Schuylkill River Hydrology and Consumptive Use

Blue Marsh Reservoir, Berks County, PA

Report Produced by the
City of Philadelphia Water Department
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Office of Watersheds
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Executive Summary

PWD Objective

The Philadelphia Water Department's (PWD) Source Water Protection Program is responsible for tracking and analyzing trends in water quantity and quality of the two sources of drinking water for the City of Philadelphia. A critical part of the program's water quantity focus is to investigate the current and future water use patterns, how climate change may influence the drinking water supply, and what the balance is between the needs of the power sector, drinking water supply, aquatic communities, and recreational interests. Ultimately, PWD needs to know how upstream consumptive use impacts drinking water availability to the City of Philadelphia. In order to prioritize research and study interests to obtain this information, there are two critical questions that PWD addresses in this analysis:

- Is there enough water to meet current needs?
- What are the current competing water needs in the Schuylkill River?

By answering these questions, the Schuylkill River Hydrology and Consumptive Use Analysis is a first step towards identifying the factors that influence the quantity of drinking water available to Philadelphia from the Schuylkill River. Preliminary observations of consumptive use and hydrology are made, and critical future studies are identified. The work presented here builds upon work done by the Pennsylvania Department of Environmental Protection (PADEP) in the Act 220 studies because it focuses solely on the Schuylkill River as a drinking water supply to Philadelphia.

Scope of Work

The Schuylkill River Hydrology and Consumptive Use Analysis has three parts:

I. A hydrological comparison of streamflow gauges is performed to identify which gauge is most representative of drinking water available to Philadelphia. This gauge is then used to determine if the Schuylkill River is providing the maximum Philadelphia demand 100% of the year.

II. Consumptive use in the Schuylkill River upstream of the Philadelphia border is estimated by taking the difference of total withdrawals and discharges. Data for this calculation was obtained from PADEP and the Delaware River Basin Commission (DRBC). There are methodological differences between this analysis and Act 220 which are noted in each section and summarized in the Appendices.

III. The PWD daily average withdrawal from the Schuylkill River intakes is added to the upstream consumptive use to calculate total consumptive use. Total consumptive use is then compared to the metric that PWD uses to define watershed-wide water stress; a consumptive use greater than 50% of the pre-development 1 in 25 year annual average baseflow (a statistic that represents the lowest average baseflow for an entire year that occurs approximately once every 25 years).

Observations

The streamflow gauge at Fairmount Dam does not represent drinking water availability to PWD. The streamflow gauge at Norristown was observed to be the most representative of Schuylkill River drinking water availability to the City of Philadelphia.

In the summer, the Schuylkill does not provide Philadelphia's maximum demand 100% of the time. Two percent of the time, the maximum demand of 286 CFS can not be provided by the Schuylkill River. When a hypothetical pass-by requirement of 100 CFS is added onto the maximum demand and compared to availability, the Schuylkill River can not provide this flow (386 CFS) 6% of the time.

The Schuylkill River is approaching water stress conditions. Combined upstream consumptive use and downstream consumptive use total 42% of the 1 in 25 year annual average baseflow, which implies the Schuylkill River is approaching a water stress situation. The upstream consumptive use is 22% and the downstream consumptive use is 20% of the pre-development 1 in 25 year annual average baseflow.

Wastewater can compose up to 60% of the streamflow of the Schuylkill River. The total Schuylkill River watershed wastewater discharge was calculated to be 210 CFS. During dry conditions when the streamflow approaches the current 7Q10 flow rate at Norristown, the Schuylkill River water approaching Philadelphia is 60% treated wastewater for more than a week at a time. On some days, the Schuylkill River water approaching Philadelphia is over 90% treated wastewater.

The impacts of such large quantities of discharged treated wastewater are not fully understood. Upon identification of the significant presence of treated wastewater in the drinking water supply, PWD will begin investigating any drinking water quality and quantity implications.

Downstream drinking water, ecological, and recreational needs must be considered in Blue Marsh Reservoir operational policies. The analysis has observed that the Schuylkill River is approaching a water stress situation, even with the beneficial releases of Blue Marsh reservoir to repel the salt front. PWD would like to see downstream drinking water, ecological, and recreational needs incorporated into the release goals of Blue Marsh Reservoir.

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Section 1 Introduction

An integral part of source water protection for a public water supplier is to understand the current and future vulnerability of the supply with regard to the quantity of water available, and to identify ways of ensuring a safe and steady supply under all conditions. Given anticipated changes across the watershed due to population growth, suburban development, climate uncertainty, and demand from the energy sector, it is critical to assess the current availability of water to the Philadelphia Water Department (PWD). Water budgeting is one method that can be used to observe how water discharges and withdrawals may or may not be balanced at local and watershed-wide scales. In this application, water budgets are calculated for the Schuylkill River above the Queen Lane and Belmont drinking water intakes. This study tracks the flux of water from potable, industrial, agricultural, power, mining, and commercial water-supply related withdrawals and discharges. Such an analysis provides a broad view of where and how water is currently used and consumed in the Schuylkill River watershed.

This study was initiated after the PADEP completed the first round of technical work to support the Water Resources Planning Act (Act 220) approved on December 16, 2002. Act 220 authorizes the PADEP to assemble a State Water Plan that evaluates water usage and needs across Pennsylvania every five years. To assess water use and needs, the PADEP performed a water budget for over 10,000 sub-watersheds across Pennsylvania ranging in size from 15 to over 100 square miles. Through Act 220, the PADEP requires all intakes that withdraw greater than 10,000 gallons per day, from surface or groundwater, to submit average daily water withdrawals every five years beginning in 2003. The registration requirement provides PADEP with data to perform the water budget analyses.

The state defines watersheds with a consumptive use above 50% of the 7Q10 as having stressed water resources. In the second phase of PADEP's Act 220 efforts, stressed sub-watersheds identified through the water budget analysis will undergo data verification and may ultimately become the focus of smaller scale resource management and planning efforts. In PADEP's analysis and in this study, water stress is a situation where the demand of the population and economy cannot be met by the amount provided by the water supply. While in water stress, it is implied that the prioritization of one water use over another must occur to allocate water to the most critical use. In the eyes of PWD, ensuring an adequate drinking water supply for the population of the Schuylkill River watershed is of highest priority.

Although the analysis performed in this report is similar to the PADEP Act 220 work, the focus and scale of the projects are different. The primary focus of this analysis is the Schuylkill River as a drinking water supply to the City of Philadelphia. The scale of this analysis is the entire Schuylkill River as one unit, given this is a preliminary analysis of water quantity and the intakes are located at the furthest downstream location for freshwater withdrawals. The criterion used here to define water stress is consumptive use exceeding 50% of the 1 in 25 year annual average baseflow for the entire Schuylkill River watershed. The use of the 1 in 25 year annual average baseflow as a metric for water stress is a more appropriate metric for PWD's watershed wide approach because it is indicative of

the long term annual behavior of the whole watershed, and the numbers used attempt to exclude the influence of existing consumptive use. The 7Q10 is a metric representative of how streams behave under the influence of seasonally dry periods where streamflow can fall sharply for a short duration. The 1 in 25 year annual average baseflow is also used by Chester County and the Delaware River Basin Commission in their respective water planning efforts, and therefore has regional acceptance as a water stress metric.

The PADEP Act 220 analyses and this study are complementary to one another. As a regulator of state water use, the PADEP focus must be inclusive of the water needs for all sectors. This analysis can support PADEP's effort by offering conclusions critical to the management of one sector in greater detail: the Schuylkill River as a drinking water supply.

The results of this study provide baseline information critical for further examination of regional water use, state and federal policies governing water quantity, and how PWD prioritizes water supply management objectives. This information will ultimately help PWD in its efforts to optimize both the Schuylkill and Delaware intakes and remain active in policy and development decisions that impact the quantity of the drinking water supply.

Section 2 Philadelphia Water Department

The Philadelphia Water Department (PWD) owns and operates three drinking water treatment plants that provide water to Philadelphia and surrounding communities. The two plants located on the Schuylkill River, Queen Lane and Belmont, provide an average of 110 million gallons per day (MGD) of potable drinking water to a population of approximately 700,000 persons in Philadelphia and surrounding communities. The intake of the Queen Lane Drinking Water Treatment Plant is located immediately downstream of the confluence of the Wissahickon Creek and Schuylkill Rivers in the East Falls neighborhood of Philadelphia. The intake of the Belmont Drinking Water Treatment Plant is located two miles downstream of Queen Lane. The locations of the Philadelphia drinking water treatment plants are depicted in Figure 2-1.

Figure 2-1 Philadelphia Schuylkill River Drinking Water Intakes

Queen Lane and Belmont are not in the tidal portion of the Schuylkill River. They are physically separated from the tidal portion of the Schuylkill River by Fairmount Dam, so there is no mixing between waters of the Delaware Bay and the Schuylkill River in the vicinity of the Queen Lane and Belmont intakes. The absence of tidal influence on the Schuylkill intakes is in contrast to the Baxter Water Treatment Plant located in the freshwater-tidal portion of the Delaware River. Baxter is located on the Delaware River in the Torresdale neighborhood and provides 60% of the drinking water to Philadelphia.

The locations of the drinking water intakes, two in a non-tidal area and one in a tidal area, highlight some fundamental water resource management challenges to PWD. In the tidal portion of the Delaware River at the Baxter intake, water quantity and quality are governed by both upstream and downstream forces. At the Queen Lane and Belmont intakes, the consumptive use, withdrawals, and discharges upstream influence Schuylkill River water quantity and quality.

2.1 Philadelphia Potable Water Demand

In Philadelphia, potable water demand includes both drinking water and process water for industrial and manufacturing operations. The demand for high quality, potable water is therefore dependent upon the population and economic structure of the customer service area. The water demand of economies with a large industrial base, such as Philadelphia in the first half of the 20th century, include industrial water users with a large demand and the far smaller daily needs of the population. In the second half of the 20th century Philadelphia experienced a dramatic decrease in the industrial sector, and has seen a decline in population and water demand ever since.

Figure 2-2 below was created by the Delaware Valley Regional Planning Commission to depict the shift in population from Philadelphia to the surrounding counties between 1930 and 2000. As Figure 2-2 indicates, Philadelphia was the dominant population center in 1930 with approximately 60% of the regional population. Since 1930, the distribution has changed to where Philadelphia only comprised 30% of the regional population and the suburban counties comprised 70% in 2000.

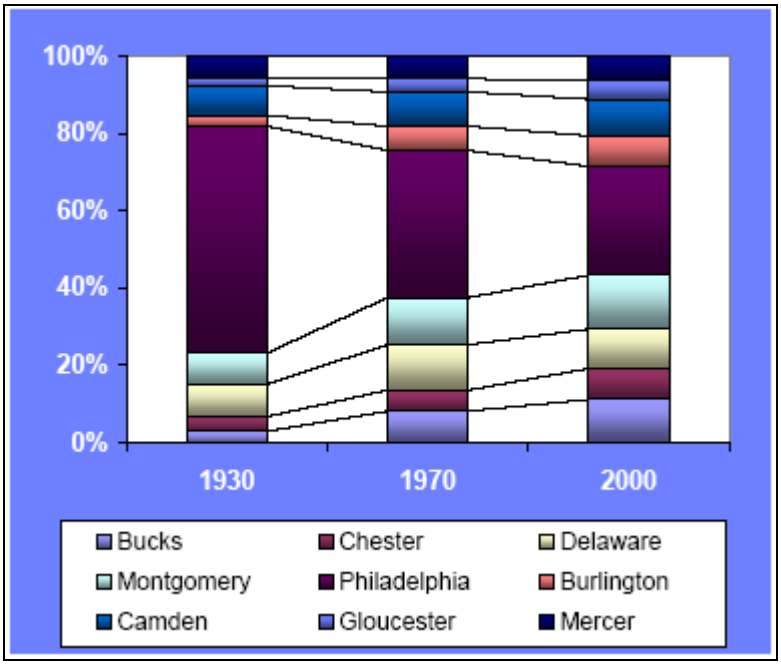

Figure 2-2 Percent of the Philadelphia Metropolitan Area Population
Figure Original Location: DVRPC. 2006. *Population Change in the Delaware Valley 1930-2000*, Regional Data Bulletin Number 82, Page 3.

More specifically, since 1950 the population of Philadelphia has been declining steadily each decade. Figure 2-3 below presents the populations of Philadelphia and nearby counties within the Schuylkill River watershed.

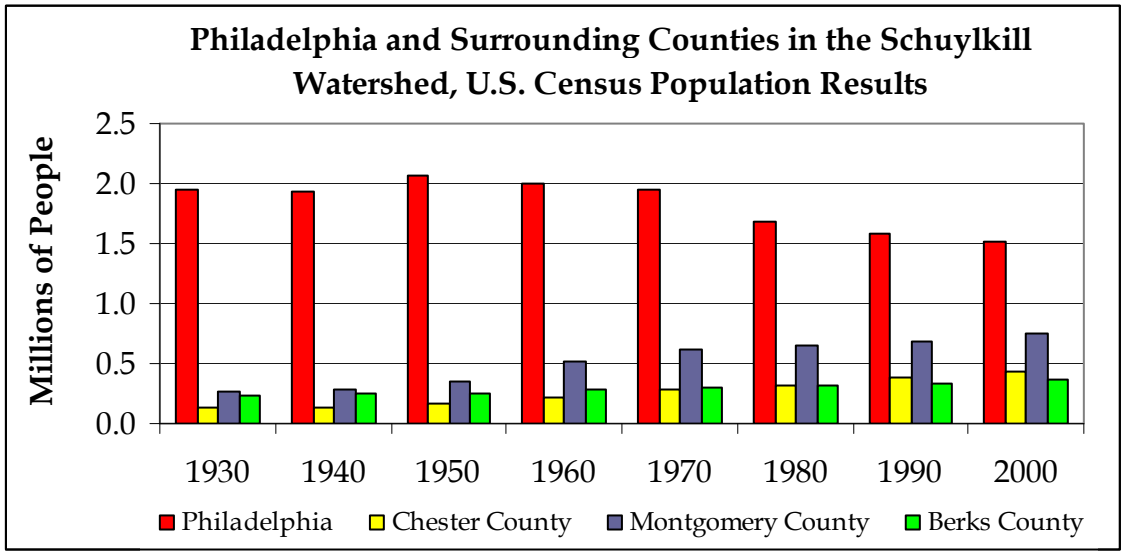

Figure 2-3 U.S. Census Population Results
Note: Total county populations are used; census blocks have changed over time making a direct comparison of watershed-only population difficult for a long term comparison

According to Figure 2-3 above, Philadelphia lost 554,055 people from 1950 to 2000. Also included in the graph are the populations of three counties with land area in the Schuylkill River watershed in close proximity to Philadelphia. Over that same period of time, Chester, Montgomery, and Berks Counties, gained over 625,000 people.

PWD is the sole provider of potable water within Philadelphia. Any reductions in water use in the city reduce the demand for water purchased from PWD. Due to the population decline of the city and the loss of large industrial and manufacturing customers, PWD has experienced declining water demand. The decrease in demand over the past thirty years is reflected below in Figure 2-4, which shows a decline in daily average raw water withdrawal of approximately 100 million gallons per day by PWD from the Schuylkill and Delaware Rivers between 1980 and 2008.

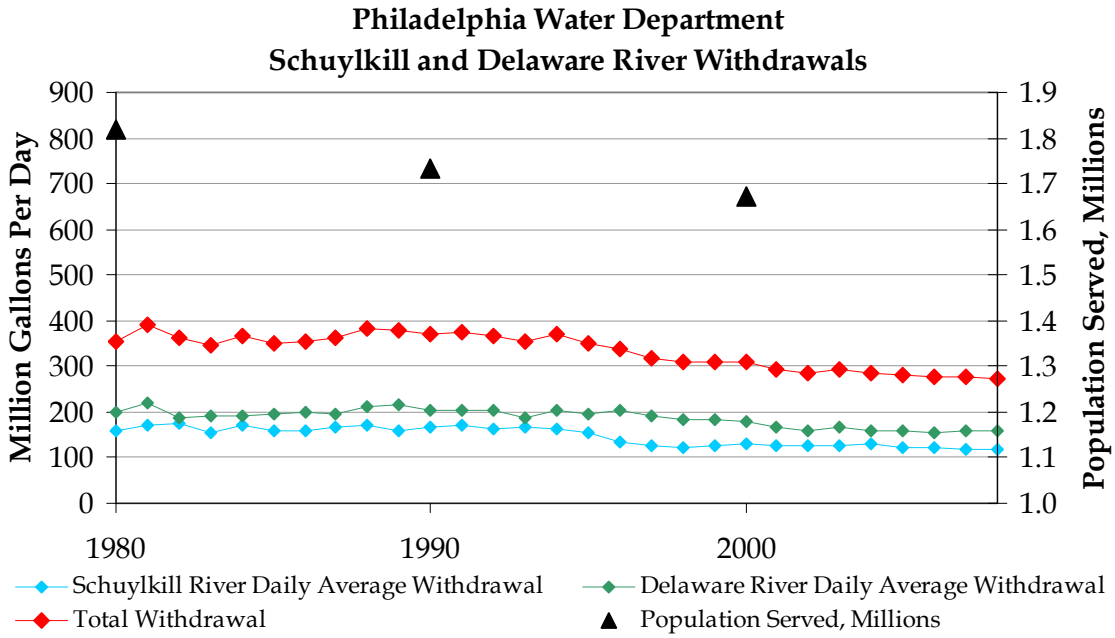

Figure 2-4 1980-2008 PWD Annual Withdrawals
Note: Population served includes Philadelphia plus interconnection customers, based on US Census and PWD accounting

The large-scale population trends presented in this section briefly describe regional demographic changes, and allude to what future demographic shifts may occur in the Schuylkill River watershed. A more detailed look at regional population can be found in *Population Change in the Delaware Valley* (DVRPC 2006). The regional trends add emphasis to the need for PWD to understand the water quantity dynamics of the Schuylkill River now that the water consuming populations have shifted from downstream to upstream locations.

2.2 Source Water Assessments and Protection Plan

PWD has a history of extensive research and water quality related analyses. This quantity based analysis is a continuation of the initiative that PWD has taken in monitoring and assessing the water supply over the past decade. PWD is responsible for a series of comprehensive, award-winning, watershed-wide Source Water Assessment Reports (SWA). The SWA series identified the susceptibility and baseline water quality of nineteen drinking water intakes on the Schuylkill River in addition to the two PWD intakes.

Completed in 2002, the PWD SWAs include comprehensive data analyses of water quality, susceptibility to pollution, loading from point and non-point sources, and land cover change. In partnership with communities and water suppliers throughout the Schuylkill River watershed, PWD helped produce SWAs for nineteen intakes, in addition to the two PWD intakes on the Schuylkill River. Table 2.1-1 below lists the water suppliers and municipalities for which individual SWAs exist. The locations of these intakes are depicted in Figure 2-5.

Table 2.1-1 List of PWD Assisted Schuylkill River Source Water Assessments

Publication Year	Schuylkill River Public/Private Water Suppliers and Intakes
April 2002	Ambler
February 2003	Auburn
October 2002	Birdsboro
October 2002	Boyertown
March 2002	East Greenville
November 2002	Hamburg Centre
March 2003	Mary D
March 2003	Minersville
January 2002	Philadelphia – Belmont
January 2002	Philadelphia - Queen Lane
January 2002	Philadelphia Suburban Water Company - Perkiomen Creek*
January 2002	Philadelphia Suburban Water Company - Pickering Creek*
January 2002	Philadelphia Suburban Water Company - Schuylkill River*
March 2002	Phoenixville
March 2002	Pottstown
March 2003	Schuylkill County Municipal Authority
May 2003	Schuylkill Haven
May 2003	Tamaqua
April 2002	Philadelphia Suburban Water Company - Upper Merion*
November 2002	Wernersville
October 2002	Western Berks

**Philadelphia Suburban Water Company is now Aqua Pennsylvania*

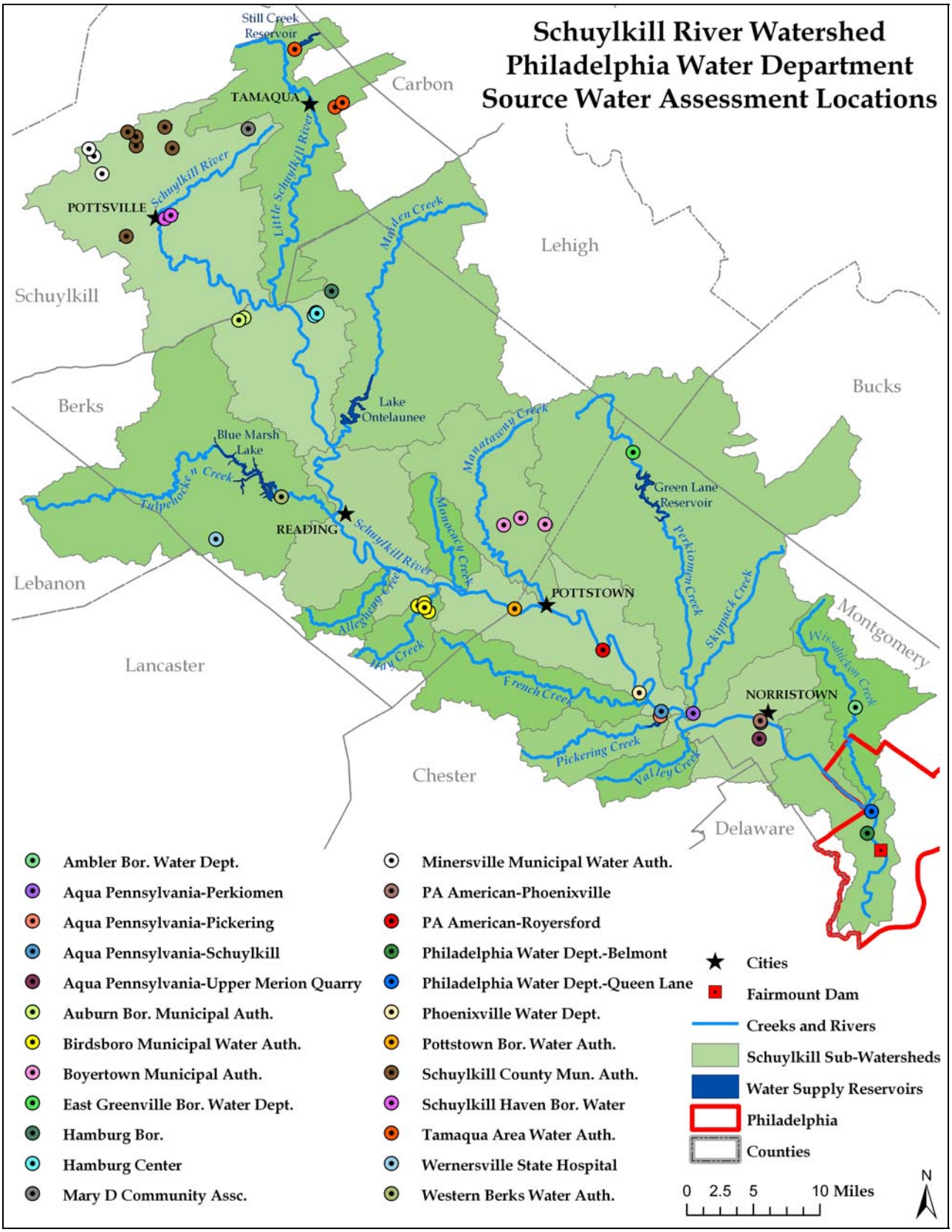

Figure 2-5 PWD-Assisted Source Water Assessment Intake Locations

Each SWA includes multiple parts; a general section describing water quality of the entire river, and a second section focused specifically on conditions of and threats to each drinking water intake. The majority of conclusions from the SWAs are related to water quality conditions throughout the watershed. The water quantity related conclusions are excerpted below from the General Section, Executive Summary.

- Approximately 1.75 million people in the watershed receive drinking water from the Schuylkill River and its tributaries. About 80 percent of those persons receive drinking water from surface water supplies withdrawing water from the river below Pottstown.

- Between 700 and 900 million gallons of water are withdrawn every day from ground and surface water within the Schuylkill River watershed. Between 570 and 600 million gallons are withdrawn every day from surface water (streams and rivers) for a variety of purposes.

- Approximately 40 percent of the surface water withdrawn from the Schuylkill River and its tributaries is used for drinking water. Another 30 percent is used for thermoelectric power generation. The remaining amounts of surface water are used for agriculture, commercial and mining.

- The Perkiomen Creek Watershed and the area along the river from Phoenixville to Reading have seen the greatest population increases between 1990 and 2000. The area along the Schuylkill River from Philadelphia to Conshohocken has seen a significant decrease in population over the past decade. This data suggests more persons are moving upriver and contributing to sprawl.

- Monocacy Creek, Wissahickon Creek, and Valley Creek had the greatest number of dischargers per acre of drainage area. Based upon drainage area and flow, the Wissahickon Creek had the highest discharger density.

- Flow variability and nutrients were listed as the two most frequent primary causes of impairment in the watershed.

- Both sewer system capacity and integrity as well as treatment plant capacity during wet weather periods represent the greatest and most difficult sewage related issues in the watershed. Infrastructure improvements for adequate wastewater collection and treatment systems are needed to address infiltration and inflow or system capacity issues. These improvements will eliminate events such as overflowing manholes of raw sewage into downstream water supplies.

- USDA funding such as EQUP and CRP that remove agricultural lands from production in sensitive water supply areas should be increased, more accessible, and discussed more aggressively with farmers. Water suppliers should also be included in EQUP and CRP funding decisions in order to maximize water supply protection.

The SWA water quantity-related conclusions are general observations of the location of water withdrawals and discharges relative to large towns, boroughs, and growth areas. The SWA identifies existing stormwater quantity-driven challenges and the potential for additional future problems due to land use change and population growth. The SWA also underscores the recent growth in suburban areas and the need to understand the relationship between suburban sprawl and Schuylkill River hydrology.

A follow-up report to the SWA titled the Schuylkill River Source Water Protection Plan outlines the need for and structure of the Schuylkill Action Network (SAN). The SAN is a watershed-wide network that brings together representatives of public, private, state and federal agencies and organizations to prioritize water quality problems, seek solutions, and initiate projects to improve water quality.

The SAN has been successfully operating since 2003 and has implemented over 50 water quality improvement projects throughout the 2,000 square mile watershed. Water quality within the Schuylkill River watershed is improving, and the committed members of the SAN keep watershed protection and source water improvement a priority in Southeastern Pennsylvania.

The success of the SAN in raising the awareness of watershed protection and implementing water quality improvement projects allows the PWD Source Water Protection Program to shift focus to water quantity related issues, including regional policy, reservoir capacity, consumptive use, Philadelphia and upstream demands, demographics, and climate change. The impacts of where water users are located in the watershed, where they once were, and where they may be going will shape the nature of PWD source water protection efforts aimed at ensuring a reliable supply of drinking water to Philadelphia from the Schuylkill River.

This report includes a water budget and hydrologic analyses to reach preliminary conclusions of the balance between what PWD requires and the upstream demands and withdrawals across the Schuylkill River watershed. The results of this report are intended to inform future additional, more detailed analyses of supply and demand in the Schuylkill River watershed.

Section 3 Hydrology

3.1 Low Flow Conditions

Baseflow, the contribution of groundwater to streams, is used in this analysis as a metric against which to compare the difference between withdrawals and discharges of the whole Schuylkill River watershed and sub-watersheds. The 1 in 25 year annual average baseflow is used here to represent low flow conditions in the Schuylkill River watershed. The 1 in 25 year annual average baseflow represents the lowest annual average baseflow that has an expected recurrence interval of once every 25 years. The 1 in 25 year annual average baseflow is also compared to the streamflow of the Schuylkill River after Philadelphia drinking water withdrawals in order to compare the frequency with which low flow conditions occur at the Fairmount dam given large withdrawals. Based on available data, baseflow of the Schuylkill River watershed and the individual sub-watersheds is calculated separately.

3.1.1 Total Schuylkill River Baseflow Calculation

An existing USGS paper titled *Estimated Groundwater Availability in the Delaware River Basin*, 1997-2000 quantified annual average baseflow per square mile of watershed at multiple recurrence intervals for each of the watersheds contributing to the Schuylkill River. The USGS used digitized geologic data and the regional stream gauge network to identify gauges that drain watersheds dominated by one lithology. The pre-development baseflow recurrence intervals of the geologically-grouped stream gauges were estimated, and the results used to assume the baseflow of sub-watersheds underlain by similar formations throughout the Delaware River Basin. The USGS used GIS to find the area weighted pre-development average baseflow for sub-watersheds underlain by one or more geological groupings. The analysis led to a range of values for the pre-development 1 in 25 year recurrence interval for various sub-watersheds between 0.183 and 0.584 million gallons per day per square mile. These values are shown in Table 3.1-1 below (Sloto RA and Buxton DE 2006).

Table 3.1-1 Schuylkill River Sub-Watershed Groundwater Availabilities

USGS Sub-Watershed ID	Area, Sq. Miles	Groundwater Availability MGD/mi² Pre-development Annual Average Baseflow Recurrence Interval				
		2-Year	5-Year	10-Year	25-Year	50-Year
94	137	0.849	0.668	0.615	0.543	0.475
95	66.9	0.915	0.707	0.65	0.584	0.505
96	138	0.832	0.656	0.61	0.534	0.474
97	107	0.562	0.462	0.424	0.36	0.286
98	90.8	0.526	0.444	0.419	0.367	0.284
99	125	0.607	0.485	0.431	0.349	0.288
100	131	0.605	0.48	0.427	0.344	0.284
101	88.3	0.588	0.476	0.427	0.355	0.288
102	170	0.525	0.403	0.356	0.297	0.249
103	91.5	0.616	0.493	0.425	0.351	0.297
104	140	0.458	0.348	0.299	0.25	0.222
105	70.2	0.527	0.394	0.346	0.3	0.266
106	144	0.433	0.347	0.3	0.253	0.213
107	134	0.341	0.272	0.231	0.193	0.165
108	84	0.325	0.257	0.219	0.183	0.156
109*	93.6	0.552	0.412	0.357	0.302	0.272
110*	53.0	0.534	0.4	0.349	0.292	0.256

Source: USGS SIR 2006-5125, Schuylkill River sub-watersheds only (Sloto RA and Buxton DE 2006)
**Philadelphia area subtracted (10.7square miles from USGS 110 and 35.4 square miles from USGS 109)*

The area of Philadelphia County in the Schuylkill River watershed (46.1 square miles) was removed from the baseflow calculation above in Table 3.1-1 (sub-watersheds 109 and 110), reducing their original size listed in the USGS document in order to exclude Philadelphia. By excluding Philadelphia, the calculated baseflow values will represent the amount of water in the Schuylkill River as it enters the city.

Multiplying the baseflow in Table 3.1-1 times the area of the sub-watershed and totaling the results calculates the pre-development baseflow or groundwater discharge of the total Schuylkill River watershed. Table 3.1-2 presents the pre-development baseflow in million gallons per day, cubic feet per second, and inches per year.

Table 3.1-2 Schuylkill River Pre-development Total Groundwater Discharge

Units	Groundwater Discharge Recurrence Interval				
	2-Year	5-Year	10-Year	25-Year	50-Year
Total MGD	1,069	842	752	639	543
Total CFS	1,655	1,303	1,165	989	840
Total Inches/year	12.05	9.49	8.48	7.20	6.12

3.1.2 Sub-Watershed Baseflow Calculation

When interpreting the total Schuylkill River watershed baseflow, the original published USGS results can be used as is, as described earlier. If the objective is to examine individual sub-watershed baseflow, the original USGS data must be manipulated in GIS because the USGS used sub-watershed boundaries that differ from those used in this analysis of the Schuylkill River watershed.

GIS was used to intersect the two different sub-watershed delineations, calculating the areas of the USGS sub-watersheds that lie within the boundary of the PWD sub-watershed delineations. Once the areas were calculated, the pre-development MGD/square mile discharge value assigned to each USGS sub-watershed could be re-assigned and multiplied by the sub-watershed section area to calculate the contribution of each sub-watershed to the total Schuylkill River pre-development 1 in 25 year annual average baseflow. The results are shown below in Tables 3.1-3 and 3.1-4.

Table 3.1-3 Sub-Watershed Baseflow Calculation

PWD Sub-Watershed	USGS Sub-Watershed ID	Area of USGS Sub-Watershed in PWD Sub-Watershed (Mi^2)	USGS Pre-development 1 in 25 Year Annual Average Baseflow MGD / Mi^2	Pre-development 1 in 25 Year Annual Average Baseflow MGD
Allegheny Creek	102	17.62	0.297	5.23
French Creek	105	70.20	0.3	21.06
Hay Creek	102	22.12	0.297	6.57
Little Schuylkill	94	137.00	0.543	74.39
Lower Schuylkill	109	34.18	0.302	10.32
Maiden Creek	98	90.80	0.367	33.32
Maiden Creek	99	125.00	0.349	43.63
Manatawny Creek	103	91.50	0.351	32.12
Middle Schuylkill 1	104	6.40	0.25	1.60
Middle Schuylkill 1	109	59.40	0.302	17.94
Middle Schuylkill 2	102	31.31	0.297	9.30
Middle Schuylkill 2	104	71.41	0.25	17.85
Middle Schuylkill 3	97	25.00	0.36	9.00
Middle Schuylkill 3	102	73.17	0.297	21.73
Monocacy Creek	102	25.77	0.297	7.65
Perkiomen Creek	106	144.00	0.253	36.43
Perkiomen Creek	107	134.00	0.193	25.86
Perkiomen Creek	108	84.00	0.183	15.37
Pickering Creek	104	38.84	0.25	9.71
Tulpehocken Creek	100	131.00	0.344	45.06
Tulpehocken Creek	101	88.30	0.355	31.35
Upper Schuylkill	95	66.90	0.584	39.07
Upper Schuylkill	96	138.00	0.534	73.69
Upper Schuylkill	97	82.00	0.36	29.52
Valley Creek	104	23.35	0.25	5.84
Wissahickon Creek	110	52.96	0.292	15.47
Total		**1864.3**		**639.1**

The conversion from million gallons per day to inches per year uses the total area of the Schuylkill River watershed excluding Philadelphia (1864.3 square miles). By dividing through by the Schuylkill River watershed area, as opposed to the area of each sub-watershed, the results represent the portion of baseflow contributed to the entire Schuylkill River by each sub-watershed. The results are presented below in Table 3.1-4.

Table 3.1-4 Sub-Watershed Contribution to Pre-development 1 in 25 Year Baseflow

Sub-Watershed	Sub-Watershed Area, Square Miles	MGD	CFS	Inches Per Year
Allegheny Creek	17.62	5.23	8.09	0.06
French Creek	70.20	21.06	32.58	0.24
Hay Creek	22.12	6.57	10.17	0.07
Little Schuylkill	137.00	74.39	115.08	0.84
Lower Schuylkill	34.18	10.32	15.97	0.12
Maiden Creek	215.80	76.95	119.04	0.87
Manatawny Creek	91.50	32.12	49.68	0.36
Middle Schuylkill 1	65.80	19.54	30.22	0.22
Middle Schuylkill 2	102.72	27.15	42.00	0.31
Middle Schuylkill 3	98.17	30.73	47.54	0.35
Monocacy Creek	25.77	7.65	11.84	0.09
Perkiomen Creek	362.00	77.67	120.15	0.88
Pickering Creek	38.84	9.71	15.02	0.11
Tulpehocken Creek	219.30	76.41	118.21	0.86
Upper Schuylkill	286.90	142.28	220.11	1.60
Valley Creek	23.35	5.84	9.03	0.07
Wissahickon Creek	52.96	15.47	23.93	0.17
Total	**1864.3**	**639.1**	**988.7**	**7.20**

The Upper Schuylkill sub-watershed contributes 220 CFS to total baseflow, which is almost twice the amount of water than the next greatest contributor. The Perkiomen Creek sub-watershed, which has the greatest surface area, has the second highest contribution of baseflow, 120 CFS.

3.1.3 Low Flow Observations

The pre-development 1 in 25 year annual average baseflow might be considered a surrogate "natural low flow standard". In this sense, it can be compared here to the most downstream gauged location on the Schuylkill River at Fairmount Dam. A baseflow duration curve was calculated from a sliding interval hydrograph separation of daily average streamflow data from the Schuylkill River at Philadelphia (Fairmount Dam), USGS stream gauge ID#01474500, (2N days = 9). The sliding interval method is used to approximate the baseflow component of streamflow recorded at the Fairmount Dam gauge 01474500. This gauge is chosen for comparison because it is the most downstream non-tidal gauge on the Schuylkill River.

The Fairmount Dam gauge is located below Philadelphia's two Schuylkill River drinking water intakes, and represents the amount of water left in the river after upstream consumptive losses have occurred and Philadelphia has withdrawn its share for water supply. Therefore, a gauge-calculated current 1 in 25 year annual average baseflow

recurrence value should be considerably lower than the pre-development 1 in 25 year annual average baseflow value calculated from the individual watersheds, which is based on the more natural groundwater availability of the underlying geology. Given those differences, it is useful to identify where the naturally occurring 1 in 25 year annual average baseflow falls on a flow duration curve at the gauge at Fairmount Dam. This will give an idea of how often flow drops below the "standard" of the pre-development 1 in 25 year baseflow value for the watershed after withdrawal of water for Philadelphia's water supply.

Because the construction of Blue Marsh Reservoir had a significant impact on the low flow pattern of the Schuylkill River, the baseflow duration curve (Figure 3-1) is divided into two periods of analysis:

- Pre-Construction of Blue Marsh Reservoir period of record 1932-1976
- Post-Construction of Blue Marsh Reservoir period of record 1978-2006

The pre-development 1 in 25 year annual average baseflow calculation is approximately 990 CFS (639 MGD), and is also included in Figure 3-1. This represents an estimate of flow in the Schuylkill prior to the extensive groundwater and surface water withdrawals that currently affect flows. Of interest is the exceedence percentage where the pre-development 1 in 25 year annual average baseflow value intersects the baseflow duration curve of each series. The intersection points were calculated by interpolation and rounded to the nearest whole number.

Table 3.1-5 Percent of Time the Pre-development 1 in 25 Year Annual Average Baseflow is Exceeded

Series	Percent of Time the 1 in 25-Year Baseflow is Exceeded
Pre-Blue Marsh Construction	55%
Post-Blue Marsh Construction	65%

Under current conditions, indicated by the post-Blue Marsh series, the remaining baseflow after withdrawal of Philadelphia's water is below the estimated 1 in 25 year annual average baseflow about 35% of the time in the past 32 years. This is an improvement over the period prior to the construction of Blue Marsh Reservoir, when remaining baseflow was below the 1 in 25 year annual average baseflow about 45% of the time. Even the post-Blue Marsh reservoir number, however, indicates that low flow conditions at the Fairmount Dam occur with regularity each year.

Blue Marsh Reservoir is used for water supply storage, recreational activity, and salinity management in the tidal Delaware River. In low flow conditions, Blue Marsh is one of nearly a dozen reservoirs in the Delaware Basin to make releases intended to augment freshwater streamflow. The augmented streamflow counteracts the tidal encroachment of high salinity water, keeping Philadelphia area drinking water and industrial intakes free from salinity intrusion. By reducing the duration of low flows on the Schuylkill River, the salinity management releases from Blue Marsh Reservoir have likely provided additional ecological, water supply, and water quality benefits to downstream communities.

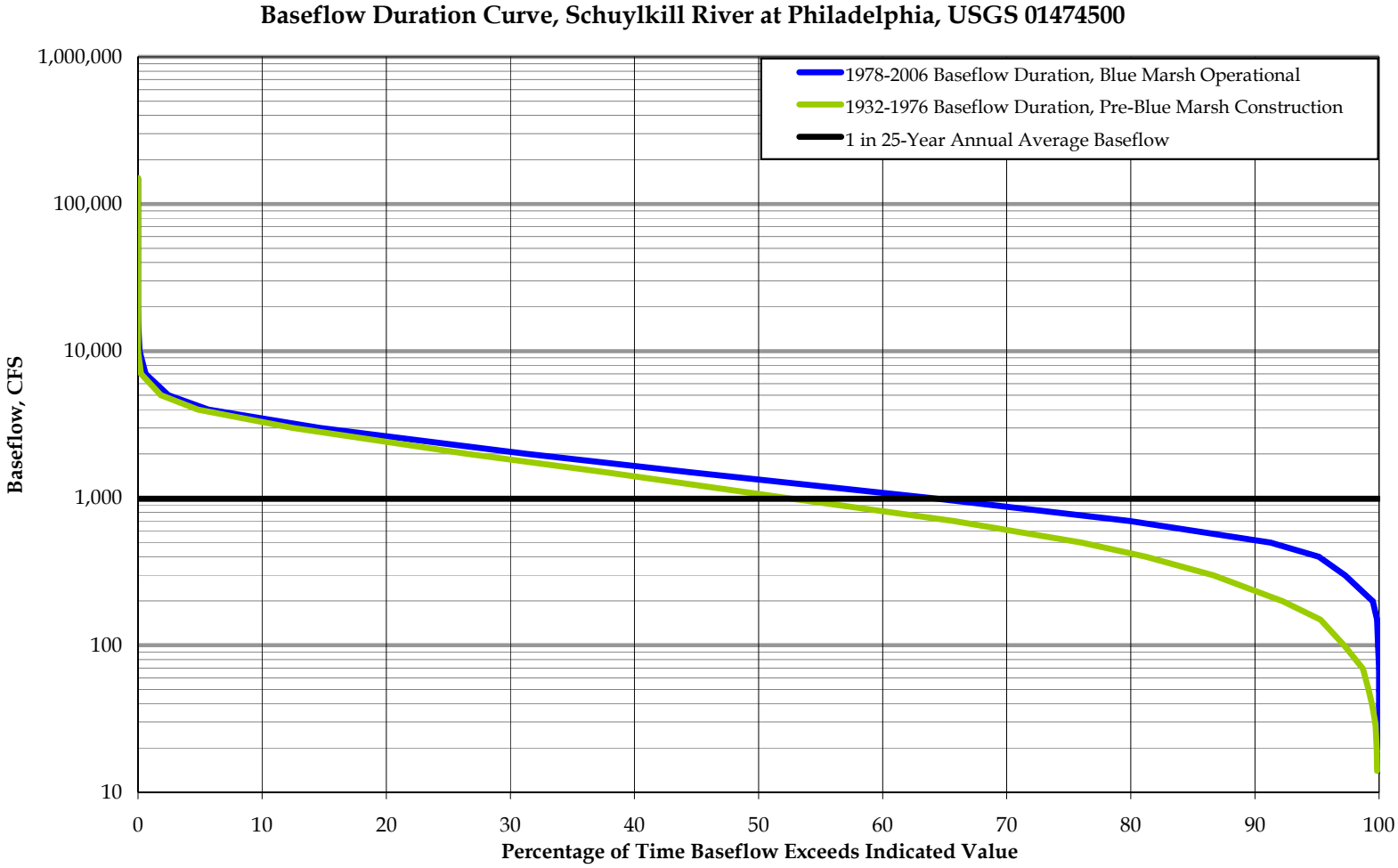

Figure 3-1 Baseflow Duration of the Schuylkill River at Philadelphia Compared to Pre-development 1 in 25 Year Annual Average Baseflow

PWD's drinking water withdrawals for the fiscal years 1999-2008 have averaged a total of 193 CFS (125 MGD) from the Queen Lane and Belmont intakes. This represents about 20% of the pre-development 1 in 25 year annual average baseflow. The baseflow duration curve suggests that this amount of withdrawal in conjunction with upstream consumptive use does result in relatively low flows below the intakes about 1/3 of the time during the year when compared to a drought indicator such as the 1 in 25 year annual average baseflow. Any increase in withdrawals would further decrease the amount of time that the 1 in 25 year baseflow is exceeded below the intakes. In order to understand how much water is approaching Philadelphia, the flow duration curve of the nearest upstream gauge is developed and compared to Philadelphia's drinking water needs in the following section.

3.2 Upstream Conditions

Given that the USGS gauge at Fairmount Dam represents the Schuylkill River after consumptive losses and Philadelphia withdrawals, the nearest upstream gauge can provide insight into how much water is available to Philadelphia. This comparison will put the pre-development 1 in 25 year annual average baseflow recurrence value of 639 MGD (989 CFS) in perspective with the PWD maximum and daily withdrawals, as well as a theoretical pass-by regulation at the Fairmount Dam.

A pass-by requirement stipulates a streamflow that must pass the Fairmount Dam a certain percentage of the year. A pass-by requirement of 89 CFS has been suggested by the Fish and Wildlife Service (FWS) to PWD for the protection of fish species in the tidal Schuylkill River. Although the pass-by flow is not currently required, there is a possibility that it could be in the future. Eighty-nine CFS represents the current Schuylkill River 7Q10 for the period of record of the Fairmount Dam streamflow gauge as calculated by FWS (1931 – 2009). In this analysis a pass-by requirement of 100 CFS is added onto the PWD maximum daily withdrawal (286 CFS) to determine if the Schuylkill River can provide that combined amount of water to Philadelphia 100% of the time.

To identify the availability of water approaching Philadelphia, the nearest upstream gauge is examined, USGS Schuylkill River at Norristown ID# 01473500. The Norristown gauge is compared to the stream gauge at Fairmount Dam to identify any similarities or differences. The Norristown gauge does not have a long consecutive record of streamflow measurements; the most recent consecutive period of record is from August 8, 2001 until the present. Given the small streamflow record, a flow duration curve (Figure 3-2) is constructed for both Norristown and Fairmount Dam that includes the maximum number of full years available, 7 years from 8/8/01 – 8/7/08.

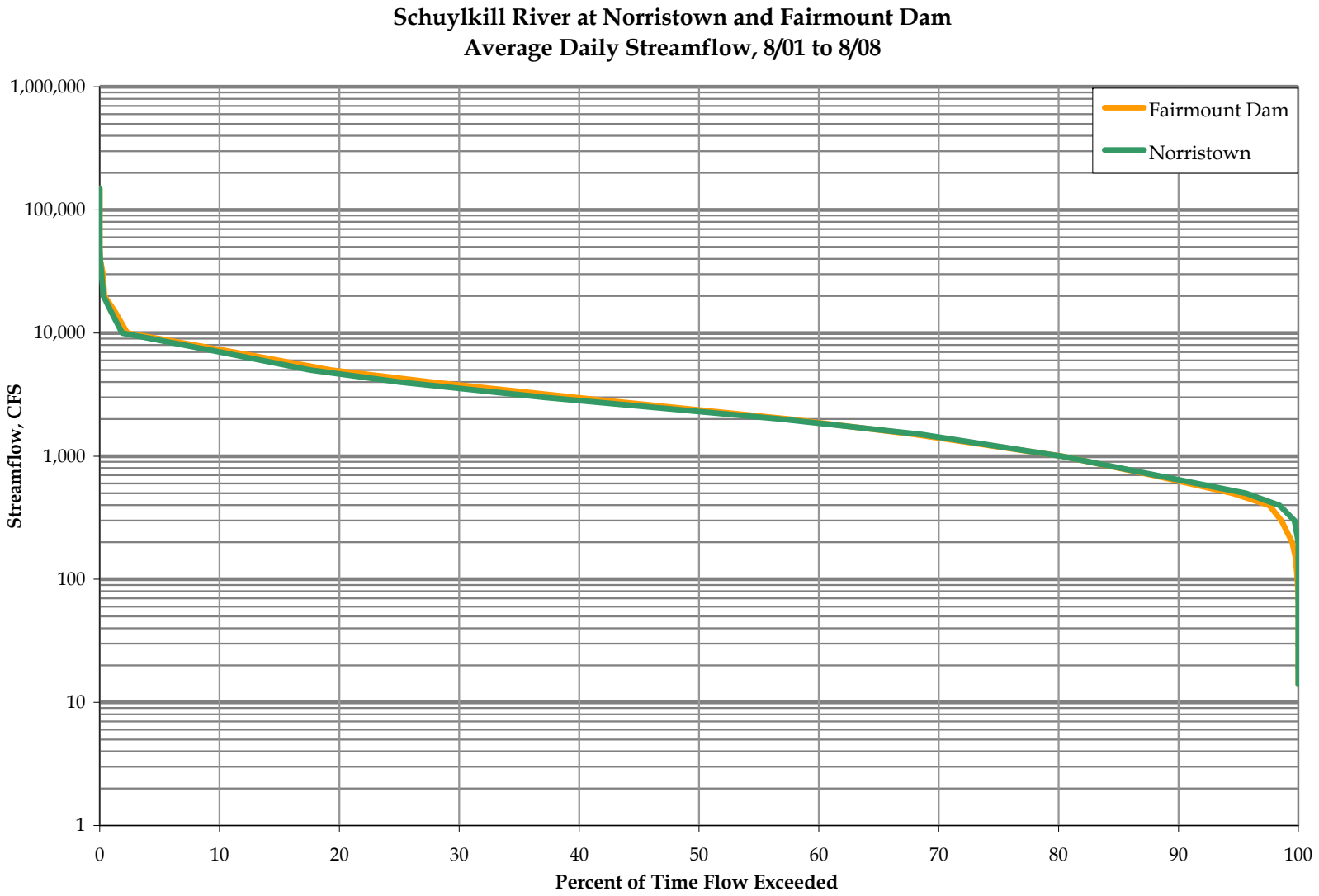

Figure 3-2 Schuylkill River at Norristown and Fairmount Dam

Figure 3-2 shows that the curves of the two gauges are nearly identical. This is striking given that the drainage area of the Fairmount Dam gauge is 133 square miles larger than that of the Norristown gauge. Additionally, four small to medium sized tributaries enter the Schuylkill River between the two gauges; Stony Creek, Gulph Mills Creek, Mill Creek and Wissahickon Creek. The only area where the curves diverge is at the lower streamflow, higher exceedence portion of the graph.

In order to understand why the two curves are so similar, a zoom in of the divergent area is presented below in Figure 3-3. In this portion of the curve, the influence of withdrawals and discharges is most apparent because the influence of tributary streamflow and runoff is reduced during low flow conditions.

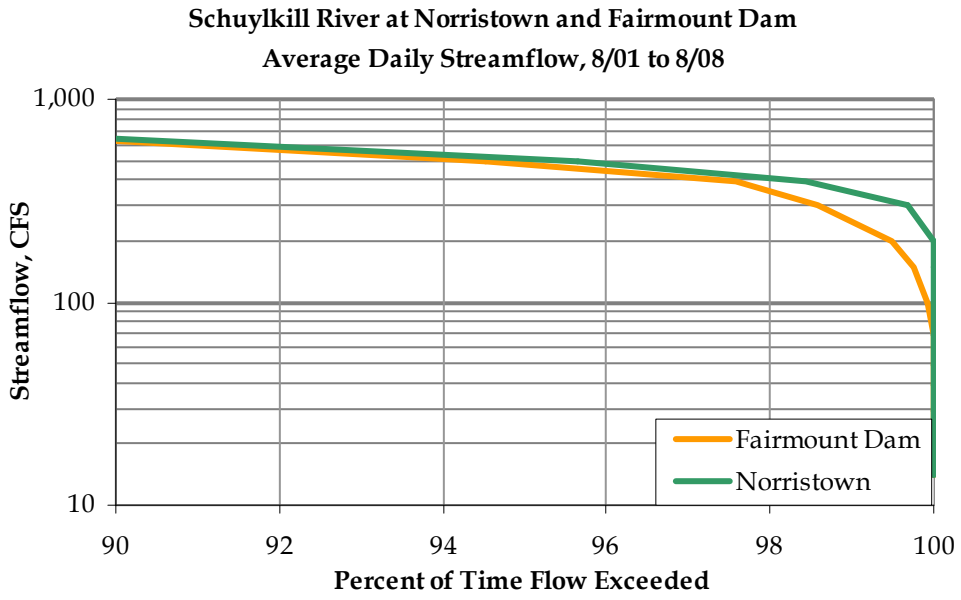

Figure 3-3 Schuylkill River at Norristown and Fairmount Dam Exceedence

In the close-up of the divergent area, the difference between Norristown and Fairmount Dam begins at 97% exceedence. From that point on, the two duration curves widen by more than 100 CFS. Streamflow normally increases as measurements move downstream due to increases in baseflow and tributary contributions. The opposite effect is observed between Fairmount Dam and Norristown, where during normal conditions the gauges are equal, and during low flow conditions the upstream gauge has more streamflow. This discrepancy can be attributed to the influence of surface water withdrawals exceeding tributary and baseflow inputs between the two gauges.

A detailed water budget is calculated later in this report, but some of the data is called upon here to determine if there is in fact a 100 CFS difference between withdrawals and inputs in the section of the Schuylkill River between Norristown and Fairmount Dam.

Table 3.2-1 below lists the total withdrawals and discharges located between Fairmount Dam and Norristown.

Table 3.2-1 Withdrawals and Discharges from Norristown to Philadelphia

Discharges	CFS	Withdrawals	CFS
1 in 25 Year Baseflow*	62	PWD Average Daily	193
Wissahickon Creek**	21	Norristown Water Dept. Average Daily	14.8
Lower Schuylkill Wastewater	3.4	Jefferson Smurfit Corp.	2.5
Middle Schuylkill 1 Wastewater	23.3		
Total	**109.7**		**210.3**

**Estimated Baseflow = 133 Mi^2 * 0.302 MGD/Mi^2 = 40 MGD = 62 CFS; Section 3.1 USGS ID 109*
***Flow at 98% exceedence*

The totals in Table 3.2-1 do show that withdrawals exceed discharges by 100 CFS between Norristown and Fairmount Dam. The withdrawals of the Philadelphia and Norristown Water Departments are daily averages, and therefore fluctuate seasonally and weekly depending upon pumping schedules. The discharge of small tributaries could not be accounted for, so the drought representative pre-development 1 in 25 year annual average baseflow was estimated based on the discharge per square mile identified in Table 3.1-1 for USGS sub-watershed 109. According to this analysis, the large PWD withdrawals are primarily responsible for the 100 CFS loss of streamflow between Norristown and Fairmount Dam during low flow conditions. Under normal flow conditions, the baseflow contribution of the watershed between the gauges more closely balances the withdrawals, as can be observed by the lack of difference between the two flow duration curves depicted in Figure 3-2.

In summary, this analysis of the difference between the Norristown and Fairmount Dam gauges indicates that under low flow conditions, PWD withdraws approximately 100 CFS more than the volume of water added to the river from tributaries, baseflow, and point source discharges.

Given the observed balance at normal flow between PWD withdrawals and groundwater discharges on the streamflow of the Schuylkill River between Norristown and Fairmount Dam, the Norristown streamflow gauge can be used to conservatively estimate the availability of water to PWD for drinking water withdrawals. The Norristown gauge does not represent the total availability of water to Philadelphia because additional tributary streamflow and baseflow between the two gauges is not accounted for.

Figure 3-4 below depicts the flow duration of the Norristown gauge and includes two PWD withdrawal scenarios:

1. PWD Maximum Daily Withdrawal + Pass-By Regulation, 386 CFS
2. PWD Maximum Daily Withdrawal, 286 CFS

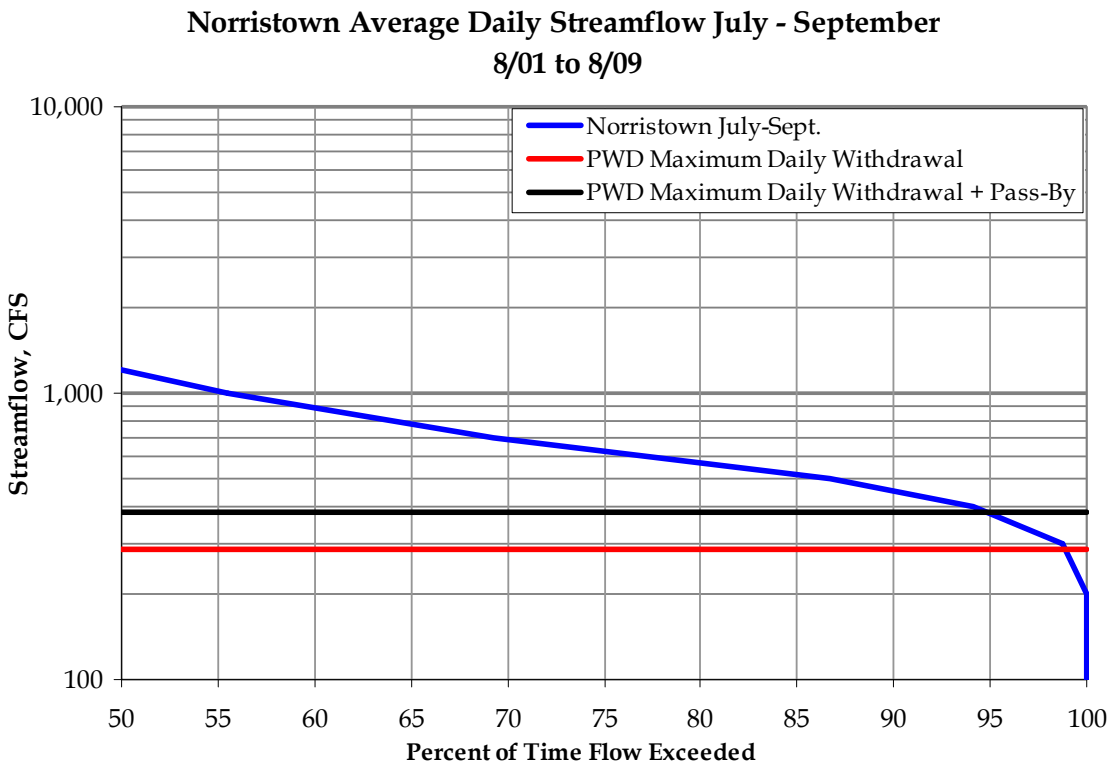

Figure 3-4 Seasonal Norristown Flow Duration Curve and PWD Withdrawals

According to Figure 3-4, streamflow would be too low to meet the PWD maximum daily withdrawal 2% of the time, and streamflow would be too low to meet the maximum daily withdrawal plus hypothetical pass-by regulation 6% of the time. *Figure 3-4 indicates that the PWD maximum withdrawal of 286 CFS can not be met 100% of the time.*

The PWD drinking water demand from the Schuylkill River exceeds the seasonal low flows, as shown in Figure 3-4. As the groundwater discharge to the river and its tributaries decreases during late summer low flow conditions, the percentage of streamflow comprised of wastewater treatment plant effluent increases. According to Table 4.3-1, the estimated average daily contribution of wastewater treatment plant effluent to the Schuylkill River is 183 CFS. If streamflow were to fall to the 95 th percentile of streamflow at Norristown (400 CFS), approximately 50% of the PWD Schuylkill withdrawals would be comprised of wastewater treatment plant effluent. At the 99th percentile of flows coming into Philadelphia, almost all the flow is derived from wastewater (Section 6.1).

Given that PWD withdraws more water than what is added through tributaries and baseflow between Norristown and Fairmount Dam during low flow conditions, any increases in upstream consumptive use that lower streamflow at Norristown will directly reduce the availability of water to PWD. This is an important relationship to consider when evaluating flow management policies, monitoring the withdrawal practices of large upstream users, assessing vulnerability to climate change, and determining other factors influencing flow; especially if a pass-by requirement is implemented at Fairmount Dam. Additionally, more water flowing past Norristown will decrease the percentage of

wastewater treatment plant effluent in the water that PWD withdraws from the river for drinking water purposes

Due to the fact that PWD withdrawals are roughly equivalent to seasonally low streamflow values entering the city, it is critical to identify the demand driven factors that influence streamflow, mainly consumptive use. In order to understand the consumptive use of the Schuylkill River, including where and how water is used and discharged, a water budget was developed for the area of the Schuylkill River watershed outside of Philadelphia.

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Section 4 Water Budget Methodology

It is critical to PWD to understand where and how water is used upstream of Philadelphia given how close seasonally low streamflow values are to PWD demand (Section 3). A water budget was developed to quantify the differences between withdrawals and discharges throughout the Schuylkill River watershed and to calculate the location and magnitude of consumptive losses. This section describes the data collection and methods used to estimate surface water and groundwater withdrawals and discharges throughout the Schuylkill River watershed. For some water uses such as irrigation, amounts were estimated based upon a number of assumptions. For other categories such as industrial discharge, data supplied by the PADEP were used.

4.1 Potable Water Supply

The potable water supply can be divided among many descriptive categories such as:

- Private domestic supply
- Groundwater or surface water supply
- Community, Transient Non-Community, or Non-Transient Non-Community populations served; an EPA classification
- Public Water Supply; a PADEP classification

Data obtained from EPA, PADEP, and PWD sources are compiled in this section to describe the data acquisition and estimation of the potable water supply in the Schuylkill River watershed.

4.1.1 Private Domestic Wells

When estimating the potable water supply, one of the difficult supplies to obtain information on is the number and capacity of private domestic groundwater wells. These private supplies are often limited to one well per household in areas not reached by public water supply infrastructure. The methodology used to estimate the volume withdrawn from private domestic wells and the remainder of the potable supply is described and summarized below.

There are many households located outside of the service areas of community water systems. These households rely on privately owned and operated domestic groundwater wells drilled on the property for potable water supply. The water use of these systems must be estimated because no federal or state agency tracks their number and capacity. In order to estimate the private domestic supply from groundwater wells, a map of the public water supply service areas was used to identify locations that fall outside of the service areas. The population identified outside of the public service areas is assumed to be on private groundwater supplies, and is multiplied by a per capita water use value to estimate the total amount of water supplied to these sources.

A shapefile of the public water supply service areas located within the Schuylkill River watershed was provided by Michael Hill at PADEP (Figure 4.1-1). The map was constructed during the Act 220 State Water Planning effort. PADEP issued surveys and contacted water suppliers directly to identify the locations throughout the state served by

public water suppliers. The PADEP term 'public water supply' does not indicate whether the utility is publicly or privately owned, it just means that the utility is a 'community water supply' as classified by the EPA. Community water supply will be used throughout the remainder of this document to describe utilities that serve at least 15 year-round residences or 25 persons on a year-round basis.

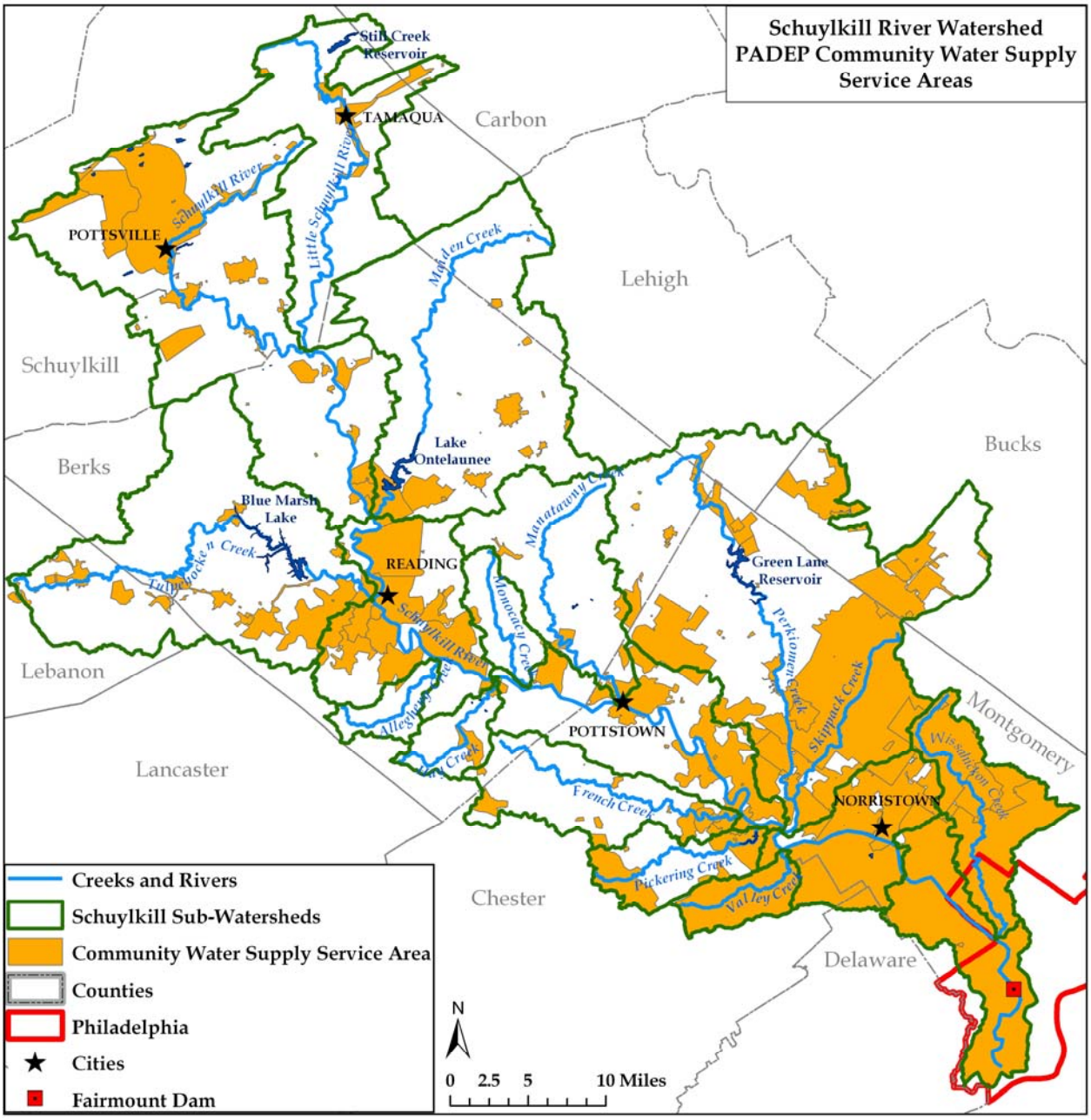

Figure 4.1-1 Map of Community Supplies in the Schuylkill River Watershed
Source: PADEP public water supply service area shapefile, Michael Hill

The public water supply map was intersected with the 2000 U.S. Census in GIS to calculate the population served by the utilities listed in the map geodata. The SDWIS search described in Section 4.1.2 resulted in additional public water suppliers that are not included

in the map. Lori Ruesskamp provided population served information for permits identified through the SDWIS search, so this population was added to the population of the public water supplier map to calculate the total population served by public water supply in the Schuylkill River watershed. The total population of the public water supply areas was then subtracted from the total population of the Schuylkill River watershed, excluding Philadelphia, to calculate the population served by private domestic wells based on 2000 data. The results of these calculations are presented below in Table 4.2-1.

Table 4.1-1 Population in 2000 on Private Household Drinking Water Wells

Sub-Watershed	Census	Map Derived Population on PWS	Additional SDWIS Population on PWS	Estimated Population on Private Wells
Allegheny Creek	4,891	80	0	4,811
French Creek	25,144	14,982	130	10,032
Hay Creek	5,659	3,186	45	2,428
Little Schuylkill	24,545	15,928	0	8,618
Lower Schuylkill*	72,761	71,307	0	1,455
Maiden Creek	40,414	18,478	29	21,907
Manatawny Creek	30,682	12,650	156	17,877
Middle Schuylkill 1	134,706	132,025	250	2,431
Middle Schuylkill 2	91,151	67,510	100	23,540
Middle Schuylkill 3	183,237	170,334	89	12,814
Monocacy Creek	5,228	679	0	4,549
Perkiomen Creek	237,308	176,894	255	60,159
Pickering Creek	17,233	11,857	0	5,376
Tulpehocken Creek	65,395	38,968	52	26,375
Upper Schuylkill	86,952	59,084	645	27,223
Valley Creek	22,917	22,840	0	77
Wissahickon Creek*	108,540	108,298	0	241
Total	**1,156,762**	**925,099**	**1751**	**229,912**

**Calculations exclude Philadelphia County*

Twenty percent of the population in the Schuylkill River watershed is supplied by private drinking water wells. To estimate the volume of water withdrawn from the watershed by private domestic wells, the population on private domestic wells is multiplied by a water use factor of 80 gallons per day per person. The results of this calculation are presented below in Table 4.1-2. The per capita value of 80 gallons per day was chosen due to considerations outlined in the PADEP State Water Plan Update water budget methodology. According to the PADEP water budget documentation, a survey of 21 public water suppliers on the Lehigh River by Camp, Dresser and McKee and DRBC resulted in the 80 gallons per day water use factor (Stuckey MH 2008).

Table 4.1-2 Volume of Water Supplied to Private Domestic Wells

Sub-Watershed	Estimated Population in 2000 on Private Wells	Volume Withdrawn by Private Wells**		
		MGD	Inches Per Year	CFS
Allegheny Creek	4,811	0.385	0.0043	0.595
French Creek	10,032	0.803	0.0090	1.242
Hay Creek	2,428	0.194	0.0022	0.300
Little Schuylkill	8,618	0.689	0.0078	1.067
Lower Schuylkill*	1,455	0.116	0.0013	0.180
Maiden Creek	21,907	1.753	0.0197	2.711
Manatawny Creek	17,877	1.430	0.0161	2.212
Middle Schuylkill 1	2,431	0.194	0.0022	0.301
Middle Schuylkill 2	23,540	1.883	0.0212	2.913
Middle Schuylkill 3	12,814	1.025	0.0115	1.586
Monocacy Creek	4,549	0.364	0.0041	0.563
Perkiomen Creek	60,159	4.813	0.0542	7.445
Pickering Creek	5,376	0.430	0.0048	0.665
Tulpehocken Creek	26,375	2.110	0.0238	3.264
Upper Schuylkill	27,223	2.178	0.0245	3.369
Valley Creek	77	0.006	0.0001	0.010
Wissahickon Creek*	241	0.019	0.0002	0.030
Total	**229,912**	**18.4**	**0.207**	**28.5**

**Calculations exclude Philadelphia County*
***Based on 80 gallons per day per person*

The final estimation of the volume supplied by private domestic wells is 18.4 million gallons per day, or 0.207inches per year.

4.1.2 Surface and Groundwater Potable Supplies

Information about the many classifications of potable water supply, excluding private domestic wells, can be found through both the EPA and PADEP. The EPA houses a database of drinking water supplies called the Safe Drinking Water Information System (SDWIS). The SDWIS can be searched according to county for information such as whether the supply comes from ground or surface water sources and what type of population is served.

For this analysis, the SDWIS was searched for a list of water suppliers within all the counties that comprise the Schuylkill River watershed. GIS was used to reduce that list to only the suppliers that fall within the watershed boundary.

The SDWIS does not provide information about the population served or amount of water withdrawn. PADEP was consulted for this information, and Lori Ruesskamp was able to

match the permit numbers provided from the SDWIS search to population and capacity numbers the state has on record. The state had collected the population and capacity numbers during their State Water Plan Update process during 2003.

There were many suppliers listed, primarily under the transient non-community and non-transient non-community categories, that had not registered their withdrawal information according to Act 220 requirements. For these suppliers the PADEP could not provide capacity information. The withdrawal amounts for these suppliers were estimated under the assumption that because Act 220 registration was required for those who supply greater than 10,000 gallons per day, those who didn't register must fall below that benchmark. This is a broad assumption, and may not be the case for many of the unregistered suppliers. The unregistered suppliers vary from hotels to churches, camps, and gas stations. Given the many different types of non-registered suppliers, the water withdrawals of churches are assigned a withdrawal of 1,000 gallons per day, and everything else is assigned a withdrawal of 5,000 gallons per day.

Additionally, the withdrawal and discharge data provided by Michael Hill from PADEP included information about groundwater wells operated by primarily surface water suppliers or systems that purchase wholesale surface water. There are 7 systems that were manually added to the count of community groundwater withdrawals. These 7 systems are listed below in Table 4.1-3.

Table 4.1-3 Additional Groundwater Withdrawals

System Name	Average Withdrawal Gallons Per Day
Aqua PA Main System	8,377,432
East Greenville Waterworks	170,864
Hamburg Borough Municipal Authority	772,414
North Penn Water Authority	1,280,833
North Wales Borough Water	805,717
PA American Glen Alsace	1,189,863
Wernersville Municipal Authority	436,953
Total	**13,034,076**

Source: PADEP Michael Hill

A complete list of the potable water suppliers, including their average daily withdrawals, withdrawal watershed, and source of information is provided in Appendix A.

Table 4.1-4 below divides the potable water supply, including private domestic wells from earlier calculations, into the daily amounts withdrawn from surface and groundwater sources. Among the EPA classifications, the largest potable withdrawals in the Schuylkill River watershed by far come from community water supplies. The total community water supply withdrawn from surface waters is 2.8 times larger than the community water supply from groundwater. The public surface water suppliers are located near the largest cities in the watershed, including Reading, Norristown, Phoenixville, Pottstown and Pottsville. The remainder of the watershed is supplied by distributed groundwater suppliers and private

domestic wells. Withdrawals from the non-transient non-community and transient non-community groups are approximately the same, and only come from groundwater resources.

The majority of potable water, 63.4%, supplied to residents of the Schuylkill River watershed comes from surface water intakes. The second largest potable supplies come from community and private domestic groundwater sources, 22.4% and 11.5% respectively. Surface waters throughout the Schuylkill River watershed serve the largest population of consumers and the largest volume of potable water compared to various groundwater sources.

Table 4.1-4 Potable Supplies above the Philadelphia Schuylkill Intakes

Potable Source		Inches Per Year	MGD	CFS	% of 1 in 25 Year Baseflow	% of Potable Supply
Surface Water	Community	1.1415	101.3	156.7	15.8%	63.4%
Groundwater	Community	0.4037	35.8	55.4	5.6%	22.4%
	NTNC	0.0242	2.1	3.3	0.3%	1.3%
	TNC	0.0250	2.2	3.4	0.3%	1.4%
	Bulk/Vended	0.0002	0.0	0.0	0.0%	0.0%
	Private Domestic	0.2072	18.4	28.5	2.9%	11.5%
Total		**1.8017**	**159.9**	**247.4**	**25%**	**100%**

NTNC is Non-Transient Non-Community Supply, TNC is Transient Non-Community Supply

The above table shows that potable supply above the Schuylkill intakes in Philadelphia is currently taking about 1.8 inches per year of the 7.2 inches per year represented by the relatively dry 1 in 25 year annual average baseflow, or about 25%.

Table 4.1-5 Volumes of Water Withdrawn for Potable Supply by Sub-watershed

	Million Gallons Per Day							Inches Per Year						
Sub-Watershed	Surface Water	Groundwater					Total MGD	Surface Water	Groundwater					Total Inches Per Year
	Community	Community	NTNC	TNC	Bulk/ Vended	Private Domestic		Community	Community	NTNC	TNC	Bulk/ Vended	Private Domestic	
Allegheny Creek	0.000	0.000	0.040	0.028	0.000	0.385	**0.453**	0.0000	0.0000	0.0005	0.0003	0.0000	0.0043	**0.0051**
French Creek	0.000	0.165	0.046	0.366	0.000	0.803	**1.380**	0.0000	0.0019	0.0005	0.0041	0.0000	0.0090	**0.0155**
Hay Creek	0.550	0.031	0.006	0.022	0.000	0.194	**0.803**	0.0062	0.0003	0.0001	0.0002	0.0000	0.0022	**0.0091**
Little Schuylkill	3.000	0.018	0.025	0.142	0.001	0.689	**3.875**	0.0338	0.0002	0.0003	0.0016	0.0000	0.0078	**0.0437**
Lower Schuylkill	0.000	1.332	0.002	0.005	0.000	0.116	**1.455**	0.0000	0.0150	0.0000	0.0001	0.0000	0.0013	**0.0164**
Maiden Creek	14.000	1.511	0.595	0.189	0.000	1.753	**18.048**	0.1577	0.0170	0.0067	0.0021	0.0000	0.0197	**0.2033**
Manatawny Creek	0.860	0.127	0.008	0.088	0.000	1.430	**2.514**	0.0097	0.0014	0.0001	0.0010	0.0000	0.0161	**0.0283**
Middle Schuylkill 1	14.478	0.854	0.089	0.030	0.000	0.194	**15.644**	0.1631	0.0096	0.0010	0.0003	0.0000	0.0022	**0.1763**
Middle Schuylkill 2	34.825	3.108	0.122	0.187	0.003	1.883	**40.129**	0.3924	0.0350	0.0014	0.0021	0.0000	0.0212	**0.4521**
Middle Schuylkill 3	0.000	6.236	0.066	0.095	0.000	1.025	**7.421**	0.0000	0.0703	0.0007	0.0011	0.0000	0.0115	**0.0836**
Monocacy Creek	0.000	0.026	0.005	0.016	0.000	0.364	**0.411**	0.0000	0.0003	0.0001	0.0002	0.0000	0.0041	**0.0046**
Perkiomen Creek	15.913	6.499	0.439	0.569	0.005	4.813	**28.238**	0.1793	0.0732	0.0050	0.0064	0.0001	0.0542	**0.3181**
Pickering Creek	3.595	2.026	0.005	0.032	0.000	0.430	**6.088**	0.0405	0.0228	0.0001	0.0004	0.0000	0.0048	**0.0686**
Tulpehocken Creek	3.617	4.154	0.126	0.184	0.005	2.110	**10.196**	0.0407	0.0468	0.0014	0.0021	0.0001	0.0238	**0.1149**
Upper Schuylkill	10.477	1.204	0.309	0.230	0.001	2.178	**14.399**	0.1180	0.0136	0.0035	0.0026	0.0000	0.0245	**0.1622**
Valley Creek	0.000	0.960	0.005	0.005	0.000	0.006	**0.976**	0.0000	0.0108	0.0001	0.0001	0.0000	0.0001	**0.0110**
Wissahickon Creek	0.000	7.582	0.257	0.029	0.000	0.019	**7.888**	0.0000	0.0854	0.0029	0.0003	0.0000	0.0002	**0.0889**
Total	**101.3**	**35.8**	**2.1**	**2.2**	**0.0**	**18.4**	**159.9**	**1.1415**	**0.4037**	**0.0242**	**0.0250**	**0.0002**	**0.2072**	**1.8017**

NTNC is Non-Transient Non-Community Supply, TNC is Transient Non-Community Supply

When looking strictly at population and not volume, it is estimated here that in the Schuylkill River watershed, 52% of the population is supplied by surface water and 48% of the population is supplied by groundwater (20% from private domestic wells). Figure 4-2 depicts this breakdown, and Table 4.2-6 below presents the details by sub-watershed. These numbers account for community water supplies and private domestic wells.

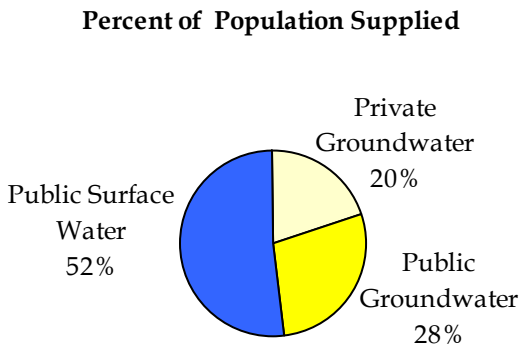

Figure 4-2 Percent of Population Supplied by Different Sources

As depicted above, surface water supplies 52% of the population in the Schuylkill River watershed. The populations of the Middle Schuylkill 1, Lower Schuylkill, and Valley Creek sub-watersheds are almost entirely reliant on public surface water community supplies.

The Perkiomen Creek watershed has the largest total population on private domestic groundwater, twice as many people as the Upper Schuylkill sub-watershed which serves the second highest population on private domestic groundwater. The Perkiomen Creek watershed also has the largest population on public groundwater community supplies, over 148,000 people, or 62% of the Perkiomen Creek sub-watershed. Taken together with the population supplied by private domestic wells, 87.9% of the Perkiomen Creek sub-watershed, or 20.5% of the total Schuylkill River watershed population, is served by groundwater resources.

In addition to the Perkiomen, the Allegheny, Maiden and Tulpehocken Creek sub-watersheds supply over 85% of their populations with groundwater. Also notable are the Allegheny Creek and Monocacy Creek sub-watersheds, which get 98% and 87% of their potable water supply from private domestic wells, respectively.

Table 4.1-6 Populations Served by Community and Private Domestic Supplies

Sub-Watershed	Schuylkill Population*	Community Water Supply, Population Served		Private Domestic Groundwater, Population Served	Community Water Supply, % of Sub-Watershed Population Served		Private Domestic Groundwater, % of Population Served	Community + Private Groundwater, % of Population Served
		Groundwater	Surface Water		Groundwater	Surface Water		
Allegheny Creek	4,891	80	0	4,811	1.6%	0.0%	98.4%	100.0%
French Creek	25,144	2,985	12,127	10,032	11.9%	48.2%	39.9%	51.8%
Hay Creek	5,659	595	2,636	2,428	10.5%	46.6%	42.9%	53.4%
Little Schuylkill	24,545	8,145	7,782	8,618	33.2%	31.7%	35.1%	68.3%
Lower Schuylkill*	72,761	220	71,086	1,455	0.3%	97.7%	2.0%	2.3%
Maiden Creek	40,414	17,847	660	21,907	44.2%	1.6%	54.2%	98.4%
Manatawny Creek	30,682	1,717	11,089	17,877	5.6%	36.1%	58.3%	63.9%
Middle Schuylkill 1	134,706	4,905	127,370	2,431	3.6%	94.6%	1.8%	5.4%
Middle Schuylkill 2	91,151	3,553	64,057	23,540	3.9%	70.3%	25.8%	29.7%
Middle Schuylkill 3	183,237	44,886	125,537	12,814	24.5%	68.5%	7.0%	31.5%
Monocacy Creek	5,228	12	667	4,549	0.2%	12.8%	87.0%	87.2%
Perkiomen Creek	237,308	148,429	28,720	60,159	62.5%	12.1%	25.4%	87.9%
Pickering Creek	17,233	220	11,637	5,376	1.3%	67.5%	31.2%	32.5%
Tulpehocken Creek	65,395	29,330	9,690	26,375	44.9%	14.8%	40.3%	85.2%
Upper Schuylkill	86,952	12,619	47,110	27,223	14.5%	54.2%	31.3%	45.8%
Valley Creek	22,917	109	22,730	77	0.5%	99.2%	0.3%	0.8%
Wissahickon Creek*	108,540	51,287	57,011	241	47.3%	52.5%	0.2%	47.5%
Total	**1,156,762**	**326,940**	**599,910**	**229,912**	**28%**	**52%**	**20%**	**48%**

**Population excludes Philadelphia*
Source: PADEP public water supply service area shapefile intersected with 2000 Census

Tables 4.1-5 and 4.1-6 above can be used to compute the per capita water uses of the groundwater and surface water communities. The surface water community supply uses 168 gallons per person per day, groundwater community supply uses 110 gallons per person per day, and the private domestic wells use 80 gallons per person per day. The groundwater per capita use rate is less than the surface water use rate, and both are higher than the private domestic consumption. These observations support the use of 80 gallons per day per person as an assumption of water use for the private domestic supply category. The groundwater and surface water community supply consumption rates should be higher than the estimated private well rate because they include the water being used by industrial and commercial enterprises.

4.2 Wastewater

In this analysis, wastewater can be divided into two groups: the treated effluent discharged to surface waters by wastewater treatment plants and the groundwater discharges of septic or onlot systems to groundwater. The assumptions made to estimate the volume of these two wastewater groups are listed below.

1. 85% of potable water withdrawn by households becomes wastewater
2. Households on private domestic wells use septic systems
3. Some households on community water systems use septic systems

Given these assumptions, three sources of information were used to estimate wastewater volume; the potable water supply estimates, EPA Permit Compliance System database, and Schuylkill Action Network 2007 sanitary survey.

4.2.1 Wastewater Treatment Plant Discharge

The EPA Permit Compliance System (PCS) database is a compilation of site, permit, and compliance information for permitted facilities in the U.S. A search was performed during October 2008 for wastewater treatment facilities located in the Schuylkill River watershed. The PCS database provided the location and permitted discharge of each facility.

The permitted flows of a treatment facility are often the capacity flow, not the daily average flow of the facility. Using the permitted flows in a preliminary water budget may overestimate the discharge from wastewater treatment facilities. In order to understand the relationship between average flow and permitted flow, a SAN survey from 2007 was used to complement the PCS data.

In 2007, the SAN Pathogens Workgroup conducted a survey of selected wastewater treatment plants in order to obtain some basic information about the facilities. The survey requested the daily average flow, permitted flow, service area potable water source, highest treatment stage, and tertiary treatment method where applicable.

The SAN survey obtained information on 64 facilities and the PCS database search returned information on 74 additional facilities for a total of 137 wastewater treatment plant discharges in the Schuylkill River watershed. In order to estimate the daily average flow of the facilities obtained from the PCS database not covered by the SAN survey, a relationship between the average and permitted flows from the SAN survey was calculated. The

average flow was divided by the permitted flow for each facility in the SAN survey, given two exclusions. Facilities that reported average flows equal to the permitted flows were excluded, as were facilities that reported average flows higher than the permitted flows. These exclusions are attributed to potential errors in the survey information, and their daily average flow was estimated along with the remaining PCS facilities. The median of the average/permitted results (0.613) was then calculated and multiplied by the permitted flow to obtain average flows for facilities not covered by the SAN survey and those surveyed facilities whose average flows were excluded as potentially in error. A complete listing of the survey information, estimation methodology, and final daily average flows are presented in Appendix A. The total daily average flow of wastewater treatment plant effluent per sub-watershed is presented below in Table 4.2-1.

Table 4.2-1 Total Daily Average Wastewater Treatment Plant Discharge

Sub-Watershed	Average Wastewater Treatment Plant Discharge			% of 1 in 25 Year Baseflow
	MGD	Inches Per Year	CFS	
Allegheny Creek	0.45	0.005	0.7	0.1%
French Creek	0.0002	0.000	0.0	0.0%
Hay Creek	0	0.000	0.0	0.0%
Little Schuylkill	2.62	0.030	4.1	0.4%
Lower Schuylkill*	2.20	0.025	3.4	0.3%
Maiden Creek	1.43	0.016	2.2	0.2%
Manatawny Creek	0.55	0.006	0.9	0.1%
Middle Schuylkill 1	26.39	0.297	40.8	4.1%
Middle Schuylkill 2	12.97	0.146	20.1	2.0%
Middle Schuylkill 3	22.51	0.254	34.8	3.5%
Monocacy Creek	0.0012	0.000	0.0	0.0%
Perkiomen Creek	24.05	0.271	37.2	3.8%
Pickering Creek	0.0002	0.000	0.0	0.0%
Tulpehocken Creek	3.31	0.037	5.1	0.5%
Upper Schuylkill	10.92	0.123	16.9	1.7%
Valley Creek	0.0010	0.000	0.0	0.0%
Wissahickon Creek*	11.08	0.125	17.1	1.7%
Total	**118.48**	**1.335**	**183.3**	**18.5%**

**Discharges exclude Philadelphia*

According to the results presented in Table 4.2-1, 118.48 million gallons per day of treated effluent is discharged throughout the Schuylkill River watershed.

4.2.2 Septic System Discharge

A portion of households and businesses on all types of potable water supplies use septic systems to treat and release sanitary waste. It is assumed here that all households with private domestic wells have septic systems. Additionally, there is a portion of households with community, non-transient non-community, and transient non-community water supplies that have septic systems which must be estimated. If only households on private domestic wells were assumed to have septic systems, the volume discharged to septic systems may be underestimated.

The volume of water discharged to septic systems from households with private domestic groundwater supplies is estimated to be 85% of the daily average withdrawal. This assumes that about 15% of the water is for outdoor use. Table 4.2-2 below lists the results of this calculation.

Table 4.2-2 Wastewater from Private Domestic Supplies to Septic Systems

Sub-Watershed	Average Private Domestic Discharge to Septic Systems			% of Pre-development 1 in 25 Year Baseflow (989 CFS)
	MGD	Inches Per Year	CFS	
Allegheny Creek	0.327	0.004	0.506	0.1%
French Creek	0.682	0.008	1.055	0.1%
Hay Creek	0.165	0.002	0.255	0.0%
Little Schuylkill	0.586	0.007	0.907	0.1%
Lower Schuylkill	0.099	0.001	0.153	0.0%
Maiden Creek	1.490	0.017	2.305	0.2%
Manatawny Creek	1.216	0.014	1.881	0.2%
Middle Schuylkill 1	0.165	0.002	0.256	0.0%
Middle Schuylkill 2	1.601	0.018	2.476	0.3%
Middle Schuylkill 3	0.871	0.010	1.348	0.1%
Monocacy Creek	0.309	0.003	0.479	0.0%
Perkiomen Creek	4.091	0.046	6.329	0.6%
Pickering Creek	0.366	0.004	0.565	0.1%
Tulpehocken Creek	1.793	0.020	2.775	0.3%
Upper Schuylkill	1.851	0.021	2.864	0.3%
Valley Creek	0.005	0.000	0.008	0.0%
Wissahickon Creek	0.016	0.000	0.025	0.0%
Total	**15.634**	**0.176**	**24.186**	**2.4%**

To estimate the volume of water discharged to septic systems from the remainder of the potable water supply, the difference between 85% of the total potable supply (excluding private domestic supply) and the volume of treated effluent is calculated. It is important to include the discharge to septic systems from the remainder of the potable supply in addition to the discharge to septic systems from households with private domestic supplies so as not to underestimate the total discharge to septic systems.

Where the discharge to septic systems from the potable supply (excluding private domestic) is calculated:

Step 1	Public Water Supply Discharge to Septic Systems*	=	85% Potable Supply* (0.85 * 141.5 MGD = 120.3)	-	Wastewater Plant Discharge (118.5 MGD)
		=	1.8 MGD		
Step 2	Private Domestic Supply Discharge to Septic Systems	=	85% Private Domestic Supply (0.85 * 18.4 MGD)		
		=	15.6 MGD		
Final	**Total Discharge to Septic Systems**	=	Public Water Supply Discharge to Septic Systems* (1.8 MGD)	+	Private Domestic Supply Discharge to Septic Systems (15.6 MGD)
		=	**17.4 MGD (26.9 CFS)**		

*Excludes private domestic supply

For these reasons, the estimate of contributions to septic systems from the potable water supply, excluding those from private domestic wells, cannot be interpreted on a scale smaller than the total Schuylkill River watershed. The column in Tables 4.2-3 and 4.2-4 representing these numbers is therefore only tabulated for the total watershed.

In contrast, the estimated contribution to septic systems from private domestic wells can be easily interpreted on a sub-watershed scale. The data used to derive this estimate was based on the location of populations without access to community water supplies, so the data represents the location of where the water is withdrawn and returned to the groundwater.

Tables 4.2-3 and 4.2-4 present estimates of the contributions of wastewater to septic systems.

Table 4.2-3 Estimation of Discharge to Septic Systems, Million Gallons Per Day

Sub-Watershed	Million Gallons Per Day			
	85% Potable Supply*	Treated Wastewater Discharge**	Discharge to Septic Systems from Potable Supply *	Discharge to Septic Systems from Private Domestic ***
Allegheny Creek	0.06	0.45	-	0.33
French Creek	0.49	0.0002	-	0.68
Hay Creek	0.52	0	-	0.17
Little Schuylkill	2.71	2.62	-	0.59
Lower Schuylkill	1.14	2.20	-	0.10
Maiden Creek	13.85	1.43	-	1.49
Manatawny Creek	0.92	0.55	-	1.22
Middle Schuylkill 1	13.13	26.39	-	0.17
Middle Schuylkill 2	32.51	12.97	-	1.60
Middle Schuylkill 3	5.44	22.51	-	0.87
Monocacy Creek	0.04	0.0012	-	0.31
Perkiomen Creek	19.91	24.05	-	4.09
Pickering Creek	4.81	0.0002	-	0.37
Tulpehocken Creek	6.87	3.31	-	1.79
Upper Schuylkill	10.39	10.92	-	1.85
Valley Creek	0.82	0.0010	-	0.01
Wissahickon Creek	6.69	11.08	-	0.02
Total	**120.3**	**118.48**	**1.8**	**15.63**

**Excludes Private Domestic Wells*
*** From Section 4.2 Calculations*
**** Defined as 85% of the Supply from Private Domestic Wells*

Table 4.2-4 Estimation of Discharge to Septic Systems, Inches Per Year

Sub-Watershed	Inches Per Year			
	85% Potable Supply*	Treated Wastewater Discharge**	Discharge to Septic Systems from Potable Supply *	Discharge to Septic Systems from Private Domestic ***
Allegheny Creek	0.001	0.005	-	0.004
French Creek	0.006	0.000	-	0.008
Hay Creek	0.006	0.000	-	0.002
Little Schuylkill	0.031	0.030	-	0.007
Lower Schuylkill	0.013	0.025	-	0.001
Maiden Creek	0.156	0.016	-	0.017
Manatawny Creek	0.010	0.006	-	0.014
Middle Schuylkill 1	0.148	0.297	-	0.002
Middle Schuylkill 2	0.366	0.146	-	0.018
Middle Schuylkill 3	0.061	0.254	-	0.010
Monocacy Creek	0.000	0.000	-	0.003
Perkiomen Creek	0.224	0.271	-	0.046
Pickering Creek	0.054	0.000	-	0.004
Tulpehocken Creek	0.077	0.037	-	0.020
Upper Schuylkill	0.117	0.123	-	0.021
Valley Creek	0.009	0.000	-	0.000
Wissahickon Creek	0.075	0.125	-	0.000
Total	**1.355**	**1.335**	**0.020**	**0.176**

**Excludes Private Domestic Wells*
*** From Section 4.2 Calculations*
**** Defined as 85% of the Supply from Private Domestic Wells*

4.3 Agriculture

Three types of agricultural water use are accounted for in this water budget; processing, livestock, and irrigation. All three agricultural water uses are assumed to be 100% consumptive. The processing and livestock numbers are taken directly from data provided by PADEP that was used in the Act 220 State Water Plan Update. The irrigation numbers are estimated based on survey information conducted every 5 years by the U.S. Department of Agriculture.

4.3.1 Processing

The average daily withdrawal information for agricultural processing facilities and operations was obtained from Michael Hill at PADEP. The information was collected by PADEP during the Act 220 registration process. There was no accessible withdrawal information about these facilities available other than what PADEP shared, so PADEP numbers are used in this water budget analysis and are displayed below in Table 4.3-1.

Table 4.3-1 Agricultural Processing Water Use

Sub-Watershed	Groundwater		Surface Water	
	Gallons Per Day	Inches Per Year	Gallons Per Day	Inches Per Year
Allegheny Creek				
French Creek				
Hay Creek				
Little Schuylkill	70,719	0.0008		
Lower Schuylkill				
Maiden Creek	14,958	0.0002		
Manatawny Creek	67,733	0.0008		
Middle Schuylkill 1				
Middle Schuylkill 2	200,757	0.0023		
Middle Schuylkill 3	41,469	0.0005		
Monocacy Creek				
Perkiomen Creek	10,490	0.0001		
Pickering Creek				
Tulpehocken Creek	258,716	0.0029		
Upper Schuylkill	542,885	0.0061	98,400	0.0011
Valley Creek				
Wissahickon Creek	902	0.0000	25,666	0.0003
Total	**1,208,629**	**0.0136**	**124,066**	**0.0014**

The PADEP total agricultural processing withdrawals are less than 1.5 million gallons per day, indicating that agricultural processing consumes a very small amount of water in the Schuylkill River watershed.

The PADEP information did not include discharge information for the facilities, and it is unclear whether this was because there were no point-source discharges generating a

discharge monitoring report (DMR), or possibly the facilities send the wastewater to a municipal treatment facility. If the latter is the case with some facilities, the discharges are accounted for in the wastewater treatment discharge calculations. They are just not articulated as agricultural processing discharge. Another reason for no discharge data could be that because the water budget calculated for the State Water Plan assumed all agricultural uses are 100% consumptive, no discharge data was collected.

Regarding agricultural processing water, the consumptive use is not assumed to be 100%. However, without discharge information it is difficult to estimate what proportion of the withdrawals are consumed. It is assumed here that the discharges are contained within the wastewater treatment plant discharge calculations, but are not categorically separated from the household and commercial contributions.

4.3.2 Livestock

PADEP estimated the amount of water required to care for livestock in order to account for this agricultural water use in the State Water Plan. With no other way to estimate livestock water requirements, the PADEP numbers are used in this water budget. The data was shared by Michael Hill and is reproduced for the Schuylkill River watershed in Table 4.3-2.

Table 4.3-2 Livestock Operations Water Use

Sub-Watershed	Gallons Per Day	Inches Per Year
Allegheny Creek	6,182	0.0001
French Creek	7,056	0.0001
Hay Creek	6,524	0.0001
Little Schuylkill	34,420	0.0004
Lower Schuylkill		
Maiden Creek	113,020	0.0013
Manatawny Creek	118,392	0.0013
Middle Schuylkill 1		
Middle Schuylkill 2	58	0.0000
Middle Schuylkill 3	66,099	0.0007
Monocacy Creek	33,230	0.0004
Perkiomen Creek	208,019	0.0023
Pickering Creek		
Tulpehocken Creek	1,040,267	0.0117
Upper Schuylkill	194,361	0.0022
Valley Creek		
Wissahickon Creek		
Total	**1,827,629**	**0.0206**

Source: PADEP, Michael Hill

The PADEP did not specify whether the water for livestock comes from groundwater or surface water sources. It is assumed here that the water for livestock is withdrawn from groundwater.

4.3.3 Irrigation

Natural variation in precipitation and climatic patterns, crop type, irrigation technology, farming technique, and soil type are several factors that influence the amount of water required by crops from planting to harvest. Climatic conditions can greatly influence the amount of irrigation required by farms across Pennsylvania. For the purposes of this water budget, irrigation volume is calculated based on the maximum length of the growing season, the area of irrigated lands, and a technology-based estimate of irrigation volume per acre per day, where:

Growing Season Days x Acres Irrigated x Volume/Acre/Day Approximation
=Total Irrigated Volume

Information from three sources was used; the USDA 2002 Census of Agriculture, USGS 2001 National Land Cover Dataset, and the Penn State University Cooperative Extension.

Often only a portion of agricultural lands are irrigated. To calculate the area of irrigated land in the Schuylkill River watershed, the ratio of irrigated acres to land in irrigated farms was first calculated for each county (USDA 2002). Presented below in Table 4.3-3 are the irrigation statistics for each county in the watershed, except Philadelphia.

Table 4.3-3 USDA Agriculture Census Irrigation Information

County	Acres in Irrigated Farms*	Irrigated Acres*	Irrigation Ratio	Percent Irrigated
Berks	15,771	1,914	0.1214	12.14%
Bucks	7,160	1,017	0.1420	14.20%
Carbon	1,391	80	0.0575	5.75%
Chester	12,812	1,846	0.1441	14.41%
Delaware	498	63	0.1265	12.65%
Lancaster	46,856	6,051	0.1291	12.91%
Lebanon	7,970	1,857	0.2330	23.30%
Lehigh	6,976	676	0.0969	9.69%
Montgomery	3,065	464	0.1514	15.14%
Schuylkill	19,152	1,876	0.0980	9.80%

**Source: USDA 2002 Agriculture Census, Pennsylvania Report Table 10*

According to the USDA information, Lebanon County irrigates the largest amount of acres in irrigated farms, 23.3%. In contrast Carbon, Lehigh, and Schuylkill Counties irrigate less than 10% of the acres in irrigated farms. Differences among counties may be due to climatic differences in precipitation and wind patterns, soil type, or water requirements of cultivated crops.

The area of irrigated agricultural lands in the Schuylkill River watershed is calculated based on the assumption that a portion of each agricultural parcel is irrigated, and that portion is represented by the ratios calculated in Table 4.3-3 above. For sub-watersheds that include

more than one county, Geographic Information Systems (GIS) software is used to assign the appropriate irrigation ratio to the county-specific area.

The area of agricultural lands in the watershed is calculated using Geographic Information Systems (GIS) and the National Land Cover Dataset (USGS 2001 NLCD) which is the most recent land cover dataset available for all counties. The area of land cover class descriptions for pasture, hay, and cultivated crops (class codes 81 and 82) were added together to comprise the total agricultural lands in the Schuylkill River watershed. Table 4.3-4 presents the results of the GIS calculations.

Table 4.3-4 Agricultural Areas in the Schuylkill River Watershed

Sub-Watershed	Agricultural Land Covers		Total Agricultural Lands, Acres
	Pasture, Hay Acres	Cultivated Crops, Acres	
Allegheny Creek	2,193.4	1,550.8	3,744.2
French Creek	12,961.8	6,623.0	19,584.8
Hay Creek	2,041.9	1,306.1	3,348.0
Little Schuylkill	8,931.1	3,993.8	12,924.9
Lower Schuylkill*	1,914.1	2,242.9	4,157.0
Maiden Creek	38,112.1	33,461.0	71,573.1
Manatawny Creek	14,586.8	13,565.0	28,151.8
Middle Schuylkill 1	4,420.4	4,627.7	9,048.0
Middle Schuylkill 2	17,850.1	7,212.2	25,062.3
Middle Schuylkill 3	6,466.5	6,310.2	12,776.7
Monocacy Creek	6,568.9	3,985.5	10,554.5
Perkiomen Creek	60,580.2	46,192.4	106,772.7
Pickering Creek	7,194.2	4,777.5	11,971.7
Tulpehocken Creek	45,233.4	37,094.9	82,328.3
Upper Schuylkill	31,525.3	13,373.7	44,899.0
Valley Creek	2,346.9	2,213.7	4,560.6
Wissahickon Creek*	4,962.5	3,264.8	8,227.2
Total	**267,889.7**	**191,795.2**	**459,684.8**

**Excludes Philadelphia*

Information published online by the Pennsylvania State University College of Agricultural Sciences Cooperative Extension was used to identify the water use by different irrigation methods as well as the maximum length of the growing season in the Schuylkill River watershed. According to the Cooperative Extension, the length of the growing season in Southeastern Pennsylvania ranges from 121-180 days per year (PSU 2009). In this analysis, the length of the growing season is assumed to be 180 days. By using the maximum number of growing season days the amount of water consumed by irrigation is more likely to be overestimated than underestimated.

A comparison of water use at farms published online by the Cooperative Extension lists the different water consumption rates of drip and spray irrigation techniques. According to the

Cooperative Extension, drip irrigation uses 1,000 gallons/day/acre irrigated and spray irrigation uses 4,000 gallons/day/acre irrigated (PSU 2005). In this analysis the average of the two technologies, 2,500 gallons/day/acre irrigated, is used. This represents the assumption that half of the irrigated acres in the Schuylkill River watershed use drip irrigation and the other half use spray irrigation.

Table 4.3-5 below pulls all of the information together, and in the final column presents the estimated annual volume of water used for irrigation in the Schuylkill River watershed.

Table 4.3-5 Estimate of Water Used for Irrigation

Sub-Watershed	Irrigation Rate, Gal./Day/Acre	Growing Season Days/Yr	Pasture, Hay + Cultivated Crops		
			Total Irrigated Acres	Irrigated Million Gal./Yr	Irrigated In./Yr
Allegheny Creek	2,500	180	454.54	204.54	0.0063
French Creek	2,500	180	2802.68	1,261.21	0.0389
Hay Creek	2,500	180	406.45	182.90	0.0056
Little Schuylkill	2,500	180	1255.68	565.06	0.0174
Lower Schuylkill*	2,500	180	501.51	225.68	0.0070
Maiden Creek	2,500	180	8322.03	3,744.91	0.1156
Manatawny Creek	2,500	180	3446.96	1,551.13	0.0479
Middle Schuylkill 1	2,500	180	1354.16	609.37	0.0188
Middle Schuylkill 2	2,500	180	3568.83	1,605.98	0.0496
Middle Schuylkill 3	2,500	180	1551.09	697.99	0.0215
Monocacy Creek	2,500	180	1281.31	576.59	0.0178
Perkiomen Creek	2,500	180	15128.27	6,807.72	0.2101
Pickering Creek	2,500	180	1725.13	776.31	0.0240
Tulpehocken Creek	2,500	180	12681.19	5,706.53	0.1761
Upper Schuylkill	2,500	180	5158.22	2,321.20	0.0716
Valley Creek	2,500	180	657.45	295.85	0.0091
Wissahickon Creek*	2,500	180	1160.60	522.27	0.0161
Total			**61,456.10**	**27,655.25**	**0.8536**

**Excludes Philadelphia*

The estimated amount of water used for irrigation in the Schuylkill River watershed is 0.85 inches per year, or 27,655 million gallons per year. In the water budget analysis, the irrigation water calculated here is assumed to be 100% consumptive.

4.4 Mining

PADEP collected data on the withdrawals and discharges of the mining and mineral industries across the state during the Act 220 registration process. Michael Hill from PADEP shared the Schuylkill River watershed data, and the results are presented below in Table 4.4-1. PADEP assumes an 8% consumptive use for the mining industry because most facilities pump quarries or mines and directly discharge the water in order to reach submerged layers.

Table 4.4-1 Mining and Mineral Industry Withdrawals and Discharges

Sub-Watershed	Gallons Per Day			Inches Per Year		
	Discharge	Groundwater Withdrawal	Surface Water Withdrawal	Discharge	Groundwater Withdrawal	Surface Water Withdrawal
Little Schuylkill	1,090,995	1,187,749		0.0123	0.0134	
Maiden Creek	6,533,443	7,101,569		0.0736	0.0800	
Middle Schuylkill 2	156,006	169,572		0.0018	0.0019	
Middle Schuylkill 3	316,066	335,664	30,054	0.0036	0.0038	0.0003
Monocacy	907,581	986,502		0.0102	0.0111	
Perkiomen Creek	701,975	1,003,683		0.0079	0.0113	
Upper Schuylkill	10,053,226	11,341,826		0.1133	0.1278	
Valley Creek	5,811,864	6,317,243		0.0655	0.0712	
Wissahickon Creek	8,540,000	8,900,000		0.0962	0.1003	
Total	**34,111,156**	**37,343,808**	**30,054**	**0.3843**	**0.4207**	**0.0003**

Within the PADEP data, the Eastern Industries Inc. Kutztown Quarry located within the Maiden Creek sub-watershed was not assigned a discharge, only a groundwater withdrawal (7,101,569 gallons per day). It seemed out of place that such a large daily withdrawal would be 100% consumptive, so a discharge was calculated according to the PADEP assumption of 8% consumptive use and included in Table 4.4-1.

4.5 Golf Courses

As reported by PADEP, the majority of golf courses across the state did not register their water use for inclusion in the State Water Plan. PADEP estimated the water use per golf course by assigning 4,270 gallons per day per hole. The PADEP results are included in this water budget analysis and presented below in Table 4.5-1.

Table 4.5-1 Golf Course Water Use

Sub-Watershed	Groundwater			Surface Water			Total		
	MGD	Inches Per Year	CFS	MGD	Inches Per Year	CFS	MGD	Inches Per Year	CFS
Allegheny Creek	0.00	0.0000	0.0	0.23	0.0026	0.4	0.23	0.0026	0.4
French Creek	0.27	0.0030	0.4	0.67	0.0076	1.0	0.94	0.0106	1.5
Hay Creek	0.15	0.0017	0.2	0.00	0.0000	0.0	0.15	0.0017	0.2
Little Schuylkill	0.00	0.0000	0.0	0.27	0.0031	0.4	0.27	0.0031	0.4
Lower Schuylkill	0.19	0.0021	0.3	0.11	0.0012	0.2	0.30	0.0033	0.5
Maiden Creek	0.04	0.0005	0.1	0.00	0.0000	0.0	0.04	0.0005	0.1
Manatawny Creek	0.00	0.0000	0.0	0.14	0.0016	0.2	0.14	0.0016	0.2
Middle Schuylkill 1	0.07	0.0008	0.1	0.38	0.0043	0.6	0.45	0.0051	0.7
Middle Schuylkill 2	0.36	0.0040	0.6	0.03	0.0004	0.1	0.39	0.0044	0.6
Middle Schuylkill 3	0.00	0.0000	0.0	0.00	0.0000	0.0	0.00	0.0000	0.0
Monocacy Creek	0.00	0.0000	0.0	0.00	0.0001	0.0	0.00	0.0001	0.0
Perkiomen Creek	0.36	0.0040	0.6	0.48	0.0055	0.8	0.84	0.0095	1.3
Pickering Creek	0.16	0.0018	0.2	0.00	0.0000	0.0	0.16	0.0018	0.2
Tulpehocken Creek	0.18	0.0020	0.3	0.28	0.0031	0.4	0.46	0.0052	0.7
Upper Schuylkill	0.01	0.0001	0.0	0.00	0.0000	0.0	0.01	0.0001	0.0
Valley Creek	0.07	0.0008	0.1	0.12	0.0013	0.2	0.19	0.0022	0.3
Wissahickon Creek	0.37	0.0042	0.6	0.18	0.0021	0.3	0.56	0.0063	0.9
Total	**2.23**	**0.0251**	**3.4**	**2.9**	**0.0328**	**4.5**	**5.1**	**0.1**	**8.0**

Water use by golf courses is assumed to be 100% consumptive due to irrigation and other green maintenance. The French Creek and Perkiomen Creek sub-watersheds withdraw the largest amounts of surface water for golf courses. The Wissahickon, Perkiomen, and Middle Schuylkill 2 sub-watersheds withdraw the most amount of groundwater for golf courses. Golf courses consume approximately 680,000 more gallons of water per day from surface water intakes than groundwater wells.

4.6 Power

Information on the multiple power generating stations throughout the Schuylkill River watershed was obtained from David Sayers at DRBC and Michael Hill at PADEP. David Sayers provided a spreadsheet that includes the withdrawal volumes and consumptive use of each facility. Michael Hill from PADEP provided the power industry information used in the State Water Plan. The data collected by PADEP and DRBC did not match in most cases. From conversations with DRBC and PADEP, the DRBC data was deemed most accurate and is used here to tentatively represent water use by the power sector in the Schuylkill River watershed. The facility specific information provided by DRBC is presented in Table 4.6-1, and a summary of the results by sub-watershed is presented below in Table 4.6-2.

Table 4.6-1 Power Facilities Water Use, Gallons Per Day

Facility	Estimated Discharge, GPD**	Surface Water Withdrawal, GPD	Groundwater Withdrawal, GPD	DRBC % Consumptive	Sub-Watershed
AES Ironwood Lebanon City	0		265,700	100.0%	Tulpehocken Creek
Conectiv Bethlehem Plant	151,259	491,100		69.2%	Perkiomen Creek
Exelon Cromby Generating Station	154,925,928	156,018,055		0.7%	Middle Schuylkill 2
Exelon Limerick Generating Station*	8,328,854	39,102,600		78.7%	Middle Sch. 2 Dis. & With., Perk. With.
Northeastern Power Company	0		143,800	100.0%	Little Schuylkill
Reliant Energy Mid-Atlantic Power Holdings LLC - Titus	13,824,585	15,108,836		8.5%	Middle Schuylkill 3
Wheelabrator Frackville Energy Company	0		533,300	100.0%	Upper Schuylkill
Total	**177,230,626**	**210,720,590**	**942,800**	**16.3%**	

Source: David Sayers, DRBC
**Nuclear power, the other facilities are fossil fuel*
***Consumptive use percentages used to estimate discharge*

According to the available data, the consumptive use for the power sector is 16.3% overall. The three stations with the largest withdrawals are the Limerick, Cromby and Titus facilities. The Exelon Cromby facility consumes an estimated 1.1 million gallons per day and the Titus facility 1.3 million gallons per day of water. In comparison, the Exelon Limerick facility consumes 30.7 million gallons per day. The main difference in water use between the three largest power withdrawals is the type of fuel used to generate electricity. Limerick is a nuclear facility with a maximum capacity of 2.3 gigawatts, whereas Cromby and Titus are fossil fuel based facilities with capacities of 345 megawatts and 225 megawatts, respectively. Based on these three main facilities, over 11,500 gallons of water are consumed for each megawatt of power produced in the Schuylkill River.

According to Tables 4.6-1 and 4.6-2, surface water meets almost the entire needs of the power sector. An estimated 31.8 million gallons per day are withdrawn from the Middle Schuylkill 2 sub-watershed. This is approximately equivalent to a streamflow reduction of 49 CFS in the river as it passes the Cromby and Exelon facilities.

Table 4.6-2 Power Industry Water Use

Sub-Watershed	Million Gallons Per Day			Inches Per Year			CFS		
	Dis.	Ground With.	Surface With.	Dis.	Ground With.	Surface With.	Dis.	Ground With.	Surface With.
Allegheny Creek									
French Creek									
Hay Creek									
Little Schuylkill		0.1			0.00			0	
Lower Schuylkill									
Maiden Creek									
Manatawny Creek									
Middle Schuylkill 1									
Middle Schuylkill 2	163.3		195.1	1.84		2.20	253		302
Middle Schuylkill 3	13.8		15.1	0.16		0.17	21		23
Monocacy Creek									
Perkiomen Creek	0.2		0.5	0.00		0.01	0		1
Pickering Creek									
Tulpehocken Creek		0.3			0.00			0	
Upper Schuylkill		0.5			0.01			1	
Valley Creek									
Wissahickon Creek									
Total	**177.2**	**0.9**	**210.7**	**2.00**	**0.01**	**2.37**	**274**	**1**	**326**

Source: David Sayers, DRBC

The PADEP data included a discharge of 9,135,500 gallons per day into the Middle Schuylkill 2 sub-watershed that could not be verified by the Exelon Limerick operating policies. The discharge was described as a 'Perkiomen Creek transfer'. Under the operating policies, Exelon discharges approximately 10 cubic feet per second from the Bradshaw Reservoir into the East Branch of the Perkiomen Creek. This discharge is accounted for in the Miscellaneous Section 4.8. Exelon Limerick also withdraws water from the Middle Schuylkill 2 and Perkiomen Creek, and discharges water into the Middle Schuylkill 2. The figures for these discharges and withdrawals are consistent with information provided by DRBC. The 'Perkiomen Creek transfer' is not accounted for in the data submitted by DRBC and cannot be identified in the operating dockets, so this discharge was recommended for further verification by PADEP. If this transfer can be identified at a later date it will be added back into the water budget.

4.7 Industry

Both the EPA and PADEP track industrial discharges, but PADEP is responsible for permit compliance, and therefore tracks the discharge volumes. DMRs for facilities in the Schuylkill River watershed were digitized during the State Water Plan updating process. Michael Hill at PADEP provided the information collected for industrial facilities, including discharges, groundwater withdrawals, and surface water withdrawals. The information provided by PADEP is summarized below in Table 4.7-1, and detailed in Appendix A.

Table 4.7-1 Industrial Withdrawals and Discharges

Sub-Watershed	MGD			Inches Per Year			CFS		
	Dis.	Ground. With.	Surf. With.	Dis.	Ground. With.	Surf. With.	Dis.	Ground. With.	Surf. With.
Allegheny Creek									
French Creek	0.0	0.3		0.000	0.003		0.0	0.4	
Hay Creek	0.0	0.0		0.000	0.000		0.0	0.0	
Little Schuylkill		0.2			0.002			0.3	
Lower Schuylkill	4.9	0.0	6.5	0.055		0.073	7.5	0.0	10.0
Maiden Creek	0.2	0.4		0.003	0.005	0.000	0.4	0.7	
Manatawny Creek									
Middle Schuylkill 1	0.2	3.3	0.2	0.003	0.037	0.003	0.4	5.1	0.4
Middle Schuylkill 2		0.7	0.2		0.007	0.002	0.0	1.0	0.3
Middle Schuylkill 3	1.0	1.3	0.4	0.011	0.014	0.004	1.5	2.0	0.6
Monocacy Creek									
Perkiomen Creek	0.5	1.9		0.006	0.021		0.8	2.9	
Pickering Creek		0.4			0.005			0.6	
Tulpehocken Creek		0.1			0.001			0.1	
Upper Schuylkill		0.9			0.010			1.3	
Valley Creek									
Wissahickon Creek	0.8	0.7		0.009	0.007	0.000	1.3	1.0	
Total	**7.7**	**10.0**	**7.3**	**0.086**	**0.113**	**0.082**	**11.9**	**15.5**	**11.3**

Source: PADEP, Michael Hill

The data collected by PADEP, reproduced here, indicates there are only 7.3 million gallons per day of industrial withdrawal and 7.7 million gallons per day of industrial discharge into the Schuylkill River watershed above Philadelphia. It is unclear what percentage of actual discharges and withdrawals for industrial facilities are accounted for in Table 4.7-1. Two lists were found to check against the name and number of facilities represented; the EPA PCS database, and a PADEP GIS layer of all NPDES discharges within the Schuylkill River watershed.

The EPA information could be used to verify the number of discharges and withdrawals by checking for consistency between the number of facilities on record as having NPDES permits. One of the ways the EPA NPDES information is divided is by 'major' or 'minor' permit holders. Of the 43 major NPDES permit holders upstream of Philadelphia, 3 are industrial. Of the three major industrial dischargers, only one discharge is accounted for here (Arcelor-Mittal, formerly Lukens Steel, Conshohocken Plant). Of the 142 minor dischargers upstream of Philadelphia, 43 are industrial. Of the 43 minor industrial dischargers, only 11 are accounted for in Table 4.7-1. In summary, according to the EPA list of 46 industrial NPDES permit holders in the Schuylkill River watershed, 14 are accounted for here.

The PADEP list of discharges and withdrawals was not clear as to which facilities held NPDES permits. For facilities denoted as a discharge, the definition in the metadata is "A Discharge sub-facility type represents the return of water used at a Water Resources primary facility." This list contains multiple classifications of the discharges, including septic, onlot septic, discharge, instream discharge, sewage treatment plant, and waste pond designations. The majority of the facilities listed in this dataset discharge to septic or onlot septic sub-facilities, and the distinction between those two descriptions is never defined. These facilities are likely built to handle the waste generated by employees rather than industrial processes, so it can be assumed the discharge is very small.

Overall, it is unclear what percentage of total industrial discharge is represented in this analysis. According to the EPA quick verification, there are at least 32 facilities un-accounted for, including two major dischargers (Moyer Packing and Carpenter Specialty Alloys). Interestingly, the groundwater withdrawals of these facilities are accounted for but not the discharges.

4.8 Miscellaneous

Of the data supplied by PADEP, the commercial and 'xxx' categories contained similar types of water users. These categories are combined here into a miscellaneous category. Additionally, several of the water users in both categories from the PADEP list are already accounted for in the potable water supply Section 4.1, and were therefore removed from the miscellaneous calculations.

In speaking to Michael Hill over the phone, he mentioned that the site-specific discharge data was accounted for by digitizing monthly DMRs and taking the average discharge flow. The summarized data is presented below in Table 4.8-1. The companies included in the miscellaneous category calculations are listed in Appendix A.

Table 4.8-1 Miscellaneous Water Users

Sub-Watershed	MGD			Inches Per Year			CFS		
	Dis.	Ground With.	Surface With.	Dis.	Ground With.	Surface With.	Dis.	Ground With.	Surface With.
Allegheny Creek									
French Creek	0.05	0.02		0.001			0.1		
Hay Creek	0.01								
Little Schuylkill	0.02	0.04						0.1	
Lower Schuylkill	0.02								
Maiden Creek	0.15		0.22	0.002		0.002	0.2		0.3
Manatawny Creek		0.02	0.01						
Middle Schuylkill 1	0.16	0.05		0.002	0.001		0.3	0.1	
Middle Schuylkill 2	0.38	0.02		0.004			0.6		
Middle Schuylkill 3	0.51			0.006			0.8		
Monocacy Creek		0.01							
Perkiomen Creek	20.45	0.20	0.46	0.230	0.002	0.005	31.6	0.3	0.7
Pickering Creek									
Tulpehocken Creek	0.06			0.001			0.1		
Upper Schuylkill									
Valley Creek	0.05			0.001			0.1		
Wissahickon Creek	0.13			0.001			0.2		
Total	**21.99**	**0.35**	**0.70**	**0.248**	**0.004**	**0.008**	**34.0**	**0.5**	**1.1**

The largest discharge of this group of facilities, 16.9 million gallons per day, is what Exelon discharges from the Bradshaw Reservoir into the East Branch of the Perkiomen Creek. This discharge is required of Exelon by DRBC to replace water withdrawn from the Perkiomen Creek to meet the cooling water needs of the Limerick Generating Station. Without this discharge accounted for, the total discharges from water users included in this category is a relatively small volume (0.06 inches per year).

4.9 Self-Supplied Commercial and Industrial

The spreadsheet provided by PADEP that contains withdrawal and discharge information collected during the State Water Plan update includes two categories of estimated water withdrawal data; self-supplied commercial and self-supplied industrial. The PADEP created these two categories to estimate water use at employment centers across the state. The PADEP estimated these groundwater withdrawals by multiplying a per capita water rate (665 gpd industrial and 42 gpd commercial) by the number of people employed per facility according to the Pennsylvania Department of Labor and Industry. In the State Water Plan documentation (Stuckey MH 2008), the PADEP mentions that some sources are likely double-counted because the water use may be accounted for in the public water facility withdrawals and was also estimated under the self-supplied commercial or industrial calculations. It is difficult to identify what is or is not accounted for, so for the purposes of this water budget, the PADEP estimations are included in their entirety for these two categories. Table 4.9-1 below presents the groundwater withdrawal estimates.

Table 4.9-1 Self-Supplied Commercial and Industrial Water Use

Sub-Watershed	MGD		Inches Per Year		CFS	
	Self-Supplied Commercial	Self-Supplied Industrial	Self-Supplied Commercial	Self-Supplied Industrial	Self-Supplied Commercial	Self-Supplied Industrial
Allegheny Creek	0.02		0.000		0.03	
French Creek	0.06	0.04	0.001	0.000	0.09	0.06
Hay Creek	0.01		0.000		0.01	
Little Schuylkill	0.02	0.44	0.000	0.005	0.03	0.68
Lower Schuylkill	0.02	0.00	0.000	0.000	0.03	0.00
Maiden Creek	0.13	0.27	0.001	0.003	0.20	0.41
Manatawny Creek	0.11	0.56	0.001	0.006	0.16	0.86
Middle Schuylkill 1	0.04	0.00	0.000	0.000	0.05	0.00
Middle Schuylkill 2	0.22	0.21	0.002	0.002	0.34	0.33
Middle Schuylkill 3	0.08	0.19	0.001	0.002	0.12	0.30
Monocacy Creek	0.03	0.08	0.000	0.001	0.05	0.13
Perkiomen Creek	0.45	0.93	0.005	0.011	0.69	1.45
Pickering Creek	0.03	0.02	0.000	0.000	0.05	0.02
Tulpehocken Creek	0.28	1.35	0.003	0.015	0.44	2.09
Upper Schuylkill	0.26	1.34	0.003	0.015	0.41	2.07
Valley Creek	0.00		0.000		0.00	
Wissahickon Creek	0.00		0.000		0.00	
Total	**1.75**	**5.43**	**0.020**	**0.061**	**2.71**	**8.39**

Overall, the withdrawals from the self-supplied commercial and industrial facilities are small, so any double counting is not likely to impact the final water budget results in a significant way.

Section 5 Water Budget Upstream of Philadelphia

The information in Section 4 was gathered in order to estimate the relationship between water withdrawals, discharges, and consumptive use in the Schuylkill River watershed. The data is used in a water budget, where the total discharges are subtracted from the total withdrawals to observe approximately how much water is consumed in the watershed each year and how that quantity relates to low flows. In this water budget the difference between withdrawals and discharges, or consumptive use, is compared to the 1 in 25 year annual average baseflow (Section 3).

Typically, the water budget equation balances inputs and losses to the system, where;

ET=Avg. Precip – RO + WW/Ind Rech. + EDR – SWW – GWW – EDW + SW Disch. – BF

ET	Evapotranspiration
Avg. Precip.	Average precipitation
RO	Runoff
WW/Ind Rech.	Wastewater and industrial discharges to groundwater
EDR	Estimated domestic recharge to groundwater
SWW	Surface water withdrawals
GWW	Groundwater withdrawals
EDW	Estimated domestic groundwater withdrawals
SW Disch.	Total surface water discharges
BF	Baseflow

Evapotranspiration is not measured, so the equation is set up to solve for it. In fact, the variable ET in the equation represents evapotranspiration plus all the errors in measuring each of the other variables.

This water budget analysis compares the difference between withdrawals and discharges, or consumptive use, to low baseflow conditions. In this analysis, the pre-development 1 in 25 year annual average baseflow is the measurement against which consumptive use for the whole Schuylkill River watershed will be calculated. The watershed is identified as approaching water supply stress when the consumptive use is greater than 50% of the pre-development 1 in 25 year annual average baseflow. The Southeastern Pennsylvania Groundwater Protection Area administered by DRBC regulates net groundwater withdrawals so that they do not exceed the pre-development 1 in 25 year annual average baseflow determined for each township. The criteria used here, 50% of the pre-development 1 in 25 year annual average baseflow, is purposefully more strict than the DRBC regulations in order to identify if the Schuylkill River is approaching a water stress situation. Also, the pre-development 1 in 25 year annual average baseflow is considerably more than the actual flows determined for shorter periods of time, such as the widely used

7Q10 (lowest weekly average flow with a recurrence interval of 10 years), or low flows experienced on certain days during the late summer (Figure 3-1).

This type of water budget does not include precipitation, runoff, and estimated evapotranspiration, but can provide reasonable conclusions about where water is withdrawn, consumed, and discharged throughout the Schuylkill River watershed. The groundwater and surface water withdrawals and discharges can be combined and separated in order to look at groundwater and surface water consumptive use both collectively and individually. The water budget is calculated for the whole Schuylkill River.

5.1 Observations by Category

Summarized below in Figure 5.1-1 is a pie chart showing the different water withdrawal categories. From Table 5.1-1, the two largest water withdrawals are for potable supplies and power sector needs.

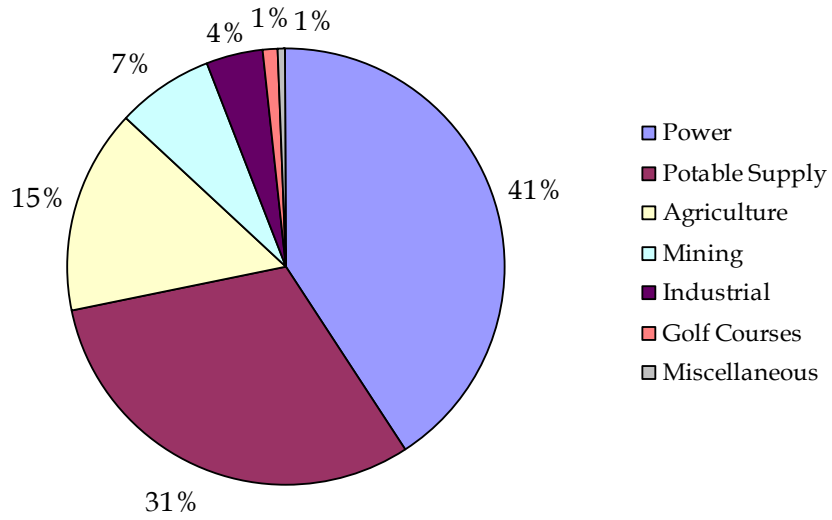

Figure 5.1-1 Categories of Total Water Withdrawals

Power sector use is the largest water withdrawal in the Schuylkill River watershed averaging 330 CFS, or 2.4 inches per year. However, the consumptive loss of the power sector is estimated to be only 16.3%, meaning the majority of the water withdrawn is returned to the river as cooling water return flow.

Potable water supply is the second largest water withdrawal at 248 CFS, or 1.8 inches per year. The consumptive use of potable water withdrawals is only 15%, so the majority of this water is returned to the watershed as treated wastewater.

The third largest water use, agriculture, is a combination of livestock needs, processing, and irrigation. These numbers are mostly estimates based on the most up to date agricultural census available. Agriculture withdraws twice the amount of water as the mining sector and over four times as much water as the industrial sector. One important facet of agricultural water use is that irrigation and livestock needs are assumed to be 100%

consumptive. This is in contrast to potable supply, which is assumed to be 15% consumptive, and mining, which is assumed to be 8% consumptive.

The assumptions made about consumptive use are directly reflected in the comparison of discharge categories in Figure 5.1-2. Wastewater treatment plants and the power sector discharge the most amount of water in the Schuylkill River watershed. The power sector releases 47% of all discharges in the Schuylkill River watershed, primarily from three facilities.

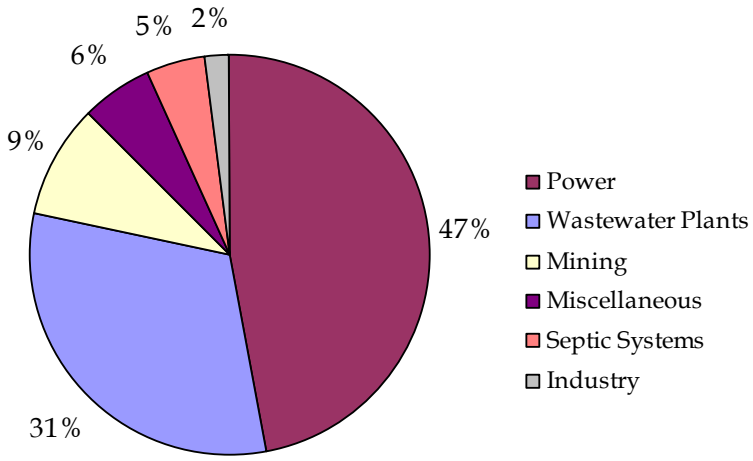

Figure 5.1-2 Categories of Total Water Discharges

When septic discharges are combined with wastewater treatment plant discharges, approximately 36% of all discharges, or 210 CFS, is returned to the Schuylkill River watershed in the form of treated wastewater (mainly secondary). This number may potentially be larger given limitations in estimation methodology and data collection.

Table 5.1-1 Summary of all Withdrawals and Discharges by Category

	Inches Per Year	MGD	CFS
Agricultural Processing			
Groundwater Withdrawal	0.0136	1.2	1.9
Surface Water Withdrawal	0.0014	0.1	0.2
Livestock Ground	0.0206	1.8	2.8
Irrigation Ground	0.8536	75.8	117.2
Golf Courses			
Surface Water Withdrawal	0.0328	2.9	4.5
Groundwater Withdrawal	0.0251	2.2	3.4
Industry			
Discharge	0.0864	7.7	11.9
Groundwater Withdrawal	0.1130	10.0	15.5
Surface Water Withdrawal	0.0826	7.3	11.3
Self-Supplied Ground	0.0611	5.4	8.4
Mining			
Discharge	0.3843	34.1	52.8
Groundwater Withdrawal	0.4207	37.3	57.8
Surface Water Withdrawal	0.0003	0.0	0.0
Miscellaneous			
Discharge	0.2477	22.0	34.0
Groundwater Withdrawal	0.0038	0.3	0.5
Surface Water Withdrawal	0.0078	0.7	1.1
Self-Supplied Ground	0.0197	1.7	2.7
Potable Groundwater			
Private Domestic	0.2072	18.4	28.5
Community	0.4037	35.8	55.4
Bulk	0.0001	0.0	0.0
Non-Transient Non-Community	0.0241	2.1	3.3
Transient Non-Community	0.0250	2.2	3.4
Potable Surface Water			
Community	1.1415	101.3	156.7
Power Sector			
Discharge	2.00	177.2	274.2
Groundwater Withdrawal	0.01	0.9	1.5
Surface Water Withdrawal	2.37	210.7	326.0
Wastewater			
Treated Wastewater Discharge	1.3349	118.5	183.3
Discharge to Septic Systems	0.1761	15.6	24.2
Additional Discharge to Septics	0.0200	1.8	2.7

5.2 Consumptive Use

The data from Section 4 is summarized and presented below in Tables 5.2-1 and 5.2-2. The detailed withdrawals and discharges can be found in the specific section of each water use category.

Table 5.2-1 Schuylkill River Watershed Consumptive Use

	Cons. Use %	Inches Per Year			MGD			CFS		
		With.	Dis.	Cons. Use	With.	Dis.	Cons. Use	With.	Dis.	Cons. Use
Total	27%	5.84	4.25	1.60	518.6	376.9	141.7	802	583	219
Surface Water	0.1%	3.64	4.05	-0.41	323.1	359.5	-36.3	500	556	-56
Groundwater	90%	2.20	0.20	2.01	195.5	17.4	178.1	302	27	275

Consumptive use in the Schuylkill River watershed above Philadelphia is 27% of all surface and groundwater withdrawals. The consumptive use of groundwater is striking at 90%. One reason for the high percentage is that groundwater is a significant drinking water resource and is returned to surface waters in the form of wastewater, rather than septic systems, spray irrigation, or other groundwater recharge mechanisms. There are also many groundwater withdrawals assumed in this analysis to be 100% consumptive, such as golf courses, agricultural irrigation, and livestock care. The transfer of groundwater to surface water is also reflected in the consumptive use of surface water, which reflects a net gain of 56 CFS.

Table 5.2-2 Consumptive Use Percentages of Select Water Use Categories

Water Use	Percentage Consumed	Inches Per Year Consumed	MGD Consumed	CFS Consumed
Golf Course Irrigation	100%	0.058	5.1	8
Irrigation	100%	0.854	75.8	117
Livestock Care	100%	0.021	1.8	3
Mining	8%	0.037	3.3	5
Potable Water Supply	15%	0.270	24.0	37
Power	16.3%	0.388	34.4	53

The category of water use that consumes the most water by volume is irrigation. The second largest consumptive use by volume is the power sector, which on average consumes 16.3% of all water withdrawn. This percentage was calculated from data provided by DRBC, detailed in Section 4.6.

Adequate data are not available to calculate the consumptive use of many categories, including industrial, self supplied commercial, self supplied industrial, miscellaneous, and agricultural processing. Additionally, it is difficult to compare how accurate the estimate of irrigation water use is given precipitation variability, crop needs, and agricultural practices.

In summary, consumptive use in the Schuylkill River watershed upstream of Philadelphia is estimated to be about 27%. This number is largely driven by the consumptive needs of agriculture, power production, and potable water supply.

5.3 Consumptive Use and Hydrology

The consumptive use, or difference between withdrawals and discharges, is tabulated in Table 5.1-1 above. Overall, withdrawals exceed discharges by 219 CFS when accounting for surface water and groundwater resources in the Schuylkill River watershed upstream of Philadelphia.

Interestingly, the results show a net gain of 56 CFS in the surface water only category, meaning that more water is discharged to rivers and streams than is withdrawn. This is due to the large amount of potable drinking water supply pumped from groundwater resources and returned to rivers by wastewater treatment plants.

The difference between groundwater withdrawals and discharges in the Schuylkill River watershed is 275 CFS, or 90% of all groundwater withdrawn. Only 10% of all groundwater withdrawn is returned to the subsurface. According to the water budget, the groundwater potable supply is being discharged as wastewater effluent to surface waters. Given the lack of availability of data that records discharges to groundwater after potable use, these numbers may be a slight over-estimation. However, it is unlikely that undocumented large-scale recharge of effluent or spray irrigation deployments exists.

To interpret how the observed consumptive use from total, surface, and groundwater resources relates to the hydrology of the Schuylkill River above Philadelphia, comparisons are made against natural low flows represented by the 1 in 10, 25, and 50 year annual average baseflow.

Table 5.3-1 Consumptive Use and Pre-development Annual Average Baseflow Upstream of Philadelphia

	Consumptive Use CFS	1 in 10 Year Baseflow 1165 CFS	1 in 25 Year Baseflow 989 CFS	1 in 50 Year Baseflow 840 CFS
Total Water	219	19%	22%	26%
Surface Water	-56	-5%	-6%	-7%
Groundwater	275	24%	28%	33%

The impact of upstream withdrawals on baseflow can be estimated through the relationship between consumptive use and baseflow calculated in Section 3.1.1 using data from Stuckey 2008. As mentioned earlier, the consumptive use calculated in this analysis represents flow that would be in the Schuylkill River if not for the needs of the Schuylkill River economy and population upstream of Philadelphia. The Chester County *Watersheds* plan identifies consumptive use that is 50% of the 1 in 25 year annual average baseflow as the indicator for a stressed groundwater supply. The Chester County 50% target was selected as an action level through deliberation between multiple stakeholders to provide a threshold after which consumptive use and water export would be restricted. In this water budget, the Chester

County example is useful for comparing the magnitude to which consumptive uses relates to the 1 in 25 year annual average baseflow.

Consumptive use of the Schuylkill River upstream of Philadelphia, according to the data used in this water budget, is 22% of the pre-development 1 in 25 year annual average baseflow. Given that the water budget was based on 2003 withdrawal and discharge data, the results broadly imply that the Schuylkill River watershed above the City of Philadelphia is not in a water stress situation. This does not conclude that certain municipalities or sub-watersheds are not facing water stress; it just implies that on a whole, the watershed area upstream of Philadelphia is not. The relationship of this conclusion to the ability of the Schuylkill River to provide drinking water to Philadelphia is examined in the following section.

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Section 6 Schuylkill River Water Availability to PWD

The overall goal of this study is to perform a preliminary assessment of the availability of drinking water to Philadelphia from the Schuylkill River. In order to do this, a two step process was chosen that begins with the calculation of upstream consumptive use using a water budget. The results of the upstream water budget are then added to the daily average withdrawal to calculate if the freshwater portion of the Schuylkill River watershed including Philadelphia is in a water stress situation. As used previously, a consumptive use that is 50% of the pre-development 1 in 25 year annual average baseflow will be used to identify a water stress situation. The PWD Schuylkill withdrawal is assumed to be 100% consumptive in this analysis because the water is returned outside of the freshwater portion of the river, which is currently the only portion of the watershed available for drinking water supply.

The PWD daily average withdrawal is not originally included in the water budget (Sections 4-5) because the goal of that exercise is to observe upstream consumptive use only. Table 6.1-1 below combines the results of upstream consumptive use and the PWD consumptive use to observe water stress of the freshwater system.

Table 6.1-1 Consumptive Use Compared to Pre-development Flows

	Consumptive Use CFS	1 in 10 Year Baseflow 1165 CFS	1 in 25 Year Baseflow 989 CFS	1 in 50 Year Baseflow 840 CFS
Schuylkill Upstream of Philadelphia				
Total Water	219	19%	22%	26%
Surface Water	-56	-5%	-6%	-7%
Groundwater	275	24%	28%	33%
Philadelphia Schuylkill Withdrawals				
Daily Average	193	17%	20%	23%
Total Schuylkill Results				
Total Upstream and PWD Daily Average Withdrawal	412	35%	42%	49%

When the total upstream consumptive use is added to PWD withdrawals, the total Schuylkill consumptive use is 42% of the pre-development 1 in 25 year annual average baseflow. This calculation indicates that the freshwater Schuylkill River is approaching a water stress situation.

The results here show that the upstream consumptive use (22%) is slightly larger than the PWD daily average withdrawal consumption (20%). One of the goals of this analysis was to calculate and compare these two figures. Although the upstream consumption value is largely influenced by previously discussed assumptions, very large changes in the input data would be required to alter the conclusion that upstream consumptive use and average

Philadelphia consumptive use are comparable. Taking these two consumption factors together, on average, the consumptive use of the freshwater Schuylkill River is 42% of the pre-development 1 in 25 year annual average baseflow, and therefore approaching a water stress situation.

If one considers that on average, 5% of the time flows are even lower than 50% of the pre-development 1 in 25 year annual average flow, then the situation of a stressed river is even more apparent. The explicit water quantity and water quality consequences of such a situation are unknown. Potential issues include drinking source water quality deterioration due to high percentages of wastewater effluent and ecological fragility due to combined water quality, temperature, and quantity stresses. These issues are briefly explored in the following sections to put the results in context with existing PWD observations of the Schuylkill River source water supply.

6.1 Wastewater Discharge

PWD is currently studying the influence that treated wastewater effluent has on Schuylkill River water quality and the Philadelphia intakes, particularly during low streamflow periods. Information obtained during the water budget analysis is used here to estimate the amount of treated wastewater effluent that is present in the Schuylkill River under a range of streamflow conditions. It is important to note here that PWD has never violated any of the Safe Drinking Water Act regulations governing the quality of finished potable water. The amount of wastewater effluent in the Schuylkill River is calculated here as a tool used to guide PWD investigations into the relationship between wastewater discharge, drinking water supply protection, and long term and recent water quality observations.

As identified in Section 4.2, approximately 210 CFS of treated wastewater is released into the Schuylkill River watershed. There is not a large enough period of record at the Norristown streamflow gauge to calculate the 7Q10 low flow statistic. However, the 7Q10 calculated for the Schuylkill River at Fairmount Dam is 245 CFS (1978-2008 post Blue Marsh Reservoir construction). Given the relationship observed in Section 3.2 between the two gauges during low flows, it is estimated here that the 7Q10 at Norristown is 345 CFS.

According to the estimated 7Q10 of the Schuylkill River at Norristown, when the river approaches these conditions, approximately 61% of the water approaching Philadelphia is wastewater effluent.

Figure 6.1-1 presents how frequently specific percentages of wastewater in the streamflow approaching Philadelphia actually occur. During low flow periods, when the streamflow begins to decrease from 989 CFS, the percentage of wastewater treatment plant discharge reaching the intake begins at 20% and increases to 61% when streamflow falls to the estimated Norristown 7Q10 of 345 CFS.

The graph shows that 20% of the time, the Schuylkill River approaching Philadelphia is 20% wastewater (red line). Ten percent of the time, when the streamflow is at or below 600 CFS, the wastewater contribution is approximately 34%. During critical low flow periods, when the streamflow drops to the estimated 7Q10 of 345 CFS, the wastewater contribution is 61%. These critical low flow periods occur approximately 3% of the time (red line).

When the flow duration data supplying Figure 6.1-1 is limited to the months of July, August, and September only (blue line), high percentages of wastewater content in the streamflow approaching Philadelphia occur more frequently. The blue line simulates the seasonally dry months of the mid-late summer. During these months, the water approaching Philadelphia is approximately 46% treated wastewater discharge for 10% of the time.

Although the contribution of wastewater to the Schuylkill River is significant during dry periods, it is critical to mention that this has never driven PWD to violate any Safe Drinking Water Act regulations of finished potable drinking water. The presence of wastewater effluent in the Schuylkill River does not make PWD unique among drinking water providers that withdraw from large rivers. Understanding the relationship between wastewater effluent and water quantity must occur before any study between water quality and effluent can begin.

The water budget results have provided PWD with a preliminary understanding of the presence of wastewater effluent in the river during varying conditions, and will be used to explore the relationship between effluent discharge and source water quality.

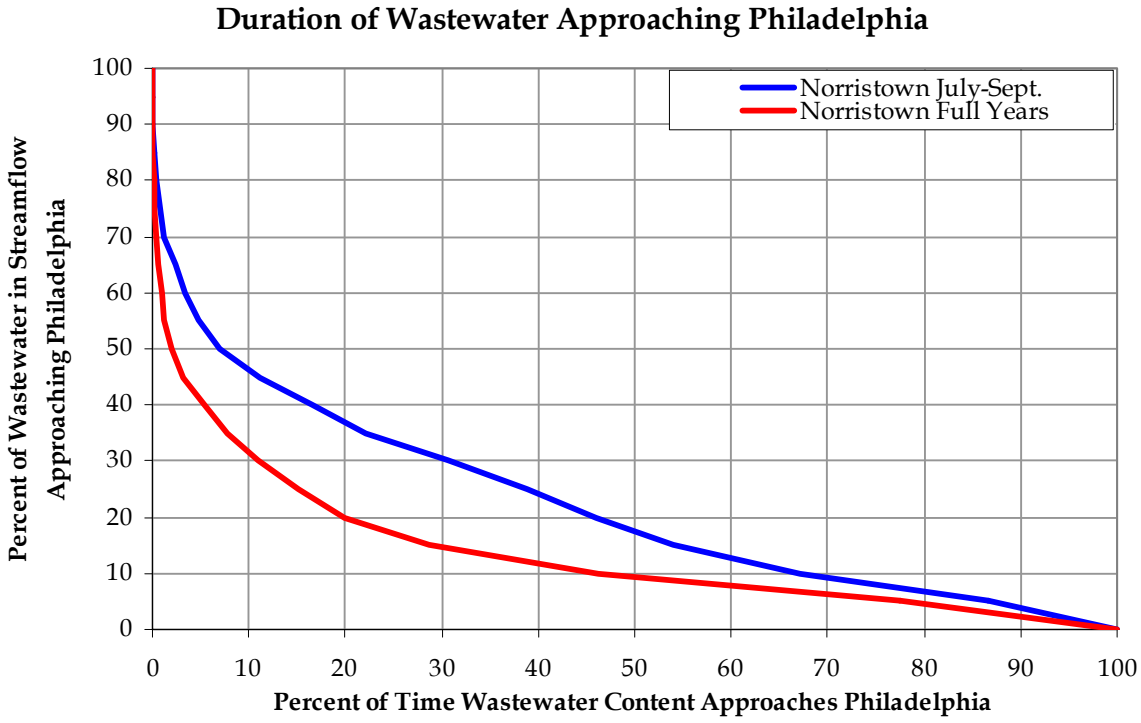

Figure 6.1-1 Duration of Percentage of Wastewater Approaching Philadelphia

6.2 Ecological Health

The relationship between existing water quantity stress, seasonal water quality changes, and ecological health is poorly understood in the Schuylkill River riparian and aquatic ecosystems. As a drinking water provider, PWD has a vested interest in maintaining the ecological integrity of the drinking water supply. Healthy communities of plants, aquatic vertebrates and invertebrates are indicative of high water quality and ultimately a superior drinking water supply.

Seasonally dry periods, where the streamflow vacillates around the 95th percentile of streamflow at Norristown (400 CFS) and the wastewater contribution exceeds 50%, occur each summer as indicated above. This can lead to poor Schuylkill River water quality. The dynamics of how this situation impacts Schuylkill River ecology are unclear, but one incidence in 2008 made it clear to PWD that a greater understanding of these dynamics is critical to source water protection and management.

Late in the summer of 2008 a massive clam die off (*Corbicula fluminea*) occurred between 8/20/08 and 9/6/08. This date range includes the beginning of the event, the cessation of clam die off, and the return to normal water quality conditions. The cause of the clam kill has not been established, but the event is relevant to the discussion of low streamflow and water quantity composition given how the clam kill exacerbated already stressed water quality conditions and may have been exacerbated itself by stressed water quantity conditions.

Figure 6.2-1 below presents two streamflow records, Fairmount Dam and Pottstown in yellow and blue, the flow target below which Exelon must replace the amount of water consumed by the Limerick Generating Station in green, and the 95th percentile of streamflow approaching Philadelphia in black (Norristown stream gauge). During this clam kill event, the first sign of perturbation was a jump in pH at Norristown on August 21 from 7.5 to 9 in less than 24 hours. The pH at Norristown remained above 9 until August 28 when it declined back to 7.5 three days later. The water quality conditions were exacerbated by the accumulation of entrained decomposing clams behind Fairmount Dam. Ammonia levels rose from 0.02 mg/L to 0.43 mg/L at the Belmont intake between August 29 and September 1, during which time the treatment plant experienced rapid fouling of the filters in addition to poor raw water quality.

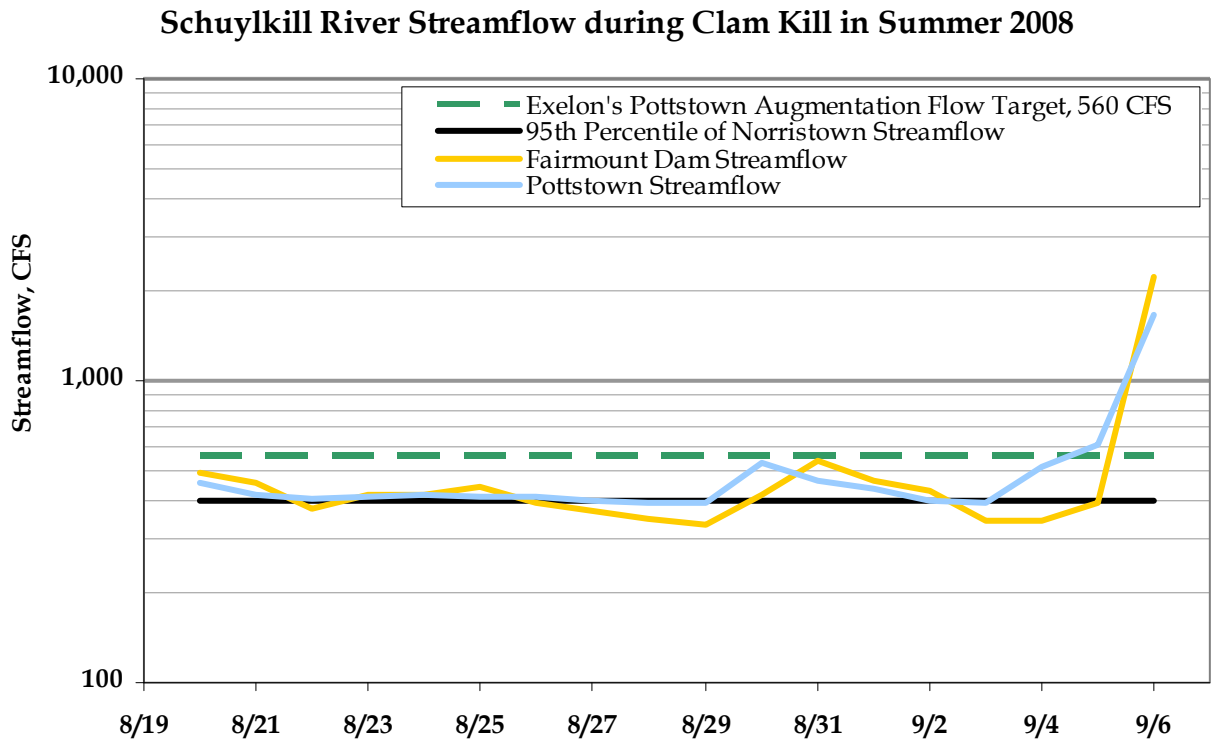

Figure 6.2-1 Clam Kill Example

No relationship between the cause of the clam kill and streamflow conditions has been established, but it cannot be ignored that streamflow levels of the Schuylkill River during this event were extremely low. The streamflow at Fairmount Dam is lower than the streamflow at Pottstown throughout the event, which is highly irregular given the drainage area to Fairmount Dam is 747 square miles larger than that to the Pottstown gauge. The reduction of streamflow at Fairmount Dam in relation to upstream gauges is similar to what was observed between the Norristown and Fairmount gauges in Section 3.2.

It may never become clear what triggered the mass die off of clams from Pottstown to Philadelphia, but water quality improvement was observed at the Belmont intake when streamflow increased following rainfall events between September 4 and 5. During the clam kill, streamflow at the Fairmount Dam was approaching 7Q10 conditions (event minimum of 343 CFS on August 29) and the flow at Pottstown was below the Exelon flow augmentation trigger, where up to 65 CFS is pumped from a mine and reservoir in Schuylkill County to replace the consumptive losses from Limerick Generating Station.

The clam kill is mentioned here to highlight that low flows composed largely of wastewater treatment plant effluent do occur, there are routine water quality implications associated with low flow events and compounding events such as the clam kill. This example also demonstrates how policies such as the Exelon flow augmentation trigger must be maintained as not to deprive the lower Schuylkill River of critical freshwater during low streamflow periods.

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Section 7 Conclusions and Future Studies

The critical observations and conclusions from this water budget analysis will be used by PWD to advance its understanding of Schuylkill River drinking source water availability.

7.1 Critical Observations

The streamflow gauge at Fairmount Dam does not represent drinking water availability to PWD. The streamflow gauge at Norristown is the most representative of Schuylkill River drinking water availability to the City of Philadelphia. The Fairmount Dam gauge reflects the amount of water remaining in the Schuylkill River after PWD has made withdrawals and is not appropriate for analysis of actual supply to Philadelphia. It is critical that PWD has a monitoring location that is indicative of the amount of water available to the drinking water intakes that can be studied for long term and seasonal hydrological trends. For this purpose, Norristown is the nearest upstream gauge, and closely reflects the amount of water available to PWD for drinking water withdrawals.

In the summer in the past ten years, the Schuylkill does not provide Philadelphia's maximum demand 100% of the time. Two percent of the time in the past ten years, the maximum demand of 286 CFS cannot be provided by the Schuylkill River. When a hypothetical pass-by requirement of 100 CFS is added onto the maximum demand and compared to availability, in the past ten years the Schuylkill River could not have provided this flow (386 CFS) 6% of the time. Independent of the water budget results, this observation implies that the Schuylkill River is already in or approaching a water stress situation because it is currently not capable of meeting the drinking water needs of Philadelphia 100% of the time.

The Schuylkill River is approaching water stress conditions. Combined upstream and downstream consumptive use total 42% of the 1 in 25 year annual average baseflow, which means the Schuylkill River is approaching a water stress situation. The upstream consumptive use is 22% and the downstream consumptive use is 20% of the pre-development 1 in 25 year annual average baseflow. Water stress implies a threshold past which water availability for all uses is compromised and growth (particularly in the power sector) will need to be curtailed by the lack of available water. This observation indicates that expansion of consumptive use upstream ultimately decreases the amount of water available to Philadelphia for drinking water supply. The water budget results also confirm the prior observation that the Schuylkill River is approaching a water stress situation because it cannot meet Philadelphia's drinking water demand 100% of the time.

Wastewater can compose up to 60% of the streamflow of the Schuylkill River. The total Schuylkill River watershed wastewater discharge was estimated to be 210 CFS. During dry conditions when the streamflow approaches the current 7Q10 flow rate at Norristown, the Schuylkill River water approaching Philadelphia is 60% treated wastewater for more than one week at a time. On some days, the Schuylkill River water approaching Philadelphia is over 90% treated wastewater.

The impacts of such large quantities of discharged treated wastewater are not fully understood. Upon identification of the significant presence of treated wastewater in the drinking water supply, PWD has begun investigating any drinking water quality and quantity implications. The majority of wastewater treatment facilities in the Schuylkill River watershed employ secondary treatment technology and there are known upstream combined sewer overflows and sewers that carry waste to the river without even primary treatment; only 6 out of 137 facilities included in the water budget employ tertiary treatment technology. Although no Safe Drinking Water Act violations have occurred at the PWD intakes, it is critical for PWD to understand the watershed wide ecological, water quality, and water quantity implications to the drinking source water supply of such large volumes of discharged wastewater.

Downstream drinking water, ecological, and recreational needs must be considered in Blue Marsh operational policies. Blue Marsh Reservoir makes releases during low streamflow periods for Tulpehocken Creek fisheries and salinity repulsion in the tidal Delaware River. It is critical that these releases continue and new releases are established. The 7Q10 of the Schuylkill River increases 255% when pre-construction Blue Marsh and post-construction Blue Marsh operational periods are compared. Even given that observation, all of the water quantity conclusions that imply the Schuylkill River is approaching water stress are made with data representative of the operational period. The post-Blue Marsh period encompasses dates used to calculate the observations made in the following: Section 3.2, that the PWD maximum daily withdrawal is not provided by the river 100% of the time; Section 6, that identifies the Schuylkill as water stressed; Section 6.1, that identifies the river can climb to over 90% wastewater effluent; and Section 6.2, detailing a wide ranging ecological disturbance with water quality implications. It is reasonable to conclude that the water quantity challenges observed in this analysis would be exacerbated by any reduction in releases from this critical body. PWD plans to begin a more detailed study of Blue Marsh Reservoir in order to understand its operations, inflow and release dynamics, water quality, recreational use, and demands. PWD would like to see downstream drinking water, ecological, and recreational needs incorporated into the release goals of Blue Marsh Reservoir.

Enhanced data collection and validation activities are critical to water supply management. The water budget approach, which is data intensive, is heavily influenced by the accuracy and availability of the data used. Therefore, the results of any water budget are imprecise and must be broadly interpreted to accommodate data errors and assumptions. Whether using a water budget or dynamic modeling approach, data collection is critical to increasing the precision of results that will guide water supply management. For this exercise, the PADEP had recently obtained vast amounts of water use information for 2003 as a part of the Act 220 registration requirements. PADEP was generous enough to share the data with PWD for use throughout this analysis. Data accuracy problems were observed however, and corrected when observed. Additional steps are needed to validate the data accuracy and assess completeness of data by category.

7.2 Conclusions

The critical observations generated from this analysis lead PWD to conclude a Schuylkill River streamflow objective at Norristown should be studied.

It was observed that the Schuylkill River is approaching a water stress situation. Given this observation, meeting the drinking water demands of communities in the Schuylkill River watershed must be a watershed management priority. Additionally, since it has been observed that any increases in upstream consumptive use will directly reduce the drinking water availability to Philadelphia, the Schuylkill River must be managed so that both upstream and downstream needs are met. In order to guarantee a reliable drinking water supply to Philadelphia from the Schuylkill and Delaware Rivers, PWD feels that a streamflow objective at Norristown is necessary to study and consider.

The streamflow objective will provide a distinction between adequate and inadequate water supply below Norristown, linking hydrological observations, ecological needs, recreation, and drinking water supply availability. PWD has begun to investigate what streamflow objective at Norristown would be most protective of the Philadelphia Schuylkill River and Delaware River drinking water supplies in the short and long term.

Examination of an estimated minimum Schuylkill flow target at Norristown to protect Lower Schuylkill River drinking water supply and ecological needs under current and future conditions is critical. Any estimate of current conditions is highly subject to change, because it does not include:

1. Climate change impacts on drought, precipitation, and hydrology
2. Sea level rise changes to salinity dynamics at the Baxter intake
3. Increases in upstream consumptive use
4. Ecological flow needs between Norristown and the Schuylkill confluence
5. Increases in freshwater sodium and chloride concentrations

7.3 Additional Studies

This analysis provides PWD with preliminary water quantity results that will be used to inform future studies of the Schuylkill River water supply. Using the conclusions of this analysis as a guide, PWD's short term and long term next steps include the following studies:

- Short term - Blue Marsh Reservoir operation and capacity
- Short term - Seasonal water withdrawal and discharge variability
- Long term - Wastewater effluent and water quality
- Long term - Ecological health and water quality and quantity stressors
- Long term - Study of rainfall runoff relationship dynamics and influences

7.4 Summary of Findings

The results obtained from Sections 3, 4, 5, and 6 are categorized and itemized here for reference.

Low Streamflow Conditions

- When the Schuylkill River streamflow falls to the Norristown estimated 7Q10 value of 345 CFS, 61% of that flow is wastewater treatment plant effluent. At the 95% flow exceedence value of the Norristown streamflow gauge, 50% of the Philadelphia withdrawals are composed of wastewater treatment plant effluent.
- When the streamflow begins to decrease from 989 CFS, the percentage of wastewater treatment plant discharge reaching the intake begins at 20% and increases to over 90% when streamflow falls to its lowest drought levels.
- It has been observed that under some low flow conditions, the streamflow at Fairmount Dam is less than the streamflow at Pottstown and Norristown, regardless of the increase in drainage area.

PWD Demand

- The PWD Schuylkill River maximum daily withdrawal is 286 CFS, and the daily average withdrawal is 193 CFS.
- PWD withdraws the amount of water that enters the Schuylkill River between Norristown and Fairmount Dam from natural and point sources, plus an additional 100 CFS.
- PWD maximum daily withdrawal is not provided by the river 100% of the time.
- PWD daily average withdrawal is 20% of the 1 in 25 year annual average baseflow.

Schuylkill River Hydrology

- The continuing operation of Blue Marsh Reservoir is critical to maintaining the Schuylkill River as a drinking water source to Philadelphia, for quantity and quality considerations.

Water Availability

- Any policies that reduce the streamflow at Norristown will directly reduce water availability to PWD.
- PWD demands are nearly the same as the seasonal low flows of the Schuylkill River below Norristown.
- Maintenance of consumptive use at or below the current level is critical, and Exelon Limerick and Blue Marsh policies are critical for augmentation.
- Current total consumptive use, including PWD, is approaching 50% of the 1 in 25 year annual average baseflow, indicative of water stress in this study.
- The most consumptive sectors are agricultural irrigation and the power industry.
- The largest water consumers in the Schuylkill River watershed are Exelon Limerick and PWD.

Water Budget

- 52% and 48% of the upstream population is supplied by surface water and groundwater, respectively, and 20% of the population is on private wells.
- Upstream consumptive use, excluding Philadelphia, is 27% (219 CFS).
- Upstream groundwater consumptive use is 90%.
- Upstream surface water consumptive use shows a net gain of 0.1% due to the transfer of groundwater to surface discharging wastewater treatment plants.
- Upstream consumptive use is 22% of the pre-development 1 in 25 year annual average baseflow.
- PWD consumptive use is 20% of the pre-development 1 in 25 year annual average baseflow.
- Total Schuylkill consumptive use is 42% of the pre-development 1 in 25 year annual average baseflow, approaching the 50% threshold indicative of water stress.
- The largest water withdrawals and discharges are from the power industry.

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References

PSU (2005). Water Facts #2 : Water System Planning-Estimating Water Needs, Pennsylvania State University: College of Agricultural Sciences-Cooperative Extension.

PSU (2009). Length of Growing Season, Pennsylvania State Climatologist.

Sloto RA and Buxton DE (2006). Estimated ground-water availability in the Delaware River Basin, 1997-2000. USGS. **SIR 2006-5125**.

Stuckey MH (2008). Development of the Water-Analysis Screening Tool used in the Initial Screening for the Pennsylvania State Water Plan Update of 2008. USGS. **OFR 2008-1106**.

USDA (2002). Census of Agriculture Pennsylvania, National Agricultural Statistics Service, Agricultural Statistics Board.

USGS (2005). 2001 National Land Cover Dataset.

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Appendix A Data

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Table A-1 Community Supplies from EPA SDWIS

Additional Community Supplies	Population Served	Withdrawal Sub-Watershed
ABRAXAS ACADEMY	45	Hay Creek
AQUA PA EAST POINTE	29	Middle Schuylkill 3
AQUA PA HILLCREST ESTATES II	270	Upper Schuylkill
AQUA PA STONECROFT	25	Tulpehocken Creek
BERKS LEISURE LIVING HOME	27	Tulpehocken Creek
BIG O MOBILE HOME PARK	61	Manatawny Creek
BUCKS RUN APARTMENTS	120	Perkiomen Creek
MEADOWBROOK WATER SYSTEM	85	Perkiomen Creek
MOHRSVILLE WATER ASSN	375	Upper Schuylkill
PARK PLACE	29	Maiden Creek
PAW GOLDEN OAKS	95	Manatawny Creek
SK PROPERTIES LP MISTY MEADOWS	60	Middle Schuylkill 3
SPRUCE COURT APARTMENTS	100	Middle Schuylkill 2
ST STEPHENS GREEN	130	French Creek
VALLEY FORGE CROSSING MHP	250	Middle Schuylkill 1
VALLEY RUN WATER SYSTEM	50	Perkiomen Creek
These additional community water systems were identified through a search of the SDWIS database, and support from Lori Ruesskamp from PADEP. These systems were not included in the list of Community Water Supplies provided by PADEP (Michael Hill) via a GIS map of service area.		

Table A-2 Groundwater Withdrawals of Primary Surface Water Systems

System Name	GPD
Aqua PA Main System	8,377,432
East Greenville Waterworks	170,864
Hamburg Boro Municipal Authority	772,414
North Penn Water Authority	1,280,833
North Wales Borough Water	805,717
Wernersville Municipal Authority	436,953
Total	**11,844,213**

Table A-3 Potable Water Supplies Accounted For

Water System Name	Withdrawal, GPD	Primary Source	System Type	Withdrawal Sub-Watershed
183 PLAZA	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
ABRAXAS ACADEMY	15,000	GROUND	Community	Hay Creek
ABUNDANT LIFE ASSEMBLY OF GOD	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ACOPIAN CENTER	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
ACTION IMPACT	5,000	GROUND	Trans. Non-Comm.	French Creek
AIR PRODUCTS AND CHEMICALS INC	15,000	GROUND	Non-Trans. Non-Comm.	Little Schuylkill
ALBANY TWP ELEM SCH	1,800	GROUND	Non-Trans. Non-Comm.	Maiden Creek
ALEXANDERS AT NEW JERUSELEM	385	GROUND	Trans. Non-Comm.	Manatawny Creek
ALEXS TAVERN	3,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ALLEGHENY EAST CONF	4,000	GROUND	Non-Trans. Non-Comm.	Manatawny Creek
ALLSTAR CAFÉ	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ALLSTAR GRILLE AND PIZZERIA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ALMOST HOME CHILDRENS CTR	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
ALSACE CHRISTIAN FELLOWSHIP	250	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ALSACE MANOR FIRE CO	50	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
AMATOS PIZZA	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
AMBLER BORO WATER DEPT	2,000,000	GROUND	Community	Wissahickon Creek
AMER HOUSE OF FRITZTOWN	200	GROUND	Trans. Non-Comm.	Tulpehocken Creek
AMER HUNGARIAN SPORTS CLUB	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
AMITY AC SWIMMING POOL	3,250	GROUND	Trans. Non-Comm.	Monocacy Creek
AMITY FIRE CO	450	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ANDORRA SPRING WATER COMPANY	50	GROUND	Vended	Lower Schuylkill
ANGELOS DINER	1,050	GROUND	Trans. Non-Comm.	Perkiomen Creek
APPALACHIAN CAMPSITES	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
AQUA PA EAST POINTE	5,000	GROUND	Community	Middle Schuylkill 3
AQUA PA FLYING HILLS WA SYS	198,143	GROUND	Community	Middle Schuylkill 3
AQUA PA GEIGERTOWN WATER SYS	16,000	GROUND	Community	Hay Creek
AQUA PA GREEN HILLS CORP CNTR	30,000	GROUND	Non-Trans. Non-Comm.	Allegheny Creek
AQUA PA HILLCREST ESTATES II	5,000	GROUND	Community	Upper Schuylkill
AQUA PA MAIN SYSTEM	3,595,342	SURFACE	Community	Pickering Creek
AQUA PA MAIN SYSTEM	4,901,554	SURFACE	Community	Middle Schuylkill 1
AQUA PA MAIN SYSTEM	15,204,969	SURFACE	Community	Perkiomen Creek
AQUA PA MAIN SYSTEM	23,825,229	SURFACE	Community	Middle Schuylkill 2
AQUA PA PERKIOMEN TOWNSHIP	162,000	GROUND	Community	Perkiomen Creek
AQUA PA PERKIOMEN WOODS	90,000	GROUND	Community	Perkiomen Creek
AQUA PA STONECROFT	5,000	GROUND	Community	Tulpehocken Creek
AQUA PA UWCHLAN	2,010,000	GROUND	Community	Pickering Creek
AQUABILITIES	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
ARBYS RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
ARIELLES COUNTRY INN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ARKEMA INC	50,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
ARROWHEAD GC	1,000	GROUND	Trans. Non-Comm.	Monocacy Creek
AUBURN MUNICIPAL AUTHOUITY	70,000	SURFACE	Community	Upper Schuylkill
AUDUBON MART	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
AUDUBON WATER COMPANY	833,758	GROUND	Community	Middle Schuylkill 1
AVANTE APARTMENTS	15,000	GROUND	Community	Perkiomen Creek

B & G LUNCH INC	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
BABY DOLLS	700	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
BALANCED WELLNESS CENTER	100	GROUND	Trans. Non-Comm.	Maiden Creek
BALLY MEDICAL CTR	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BALLY MUNI WATER WORKS	218,000	GROUND	Community	Perkiomen Creek
BARTO HOTEL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BARTO SHELL	250	GROUND	Trans. Non-Comm.	Perkiomen Creek
BASILES ITALIAN DELIGHT	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
BAY PONY INN AT LEDERACH	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BC MONTESSORI COUNTRY DAY SCH	5,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
BCIU ALSACE SCH BLDG	1,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
BEACHCOMBER SWIM CLUB	1,500	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
BEAR ROCK JUNCTION MINI GOLF	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
BECHTELSVILLE SVC CTR	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BEHLER PATTERNS INC	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BELLA PIZZERIA	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
BELLEMANS UNION CH	215	GROUND	Trans. Non-Comm.	Upper Schuylkill
BEREAN BIBLE CHURCH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
BERKLEIGH CC	1,050	GROUND	Non-Trans. Non-Comm.	Maiden Creek
BERKLEIGH HEIGHTS MHP INC	10,000	GROUND	Community	Maiden Creek
BERKS HOMES	5,000	GROUND	Non-Trans. Non-Comm.	Allegheny Creek
BERKS LEISURE LIVING HOME	3,000	GROUND	Community	Tulpehocken Creek
BERN REFORMED UCC	800	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BERN TWP REC ASSN SWIM POOL	2,500	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BERNVILLE BORO AUTH	47,824	GROUND	Community	Tulpehocken Creek
BERNVILLE FAMILY PRACTICE	500	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BERNVILLE GRANGE NO 1887	245	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BERTIES INN	210	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
BETH ISRAEL SYNOGOGUE	1,000	GROUND	Trans. Non-Comm.	Pickering Creek
BETHANY CHILDRENS HOME	21,924	GROUND	Community	Tulpehocken Creek
BETHANY EVAN CONGREGATION CH	64	GROUND	Trans. Non-Comm.	Perkiomen Creek
BETHEL CHURCH/MONTESSORI	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
BETHEL ELEMENTARY CENTER	3,200	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
BIG BERTHAS GRILL	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BIG H FARMS PLANT 1	11,000	GROUND	Trans. Non-Comm.	Maiden Creek
BIG H FARMS PLT 2	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
BIG O MOBILE HOME PARK	3,500	GROUND	Community	Manatawny Creek
BIG SPRING VENDED WATER	5,000	GROUND	Vended	Tulpehocken Creek
BILLS PRODUCE	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BIRCHRUNVILLE CAFÉ	5,000	GROUND	Trans. Non-Comm.	French Creek
BIRDSBORO MUNI WATER AUTH	550,000	SURFACE	Community	Hay Creek
BLACK DOG CAFÉ	500	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BLACKWOOD GC	700	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
BLUE FALLS GROVE INC	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
BLUE MARSH CANTEEN	300	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BLUE MARSH LAKE VISITORS CTR	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BLUE MOUNTAIN ACAD	11,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BLUE MOUNTAIN BANQUET HALL	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BLUE MOUNTAIN CAMP	8,500	GROUND	Trans. Non-Comm.	Upper Schuylkill

BLUE MOUNTAIN HIGH SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BLUE MT 7 DAY ADVENTIST SCH	500	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BLUE MT CHRISTIAN RETREAT #1	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
BLUE MT CHRISTIAN RETREAT #2	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
BLUE MT CHRISTIAN RETREAT #3	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
BLUE MT CHRISTIAN RETREAT #4	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
BLUE MTN COOP TILDEN IND PARK	60,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BLUE MTN ELEMENTARY WEST	1,900	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BLUE MTN FAMILY RESTAURANT	1,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BLUE RIDGE HOTEL	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BLUE ROCKS CAMPGROUND	2,750	GROUND	Trans. Non-Comm.	Maiden Creek
BLUE SPRUCE MKT	200	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BLUEGRASS FOLDING CARTON CO	24,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
BLYTHE TWP MUNICIPAL AUTHORITY	1,334,000	SURFACE	Community	Upper Schuylkill
BOBS HAVEN DELI	5,000	GROUND	Trans. Non-Comm.	French Creek
BODKIN AUTOMOTIVE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BOGGS MARKET	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BOROUGH OF DUBLIN	110,000	GROUND	Community	Perkiomen Creek
BOULDER WOODS CAMPGROUND	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BOYERS FOOD MKT	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
BOYERS FOOD MKT	3,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BOYERS MARKET AND CATERING	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
BOYERTOWN EARL ELEM SCH	2,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
BOYERTOWN MUNI AUTH	860,000	SURFACE	Community	Manatawny Creek
BOYERTOWN PINE FORGE ELEM SCH	2,000	GROUND	Non-Trans. Non-Comm.	Manatawny Creek
BOYERTOWN ROD & GUN CLUB INC	210	GROUND	Trans. Non-Comm.	Manatawny Creek
BRECKNOCK TWP FIRE CO	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
BRICK TAVERN INN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
BRIDGES RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
BRUSH WELLMAN INC	101,507	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
BUCKS RUN APARTMENTS	7,100	GROUND	Community	Perkiomen Creek
BURN BRAE DAY CAMP OF CREATIVE	2,500	GROUND	Trans. Non-Comm.	Wissahickon Creek
BUTTER VALLEY GOLF PORT	3,125	GROUND	Trans. Non-Comm.	Perkiomen Creek
C & C PIZZA	250	GROUND	Trans. Non-Comm.	Tulpehocken Creek
C & D CATERING	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
C S GARBER WELL DRILLING	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
CACOOSING GUN CLUB	5,000	GROUND	Trans. Non-Comm.	Allegheny Creek
CACOOSING MEADOWS REC AREA	100	GROUND	Trans. Non-Comm.	Tulpehocken Creek
CAFE 663	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CALABRIA RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
CALVARY UNITED CH OF CHRIST	114	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMEL INN	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CAMELOT INN	245	GROUND	Trans. Non-Comm.	Tulpehocken Creek
CAMP ADAHI & ADAHI KIDS	5,000	GROUND	Non-Trans. Non-Comm.	Allegheny Creek
CAMP CALVARY	3,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
CAMP ED MAR	400	GROUND	Trans. Non-Comm.	Maiden Creek
CAMP ESPERANZA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
CAMP GREEN LANE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP INNABAH	5,000	GROUND	Trans. Non-Comm.	French Creek

CAMP JOY	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP KWEEBEC	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP LAUGHING WATER GSSEPA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP MANATAWNY	600	GROUND	Trans. Non-Comm.	Manatawny Creek
CAMP MENOLAN E CONF MENNONITES	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP RAINBOW	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP SANKANAC	5,000	GROUND	Trans. Non-Comm.	French Creek
CAMP TWEEDALE	5,000	GROUND	Trans. Non-Comm.	Valley Creek
CAMP UNAMI	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CAMP WELKINWEIR	5,000	GROUND	Trans. Non-Comm.	French Creek
CAMPBELL MFG INC	2,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
CAMPHILL VILLAGE USA INC	8,000	GROUND	Community	French Creek
CAMPS ARTHUREETA	5,000	GROUND	Trans. Non-Comm.	Wissahickon Creek
CANDYS HOMEMADE ITAL ICES	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CARMINE PARKSIDE DELI	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
CARON FOUNDATION	20,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
CEDARS PUB	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CEGEES DRIVE IN	500	GROUND	Trans. Non-Comm.	Maiden Creek
CENTER SQUARE GOLF COURSE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
CENTRAL PERKIOMEN PARK	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CHARLESTOWN PLAY HOUSE	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
CHEERS TAVERN STAGECOACH INN	385	GROUND	Trans. Non-Comm.	Perkiomen Creek
CHIAROS GREEN LANE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CHIAROS SKIPPACK	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
CHICCARINES RESTAURANT	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
CHRIST EVAN LUTH CH	215	GROUND	Trans. Non-Comm.	Manatawny Creek
CHRIST LUTH CH	143	GROUND	Non-Trans. Non-Comm.	Manatawny Creek
CHRISTINES CREEKSIDE INN	5,000	GROUND	Trans. Non-Comm.	Hay Creek
CHRISTMAS PINES CAMPGROUND	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CLAUSERS MINI MARKET AUBURN	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CLOUD NINE SHOWBAR	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
COLEBROOKDALE CHAPEL	300	GROUND	Trans. Non-Comm.	Manatawny Creek
COLLEGEVILLE PARK WATER ASSOC	28,800	GROUND	Community	Perkiomen Creek
COLLEGEVILLE TRAPPE JOINT PWD	638,000	GROUND	Community	Perkiomen Creek
COMM FIRE CO OF VIRGINVILLE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
COMMUNITY FIRE CO OF FRITZTOWN	280	GROUND	Trans. Non-Comm.	Tulpehocken Creek
CONGREGATION OF JEHOVAH WITNES	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
CONSERVATIVE BAPTIST BRETH CH	80	GROUND	Trans. Non-Comm.	Tulpehocken Creek
COOK TECHNOLOGIES INC	1,650	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
CORNER PANTRY	50	GROUND	Trans. Non-Comm.	Monocacy Creek
CORNERSTONE PLAZA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
COUNTRY ACRES MHP	14,000	GROUND	Community	Tulpehocken Creek
COUNTRY CHEFS KITCHEN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
COUNTRY COMMONS YOUNGS MARKET	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
COUNTRY FARE RESTAURANT	6,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
COUNTRY HILLS APTS	5,000	GROUND	Community	Upper Schuylkill
COUNTRY PLACE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
COVATTAS BRINTON LODGE	665	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
COVENTRY CAFÉ	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2

COVENTRY GARDEN APARTMENTS	9,500	GROUND	Community	Middle Schuylkill 2
COVENTRY MANOR NURSING HOME	2,400	GROUND	Community	French Creek
COVENTRY MART, INC.	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
COVENTRY TEA ROOM	5,000	GROUND	Trans. Non-Comm.	French Creek
COVENTRY TERRACE	16,000	GROUND	Community	Middle Schuylkill 2
COVENTRYVILLE U M CHURCH	5,000	GROUND	Trans. Non-Comm.	French Creek
CRAB CRAZY AT FRIENDSHIP FARM	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
CRAFTEX MILLS INC	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
CRAZY MARES	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CREEK SIDE PUB	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CRESTWOOD SWIM POOL	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
CROC-O-DIAL DELI	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
CROWS NEST PRESERVE	5,000	GROUND	Trans. Non-Comm.	French Creek
CRYSTAL CAVE	560	GROUND	Trans. Non-Comm.	Maiden Creek
CUMRU TWP MUNI BLDG	500	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
CUMRU TWP REC BLDG	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
CUTILLOS	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
DANIEL BOONE HOMESTEAD	10,000	GROUND	Trans. Non-Comm.	Monocacy Creek
DANS DELI	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
DAYDREAM NURSERY SCHOOL	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
DB MONOCACY KINDERGARTEN CTR	1,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
DEER LAKE CITIZENS ASSOC	5,000	GROUND	Community	Upper Schuylkill
DEITSCH ECK HOTEL RESTAURANT	1,050	GROUND	Trans. Non-Comm.	Maiden Creek
DELMONT SCOUT RESERVATION	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
DOLCE VITA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
DOUBLE TT DINER	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
DOUGLASSVILLE HOTEL	650	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
DRYVILLE HOTEL	700	GROUND	Trans. Non-Comm.	Manatawny Creek
DUNKIN DONUTS	1,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
DUTCH COTTAGE TAVERN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
DUTCH MOTEL	300	GROUND	Trans. Non-Comm.	Tulpehocken Creek
DUTCHWAY FARM MARKET #1	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
E COVENTRY ELEM SCH	3,600	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
E&Y FARM APARTMENTS	5,000	GROUND	Community	Maiden Creek
EAGLE BRASS CO	10,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
EARL BOWL INC	750	GROUND	Trans. Non-Comm.	Perkiomen Creek
EARL TWP VOL FIRE CO NO 1	245	GROUND	Trans. Non-Comm.	Manatawny Creek
EAST COVENTRY PARK	5	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
EAST GREENVILLE BORO WATER DEP	220,000	SURFACE	Community	Perkiomen Creek
EAST PENN MFG CO	225,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
EAST ROCKHILL TWP PARK	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
EASTERN LEBANON CO HIGH SCH	6,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
EASTERN LEBANON CO MIDDLE SCH	3,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
EASY DOES IT	5,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
EBENEZER UNITED CH OF CHRIST	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
ECONO LODGE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ECONOMY GAS	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
EITEL PRESSES	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
EMERGENCY CARE RESEARCH INST	1,500	GROUND	Non-Trans. Non-Comm.	Lower Schuylkill

EMILS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
EMILYS PUB	5,000	GROUND	Trans. Non-Comm.	Allegheny Creek
ENERGY STATION RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ENVIRONMENTAL STONE PRODUCTS	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
EVANS DIPPER	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
EVANSBURG STATE PARK	900	GROUND	Trans. Non-Comm.	Perkiomen Creek
EVERGREEN CC INC	280	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
EVERGREEN MINIATURE GOLF	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
EXELON NUCLEAR POWER PLANT	15,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
EXETER FAMILY RESTAURANT	1,050	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
FAIRVIEW INN	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
FAITH BIBLE BAPTIST CH	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
FAMILY TIME FARM	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
FAR AWAY AUBURN	1,000	GROUND	Bulk	Upper Schuylkill
FASAGEOS ITALIAN RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
FEAST AND FANCY	5,000	GROUND	Trans. Non-Comm.	Wissahickon Creek
FELLOWSHIP HOUSE FARM	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
FIES CATERING	200	GROUND	Trans. Non-Comm.	Monocacy Creek
FINAL RESULTS FITNESS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
FINLAND INN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
FISHERMENS PARADISE	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
FITZWATER STATION	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
FLANDERS PRECISIONAIRE	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
FLEETWOOD BIBLE CHURCH	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
FLEETWOOD BORO WATER SYS	600,000	GROUND	Community	Maiden Creek
FLOURTOWN SWIM CLUB	5,000	GROUND	Trans. Non-Comm.	Wissahickon Creek
FLYING HILLS RACQUETBALL CTR	1,800	GROUND	Trans. Non-Comm.	Allegheny Creek
FLYNNS INN	245	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
FORT MOTEL	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
FOUR POINTS CONVENIENCE STORE	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
FREDERICK MENNONITE COMMUNITY	27,000	GROUND	Community	Perkiomen Creek
FRENCH CREEK ELEM SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	French Creek
FRENCH CREEK STATE PARK	250,000	GROUND	Trans. Non-Comm.	French Creek
FRIEDEN MANOR MHP	23,000	GROUND	Community	Upper Schuylkill
FRIEDENS BIBLE CHAPEL	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
FRIEDENS LUTH CH	95	GROUND	Trans. Non-Comm.	Maiden Creek
FROG HOLLOW TENNIS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GABELSVILLE ATHLETIC ASSN	245	GROUND	Trans. Non-Comm.	Manatawny Creek
GALEN HALL CC INC	700	GROUND	Trans. Non-Comm.	Tulpehocken Creek
GANLYS PUB & DELI	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
GASSERS GOLF SNACK BAR	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
GATEWAY CHRISTIAN SCH	2,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GEAR JAMMERS	350	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
GEISINGERS MHP	5,500	GROUND	Community	Perkiomen Creek
GENETTIS	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
GIANNOTTIS COUNTRY MANOR	450	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
GIANNOTTIS RESTAURANT	700	GROUND	Trans. Non-Comm.	Maiden Creek
GIBRALTAR FIRE CO	300	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
GIBRALTAR PLAYGROUND	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3

GILBERTSVILLE ELEMENTARY	3,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
GILBERTSVILLE FIRE COMPANY	7,500	GROUND	Trans. Non-Comm.	Perkiomen Creek
GILBERTSVILLE GOLF CLUB	875	GROUND	Trans. Non-Comm.	Perkiomen Creek
GILBERTSVILLE TEAROOM	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GIORGI FARM 1	5,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GIORGI MUSHROOM FARM 2	3,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GIORGI MUSHROOM FARM1 PLANT 11	2,000	GROUND	Trans. Non-Comm.	Maiden Creek
GIORGIO FOODS INC	290,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GIORGIO FRESH	5,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GIOVANNIS II	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GIUSEPPES ITALIAN RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
GLEN DALE SWIMMING ASSN	600	GROUND	Trans. Non-Comm.	Manatawny Creek
GLEN GERY INC	60,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
GLORIA DEI LUTHERAN CHURCH	1,350	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
GOLDEN OAKS CLUBHOUSE	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
GOOD SAMARITIAN SOUTH	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
GOODWILL FIRE CO	225	GROUND	Trans. Non-Comm.	Maiden Creek
GOUGLERSVILLE FIRE CO	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
GOV MIFFLIN BRECKNOCK ELEM SCH	2,800	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
GRACE ASSEMBLY OF GOD CHURCH	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
GRACE BIBLE CHURCH	1,000	GROUND	Trans. Non-Comm.	Little Schuylkill
GRACE BRETHREN CH	2,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
GRACE FELLOWSHIP CHURCH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
GRACIES RESTAURANT	300	GROUND	Trans. Non-Comm.	Manatawny Creek
GRAMIAS	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
GRANDMA BRENNAS BAKERY & REST	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GRANDVIEW HOSPITAL	73,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
GRAVEL PIKE INN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GREAT OAK SPRING WATER CO	3,000	GROUND	Bulk	Middle Schuylkill 2
GREAT OAK SPRING WATER CO	4,500	GROUND	Vended	Perkiomen Creek
GREEN ACRES GOLF INC	490	GROUND	Trans. Non-Comm.	Tulpehocken Creek
GREEN ACRES MHP	7,500	GROUND	Community	Maiden Creek
GREEN HILL MHP	20,000	GROUND	Community	Perkiomen Creek
GREEN HILLS GC	325	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
GREEN HILLS SPORTS CAMP	5,000	GROUND	Trans. Non-Comm.	Hay Creek
GREEN LANE FIRE CO	450	GROUND	Trans. Non-Comm.	Perkiomen Creek
GREEN LANE PARK NORTH	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GREEN LANE PARK SOUTH	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GREEN LANE TEXACO	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
GREENWICH TWP ELEM SCH	1,800	GROUND	Non-Trans. Non-Comm.	Maiden Creek
GRESHVILLE INN	700	GROUND	Trans. Non-Comm.	Perkiomen Creek
GRIMS MOBILE HOME COURT	1,700	GROUND	Community	Maiden Creek
GRINGS MILL RECREATION AREA	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
GUERS DAIRY	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
GYPSY ROSE HOTEL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
HAAGS HOTEL	2,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
HAFER PETROLEUM EQUIPMENT LTD	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
HAMBURG CONGREGATION OF JEHOVA	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
HAMBURG MUNI WATER&SEWER AUTH	483,462	SURFACE	Community	Upper Schuylkill

HAPPY DAYZ GRILL	875	GROUND	Trans. Non-Comm.	Upper Schuylkill
HAPPY VALLEY MOBILE HOME PARK	2,850	GROUND	Community	Maiden Creek
HARLEYSVILLE COMMUNITY CENTER	750	GROUND	Trans. Non-Comm.	Perkiomen Creek
HARPOON LOUIES	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
HART SCOUT RESERVATION	3,871	GROUND	Trans. Non-Comm.	Perkiomen Creek
HARVEST FELLOWSHIP COLEBROOK	1,000	GROUND	Trans. Non-Comm.	Manatawny Creek
HARVEY MOYER SPORTS COMPLEX	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
HATFIELD QUALITY MEATS INC	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
HAWK MT SANCTUARY	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
HAWKEYE JENSEN	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
HEISLERS CLOVERLEAF DAIRY	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
HENDRICKS FAMILY CENTER	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
HEREFORD EST MHP	65,000	GROUND	Community	Perkiomen Creek
HESS EXPRESS	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
HICKORY PARK RESTAURANT	1,500	GROUND	Trans. Non-Comm.	Perkiomen Creek
HICKORY VALLEY G C SNACK BAR	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
HIDDEN MEADOWS CAMP	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
HIGH POINT BAPTIST ACAD	6,000	GROUND	Non-Trans. Non-Comm.	Hay Creek
HIGH POINT BIBLE CONFERENCE	5,000	GROUND	Trans. Non-Comm.	Hay Creek
HIGHLAND EST MHP	38,000	GROUND	Community	Maiden Creek
HILL UNITED CH OF CHRIST	140	GROUND	Trans. Non-Comm.	Perkiomen Creek
HILLCREST CAMPSITE	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
HILLCREST HALL	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
HILLSIDE AQUATIC CLUB	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
HILLSIDE MOTEL	280	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
HILLTOP DRIVE IN	150	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
HOMESTEAD FARMS CAMPGROUND	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
HOOD CO INC	900	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
HOPE COMMUNITY CHURCH	1,000	GROUND	Trans. Non-Comm.	Manatawny Creek
HOPEWELL COMMUNITY CHURCH	1,000	GROUND	Trans. Non-Comm.	Manatawny Creek
HOPEWELL FURNACE NHS	5,000	GROUND	Trans. Non-Comm.	French Creek
HORNINGS MARKET OF MYERSTOWN	1,500	GROUND	Trans. Non-Comm.	Tulpehocken Creek
HORNINGS ROADSIDE MKT BETHEL	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
HUMMELS SNACK BAR	245	GROUND	Trans. Non-Comm.	Maiden Creek
IBEW LOCAL 380	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
INDIAN CREEK MENNONITE SCHOOL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
INDIAN FORT INN	400	GROUND	Trans. Non-Comm.	Upper Schuylkill
INDIAN VALLEY COUNTRY CLUB	8,500	GROUND	Trans. Non-Comm.	Perkiomen Creek
INN AT MOSELEM SPRINGS	1,400	GROUND	Trans. Non-Comm.	Maiden Creek
IRISH CREEK VILLAGE MHP	5,900	GROUND	Community	Upper Schuylkill
ISLAND PIZZA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ITS JUST BARBEQUE	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
JACOBS CHURCH	500	GROUND	Trans. Non-Comm.	Maiden Creek
JENN AND JESSIES	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
JOHN GRASSE ELEMENTARY SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
JOHN HAAS SEAFOOD & RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
JOHN PAUL II CENTER	1,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
JOSEPHS ITALIAN MARKET	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
JUBS	5,000	GROUND	Trans. Non-Comm.	Allegheny Creek

JULIAS MARKET	5,000	GROUND	Trans. Non-Comm.	French Creek
JUSTINS CARRIAGE HOUSE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
KAERCHER CREEK PARK	10,560	GROUND	Trans. Non-Comm.	Upper Schuylkill
KAMP KEYSTONE	2,600	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
KEMPTON COMM CTR	400	GROUND	Trans. Non-Comm.	Maiden Creek
KEMPTON HOTEL	875	GROUND	Trans. Non-Comm.	Maiden Creek
KEMPTON NEW CH SCH	1,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
KEMPTON ROD & GUN CLUB	245	GROUND	Trans. Non-Comm.	Maiden Creek
KEN GRILL RECREATION ASSN	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
KENILWORTH DELI	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
KEYSTONE EAST MHP	25,500	GROUND	Community	Monocacy Creek
KEYSTONE FIRE CO NO 1	450	GROUND	Trans. Non-Comm.	Perkiomen Creek
KIMBERTON GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	French Creek
KIMBERTON WALDORF SCHOOL	4,000	GROUND	Non-Trans. Non-Comm.	French Creek
KIMS CATERING	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
KINGS ACADEMY	1,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
KOLB BROTHERS MEATS INC	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
KOLB FARM STORE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
KRUMSVILLE INN	280	GROUND	Trans. Non-Comm.	Maiden Creek
KUTZTOWN BOROUGH WATER	892,762	GROUND	Community	Maiden Creek
KUTZTOWN PRODUCE AUCTION	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
KUTZTOWN ROD & GUN CLUB INC	350	GROUND	Trans. Non-Comm.	Maiden Creek
KUTZTOWN TEMPLE ASSN	595	GROUND	Trans. Non-Comm.	Maiden Creek
LAKE WYNONAH MUNICIPAL AUTH	385,000	GROUND	Community	Upper Schuylkill
LAKESIDE BAR AND GRILLE	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
LAKESIDE YOUTH SERVICE	1,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
LANDINGVILLE FIRE COMPANY	3,750	GROUND	Trans. Non-Comm.	Upper Schuylkill
LANDIS STORE HOTEL	350	GROUND	Trans. Non-Comm.	Perkiomen Creek
LANDIS SUPERMARKETS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LANTERN LODGE MOTOR INN	4,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
LAUREL HEALTH RESOURCES	18,000	GROUND	Community	Upper Schuylkill
LAZY K CAMPGROUND	6,000	GROUND	Community	Perkiomen Creek
LCA NLSA PINE LAKES DIVISION	10,001	GROUND	Community	Maiden Creek
LE MA KE DE MOBILE CT	4,000	GROUND	Community	Upper Schuylkill
LEDERACH CORNER STORE TEA ROOM	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LEDGEROCK GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
LEESPORT BORO WATER AUTH	192,000	GROUND	Community	Upper Schuylkill
LEGION MAPLE CLUB	40	GROUND	Trans. Non-Comm.	Little Schuylkill
LEHIGH PORTLAND CEMENT CO	40,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
LEHIGH VALLEY DAIRIES NTNC	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
LEIDYS INC	143,200	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
LENAPE PARK	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LIMEKILN SIMMONS	5,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
LIMERICK DINER	4,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LIMESTONE ACRES	15,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
LINFIELD DELI AND PIZZERIA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
LITTLE OLEY TAVERN	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
LITTLE ZION LUTHERAN CHURCH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LOCUST LAKE STATE PARK	12,000	GROUND	Trans. Non-Comm.	Little Schuylkill

LOMIRE DMD & ASSOC	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LONGACRES DAIRY	10,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
LOWER HEIDELBERG MINI MALL	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
LOWER PERKIOMEN VALLEY PARK	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
LOWER POTTSGROVE SPORTMAN ASSN	750	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
LUBRANOS PIZZERIA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
LYONS BORO	30,000	GROUND	Community	Maiden Creek
M&S GAS AND MINI MART	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MADELINES	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MAIDENCREEK TWP WATER AUTH	469,750	GROUND	Community	Maiden Creek
MALS AMERICAN DINER	350	GROUND	Trans. Non-Comm.	Perkiomen Creek
MALVERN COURTS INC	17,280	GROUND	Community	Valley Creek
MANOR GC	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MANUFACTURERS GOLF & CC	20,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
MAPLE GLEN TAVERN	300	GROUND	Trans. Non-Comm.	Perkiomen Creek
MAPLE LEAF FARM	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MARGHERITAS PIZZERIA	50	GROUND	Trans. Non-Comm.	Maiden Creek
MARIAN HIGH SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Little Schuylkill
MARIES KITCHEN	665	GROUND	Trans. Non-Comm.	Maiden Creek
MARION FIRE CO	420	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MARKET AT MAIN	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
MARKLEY FARMS SWIM CLUB	1,500	GROUND	Trans. Non-Comm.	Wissahickon Creek
MARLBOROUGH ELEMENTARY SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
MARTECH MEDICAL PRODUCTS	6,500	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
MARTINS DAM CLUB	300	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
MARTINS FARM MARKET	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MARY D COMMUNITY ASSOCIATION	18,000	SURFACE	Community	Upper Schuylkill
MASSARIS BLU TAVERN RESTAURAN	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MAXATAWNY ELEM SCHOOL	1,800	GROUND	Non-Trans. Non-Comm.	Maiden Creek
MAZZOLAS PIZZA	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
MCARDLES PUB	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
MEADOW BROOK GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
MEADOWBROOK CC	420	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MEADOWBROOK WATER SYSTEM	5,000	GROUND	Community	Perkiomen Creek
MEL DOR MOTEL	1,405	GROUND	Trans. Non-Comm.	Perkiomen Creek
MEREDITH MANOR	5,000	GROUND	Trans. Non-Comm.	French Creek
MERMAID SWIM AND GC	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
MERRYMEAD FARM	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
MICHAEL BS	245	GROUND	Trans. Non-Comm.	Upper Schuylkill
MILE HILL SEAFOOD	60	GROUND	Trans. Non-Comm.	Perkiomen Creek
MILFORD BIBLE CAMP	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
MILFORD JR HIGH SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
MILFORD TWP WATER AUTHORITY	194,000	GROUND	Community	Perkiomen Creek
MINERSVILLE MUNICIPAL WATER AU	1,000,000	SURFACE	Community	Upper Schuylkill
MOHNTON FISH & GAME ASSN	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
MOHRSVILLE WATER ASSN	17,000	GROUND	Community	Upper Schuylkill
MONARCH FIRE CO NO 1	385	GROUND	Trans. Non-Comm.	Monocacy Creek
MONTGOMERY SCHOOL	4,500	GROUND	Non-Trans. Non-Comm.	Pickering Creek
MOPAC SOUDERTON BEEF DIVISION	220,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek

MOPAC SOUDERTON RENDERING DIV	5,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
MORNING STAR FELLOWSHIP	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
MOSELEM SPRINGS GC	700	GROUND	Trans. Non-Comm.	Maiden Creek
MOTEL DESKA	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MOUNTAIN SPRINGS MHP	15,798	GROUND	Community	Tulpehocken Creek
MOUNTAIN VALLEY GOLF COURSE	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
MOYERS DUTCH MARKET	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
MT PENN MUNI WATER AUTH	740,000	GROUND	Community	Middle Schuylkill 3
MT PLEASANT FIRE CO	245	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MT SPRINGS CAMPING RESORT	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
MT VILLAGE MHP	60,000	GROUND	Community	Perkiomen Creek
MUHLENBERG TWP MUNI AUTH	4,100,000	GROUND	Community	Middle Schuylkill 3
MUSSOS ITALIAN RESTAURANT	455	GROUND	Trans. Non-Comm.	Allegheny Creek
MYERSTOWN MENNONITE SCH	1,500	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
MYERSTOWN WATER AUTH	480,000	GROUND	Community	Tulpehocken Creek
N HANOVER EVANGEL LUTH CHURCH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
N WESTERN RECREATION COMM PARK	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
NATIONAL CENTER FOR PADRE PIO	1,500	GROUND	Trans. Non-Comm.	Perkiomen Creek
NEVERSINK GUN CLUB	500	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
NEW ENGLAND FIRE CO	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
NEW ENGLAND VALLEY MENN CHURCH	1,000	GROUND	Trans. Non-Comm.	Little Schuylkill
NEW HANOVER UPPER FRED E S	4,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
NEW HANOVER VFC	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
NEW JERUSALEM LUTH CH	100	GROUND	Trans. Non-Comm.	Manatawny Creek
NEW JERUSALEM UCC	1,000	GROUND	Trans. Non-Comm.	Manatawny Creek
NEW LIFE BIBLE FELLOWSHIP CH	400	GROUND	Trans. Non-Comm.	Manatawny Creek
NEW LIFE YOUTH&FAMILY SERVICES	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
NEW RINGGOLD FIRE CO	1,050	GROUND	Trans. Non-Comm.	Little Schuylkill
NEW RINGGOLD MARKET	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
NINE OAKS SWIM CLUB	650	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
NOLDE ENVIRONMENTAL ED CTR	500	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
NORCO FIRE COMPANY	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
NORRITON PRESBYTERIAN CHURCH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
NORTH COVENTRY ELEMENTARY SH	3,500	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
NORTH HEIDELBERG WATER CO	45,000	GROUND	Community	Tulpehocken Creek
NORTHERN VALLEY EVAN FREE CH	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
NORTHKILLE ROD & GUN CLUB	280	GROUND	Trans. Non-Comm.	Tulpehocken Creek
NWLSD ELEMENTARY SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
NWLSD HIGH SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
OAK LANE DAY SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Wissahickon Creek
OLD ZIONSVILLE UCC	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
OLDE 22 INN	525	GROUND	Trans. Non-Comm.	Tulpehocken Creek
OLDE HOMESTEAD GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
OLEY TWP MUNI AUTH	112,000	GROUND	Community	Manatawny Creek
OMNOVA SOLUTIONS INC	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
ONTELAUNEE ROD AND GUN CLUB	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
ORTINOS NORTH	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ORWIGSBURG GUN CLUB	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
ORWIGSBURG MUNICIPAL WATER WKS	290,000	GROUND	Community	Upper Schuylkill

OSTERIA EVANSBURG	500	GROUND	Trans. Non-Comm.	Perkiomen Creek
OUR PLACE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
OWEN J ROBTS M.S.	22,000	GROUND	Non-Trans. Non-Comm.	French Creek
OZ GEDNEY LLC	12,500	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
PA AMERICAN MERLIN HILLS	100,000	GROUND	Community	French Creek
PA AMERICAN NORRISTOWN	9,576,000	SURFACE	Community	Middle Schuylkill 1
PA AMERICAN WATER COMPANY	2,500,000	SURFACE	Community	Middle Schuylkill 2
PA DUTCH CAMPSITES	7,500	GROUND	Trans. Non-Comm.	Tulpehocken Creek
PALACE MISSION CHURCH	60	GROUND	Trans. Non-Comm.	Lower Schuylkill
PAPA BERNARDS PIZZA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PARK CREST CALLEAARGA	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
PARK PLACE	1,500	GROUND	Community	Maiden Creek
PARKHOUSE	84,000	GROUND	Community	Middle Schuylkill 2
PAT GARRETT ROADHOUSE	665	GROUND	Trans. Non-Comm.	Tulpehocken Creek
PAW GOLDEN OAKS	5,000	GROUND	Community	Manatawny Creek
PAW PENN DISTRICT	2,500,000	GROUND	Community	Tulpehocken Creek
PEARL S BUCK INTERNATIONAL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PENCO PRODUCTS INC	15,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
PENLLYN CLUB	5,000	GROUND	Trans. Non-Comm.	Wissahickon Creek
PENN DUTCH INN	280	GROUND	Trans. Non-Comm.	Maiden Creek
PENN SQUARE CATERERS	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
PENNYPACKER MILLS HISTORIC STE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PERKASIE BOROUGH AUTHORITY	711,000	GROUND	Community	Perkiomen Creek
PERKIOMEN VALLEY ACADEMY	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
PERKIOMEN VIEW HOTEL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PERKIOMENVILLE AUCTION HOUSE	3,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PERKIOMENVILLE MENNONITE CHURC	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PERRY PLAZA P C EXPRESS	700	GROUND	Trans. Non-Comm.	Upper Schuylkill
PERRY RESTAURANT	500	GROUND	Trans. Non-Comm.	Upper Schuylkill
PERRY TWP GOLF	560	GROUND	Trans. Non-Comm.	Upper Schuylkill
PHEASANTLAND ROLLERDOME	175	GROUND	Trans. Non-Comm.	Manatawny Creek
Philadelphia Water Department	TBD	SURFACE	Community	Lower Schuylkill
Philadelphia Water Department	TBD	SURFACE	Community	Lower Schuylkill
PHOENIX MOBILE HOMES	10,000	GROUND	Community	French Creek
PHOENIXVILLE BOWLING CENTER	5,000	GROUND	Trans. Non-Comm.	French Creek
PHOENIXVILLE MOBILE HOMES INC	5,000	GROUND	Community	French Creek
PHOENIXVILLE WATER DEPT	2,500,000	SURFACE	Community	Middle Schuylkill 2
PICKERING VALLEY GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
PIKE TWP SPORTSMANS CLUB	525	GROUND	Trans. Non-Comm.	Manatawny Creek
PIKELAND VILLAGE SQUARE	5,000	GROUND	Non-Trans. Non-Comm.	French Creek
PILGRIMS PRIDE CORP	133,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
PINE HILL CAMPGROUND	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
PINE TREE MARKET AND DELI	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PINE VALLEY FARMS SPRING NO 1	1,000	GROUND	Bulk	Little Schuylkill
PINEBROOK PLACE HECK & LAUDE	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
PINELAND PARK	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
PIT STOP TAVERN	350	GROUND	Trans. Non-Comm.	Manatawny Creek
PLEASANT HILL GC	455	GROUND	Trans. Non-Comm.	Maiden Creek
PLEASANT RUN MHP	2,000	GROUND	Community	Perkiomen Creek

PLEASANTVILLE DINER	600	GROUND	Trans. Non-Comm.	Manatawny Creek
PLEASANTVILLE INN	280	GROUND	Trans. Non-Comm.	Manatawny Creek
PORCH	800	GROUND	Trans. Non-Comm.	Tulpehocken Creek
PORT CLINTON WATER COOP ASSOC	18,000	GROUND	Community	Little Schuylkill
POST PRECISION CASTINGS INC	40,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
POTTSTOWN BOROUGH WATER AUTH	6,000,000	SURFACE	Community	Middle Schuylkill 2
POTTSTOWN YOUTH CENTER INC	500	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
POWDERBOURNE SPORTMANS CLUB	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
PRACTICE MANAGEMENT ADVISORS	5,000	GROUND	Non-Trans. Non-Comm.	Little Schuylkill
PROTO CAST	300	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
QUAKAKE VOLUNTEER FIRE COMPANY	30	GROUND	Trans. Non-Comm.	Little Schuylkill
QUAKERWOODS CAMPGROUND	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
RADISSON VALLEY FORGE HOTEL	88,750	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 1
RAF PENNSBURG LP	20,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
RAILROAD STREET BAR AND GRILL	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
RAJAH SHRINE COMPLEX	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
RAUCHS SHELL FOOD MART	800	GROUND	Trans. Non-Comm.	Maiden Creek
READING ALLOYS	10,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
READING AREA WATER AUTH	14,000,000	SURFACE	Community	Maiden Creek
READING BAKERY SYSTEMS	1,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
READING EVAN FREE CHURCH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
RED AND WHITE MARKET	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
RED HILL WATER AUTHORITY	412,000	GROUND	Community	Perkiomen Creek
REDNERS QUICK SHOPPE	1,000	GROUND	Trans. Non-Comm.	Manatawny Creek
RENEWAL CENTERS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
RENNINGERS FARM MKT	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
RENNINGERS LAND DEVELOPMENT	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
RICH MAIDEN GC	700	GROUND	Trans. Non-Comm.	Maiden Creek
RICHLAND BORO WATER SUPPLY	110,000	GROUND	Community	Tulpehocken Creek
RICHMOND ELEM SCH	2,200	GROUND	Non-Trans. Non-Comm.	Maiden Creek
RIDGE BAR & GRILL	1,500	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
RIDGE ROAD COMPLEX	350	GROUND	Trans. Non-Comm.	Perkiomen Creek
RIDGLEA	35,000	GROUND	Community	French Creek
RINGGOLD INN	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
RINGING HILL FIRE COMPANY	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
RINGING ROCK SKATING RINK	700	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
RISING SUN RESTAURANT & TAVERN	1,050	GROUND	Trans. Non-Comm.	Perkiomen Creek
RISSERS RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
RIVERBEND ENVIRONMENTAL ED CTR	5,000	GROUND	Trans. Non-Comm.	Lower Schuylkill
RIVERBOAT SALOON	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
RIVEREDGE	5,000	GROUND	Community	Middle Schuylkill 2
ROBESON LUTH CH	135	GROUND	Trans. Non-Comm.	Allegheny Creek
ROBIN HILL CAMPGROUND	750	GROUND	Trans. Non-Comm.	Maiden Creek
ROCKLAND ELEM SCH	1,000	GROUND	Non-Trans. Non-Comm.	Manatawny Creek
ROCKWELLS INC	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
RODALE FARM GUESTHOUSE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
RODALE FARM VISITOR CENTER	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
RODALE INST EXPERIMENTAL FARM	5,000	GROUND	Non-Trans. Non-Comm.	Maiden Creek
ROLLING TURF GOLF COURSE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek

ROMAN DELIGHT III	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
RONS CROOKED HILL TAVERN	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
ROSAS FAMILY RESTAURANT	490	GROUND	Trans. Non-Comm.	Tulpehocken Creek
ROSEMOUNT CAMPING RESORT	1,875	GROUND	Trans. Non-Comm.	Little Schuylkill
RT 100 DELI BAKERY	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
RUSSOS PIZZA DEN	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
S C I GRATERFORD	910,000	GROUND	Community	Perkiomen Creek
S-A TROUT PONDS	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SACONY PARK CAMPGROUND	500	GROUND	Trans. Non-Comm.	Maiden Creek
SAINT LUKE KNOLLS	2,400	GROUND	Community	Perkiomen Creek
SAINT PAULS UCC	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SALEM SHALTERS LUTH CH	500	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SALEM UNITED CH OF CHRIST	80	GROUND	Trans. Non-Comm.	Manatawny Creek
SALFORD HILLS ELEM SCHOOL	2,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
SALFORDVILLE HOTEL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SAMMY'S MT. VIEW M.H.P.	2,000	GROUND	Community	Tulpehocken Creek
SANATOGA R E & DEVEL LTD PRTSP	12,000	GROUND	Community	Middle Schuylkill 2
SASSAMANSVILLE FIRE CO	1,250	GROUND	Trans. Non-Comm.	Perkiomen Creek
SAVORY GRILLE	350	GROUND	Trans. Non-Comm.	Perkiomen Creek
SCHLEICHERS FAMILY RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
SCHMECKS FAMILY RESTAURANT	1,785	GROUND	Trans. Non-Comm.	Upper Schuylkill
SCHUYLKILL CANAL REC AREA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
SCHUYLKILL CO MUN AUTH	5,371,998	SURFACE	Community	Upper Schuylkill
SCHUYLKILL COUNTRY CLUB	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SCHUYLKILL COUNTY AIRPORT	1,200	GROUND	Trans. Non-Comm.	Upper Schuylkill
SCHUYLKILL HAVEN BORO WATER	2,200,000	SURFACE	Community	Upper Schuylkill
SCHUYLKILL RACQUET CLUB	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SCHUYLKILL VALLEY BIBLE CH	36	GROUND	Trans. Non-Comm.	Upper Schuylkill
SCHWENKSVILLE BOROUGH AUTH	250,000	GROUND	Community	Perkiomen Creek
SCI CAST INTL	600	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
SCORES PUB	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
SCOTTYS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SCOUPE DE VILLE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SECOND MOUNTAIN ROD & GUN CLUB	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SEISHOLTSVILLE FIRE CO	315	GROUND	Trans. Non-Comm.	Perkiomen Creek
SELLERSVILLE BORO WATER WORKS	488,500	SURFACE	Community	Perkiomen Creek
SEVEN STARS INN	5,000	GROUND	Trans. Non-Comm.	French Creek
SHADES OF GREEN	5,000	GROUND	Trans. Non-Comm.	Allegheny Creek
SHADY LANE EST MHP	3,000	GROUND	Community	Perkiomen Creek
SHALMET CORPORATION	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
SHANES TAVERN	2,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
SHANESVILLE HOTEL	245	GROUND	Trans. Non-Comm.	Manatawny Creek
SHARTLESVILLE COM FIRE CO NO 1	385	GROUND	Trans. Non-Comm.	Tulpehocken Creek
SHEARER ELEGANCE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
SHEETZ MKT	1,500	GROUND	Trans. Non-Comm.	Maiden Creek
SHERYL ANNS VICTORIAN TEAROOM	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SHOEMAKERSVILLE BORO WATER SYS	100,000	GROUND	Community	Upper Schuylkill
SHOPPES AT WOODSIDE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SHOPS AT KIRBYVILLE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek

SHORTYS SUNFLOWER CAFÉ	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
SITTLERS GOLF CTR	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
SITTLERS MHP	5,658	GROUND	Community	Maiden Creek
SK PROPERTIES LP MISTY MEADOWS	3,000	GROUND	Community	Middle Schuylkill 3
SKIPPACK ITALIAN MARKET	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SKIPPACK RECREATIONAL ASSOC	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SKIPPER DIPPERS	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
SKYVIEW RESTAURANT	1,050	GROUND	Trans. Non-Comm.	Maiden Creek
SLEEPY HOLLOW ATHLETIC CLUB	630	GROUND	Trans. Non-Comm.	Allegheny Creek
SLEEPY HOLLOW POOL & SK BAR	5,000	GROUND	Trans. Non-Comm.	Allegheny Creek
SMART MART 4	200	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SMITHS COUNTRY INN	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
SONNYS QUICK STOP II	5,000	GROUND	Trans. Non-Comm.	French Creek
SOUTH MOUNTAIN YMCA	13,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
SOUTHEND GUN CLUB INC	200	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SPECIAL T DESIGN & MFG CO	5,000	GROUND	Non-Trans. Non-Comm.	Monocacy Creek
SPINNERSTOWN HOTEL INC	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SPRING MOUNTAIN ADVENTURES	3,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SPRING VALLEY FITNESS CENTER	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
SPRINGFORD COUNTRY CLUB	3,400	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
SPRINGFORD SD DISTRICT OFFICE	4,500	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
SPRUCE COURT APARTMENTS	8,900	GROUND	Community	Middle Schuylkill 2
SPUNKTOWN TAVERN	385	GROUND	Trans. Non-Comm.	Perkiomen Creek
ST ANDREWS UNITED METH CH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ST BENEDICT CH	1,000	GROUND	Trans. Non-Comm.	Hay Creek
ST GABRIELS HALL	36,000	GROUND	Community	Perkiomen Creek
ST JAMES LUTH CH	1,000	GROUND	Trans. Non-Comm.	Hay Creek
ST JOHNS LUTH CH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ST JOHNS UCC PRICETOWN	35	GROUND	Trans. Non-Comm.	Maiden Creek
ST JOHNS UNITED CH OF CHRIST	70	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ST JOHNS(GERNANTS)LUTH & UCC	750	GROUND	Trans. Non-Comm.	Upper Schuylkill
ST JOSEPHS HILL CH	1,000	GROUND	Non-Trans. Non-Comm.	Manatawny Creek
ST LUKE LUTHERAN CHURCH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ST LUKES LUTHERAN CHURCH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ST MARY ROMAN CATH CH KUTZTOWN	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
ST MARY ROMAN CATH CH TILDEN	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
ST MATTHEWS U C C	1,000	GROUND	Trans. Non-Comm.	Pickering Creek
ST MICHAELS UNION CH	500	GROUND	Trans. Non-Comm.	Upper Schuylkill
ST PAULS LUTHERN PRE SCHOOL	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
ST PAULS UNITED METH CH	85	GROUND	Trans. Non-Comm.	Hay Creek
ST STEPHENS GREEN	5,000	GROUND	Community	French Creek
STATE POLICE BARRACKS AND DJ	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
STATE POLICE TRAINING CENTER	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
STEELCO	10,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
STILL CREEK TAVERN	200	GROUND	Trans. Non-Comm.	Little Schuylkill
STONERSVILLE FIRE CO	350	GROUND	Trans. Non-Comm.	Monocacy Creek
STONERSVILLE HOTEL	245	GROUND	Trans. Non-Comm.	Monocacy Creek
STONEWALL GC NORTH COURSE	5,000	GROUND	Trans. Non-Comm.	French Creek
STONY RUN HOTEL	1,200	GROUND	Trans. Non-Comm.	Maiden Creek

STONY RUN MOBILE HOME PARK	11,119	GROUND	Community	Middle Schuylkill 2
STOPPERS PUB	350	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
STOUDTS SERVICE STATION	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
STRAUSSTOWN ELEM SCH	1,500	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
STRAUSSTOWN LIONS PLAYGROUND	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
STRAUSSTOWN ROD & GUN CLUB	525	GROUND	Trans. Non-Comm.	Tulpehocken Creek
STRAWBERRY FAMILY RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
STUCKEYS DAIRY QUEEN	700	GROUND	Trans. Non-Comm.	Tulpehocken Creek
SUBURBAN MANAGEMENT	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
SUBWAY GILBERTSVILLE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
SUGLIA S EXPRESS	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SULOMANS MILK	1,200	GROUND	Trans. Non-Comm.	Perkiomen Creek
SUMMERS CAFÉ	525	GROUND	Trans. Non-Comm.	Manatawny Creek
SUMMIT VIEW RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
SUMNEYTOWN HOTEL	350	GROUND	Trans. Non-Comm.	Perkiomen Creek
SUNNY RIDGE RESTAURANT INC	5,000	GROUND	Trans. Non-Comm.	French Creek
SUNOCO FOOD SHOP	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
SUNOCO OLEY	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
SUPERIOR WATER CO IVY RIDGE	5,000	GROUND	Community	Perkiomen Creek
SUPERIOR WATER COMPANY	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
SUPERIOR WATER COMPANY CPF	29,000	GROUND	Community	Perkiomen Creek
SUPERIOR WATER COMPANY MAIN	255,000	GROUND	Community	Perkiomen Creek
SWAMP PIKE PUB	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
SWEETWATER GOLF COURSE	625	GROUND	Trans. Non-Comm.	Perkiomen Creek
SYLVIAS RESTAURANT	1,250	GROUND	Trans. Non-Comm.	Tulpehocken Creek
TAILGATERS INC	525	GROUND	Trans. Non-Comm.	Manatawny Creek
TAMAQUA AREA WATER AUTHORITY	3,000,000	SURFACE	Community	Little Schuylkill
TCS TAVERN	1,380	GROUND	Trans. Non-Comm.	Maiden Creek
TELFORD BOROUGH AUTHORITY	592,000	GROUND	Community	Perkiomen Creek
TELTRON TECHNOLOGIES	430	GROUND	Non-Trans. Non-Comm.	Monocacy Creek
TEVA PHARMACEUTICALS USA	5,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
THE ANCHOR DELI	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
THE BROWN BAG	150	GROUND	Trans. Non-Comm.	Little Schuylkill
THE CAFÉ	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
THE FLYING DOG	245	GROUND	Trans. Non-Comm.	Manatawny Creek
THE FREEZE	400	GROUND	Trans. Non-Comm.	Upper Schuylkill
THE MAIN EVENT	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
THE MCKEANSBURG HOTEL	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
THE NUTTY PEAR	5,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
THE OAK HILL INN	1,050	GROUND	Trans. Non-Comm.	Upper Schuylkill
THE RED HILLS TAVERN	2,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
THE STABLES	5,000	GROUND	Trans. Non-Comm.	French Creek
THE STONEWALL LINK	5,000	GROUND	Trans. Non-Comm.	French Creek
THE TIMBERS RESTAURANT	1,225	GROUND	Trans. Non-Comm.	Maiden Creek
THE WESTY BAR AND GRILL	2,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
THREE CS FAMILY RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
TIKI BAR	350	GROUND	Trans. Non-Comm.	Manatawny Creek
TIMOTHYS CENTER STAGE	350	GROUND	Trans. Non-Comm.	Maiden Creek
TIMS UGLY MUG BAR & GRILLE	700	GROUND	Trans. Non-Comm.	Middle Schuylkill 2

TINY TREASURES	500	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
TITUS POWER PLT	8,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
TONYS FAMILY RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
TOWAMENCIN MENNONITE CHURCH	30	GROUND	Trans. Non-Comm.	Perkiomen Creek
TRINACRIA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
TRINITY EVAN CONGREGATIONAL CH	1,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
TRINITY LUTH CH	142	GROUND	Trans. Non-Comm.	Perkiomen Creek
TROUT RUN SPORTS COMPLEX	100	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
TULPEHOCKEN HOTEL	350	GROUND	Trans. Non-Comm.	Tulpehocken Creek
TULPEHOCKEN JR SR HIGH SCH	6,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
TULPEHOCKEN TRINITY UCC	800	GROUND	Trans. Non-Comm.	Tulpehocken Creek
TURKEY HILL MINI MKT 257	5,000	GROUND	Trans. Non-Comm.	Hay Creek
TURTLE CREEK GOLF CLUB	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
TUSCARORA STATE PARK	4,000	GROUND	Trans. Non-Comm.	Little Schuylkill
TWIN PONDS GOLF CLUB	2,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
TWIN VALLEY ROBESON ELEM SCH	2,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 3
TWO HUNDRED PINEBROOK PLACE	5,000	GROUND	Non-Trans. Non-Comm.	Upper Schuylkill
TYLERSPORT FIRE CO	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
UNCLE GENES PIZZA	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
UNION FIRE CO OF KULPTOWN	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
UNION HOUSE	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
UNION JACKS	175	GROUND	Trans. Non-Comm.	Wissahickon Creek
UNION JACKS OLD CONGO HOTEL	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
UPPER BERN ELEM SCH	3,000	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek
UPPER DUBLIN RACQUET CLUB	5,000	GROUND	Trans. Non-Comm.	Wissahickon Creek
UPPER FREDERICK FIRE CO	100	GROUND	Trans. Non-Comm.	Perkiomen Creek
UPPER HANOVER WATER AUTHORITY	600,000	GROUND	Community	Perkiomen Creek
UPPER MILFORD MENNONITE CHURCH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
UPPER MILFORD WD FIRE CO #1	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
UPPER PROVIDENCE LITTLE LEAGUE	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 2
UPPER SALFORD VOL FIRE CO	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
URBAN ACRES MHP	9,000	GROUND	Community	Maiden Creek
VALENTINOS RESTAURANT	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
VALLEY FORGE CROSSING MHP	20,000	GROUND	Community	Middle Schuylkill 1
VALLEY FORGE DISTRIBUTION CTR	14,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
VALLEY FORGE NATL PARK	2,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
VALLEY FORGE VOL FIRE CO	5,000	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
VALLEY ROAD FARM	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
VALLEY RUN WATER SYSTEM	5,000	GROUND	Community	Perkiomen Creek
VALLEY VIEW MHP BLANDON	6,750	GROUND	Community	Manatawny Creek
VERNFIELD VILLAGE MKT AND DELI	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
VICTORY VALLEY CAMP	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
VILLAGE AT SUMMIT CREST	3,100	GROUND	Community	Maiden Creek
VINCE AND FRIENDS	2,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
VINCENT ELEM SCHOOL	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
VINEYARD COMMUNITY CHURCH	1,000	GROUND	Trans. Non-Comm.	French Creek
VINNYS AT CHESTER SPRINGS	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
VIRGINVILLE GRANGE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
VIRGINVILLE HOTEL	420	GROUND	Trans. Non-Comm.	Maiden Creek

VITOS PIZZA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WALTZ FARMS INC	375	GROUND	Trans. Non-Comm.	Perkiomen Creek
WANAMAKERS GENERAL STORE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
WANDA KENESKY	250	GROUND	Trans. Non-Comm.	Little Schuylkill
WARWICK ADMINISTRATION BLDG	5,000	GROUND	Non-Trans. Non-Comm.	French Creek
WARWICK CHILD CARE CENTER	5,000	GROUND	Non-Trans. Non-Comm.	French Creek
WARWICK COUNTY PARK	5,000	GROUND	Trans. Non-Comm.	French Creek
WARWICK DAYCARE-NORTH COVENTRY	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
WARWICK WOODS CAMPGROUND	5,000	GROUND	Trans. Non-Comm.	French Creek
WASHINGTON INN	1,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
WATER WORLD	5,000	GROUND	Trans. Non-Comm.	French Creek
WATERSHED CONVENIENCE STORE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WAY HAR FARMS STORE	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
WEAVERS HARDWARE CO	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
WEGMANS DELI & CATERING	700	GROUND	Trans. Non-Comm.	Monocacy Creek
WELCOME UNITED METHODIST CH	1,000	GROUND	Trans. Non-Comm.	Upper Schuylkill
WENTZS U C C CHURCH	150	GROUND	Trans. Non-Comm.	Perkiomen Creek
WERNERSVILLE STATE HOSP	116,896	SURFACE	Community	Tulpehocken Creek
WEST PENN FISH & GAME ASSOC	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
WESTERN BERKS WATER AUTH	3,500,000	SURFACE	Community	Tulpehocken Creek
WESTERN CTR FOR TECH STUDIES	4,000	GROUND	Non-Trans. Non-Comm.	Perkiomen Creek
WETHERILL ESTATES	16,000	GROUND	Community	Pickering Creek
WETLANDS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WHITE BIRCH - THE HUT	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
WHITE BIRCH GOLF COURSE	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
WHITE DEER RUN AT BLUE MTN	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
WHITELAND POINTE	5,000	GROUND	Non-Trans. Non-Comm.	Valley Creek
WILCOX FARMS	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
WILDE SNACK FOODS	5,000	GROUND	Trans. Non-Comm.	Tulpehocken Creek
WILL O HILL APTS	23,000	GROUND	Community	Tulpehocken Creek
WILLOW CREEK ORCHARDS	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WILLOW HOLLOW GC	450	GROUND	Trans. Non-Comm.	Tulpehocken Creek
WILLOW SPRINGS PARK	250	GROUND	Trans. Non-Comm.	Tulpehocken Creek
WINDHAVEN MHP	11,000	GROUND	Community	Middle Schuylkill 2
WING POINTE	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
WOLFS CORNER DELI	5,000	GROUND	Trans. Non-Comm.	Little Schuylkill
WOMELSDORF ROBESONIA JT AUTH	450,000	GROUND	Community	Tulpehocken Creek
WOOD ON TAP	5,000	GROUND	Trans. Non-Comm.	Maiden Creek
WOODLAND MHP	4,700	GROUND	Community	Perkiomen Creek
WOODS GOLF CENTER	300	GROUND	Trans. Non-Comm.	Middle Schuylkill 1
WOODSIDE INN	300	GROUND	Trans. Non-Comm.	Perkiomen Creek
WOODSIDE VILLA	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WORCESTER GOLF COURSE	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
WORLD TRAVEL INC	5,000	GROUND	Non-Trans. Non-Comm.	Middle Schuylkill 2
WOXALL GULF	5,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
YELLOW HOUSE HOTEL	5,000	GROUND	Trans. Non-Comm.	Manatawny Creek
YELLOW SPRING AT 1657	5,000	GROUND	Trans. Non-Comm.	Pickering Creek
YERKES WATER ASSOCIATION	8,100	GROUND	Community	Perkiomen Creek
ZION BLUE MOUNTAIN CHURCH	500	GROUND	Non-Trans. Non-Comm.	Tulpehocken Creek

ZION MENNONITE CH	150	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ZION MOSLEM LUTH CH	1,000	GROUND	Trans. Non-Comm.	Maiden Creek
ZION SPIES EVAN LUTH CH	300	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ZIONS EVANGELICAL LUTHERAN CH	1,000	GROUND	Trans. Non-Comm.	Perkiomen Creek
ZIONS SPIES EVAN REFORMED CH	143	GROUND	Trans. Non-Comm.	Middle Schuylkill 3
ZIONS UNITED CH OF CHRIST	179	GROUND	Trans. Non-Comm.	Upper Schuylkill
Total	**128,491,126**			

Table A-4 Wastewater Treatment Facilities

Facility	Sub-Watershed	Permit #	Estimated Ave. Discharge, MGD	Permitted Discharge, MGD
Abington Twp. STP	Wissahickon Creek	PA0026867	2.3968	3.9100
Adams, James and Sandra	Maiden Creek	PA0086169	0.0002	0.0004
Alsace TWP - Alsace Manor STP	Middle Schuylkill 3	PA0246956	0.0435	0.0710
Ambler Municipal STP	Wissahickon Creek	PA0026603	4.8	6.5000
Amity Twp STP	Middle Schuylkill 2	PA0070351	0.9	2.2000
Antietem Valley Mun. Auth.	Middle Schuylkill 3	PA0026646	1.006	1.2250
Bally Borough STP	Perkiomen Creek	PA0022543	0.35	0.5000
Berks County - Berks Co WWTP	Middle Schuylkill 3	PA0033995	0.3	0.5000
Berks-Mont. M.A. West Swamp Creek	Perkiomen Creek	PA0024180	1.1647	1.9000
Berks-Montgomery Morysville STP	Manatawny Creek	PA0023540	0.21	0.3200
Bernville Borough Auth.	Tulpehocken Creek	PA0024023	0.14	0.2850
Birdsboro Borough STP	Middle Schuylkill 3	PA0021709	0.9	1.3500
Blue Mountain School District	Upper Schuylkill	PA0061760	0.0074	0.0120
Blythe Twp Mun Auth - Crystal Run WTP	Upper Schuylkill	PA0063304	0.0172	0.0280
Blythe Twp Mun Auth - New Philadelphia	Upper Schuylkill	PA0065013	0.0233	0.0380
Boyertown Boro	Perkiomen Creek	PA0024376	0.5	0.7500
Branch Twp Mun Auth	Upper Schuylkill	PA0064068	0.2759	0.4500
Brandywine Realty Trust	Middle Schuylkill 1	PA0058467	0.0011	0.0018
Bridgeport Borough STP	Middle Schuylkill 1	PA0020397	0.55	0.9000
Candlewyck Estates Homeowners	Perkiomen Creek	PA0057673	0.0010	0.0016
Centerport Boro Mun Auth	Upper Schuylkill	PA0085669	0.0368	0.0600
Centre Twp Mun Auth – Dauberville	Upper Schuylkill	PA0086771	0.0490	0.0800
Centre Twp Mun Auth – Hillcrest	Upper Schuylkill	PA0246654	0.0153	0.0250
Centre Twp Mun Auth – Kingsgate	Upper Schuylkill	PA0086525	0.0074	0.0120
Chaban, Nicholas	Perkiomen Creek	PA0056006	0.0003	0.0005
Chapman, Dave	French Creek	PA0051951	0.0002	0.0004
Chicos, Paul	Lower Schuylkill	PA0057517	0.0003	0.0005
Christman, Dennis	Maiden Creek	PA0088021	0.0481	0.0785
Coaldale-Lansford-Summit Hill	Little Schuylkill	PA0026476	1.1	1.6500
Conshohocken Boro Auth	Lower Schuylkill	PA0026794	1.2	2.3000
Cressona Borough Auth.	Upper Schuylkill	PA0024015	0.48	0.7800
Daniel Boone Homestead	Middle Schuylkill 3	PA0051641	0.0049	0.0080
Deer Lake Municipal Authority	Upper Schuylkill	PA0042170	0.16	0.2290
Dublin Boro STP	Perkiomen Creek	PA0021741	0.3065	0.5000
Dzedzy, Frank	Pickering Creek	PA0053546	0.0002	0.0004
E Rockhill Twp	Perkiomen Creek	PA0056847	0.0693	0.1130
E Vincent Twp Mun Auth	Middle Schuylkill 2	PA0050466	0.3065	0.5000
E. Norriton-Plymouth Joint Auth.	Middle Schuylkill 1	PA0026816	5	8.1000
Eastman, Roger	Perkiomen Creek	PA0058823	0.0003	0.0005
Eves, Barry & Kristen	Middle Schuylkill 2	PA0056511	0.0002	0.0004
Exeter Twp. STP	Middle Schuylkill 3	PA0026972	0.7356	1.2000
Ferrence, Todd	Perkiomen Creek	PA0054178	0.0002	0.0004
Fleetwood Borough STP	Maiden Creek	PA0021636	0.3739	0.6100
Frederick Mennonite Community	Perkiomen Creek	PA0050989	0.0306	0.0499
Freedom's Foundation at Valley Forge	Middle Schuylkill 1	PA0050482	0.0116	0.0189
Godshall, Perry & Claudia	Perkiomen Creek	PA0054046	0.0002	0.0004

Goshenhoppen Village Inc.	Perkiomen Creek	PA0055271	0.0362	0.0590
Greater Pottsville Area Sewer Auth - Main Plant	Upper Schuylkill	PA0043885	5.63	8.2000
Greater Pottsville Sewer Auth - West End	Upper Schuylkill	PA0043877	0.3065	0.5000
Green Lane-Marlborough Joint Auth.	Perkiomen Creek	PA0050521	0.13	0.2000
Hamburg Mun. Auth.	Upper Schuylkill	PA0021601	0.6	1.5000
Hamburg Mun. Auth.	Upper Schuylkill	PA0086878	0.0184	0.0300
Hilltown Twp Water & Sew Auth	Perkiomen Creek	PA0058271	0.0920	0.1500
Historic Salem Village Homeowners Assc	Valley Creek	PA0056731	0.0010	0.0017
Irish Creek Village	Upper Schuylkill	PA0052400	0.0055	0.0090
Kutztown Borough STP	Maiden Creek	PA0031135	0.8	1.5000
Lake Wynonah Mun. Auth.	Upper Schuylkill	PA0061328	0.01025	0.3250
Lattanzi, Marc & Elizabeth	Perkiomen Creek	PA0056715	0.0003	0.0005
Leesport Borough STP	Upper Schuylkill	PA0070149	0.275	0.5000
Lenhartsville Boro	Maiden Creek	PA0246921	0.0259	0.0423
Limerick Twp Mun Auth - King Road	Middle Schuylkill 2	PA0051934	1	1.7000
Limerick Twp Mun Auth - Possum Hollow Run	Middle Schuylkill 2	PA0058041	0.4291	0.7000
Litka-Mistic SRSTP	Perkiomen Creek	PA0054259	0.0003	0.0005
Long, George	Perkiomen Creek	PA0057215	0.0002	0.0004
Lwr Salford Twp Auth - Indian Hills	Perkiomen Creek	PA0051004	0.001	0.0070
Lwr. Frederick Twp. STP	Perkiomen Creek	PA0050105	0.175	0.2000
Lwr. Perkiomen Valley Reg Sew – Oaks	Perkiomen Creek	PA0026964	7.9	20.0000
Lwr. Salford Twp Auth	Perkiomen Creek	PA0056413	0.5517	0.9000
Lwr. Salford Twp. STP	Perkiomen Creek	PA0024422	0.35	0.5900
Lynn Twp (STP or MA)	Maiden Creek	PA0070254	0.085	0.8000
Lyons Boro Mun Auth	Maiden Creek	PA0085171	0.0920	0.1500
Maidencreek Twp. STP	Allegheny Creek	PA0070271	0.45	0.8000
Marian High School	Little Schuylkill	PA0061310	0.0215	0.0350
McClure, Wayne	Upper Schuylkill	PA0063193	0.0002	0.0004
Mik-Joan Inc	Upper Schuylkill	PA0061212	0.0031	0.0050
Milford-Trumbauersville Area Sewer	Perkiomen Creek	PA0042021	0.53	0.8000
Minersville Sewer Auth.	Upper Schuylkill	PA0027693	0.068	1.0000
Myerstown Sewer Auth.	Tulpehocken Creek	PA0021075	0.9808	1.6000
Myerstown Water Auth	Tulpehocken Creek	PA0086967	0.0184	0.0300
N Coventry Mun Auth	Middle Schuylkill 2	PA0025437	0.7	1.5000
Neighborhood Homeowners Assoc.	Monocacy Creek	PA0247006	0.0012	0.0020
New Hanover Twp Auth	Perkiomen Creek	PA0057819	0.5057	0.8250
New Hanover Upper Frederick Elem. School	Perkiomen Creek	PA0033880	0.0061	0.0100
Norristown Mun Waste	Middle Schuylkill 1	PA0027421	6	9.7500
North Wales Boro	Wissahickon Creek	PA0022586	0.5119	0.8350
Northeastern Schuylkill JMA	Little Schuylkill	PA0063878	0.09	0.2450
Oley Twp. STP	Manatawny Creek	PA0024961	0.34	0.4000
Omnova Solutions Inc	Upper Schuylkill	PA0036463	0.0033	0.0054
Orwigsburg, Borough of, Mun. Auth.	Upper Schuylkill	PA0021547	0.5	0.9000
Paul, Peter	Middle Schuylkill 1	PA 0054771	0.0002	0.0004
Pennridge WWT Auth	Perkiomen Creek	PA0020460	3.4	4.3250
Phoexnixville Boro STP	Middle Schuylkill 2	PA0027154	2	4.0000
Pinebrook II STP	Upper Schuylkill	PA0070289	0.0736	0.1200
Pisano, Claire	Perkiomen Creek	PA 0055981	0.0003	0.0005
Plummer, J. Randall	Wissahickon Creek	PA0057177	0.0002	0.0004

Pottstown Boro Auth	Middle Schuylkill 2	PA0026786	7	12.8500
Reading, City of STP	Middle Schuylkill 3	PA0026549	17.4705	28.5000
Robeson Twp. STP	Middle Schuylkill 3	PA0051900	0.1839	0.3000
Robesonia-Wernersville STP	Tulpehocken Creek	PA0031062	1.3	1.4000
Royersford Boro	Middle Schuylkill 2	PA0021512	0.3310	0.5400
Rush Twp Sewer Auth - Still Creek WTP	Little Schuylkill	PA0063053	0.1079	0.1760
Schuykill County Mun. Auth.	Upper Schuylkill	PA0062821	0.1146	0.1870
Schuylkill Haven, Borough of	Upper Schuylkill	PA0029017	1.003	2.8000
Schuylkill Valley Sew Auth	Upper Schuylkill	PA0064211	0.3372	0.5500
Schwenksville Borough Auth.	Perkiomen Creek	PA0020303	0.214	0.3000
Shoemakersville Borough	Upper Schuylkill	PA0024074	0.4	0.6000
Sinking Springs Borough STP	Tulpehocken Creek	PA0028649	0.5	1.0000
Smith, William	Perkiomen Creek	PA0057207	0.0003	0.0005
Souderton Boro	Perkiomen Creek	PA0021857	1.5	2.0000
Spring City Boro	Middle Schuylkill 2	PA0028614	0.3	0.3450
Spring Twp. STP	Middle Schuylkill 3	PA0043052	1.25	1.2800
St. Clair Sewer Auth.	Upper Schuylkill	PA0025224	0.5	0.6800
Stralkowski, Ronald	Middle Schuylkill 1	PA0056961	0.0002	0.0004
Strausstown Boro	Tulpehocken Creek	PA0246611	0.0398	0.0650
Sugg, Robert A.	Perkiomen Creek	PA0055832	0.0003	0.0005
Tamaqua Borough Auth. STP	Little Schuylkill	PA0027006	1.3	2.6000
Telford Boro Auth	Perkiomen Creek	PA0036978	0.7	1.1000
U Frederick Twp - Perkiomen Crossing	Perkiomen Creek	PA0054810	0.0294	0.0479
U Frederick Twp & Ivy Ridge	Perkiomen Creek	PA0057061	0.0130	0.0212
U Hanover Auth	Perkiomen Creek	PA0012891	0.0368	0.0600
U Merion Mun Utility Auth - Matsunk WPCC	Middle Schuylkill 1	PA0026085	3.5	5.0000
U Merion Mun Utility Auth - Trout Run	Middle Schuylkill 1	PA0026131	3	6.0000
U Montgomery Joint Auth	Perkiomen Creek	PA0020532	0.575	2.0000
U Salford Twp – Farmhouse	Perkiomen Creek	PA0057606	0.0002	0.0004
U Salford Twp - Twp Park	Perkiomen Creek	PA0058025	0.0009	0.0015
U. Gwynedd Twp	Wissahickon Creek	PA0023256	2.7	5.7000
U. Gwynedd/Towamencin Mun. Auth.	Perkiomen Creek	PA0039004	4.5	6.5000
Upper Bern Twp	Tulpehocken Creek	PA0088251	0.0337	0.0550
Upper Dublin Twp WWTP	Wissahickon Creek	PA0029441	0.6743	1.1000
Valley Forge Sewer Auth	Middle Schuylkill 1	PA0043974	8.33	9.2000
Washington Twp Mun Auth	Perkiomen Creek	PA0086142	0.1533	0.2500
Whitemarsh Twp Auth	Lower Schuylkill	PA0026298	1	2.0000
Womelsdorf Boro. STP	Tulpehocken Creek	PA0028975	0.3	0.4750
Worcester Twp - Berwick Place STP & Sew Sys	Perkiomen Creek	PA0055671	0.0920	0.1500
Worcester Twp - Valley Green WTP	Perkiomen Creek	PA0050393	0.1349	0.2200
Wulff, AL	Lower Schuylkill	PA0052779	0.0003	0.0005
Wyomissing Valley STP	Middle Schuylkill 3	PA0026638	0.6130	1.0000
Total			**118.48**	

Table A-5 Agricultural Processing Facilities

Facility Name	Source	Withdrawal, GPD	Sub-Watershed
ALLEN S BRUBACKER FARM JACKSON TWP LEBANON CNTY	Ground	163,800	Tulpehocken Creek
BISON MEADOWS FARM BLYTHE TWP SCHUYLKILL CNTY	Ground	376	Little Schuylkill
DANIEL H SCHULER FARM RICHMOND TWP BERKS CNTY	Ground	136	Maiden Creek
DAVID B FAIRMAN FARM BUSHKILL TWP NORTHAMPTON CNTY	Surface	4,666	Wissahickon Creek
EATON FARMS BERN TWP BERKS CNTY	Ground	533,745	Upper Schuylkill
EATON FARMS BERN TWP BERKS CNTY	Surface	86,400	Upper Schuylkill
GALE NURSERIES LOWER GWYNEDD TWP MONTGOMERY CNTY	Ground	902	Wissahickon Creek
GALE NURSERIES LOWER GWYNEDD TWP MONTGOMERY CNTY	Surface	21,000	Wissahickon Creek
GINO GASPARI & SONS 2103 GEORGIA RD LOCATION (PLANT 1)	Ground	30,051	Middle Schuylkill 3
GINO GASPARI & SONS BLOOMSBURG RD LOCATION (PLANT 3)	Ground	938	Tulpehocken Creek
GINO GASPARI & SONS FRUSH VALLEY RD LOCATION (PLANT 5&7)	Ground	2,276	Middle Schuylkill 3
GINO GASPARI & SONS HARTZ RD LOCATION (PLANT 4)	Ground	6,577	Middle Schuylkill 3
GINO GASPARI & SONS MOUNTAINSIDE RD LOCATION (PLANT 2)	Ground	947	Middle Schuylkill 3
GINO GASPARI & SONS MT LAUREL RD LOCATION (PLANT 6)	Ground	597	Middle Schuylkill 3
GINO GASPARI & SONS PRIVATE RD NEAR MOUNTAIN RD LOC (PLANT8)	Ground	1,021	Middle Schuylkill 3
HOBERTS FRUIT FARM BERKS CNTY	Ground	4,000	Manatawny Creek
HOBERTS FRUIT FARM BERKS CNTY	Ground	8,000	Perkiomen Creek
HOPEWELL NURSERY AMITY TWP BERKS CNTY	Ground	63,733	Manatawny Creek
JOHN J DRUMHEILER FARM MONTGOMERY CNTY	Ground	228	Middle Schuylkill 2
KOCHS TURKEY FARM WALKER TWP SCHUYLKILL CNTY	Ground	70,343	Little Schuylkill
LALISA HOLSTEINS BALLY BORO	Ground	840	Perkiomen Creek
LUTZ WUTZ FARM DOUGLASS TWP MONTGOMTERY CNTY	Ground	1,650	Perkiomen Creek
PENN VALLEY PIG UPPER BERN TWP BERKS CNTY	Ground	7,890	Upper Schuylkill
PLANTS UNLIMITED LEESPORT BORO BERKS CNTY	Ground	1,250	Upper Schuylkill
PLANTS UNLIMITED LEESPORT BORO BERKS CNTY	Surface	12,000	Upper Schuylkill
PLUSHANSKI FARMS GREENWICH TWP BERKS CNTY	Ground	14,822	Maiden Creek
ROY S KOLB & SONS FARM EAST COVENTRY TWP CHESTER CNTY	Ground	6,517	Middle Schuylkill 2
SCATTERED ACRES FARM BERKS CNTY	Ground	15,978	Tulpehocken Creek
SHEMIN NURSERIES	Ground	194,012	Middle Schuylkill 2
WEILERS PRODUCE MARION TWP BERKS CNTY	Ground	78,000	Tulpehocken Creek
Total		**1,332,695**	

Table A-6 Mining Sector Water Use

Facility Name	Discharge, GPD	Withdrawal, GPD	Withdrawal Source	Sub-Watershed
BIRDSBORO MATERIALS ROBESON TWP BERKS CNTY		13,714	Ground	Middle Schuylkill 3
BIRDSBORO MATERIALS ROBESON TWP BERKS CNTY		8,454	Surface	Middle Schuylkill 3
BLOOMING GLEN QUARRY		763,016	Ground	Perkiomen Creek
CARBONITE FILTER CORP	13,800	15,000	Ground	Little Schuylkill
WARNER CO. CEDAR HOLLOW QUARRY	2,599,970	2,826,054	Ground	Valley Creek
DYER QUARRY INC	316,066	321,950	Ground	Middle Schuylkill 3
DYER QUARRY INC		21,600	Surface	Middle Schuylkill 3
EASTERN IND INC-Kutztown*	6,533,443	7,101,569	Ground	Maiden Creek
EASTERN IND INC-Oley	907,581	986,502	Ground	Monocacy
GLASGOW CO CATANACH QUARRY	3,211,894	3,491,189	Ground	Valley Creek
HAINES & KIBBLEHOUSE INC	701,975			Perkiomen Creek
HIGHWAY MATERIALS INC	8,540,000	8,900,000	Ground	Wissahickon
LEHIGH COAL & NAVIGATION CO	1,077,195	1,172,749	Ground	Little Schuylkill
NACEVILLE MATERIALS		240,667	Ground	Perkiomen Creek
READING ANTHRACITE CO	10,053,226			Upper Schuylkill
READING ANTHRACITE CO WADESVILLE NO P33		5,976,493	Ground	Upper Schuylkill
READING ANTHRACITE NEW ST NICHOLAS BR		5,365,333	Ground	Upper Schuylkill
READING MATERIALS DOUGLASSVILLE QUARRY	156,006	169,572	Ground	Middle Schuylkill 2
Total	**34,111,156**	**37,373,862**		

*No discharge present in original PADEP data, so one was assumed and calculated according to PADEP method:
Withdrawal *0.92 = Discharge

Table A-7 Golf Course Water Use

Course Name	Ground, GPD	Surface, GPD	Sub-Watershed
ARROWHEAD GOLF COURSE		4,858	Monocacy Creek
BALA GOLF CLUB		92,753	Lower Schuylkill
BELLA VISTA GC NEW HANOVER TWP MONTGOMERY CNTY		116,226	Perkiomen Creek
BELLEWOOD GC NORTH COVENTRY TWP CHESTER CNTY	47,676	135,968	Middle Schuylkill 2
BLACKWOOD GC	56,052		Middle Schuylkill 2
BROOKSIDE CC POTTSTOWN		134,597	Middle Schuylkill 2
CENTER SQUARE GOLF CLUB INC	2,510	25,793	Middle Schuylkill 1
CHESTER VALLEY GOLF CLUB	72,541	118,814	Valley Creek
CLUB AT SHANNONDELL LOWER PROVIDENCE TWP MONT. CNTY	54,786		Perkiomen Creek
COLONIAL CC	35,280		Tulpehocken Creek
FRENCH CREEK GC ELVERSON BORO CHESTER CNTY	209,814	184,271	French Creek
GILBERTSVILLE GC	120,448		Perkiomen Creek
GREEN ACRES GOLF COURSE		71,545	Tulpehocken Creek
GULPH MILLS GOLF CLUB		24,836	Middle Schuylkill 1
HANSEN NURSERIES	59,383		Perkiomen Creek
HEIDELBERG COUNTRY CLUB		157,142	Tulpehocken Creek
HICKORY VALLEY GOLF CLUB		65,000	Perkiomen Creek
INDIAN VALLEY CC	7,729	43,147	Perkiomen Creek
KIMBERTON GOLF CLUB INC		44,258	French Creek
LEBANON VALLEY GOLF COURSE	28,569		Tulpehocken Creek
LIMERICK GOLF CLUB		128,227	Perkiomen Creek
MACOBY RUN GC	114,294	86,687	Perkiomen Creek
MAINLAND GC		45,676	Perkiomen Creek
MANOR GOLF COURSE	25,620		Tulpehocken Creek
MEADOW BROOK GOLF CLUB	13,635		Pickering Creek
MEADOWLANDS CC	236,309		Wissahickon Creek
MOSELEM SPRINGS GOLF CLUB	1,267	106,668	Maiden Creek
NORTH HILLS CC	51,180		Wissahickon Creek
PERRY TOWNSHIP GOLF INC	5,620		Upper Schuylkill
PHILADELPHIA CRICKET CLUB		183,411	Wissahickon Creek
PHOENIXVILLE CC	24,580		Middle Schuylkill 1
PICKERING VALLEY GC SCHUYLKILL TWP CHESTER CNTY	143,300		Pickering Creek
Pleasant Hills Golf Course	40,800		Maiden Creek
PLYMOUTH CC MONTGOMERY CNTY	23,460	92,934	Middle Schuylkill 1
READING COUNTRY CLUB		33,265	Middle Schuylkill 3
RICH MAIDEN GC	2,739		Maiden Creek
SPRING FORD CC	252,483	33,123	Middle Schuylkill 2
SPRING HOLLOW GC SPRING CITY BORO CHESTER CNTY		76,987	Middle Schuylkill 2
STONEWALL LINKS NORTH GC WARWICK TWP CHESTER CNTY	60,252		French Creek
SUNNYBROOK GOLF CLUB	84,231		Wissahickon Creek
THE ACE CLUB	189,893	180,833	Lower Schuylkill
ULRICH FARM AND MARKET		10,000	Tulpehocken Creek
WEAVERS ORCHARD INC	152,118	673,500	Hay Creek
WHITE BIRCH GC		1,524	Little Schuylkill
WILLOW HOLLOW GC	91,270	40,354	Tulpehocken Creek
WOODS GOLF CENTER	20,834		Middle Schuylkill 1
Total	**2,228,673**	**2,912,397**	

Table A-8 Power Sector Water Use

Facility	Estimated Discharge, GPD**	Surface Water Withdrawal, GPD	Groundwater Withdrawal, GPD	DRBC % Consumptive	Sub-Watershed
AES Ironwood Lebanon City	0		265,700	100.0%	Tulpehocken Creek
Conectiv Bethlehem Plant	151,259	491,100		69.2%	Perkiomen Creek
Exelon Cromby Generating Station	154,925,928	156,018,055		0.7%	Middle Schuylkill 2
Exelon Limerick Generating Station*	8,328,854	39,102,600		78.7%	Middle Sch. 2 Dis. & With., Perk. With.
Northeastern Power Company	0		143,800	100.0%	Little Schuylkill
Reliant Energy Mid-Atlantic Power Holdings LLC - Titus	13,824,585	15,108,836		8.5%	Middle Schuylkill 3
Wheelabrator Frackville Energy Company	0		533,300	100.0%	Upper Schuylkill
Total	**177,230,626**	**210,720,590**	**942,800**	**16.3%**	

Source: David Sayers, DRBC
**Nuclear power, the other facilities are fossil fuel*
***Consumptive use percentages used to estimate discharge*

Table A-9 Industrial Sector Water Use

Facility	Surface, GPD	Ground, GPD	Discharge, GPD	Sub-Watershed
BALDWIN HARDWARE CORP		437,000		Middle Schuylkill 3
BRUSH WELLMAN CORP		79,056		Upper Schuylkill
CAMBRIDGE LEE READING TUBE DIV	376,561			Middle Schuylkill 3
CARPENTER TECHNOLOGY CORP		756,725		Middle Schuylkill 3
CARTECT CORP			987,650	Middle Schuylkill 3
EAFCO INC		38,345		Perkiomen Creek
EAST PENN MFG CO INC		243,609		Maiden Creek
GESSNER PRODUCTS CO INC		52,856		Wissahickon Creek
GLASGOW INC MCCOY QUARRY		3,030,460		Middle Schuylkill 1
GLEN GERY BRICK - MID ATLANTIC DIV		22,945		Upper Schuylkill
GUERS DAIRY INC / DAN-ED CORP		43,258		Upper Schuylkill
HATFIELD QUALITY MEATS HATFIELD TWP MONT. CNTY		467,734		Perkiomen Creek
HENKLE CORP FORMER AMCHEM PRODUCTS		1,059		Wissahickon Creek
HENRY KIMBERTON FAC		258,692	9,651	French Creek
HOFMANN INDUSTRIES INC SINKING SPRING PLANT		36,568		Tulpehocken Creek
HONEYWELL GW REMEDIATION SITE		12,386		Wissahickon Creek
HONEYWELL INC			4,228	Wissahickon Creek
INDEPEN CONST MATERIALS		411,011		Pickering Creek
ISG PLATE PLYMOUTH TWP MONTGOMERY CNTY	231,024	155,730		Middle Schuylkill 1
JAMES P LINETTE INC		21,203		Tulpehocken Creek
JEFFERSON SMURFIT CORP	6,480,000		4,861,917	Lower Schuylkill
JOHNSON MATTHEY INC		124		Middle Schuylkill 1
LEHIGH VALLEY DAIRY INC - SCHUYLKILL CO		36,740		Upper Schuylkill
LEIDYS INC		62,277		Perkiomen Creek
LUKENS STEEL/ CONSH PLANT			239,583	Middle Schuylkill 1
MARKEL CORP		120,499		Middle Schuylkill 1
MCCONWAY & TORLEY CORP KUTZTOWN		198,768		Maiden Creek
MERCK AND COMPANY WEST POINT BASINS			269,083	Perkiomen Creek
MERCK AND COMPANY WEST POINT BASINS			810,750	Wissahickon Creek
MERCK & CO INC		395,674		Perkiomen Creek
MERCK & CO INC		589,520		Wissahickon Creek
MID ATLANTIC CANNERS		129,268		Upper Schuylkill
MOYER PACKING CO		151,830		Perkiomen Creek
MOYER PACKING CO RENDERING DIV 1		139,712		Perkiomen Creek
NEAPCO INC		3,702		Middle Schuylkill 2
OCCIDENTAL CHEMICAL CORP	203,564	517,101		Middle Schuylkill 2
OZ/GEDNEY CO-BIRCH DIV		24,530		Upper Schuylkill
PERKASIE INDS CORP		61,892		Perkiomen Creek
PILGRIMS PRIDE CORP		101,624		Perkiomen Creek
POST PRECISION CASTINGS INC		6,683		Tulpehocken Creek
RAHNS BECHTELSVILLE COLEBROOKDALE TWP BERKS CNTY PLANT		6,962		Perkiomen Creek
RAHNS BLOOMING GLEN HILLTOWN TWP BUCKS CNTY PLANT		6,148		Perkiomen Creek
RAHNS RAHNS PERKIOMEN TWP MONT. CNTY PLANT		14,666		Perkiomen Creek
RAHNS RICHMOND TWP BERKS CNTY PLANT		5,904		Maiden Creek
Rohm & Haas Co	42,896			Wissahickon Creek
SANATOGA QUARRY		136,884		Middle Schuylkill 2
SCI CAST COLEBROOKDALE TWP BERKS CNTY PLANT		971		Perkiomen Creek

SEALED AIR CORPORATION		86,408		Middle Schuylkill 3
SMURFIT STONE CONTAINER CORP		7,239		Middle Schuylkill 2
SUNOCO 0363 2783			3,633	Lower Schuylkill
SUPERIOR TUBE CO		175,253	216,282	Perkiomen Creek
T/A THREE SPRINGS WATER COMPAN			7,200	Hay Creek
TEVA PHARMACEUTICALS SELLERSVILLE BUCKS CNTY PLANT		65,698		Perkiomen Creek
TUSCAN LEHIGH DAIRIES		210,897	18,964	Perkiomen Creek
WISSAHICKON SPRING WATER EAST BRUNSWICK TWP SCHUYLKILL CNTY		171,508		Little Schuylkill
WOLFE DYE BLEACH WORKS INC		530,078		Upper Schuylkill
Xxx			241,248	Maiden Creek
Total	**7,334,045**	**10,027,197**	**7,670,189**	

Table A-10 Miscellaneous Water Use

Facility	Discharge, MGD	Surface, GPD	Ground, GPD	Sub-Watershed
AMERICAN INKS AND COATINGS CORPORATION NCCW AND SWRO	5,568			Middle Schuylkill 1
AMETEK US GAUGE DIV PLANT 2 (GR WATER REMED)			106,456	Perkiomen Creek
BERKSHIRE AUTO & GARAGE READING CITY BERKS CNTY			1,008	Middle Schuylkill 3
BLUE BELL GULF	110,000			Wissahickon Creek
BROWN PRINTING EAST GREENVILLE DIV	11,314			Perkiomen Creek
COVENTRY RIDGE SUBDV	7,818			Middle Schuylkill 2
COVENTRY TERRACE MHP	17,800		*	Middle Schuylkill 2
EAGLES PEAK CAMPGROUND	4,972			Tulpehocken Creek
EAST COVENTRY SCHOOL	1,791			Middle Schuylkill 2
EAST VINCENT BUSINESS PARK	47,683			Middle Schuylkill 2
EAST VINCENT TWP MS4	223,658			Middle Schuylkill 2
EASTERN UNIV RADNOR TWP DELAWARE CNTY		51		Middle Schuylkill 1
ENSERV,INC.	51,224			Valley Creek
EXELON BRADSHAW RESVR	16,967,273			Perkiomen Creek
FORT ZELLER ELEM	819			Tulpehocken Creek
FOUNTAIN COURT	4,478			Lower Schuylkill
HANDY & HARMAN TUBE CO	9,083			Middle Schuylkill 1
HIGH POINT BAPTIST CHAPEL	5,410		*	Hay Creek
HILL SCH POTTSTOWN BORO MONTGOMERY CNTY			665	Middle Schuylkill 2
ICEDALE GWCU	0			Middle Schuylkill 2
IRELAND HOTELS INC	32,000			Middle Schuylkill 1
KNOLL FURNITURE MFG FAC	37,891			Perkiomen Creek
L SALFORD-INDIAN HLS	1,000			Perkiomen Creek
LOWER MILFORD ELEM. SCHOOL	1,000			Perkiomen Creek
MAINLAND STP	644,182			Perkiomen Creek
MAJIC/ SEW	6,733			Little Schuylkill
MASONIC VILLAGE WHITEMARSH TWP MONT. CNTY			4,355	Wissahickon Creek
NORTH PENN AREA 12 SUPERFUND SITE	10,177			Middle Schuylkill 1
OAK TERRACE COUNRTY CLUB	1,960			Wissahickon Creek
OWEN J ROBERTS SCH DIST MAIN CAMPUS			16,849	Middle Schuylkill 2
OWEN J ROBERTSMAIN CAMPUS	20,917			French Creek
PALMER INTL SKIPPACK FACILITY	151,200			Perkiomen Creek
PECO W CONSHOHOCKEN GAS PLT	2,500			Lower Schuylkill
PECO W CONSHOHOCKEN GAS PLT	14,000			Middle Schuylkill 1
PHILA CC STP	15,500			Lower Schuylkill
POCONO PLATEAU	7,083			Perkiomen Creek
POSSUM HOLLOW STP & SEW SYS	75,000			Middle Schuylkill 2
POST OFFICE INN	626			Allegheny Creek
POTTSTOWN LANDFILL		14,316	19,876	Manatawny Creek
POTTSTOWN LANDFILL			8,640	Monocacy Creek
PRECISION TUBE CO	15,423			Wissahickon Creek
PROCESS RECOVERY CORP	16,667			Middle Schuylkill 3
QUAKER ALLOY	50,000			Tulpehocken Creek
RIVERSIDE FAC	60,000			Middle Schuylkill 1

ROCKWOOD SPRING W C	10,875			Middle Schuylkill 2
SETON MANOR RUSH TWP SCHUYLKILL CNTY			36,178	Little Schuylkill
SFS DIBIASE CONSTRUCTION	2,000			Middle Schuylkill 3
SOUTH COVENTRY TWP CHESTER CNTY			16,123	French Creek
SOVEREIGN PACKAGING GROUP INC	19,200			French Creek
SPRING MOUNTAIN SKI AREA UPPER SALFORD TWP MONTGOMERY CNTY		461,515		Perkiomen Creek
STRAWBERRY FAMILY RESTURANT	767		*	Perkiomen Creek
SWAMP CREEK PLT	2,307,500			Perkiomen Creek
TSC HENDERSON RD SITE (GW REMED)			45,613	Middle Schuylkill 1
TURKEY HILL GROUND WATER CLEANUP	2,366			Perkiomen Creek
UNIFORM TUBES INC GW REMEDIATION			89,077	Perkiomen Creek
VALLEY FORGE TERRACE MHP WWTP	32,400			Middle Schuylkill 1
WARNER-JENKINSON	475,529			Middle Schuylkill 3
WARWICK BUILDING OWEN J ROBERTS SCH DIST CHESTER CNTY			172	French Creek
WARWICK POTTERY WORKSWARWICK TWP CHESTER CNTY			0	French Creek
WATER POLL CONROL FAC	11,678			Little Schuylkill
WEATHERSTONE DEV	8,621			French Creek
WESTERN BERKS REFUSE AUTH	18,750			Middle Schuylkill 3
WLLNPPCK LK ESTATES	314,167			Perkiomen Creek
WYETH PHARMACEUTICALS UTILITY PLANTS	1,964			Perkiomen Creek
Xxx		220,646		Maiden Creek
Xxx	146,821			Maiden Creek
Total	**21,985,385**	**696,528**	**345,012**	

* Water withdrawals reported in Potable Water Supply Section

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Appendix B Pennsylvania State Water Plan Comparison

The PADEP results of the water budget conducted on behalf of the State Water Plan update are compared here to the results presented in Section 5. PADEP performed a water budget for hundreds of designated pour points across the Schuylkill River watershed as part of a larger water budget for the state. The State Water Plan results for pour point ID# 229074 encompass the entire Schuylkill River watershed above, and not including, the Queen Lane intake. This area includes the Wissahickon Creek but not the Philadelphia intakes and is 1,880 square miles. After reviewing this location and comparing it geographically to the region the water budget from Sections 4 and 5 covers, pour point ID# 229074 appeared to be the best geographic fit even though it covers 15.7 additional square miles. The two nearest pour points were 48.1 square miles smaller (ID# 229072) or 48.9 square miles larger (ID# 200637) than the area examined in Sections 4 and 5. The results of the State Water Plan water budget for pour point ID# 229074 are presented below in Table B-1 and compared to the results from Sections 4 and 5.

Table B-1 PADEP and PWD Water Budget Comparison

PADEP Numbers, ID# 229074			**PWD Numbers**	
Registered Withdrawals	**Inches Per Year**		**Inches Per Year**	**Withdrawal Category**
Public Supply	1.4880		1.8017	Potable Supply
Industrial	0.1941		0.1956	Industrial
Commercial	0.0586		0.0117	Miscellaneous
Electric	2.3810		2.385	Power Sector
Agriculture	0.0249		0.8892	All Agriculture
Mining	0.4176		0.4211	Mining/Mineral
Estimated / Un-Registered Withdrawals			0.0611	Self-Supplied Industrial
Residential	0.0206		0.0197	Self-Supplied Commercial
Industrial	0.0606		0.0579	Golf Courses
Commercial	0.0553			
Agriculture	0.0800			
Total Withdrawals	**4.7807**		**5.8424**	
Total Discharges	**2.9200**		**4.2462**	
Consumptive Use	**38.9%**		**27%**	

For the pour point with the closest geographical match, ID#229074, the withdrawals total 4.78 inches per day and the discharges total 2.92 inches per day, which equates to a 38.9% consumptive use. In comparison, the PADEP consumptive use is 11.9% more than the consumptive use calculated in Section 5. The discharges used in this analysis are nearly double the discharges used by the PADEP which is due to notable differences in data sources and how the withdrawals and discharges are calculated.

There are several differences between methodology and data interpretation that may account for the differences in withdrawals and discharges, and ultimately consumptive use:

1. PWD includes septic system discharges in the total discharge
The documentation for the State Water Plan methodology states that septic system discharges are estimated and included in the total discharge calculation, but the data supplied by the state does not reflect such a discharge. The result tables compiled by the PADEP Act 220 database show pour points in rural watersheds showing no increase in discharge over increases of tens of square miles. Intuitively, this should be a location where septic system discharges are located, and would be reflected in the changing discharges among pour points. Some examples of this observation are the Pickering Creek, Upper Schuylkill River, West Branch Schuylkill River, Little Schuylkill River, Maiden Creek, and Tulpehocken Creek PADEP results.

2. PWD excluded a 9.1 MGD discharge in the Schuylkill as redundant (Section 4.7)
The inclusion of this discharge would have reduced the PWD calculated consumptive use to 48.2%. This discharge could not be supported by the supplied DRBC data or policies regulating the discharge and withdrawals of the Limerick Generating Station, so it was not accounted for in the PWD water budget.

3. PWD has higher irrigation estimates
The total irrigation estimates for the Schuylkill River watershed using the PADEP methodology is 4.8 million gallons per day. PWD estimated irrigation needs to be 75.7 million gallons per day. The Schuylkill is 37.5% agricultural according to the 2000 USGS NLCD. Approximately 61,456 of the total 460,000 agricultural acres are irrigated. By converting the PADEP irrigation estimate to inches per year, they are estimating that farmers irrigate 0.05 inches per year, which seems low. PWD is estimating that Schuylkill River watershed farmers irrigate 0.85 inches per year, which is equivalent to 0.65 inches per week applied to irrigated areas during the growing season (26 weeks).

4. PWD has higher private well estimates
The PADEP private well estimate numbers aren't available, but even slight differences in estimate methodology could produce large differences in withdrawals.

5. Consumptive use assumptions are different
In the PADEP methodology, the residential consumptive use is estimated to be 10%, whereas in the PWD analysis the consumptive use is estimated to be 15%.

6. PWD added a mining discharge (Section 4.5)
Detailed in Section 4.5, there was a large >7 million gallons per day mining withdrawal that did not have a discharge. Since PADEP generated many of the discharges that were provided to PWD, it was assumed that a discharge for this large withdrawal was accidentally omitted, and so it was manually re-added following the PADEP assumption of 8% consumptive use.

7. DRBC power sector data was used

Following discussions between PWD and DRBC, the DRBC power sector data was decidedly more accurate and was included in this analysis. The largest differences were between the discharges associated with the Cromby and Titus facilities. PADEP had over 70% consumptive use for those facilities, whereas DRBC registered only 0.7-8.5% consumptive use. This difference in data would significantly change the results of any study incorporating the incorrect discharges.

In summary, there are differences in the methodology and data used in the PADEP and PWD water budgets that can account for many of the discrepancies between the results of the two analyses. Due to limitations in the availability of PADEP geographic data, the results of the water budgets conducted on smaller sub-watersheds could not be compared.

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Appendix C Chester County *Watersheds* Comparison

A large part of the water budget methodology was taken from the Chester County *Watersheds* Integrated Water Resource Plan. In *Watersheds*, the focus is on groundwater resource preservation and management, so the net groundwater balance is central to the water budget. The net groundwater, equal to the difference between groundwater withdrawals and discharges, was compared to the 1 in 25 year annual average baseflow. In this analysis the net water loss is calculated as the difference between total withdrawals and discharges from surface and groundwater resources. By incorporating both surface and groundwater resources into the water budget, the analysis is able to capture all human-induced water fluxes for comparison with the 1 in 25 year annual average baseflow. PWD is interested in observing the patterns of all withdrawals and demands in the Schuylkill River watershed, so both groundwater and surface water resources are included in the water budget.

In addition to the differences in methodology, the limited geographic reach of the *Watersheds* also restricts comparisons between the two sets of results. Only those areas of the Schuylkill River watershed that are located in Chester County can be directly compared. Schuylkill River tributaries within Chester County include Pickering, Valley, and French Creeks, as well as some direct drainage to the mainstem Schuylkill River.

Watersheds identified the net groundwater withdrawals of two lower reaches of Valley Creek as 92% and 82% of the 1 in 25 year annual average baseflow, which are above the desired management target of 50%. The net water loss calculated by PWD for Valley Creek was 41.6% of the annual average baseflow. The difference between the two results, given the different methodologies, is the influence of a quarry making large groundwater withdrawals and subsequently discharging the water into Valley Creek. This quarry activity dominated the *Watersheds* calculation because it only considered groundwater resources. The results were less substantial in the PWD analysis because the entire tributary was considered, and the quarry discharges were incorporated into the water budget. Both analyses however indicate that the water supply in Valley Creek is approaching water stress.

Watersheds also identified a direct drainage area that includes Spring City borough with a net groundwater balance 92% of the 1 in 25 year annual average baseflow. This location is a small portion of the Middle Schuylkill 2 sub-watershed that was identified in Section 5 as exceeding the 1 in 25 year baseflow several times over.