

### ***Surface Water Quality and Quantity***

The Upper Perkiomen Creek watershed includes six main subwatersheds: the Main Branch Perkiomen Creek; the Northwest Branch (or West Branch) Perkiomen Creek; Hosensack Creek; Macoby Creek; Unami Creek; and Deep Creek. The *stream order* of these watersheds is important to note, since the Upper Perkiomen Creek watershed includes vast areas of headwater tributaries. The majority of stream miles in these subwatersheds consist of First Order and Second Order streams. A First Order stream is the original headwaters tributary that flows from a spring or seep. A *perennial* stream that flows year round should be counted for this purpose, while an *ephemeral* or temporary stream should not. When two First Order streams converge, they form a segment known as a Second Order stream. Two Second Order streams merge to form a Third Order stream, and so on. The Upper Perkiomen Creek watershed can be considered largely a headwaters area, so that the stream reaches only a level of Fourth Order at the Green Lane Reservoir, and does not constitute a large river. Like the fine bronchial tubes in the human lung, the First Order and Second Order headwater streams in the watershed provide the greatest surface area for pollutants to enter the system.

The *quality and quantity* of water in these streams, and the condition of the stream channel and stream bed are generally characterized by the influence of natural conditions such as the underlying geology, topography, and soils, and the adjacent vegetation, combined with the long history of human influence – with the initial forest clearing, agricultural use, construction of mills, dams and ponds, road and building construction, and modern development, conservation and restoration. The physical characteristics of the stream channel, the quality of the water (both chemical, biological and physical), and the quantity of water during periods of average flow, draught and flooding are all influenced by the interaction of these natural and cultural forces.

The stream quality of the Upper Perkiomen Creek watershed is relatively good, with PA DEP classification of protected status for “Cold Water Fishes” on 3 of the main tributaries (Hosensack, Indian Creek, and the Northwest Branch of Perkiomen Creek) and “Trout Stocking Fishes” on 4 main stream segments (Unami/Ridge Valley Creeks, Macoby Creek, the main stem of Perkiomen Creek, and Deep Creek). The only designation of “Warm-Water Fishes/Migratory Fishes” is a small section of the main stem of Perkiomen Creek, just below the impoundment for Green Lane Reservoir. Certain stream segments are believed to be higher in quality than their current designations reflect. The growing amount of volunteer stream monitoring in the Upper Perkiomen can provide an important basis for potential nominations to upgrade the quality designations of these streams in the future.

Municipal officials responding to questionnaires and interviews recognized water quality issues as important. 12 of the 14 respondents to the municipal survey thought

that stream water quality was important to their municipality and 10 indicated that improving water quality in their municipality as well as for the entire creek should be emphasized in this Conservation Plan. 9 respondents thought that existing storm water regulations were not sufficient to maintain the integrity of receiving waterways and 11 thought groundwater protection (recharge, quality, well drawdown, and septic systems) was important. Watershed assessments and actions taken by the various counties over the years have confirmed that septic systems are a concern for stream quality in the Upper Perkiomen watershed, however, 11 of the 14 respondents to the municipal survey felt that septic systems were adequately regulated within their jurisdiction.

Numerous water quality issues were identified at the public meetings. It was noted that Cold Water Fishes (CWF) designations should remain in portions of streams where they are in effect and, where applicable, these designations should be upgraded to EV status. There were several comments regarding locating and eliminating off-line, artificial ponds and in-line dams that are serving no valuable purpose and are causing increases in water temperature. Other water quality issues raised in public meetings included:

- The proximity of septic tanks to streams
- Septic regulations and maintenance
- Protecting riparian buffers where currently existing or restoring them where lost
- Erosion along streambanks
- TCE contamination of groundwater associated with Superfund and other hazardous waste sites
- Well head protection

*As land in the watersheds continues to face increasing pressure for subdivision and land development, the need to maintain and restore the quality and quantity of the streams of the Upper Perkiomen watershed program area must be central to the decision-making process. Conservation and restoration of land along streams are perhaps the most important steps that can be taken to balance the impacts of future development.*

### **Surface Water Quantity**

#### **Stream Flow**

Two stream flow gages are maintained by the United States Geological Survey (USGS) in the Upper Perkiomen watershed, just above Green Lane Reservoir. These gages have provided a continuous daily record of flow levels, volumes and velocities for streams draining most of the northern and western portions of the watershed since they began recording in 1982. Information for these gages is available through the USGS web site – including “real time” measurements of gage height in feet and discharge in cubic feet per second relayed to the internet via satellite. This system allows important, nearly immediate information on flooding or drought problems. Interested parties can log on

to the USGS web site at <http://water.usgs.gov/pa/nwis> to obtain information about stream level, volume and velocities posted every few hours.

*Station #01472198* is located on the main stem Perkiomen Creek 100 feet upstream from the bridge on Church Road, 0.9 miles upstream from Molasses Creek and 1.0 miles southwest of East Greenville. This gage is 288.5 feet in elevation above sea level, and measures flows from a 38-square mile drainage area that includes the upper portion of the main stem Perkiomen Creek, Hosensack Creek and Indian Creek.

Name	Length (mi.)	Drainage Area (sq.mi.)	Stream Order	Quality	Discharges	Intakes
<i>Perkiomen Creek</i>	14.7	29.6	4th	TSF	14	1
<i>NW Branch</i>	11.8	23.1	3rd	CWF	6	--
<i>Hosensack/Indian Creeks</i>	7.4	18	3rd	CWF	0	--
<i>Macoby Creek</i>	10.5	18	3 <sup>rd</sup>	TSF	12	--
<i>Unami/Ridge Valley Creeks</i>	28.6	50	3rd	TSF	6	--
<i>Deep Creek</i>	2.1	5.7	2nd	TSF	2	--

*Table 1. This table provides an overview of the range of subwatershed sizes, the lengths of stream in each, stream quality designations and discharges/intakes. A stream such as Macoby Creek stands out as handling a high amount of discharges from wastewater and industrial treatment plants relative to its size. The overall number of discharge points (42) is unusually high for a rural watershed.*

A summary of daily mean streamflow values for this station over 20 years of record indicates that the highest flows generally occur during the winter and early spring months from December through April, with the highest daily mean flows ranging from 171 to 198 cubic feet per second (cfs). The highest recorded peak flow at this station was 4,800 cfs on September 16, 1999, generated by Hurricane Floyd (a “100-year storm”).

*Table 1.*

The wet year of 1984 produced the highest monthly mean flow for a consecutive 6-month period in the last 20 years. The lowest flows over the last 20 years have typically occurred during the late summer and early fall months of July through October, with the lowest daily mean flows ranging from 17.1 to 27.3 cfs. The lowest recorded peak flow at this station was 4.2 cfs, however, the 20-year low of 6.24 cfs was recorded on August 5, 1999, exactly 6 weeks before the 20-year high during Hurricane Floyd. The drought in the summer of 1999 produced the lowest monthly mean streamflow for a consecutive three-month period in the last 20 years. The highest and lowest 20-year gauge height readings also correspond with the tumultuous weather of 1999, ranging from a low of 1.37 feet on August 5 to a high of 6.53 on September 16.

*Station #01472199* is located on the Northwest Branch Perkiomen Creek at Hillegass, 0.3 miles downstream from a bridge on a private road. These gages provide a valuable long-term record of stream flow in the watershed – including both the baseflow of

streams fed by groundwater seeps and springs, and the influence of runoff (or “overland flow”) on stream volume and velocity. The record from these gages demonstrates, predictably, that rainfall and stream flow are closely related, with wet periods generating high flows and droughts producing low flows.

Station	Low Flow	Peak Flow	Avg. Year Round Flow	Avg. August Flow
Main Branch	4.2 cfs	2,800 cfs	62 cfs	29.6 cfs
NW Branch	3.8 cfs	1,760 cfs	39 cfs	16.0 cfs

Table 2. The low, peak and average flow rates (in cubic feet per second, or cfs) for the two USGS stream gages in the Upper Perkiomen Creek.

In many watersheds, including the Upper Perkiomen Creek, the amount of runoff (as measured in stream flow) is influenced by other factors in addition to total precipitation, including: the pattern of precipitation (the duration of rain or snow falling in different parts of the watershed); the soil moisture content between storm events; the land cover (parking lots generate many times more runoff than forests); land forms (such as slopes); and the presence of frozen ground (Cahill, 1994).

For example, the 1984 water year (Oct. 1 to Sept. 30) was very wet, with 66.3 inches of precipitation measured at the NOAA rain gage in Palm -- a 48% increase in the amount of precipitation over the average of 44.7 inches. The mean stream flow in that year measured at the East Greenville gage on the main stem Perkiomen Creek was 103 cubic feet per second (cfs) – a 77% increase over the 1982-1992 average of 58.3 cfs. In other words, *increased precipitation lead to a disproportionately higher increase in runoff*, leading to greater volume and velocity of water in streams, flooding potential, greater erosive force and higher reservoir levels.

During the same 11 year period, the 1992 water year was relatively dry, with only 35.6 inches of precipitation measured at the Palm gage – 20% below average. The mean stream flow in that year at the East Greenville gage was 35.7 cfs – a 39% decrease over the 11-year average. This means that *decreased precipitation lead to a disproportionately larger decrease in runoff*, with associated impacts to stream and wetland ecosystems, and lower reservoir levels. The 1994 Watershed Management Study calculated that approximately 13 inches of the 44.7 inches of precipitation form the annual stream baseflow, which is slightly higher than adjacent watersheds (Cahill,1994).

Natural cycles of drought and flooding characterize the climate of the northern Piedmont region in general and the long-term hydrology of the Upper Perkiomen watershed in particular. These cycles of drought and flooding have historically influenced stream channel characteristics, the diversity of aquatic life, groundwater levels. With the introduction of human land use patterns over the last three centuries, the impacts of drought and flooding cycles have in many ways been exacerbated – such

as the accelerated erosion of streambanks devoid of woodland cover, and reduced stream baseflow (and reservoir levels) in areas with extensive impervious surface coverage.

### ***Flooding***

While the Upper Perkiomen Creek watershed certainly experiences significant amounts of stormwater runoff reaching streams, flooding has not yet proven to be a major problem in terms of property damage or safety concerns. Floodplains are mapped on the Hydrologic Resources map (**see Figure 7c**). Stream corridors and floodplains are still relatively undeveloped, and impervious surface coverage in the watershed is relatively minimal compared to more developed areas. The watershed has not yet been impacted by the typical flood problems associated with conventional stormwater management systems in suburban areas -- basins scattered throughout each subwatershed, discharging increased volumes of water directly to wetlands and streams over extended periods of time. *With proper planning in the Upper Perkiomen watershed, the cumulative flooding impacts of conventional stormwater management systems can be avoided as development continues.*

The greatest concentrations of impervious surface coverage occur in the villages along Route 29, adjacent to the Green Lane Reservoir. Therefore, the greatest concentrations of stormwater runoff do not have much opportunity to reach serious volumes and velocities prior in the Macoby Creek and main stem Perkiomen Creek before they merge with Green Lane Reservoir. Areas of severe streambank erosion are probably the most tangible signs of flood problems.

Numerous flooding events on the Perkiomen Creek were documented in the Schuylkill River Basin Limited Reconnaissance Study prepared by the Army Corps of Engineers in 1990, however these were all located in the lower portions of the watershed in Collegetown, Schwenksville and Perkiomen Junction. *The Army Corps study is an important reminder that the land use decisions in the Upper Perkiomen Creek watershed can have serious implications, including exacerbated flooding problems, for downstream communities.*

The Pennsylvania Floodplain Management Act of 1978 (Act 166), requires all municipalities in the state to adopt floodplain ordinances that meet minimum standards for their citizens to be eligible for federal flood insurance and for the municipalities to continue to receive state funding. Thirteen respondents to the municipal survey reported that they had adopted floodplain regulations in accordance with Act 166.

### ***Surface Water Quality***

Water quality refers to the current condition of stream water relative to its natural physical, chemical and biological characteristics. The highest quality streams are those that tend to occur in forested watersheds, with low levels of

sedimentation and turbidity, minimal streambank erosion, balanced levels of pH, total phosphorus, nitrogen, and naturally occurring chemicals and minerals, high levels of dissolved oxygen, low levels of bacteria and algae, and a rich biota of native aquatic plants, benthic macroinvertebrates and fish. Unfortunately, these optimum “presettlement” conditions are often difficult to find in watersheds such as the Upper Perkiomen that have experienced centuries of changing land use patterns.

Maintaining stream quality to the highest possible standards in the Upper Perkiomen watershed is critically important for several reasons. The health and diversity of the plants and animals that make up the stream ecosystem hinges on clean water. The wide range of human uses of stream water, such as swimming, fishing, drinking and household use, industrial and agricultural use, all depend on clean water. The direct benefits to the local economy generated by these human uses also rely on stream quality.

The three questions to ask about stream quality in the Upper Perkiomen Creek watershed, then, are:

- 1) how close to optimum stream quality are the various streams in the watershed?
- 2) what are the main reasons they are not optimum?
- 3) how can stream quality be maintained and improved to the highest standard possible?

### *Stream Quality Classifications*

Pennsylvania’s Department of Environmental Protection has established a system for classifying streams in the State as specified in Chapter 93, Title 25 of the Pennsylvania Code. The standards are based on water uses which are to be protected and will be considered by DEP in its regulation of discharges from sewage treatment plants, industrial plants and stormwater management facilities. Current Water Quality Classifications for the Upper Perkiomen watershed are summarized in map form in this report (**see Figure 8: Water Quality Classifications**). The highest quality designations for the watershed (Cold Water Fishes – CWF) are found in the less developed headwaters areas of the Northwest Branch, main stem Perkiomen, and Hosensack/Indian Creeks. The majority of the watershed (roughly 2/3rds) including the lower portion of the main stem Perkiomen, Macoby Creek, and Unami/Ridge Valley Creeks is rated as Trout Stocking Fishes (TSF). A small area of Warm Water Fishes (WWF), the lowest category in the watershed, occurs along the stretch of the main stem Perkiomen below the Green Lane Reservoir impoundment.

The various uses are summarized below:

- CWF-- *Cold Water Fishes* – Maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.
- MF – *Migratory Fishes* – Passage, maintenance, and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.
- TSF – *Trout Stocking* – Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
- WWF -- *Warm Water Fishes* – Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.

Chapter 93 also includes two categories of Special Protection Waters:

- HQ – *High Quality Waters* – A stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection.
- EV – *Exceptional Value Waters* – A stream or watershed which constitutes an outstanding national, State, regional, or local resource, such as waters of national, State, or county parks or forests, or waters which are used as a source of unfiltered potable water supply, or waters which have been characterized by the Fish Commission as “Wilderness Trout Streams,” and other waters of substantial recreational or ecological significance.

The Perkiomen Valley chapter of Trout Unlimited (PVTU) has stated that one of its goals is to upgrade the status of the Northwest Branch to Exceptional Value. This group has also discussed upgrading the entire upper portion of the watershed above Green Lane Reservoir to EV status before it is degraded by development. The ongoing assessment of streams in the watershed by DEP as part of the Unassessed Waters program described in this section may provide valuable data on stream quality to help support such nominations.

#### ***Point Source Pollution***

The numerous industrial plants and sewage treatment plants in the Upper Perkiomen Creek watershed are the main sources of “point source” pollution, or pollution that can be tracked to a single source (such as a discharge pipe). Wastewater from residential uses in these plants generally contributes nutrients such as nitrogen and phosphorus from human waste and household detergents. Industrial wastewater may have far more complex pollutants related to specific manufacturing and processing equipment. (see **Figure 9: Point Source Discharges**).

A total of 42-point source discharges exist in the Upper Perkiomen Creek watershed, although at least 7 of these are “land application” systems (6 spray irrigation/1 drip irrigation) that discharge to soil rather than streams. These discharges are summarized in the following table. Six public sewage treatment plants serve the Upper Perkiomen Valley: the Upper Montgomery Joint Authority’s plan on Mensch Road at the Green Lane Reservoir; the Upper Hanover Authority’s plant on Frey Road at Macoby Creek; the Green Lane-Marlborough Joint Authority plant on Park Drive at the Perkiomen Creek; the Milford-Trumbauersville plant on the Unami Creek; and the Washington Township plant and the Bally plant on the Northwest Branch. In addition, at least 15 privately run sewage treatment plants (STP’s) operate in the watershed. These include package plants servicing: five mobile home parks; two schools; one dairy; two restaurants; and a summer camp. With the exception of the mobile home parks, the regional trend toward constructing package treatment plants for large-scale residential subdivisions has not yet reached the Upper Perkiomen watershed.