level of data gathering was not considered necessary for this study of future impacts.

Based on a set of assumptions with respect to the number of dwelling units in each sub-basin (as estimated from the existing land use type, Table 7) and the water use per dwelling unit (300 GPD/DU), the existing water use is summarized in Table 8 by sub-basin and Table 9 by municipality. The estimated water demand is based on assumptions as to the average number of dwelling units which exist in a given sub-basin, as approximated by the existing zoning. Of course, where a current count of actual dwelling units can be made, it is a more accurate statistic, and as the individual sub-basins are studied in greater detail, that value will replace this estimate.

Table 7.

Dwelling Unit Assumptions of Existing Land Use

Land Use Category	Description	Equivalent DUs per Acre
AG	agriculture	0.02
IN	institutional	0.10
RA	residential, >/= 1 ac./DU	0.30
RB	residential, ½ ac/DU	1.50
RC	¼ to ½ ac./DU	3.00
RD	village, urban	5.00
VA	vacant	0.00
CO/D	commercial/industrial	0.20
OS	open space	0.00
EA	easement	0.00
UT	utility	0.00
MU	mixed use (res./comm.)	3.00

Table 8 estimates the water use for each sub-basin and then assumes that 20% of this use will be lost as consumptive loss. The estimate of 20% consumptive loss with groundwater withdrawals is based on the assumption of on-site wastewater treatment and bed effluent. As shown in the table (the number 2 means not true), under current conditions none of the sub-basins produce an evaporative loss which is greater than 50% of the Q7-10 low flow.

TABLE 8
Existing Water Use by Sub-basin

Sub-basin	Area (acre)	EDUs	Water Use (gpd)	On-site Wastewater (gpd)	Consumptive Loss (gpd) [20%]	Exceeds GW Limit [1]* 1-Yes(Bad) 2-No(Good)	Nitrate Load (lb/yr) [2]*	Nitrate Limit (lb/yr) (3)
P1f	816	232	69,682	55,746	13,936	2	7,640	8862
P2a	220	30	9,042	7,234	1,808	2	991	2389
P3a	507	71	21,362	17,089	4,272	2	2,342	5506
P4a	1,488	502	150,518	120,414	30,104	2	16,503	16160
P5e	269	49	14,651	11,721	2,930	2	1,606	2921
P6a	711	137	41,175	32,940	8,235	2	4,514	7721
P7b	577	124	37,303	29,842	7,461	2	4,090	6266
P8a	53	9	2,789	2,231	558	2	306	576
P9d	555	95	28,497	22,798	5,699	2	3,125	6027
P10a	271	58	17,411	13,928	3,482	2	1,909	2943
P11a	340	127	37,975	30,380	7,595	2	4,164	3692
P12c	328	36	10,776	8,621	2,155	2	1,182	3562
P13a	288	76	22,664	18,132	4,533	2	2,485	3128
P14b	454	79	23,722	18,978	4,744	2	2,601	4930
P15a	474	48	14,479	11,583	2,896	2	1,588	5148
P16a	1,462	198	59,318	47,454	11,864	2	6,504	15877
P17a	396	155	46,591	37,273	9,318	2	5,108	4301
S1	253	36	10,905	8,724	2,181	2	1,196	2748
S2a	225	51	15,164	12,132	3,033	2	1,663	2444
S3a	167	94	28,107	22,485	5,621	2	3,082	1814
S4b	994	443	132,838			2		
S5a	305	53	15,941	12,753	3,188	2	1,748	3312
S6a	1,636	207	62,116	49,693	12,423	2	6,810	17767
SR1	713	766	229,655			2		
SR2	361	663	199,030			2		
SR3	85	62	18,580			2		
SR4	122	29	8,833			2		
SR5	574	41	12,424			2		
SR6	405	159	47,821			2		
SR7	282	66	19,667	15,734	3,933	2	2,156	3063
SR8	204	52	15,542	12,434	3,108	2	1,704	2215
SR9	172	77	23,070	18,456	4,614	2	2,529	1868
SR10	480	131	39,153	31,322	7,831	2	4,293	5213
SR11	400	60	17,880	14,304	3,576	2	1,960	4344
SR12	593	94	28,308	22,646	5,662	2	3,104	6440
SR13	227	55	16,559	13,247	3,312	2	1,816	2465
SR14	238	113	33,770			2		
SR15	426	365	109,464			2		
SR16	139	65	19,630			2		
SR17	331	116	34,873			2		
SR18	971	790	236,894			2		
SR19	1,193	301	90,236	72,188	18,047	2	9,894	12956
SR20	43	6	1,829	1,463	366	2	201	467
SR21	156	27	8,138	6,510	1,628	2	892	1694
SR22	253	27	8,147	6,518	1,629	2	893	2748
SR24	503	168	50,357	40,285	10,071	2	5,521	5463
SR25	245	30	8,927	7,141	1,785	2	979	2661
SR26	1,025	63	19,016	15,213	3,803	2	2,085	11132
TOTAL/48	**22,930**	**7,236**	**2,170,829**	**869,612**	**217,401**		**119,184**	**190,821**

[1]* based on 50% depletion of Q 7-10 limit
[2]* Based on 45 mg/l
(3)* Based on 446 GPD/Ac and 2 mg/l NO3 background

TABLE 9

Existing Water Use by Municipality

Sub-basin	Municip	Area (acre)	EDUs	Water Use (gpd)	On-site Wastewater (gpd)	Cons Loss (gpd)	Nitrate Load (lb/yr)	Nitrate Limit (lb/yr)	Exceeds Nitrate Limit 1-Yes(Bad) 2-No(Good)
P1f	EAST COVENTRY	799	231	69,422	55,538	13,884	7,612	8673	2
P2a	EAST COVENTRY	202	30	8,911	7,129	1,782	977	2192	2
P3a	EAST COVENTRY	507	71	21,362	17,089	4,272	2,342	5501	2
P4a	EAST COVENTRY	739	239	71,564	57,251	14,313	7,846	8028	2
P5e	EAST COVENTRY	269	49	14,651	11,721	2,930	1,606	2925	2
P6a	EAST COVENTRY	711	137	41,175	32,940	8,235	4,514	7726	2
P7b	EAST COVENTRY	368	47	14,127	11,302	2,825	1,549	3998	2
P8a	EAST COVENTRY	30	3	752	602	150	82	326	2
P9d	EAST COVENTRY	510	87	24,980	19,984	4,996	2,739	5544	2
P10a	EAST COVENTRY	1	1	218	174	44	24	11	1
P12c	EAST COVENTRY	131	19	5,654	4,523	1,131	620	1420	2
S6a	EAST COVENTRY	373	62	18,704	14,964	3,741	2,051	4054	2
SR7	EAST COVENTRY	16	1	430	344	86	47	177	2
SR8	EAST COVENTRY	1	0	21	17	4	2	8	2
SR9	EAST COVENTRY	172	77	23,070	18,456	4,614	2,529	1866	1
SR10	EAST COVENTRY	480	131	39,153	31,322	7,831	4,293	5213	2
SR11	EAST COVENTRY	400	60	17,880	14,304	3,576	1,960	4342	2
SR12	EAST COVENTRY	593	94	28,308	22,646	5,662	3,104	6435	2
SR13	EAST COVENTRY	227	55	16,559	13,247	3,312	1,816	2469	2
SR14	EAST COVENTRY	155	55	16,547					
SR15	EAST COVENTRY	53	22	6,698					
Total		**6,737**	**1,471**	**440,186**	**333,552**	**83,388**	**45,714**	**70908**	
S1	EAST PIKELAND	236	36	10,905	8,724	2,181	1,196	2568	2
S2a	EAST PIKELAND	214	43	12,857	10,285	2,571	1,410	2322	2
S3a	EAST PIKELAND	147	90	27,063	21,650	5,413	2,967	1599	1
S4b	EAST PIKELAND	315	75	22,368	17,894	4,474	2,452	3417	2
SR1	EAST PIKELAND	364	76	22,864					
Total		**1,276**	**320**	**96,057**	**58,554**	**14,639**	**8,025**	**9906**	
P1f	EAST VINCENT	17	1	260	208	52	29	190	2
P2a	EAST VINCENT	18	0	131	105	26	14	193	2
P9d	EAST VINCENT	22	6	1,920	1,536	384	211	240	2
P10a	EAST VINCENT	117	33	9,884	7,907	1,977	1,084	1276	2
S2a	EAST VINCENT	12	8	2,308	1,846	462	253	125	1
S3a	EAST VINCENT	19	3	1,044	835	209	114	210	2
S4b	EAST VINCENT	672	352	105,480	84,384	21,096	11,565	7293	1
S5a	EAST VINCENT	305	53	15,941	12,753	3,188	1,748	3312	2
S6a	EAST VINCENT	1,263	145	43,411	34,729	8,682	4,760	13713	2
SR1	EAST VINCENT	48	85	25,580					
SR2	EAST VINCENT	242	330	98,973					
SR3	EAST VINCENT	27	1	410					
SR4	EAST VINCENT	117	15	4,574					
SR5	EAST VINCENT	574	41	12,424					
SR6	EAST VINCENT	405	159	47,821					
SR7	EAST VINCENT	266	64	19,238	15,390	3,848	2,109	2885	2
SR8	EAST VINCENT	203	52	15,522	12,417	3,104	1,702	2206	2
SR9	EAST VINCENT	0	0	0	0	0	0	0	
Total		**4,327**	**1,350**	**404,921**	**172,111**	**43,028**	**23,588**	**31644**	
P4a	NORTH COVENTRY	749	263	78,953	63,163	15,791	8,657	8137	1
P7b	NORTH COVENTRY	209	77	23,176	18,541	4,635	2,541	2271	1
P8a	NORTH COVENTRY	23	7	2,037	1,630	407	223	250	2
P12c	NORTH COVENTRY	43	1	383	306	77	42	464	2
P14b	NORTH COVENTRY	187	23	6,966	5,573	1,393	764	2026	2
P15a	NORTH COVENTRY	81	6	1,932	1,546	386	212	885	2
P16a	NORTH COVENTRY	1,462	198	59,318	47,454	11,864	6,504	15873	2

P17a	NORTH COVENTRY	396	155	46,591	37,273	9,318	5,108	4298	1
SR14	NORTH COVENTRY	82	57	17,223					
SR15	NORTH COVENTRY	373	343	102,766					
SR16	NORTH COVENTRY	139	65	19,630					
SR17	NORTH COVENTRY	331	116	34,873					
SR18	NORTH COVENTRY	971	790	236,894					
SR19	NORTH COVENTRY	1,193	301	90,236	72,188	18,047	9,894	12956	2
SR20	NORTH COVENTRY	43	6	1,829	1,463	366	201	471	2
SR21	NORTH COVENTRY	156	27	8,138	6,510	1,628	892	1694	2
SR22	NORTH COVENTRY	223	27	8,147	6,518	1,629	893	2425	2
SR24	NORTH COVENTRY	503	168	50,357	40,285	10,071	5,521	5461	1
SR25	NORTH COVENTRY	245	30	8,927	7,141	1,785	979	2661	2
SR26	NORTH COVENTRY	381	63	19,008	15,206	3,802	2,084	4139	2
Total		**7,791**	**2,725**	**817,383**	**324,798**	**81,199**	**44,514**	**64009**	
P9d	SOUTH COVENTRY	23	2	540	432	108	59	246	2
P10a	SOUTH COVENTRY	152	24	7,309	5,847	1,462	801	1652	2
P11a	SOUTH COVENTRY	340	127	37,975	30,380	7,595	4,164	3697	1
P12c	SOUTH COVENTRY	155	16	4,739	3,791	948	520	1681	2
P13a	SOUTH COVENTRY	288	76	22,664	18,132	4,533	2,485	3130	2
P14b	SOUTH COVENTRY	268	56	16,757	13,405	3,351	1,837	2907	2
P15a	SOUTH COVENTRY	392	42	12,547	10,038	2,509	1,376	4258	2
Total		**1,618**	**342**	**102,532**	**82,026**	**20,506**	**11,242**	**17571**	
S4b	SPRING CITY	7	17	4,989	3,991	998	547	80	
SR1	SPRING CITY	301	604	181,209					
SR2	SPRING CITY	120	334	100,063					
SR3	SPRING CITY	58	61	18,169					
SR4	SPRING CITY	5	14	4,260					
Total		**490**	**1,029**	**308,690**	**3,991**	**998**	**547**	**80**	
S1		17	0	0	0	0	0		
SR1		0	0	0					
SR12		0	0	0		0	0		
SR22		0	0	0	0	0	0		
SR22		29	0	0	0	0	0		
SR26		0	0	1	1	0	0		
SR26		0	0	8	6	2	1		
SR26		0	0	0	0	0	0		
SR26		644	0	0	0	0	0		
Total		**22,929**	**7,237**	**2,169,778**	**1,735,822**	**433,955**	**237,898**	**194118**	

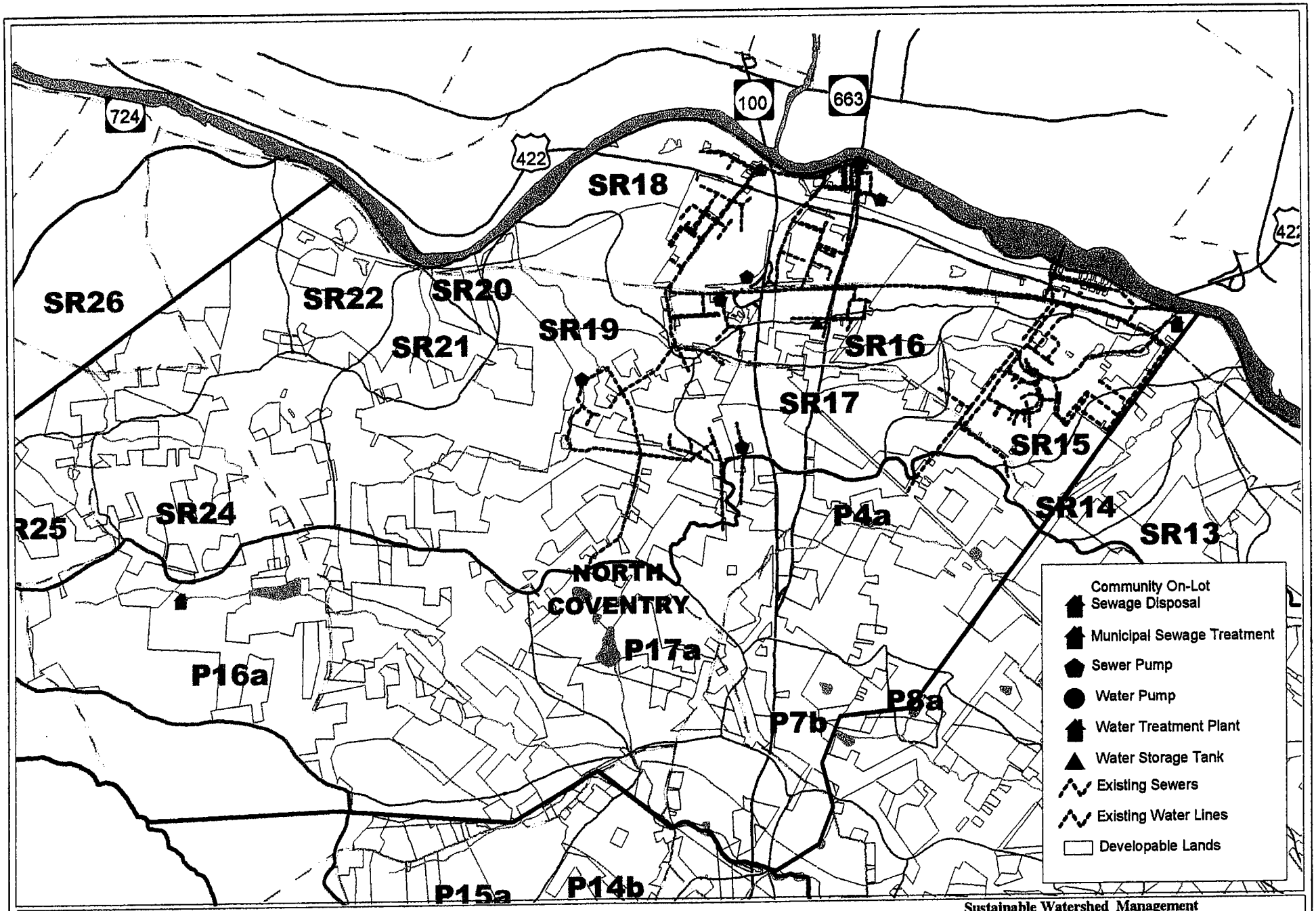
For example, in sub-basin P1f, the 816 acres should yield 192 GPD/acre in a drought, and setting a consumptive loss limit at 50% of this base flow means that 78,336 GPD can be evaporated. The 232 existing dwelling units in the watershed at present, all of which are assumed to use on-site wastewater systems, will lose about 13,936 GPD, or only 17% of the Q 7-10 flow, and so the answer to the limit question is no (2).

For those sub-basins which withdraw groundwater and discharge effluent to a regional conveyance system, with subsequent export from the sub-basin, the withdrawal is 100% consumptive from a water balance perspective. This issue is of particular importance in Sub-basin SR 19, in North Coventry Township, where extensions to the NCMUA convey local groundwater out of the sub-basin (Figure 21), which drains directly to the Schuylkill River. Current expansion of the system will impact the headwaters of sub-basin P17a in the Pigeon Creek in a similar fashion, and could be much more significant. The potential also exists for the same condition in sub-basin P4a, another first order headwater stream of Pigeon Creek, where the expansion of the NCMUA will create a similar situation in the near future.

For those sub-basins where both public water and wastewater are provided throughout most of the drainage, such as SR1, 2, 3, 4, 5, 15 and 18, and those sub-basins which have partial service, such as S4b, SR6, SR14, 16 and 19, the wastewater statistic is deleted from Tables 8 and 9 because it would only confuse the issue. For all of these sub-basins, the water supply is imported from the Schuylkill River and the resultant effluent is returned to the same system, in a kind of "put and take" scenario, very much like the areas around Phoenixville in the French Creek basin. Development still has an impact of water resources, but in the form of potential lost groundwater recharge and increased runoff with NPS pollution, from new (and existing) impervious surfaces.

Consider the lower Stony Run sub-basin (discussed in detail under Case Studies), where proposed development will be served by imported water and the wastewater will be exported, producing a zero net change, in terms of baseflow depletion by water use. The new impervious surfaces, however, will result in a loss of runoff from these new developments, and the detention systems, both existing and planned, will do nothing to offset the impact. Each square foot of new rooftop, driveway and road will reduce groundwater recharge by 1.3 CF and increase runoff by 3 CF per year, unless recharge designs are developed for the stormwater management system.

In those sub-basins where both individual wells and on-site systems are utilized, the impact of consumptive loss on base flow is not the only issue. The Nitrate loading to the groundwater with land application of effluent raises the issue of increased Nitrate in the aquifer above the standard of 10 mg/l. The Nitrate loading estimated in the last column of Table 8 is evaluated in terms of the annual dry year groundwater volume available to dilute this addition, assuming an existing background concentration of 2 mg/l in the groundwater. Where this Nitrate limit (based on an annual groundwater volume of 446 GPD/Acre for a dry year) is less than the present loading in sub-basins which are supplied from individual wells, there is concern as to potential water quality constraints at present.



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Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 21
Expansion of Sewer Infrastructure in North Coventry

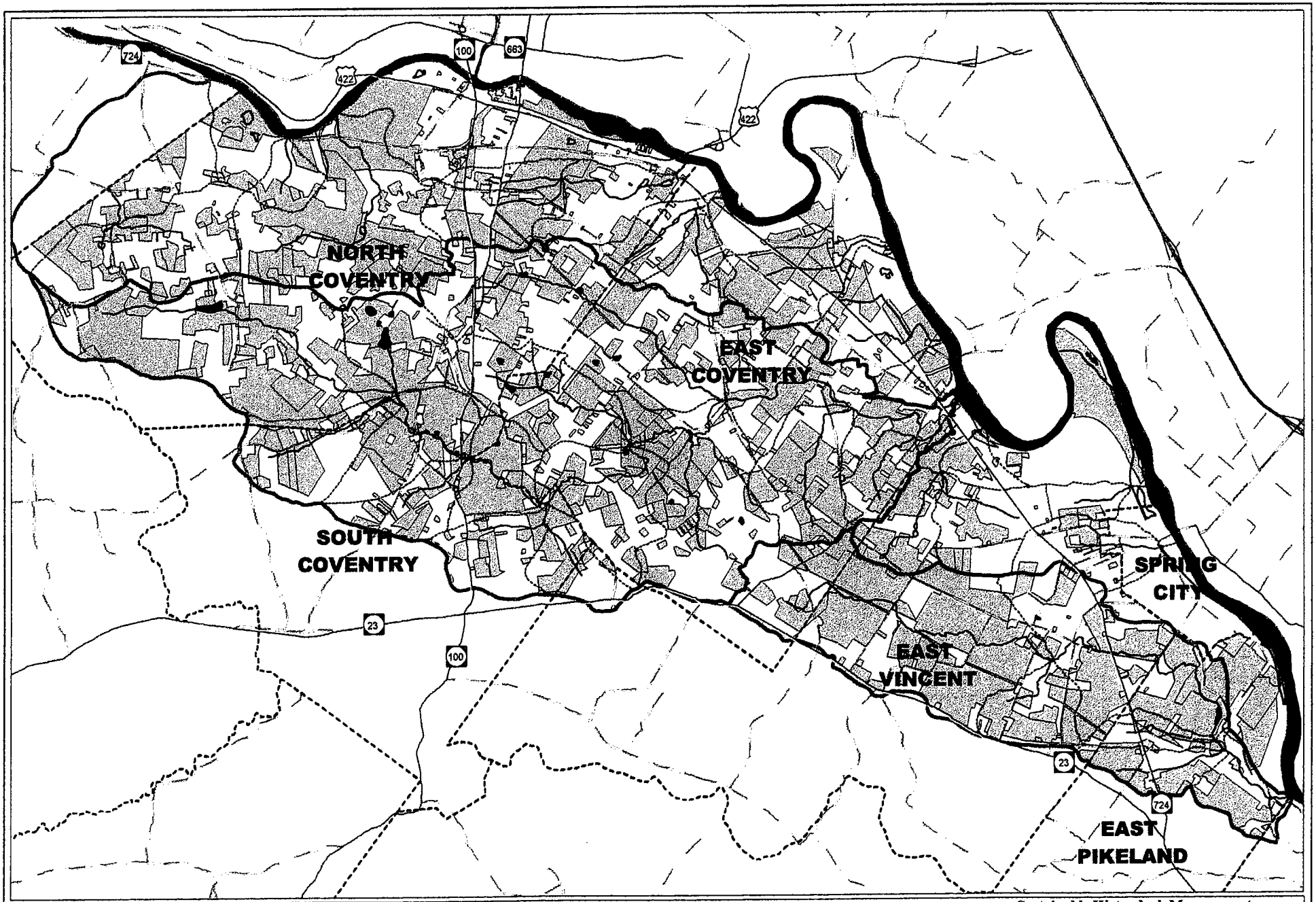
"Futures" Analysis

Before analyzing the potential impact of future growth on the regional water resources, it is useful to consider exactly how the resource capacity is estimated. As stated previously, the groundwater yield as stream base flow is used as the surrogate for system capacity, rather than the entire volume of water which may be contained in an aquifer at any given moment. This interrelationship between groundwater storage and surface water flow is frequently neglected in water resource studies, where the total discharge or stream flow (including both wet and dry periods) from a drainage area is the primary focus of analysis. The terms "safe yield" and "water budget" have been frequently mis-applied to suggest that a given amount of water can be withdrawn from an aquifer per unit area without impact. While such concepts have been used as the basis for regulation, the reality is that any withdrawal of a water resource, without recycling or compensation, has some given quantitative (and qualitative) effect elsewhere in the water system. This interconnection between ground and surface flows is an assumption which drives much of the analysis developed in the WBM. The projected impacts of both existing and future development are driven by this estimated limit of system capability.

Simulating different "future" outcomes or scenarios is based initially on two basic sets of conditions. In the initial analysis, the question is what will be the water resources impacts of continuation of "baseline" or "business as usual" policies and programs (i.e., the existing management system), basically a build out of existing zoning . The second alternative future considers following the Landscapes Plan as the pattern of future land development. In both instances, the process begins with an estimate of potentially developable lands, derived as the vacant parcels and unrestricted agricultural parcels in the study area, as shown in Figure 22.

Future Land Use With Current Zoning

For the 11,153 acres shown in Figure 22, the generalized Zoning categories have been applied to the developable parcels, and produce a pattern as shown in Figure 23. As in the case of existing land use, a set of assumptions have been made with respect to assumed dwelling unit density in these zones, as shown in Table 10. This table also includes a second set of assumptions which will be considered with respect to the potential pollutant impact of this future development. The data shows assumed impervious cover percentages associated with this new development, and the annual pollutant loading which would be generated by this new development without appropriate controls for nonpoint sources. Note that the strategy of groundwater recharge of all future stormwaters would effectively eliminate or greatly reduce this pollutant loading, so that these values represent a "worst case" scenario in terms of water quality impacts.



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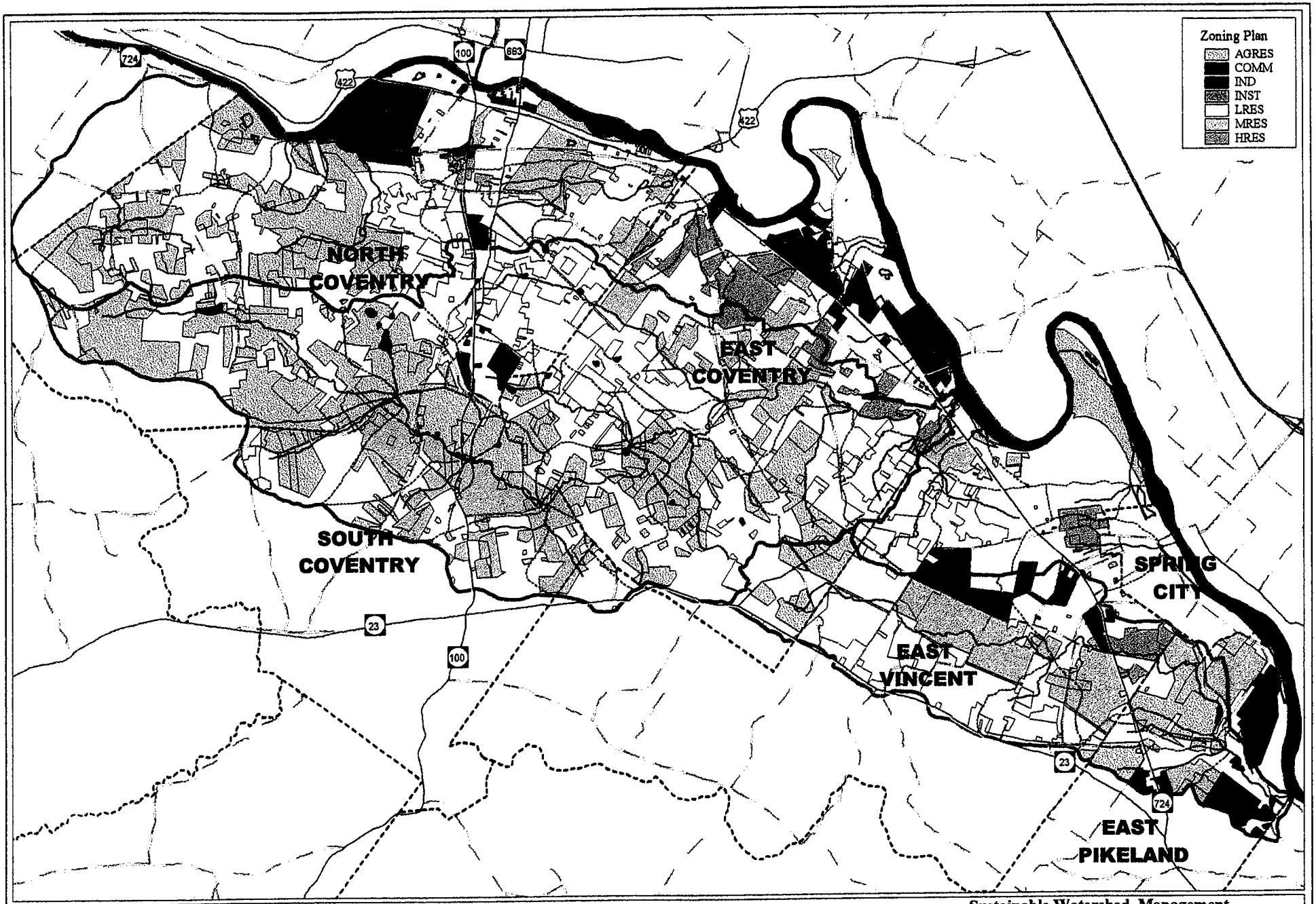
2000 0 2000 4000 6000 Feet

Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 22
Developable Land Parcels

P:\APRS\PigeonStony apr - Developable



P:\AFRS\PigeonStony apr - Dev-Zoning

Table 10.

Future Land Use with Current Zoning - Water Balance Model Assumptions

Future Land Use Category	Description	Equivalent DUs per acre	Impervious Cover Factor	NPS Factors NO3	TP	COD	Pb	Oil/G
INST	Institutional	0.10	0.10	0.5	0.8	50	50	3
AGRES	Res. > 2 ac	0.50	0.04	1.5	0.6	100	150	3
LRES	Res. 1-2 ac	0.75	0.08	1.8	0.7	100	180	5
MRES	¼ - 1 ac	2.00	0.15	2	0.8	100	200	5
HRES	< ¼ ac	5.00	0.30	1	0.6	100	250	10
VILL	village/urban	8.00	0.50	1	0.4	90	250	10
COMM	commercial	0.40	0.60	0.8	0.4	80	200	15
IND	industrial	0.50	0.70	0.9	0.2	60	100	20

With respect to potential depletion of base flow during drought, Table 11 summarizes the additional water use, consumptive loss and possible Nitrate load by sub-basin within each municipality. This additional water use is added to the existing use in Table 12, and the question of base flow depletion tested by using the criteria of 50% depletion of the Q7-10 low flow as a depletion limit. This data is particularly interesting in the Schuylkill River sub-basins of East Coventry Township (SR11,13 and 14), where future development would have a significant impact if local groundwater supplies are the primary source. Some would argue that a loss of 50% base flow is unacceptable in terms of water quality impact, and more stringent criteria may evolve as the next phase of watershed planning evolves. For example, it has been proposed that in first order sub-basins, the drought criteria be reduced to 10% of the Q7-10 base flow. This limit would suggest that a much greater number of first order sub-basins are impacted.

Finally, the potential NPS pollutant load produced by this future development is estimated in Table 13. It is difficult to understand this impact in the abstract, without defining how much of a future pollutant input to the larger Schuylkill River this represents, but within the two small tributaries of Pigeon Creek and Stony Run, the local degradation from these inputs, absent comprehensive new stormwater management, will severely degrade the current water quality.

Table 11
Future Land Use-Zoning
Water Use by Municipality

Sub-basin	Municipality	Area (acre)	Addl. Water Use (gpd)	Addl. Wastewater (gpd)	Addl. Cons. Loss (gpd)	Addl. Nitrate Load (lb/yr)
P1f	EAST COVENTRY	417	296,922	237,537	59,384	32,555
P2a	EAST COVENTRY	145	36,382	29,105	7,276	3,989
P3a	EAST COVENTRY	325	56,719	45,375	11,344	6,219
P4a	EAST COVENTRY	276	109,928	87,942	21,986	12,053
P5e	EAST COVENTRY	134	23,471	18,777	4,694	2,573
P6a	EAST COVENTRY	305	48,077	38,462	9,615	5,271
P7b	EAST COVENTRY	218	40,705	32,564	8,141	4,463
P8a	EAST COVENTRY	20	4,531	3,625	906	497
P9d	EAST COVENTRY	251	37,712	30,169	7,542	4,135
P12c	EAST COVENTRY	109	16,297	13,037	3,259	1,787
S6a	EAST COVENTRY	175	26,423	21,139	5,285	2,897
SR7	EAST COVENTRY	12	2,533	2,026	507	278
SR8	EAST COVENTRY	0	555	444	111	61
SR9	EAST COVENTRY	72	34,785	27,828	6,957	3,814
SR10	EAST COVENTRY	178	52,169	41,735	10,434	5,720
SR11	EAST COVENTRY	279	239,756	191,805	47,951	26,287
SR12	EAST COVENTRY	111	20,080	16,064	4,016	2,202
SR13	EAST COVENTRY	94	137,189	109,751	27,438	15,042
SR14	EAST COVENTRY	54	71171	56,937		
SR15	EAST COVENTRY	1	106	85		
	Township Total	**3,174**	**1,255,509**	**1,004,408**	**236,846**	**129,841**
S1	EAST PIKELAND	122	25,045	20,036	5,009	2,746
S2a	EAST PIKELAND	133	39,404	31,523	7,881	4,320
S3a	EAST PIKELAND	68	17,437	13,949	3,487	1,912
S4b	EAST PIKELAND	251	71,519	57,215	14,304	7,841
SR1	EAST PIKELAND	215	72,943	58,355		
	Township Total	**788**	**226,348**	**181,078**	**30,681**	**16,820**
P1f	EAST VINCENT	14	8,288	6,631	1,658	909
P2a	EAST VINCENT	17	3,825	3,060	765	419
P9d	EAST VINCENT	7	1,082	865	216	119
P10a	EAST VINCENT	20	2,956	2,365	591	324
S2a	EAST VINCENT	6	917	734	183	101
S3a	EAST VINCENT	11	4,755	3,804	951	521
S4b	EAST VINCENT	336	231,861	185,489	46,372	25,422
S5a	EAST VINCENT	203	61,072	48,858	12,214	6,696
S6a	EAST VINCENT	932	312,834	250,267	62,567	34,300
SR1	EAST VINCENT	2	2,917	2,334		
SR2	EAST VINCENT	69	89,547	71,637		
SR4	EAST VINCENT	16	23,185	18,548		
SR5	EAST VINCENT	215	37,905	30,324		
SR6	EAST VINCENT	113	24,060	19,248		
SR7	EAST VINCENT	172	38,109	30,488	7,622	4,178
SR8	EAST VINCENT	101	51,860	41,488	10,372	5,686
	Township Total	**2,236**	**895,175**	**716,140**	**143,512**	**78,675**

Table 11
Future Land Use-Zoning
Water Use by Municipality

P4a	NORTH COVENTRY	346	76,931	61,545	15,386	8,435
P7b	NORTH COVENTRY	89	12,323	9,858	2,465	1,351
P8a	NORTH COVENTRY	1	269	215	54	29
P12c	NORTH COVENTRY	41	6,182	4,946	1,236	678
P14b	NORTH COVENTRY	162	24,275	19,420	4,855	2,662
P15a	NORTH COVENTRY	61	9,137	7,310	1,827	1,002
P16a	NORTH COVENTRY	870	130,490	104,392	26,098	14,307
P17a	NORTH COVENTRY	225	33,869	27,095	6,774	3,713
SR14	NORTH COVENTRY	50	23,660	18,928		
SR15	NORTH COVENTRY	140	70,921	56,737		
SR16	NORTH COVENTRY	89	70,393	56,314		
SR17	NORTH COVENTRY	215	55,204	44,163		
SR18	NORTH COVENTRY	390	114,720	91,776		
SR19	NORTH COVENTRY	750	125,070	100,056	25,014	13,713
SR20	NORTH COVENTRY	27	4,052	3,241	810	444
SR21	NORTH COVENTRY	67	10,017	8,014	2,003	1,098
SR22	NORTH COVENTRY	133	20,013	16,010	4,003	2,194
SR24	NORTH COVENTRY	185	27,763	22,211	5,553	3,044
SR25	NORTH COVENTRY	133	19,984	15,987	3,997	2,191
SR26	NORTH COVENTRY	160	23,959	19,167	4,792	2,627
	Township Total	**4,136**	**859,234**	**687,387**	**104,867**	**57,489**
P9d	SOUTH COVENTRY	18	10,644	8,515	2,129	1,167
P10a	SOUTH COVENTRY	93	55,806	44,645	11,161	6,119
P11a	SOUTH COVENTRY	113	68,058	54,446	13,612	7,462
P12c	SOUTH COVENTRY	123	73,636	58,909	14,727	8,074
P13a	SOUTH COVENTRY	138	72,602	58,082	14,520	7,960
P14b	SOUTH COVENTRY	149	72,294	57,835	14,459	7,926
P15a	SOUTH COVENTRY	185	39,015	31,212	7,803	4,278
	Township Total	**819**	**392,055**	**313,644**	**78,411**	**42,986**
	Total	**11,153**	**3,628,321**	**2,902,657**	**594,318**	**325,810**

Table 12
Total Water Use-Future, Zoning Build-out

Sub-basin	Area (acre)	EDUs	Existing Water Use (gpd)	Future Addl. Water Use (gpd)	Total	Consumptive Loss 20% of total	Limit Test exceeds = 1
P1f	816	232	69,682	305,210	374,892	74,978	2
P2a	220	30	9,042	40,207	49,249	9,850	2
P3a	507	71	21,362	56,719	78,081	15,616	2
P4a	1,488	502	150,518	186,859	337,377	67,475	2
P5e	269	49	14,651	23,471	38,122	7,624	2
P6a	711	137	41,175	48,077	89,252	17,850	2
P7b	577	124	37,303	53,027	90,330	18,066	2
P8a	53	9	2,789	4,800	7,589	1,518	2
P9d	555	95	28,497	49,437	77,934	15,587	2
P10a	271	58	17,411	58,762	76,173	15,235	2
P11a	340	127	37,975	68,058	106,033	21,207	2
P12c	328	36	10,776	96,115	106,891	21,378	2
P13a	288	76	22,664	72,602	95,266	19,053	2
P14b	454	79	23,722	96,569	120,291	24,058	2
P15a	474	48	14,479	48,152	62,631	12,526	2
P16a	1,462	198	59,318	130,490	189,808	37,962	2
P17a	396	155	46,591	33,869	80,460	16,092	2
S1	253	36	10,905	25,045	35,950	7,190	2
S2a	225	51	15,164	40,321	55,485	11,097	2
S3a	167	94	28,107	22,191	50,298	10,060	2
S4b	994	443	132,838	303,380	436,218	87,244	2
S5a	305	53	15,941	61,072	77,013	15,403	2
S6a	1,636	207	62,116	339,258	401,374	80,275	2
SR1	713	766	229,655	75,861	305,516	61,103	2
SR2	361	663	199,030	89,547	288,577	57,715	
SR3	85	62	18,580	0	374,892	74,978	2
SR4	122	29	8,833	23,185	32,018	6,404	2
SR5	574	41	12,424	37,905	50,329	10,066	2
SR6	405	159	47,821	24,060	71,881	14,376	2
SR7	282	66	19,667	40,642	60,309	12,062	2
SR8	204	52	15,542	52,415	67,957	13,591	2
SR9	172	77	23,070	34,785	57,855	11,571	2
SR10	480	131	39,153	52,169	91,322	18,264	2
SR11	400	60	17,880	239,756	257,636	51,527	1
SR12	593	94	28,308	20,080	48,388	9,678	2
SR13	227	55	16,559	137,189	153,748	30,750	1
SR14	238	113	33,770	94,831	128,601	25,720	1
SR15	426	365	109,464	71,027	180,491	36,098	2
SR16	139	65	19,630	70,393	90,023	18,005	1
SR17	331	116	34,873	55,204	90,077	18,015	2
SR18	971	790	236,894	114,720	351,614	70,323	2
SR19	1,193	301	90,236	125,070	215,306	43,061	2
SR20	43	6	1,829	4,052	5,881	1,176	2
SR21	156	27	8,138	10,017	18,155	3,631	2
SR22	253	27	8,147	20,013	28,160	5,632	2
SR24	503	168	50,357	27,763	78,120	15,624	2
SR25	245	30	8,927	19,984	28,911	5,782	2
SR26	1,025	63	19,016	23,959	42,975	8,595	2

Table 13
Future Land Use Zoning
Potential SW Pollutant Loading

Sub-basin	Additional Future Runoff		NO_3	TP	COD	Pb	Oil/Grease
	(ft^3/yr)	(gpd)	(lb/yr)	(lb/yr)	(lb/yr)	(lb/yr)	(lb/yr)
EAST COVENTRY							
P1f	9,048,179	185,426	765	369	56,078	125,793	4,551
P2a	1,644,644	33,704	179	71	10,268	19,003	551
P3a	2,315,811	47,458	238	94	14,458	23,817	576
P4a	4,163,035	85,314	500	198	25,990	49,995	1,299
P5e	963,067	19,736	99	39	6,013	9,936	242
P6a	1,806,933	37,030	176	70	11,281	17,558	381
P7b	1,746,626	35,794	185	73	10,904	18,520	471
P8a	215,685	4,420	24	9	1,347	2,420	67
P9d	1,350,676	27,680	126	51	8,432	12,649	253
P12c	583,646	11,961	55	22	3,644	5,467	109
SR6	954,512	19,561	90	36	5,959	9,000	183
SR7	115,918	2,376	13	5	724	1,274	34
SR8	16,420	336	1	1	99	241	11
SR9	5,806,405	118,992	330	92	23,749	44,009	6,750
SR10	15,272,851	312,989	865	213	59,407	103,577	18,503
SR11	13,254,872	271,634	818	418	73,524	178,140	10,211
SR12	7,138,288	146,286	393	137	31,456	65,939	7,652
SR13	3,703,599	75,898	237	140	23,122	57,517	2,283
SR14	1,952,540	40,014	135	76	12,190	29,839	1,155
SR15	66,465	1,362	4	1	249	415	83
Township Total	**72,120,173**	**1,477,970**	**5,233**	**2,114**	**378,893**	**775,109**	**55,365**
EAST PIKELAND							
S1	10,324,765	211,587	601	140	39,435	66,357	12,607
S2a	3,344,139	68,532	249	110	18,249	40,721	2,317
S3a	602,856	12,354	67	27	3,764	6,659	153
S4b	2,460,400	50,421	278	111	15,361	27,776	650
SR1	13,496,024	276,576	884	237	55,109	95,644	15,143
Township Total	**30,228,184**	**619,471**	**2,078**	**625**	**131,917**	**237,158**	**30,871**
EAST VINCENT							
P1f	278,309	5,703	35	14	1,738	3,475	87
P2a	182,666	3,743	21	8	1,140	2,053	57
P9d	38,739	794	4	1	242	363	7
P10a	105,874	2,170	10	4	661	991	20
S2a	32,853	673	3	1	205	308	6
S3a	174,999	3,586	21	8	1,093	2,120	55
S4b	14,140,023	289,774	992	446	76,145	173,838	10,898
S5a	2,557,671	52,415	298	117	15,968	29,755	796
S6a	21,605,516	442,765	1,942	670	110,000	200,460	16,073
SR1	83,961	1,721	5	3	517	1,292	54
SR2	3,312,786	67,889	200	102	18,463	43,567	2,623
SR4	626,896	12,847	40	24	3,914	9,744	388
SR5	1,346,482	27,594	134	54	8,406	13,413	285
SR6	3,954,186	81,034	271	77	17,039	29,270	4,111
SR7	2,572,646	52,722	243	87	14,026	24,841	1,566
SR8	1,776,271	36,401	219	87	11,089	21,855	547
Township Total	**52,789,880**	**1,081,831**	**4,437**	**1,704**	**280,646**	**557,343**	**37,574**

Table 13
Future Land Use Zoning
Potential SW Pollutant Loading

Sub-basin	Additional Future Runoff (ft^3/yr)	(gpd)	NO_3 (lb/yr)	TP (lb/yr)	COD (lb/yr)	Pb (lb/yr)	Oil/Grease (lb/yr)
NORTH COVENTRY							
P4a	4,544,194	93,125	456	172	26,314	47,836	2,226
P7b	4,706,195	96,445	246	121	23,783	58,221	4,251
P8a	12,848	263	1	1	80	144	4
P12c	221,431	4,538	21	8	1,382	2,074	41
P14b	869,398	17,817	81	33	5,428	8,144	163
P15a	327,251	6,706	31	12	2,043	3,065	61
P16a	4,673,637	95,778	438	175	29,178	43,767	875
P17a	1,249,035	25,597	116	46	7,755	11,829	261
SR14	848,964	17,398	104	41	5,300	10,371	265
SR15	2,536,789	51,987	309	123	15,779	31,208	821
SR16	2,177,605	44,626	223	99	13,590	29,596	925
SR17	5,294,812	108,507	426	137	25,313	44,689	4,561
SR18	21,754,394	445,816	1,340	386	90,992	166,901	24,085
SR19	15,119,741	309,851	1,045	308	67,403	111,219	14,528
SR20	920,344	18,861	55	14	3,693	6,052	1,045
SR21	358,782	7,353	34	13	2,240	3,360	67
SR22	716,787	14,689	67	27	4,475	6,712	134
SR24	994,368	20,378	93	37	6,208	9,312	186
SR25	715,736	14,668	67	27	4,468	6,703	134
SR26	858,108	17,585	80	32	5,357	8,036	161
Township Total	**68,900,420**	**1,411,987**	**5,232**	**1,813**	**340,781**	**609,238**	**54,795**
SOUTH COVENTRY							
P9d	357,392	7,324	45	18	2,231	4,462	112
P10a	1,873,850	38,401	234	94	11,699	23,396	585
P11a	2,285,212	46,831	285	114	14,267	28,534	713
P12c	2,472,505	50,669	309	123	15,436	30,872	772
P13a	2,445,504	50,116	302	121	15,268	30,151	748
P14b	2,440,023	50,004	298	119	15,233	29,839	737
P15a	1,447,388	29,662	154	61	9,036	15,404	360
Township Total	**13,321,875**	**273,007**	**1,627**	**650**	**83,170**	**162,658**	**4,027**
Pigeon Creek Total	54,369,756	1,114,208	5,433	2,241	331,328	629,776	20,580
Schuylkill River Total	126,793,043	2,598,389	8,633	2,998	597,901	1,154,736	118,313
Stony Creek Total	56197734	1151669	4541	1667	286177	556994	43739
TOTAL	237,360,533	4,864,265	18,607	6,907	1,215,406	2,341,505	182,632

Future Land Use With Landscapes

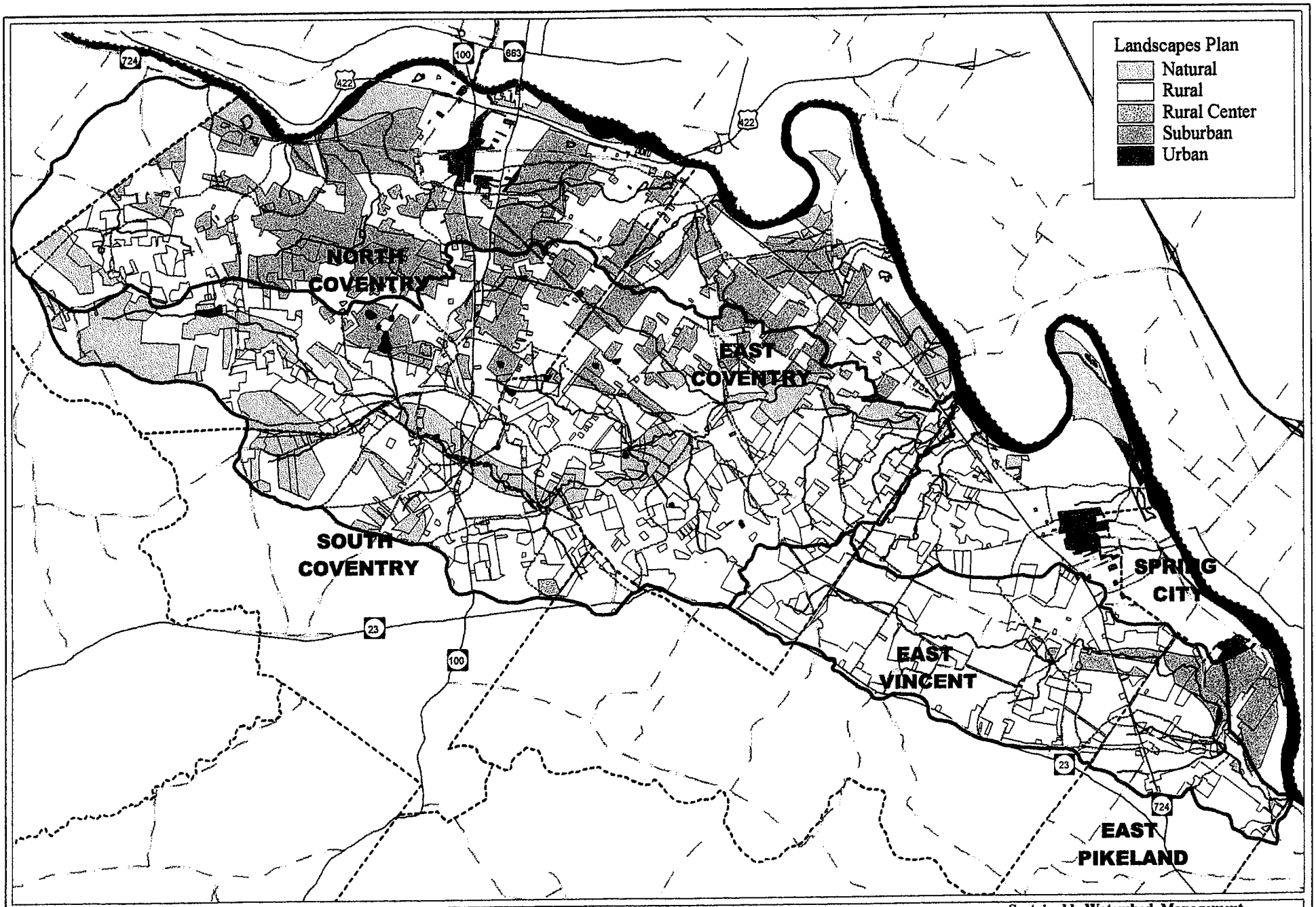
The preferred future land use plan proscribed in the Landscapes concept would greatly reduce the development density in much of the remaining vacant lands (Figure 24). The rural nature of the largest zone shown anticipates a mix of agricultural land preservation and farm lots of 5 to 10 acres per dwelling unit. While the Plan offers no specifics as to average densities anticipated or recommended with any of the given land uses, the clear intent of the Plan is to direct higher densities toward the existing developed area, with both public water and sewer provided. The other basic concept is one of "villages", situated at existing road intersections, which will provide the framework for a mix of commercial and high density residential uses, not unlike the idealized village of old. In this study area, no villages are identified, but a substantial amount of the region is proposed for higher densities, specifically along the Schuylkill River contiguous to the existing utilities.

While no specific criteria are set out with the Landscapes Plan, it is possible to assume certain representative densities, based on discussions with the CCPC and related guidance documents. The assumed densities are shown in Table 14. Table 15 estimates what the relative increase would be with this alternative future by sub-basin. During the implementation phase of Sustainable Watershed Management, several other sets of densities will be selected and tested to evaluate how different variations of the Landscapes Plan would be comparable with existing zoning impacts.

Table 14.

Future Land Use Densities Based on "Landscapes" Plan

Category	Assumed Density Dwelling Units/Acre	Impervious Cover Factor
Natural	0	0.01
Rural	0.1	0.05
Rural Center	5	0.3
Suburban	2	0.15
Suburban Center	5	0.3
Urban	8	0.5



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Pigeon Creek and Stony Run Watersheds

FIGURE 24

Developable Land - Landscapes Plan

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Table 15
Total Water Use-Future, Landscapes Build-out

Sub-basin	Area (acre)	Existing EDUs	Existing Water Use (gpd)	Future Addl. Water (gpd)	Total	Consumptive Loss 20% of total	Limit Test exceeds = 1
SR1	713	766	229,655	174,788	404,443	80,889	
SR2	361	663	199,030	142,552	341,582	68,316	
SR3	85	62	18,580	0	374,892	74,978	2
SR4	122	29	8,833	38,871	47,704	9,541	
SR5	574	41	12,424	50,828	63,252	12,650	
SR6	405	159	47,821	10,297	58,118	11,624	
SR7	282	66	19,667	5,534	25,201	5,040	2
SR8	204	52	15,542	2,637	18,179	3,636	2
SR9	172	77	23,070	21,198	44,268	8,854	2
SR10	480	131	39,153	71,861	111,014	22,203	2
SR11	400	60	17,880	165,523	183,403	36,681	2
SR12	593	94	28,308	41,955	70,263	14,053	2
SR13	227	55	16,559	56,522	73,081	14,616	2
SR14	238	113	33,770	62,109	95,879	19,176	
SR15	426	365	109,464	484,212	593,676	118,735	
SR16	139	65	19,630	97,319	116,949	23,390	
SR17	331	116	34,873	130,789	165,662	33,132	
SR18	971	790	236,894	241,434	478,328	95,666	
SR19	1,193	301	90,236	432,964	523,200	104,640	2
SR20	43	6	1,829	11,183	13,012	2,602	2
SR21	156	27	8,138	40,066	48,204	9,641	2
SR22	253	27	8,147	46,516	54,663	10,933	2
SR24	503	168	50,357	38,454	88,811	17,762	2
SR25	245	30	8,927	1,801	10,728	2,146	2
SR26	1,025	63	19,016	50,285	69,301	13,860	2
S2a	225	51	15,164	4,684	19,848	3,970	2
S3a	167	94	28,107	4,370	32,477	6,495	2
S4b	994	443	132,838	134,161	266,999	53,400	2
S5a	305	53	15,941	6,221	22,162	4,432	2
S6a	1,636	207	62,116	29,766	91,882	18,376	2

Table 15
Total Water Use-Future, Landscapes Build-out

Sub-basin	Area (acre)	Existing EDUs	Existing Water Use (gpd)	Future Addl. Water Use (gpd)	Total	Consumptive Loss 20% of total	Limit Test exceeds = 1
P1f	816	232	69,682	88,717	158,399	31,680	2
P2a	220	30	9,042	4,858	13,900	2,780	2
P3a	507	71	21,362	9,577	30,939	6,188	2
P4a	1,488	502	150,518	348,843	499,361	99,872	2
P5e	269	49	14,651	6,167	20,818	4,164	2
P6a	711	137	41,175	8,728	49,903	9,981	2
P7b	577	124	37,303	47,774	85,077	17,015	2
P8a	53	9	2,789	7,371	10,160	2,032	2
P9d	555	95	28,497	4,938	33,435	6,687	2
P10a	271	58	17,411	25,146	42,557	8,511	2
P11a	340	127	37,975	4,635	42,610	8,522	2
P12c	328	36	10,776	6,120	16,896	3,379	2
P13a	288	76	22,664	2,343	25,007	5,001	2
P14b	454	79	23,722	6,173	29,895	5,979	2
P15a	474	48	14,479	3,013	17,492	3,498	2
P16a	1,462	198	59,318	29,165	88,483	17,697	2
P17a	396	155	46,591	87,536	134,127	26,825	2

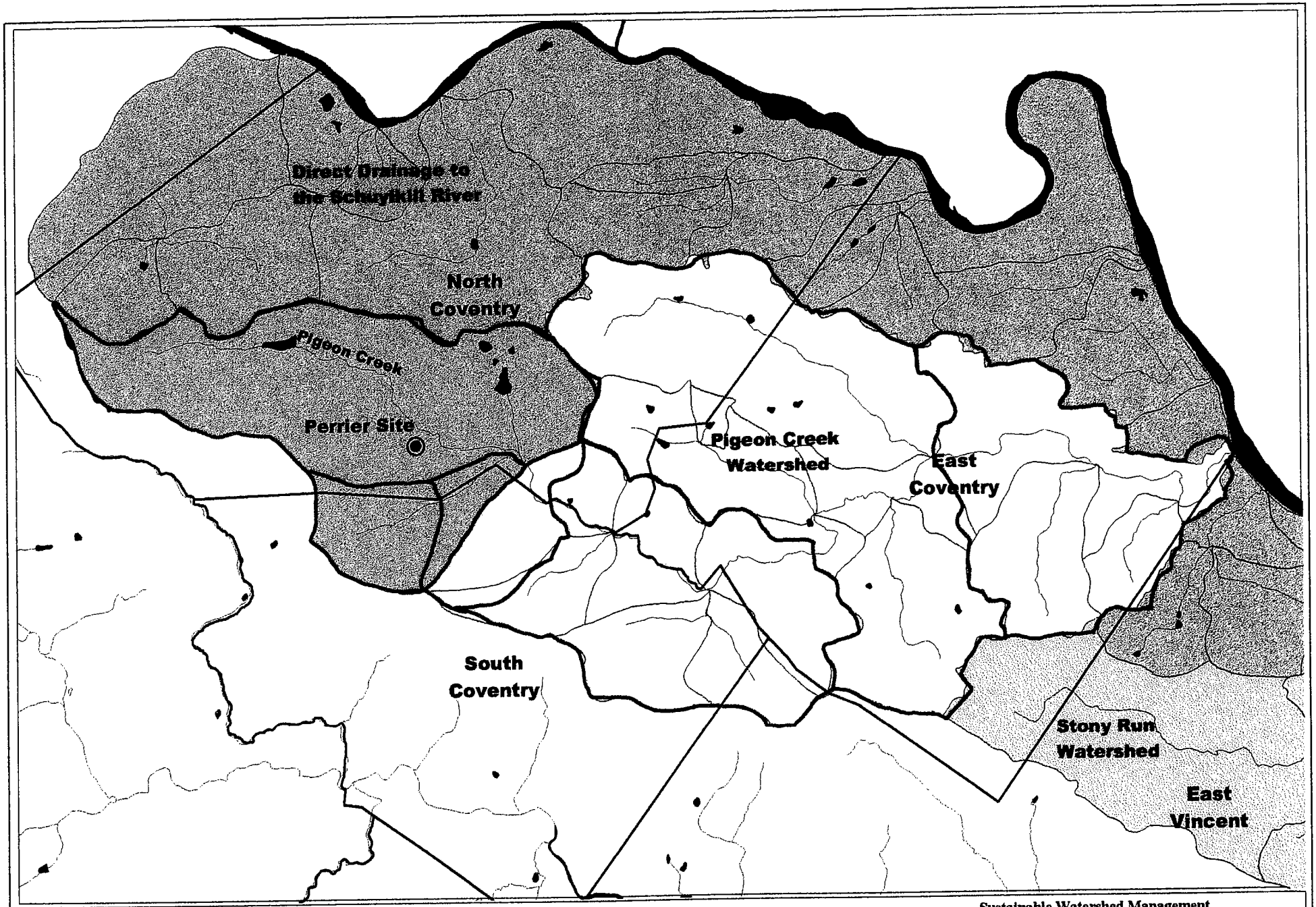
VI. CASE STUDIES

Land use and related water resource impacts are changing constantly in the current environment, and several current proposals for land development or water use serve to illustrate the anticipated conflicts produced as greater demands are placed on the regional water system. These examples are discussed here to illustrate the very different types of concern which we can anticipate will occur to an even greater degree in the future.

Perrier Groundwater Withdrawals

The headwaters of Pigeon Creek have long yielded excellent sources of spring water discharge, and over time some of these springs have been developed as commercial supplies by private companys. The development usually consists of simply impounding the spring in a small surface catchment and diverting the flowing water by pipe to a tank or container of some type. In one small watershed of 500 acres (Figure 25) located largely in South Coventry Township, two such spring bottling operations have collected spring flows from surface catchments for several decades. One company collects in the range of 15,000 GPD and the other at a greater rate, estimated in 1994 to average 65,000 GPD. The larger of the two systems, known as Great Bear Spring Water Company, sold its operation to the Perrier Corporation in 1994. The Perrier Co. intiated plans to increase the site withdrawal by drilling a deep (192 ft.) well with a pump, to not only increase supply but to allow groundwater withdrawal during periods of low or no surface discharge from the spring. The requested withdrawal would average 95,000 GPD. The permits requested from State (PADEP) and Basin (DRBC) regulatory authorities triggered a firestorm of local opposition to the proposed "bore hole" development, a controversy which continues to the present time.

The conflict centered on the issue of potential impact on local groundwater supplies and local stream flows, especially during times of drought. A number of private residences in the vicinity are actually dependent on their own springs as a source of water supply, while all of the local properties used groundwater wells. For the environmental interest groups, specifically GVA, the greatest threat was to a small perennial stream adjacent to the site and within 170 feet of the new spring/well (Figure 26). A number of concerned parties, including the township and the GVA, opposed the granting of permits for the well withdrawal before both state and basin agencies. The PA DEP, Division of Water Supply, is responsible for permitting public water systems, both surface and groundwater source and including bottling operations, but has no existing criteria for groundwater withdrawal quantity limits. The DRBC has groundwater criteria within a "Groundwater Protected Area", discussed earlier, over a broad geological zone of the Triassic formations (within which this site is situated), and specifically requires a lengthy pumping test for proposed withdrawals. It has recently developed and applied in the Neshaminy Basin of Bucks County a quantitative withdrawal criteria based on stream base flow in the watershed, and may expand this criteria throughout the Protected Area.



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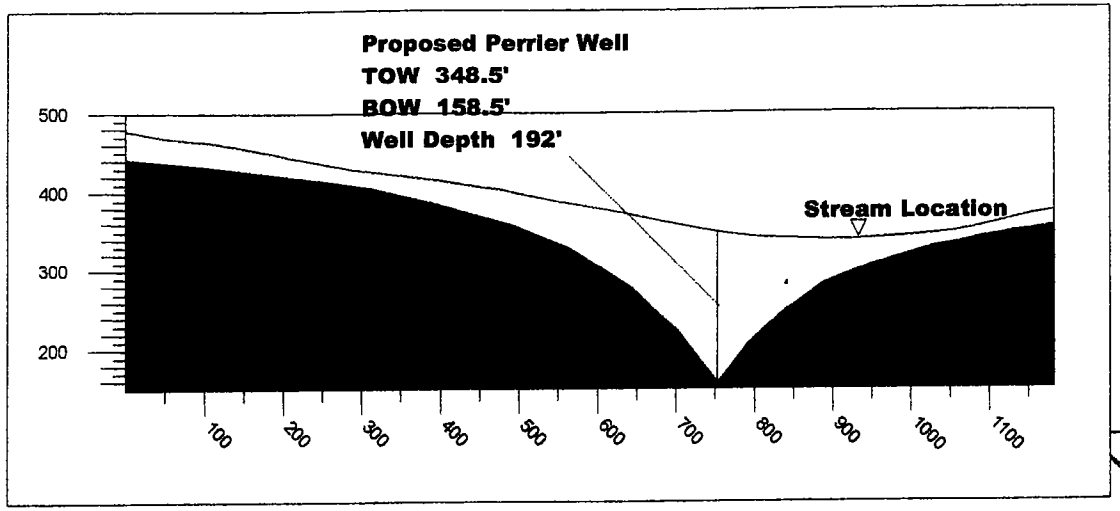
Pigeon Creek and Stony Run Watersheds

FIGURE 25
Perrier Bore Hole Sub-area in Upper Pigeon Creek



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300 0 300 600 900 Feet

Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 26
Perrier Site and Stream Cross-section

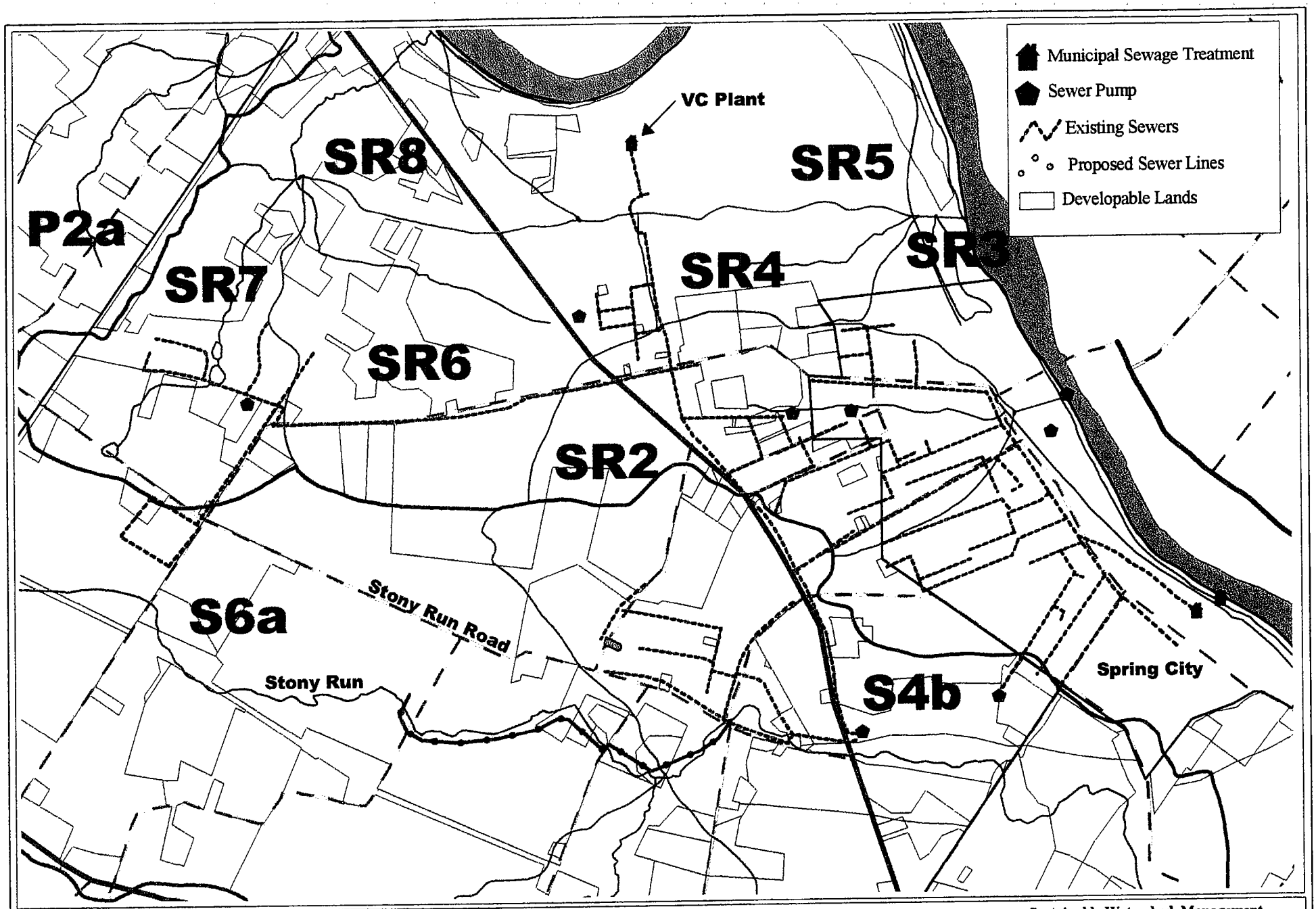
Based on the Pigeon Creek data and flow analysis discussed earlier, the GVA established that the base flow in the Pigeon Creek was quite similar to the French Creek gaging station record, and the estimated low flow statistics developed in this report were applicable to the upper reaches of Pigeon Creek. Specifically, the ten-year frequency drought of seven days duration was 192 gallons per day per acre (GPD/acre). Thus the small prennial stream which flows past the proposed bore hole would have a drought flow of about 96,000 GPD during a drought, and would be significantly impacted when the withdrawal by Perrier approached this amount. In fact, if the permitted withdrawal were allowed to be made without low flow restrictions, the stream would go dry under such demands. Without water, there would be no stream, and the loss of aquatic species would be total and complete.

Thus a groundwater quantity issue became a surface water quality issue. This should be apparent to any party who has considered the information presented in this report, which explains the fact that both surface and ground waters are different expressions of the same resource. Since government regulation and protection of resources has been piecemeal at best, it is no surprise that such a proposed action would fall through the assumed safety net, with no consideration of the related consequences of a specific withdrawal permit for a remote site. Since the proposed groundwater removal would be totally depletive (all waters would be trucked outside the Pigeon Creek, and presumably consumed there), the impact on the stream would be far greater than a well of the same capacity used by a sub-division, treated and returned to the system. The issue is similar to the use of local wells with sewer export from a sub-basin, but this application created far greater local concern as a perceived threat to the environment, especially local water supplies. The issue remains in review at present, and litigation is likely if the request goes forward.

East Vincent Wastewater System Expansion

East Vincent Township established a sewer authority a number of years ago, with the focus on serving a number of existing dwellings which had experieced malfunctions of their on-site septic systems. Since the township wraps around Spring City, it seemed logical to interconnect the needed parcels to various extensions of that system, which is the form that evolved over time. However, limitations in the capacity of the Spring City treatment plant led the township to acquire the treatment units located at the former Pennhurst State Hospital and subsequently known as the Veterans Center (VC) in 1994, renovate and restore half of the original plant capacity (1 MGD), and add to a fairly complex system of wastewater collection pipes and pump stations (Figure 27). Until recently, virtually all of this demand fell within the area of direct drainage to the Schuylkill River, and since the public water system always accompaned (and in many cases preceeded) the sewer system, the water and wastewater was a "put and take" situation, with Schuylkill River water withdrawn, used, treated and returned.

Recent development pressures in the Stony Run watershed have resulted in a decision to extend the system to serve not only these proposed units (currently estimated at 196 DUs), but to anticipate much greater demand for sewer service throughout the Stony Run,



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600 0 600 1200 1800 Feet

Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 27
East Vincent Sewer System Expansion

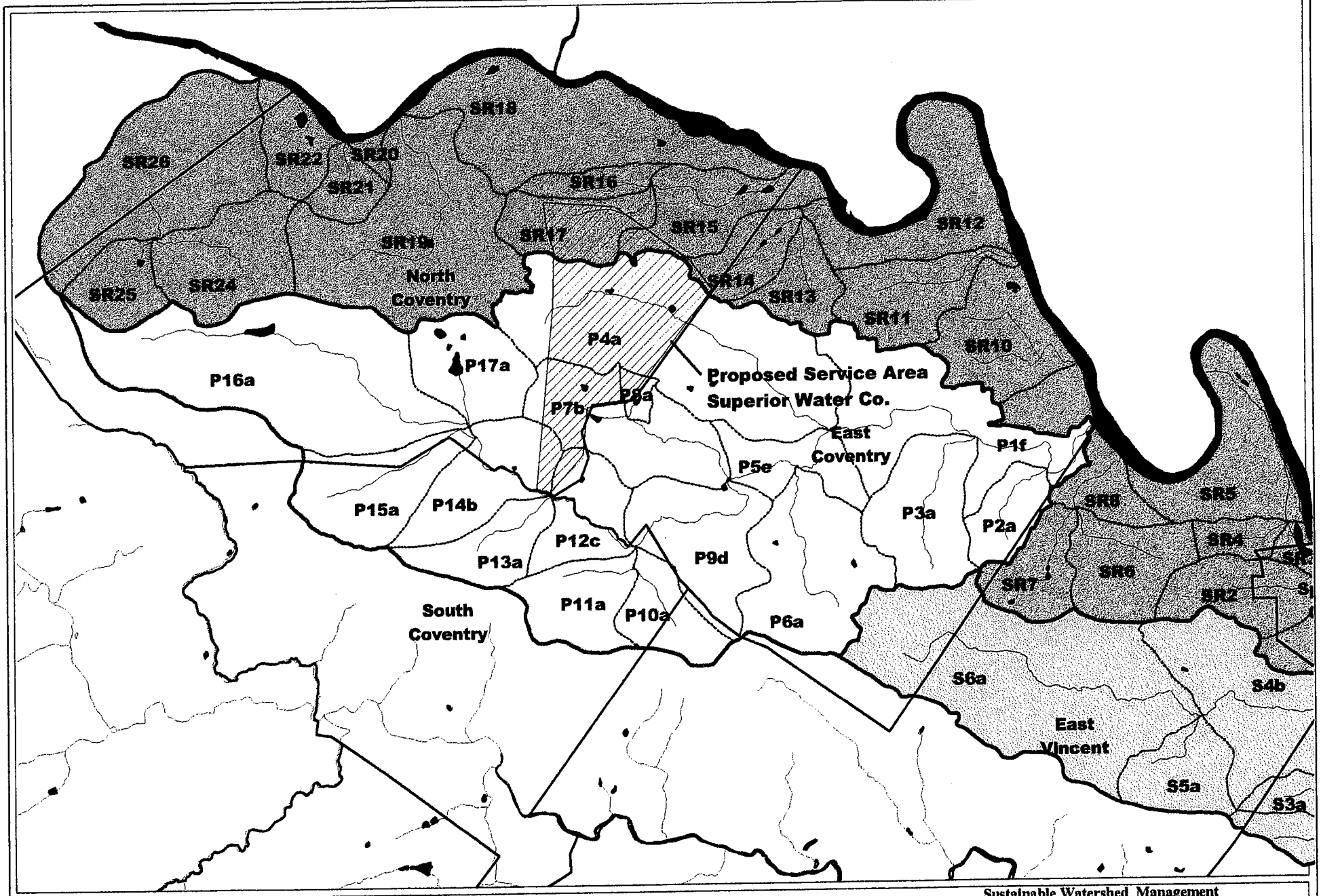
ultimately serving over 1,477 dwelling units. Much of this projected growth is in direct conflict with the hoped for land use patterns set out in Landscapes, and is viewed with widely differing opinions among current township residents. From a fiscal perspective, the township has invested heavily in the restoration of the STP and system expansion, creating a need for new customers and increased service. From a land planning consideration, the location of higher density development in relatively close proximity to the Route 724 corridor is reasonable, and may allow the protection of the western portions of the township, especially west of Route 23 in the French Creek basin. The burning issue here is how far the projected growth should extend, and where do we end the sewer. More importantly, should the sewer system serve as the framework for land development in this or any watershed, sewering the full drainage if any portion requires service.

From a water resources perspective, assuming that Schuylkill River water is pumped into the Stony Run as supply and all wastewater piped out to the River, the major impact of new development in the Stony Run would be the loss of groundwater recharge and increased stormwater flows and pollutant discharges from new impervious surfaces. The currently submitted development plans have designed stormwater management with detention basins, and these conventional methods will continue to be applied by the developers if no other guidance is imposed. Clearly, the immediate need here is to enact and implement the model Stormwater Management ordinance throughout the township, requiring no net increase in runoff quantity for the two-year storm and recharge of the same amount. The soils in this watershed are relatively thin and are less receptive to infiltration techniques, but recharge should be possible with careful design and analysis.

North Coventry Water Supply/ Wastewater Export

A recent proposal to create a new public water company in a portion of North Coventry Township (Figure 28) by the Superior Water Company, a subsidiary of the Gambone Development Corp., raised serious concerns among local residents and township officials. The existing well system was proposed to serve extensive new development along the Route 100 corridor, with discharge to the township sewer system. Again, the concern was based on withdrawal of local groundwaters (Pigeon Creek) and discharge to sewers which effectively exported the water to another basin (Schuylkill River), with resultant depletive impacts on the local stream system. Anticipated resolution of this conflict will probably limit the service area of any new development, but the potential for future impacts is great under new development pressures.

As discussed previously (pg. 49), the issue of groundwater withdrawals from a sub-basin which are subsequently transported by public sewers to a different watershed is a growing problem for the municipalities which have developed their wastewater systems along the Schuylkill River, and attempt to serve the inland growth areas by pumping stations. This conflict is no more clearly demonstrated than in the proposed Coventry Estates residential development, situated in the headwaters of a small tributary of the Pigeon Creek (SB17a), with direct depletive impacts on existing surface impoundments (see Figure 21).



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Environmental Consultants

Green Valleys Association

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2000 0 2000 4000 6000 Feet

Sustainable Watershed Management
Pigeon Creek and Stony Run Watersheds

FIGURE 28

Proposed Service Area - Superior Water Company

Cmprsmds: F:\APPS\PigeonStony.spr - Dev-Landscapes

VII. RECOMMENDED MANAGEMENT ACTIONS and IMPLEMENTATION

Should water always remain within the drainage in which it is derived? How large a scale should we apply to this issue, and should our evolving implementation strategies center on achieving a perfect water balance of supply and demand within each of the 168 sub-basins identified in this and the related French and Pickering Creek study? Is a water balance more important to a first order stream system, where the aquatic system is more vulnerable to drought impacts? Should we define the limits of infrastructure expansion for those sub-basins in which water and sewer service are partially provided at present, if in fact those systems produce no significant impact on local water resources? All of these questions will be addressed in detail during the Implementation Program, being conducted in 1998 and 1999. None of the issues raised in the Case Studies, and in a dozen other water and land conflicts which have occurred during the preparation of this report are easy to resolve, or lend themselves to simple solutions. However, the regional governments and leadership must keep the Goal of the Sustainable Watershed Management program in mind; to protect the quality and quantity of our land and water resources so that they will sustain us in the future. The legacy of land and water which we create by our current activities will be remembered long after the name of any specific development (or public official) is forgotten.

In this report, the Recommended Water Resources Plan takes the form of the Landscapes Plan, since it reflects the best land use concepts advanced for the region, and also reflects the desires of most of the municipalities in the study area. With actual densities estimated for the respective zones, the specific analysis of water resource impacts which would result from implementation of this Plan indicates a far lesser impact on most sub-basins than current zoning build-out. Between the Plan vision and current reality, however, lies a shadow which has altered the Plan from the moment it was published. Land evelopment in Northern Chester County will continue to follow the pattern of infrastructure; roads, water and sewer. One need only to examine a current map of the region to conclude that the Route 100 corridor provides the only north-south route connecting two major urban centers, and will continue to serve as the access route into the watersheds, bringing with it the expansion of regional water systems from both the north and south. Landscapes envisions only village centers along this route, but development pressures may sweep this Plan aside if a concerted effort among the member communities is not implemented quickly.

Thus the Implementation Phase, which is taking place during 1998 and1999, can be expected to require a complex array of new and modified management actions on the municipal and other government levels. These management recommendations will be tiered by government level. On the municipal level, recommendations will be further identified by type of technique (i.e., comprehensive plan, zoning ordinance, subdivision regulations, Pennsylvania Act 537 wastewater plan, water supply plan, and so forth). In many cases, alternative techniques will be proposed and debated. Choices will have to be made by the implementing municipality. Recommendations can be expected to be short-

term and long-term in nature, some requiring more time and financial commitment on the part of the responsible agencies.

Implementation can be expected to be a challenge. It must be grounded in the public participation process, during which municipal officials and other stakeholders in the Watersheds participate directly in the development of future scenarios and ultimately in the development of the Recommended Scenario. Implementation will be guided by the Northern Federation, which must be expanded to include those municipalities which are not presently a member, but are within the five major watersheds. In addition, each municipality must be brought into the process through interaction with Supervisors, Planning Commission, municipal staff and consultants.

The implications of future development on water resources, be it following the current zoning or moving to change the plan in a more conservation-minded form such as proposed by Landscapes, is sobering. Additional population will translate into demand for new water supplies, construction of wastewater treatment plants, and conversion of natural vegetation into a mosaic of impervious and maintained landscapes, without careful guidance. In sum, given these growth pressures and the water resource impacts which all of this growth will generate, the Pigeon Creek and Stony Run Watersheds and their exceptional water resources are in danger.

Assuming that pressures to develop reflect regional dynamics that cannot easily be changed--and that growth cannot simply by prevented or prohibited, several questions need to be addressed. What are the deficiencies in the existing approach to land use management such that these impacts result? Assuming that growth itself cannot be thwarted, can new land development occur in ways which minimize water resource impacts? What choices are available through changing how new land uses occur throughout the Watersheds -- such as by carefully concentrating new land development in innovative patterns which function within the limits of the available water resources, by avoiding areas most sensitive to adverse impact, and by maximizing Best Management Practices, site-by-site?

The work of Sustainable Watershed Management needs to be implemented on a watershed-wide basis, transcending municipal boundaries. For example, the technical analysis supporting evaluations of the hydrologic cycle, such as determinations of base flow and runoff, by definition become system-wide. Stream flow gaging and chemical analysis defies most municipal boundaries and must be evaluated with utmost care across the Watersheds, given the difficulties and expense of developing this information. Water quality modeling is similarly a function of watershed-wide considerations. Technically, the municipal focus alone simply does not provide the answers that are required. The Sustainable Watershed Management Plan spans these boundaries and offers a critical solution.

VII. RECOMMENDED MANAGEMENT ACTIONS and IMPLEMENTATION

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LIST OF REFERENCES

Cahill, McGuire and Smith, 1993. *Hydrologic and Water Quality Modeling With Geographic Information Systems,* T.H. Cahill, J. McGuire and C. Smith, AWRA Symposium, Mobile, AL, Mar., 1993. Proceedings by AWRA, Bethseda, MD, TPS-93-1.

CCPC, 1993. *Sewage Facilities Inventory 1991: Community Facilities Update."* Chester County Planning Commission, West Chester, PA.

CCPC, 1995a. *Draft Open Space Plan for the Federation of Northern Chester County Communities,* Chester County Planning Commission, West Chester, PA.

CCPC, 1995b. *Water Resources-Use and Service in Chester County,* Chester County Planning Commission, West Chester, PA.

CCPC, 1996a. *"Landscapes"*, the Chester County Comprehensive Plan, by the Chester County Planning Commission, West Chester, PA.

CCPC, 1996b. *Water Resources: Use and Service in Chester County.*, Chester County Planning Commission, West Chester, PA.

DER, 1992. *Special Protection Waters Implementation Handbook.* Shertzer. Department of Environmental Resources, Harrisburg, PA.

FNCCC, 1991. *Surface Water Runoff Study.* Federation of Northern Chester County Communities and the Chester County Planning Commission, West Chester, PA.

FNCCC, 1996. *Managing Land Use in Northern Chester County: A Cooperative Approach to Regional Land Use Planning.* Federation of Northern Chester County Communities, West Chester, PA.

Hardy, Wetzel & Moore, 1995. *Land Use, Organochorine Compound Concentrations, and Trends in Benthic-Invertebrate Communities in Selected Stream Basins in Chester County, Pennsylvania,* USGS Water Res. Inves. Rpt. 94-4060, with the Chester Co. Water Res. Auth., USGS, Lemoyne, PA.

Horton, 1945. *Erosional Development of Streams and Their Drainage Basins: Hydrophysical Approach to Quantitative Morphology.* Geol. Soc. Am, Bull., Vol. 56.

Lium, 1976. *Limnological Data For the Major Streams in Chester County, PA.* B.W. Lium, USGS Open File Report.

Maidment, 1992. **Handbook of Hydrology**, D. R. Maidment, Ed., McGraw Hill, NYC, NY.

McGreevy and Sloto, 1980. *Development of a Model of Ground-water Flow in Deeply Weathered Crystalline Rock, Chester County, PA.* L.J. McGreevy and R.A. Sloto, USGS Water Resources Investigations 80-2, with Chester County Water Resources Authority, August, 1980.

Moore, 1987. *Determination of Benthic Invertebrate Indices and Water Quality Trends of Selected Streams in Chester County, PA.* USGS Water Resources Investigations Report No. 85-4177, Wash., DC.

MPC, 1993. Pennsylvania Municipalities Planning Code, Act 247, Dept. of Comm. Affairs, Bu. of Comm. Plg., Plg. Serv. Div., Harrisburg, PA.

PADER, 1984. *Schuylkill River Design Guide.* DeBenedictis, PA Department of Environmental Resources, Harrisburg, Pennsylvania.

PEC, 1979. *Schuylkill River Study.* Winsor, Pennsylvania Environmental Council, Inc., Philadelphia, PA.

SCS, 1986. *Urban Hydrology for Small Watersheds,* USDA, SCS, TR-55, 210-VI-TR-55, USGPO, Wash., DC.

Shuttleworth, 1993. *Evapotranspiration,* W.J. Shuttleworth, Inst. of Hydrology, Wallingford, UK, in **Handbook of Hydrology**, McGraw Hill, NYC, NY.

Sloto, 1994. *Geology, Hydrology and Ground-Water Quality of Chester County, PA,* R.A. Sloto, USGS. Chester County Water Resources Authority, Water Resource Report 2, West Chester, PA.

USDA, 1959. **Soil Survey, Chester and Delaware Counties, PA**, U.S. Dept. of Ag., Soil Conservation Service, W.M. Kunkle, Series 1959, No. 19, GPO, Wash., DC.

USGS, 1981. *Water Resources Data, Water Year 1981,* Vol. 1, Delaware River Basin. In Cooperation with PA DER, Hbg., PA.

White and Sloto, 1990. *Base Flow-Frequency Characteristics of Selected Pennsylvania Streams*, K.E. White and R.A. Sloto, USGS Water Resources Investigations Report 90-4161, USGPO, Wash., DC.

APPENDIX

FEDERATION OF NORTHERN CHESTER COUNTY COMMUNITIES
SUSTAINABLE WATERSHED MANAGEMENT PROGRAM

COMPREHENSIVE STORMWATER MANAGEMENT ORDINANCE

Prepared by

The Brandywine Conservancy
Chadds Ford, PA
and
Cahill Associates
West Chester, PA

for

Green Valleys Association
Pottstown, PA

REVISED DRAFT
APRIL, 1998

ARTICLE I GENERAL PROVISIONS

SECTION 100. GOALS

The negative impacts of development with inadequately managed stormwater include, but are not limited to:

- **altered hydrology**
- **lowering of the groundwater table**
- **physical stream impacts**
- **biological impacts**
- **nonpoint source pollutants**

It is the goal of ___ Township to protect the health, safety, and general welfare of ___ Township residents by protecting the surface and groundwaters of the Township through effective stormwater management and control of sedimentation and erosion, as provided in this Ordinance.

SECTION 101. PURPOSE

The purpose of comprehensive stormwater management in ___ Township is:

1. To maintain the pre-development water balance in watersheds and sub-watersheds containing first-order and other especially sensitive streams in ___ Township, and to work to restore natural hydrologic regimes wherever possible throughout the stream system.

2. To maintain the pre-development volume of groundwater recharge.

3. To prevent significant increase in surface runoff volumes, pre-development to post-development, thereby worsening flooding downstream in the watershed, enlarging floodplains, eroding stream banks, and creating other flood-related health-welfare-property losses, and to work to reduce runoff volumes to natural levels

4. To maintain pre-development peak rates of discharge, site-by-site, so as not to worsen flooding at adjacent downstream sites, and to work to restore peak runoff rates to natural levels

5. To minimize nonpoint source pollutant loadings to ground and surface waters generally throughout ___ Township.

6. To minimize impacts on stream temperatures

7. To minimize aesthetic impacts

8. To manage stormwater through approaches and practices which require a minimum of structures and which rely on natural processes to the maximum.

SECTION 102. STATUTORY AUTHORITY

___ Township is empowered to regulate land use activities that affect stormwater runoff by the authority of the Pennsylvania Municipalities Planning Code, Act 247 of 1968, as amended by Act 170 of 1988, as further amended by Act 209 of 1990 and Act 131 of 1992, 53 P.S. Section 10101. Stormwater management is also enabled by Pennsylvania's Stormwater Management Act of 1978 (Act 167), as well as the Pennsylvania Environmental Amendment.

SECTION 103. APPLICABILITY

These regulations apply to:

- all activities governed by the ___ Township Subdivision and Land Development Ordinance (SLDO)
- construction of separate or additional impervious or semi-pervious surfaces (driveways, parking lots, additions to buildings, etc.)
- other earthmoving activities
- outdoor storage
- any other land disturbances.

No land or waterway shall be used or modified, no earth shall be disturbed, stripped, or moved, and no structure or other impervious surface shall be built or extended without full compliance with the terms of this Ordinance and other applicable regulations.

SECTION 104. REPEALER

An ordinance inconsistent with any of the provisions of this Ordinance is hereby repealed to the extent of the inconsistency only.

SECTION 105. SEVERABILITY

Should any section or provision of this Ordinance be declared invalid by a court of competent jurisdiction, such decision shall not affect the validity of any remaining provisions of this Ordinance.

SECTION 106. COMPATIBILITY WITH OTHER ORDINANCE REQUIREMENTS

Approvals issued/actions taken pursuant to this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or ordinance. To the extent that this Ordinance is more rigorous in terms of the standards applied for stormwater management, the specific stormwater management standards and design criteria contained in this Ordinance are to be followed.

ARTICLE II DEFINITIONS

(see Section ___)

ARTICLE III COMPREHENSIVE STORMWATER MANAGEMENT STANDARDS

SECTION 301. STANDARDS FOR PERMANENT STORMWATER MANAGEMENT

All land disturbances as listed in Table 1 shall comply with provisions of this Section.

TABLE 1

Land Disturbances Required to Comply with Section 301

1. **All minor and major subdivisions and land developments where land disturbance exceeds 5,000 sq ft.**

2. **An impervious cover addition to an existing developed property which exceeds 5 percent of lot area or 500 square feet, whichever is smaller.**

3. **A semi-impervious cover addition (gravel, lattice blocks) to an existing developed property which exceeds 800 square feet on slopes greater than 8 percent.**

4. **A temporary storage of impervious or pervious material (rock, soil, etc.) on an existing developed property where ground contact coverage exceeds 5 percent of lot area or 4,000 square feet (whichever is less), where the material is placed either on slopes exceeding 8 percent or on alluvial soils or a drainage way.**

A. Permanent Stormwater Management Standards

1. Standard 1: After installation of impervious cover, there shall be no increase in the **volume** of stormwater runoff being discharged for up to the 2-year frequency rainfall, pre-development to post-development. If the Township Engineer determines that such a standard is not achievable on the site (all or in part), based on the existing soil, bedrock, water table,

or other conditions on the parcel, Standard 3 provisions apply. For preliminary design purposes, this volume can be initially estimated as a depth of 2.5 inches per unit area of new impervious surface.

2. Standard 2: After installation of impervious cover and assuming full compliance with Standard 1, the peak rate of stormwater discharges from the site for all design storms up to and including a 100-year frequency rainfall shall not exceed the peak discharges from the site of the same storms before disturbance; design storms include:

   - 2-year, 24-hour storm;
   - 5-year, 24-hour storm;
   - 10-year, 24-hour storm;
   - 25-year, 24-hour storm;
   - 50-year, 24-hour storm;
   - 100-year, 24-hour storm.

3. Standard 3: If the volume standard set forth in Standard 1 cannot be achieved, then the peak rate standards are modified so that post-development peak rate discharges from the site for all storms up to the 10-year storm must be equal to or less than 75 percent of the respective peak rates for these storms, pre-development.

4. Standard 4: Under certain conditions, the Township, upon recommendation by the Township Engineer, may impose the following additional restrictions on stormwater discharges:

   (a) Peak discharge may be further restricted when it can be shown that a probable risk to downstream structures or unique natural areas exists or that existing severe flooding problems could be further aggravated.

   (b) Measures shall be imposed to protect against ground or surface water pollution where the type of business activity may result in significant nonpoint source pollution (so called "hot spots") or the nature of the soils or bedrock underlying a stormwater management structure constitutes substantial risk of contamination, such as might be the case in limestone formations. Special provisions to be followed in these cases are will be provided by the Township Engineer.

   (c) Where groundwater yields are very low or where a groundwater supply already is heavily used, the Township may require that the entire volume of the 2-year frequency rainfall (3.2 inches in 24 hours) be retained and infiltrated.

5. Standard 5: Significant loadings of nonpoint source pollutants shall not be discharged into either surface or groundwater. Significant is defined as resulting in an increase greater than 10 percent of existing

background concentrations of all water quality parameters of consequence identified in Federal and State criteria for this watershed. In particular, nutrients (nitrate and total phosphorus), metals (cadmium and lead), total petroleum hydrocarbons (TPH),and synthetic organic compounds identified by the US Environmental Protection Agency (USEPA) as toxic or hazardous substances must be controlled. If the volume and peak rate standards above (Standards 1 and 2) are met, then water quality impacts are assumed to be adequately controlled. If the volume standard (Standard 1) above cannot be achieved, then a water quality impact analysis must be performed, at the direction of the Township Engineer, confirming prevention of any significant increase in nonpoint source pollution, with particular focus on the pollutants discussed above. Both structural and nonstructural (preventive) measures are to be considered for reduction and prevention of nonpoint source pollution.

B. Stormwater Management Calculation Methods

1. In establishing the antecedent conditions for calculating runoff prior to land disturbance, the following assumptions shall apply:

   (a) Average antecedent moisture conditions;

   (b) A type II distribution storm;

   (c) Woodland shall be used as the prior condition for those portions of the site having trees of greater than 6 inches caliper DBH or where such trees existed within 3 years of application;

   (d) Meadow shall be used for all other areas including areas of existing cultivation or impervious surface.

   (e) In performing the TR-55 calculations, all those areas to be disturbed during construction will be assumed to be reduced one Hydrologic Soil Group category level during post-development runoff calculations (i.e., HSG B is reduced to HSG C, and so forth).

2. In all plans and designs for stormwater management system and facilities submitted to the Township Engineer for approval, stormwater peak discharge and runoff shall be determined through the use of the Soil Cover Complex Method as set forth in Urban Hydrology for Small Watersheds, Technical Release No. 55, with specific attention given to antecedent moisture conditions, flood routing, and peak discharge specifications included therein and in Hydrology National Engineering Handbook, Section 4, both by US Department of Agriculture, Natural Resources Conservation Service (Soil Conservation Service). Note that use of TR-55 with many of the natural system-based approaches and practices recommended by this Ordinance requires that calculations be performed on a detailed small sub-area basis. The Township Engineer

may permit the use of the Rational Method for calculation of runoff on land developments of 10 acres or less and for the design of storm structures.

3. In calculating runoff after development, those areas covered by concrete lattice blocks on an appropriate base, porous pavement areas on an appropriate base, and roof areas which drain to properly designed and installed storage/groundwater infiltration beds, shall be considered adequate to infiltrate any increased runoff from a 2-year storm.

C. Specific Stormwater Management System Design Criteria

1. Infiltration devices shall be selected based on suitability of soils and site conditions. Measures may include porous pavement with underground infiltration beds, vegetated infiltration beds, swales and trenches, or other seepage structures as proposed in the Pennsylvania Handbook of Best Management Practices for Developing Areas (1998) and related references prepared by the USEPA, the Washington Metropolitan Council of Governments, the Soil Conservation Service, the PA Dept. of Environmental Protection (PADEP), or other guidance documents.

2. Soil infiltration tests shall be performed for all proposed infiltration areas; these tests shall include evaluation of selected soil horizons by deep pits and percolation measurements. Testing should be reviewed and approved by the Township Engineer. The soil infiltration rate of discharge from the infiltration area being used in the proposed design shall be based on these measurements.

3. The lowest elevation of the infiltration area shall be at least two (2) feet above the Seasonal High Water Table (SHWT) and bedrock, except in the case of limestone formations, in which case the distance shall be three (3) feet.

4. All roof drains shall discharge to infiltration systems, with appropriate measures such as leaf traps and cleanouts taken to prevent clogging by vegetation.

5. All infiltration systems shall have appropriate positive overflow controls to prevent storage within one (1) foot of the finished surface or grade.

6. All infiltration systems shall have a setback of fifteen (15) from all residential structures. Care should be taken to prevent any seepage into sub-grade structures.

7. All infiltration systems shall be designed to infiltrate the stored volume within twenty-four (24) hours.

8. All surface inflows shall be treated to prevent the direct discharge of sediment into the infiltration system; accumulated sediment reduces stormwater storage capacity and ultimately clogs the infiltration

mechanism. No sand or other particulate matter may be applied to a pervious surface for winter ice conditions.

SECTION 302. STANDARDS DURING LAND DISTURBANCE

A. During the period of land disturbance, when significant sediment can be contained in runoff, this runoff shall be controlled prior to entering any proposed infiltration area.

B. Peak discharges and discharge volumes from the site shall comply with the appropriate sections above, with the following additions:

1. For purposes of calculating required detention storage during land disturbance, peak discharges and discharge volumes shall be calculated based upon the runoff coefficients for bare soils during the maximum period and extent of disturbance. Controls shall insure that the difference in volumes and rates of peak discharge before disturbance and during shall not exceed those peak discharges and discharge volumes noted in Section 301 above. It should be understood that detention storage during the period of land disturbance and prior to establishment of permanent cover may require additional facilities on a temporary basis. Such measures shall be located so as to preserve the natural soil infiltration capacities of the planned infiltration bed areas.

2. Wherever soils, topography, cut and fill or grading requirements, or other conditions suggest substantial erosion potential during land disturbance, the Township, as recommended by the Township Engineer, may require that the entire volume of all storms up to a 2-year storm from the disturbed areas be retained on site and that special sediment trapping facilities (such as check dams, etc.) be installed.

C. Sediment in runoff water shall be trapped in accordance with criteria of the County Conservation District and PADEP and removed through means approved by the Township Engineer to assure proper functioning and adequate capacity in the basins or traps.

D. Procedures shall be established for protecting soils or geologic structures with water supply potential from contamination by surface water or other disruption by construction activity.

SECTION 303. SPECIAL STORMWATER MANAGEMENT DISTRICTS

A. The Riparian Buffer Area (RBA).

1. Permitted Uses in the Riparian Buffer Area.

   This area may be included in net density calculations with uses permitted in the Township Zoning Ordinance.

2. Uniform Standards for the Riparian Buffer Area

a. A 15-foot setback zone (Zone 1) of no disturbance except for restoration shall be maintained along perennial streams and bodies of water, starting measured from the top of the bank of the waterbody

b. A 60-foot managed buffer zone (Zone 2) shall be maintained outside of Zone 1.

c. "High Quality Waters" and "Exceptional Quality Waters" designated under the PADEP Chapter 93 Rules and Regulations shall be subject to the provisions of the PADEP "Special Protection Waters Implementation Handbook" and its amendments.

d. A zone of various width of level spreading devices (Zone 3) should be maintained adjacent to the above mentioned zone when no other runoff pollution control devices are being used on a site.

B. Hydrologic Management Areas (HMAs).

HMAs are (1) water-related land areas consisting of (a) wetlands including a twenty-five foot (25') buffer area along their boundary, (b) floodplain areas, (c) open spaces in lowland areas that abut "High Quality Waters" and "Exceptional Value Waters," and (d) sites occupied by Best Management Practices, as well as (2) access easements along storm sewers, floodplains, and watercourses. These areas are to be designated as open space secured by deed restriction.

SECTION 304. SELECTION OF STORMWATER BEST MANAGEMENT APPROACHES AND PRACTICES

Optimal stormwater management which comprehensively achieves quantity and quality standards at least cost will vary from site to site and with different uses. Although stormwater plans themselves will be different, **the process or procedure for figuring out what to use where and under what conditions does have a structure.** This Comprehensive Stormwater Management Procedure has been defined; a guidance document (Appendix A The Comprehensive Stormwater Management Procedure) is available at ___ Township and through the Township Engineer. A Procedure Application Report must be submitted as part of the Comprehensive Stormwater Management Plan in order to demonstrate that the Procedure has been properly applied. Additional technical references and guidance documents also are available at ___Township and through the Township Engineer.

Note that the selection of a competent and creative design engineer by the applicant clearly is critical. In order to achieve the standards and construction and maintenance cost reductions which are intended in this regulation, additional time and money is required in the process in preliminary engineering and design. Review and approval of a Comprehensive Stormwater Management Plan will be heavily dependent on the technical review by the Township Engineer and compliance with this Ordinance.

ARTICLE IV COMPREHENSIVE STORMWATER MANAGEMENT PROCEDURES

SECTION 401. COMPREHENSIVE STORMWATER MANAGEMENT PLAN REQUIREMENT

As part of all applications for preliminary subdivision or land development plans and building permits, except those exempted by Article III, a Comprehensive Stormwater Management Plan is required and must be reviewed and approved by the ___ Township Engineer. This Comprehensive Stormwater Management Plan shall include the documentation called for in Section 402 and 403 of this Ordinance. This Plan shall be submitted to the Chester County Conservation District for its review and approval.

SECTION 402. COMPREHENSIVE STORMWATER MANAGEMENT PLAN RELATED TO SUBDIVISION OR LAND DEVELOPMENT

A. The Comprehensive Stormwater Management Plan shall demonstrate that all land disturbance activities related to the subdivision or land development comply with the performance standards set forth in Article III of this Ordinance.

B. The Comprehensive Stormwater Management Plan shall contain all of the information required by Section 404 below. The applicant and/or his engineer shall confer with the Township Engineer prior to the preparation of a Comprehensive Stormwater Management Plan.

C. The Comprehensive Stormwater Management Plan shall be reviewed by the Township Engineer, who shall submit a report thereon to the Township Planning Commission within 30 days of submission of the Plan.

D. If, in the Township Engineer's view, the Comprehensive Stormwater Management Plan as submitted satisfies all requirements of this Ordinance, he shall recommend its approval to the Planning Commission. That recommendation shall be considered by the Planning Commission and Board of Supervisors, together with the results of their own reviews and the comments of any other reviewing body.

E. If the Township Engineer determines that the Comprehensive Stormwater Management Plan fails to satisfy all requirements of this Ordinance, he shall so indicate in his report to the Planning Commission and Board of Supervisors and shall specify those items not in compliance with the Ordinance. The Township shall communicate these items to the applicant and, should the applicant want to remedy the deficiencies, the Township shall confer with the applicant to mutually agree whether a resubmission would initiate a new 90-day review period, extend the existing review period, or occur within the existing review period. The applicant and Township shall agree in writing to the terms and conditions of any such resubmission schedule.

F. The Township may approve the Comprehensive Stormwater Management Plan with conditions to be addressed as part of the final subdivision or land development application. Such conditions will be agreed to by the applicant, in writing, prior to conditional approval. If these conditions are not accepted by the

applicant, the Township may deny approval of the subdivision or land development application.

G. As part of any final subdivision or land development plan, the applicant shall submit:

1. All construction specifications for stormwater management facilities as outlined in this Ordinance and as further specified by the Township Engineer;

2. Proof of liability insurance over the term of the project, if required under Section 404(J);

3. A performance guarantee as outlined in Article VI;

4. Detailed documents necessary to comply with the maintenance requirements of Article V;

5. Such other information as is deemed necessary by the Township Engineer.

H. The applicant may request in writing the approval of the final subdivision or land development plan conditioned upon satisfactory submission of the above. No site work shall begin until all conditions are met.

I. Where the final Comprehensive Stormwater Management Plan submission does not comply with the performance standards set forth in Article III of this Ordinance, or other application requirements of this Ordinance, such failure to comply may be considered grounds for denial of the final subdivision or land development application.

SECTION 403. COMPREHENSIVE STORMWATER MANAGEMENT PLAN RELATED TO BUILDING CONSTRUCTION

A. Where individual on-lot land disturbance activities have been addressed, approved, and noted as such in an applicant's Comprehensive Stormwater Management Plan related to a subdivision or land development, applications for building permits for each individual lot shall reference such approval. In these cases, it shall not be necessary for the applicant to resubmit a Comprehensive Stormwater Management Plan concurrent with applications for building permits, provided the proposed grading of the lot and the locations of houses, driveways, and stormwater management facilities of any type are not changed.

B. In all other cases, or in cases where an applicant in A, above, wishes to alter grading, building locations, or the on-lot stormwater management system, the applicant shall submit a Comprehensive Stormwater Management Plan. This Plan shall accompany the application for a building permit and shall demonstrate that all land disturbance activities related to the building construction shall comply with the performance standards in Article III and any other applicable provisions of this Ordinance.

C. The Township may require that the Comprehensive Stormwater Management Plan contain all of the information mandated by Section 404. The applicant and/or his engineer shall confer with the Township Engineer prior to the preparation of a Comprehensive Stormwater Management Plan to determine the scope and detail of the submission.

D. The applicant's Comprehensive Stormwater Management Plan shall be reviewed by the Township Engineer, who shall submit a report thereon to the applicant and the Zoning Officer (Zoning or Building Inspector or Codes Enforcement Officer) and a copy to the Board of Supervisors, within 30 days of submission of the Plan.

E. Where revisions to the Plan are necessary in order to meet the performance standards set forth in Article III, the applicant shall discuss the contents of the report with the Township Engineer. All necessary revisions shall be effected and submitted to the Township Engineer.

F. Within 10 days after receipt of the applicant's revisions, the Township Engineer shall review the revisions and issue a supplementary report to the applicant and the Zoning Officer, with a copy to the Board of Supervisors, recommending approval or disapproval of the Plan.

G. If the final Comprehensive Stormwater Management Plan is not in compliance with the performance standards set forth in Article III, failure to so comply may be considered grounds for denial of the building permit.

H. Approval of a building permit shall constitute approval of the accompanying Comprehensive Stormwater Management Plan; these approvals may be concurrent.

SECTION 404. STORMWATER MANAGEMENT PLAN CONTENT

Except as may be modified for activities in Section 403, the Comprehensive Stormwater Management Plan required by Section 401 of the ____ Township Subdivision and Land Development Ordinance, shall consist of two parts: (a) a map or maps describing the topography of the area, the proposed alteration to the area, the proposed erosion and sedimentation control measures and facilities, and the proposed permanent stormwater control measures and facilities; and (b) a narrative report describing the project and its compliance with applicable sections of Article III, giving the purpose and the engineering assumptions and calculations for control measures and facilities. The following elements shall be included in the map and narrative portions of the Plan (except where already prepared as part of the preliminary subdivision or land development plan required by Section V of the SLDO).

A. A narrative summary of the project, including:

- general description of the project;
- general description of accelerated erosion control;
- general description of sedimentation control;

- general description of stormwater management, both during and after construction;
- date project is to begin and expected date final stabilization will be completed.

B. Mapping of various physical features of the project area at a scale of ___, both existing and proposed, including:

- the location of the project relative to highways, municipal boundaries, and other identifiable landmarks;
- property lines of proposed project area;
- contour lines at vertical intervals of not more than 2 feet for land with average natural slope of 4 percent or less, and at intervals of not more than 5 feet for land with average natural slope exceeding 4 percent (including location and elevation to which contour lines refer);
- acreage or square footage of the project;
- wetlands (both state and federal jurisdiction), streams, lakes, ponds, or other bodies of water within the subject property or within 50 feet of any boundary of the property; intermittent streams and natural drainageways also should be shown;
- other significant natural features, including existing drainage swales, tree masses, and areas of trees and shrubs to be protected during construction;
- proposed location of underground utilities, sewer and/or water lines;
- scale of map and north arrow;
- existing roads and easement.

C. Mapping of the soils and underlying geology of the project area, including:

- soil types, including depth, slope, texture, and structure
- Hydrologic Soil Group classifications and soil rated permeabilities in inches per hour
- Soil constraints including depth to bedrock, depth to Seasonal High Water Table
- geologic formations underlying the project area and extending 50 feet beyond all property boundaries;
- describe aquifer characteristics of formations; highlight special formations such as limestone.

D. A map of proposed alterations to the project area, including:

- changes to land surface and vegetative cover, including zones of disturbance, zones of non-disturbance
- areas of cuts;
- areas of fill;
- structures, roads, paved areas, and buildings;
- proposed stormwater control provisions, both nonstructural and structural facilities;
- finished contours at intervals as described in Section ___;

E. Calculations and description of the amount of runoff from the project area and the upstream watershed area, in accordance with the terms of Section 301 of this Ordinance, including:

- method of calculation and figures used (including square footages for impervious surfaces of buildings, driveways, parking areas, etc.);
- factors considered.

F. The time schedule for land disturbance activities including:

- cover removal, including all cuts and fills;
- installation of erosion and sediment control facilities and practices;
- installation of improvements, including streets, storm sewers, underground utilities, sewer and water lines, buildings, driveways, parking areas, recreational facilities, and other structures;
- program of operations to convert erosion and sedimentation controls to permanent stormwater management facilities, including a chart of the relative time sequence of activities.

G. Temporary control measures and facilities for use during land disturbance, in both map and narrative form including:

- purpose;
- temporary facilities or other soil stabilization measures to protect existing trees and shrubs from land disturbance activities;
- types, locations, and dimensioned details of erosion and sedimentation control measures and facilities;
- design considerations and calculations of control measures and facilities;
- facilities to prevent tracking of mud by construction vehicles onto existing roadways.

H. The Comprehensive Stormwater Management Procedure Report (the specific elements of this Report are defined in Appendix A and include responses to questions set out in the Procedure; additional guidance regarding application of the Procedure is available from the Township Engineer).

I. Permanent stormwater management program (indicating, as appropriate, measures for groundwater recharge) and facilities for site restoration and long-term protection, in both map and narrative form, including:

- Purpose and relationship to the objectives of this Ordinance;
- establishment of permanent vegetation or other soil stabilization measures;
- installation of infiltration facilities, roof-top storage, cisterns, seepage pits, french drains, etc., to serve individual buildings;
- use of semi-pervious materials for driveways, parking areas, etc.;
- types, locations, and dimensioned details of facilities for stormwater detention and conveyance and for groundwater recharge;
- design considerations and calculations supporting the stormwater management program;

- location of drainage easements.

J. A narrative description of the maintenance procedures for both temporary and permanent control facilities, and of ownership arrangements, including:

- the methods and frequency of removing and disposing of sedimentation and other materials collected in control facilities, both during and upon completion of the project;
- the methods and frequency of maintaining all other control facilities, as necessary
- the proposed ownership and financial responsibility for maintenance of the permanent control facilities, including drainage and other easements, deed restrictions, and other legally binding provisions.

This description will result in a Maintenance Plan, to be jointly co-signed by the applicant and Township Engineer (see Article V below).

K. At the determination of the Township Engineer, proof of liability insurance and other ameliorative measures as deemed necessary.

ARTICLE V MAINTENANCE AND INSPECTION OF PERMANENT STORMWATER MANAGEMENT FACILITIES

SECTION 501. MAINTENANCE RESPONSIBILITIES

A. General Responsibilities

The owner of stormwater management facilities shall be responsible for their proper maintenance during and after development. A Maintenance Plan shall be prepared for review and approval by the Township Engineer and shall be executed and signed by the Township Engineer and applicant. Where appropriate, as described below, this Maintenance Plan also must be signed by the Homeowners Association. Where appropriate, maintenance responsibilities must be included as deed restrictions on individual lots. During all subsequent real estate transactions, maintenance responsibilities shall be pointed out to new owners. All deeds shall incorporate these specified maintenance responsibilities, making explicit individual owners responsibilities for stormwater management measures and for the common property.

On or before completion of subdivision or land development improvements, the permanent stormwater management system for a tract shall be fully installed and functional in accordance with the approved Comprehensive Stormwater Management Plan. Temporary sediment trapping facilities in detention basins, upon inspection and approval by the Township Engineer shall be converted into permanent stormwater management basins; additional facilities designed to serve more than an individual lot shall begin operation. All such work shall be as specified in the approved Plan.

B. Homeowners Association Ownership (Other than On-Lot Stormwater Facilities)

A single entity taking the form of a private corporation, partnership firm, estate or other legal entity empowered to own real estate exclusive of individual lot owners (i.e., Homeowners Association) shall be set up to manage stormwater management facilities that are suitable for such management, and perform other functions defined in this Ordinance. Responsibilities for ownership and management of facilities shall be defined in the Comprehensive Stormwater Management Plan.

C. Individual Lot Stormwater Facilities

1. Stormwater management facilities and systems that are located on an individual lot are the responsibility of that landowner to maintain. As with non-individual lot situations, a Comprehensive Stormwater Management Plan must be prepared, including a Maintenance Plan which shall include:
    a. Any obligations concerning perpetuation of natural drainage or infiltration facilities, and/or the maintenance of facilities constructed by the individual lot owner under terms of his building permit (e.g., berms, cisterns, downspout connections, seepage pits, etc.)

b Assurances that no action will be taken by the occupant to disrupt or in any way impair the effectiveness of any stormwater management system.

c. A description of the facilities and systems on the lot, as called for above, setting forth in deed restrictions binding on the landowner's successors in interest.

D. Municipal Ownership

Where the Township has accepted an offer of dedication of the permanent stormwater management facilities, the Township shall be responsible for maintenance. Municipal ownership notwithstanding, the applicant is required to prepare a Comprehensive Stormwater Management Plan including a Maintenance Plan component, as defined above. Upon approval of the stormwater management facilities by the Township, the applicant shall provide a financial security, in a form approved by the Township Solicitor for maintenance guarantees, as follows:

1. Long-term Maintenance Bond - The long-term maintenance bond shall be in any amount equal to the present worth of maintenance of the facilities for a ten year period. The estimated annual maintenance cost for the facilities shall be based on a reasonable fee schedule provided by the Township Engineer and adopted by the Township Board of Supervisors.

2. Documentation - The terms of the maintenance guarantees shall be documented as part of the Comprehensive Stormwater Management Plan and the Maintenance Plan subpart.

E. Failure of any person, individual lot owner or private entity to properly maintain any stormwater management facility shall be construed to be a violation of this Ordinance and is declared to be a public nuisance.

SECTION 502. NEED FOR CORRECTIVE MEASURES.

If the Township determines at any time that stipulated permanent stormwater management facilities have been eliminated, altered, or improperly maintained, the owner shall be advised of corrective measures required within a period of time set by the Township Engineer. If such measures are not taken by the owner, the Township may cause the work to be done and lien all costs against the property.

SECTION 503. INSPECTIONS OF LAND DISTURBANCES RELATED TO SUBDIVISION OR LAND DEVELOPMENT

All land disturbance work shall be performed in accordance with an inspection and construction control schedule approved by the Township Engineer as part of the Comprehensive Stormwater Management Plan. The Township Engineer should be consulted for guidance regarding the timing and other details of necessary inspections.

No work shall proceed to a subsequent phase, including the issuance of the Certificate of Occupancy, until inspected and approved by the Township Engineer or his designee, who shall then file a report thereon with the Township.

SECTION 504. LAND DISTURBANCES NOT RELATED TO SUBDIVISION OR LAND DEVELOPMENT.

The timing and frequency of inspections of land disturbance activities not related to the subdivision/land development process shall be a determined by the Township Engineer prior to final approval of the Comprehensive Stormwater Management Plan. Adherence to that schedule shall be a condition of Plan approval.

SECTION 505. FEES ASSOCIATED WITH INSPECTIONS.

Inspection fees for activities associated with Sections 503 and 504 shall be paid according to the provisions of the _ Township Subdivision and Land Development Ordinance.

ARTICLE VI FEES AND PERFORMANCE GUARANTEES

SECTION 601. COMPREHENSIVE STORMWATER MANAGEMENT PLAN APPROVAL FEES.

A. Land Disturbance Related to Subdivision or Land Development.

All fees and escrow deposits incident to approval of a Comprehensive Stormwater Management Plan and conduct of the work approved thereunder, where the land disturbance activities are to be undertaken as part of a subdivision or land development, shall be established and submitted in accordance with Section __ of the Township SLDO.

B. Other Land Disturbance Activities.

1. All parties submitting a Comprehensive Stormwater Management Plan for land disturbances not related to Subdivision and Land Development shall agree, in writing, to reimburse the Township for all costs of administration and review of the Plan by the Township staff, Engineer, and Solicitor. Funds shall be deposited with the Township Secretary in an amount as specified by resolution of the Board of Supervisors.

2. Excluding fixed administrative costs, the applicant shall be charged only for time actually expended and detailed in bills from the Township Engineer and Solicitor. Any unexpended balance of the deposit shall be returned to the applicant following approval of the Plan.

3. If actual time required of either the Township Engineer or Solicitor will exceed the deposited amount, the Township shall render to the applicant a preliminary statement of time expended and shall require an additional deposit to complete reviews. Such required additional amounts must be deposited with the Township Secretary prior to approval of the Plan.

SECTION 602. PERFORMANCE GUARANTEES.

Where proposed land disturbance activities are related to a subdivision or land development, the applicant shall be subject to the requirements for a performance guarantee that are specified in Section ___ of the Township SLDO. As stipulated in Section 501(D), a long-term maintenance bond and other requirements are imposed if stormwater management facilities are being conveyed to the municipality.

ARTICLE VII VIOLATIONS AND PENALTIES

SECTION 701. NOTIFICATION OF NON-COMPLIANCE WITH COMPREHENSIVE STORMWATER MANAGEMENT PLAN.

Any activity conducted pursuant to a Comprehensive Stormwater Management Plan approved by Township shall be performed in strict compliance with the provisions of the Plan. Violations shall be treated in the following manner:

A. Any non-compliance with the provisions of the Plan that is identified by the Township Engineer or his designee in the course of inspections as specified in this Ordinance shall be remedied by the applicant/owner according to the terms in this Ordinance.

B. If at any time work does not conform to the Plan, including all conditions and specifications and modifications thereof, a written notice to comply shall be given to the applicant/owner. Such notice shall set forth the nature of corrections required and the time within which corrections shall be made. Upon failure to comply within the time specified, the applicant/owner shall be considered in violation of this Ordinance, and the Township shall issue a cease and desist order on all work on the site, including any building or other construction, until corrections are made. If corrections are not undertaken within a specified time or the applicant/owner violates the cease and desist order: (1) penalties shall be imposed and/or (2) the work shall be completed by the Township and the costs charged to the applicant/owner.

SECTION 702. PENALTIES.

Anyone violating the terms of this Ordinance shall be guilty of a summary offense and, upon conviction, shall be subject to a fine or penalty of not more than $300 for each and every violation. Each day that the violation continues after proper notification shall be a separate offense. In addition thereto, the Township may institute injunctive, mandamus, or any other appropriate action or proceeding at law or equity for the enforcement of this Ordinance or to correct violations of this Ordinance, and any court of competent jurisdiction, shall have the right to issue restraining orders, temporary or permanent injunctions, or mandamus or other appropriate forms of remedy or relief.