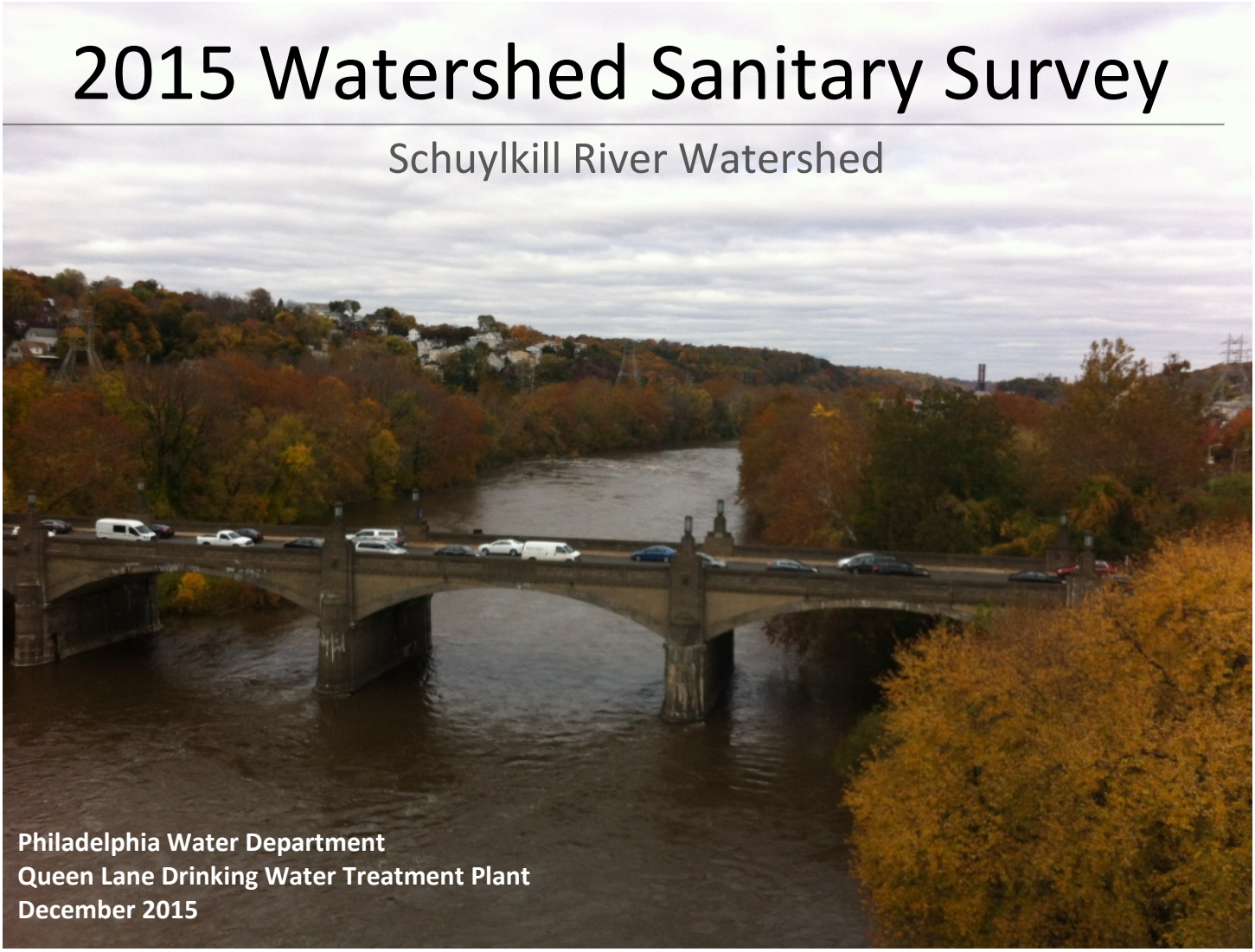
2015 Watershed Sanitary Survey

Schuylkill River Watershed



Philadelphia Water Department
Queen Lane Drinking Water Treatment Plant
December 2015

PHOTO CREDIT: E. VENTURA/PHILADELPHIA WATER DEPARTMENT

This report was produced for the Pennsylvania Department of Environmental Production in accordance with the Environmental Protection Agency National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), 25 Pa. Code §109.

PHILADELPHIA WATER EST. 1801

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Philadelphia Water Department
Source Water Protection Program
1101 Market Street, 4th FL
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Executive Summary

Background and Scope

In December 2012, the Pennsylvania Department of Environmental Protection (PADEP) approved Philadelphia Water Department's (PWD) Watershed Control Plan (WCP), a 5-year plan to reduce *Cryptosporidium* in the source watershed of the Queen Lane Water Treatment Plant (WTP). The WCP earns back-up credit towards requirements for compliance with the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). To maintain the WCP credit, PWD is required to submit annual status reports describing activities towards the implementation of the WCP. Additionally, a Watershed Sanitary Survey (WSS) must be completed every three years. This report is the first WSS due to PADEP in December 2015.

PWD submitted an approach document for the WSS to PADEP, which was approved in May 2015. Following US Environmental Protection Agency (EPA) recommendations published in the Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual, the WSS incorporates the suggested format from the 1993 Watershed Sanitary Survey Guidance Manual, prepared by the American Water Works Association (AWWA) California-Nevada Section while focusing on the priorities of the LT2ESWTR regulation. LT2ESWTR aims to reduce the incidence of disease caused by *Cryptosporidium* and other pathogens.

Pathogen Sources

In the WCP, PWD identified wastewater discharges, runoff from agricultural land use and wildlife as priority sources of *Cryptosporidium* and pathogens in the Schuylkill River watershed. The WSS compiles updated data and evaluates these potential sources of pathogens.

The first priority source is wastewater discharges. Upstream of Queen Lane, there are 152 wastewater treatment plants (WWTPs) discharging a total average of 109 million gallons per day (MGD) to the Schuylkill River watershed. Ultraviolet (UV) disinfection inactivates *Cryptosporidium* making it incapable of infecting a human or animal host. Of the WWTPs in the Schuylkill River watershed, 33 WWTPs discharging a combined average of 27.8 MGD have UV disinfection systems. Additional wastewater discharges include combined sewer overflows (CSOs), illegal discharges of untreated wastewater to streams or "wildcat sewers" and discharges to septic systems. There are four CSOs upstream of Philadelphia in source water protection Zone A, the highest protection priority area. Since 1990, the EPA has identified a number of communities in the Schuylkill River watershed with wildcat sewers. Over the past two decades, many projects have been completed or are underway to address sewerage issues in these communities. The volume of wastewater discharged to septic systems is estimated to be 17.0 MGD upstream of the Queen Lane WTP based on available potable water supply data and a series of assumptions detailed in the report. There is much greater uncertainly associated with the discharge quality and contribution of pathogens to the Schuylkill River watershed from CSOs, wildcat sewers and discharges to septic systems. Additional information on these sources exists, but it was not included in this report. The annual flow diverted to CSOs is available in compliance reporting submitted to PADEP.

Additional information wildcat sewers and septic systems may be available at the municipal level. However, collection and analysis of these data by PWD was not logistically feasible for this survey. In most cases, it would not have provided a consistent and useful level of detail to estimate the contribution of pathogens to the watershed from these sources.

The second priority source is runoff from agricultural land. In the last decade, agricultural land cover has decreased slightly in the Schuylkill River watershed. The Schuylkill River watershed is 28% agricultural land cover based on the 2011 National Land Cover Database (NLCD). There has been an increase in the livestock population of cows and horses, and a decrease livestock population of hogs and sheep. With an estimated 12% increase in cows, a significant source of *Cryptosporidium*, in the Schuylkill River watershed, PWD will continue to prioritize projects that manage stormwater on farms with primarily cows. Significant funds from the Natural Resource Conservation (NRCS) Resource Conservation Partnership Program (RCPP) and the William Penn's Delaware River Watershed Initiative (DRWI) are committed to areas in the Schuylkill and Delaware River watersheds over the next years. With this funding, increased implementation of agricultural BMPs addressing sediment, nutrient and stormwater management on farms is anticipated.

The third priority source is wildlife. PWD specifically focuses on controlling geese, identified as mechanical vectors of *Cryptosporidium* in a research study with Lehigh University. In the absence of watershed-specific data on changes in geese or other wildlife populations, it is difficult to evaluate pathogen contribution to the Schuylkill River watershed from wildlife. PWD controls goose populations at priority sites through a contract with the United States Department of Agriculture (USDA).

Protection Initiatives

PWD manages the watershed within Philadelphia city limits internally through initiatives in Office of Watersheds and outside the city's boundaries through the Source Water Protection Program. Additionally, many federal, state and regional agencies, conservation districts, county planning, watershed organizations and other partners play a critical role in watershed management upstream by overseeing wastewater discharge and stormwater permits, mining reclamation, recreational activities, county planning, resource conservation, water withdrawals and reservoir management. Coordination between PWD and these partners is accomplished through the Schuylkill Action Network (SAN), Schuylkill River Restoration Fund (SRRF), WCP program and Delaware Valley Early Warning System (EWS).

Compliance Status

PWD maintains compliance with federal and state Safe Drinking Water Act (SDWA) regulations and the Partnership for Safe Water to protect the public from health risks associated with *Cryptosporidium* and pathogens. PWD regularly monitors turbidity, fecal coliform and *E. coli,* indicators that disease-causing pathogens may be present, at the WTP intakes and throughout the water system. Additionally, through research contracts with local universities, PWD engages in additional water quality monitoring and method development for sample collection and laboratory analysis.

Conclusions and Recommendations

After review of the data collected in the 2015 WSS process, PWD believes wastewater discharges, runoff from agricultural land and wildlife continue to be priority sources of *Cryptosporidium* and pathogens. PWD recommends continuing a partnership approach to track changes and implement strategies to address these sources.

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List of Acronyms

ACE	Army Corps of Engineers
AFO	animal feeding operation
AMD	abandoned mine drainage
AWWA	American Water Works Association
BLS	Bureau of Laboratory Services
BMP	best management practice
CAFO	confined animal feeding operation
CFE	combined filter effluent
CSO	combined sewer overflow
DRBC	Delaware River Basin Commission
DRWI	Delaware River Watershed Initiative
eDMR	electronic Discharge Monitoring Report
EPA	U. S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
EWS	Delaware Valley Early Warning System
GIS	Geographic Information System
IESWTR	Interim Enhanced Surface Water Treatment Rule
IFE	individual filter effluent
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LTCP	Long Term Control Plan
LTCPU	Long Term Control Plan Update
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MPN	most probable number
MS4	municipal separate storm sewer system
NLCD	National Land Cover Database
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
NWQI	National Water Quality Incentive
OOW	Office of Watersheds
PADEP	Pennsylvania Department of Environmental Protection
PCS-ICIS	Permit Compliance System and Integrated Compliance Information System
PDE	Partnership for the Delaware Estuary
PSW	Partnership for Safe Water
PWD	Philadelphia Water Department
SAN	Schuylkill Action Network
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SIC	Standard Industrial Classification

SRHA	Schuylkill River Heritage Area
SRLM	Schuylkill Runoff Loading Model
SRRF	Schuylkill River Restoration Fund
SWA	Source Water Assessment
SWMM	Storm Water Management Model
SWPP	Source Water Protection Plan
SWTR	Surface Water Treatment Rule
TAG	Technical Advisory Group
TCR	Total Coliform Rule
TT	treatment technique
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
UV	ultraviolet
WCP	Watershed Control Plan
WSS	Watershed Sanitary Survey
WTP	water treatment plant
WWTP	wastewater treatment plant

Section 1. Introduction

In April 2011, the Philadelphia Water Department (PWD) completed a Watershed Control Plan (WCP) for compliance credit for the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). After receiving approval from the Pennsylvania Department of Environmental Protection (PADEP), the WCP went into effect December 2012. The purpose of a WCP is to develop a comprehensive source water protection approach to reducing levels of infectious *Cryptosporidium* in finished drinking water (US EPA, 2006). The elements of the PWD WCP are being achieved through previously established and ongoing efforts of the PWD's Source Water Protection Program and through WCP actions aimed to specifically reduce levels of *Cryptosporidium* in the Schuylkill River watershed. The Schuylkill River is one of two rivers from which Philadelphia gets its drinking water. As part of the WCP credit, LT2ESWTR requires a Watershed Sanitary Survey (WSS) be completed every three years. The following report serves as the 2015 WSS for PWD.

1.1 Background

The US Environmental Protection Agency (EPA) published the first source water quality based drinking water regulation on January 5, 2006. LT2ESWTR, an amendment to the Safe Drinking Water Act, serves to protect the public from waterborne illness caused by *Cryptosporidium* and other microbial pathogens in drinking water. In the United States, *Cryptosporidium* has been the cause of several outbreaks of Cryptosporidiosis, a gastrointestinal disease particularly dangerous for immunocompromised individuals. The LT2ESWTR requires public drinking water systems with surface water sources, or groundwater sources influenced by surface water, to monitor monthly for *Cryptosporidium* at each supply intake for two years. The observed *Cryptosporidium* concentrations categorize each intake into one of four 'Bins.' Public water systems placed in Bin 1 indicate the lowest concentrations of *Cryptosporidium* and require no additional treatment. Public water systems placed in Bins 2, 3 and 4 indicate increasingly greater concentrations of *Cryptosporidium* and require 4-log, 5-log and 5.5 log removals, respectively. Public water systems using conventional treatment processes, i.e. coagulation, flocculation, sedimentation, and filtration, are assumed to achieve a 3-log removal. Therefore, additional 1-log, 2-log or 2.5 log treatment credit(s) is required of a conventional treatment facility if placed in Bins 2 through 4. The EPA provides a "microbial toolbox" describing options to earn additional treatment credits including source water protection and management programs, pre-filtration processes, treatment performance programs, additional filtration components and inactivation technologies.

For the first round of LT2ESWTR sampling, PWD submitted grandfathered *Cryptosporidium* monitoring data collected from March 2001 through March 2003 and categorized each of Philadelphia's three drinking water treatment plants (WTPs) into Bins. PWD's Baxter and Belmont WTPs achieved Bin 1 status with average oocyst concentrations less than 0.075 per liter. However, Queen Lane data resulted in an average oocyst concentration of 0.076 per liter falling into Bin 2. Since Queen Lane uses conventional treatment processes, and automatically receives a 3-log removal credit, an additional 1-log removal credit is required. PWD has selected to use the combined filter effluent for 0.5-log credits, the

individual filter effluent for 0.5-log credits, and the development and implementation of a WCP for 0.5-log back up credits. PWD submitted a WCP to the PADEP in April 2011 and received approval in December 2012. To maintain the WCP credit, PWD is required to submit a status report every year, and a Watershed Sanitary Survey every three years to the Pennsylvania Department of Environmental Protection (PADEP).

1.2 Scope of Watershed Sanitary Survey

The PWD WSS will follow the four-component format described in the 1993 Watershed Sanitary Survey Guidance Manual, prepared by the American Water Works Association (AWWA) California-Nevada Section, with a focus on pathogens in the Schuylkill River watershed. PWD addresses many of the features of a WSS through the ongoing work of its Source Water Protection Program (SWPP). Much of the watershed data the WSS Guidance Manual recommends including in a WSS is documented and analyzed in the 2002 Source Water Assessment (SWA), the WCP, and other PWD reports publically available on the PWD website (phillywatersheds.org). However, since the completion of these reports, some new information and improved data has become available. This new and updated data is compiled in the WSS and will additionally be used to inform the SWPP. This report will serve as the 2015 WSS for PWD and will include the following four components described below.

1) Watershed and Water System: Provides a brief overview of the Schuylkill River watershed and the PWD water supply system
2) Pathogen Sources: Compiles updated data on sources of pathogen contamination in the Schuylkill River watershed including wastewater treatment plant (WWTP) effluent, combined sewer overflows (CSOs), illegal wastewater discharges, septic system discharge and runoff from agricultural land and wildlife
3) Protection Initiatives: Demonstrates how PWD supports and implements source water protection initiatives in the City of Philadelphia through PWD initiatives, and in the entire Schuylkill River watershed through the Source Water Protection Program and a watershed partnership approach
4) Compliance Status: Summarizes pertinent regulations that protect public health from pathogens in the drinking water supply and describe PWD's ability to treat the source water to a level that meets or exceeds federal and state regulations

Section 2. Watershed and Water Supply System

The first component of a WSS as described in the 1993 Watershed Sanitary Survey Guidance Manual from the American Water Works Association (AWWA) Nevada-California Section is a description of the watershed and water supply system.

2.1 Watershed

The Schuylkill River watershed drains an area of 1,911 square miles. It is more than 130 miles long and includes over 180 tributaries. The watershed is located in southeastern Pennsylvania and is comprised of 11 counties and more than 1.6 million residents. The headwaters of the Schuylkill River drain approximately 270 square miles of Schuylkill County and flow in a southeasterly direction into the tidal waters at the river's confluence with the Delaware Estuary. The basin includes large portions of Schuylkill, Berks, Montgomery, Chester and Philadelphia counties and smaller portions of Carbon, Lehigh, Lebanon, Lancaster, Bucks and Delaware counties. The major towns and cities along the river are Pottsville, Reading, Pottstown, Phoenixville, Norristown, Conshohocken and Philadelphia.

This section provides an overview of the Schuylkill River watershed. Some information can be referenced from other PWD reports available on phillywatersheds.org. The Schuylkill River Watershed Source Water Assessment (SWA) completed in 2002 is an excellent comprehensive resource for general information on the Schuylkill River watershed. Additionally, updated watershed information and data is also included in this section where available.

2.1.1 History

Section 1.2.2 of the 2002 SWA, available on phillywatersheds.org, includes a brief history of the Schuylkill River watershed beginning with colonial settlement of the lower Schuylkill and establishment of the city of Philadelphia and following the industrialization of the watershed and development of the Schuylkill River as a water supply.

2.1.2 Physiography, Geology, and Soils

Section 1.2.3 of the 2002 SWA includes a characterization of the physiography, geology and soils in the Schuylkill River watershed.

2.1.3 Hydrology

In 2010, PWD completed the Schuylkill River Hydrology and Consumptive Use report, also available on phillywatersheds.org. This report investigated the availability of water and the competing water needs in the Schuylkill River watershed. It includes a summary of hydrology (Section 3) and a detailed water budget. Additional information on watershed hydrology is located in Section 1.2.4 of the 2002 SWA.

2.1.4 Land Cover

The 2002 SWA includes an analysis of the available land cover data for the Schuylkill River watershed. The data analysis uses the 1992 National Land Cover Database (NLCD) GIS layer. The NLCD is created by the Multi-Resolution Land Characteristics Consortium, which is led by the US Geological Survey (USGS)

and includes federal agency partners. In the 2002 SWA, the 1992 NLCD GIS layer was intersected with 2000 Census populations to identify and include residential development that had occurred since 1992. Since the completion of the SWA, NLCD 2001, 2006 and 2011 have been released. At the time NLCD 2001 was released, it was not comparable with the 1992 data due to new improvements in mapping methodology and input data, and changes in the mapping legend. The NLCD 2011 was released in April 2014. The product suite also includes 2011 editions of the NLCD 2001 and NLCD 2006, which are comparable to the NLCD 2011 and intended for use when making comparisons between 2001, 2006 and 2011. This section includes a summary of the land cover in the Schuylkill River watershed and an analysis of the land cover changes that occurred from 2001 to 2011.

The NLCD uses a 16-class land cover classification scheme with 30-meter special resolution:

- Open Water
- Perennial Ice/Snow
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/scrub
- Grassland/herbaceous
- Pasture/hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

Detailed descriptions on the 16 land cover classifications are available at http://www.mrlc.gov. Figure 2-1 shows Schuylkill River watershed with an overlay of the NLCD 2011.

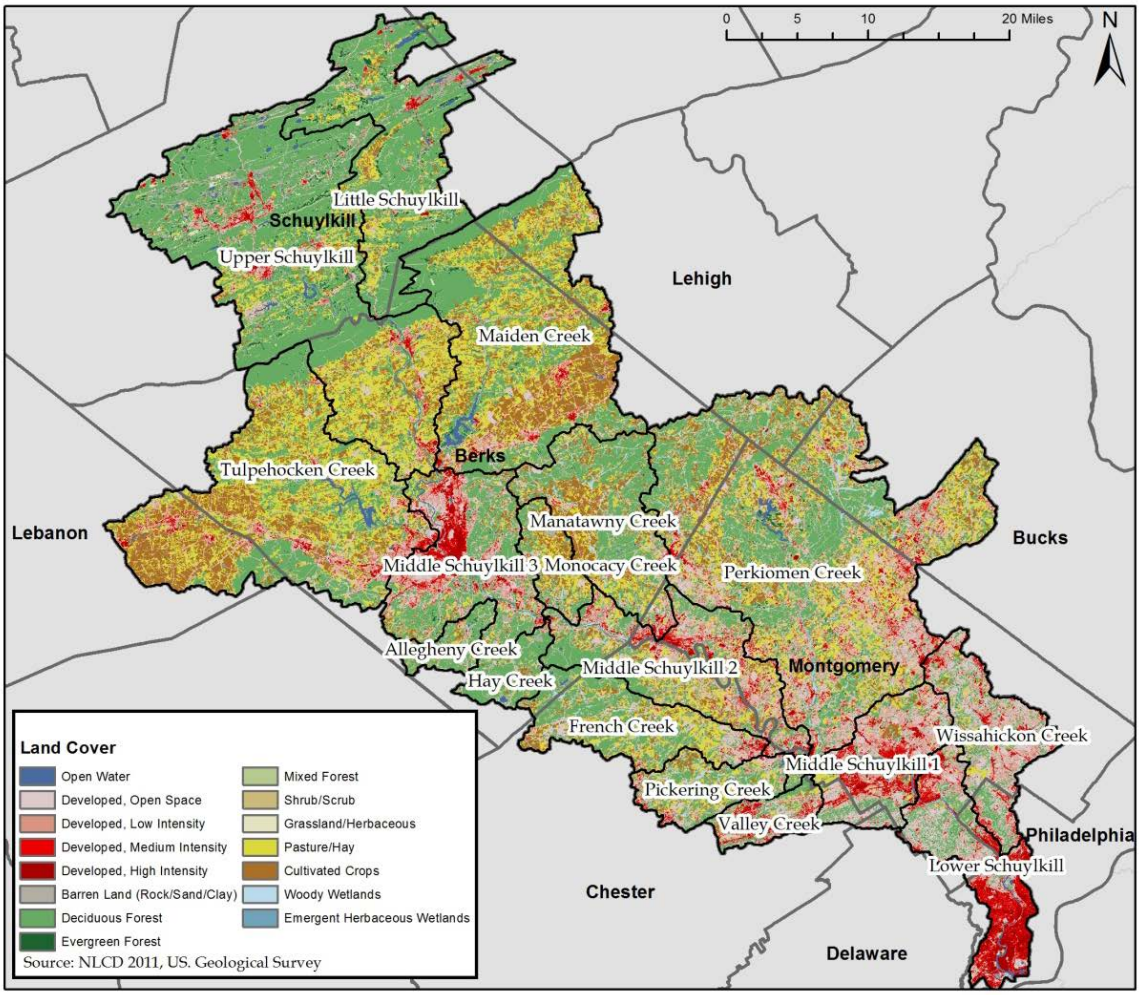


FIGURE 2-1: MAP OF LAND COVER IN SCHUYLKILL RIVER WATERSHED 2011

Table 2-1 lists the total land area by land cover class in 2001, 2006 and 2011 in square miles. Table 2-2 lists the percent land area with each land cover class in the Schuylkill River watershed in 2001, 2006 and 2011. Developed, open space, deciduous forest, pasture/hay and cultivated crops make up the largest land area, over 75%, of the watershed. In general, from 2001 to 2011, there has been an increase in developed land (open space, low intensity, medium intensity and high intensity) and barren land. There has been a decrease in deciduous forest, pasture/hay, and cultivated crop land.

TABLE 2-1 LAND AREA (SQ. MI.) BY LAND COVER CLASSIFICATION IN SCHUYLKILL RIVER WATERSHED 2001, 2006, AND 2011

Land Cover Classification	2001 Land Cover Area (Sq. Mi.)	2006 Land Cover Area (Sq. Mi.)	2011 Land Cover Area (Sq. Mi.)
Open Water	20.4	20.7	20.6
Perennial Ice/Snow	0.0	0.0	0.0
Developed-Open Space	272.0	274.3	276.2
Developed-Low Intensity	131.6	134.6	136.6
Developed-Medium Intensity	63.5	69.7	73.1
Developed-High Intensity	31.9	34.2	36.0
Barren Land	10.1	10.7	10.9
Deciduous Forest	682.1	677.8	670.9
Evergreen Forest	19.1	19.0	18.8
Mixed Forest	25.5	25.3	25.0
Shrub/Scrub	70.9	68.8	70.9
Grassland/Herbaceous	8.1	8.5	11.1
Pasture/Hay	318.1	311.8	308.5
Cultivated Crops	230.9	229.1	226.1
Woody Wetlands	25.7	25.4	25.3
Herbaceous Wetlands	1.6	1.6	1.6
Total		**1911.5**	

Source: National Land Cover Database 2001, 2006, 2011 (2011 Editions)

TABLE 2-2: PERCENT LAND AREA BY LAND COVER CLASSIFICATION IN SCHUYLKILL RIVER WATERSHED 2001-2011

LAND COVER CLASSIFICATION	2001 % LAND COVER AREA	2006 % LAND COVER AREA	2011 % LAND COVER AREA
Open Water	1.1%	1.1%	1.1%
Perennial Ice/Snow	0.0%	0.0%	0.0%
Developed-Open Space	14.2%	14.3%	14.4%
Developed-Low Intensity	6.9%	7.0%	7.1%
Developed-Medium Intensity	3.3%	3.6%	3.8%
Developed-High Intensity	1.7%	1.8%	1.9%
Barren Land	0.5%	0.6%	0.6%
Deciduous Forest	35.7%	35.5%	35.1%
Evergreen Forest	1.0%	1.0%	1.0%
Mixed Forest	1.3%	1.3%	1.3%
Shrub/Scrub	3.7%	3.6%	3.7%
Grassland/Herbaceous	0.4%	0.4%	0.6%
Pasture/Hay	16.6%	16.3%	16.1%
Cultivated Crops	12.1%	12.0%	11.8%
Woody Wetlands	1.3%	1.3%	1.3%
Herbaceous Wetlands	0.1%	0.1%	0.1%

Source: National Land Cover Database 2001, 2006, 2011 (2011 Editions)

Table 2-3 shows the net gain or net loss of land area in square miles from 2001 to 2011 in each of the 16 classes of land cover. There was a net gain of approximately 23 square miles of developed land over the ten-year period. There was a net loss of approximately 12 square miles of forest, and 14 square miles of pasture/hay and cultivated crops over the same period.

TABLE 2-3: NET GAIN OR LOSS OF LAND AREA BY LAND COVER CLASSIFICATION IN SCHUYLKILL RIVER WATERSHED 2001- 2011

LAND COVER CLASSIFICATION	NET GAIN/LOSS (SQ. MI.)
Open Water	0.13
Perennial Ice/Snow	0.00
Developed-Open Space	4.50
Developed-Low Intensity	5.05
Developed-Medium Intensity	9.90
Developed-High Intensity	3.52
Barren Land	0.76
Deciduous Forest	-11.18
Evergreen Forest	-0.34
Mixed Forest	-0.59
Shrub/Scrub	0.07
Grassland/Herbaceous	3.03
Pasture/Hay	-9.61
Cultivated Crops	-4.81
Woody Wetlands	-0.38
Herbaceous Wetlands	-0.04

Source: National Land Cover Database 2001 to 2011 Land Cover from to Change Index

Table 2-4 lists the major land cover classifications by groups and the percent land area of the Schuylkill River watershed in each group. Developed includes developed- open space, low intensity, medium intensity and high intensity land cover classifications. Forested includes deciduous forest and evergreen forest land cover classifications. Agriculture includes pasture/hay and cultivated crops land cover classifications. From 2001 to 2011, there was a 4.6% increase in developed land area, a 1.7% decrease in forested land area, and a 2.6% decrease in agricultural land area.

TABLE 2-4: PERCENT DEVELOPED, FORESTED AND AGRICULTURAL LAND IN THE SCHUYLKILL RIVER WATERSHED 2001-2011

LAND COVER GROUP	2001 % LAND COVER AREA	2006 % LAND COVER AREA	2011 % LAND COVER AREA	PERCENT CHANGE 2001 TO 2011
Developed	26.1%	26.8%	27.3%	4.6%
Forest	38.0%	37.8%	37.4%	-1.7%
Agriculture	28.7%	28.3%	28.0%	-2.6%

Source: Adapted from National Land Cover Database 2001, 2006, 2011 (2011 Editions)

The Schuylkill River watershed is divided into 17 major sub-watersheds. Table 2-5 details the land cover in each sub-watershed by these major land cover groups. The first column gives the total area in square miles for each sub-watershed. The subsequent columns list the percent developed, forest, agricultural land area. The sub-watersheds highlighted in green, orange, and red are approximately 50% or greater forested, agricultural or developed land area, respectively.

TABLE 2-5: PERCENT DEVELOPED, FOREST, AND AGRICULTURE LAND AREA BY SUB-WATERSHED IN 2011

	SUB-WATERSHED	TOTAL AREA (SQ. MI)	DEVELOPED (% AREA)	FOREST (% AREA)	AGRICULTURE (% AREA)	OTHER (% AREA)
↓ DOWNSTREAM	Little Schuylkill	137	10%	**72%**	14%	4%
	Upper Schuylkill	288	15%	**57%**	23%	4%
	Maiden	216	13%	35%	**49%**	3%
	Tulpehocken	219	19%	24%	**55%**	2%
	Allegheny	18	17%	**51%**	18%	14%
	Middle Schuylkill 3	98	**48%**	34%	9%	9%
	Hay	22	12%	**64%**	12%	12%
	Monocacy	26	14%	26%	**49%**	11%
	Manatawny	92	15%	39%	34%	12%
	French	70	18%	42%	27%	12%
	Middle Schuylkill 2	103	38%	28%	20%	13%
	Pickering	39	26%	33%	27%	14%
	Perkiomen	362	30%	30%	29%	12%
	Valley	23	**55%**	30%	8%	7%
	Middle Schuylkill 1	65	**69%**	19%	8%	4%
	Wissahickon	64	**68%**	22%	5%	4%
	Lower Schuylkill	70	**78%**	15%	1%	5%

Source: Adapted from National Land Cover Database 2011

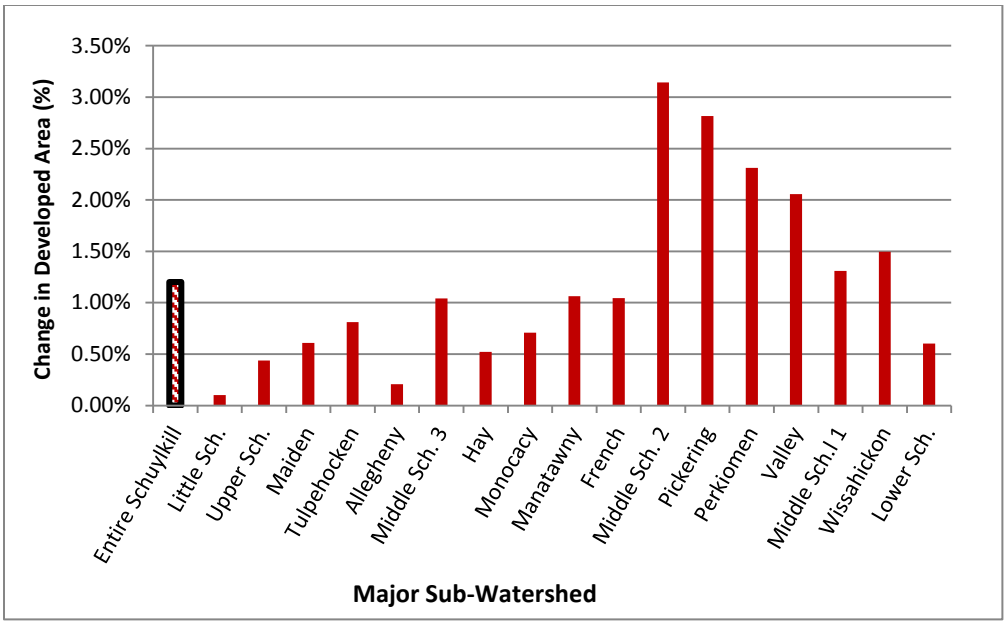


FIGURE 2-2: CHANGE IN DEVELOPED AREAS BY MAJOR SUB-WATERSHED 2001 TO 2011

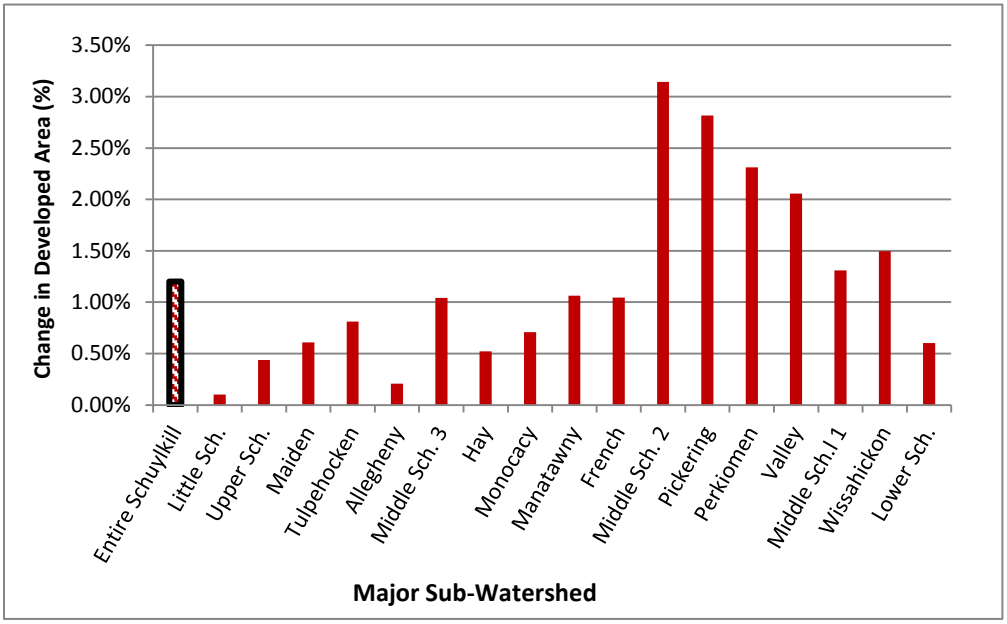
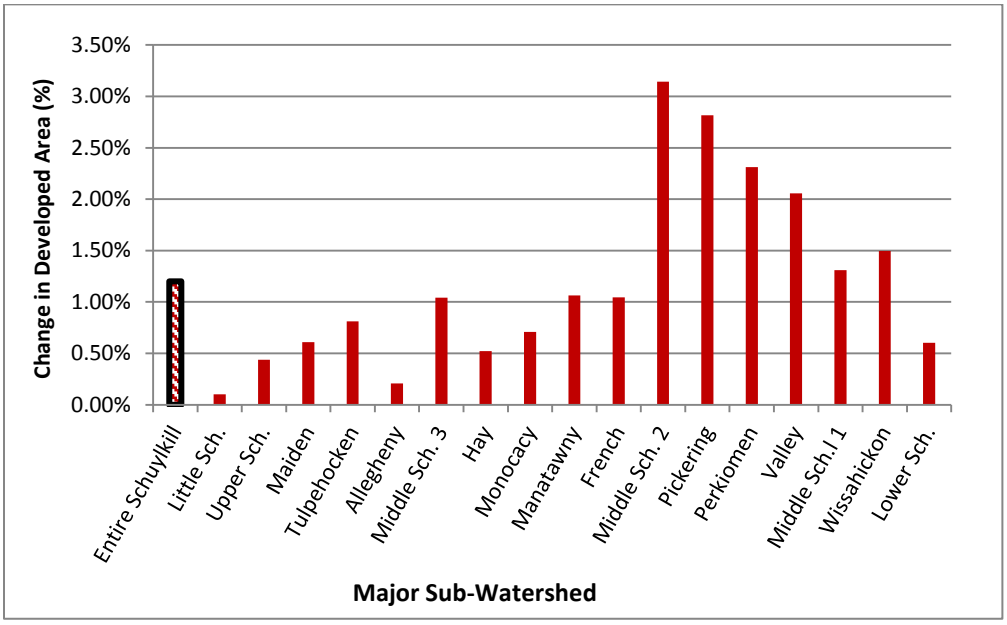


Figure 2-2 shows the percent change in developed land area by major sub-watershed with the hatched bar representing the entire Schuylkill River watershed. All sub-watersheds experienced increase in developed land from 2001 to 2011. The Middle Schuylkill 2 had the greatest percent increase. By land area, the Perkiomen Creek watershed had the largest increase in developed land, 8.4 square miles. Figure 2-3 shows the percent change in forest and agricultural land area by major sub-watershed with the hatched bar representing the entire Schuylkill River watershed. All sub-watersheds experience a decline in both forest and agricultural land with the exception of the Little Schuylkill River watershed which had a slight increase in agricultural land cover. The Middle Schuylkill 2 watershed experienced the highest percent decrease in agricultural land cover, and the Valley Creek watershed had the highest percent decrease in forest land cover. By land area, the largest decrease in forest land cover occurred in the Upper Schuylkill watershed with 3.6 square miles less forest in 2011 than in 2001. The largest

decrease in agricultural land cover occurred in the Perkiomen Creek watershed with 5.6 square miles less agricultural land in 2011 than in 2001.



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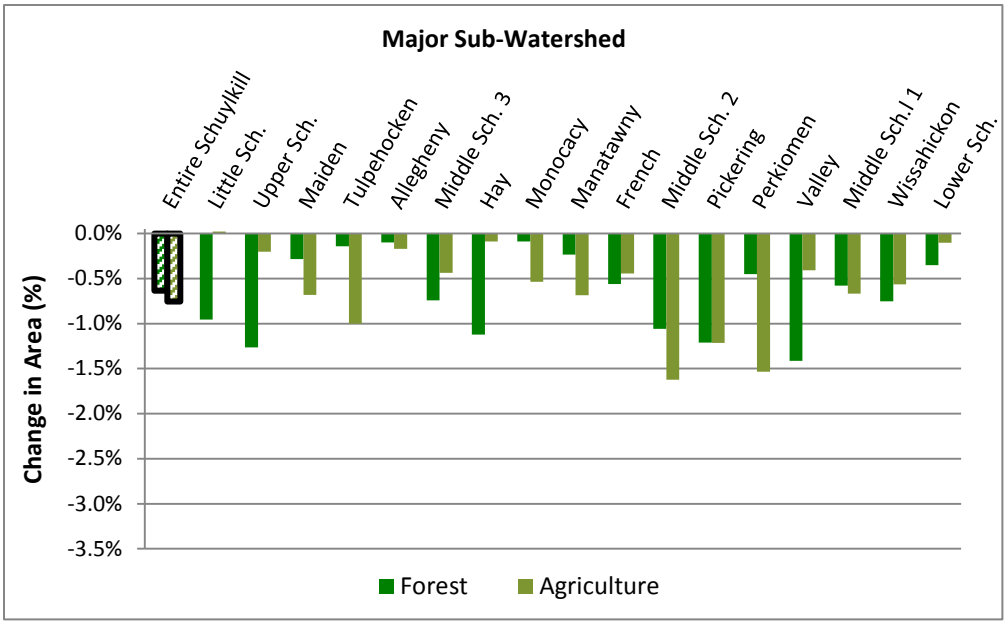


FIGURE 2-3: CHANGE IN FORESTED AND AGRICULTURAL AREAS BY MAJOR SUB-WATERSHED 2001 TO 2011

2.2 Water Supply System

Philadelphia is supplied by two surface water sources, the non-tidal Schuylkill River and tidal Delaware River. PWD owns and operates three drinking water treatment plants (WTPs); the Baxter WTP, Belmont WTP, and Queen Lane WTP. Baxter WTP is supplied by the freshwater tidal Delaware River and the Belmont and Queen Lane WTPs are supplied by the non-tidal Schuylkill River. WTPs have been owned and operated by PWD for over 100 years at their current locations. The WTPs have undergone treatment modifications over time, converting from slow sand to rapid sand filtration in the 1960s and converting again in the 1980s and 1990s to the dual media filtration used today. All three PWD WTPs are conventional treatment plants with coagulation, flocculation, sedimentation, filtration, and disinfection processes.

The PWD distribution system is responsible for moving water from the intakes to the treatment plants, and from the treatment plants to 1.61 million customers. Water is moved across Philadelphia through over 3,145 miles of water mains to approximately 483,000 residential connections, 12,900 commercial connections, 25,355 fire hydrants and residential fire suppression systems. Distribution system assets include over 91,717 valves, 2,298 miles of cast iron pipe, 756 miles of ductile iron pipe, 85 miles of steel pipe, and 6.5 miles of concrete pipe. The distribution system is also composed of the 3 intake pumping stations, 12 finished water storage facilities, and 13 finished water pumping stations that service 13 pressure districts.

PWD emergency response capabilities consist of a multi-barrier approach with established protections for the drinking water supply, treatment facilities, and distribution system. PWD has a robust Source Water Protection Program with numerous capabilities to address contamination risks upstream and facilitate rapid emergency response. These capabilities include communication and warning systems, water supply modeling, cross-channel transport modeling, watershed partnerships, and chemical and biological laboratory testing. PWD also solicits and investigates customer feedback and has multiple channels to directly communicate with customers in the event of an emergency.

Section 3. Potential Sources of Pathogens in the Watershed

Identifying potential sources of contamination in the watershed is the second component of a Watershed Sanitary Survey (WSS) as described in the 1993 Watershed Sanitary Survey Guidance Manual from the AWWA Nevada-California Section. This section will focus on potential sources of *Cryptosporidium* and pathogens to align with the priorities of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

In the WCP, PWD identified three priority sources of *Cryptosporidium*: wastewater discharges, runoff from agricultural land use; and wildlife and animal vectors. These priority sources are described in further detail in this section.

3.1 Wastewater Discharges

In the Watershed Control Plan (WCP), PWD identified wastewater discharges in the watershed as the largest source of *Cryptosporidium* in the Schuylkill River watershed. The *Cryptosporidium* loading to the Schuylkill River watershed from WWTP effluent was estimated using available data sources and a series of assumptions in the WCP. Additionally, PWD estimated the change in loading of viable *Cryptosporidium* to the Schuylkill River watershed when a few WWTPs upgraded their disinfection process to ultraviolet (UV). These WWTP upgrades were researched using publically available information.

The following section will provide an updated list of WWTPs discharging to the Schuylkill River watershed upstream of Philadelphia. It will also summarize available information on the disinfection technology used at these facilities.

3.1.1 Wastewater Treatment Plants

The EPA Permit Compliance System and Integrated Compliance Information System (PCS-ICIS) is an online database of facilities with permits to discharge treated wastewater effluent into rivers. The database includes site location, permit and compliance information.

PWD compiled an updated list of wastewater treatment plant (WWTP) facilities in the source water area. The previous list, compiled from a October 2008 search of the PCS-ICIS database was used in the Schuylkill Water Budget Report (PWD, 2010) and the WCP (PWD, 2011) available on phillywatersheds.org. A new search was performed on the EPA PCS-ICIS database in March 2015 for WWTPs using the Standard Industrial Classification (SIC) code for sewerage systems (4952). The EPA PCS-ICIS database provided site locations and permitted flow capacity. The March 2015 database search results were crosschecked with the October 2008 search results. From the 2015 search results, new WWTP were added to the list of WWTPs upstream of PWD, and facilities that have ceased discharging since 2008 or were not deemed a priority source of pathogens were removed from the list. A total of 152 WWTPs were identified in the Schuylkill River watershed upstream of Philadelphia.

A number of WWTPs were removed from the 2008 list of identified WWTPs in the Schuylkill River watershed upstream of Philadelphia. Some WWTPs have been decommissioned since that time. Other facilities were identified as industrial waste dischargers. Industrial waste dischargers were removed from the list as they are not a priority source of pathogens in the watershed. Table 3-1 details the WWTPs removed including NPDES permit number, county and sub-watershed where the WWTP was located, previously permitted discharge and status details.

A number of WWTPs were not included in the 2008 list of WWTPs in the Schuylkill River watershed, but were identified and added during the 2015 update. Many of these WWTP existed before 2008 but may not have been available on EPA and PADEP online databases. Several WWTPs have been identified as new dischargers. Jackson Township Authority WWTP construction was completed in 2009. Previously, wastewater flows were directed to Myerstown Borough Authority. Maxatawny Township Municipal Authority WWTP construction was completed in May 2012. The Lehigh County Authority Arcadia West WWTP was constructed in 2013, replacing a previously existing WWTP not identified in the 2008 list. Table 3-2 lists the WWTPs added including NPDES permit numbers, county and sub-watershed location, and annual average and permitted daily discharge flows.

TABLE 3-1: WWTPS IDENTIFIED AS ACTIVE IN 2008 THAT ARE NO LONGER ACTIVE AS OF 2015

FACILITY	PERMIT #	COUNTY	SUB-WATERSHED	PERMITTED FLOW MGD (EPA PCS-ICIS DATABASE)	STATUS DETAILS
Rush Twp Sewer Auth - Still Creek WTP	PA0063053	Schuylkill	Little Schuylkill	0.1760	Industrial waste from surface water filtration plant
Chicos, Paul	PA0057517	Montgomery	Lower Schuylkill	0.0005	Ceased discharging in 2012
Boytertown WTP	PA0084638	Berks	Manatawny Creek	0.0340	Industrial waste
Stralkowski, Ronald	PA0056961	Montgomery	Middle Schuylkill 1	0.0004	Ceased discharging in 2012
Chaban, Nicholas	PA0056006	Montgomery	Perkiomen Creek	0.0005	Ceased discharging in 2012
Dublin Boro STP	PA0021741	Bucks	Delaware River watershed	0.5000	Does not discharge to Schuylkill River watershed
Goshenhoppen Village Inc.	PA0055271	Montgomery	Perkiomen Creek	0.0590	Ceased discharging in 2011
Lwr Salford Twp Auth - Indian Hills	PA0051004	Montgomery	Perkiomen Creek	0.0070	Ceased discharging in 2012
Myerstown Water Auth	PA0086967	Lebanon	Tulpehocken Creek	0.0300	Industrial waste
Blythe Twp Mun Auth - Crystal Run WTP	PA0063304	Schuylkill	Upper Schuylkill	0.0280	Industrial waste from surface water filtration plant
Blythe Twp Mun Auth - New Philadelphia	PA0065013	Schuylkill	Upper Schuylkill	0.0380	Industrial waste from surface water filtration plant
Greater Pottsville Sewer Auth - West End	PA0043877	Schuylkill	Upper Schuylkill	0.5000	Terminated and connected to Greater Pottsville Main Plant
Hamburg Mun. Auth.	PA0086878	Berks	Upper Schuylkill	0.0300	Industrial waste
Omnova Solutions Inc	PA0036463	Schuylkill	Upper Schuylkill	0.0054	Terminated and connected to Greater Pottsville Main Plant
Pinebrook II STP	PA0070289	Schuylkill	Upper Schuylkill	0.1200	Terminated and connected to SCMA Deer Lake WWTP
Schuykill County Municipal Authority - Indian Run WWTP	PA0062821	Schuylkill	Upper Schuylkill	0.1870	Industrial waste from surface water filtration plant.
North Wales Boro	PA0022586	Montgomery	Wissahickon Creek	0.8350	Ceased discharging in 2013
Plummer, J. Randall	PA0057177	Montgomery	Wissahickon Creek	0.0004	Ceased discharging in 2014

TABLE 3-2: WWTPS IDENTIFIED AS ACTIVE IN 2015 THAT WERE NOT IDENTIFIED AS ACTIVE IN 2008

FACILITY	PERMIT #	COUNTY	SUB-WATERSHED	AVERAGE FLOW (MGD), SOURCE		PERMITTED FLOW (MGD), SOURCE	
Jones Grille (formerly White Diner)	PA0060739	Schuylkill	Little Schuylkill	0.0020	*	0.004	3
New Ringgold, Borough of, Wastewater Treatment Facility	PA0064157	Schuylkill	Little Schuylkill	0.0140	1	0.04	3
Mayall SRSTP	PAG040195	Montgomery	Lower Schuylkill	0.0002	*	0.0004	3
Karol K Schmick	PA0065234	Lehigh	Maiden Creek	0.0003	*	0.0005	3
LCA-Arcadia West	PA0064149	Lehigh	Maiden Creek	0.0136	1	0.04	3
Maxatawny Twp Mun Auth WWTP	PA0260151	Berks	Maiden Creek	0.0370	1	0.14	1
Richmond Township - Virginville WWTP	PA0260975	Berks	Maiden Creek	0.0118	*	0.023	3
SFS Adams, James & Sandra	PAG043839	Berks	Maiden Creek	0.0002	*	0.0004	3
SFS Bunner, Linda & Robert Michael	PAG043512	Berks	Maiden Creek	0.0002	*	0.0004	3
Ruscombmanor Twp WWTP	PA0085782	Berks	Manatawny Creek	0.0135	1	0.07	1
SFS Shaner, Anna & Scott	PA0261858	Berks	Manatawny Creek	0.0002	*	0.0004	3
SFS Moyer, Debra	PAG043538	Berks	Middle Schuylkill 2	0.0002	*	0.0004	3
Slawecki SRSTP	PAG040197	Montgomery	Middle Schuylkill 2	0.0003	*	0.0005	3
Reading Regional Airport Auth STP	PA0028720	Berks	Middle Schuylkill 3	0.1015	1	0.42	1
SFS Heist, Robert	PAG043650	Berks	Middle Schuylkill 3	0.0003	*	0.0005	3
SFS Rotskiske, Walter & Nancy	PAG043931	Berks	Middle Schuylkill 3	0.0002	*	0.0004	3
PA Historical & Museum Comm	PAG053543	Berks	Monocacy Creek	0.0041	*	0.008	3
SFS Souder, Michael (formerly Templin)	PAG043614	Berks	Monocacy Creek	0.0003	*	0.0005	3
SFS McGee, Kevin	PA0261866	Berks	Monocacy Creek	0.0002	*	0.0004	3
SFS Straka Terri	PA0261840	Berks	Monocacy Creek	0.0002	*	0.0004	3
Alpha SFSTP	PA0244350	Bucks	Perkiomen Creek	0.0002	*	0.0004	3
Blair Residence	PAG040167	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Franconia WWTP	PA0244295	Montgomery	Perkiomen Creek	0.0767	*	0.15	3
Linh Quang Buddhist Temple WWTP	PA0244589	Montgomery	Perkiomen Creek	0.0004	2	0.000705	3
Long SRSTP	PAG040194	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Macoby WWTP	PA0055875	Montgomery	Perkiomen Creek	0.0990	1	0.4	1
Marlborough Elementary School STP	PA0050911	Montgomery	Perkiomen Creek	0.0029	2	0.00425	3
MM Seylar Elementary School	PA0058289	Bucks	Perkiomen Creek	0.0026	*	0.005	3
Jackson Township Authority WWTP	PA0248185	Lebanon	Tulpehocken Creek	0.1720	1	0.5	1
North Heidelberg STP	PA0033766	Berks	Tulpehocken Creek	0.0494	2	0.1	3
Centre Twp Jordan Crossing WWTP	PA0087581	Berks	Upper Schuylkill	0.0088	1	0.16	1

Sammy's Mobile Home Park	PA0062634	Schuylkill	Upper Schuylkill	0.0036	*	0.007	3
Seiders Hill, Inc.	PA0063096	Schuylkill	Upper Schuylkill	0.0460	*	0.09	3

(1) Chapter 94 Reports (report for 2012, 2013 or 2014)

(2) eDMR (2014 average flow)

(3) EPA PCS-ICIS database

* Annual flow estimated based on median proportion of average flow in permitted flow

3.1.1.1 Wastewater Treatment Plant Flows

The EPA PCS-ICIS database includes permitted flow capacity but not the daily average flow. Using the permitted flow capacities may overestimate the volume of wastewater being discharged from these facilities as most WWTPs treat flows less than their permitted flow capacity. PWD used average flow collected from Chapter 94 reports submitted by municipal WWTPs to PADEP and from PADEP electronic Discharge Monitoring Report (eDMR). For WWTPs that are not required to submit a Chapter 94 report and do not submit data through eDMR, an estimated average flow was calculated. For each WWTP with a known annual average flow (105 WWTPs), the average flow was divided by the permitted capacity flow to create a ratio. The median ratio was then multiplied by the permitted capacity flow for WWTPs with unknown average annual flows.

A complete list of WWTPs discharging to the Schuylkill River watershed upstream of Philadelphia, the facility location, permit number and permitted capacity and average flows is included in Appendix A.

Table 3-3 shows the average volume of WWTP effluent discharged to each sub-watershed in the Schuylkill River watershed and the percent of the total discharge in each sub-watershed. There is an average total of 109 MGD treated wastewater discharging to the Schuylkill River watershed. The largest volume of treated wastewater is discharged to Perkiomen Creek, Middle Schuylkill 1 and Middle Schuylkill 2 watersheds. The Monocacy Creek, French Creek and Valley Creek watersheds receive the smallest volumes of treated wastewater.

TABLE 3-3: TOTAL DAILY AVERAGE WASTEWATER TREATMENT PLANT DISCHARGE BY SUB-WATERSHED

Sub-Watershed	Number of Wastewater Treatment Plants	Wastewater Treatment Plant Discharge (MGD)	Percent of Total Discharge to Schuylkill River Watershed
Allegheny Creek	1	0.5060	0.5%
French Creek	1	0.0002	<0.1%
Little Schuylkill	6	3.6228	3.3%
Lower Schuylkill (Above Philadelphia)	4	2.2284	2.0%
Maiden Creek	13	1.4325	1.3%
Manatawny Creek	4	0.3947	0.4%
Middle Schuylkill 1	9	21.8721	20.0%
Middle Schuylkill 2	12	10.1847	9.3%
Middle Schuylkill 3	13	22.2694	20.4%
Monocacy Creek	5	0.0058	<0.1%
Perkiomen Creek	45	23.0909	21.2%
Pickering Creek	1	0.0002	<0.1%
Tulpehocken Creek	9	3.4240	3.1%
Upper Schuylkill	24	9.8207	9.0%
Valley Creek	1	0.0009	<0.1%
Wissahickon Creek	4	10.3020	9.4%
Total	**152**	**109.16**	

Figure 3-1 shows the locations of 152 WWTPs on map of the Schuylkill River watershed by subwatershed. The largest, dark red dots indicate the WWTPs with the largest average daily discharges, and the smallest yellow dots show the WWTPs with the lowest average daily discharges.

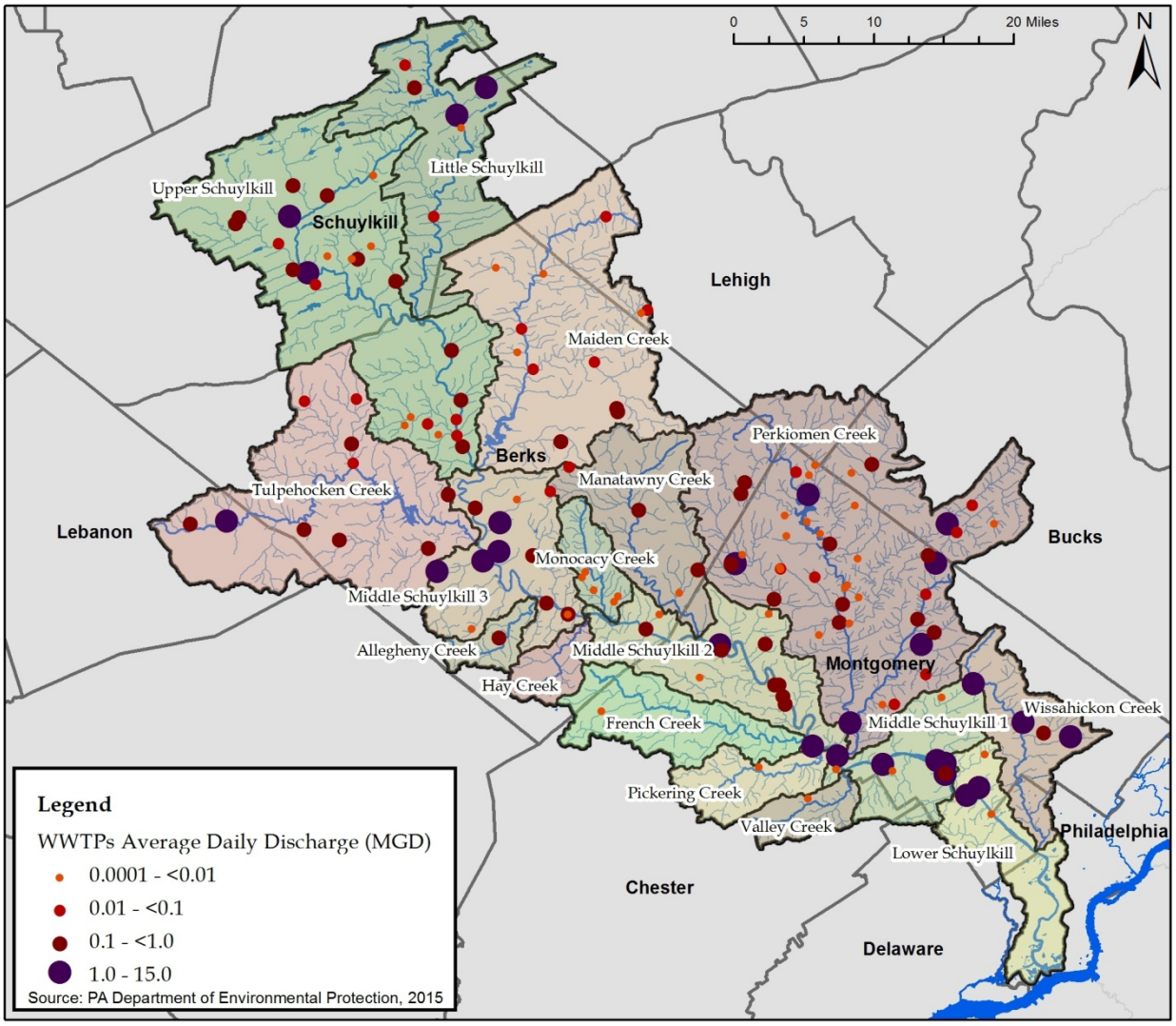


FIGURE 3-1: MAP OF WWTPS AND AVERAGE DAILY DISCHARGE IN SCHUYLKILL RIVER WATERSHED

3.1.1.2 Wastewater Treatment Technology

Wastewater treatment technology significantly impacts the *Cryptosporidium* loading to the watershed from NPDES discharges. The majority of WWTPs traditionally use secondary treatment, which may achieve 0.7- to 2-log removal. *Cryptosporidium* can be difficult to remove or inactivate using traditional treatment techniques. Alternative technologies, such as ultraviolet (UV) disinfection, can be more effective (Crockett, 2007). Typical UV applications are categorized as Low Pressure and dose approximately 40 mJ/cm^2. These applications achieve a 3- to 4-log inactivation of protozoa including *Cryptosporidium* (Water Research Foundation, 2015).

There are number of benefits to modifying disinfection processes in the wastewater treatment process, such as implementing UV. WWTPs have NPDES compliance requirements to reduce chlorine residual in effluent. The use of UV disinfection provides the opportunity to address compliance requirements and potentially lower the cost of dechlorination. Additionally, improved inactivation of *Cryptosporidium* and other pathogens provides recreational benefits. UV is more effective at inactivating *Cryptosporidium* oocysts than chlorine disinfection, but it does not physically remove them. Both viable and nonviable oocysts are accounted for in Method 1623, the sample and lab analysis method required by LT2ESWTR. Therefore, nonviable oocysts will still be counted towards a WWTP's Bin status. Modifying WWTP treatment processes for UV disinfection requires capital investment that must be weighed against other capital needs and alternatives for reducing *Cryptosporidium* and pathogen loading to the watershed.

PWD does not have jurisdiction over upstream WWTP discharges and looks to PADEP to enforce NPDES requirements. As part of the WCP program, PWD continues to track WWTP discharges and changes in treatment technologies employed upstream with assistance from watershed partners through the SAN. In a WWTP operator survey completed through the SAN in 2007, 54 WWTPs reported using chorine disinfection and 14 WWTPs reported using UV disinfection. PWD included the survey results in the 2011 WCP and identified two WWTPs, Upper Gwynedd and Fleetwood, in the Schuylkill River watershed in the process of installing UV disinfection systems. PWD tracked these WWTP upgrades through media sources.

Disinfection treatment technology information was available in the Chapter 94 Wasteload Management reports submitted to PADEP. Out of the 152 WWTPs, treatment technology was available for 98. Of those WWTPs, 32 (33%) disinfect effluent using UV. Table 3-4 lists the total WWTP discharge by major sub-watershed disinfected using UV treatment, disinfected using other treatment technology (typically chlorine) and with unknown treatment technology. Of the 109 MGD of treated WWTP effluent discharged into the Schuylkill River watershed, 27.8 MGD has been disinfected using UV, and 81.1 MGD has been treated with chlorine or other non-UV techniques. The treatment technique is unknown for many of the smaller WWTPs with a total discharge of 0.3 MGD. Over 90% of the WWTP effluent discharged to the Allegheny Creek, Maiden Creek and Wissahickon Creek sub-watersheds has been disinfected using UV. This high percentage of UV disinfected WWTP discharge is particularly notable for the Wissahickon Creek as flow from this sub-watershed influences the raw water quality for the PWD Queen Lane WTP. Figure 3-2 shows the WWTPs by discharge volume in the Schuylkill River watershed and indicates if the WWTP uses UV disinfection. The light green crosses indicate the WWTP uses UV for disinfection, and the black crosses indicate the WWTP does not us UV and in most cases uses chlorine for disinfection. The absence of a cross indicates WWTPs with unknown treatment techlology.

TABLE 3-4: WWTP DISCHARGE TREATED WITH UV DISINFECTION BY SUB-WATERSHED

SUB-WATERSHED	WWTP DISCHARGE WITH UV DISINFECTION (MGD)	WWTP DISCHARGE WITH OTHER DISINFECTION TECHNOLOGY* (MGD)	WWTP DISCHARGE WITH UNKNOWN DISINFECTION TECHNOLOGY (MGD)	% TREATED WITH UV
Allegheny Creek	0.51	0	0	100%
French Creek	0	0	0.0002	0%
Little Schuylkill	0.11	3.51	0.0020	3%
Lower Schuylkill (Above Philadelphia)	0	2.23	0.0004	0%
Maiden Creek	1.30	0.11	0.0157	91%
Manatawny Creek	0.21	0.19	0.0002	52%
Middle Schuylkill 1	6.09	15.78	0.0031	28%
Middle Schuylkill 2	0.97	9.21	0.0007	10%
Middle Schuylkill 3	0.02	22.24	0.0034	0%
Monocacy Creek	0	0	0.0058	0%
Perkiomen Creek	6.22	16.76	0.1123	27%
Pickering Creek	0	0	0.0002	0%
Tulpehocken Creek	1.81	1.56	0.0494	53%
Upper Schuylkill	0.92	8.81	0.0958	9%
Valley Creek	0	0	0.0009	0%
Wissahickon Creek	9.65	0.65	0	94%
Total	**27.8**	**81.1**	**0.3**	

**Typically chlorine disinfection*

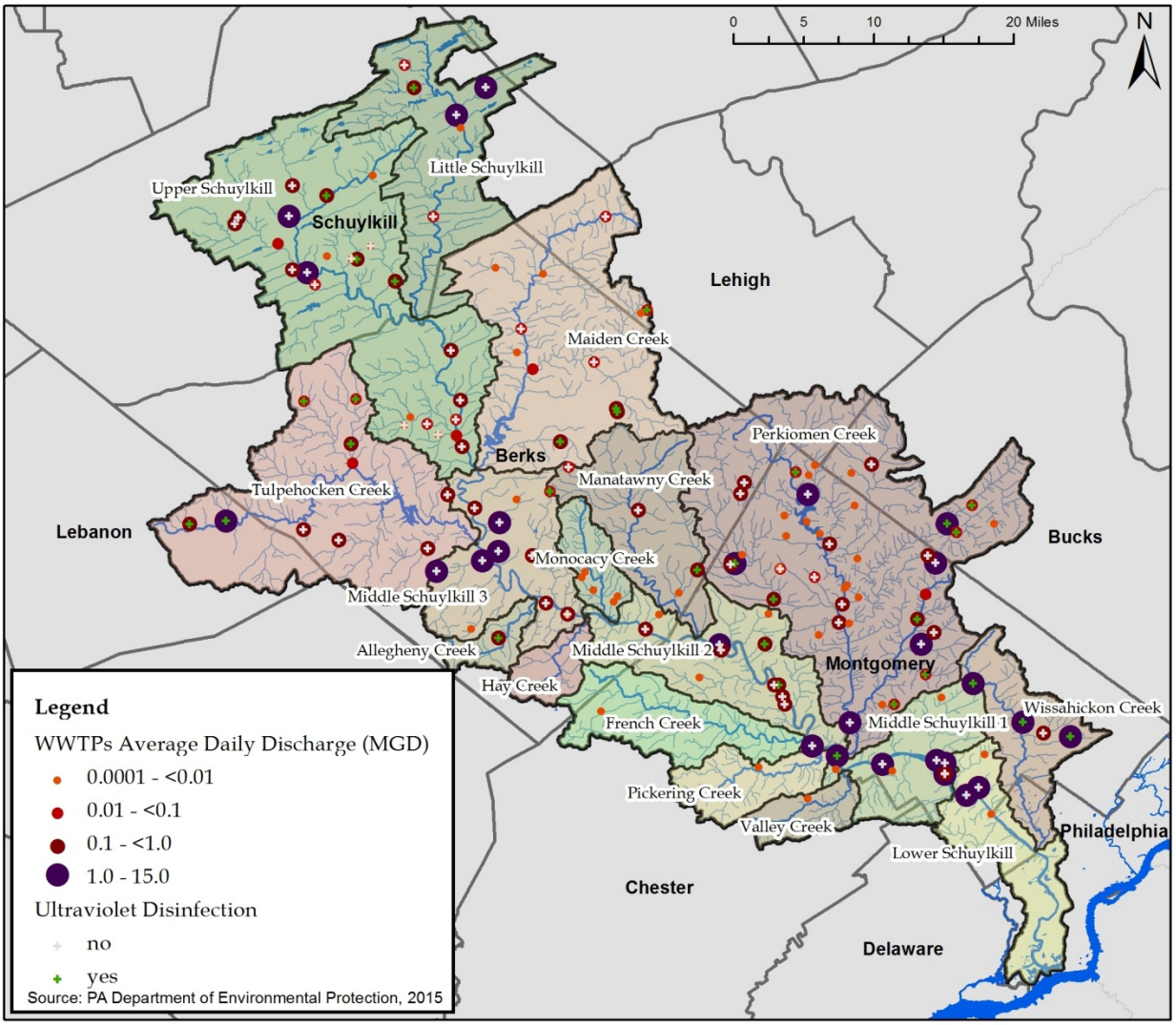


FIGURE 3-2: MAP OF WWTPS AND ULTRAVIOLET DISINFECTION IN SCHUYLKILL RIVER WATERSHED

3.1.2 Other Wastewater Discharges

3.1.2.1 Combined Sewer Overflows

There are a number of communities in the Schuylkill River watershed, including Philadelphia, with combined sewer systems that experience combined sewer overflows (CSOs) during wet weather. In the 2002 SWA, PWD identified two communities, Norristown and Bridgeport, with CSOs, that were considered potentially significant sources of *Cryptosporidium* and fecal coliform and were designated the highest protection priority (Category A). Additional communities in Schuylkill County have CSOs as well and are located further upstream from Philadelphia and were designated a lower protection priority (Category C). In 1994, EPA published the CSO Control Policy which provided guidance to communities with combined sewer systems to meet Clean Water Act goals. The policy required communities to first implement minimum technology based controls, and then develop a long-term control plan (LTCP) that would ultimately lead to full compliance with the Clean Water Act. Table 3-5

summarizes the number of CSOs in each of these communities prior to implementing an LTCP and the current remaining number of CSOs. PWD relies on the State to oversee permit compliance including the reduction and elimination of CSOs. The implantation of LTCPs is critical to this effort.

TABLE 3-5: SUMMARY OF FACILITIES WITH CSOS UPSTREAM OF PHILADELPHIA

FACILITY NAME	COUNTY	SWA PROTECTION PRIORITY (A-C)	CURRENT NUMBER OF CSO OUTFALLS	CSOS ELIMINATED OR NO LONGER OPERATIONAL
Bridgeport Borough STP	Montgomery	A	3	3
Norristown Municipal STP	Montgomery	A	1	1
St. Clair WWTP	Schuylkill	C	6	0
Coaldale-Lansford-Summit Hill Sewer Authority	Schuylkill	C	6	0
Tamaqua Borough	Schuylkill	C	12	0
Minersville Sewer Authority WWTP	Schuylkill	C	4	3
Pottsville Main STP	Schuylkill	C	22	32
Total			54	39

Source: Adapted from PADEP Combined Sewer Overflow Listing available from PADEP eLibrary (May 2015)

An LTCP for Bridgeport was approved in May 2004. In 2012, Bridgeport completed the construction of a new interceptor, and through this project, three CSOs were eliminated and a fourth was relocated. One out of two CSOs in Norristown is no longer operational. St. Clair WWTP submitted a LTCP update in 2014 to PADEP, comments were received in December, and St. Clair WWTP is expected to submit a response in 2015. Coaldale-Lansford-Summit Hill Sewer Authority received approval for their LTCP in November 2005 and is required to submit an LTCP update during its current permit cycle. Tamaqua Borough submitted a LTCP update in December 2014 outlining strategies for reducing CSO discharges over the next 25 years. The first projects to be implemented will be WWTP improvements, CSO regulator modifications and a downspout disconnection program. After several years of monitoring the success of these projects, additional projects including sewer separation and green infrastructure are planned to be designed and implemented. Minersville Sewer Authority WWTP has eliminated three CSOs through separation and is seeking funding for further separation projects. Pottsville Main STP has eliminated 32 CSOs by sewer separation and the remaining 22 CSOs have been reconstructed and metered.

3.1.2.2 Wildcat Sewers

In the 2002 Source Water Assessment, PWD identified communities in Schuylkill River watershed suspected of having 'wildcat' sewers. Wildcat sewers are illegal sewers discharging untreated waste water to creeks. The Schuylkill Action Network (SAN), a watershed-wide organization, formed in 2003 and detailed in Section 4.3.1, is divided into workgroups to address major pollutant sources, protect priority land, and conduct education and outreach in the Schuylkill River watershed. The SAN Pathogens/Compliance Workgroup works to improve NPDES compliance, reduce discharges from unsewered communities and prevent drinking water illness outbreaks. The workgroup has four strategies to address these issues: improve discharger and water supplier communication of events;

identify priority wastewater discharges and issues in the watershed; provide support for partners and communities to implement projects that reduce priority discharges; and provide a forum for partner and agency communication and coordination around discharge issues. The SAN Pathogens/Compliance workgroup members include EPA, PADEP, PENNVEST, Partnership for the Delaware Estuary (PDE), water suppliers. Since its formation, the SAN Pathogens/Compliance workgroup, particularly its members representing EPA, PADEP, PENNVEST have led efforts to identify and abate wildcat sewers in the Schuylkill River Watershed (PWD, 2011). PENNVEST has funded a number of projects that address wildcat sewers as well as other sewage issues. The SAN Pathogens/Compliance Workgroup was critical to gathering data presented in this report.

Table 3-6 lists communities with identified wildcat sewers, originally compiled by EPA in 1990, and the stream or watershed receiving the discharges. In an effort to evaluate the progress made towards connecting wildcat sewers to WWTPs, PWD compiled information from PENNVEST and news sources on projects addressing the sewerage issues in the EPA-listed communities. This information and the sources are included in the last two columns of Table 3-6. It is not possible to conclude from this information what portion of wildcat sewers or other sources of sewerage contamination to the waterways were addressed in each community. However, it is clear that tremendous progress has been made towards reducing contamination in the Schuylkill River watershed from untreated sewage discharges.

TABLE 3-6: STATUS OF WILDCAT SEWERS IN THE SCHUYLKILL RIVER WATERSHED

DISCHARGER	MUNICIPALITY	COUNTY	STREAM	UPDATE	SOURCES
Blythe Township	Blythe Township	Schuylkill	Silver Creek and Schuylkill River	The municipalities of Middleport Borough, New Philadelphia Borough, Blythe Township and Schuylkill Township joined together to form the Schuylkill Valley Sewer Authority (SVSA) and completed an Act 537 plan. A new sewage treatment plant with the capacity to treat 550,000 gallons per day and over 30 miles if sewage pipe was construction using SVSA funds and an over $18 million combined loan and grant package from PENNVEST. The new wastewater treatment plant began discharging treated effluent in June 2006. As of 2009, 1432 customers were connected to the SVSA WWTP, and 69 were not connected. Of those customers not connected, most were abandoned properties, buildings being foreclosed on or were being pursed legally to force connection.	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015; PENNVEST. www.pennvest.pa.gov
Village of Cumbola	Blythe Township	Schuylkill	Schuylkill River		
Middleport Borough	Middleport Borough	Schuylkill	Schuylkill River		
New Philadelphia	New Philadelphia Borough	Schuylkill	Silver Creek and Schuylkill River		
Schuylkill Township	Schuylkill Township	Schuylkill	Schuylkill River & tributaries		
Village of Brockton	Schuylkill Township	Schuylkill	Schuylkill River		
Village of Delano	Delano Township	Schuylkill	Pine Creek	Delano has public sewer. In 2007, Delano Township received a nearly $3 million grant and loan package from PENNVEST to construct three miles of sewer lines and a pump station to convey sewage to Northeast Schuylkill Joint Municipal Authority which was previously being discharged to Delano Creek, a branch of Pine Creek.	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015; "Governor Rendell Announces $61 Million Investment to Help Protect Pennsylvania's Waterways, Public Health; Promote Community Revitalization Efforts." April 17, 2007. PRNewswire. www.prnewswire.com
Minersville	Minersville Borough	Schuylkill	West Branch Schuylkill River	Minersville has public sewer. Minersville Sewer Authority received over $4 million loan from PENNVEST to construct almost two miles of sewer and stormwater lines and replace about one mile of water mains to eliminate a continuous discharge of untreated wastewater to the West Branch Schuylkill River.	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015; "Governor Rendell Announces Funding to Protect Pennsylvania's Waterways, Public Health; Promote Community Revitalization Efforts." Jul 18, 2006. PRNewswire. www.prnewswire.com

DISCHARGER	MUNICIPALITY	COUNTY	STREAM	UPDATE	SOURCES
Village of Llewellyn	Branch Township	Schuylkill	West Creek and West Branch Schuylkill River	The Village of Llewellyn has public sewer. Branch-Cass Regional Sewer Authority received an over $16 million loan and grant package from PENNVEST to construct over 28 miles of sewer collect lines and a 450,000 gallons per day wastewater treatment plan to serve portions of Branch, Cass and New Castle Townships and mitigate wildcat sewers and malfunctioning on-lot systems discharging untreated sewage into local streams. In 2010, Branch-Cass Regional Sewer Authority was acquired by the Schuylkill County Municipal Authority (SCMA).	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015; "PA Gov. Schweiker Administration Announces $94 Million in Loans and Grnts for Clean-Water Projects." Nov 14, 2001. PRNewswire. www.prnewswire.com; Schuylkill county Municipal Authority. www.scmawater.com
Deer Lake Municipal Authority (acquired by Schuylkill County Municipal Authority in 2008)	Deer Lake Borough	Schuylkill	Pine Creek	In 2011, Schuylkill County Municipal Authority (SCMA) received grant and loan funding from PENNVEST to expand its Deer Lake wastewater treatment plant and construct several miles of sewerage collection lines. The project would eliminate several small, inadequate wastewater treatment plants and discharges from wildcat sewers and malfunctioning on on-lot septic systems to locate streams. Expansion and construction began in 2013. The wastewater treatment plant was completed and operational in September 2014. SCMA was awarded the Governor's Award for Environmental Excellence from PADEP in 2015 for completion of the project.	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015; "Pennsylvania Governor Corbett Announces $99 Million Investment in Water Infrastructure Projects in 20 Counties." Jul 20, 2011. PRNewswire. www.prnewswire.com; Schuylkill county Municipal Authority. www.scmawater.com

DISCHARGER	MUNICIPALITY	COUNTY	STREAM	UPDATE	SOURCES
New Ringgold Municipal Authority	New Ringgold Borough	Schuylkill	Little Schuylkill and Koenig Creek	In 2001, the Borough of New Ringgold received a loan from PENNVEST to design sewage collection lines and a WWTP to eliminate malfunction on-lot septic systems contaminating local drinking water wells, Koenig Creek and the Little Lehigh. The Borough of New Ringgold received over $1.4 million in loans and grants in 2004 and over $2.6 million in loans and grants in 2005 from PENNVEST to install approximately 3 miles of sewage collection lines to eliminate the use of malfunctioning on-lot septic systems that are contaminating a local stream and drinking water wells. The WWTP was completed in 2006.	"PA Gov. Schweiker Administration Announces $94 Million in Loans and Grants for Clean-Water Projects." Nov 14, 2002. PRNewswire, www.prnewswire.com; "PENNVEST Initiates Brownfield Program, Approves $97 Million for Water Projects," Mar 24, 2004. PRNewswire. www.prnewswire.com; "PENNVEST Approves $100 Million for Water Projects." Mar 23, 2005. PRNewswire. www.prnewswire.com; "2014 Chapter 94 Annual Report Borough of New Ringgold Sewage Treatment Plant." 2014. *Chapter 94 Municipal Wasteload Management Report.*
West Hamburg	Tilden Township	Berks	Schuylkill River	In 2008, Tilden Township received a $5.3 million loan from PENNVEST to construct nearly six miles of sewage collection and transmission lines, three pump stations and other facilities to eliminate the use of wildcat sewers and malfunctioning on-lot septic systems discharging untreated and inadequately treated sewage into areas draining to the Schuylkill River.	"Governor Rendell Announces $72 Million in Water Infrastructure Investments." Apr 14, 2008. PRNewswire. www.prnewswire.com
Virginville	Richmond Township	Berks	Maiden Creek, Sacony Creek	Richmond Township received a $1.6 million loan in 2008 and over $1.7 million in loans and grants in 2001 to construct a new WWTP, pump station, and sewage collection lines to serve 247 homes in the township, where malfunctioning on-lot septic systems are contaminating local wells. The Richmond-Virginville WWTP was completed in 2013.	"Governor Rendell Announces $66 Million Investment in PA's Water Infrastructure," Oct 27, 2008, PRNewswire, www.prnewswire.com; "Governor Corbett Announces $84 Million Investment in Water Infrastructure Projects in 14 Counties," Oct 26, 2011, PRNewswire, www.prnewswire.com; Steckbeck Engineering and Surveying, Inc., *Facebook.* www.facebook.com

DISCHARGER	MUNICIPALITY	COUNTY	STREAM	UPDATE	SOURCES
Strausstown	Strausstown Borough	Berks	Tributaries to Blue Marsh Reservoir	In 2002, Strausstown Borough received a loan from PENNVEST to design a sewage collection and treatment facility to serve Strausstown Borough and portions of Upper Tulpehocken Township, where wildcat sewers and malfunctioning on-lot septic systems are contaminating almost half of the local drinking water wells. In 2007, Strausstown Borough received $3.65 million in loans and grants from PENNVEST to construct the wastewater collection and treatment system to serve both the Borough of Strausstown, as well as Upper Tulpehocken Township. The construction of approximately 3 miles of sewage collection lines and a 65,000-gallon per day wastewater treatment plant was completed in November 2009.	"Pennsylvania Gov. Schweiker Administration Announces $95.5 Million in Loans and Grants for Clean Water Projects." Mar 20, 2002. PRNewswire. www.prnewswire.com; "Governor Rendell Announces $69 Million in Clean, Safe Water Infrastructure Investments." Oct 23, 2008. PRNewswire. www.prnewswire.com; "Borough of Strausstown, Berks County, Sewage Treatment Plan, Municipal Wasteload Management." 2012. *Annual Report for 2012 DEP Rules and Regulations, Chapter 94.*
Lenhartsville	Lenhartsville Borough	Berks	Furnace Creek, Maiden Creek	Lenhartsville Borough received over $1.3 million in 2002 and over $1.6 million in 2004 in loans and grants from PENNVEST to construct a new sewage treatment plant and collection system to eliminate the use of on-lot septic systems contamination drinking water wells and local streams, including Furnace Creek and Maiden Creek. The new sewage treatment plant went online in July 2005.	"Pennsylvania Governor Schweiker Announces $3 Billion Milestone for Funding of Clean Water Projects in Pennsylvania." Nov 20, 2002. PRNewswire. www.prnewswire.com; "PENNVEST Initiates Brownfields Program, Approves $97 Million for Water Projects." Mar 24, 2004. PRNewswire. www.prnewswire.com; PENNVEST. www.pennvest.pa.gov; "Borough of Lenhartsville Waste Water Treatment and Conveyance Facilities." 2012. *Title 25 Chapter 94 Municipal Wasteload Management Annual Report.*
Sassmansville	Douglass Township	Mont-gomery	Schlegal Run and Middle Creek	In 1999, 20 houses were cited by the Montgomery County Health Department for failing sewage systems. In 2007, Berks-Montgomery Municipal Authority completed a $2.3 million project constructing a pump station and sewerage lines to serve a community of Sassmansville which is located in Douglass and New Hanover Townships.	"Douglass (Mont.) Oks Sassamansville Sewer Project." The Mercury News; Berks-Montgomery Municipal Authority Sewer Revenue Bonds. Apr 20, 2015. McElwee & Quinn Financial Printing. www.mcelweequinn.com.

DISCHARGER	MUNICIPALITY	COUNTY	STREAM	UPDATE	SOURCES
Village of Branchdale	Reilly Township	Schuylkill	Muddy Branch	The Village of Branchdale has wildcat sewers and failing on-lots. Alfred Benesch has worked on an Act 537 Plan for them but it is not affordable.	Chris McCoach, Alfred Benesch & Company, personal communication, April 7, 2015
Tamaqua	Tamaqua Borough	Schuylkill	Wabash Creek	Tamaqua Borough hired Alfred Benesch and Company to investigate wildcat sewers in Wabash Creek. A total of 101 connections were investigated - 17 had abandoned lines to Wabash Creek and were connected to the municipal sewer system. Five properties are not connected, four of which are vacant, abandoned properties with water service shut off. The remaining property is illegally discharging into Wabash Creek and has been issued several Notice of Violation Tickets and is being processed through the court system.	(Rob Jones, Tamaqua Public Works, personal communication, May 22, 2015)
South Tamaqua	West Penn Township	Schuylkill	Little Schuylkill	Act 537 planning in Walker and West Penn Townships is ongoing. The existence of wildcat sewers and malfunctioning on-lot disposal systems has been confirmed.	"Wildcat Sewers Exist in West Penn Township." Times News, LLC. Apr 5, 2013. http://www.tnonline.com/2013/apr/05/wildcat-sewers-exist-west-penn-township; Act 537 Plan. Walker Township. http://www.walkertwp.com/Pages/ACT537Plan.aspx
Albany	Albany Township	Berks	Maiden Creek	Unknown	
Port Indian	West Norriton	Mont-gomery	Schuylkill River, main stem	Unknown	

3.1.3 Wastewater Discharge to Septic Systems

Wastewater discharge through septic systems is a potential source of *Cryptosporidium* and pathogens in the Schuylkill River watershed. Malfunctioning or improperly sited or maintained septic systems may present an increased risk of contamination of groundwater and surface water. Using potable water supply data from PADEP and EPA and several assumptions, the volume of water discharged through septic systems in the Schuylkill River watershed is estimated in this section in two parts.

1. Wastewater discharged to septic systems in the Schuylkill River watershed in all counties excluding Philadelphia is estimated from potable water supplied from private domestic wells.
2. Wastewater discharged to septic systems in Philadelphia County is estimated from the number of septic systems identified upstream of the Queen Lane Intake.

Potable water supply can be divided into several categories:

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

Private domestic supply is the volume of water withdrawn from private groundwater wells in households that are not connected to public water supply infrastructure. Community water supplies, an EPA designation, serve at least 25 people or 15 residents year-round and can be either surface or groundwater supplies. Transient non-community water supplies refer to waters suppliers that regularly supply water to at least 25 of the same people at least six months per year, but not year round. Non-transient non-community water suppliers supply water in a place where people do not remain for long periods of time. Both transient and non-transient non-community water suppliers are not included in this analysis. Public water supply is a PADEP designation and does not indicate whether the waters supply is publically or privately owned. The term 'community water supply' will be used to describe these systems in this section. To estimate the wastewater discharged to septic systems in the Schuylkill River watershed in all counties excluding Philadelphia, several assumptions were made.

- The population outside any community water supplier service area is served by private household wells.
- Households with water supplied from private domestic wells also have septic systems.
- 85% of potable water withdrawn from private domestic wells becomes wastewater.
- The average daily withdrawal from the private household wells is 80 gallons per day per person.

The population outside community water supply service areas was determined using information from the US Census and public water supplier service boundaries. During the Act 220 State Water Planning effort, PADEP identified areas of the state supplied by community water suppliers. The information is included in a GIS layer available on pasda.psu.edu. The data is revised on an as needed basis, and the layer used in this analysis was revised in July 2015. Areas served by community waters systems are

shown on the map in Figure 3-3. A list of the community water suppliers with service areas displayed in Figure 3-1 is included in Appendix A.

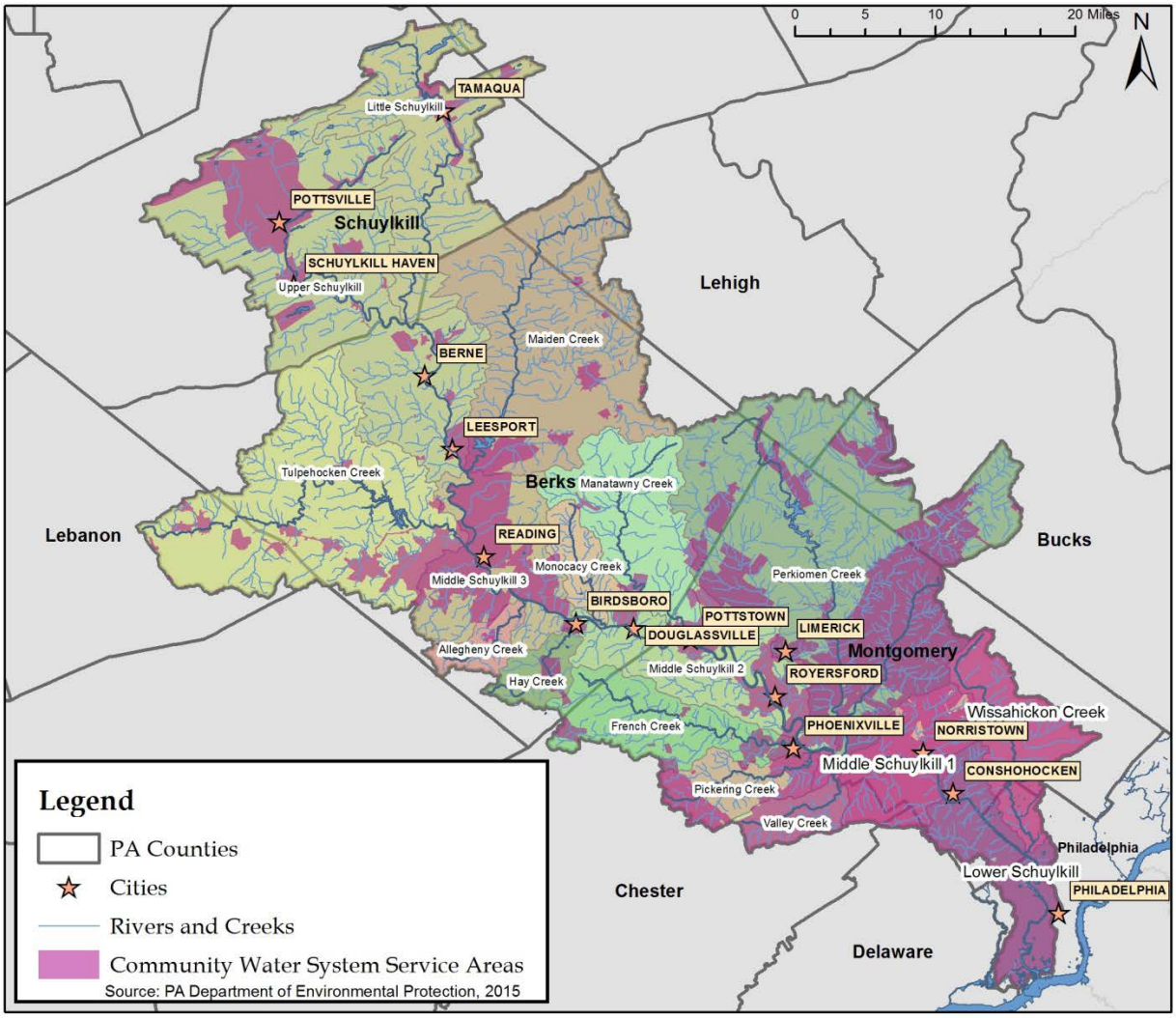


FIGURE 3-3: MAP OF COMMUNITY WATER SUPPLY SERVICE AREAS IN THE SCHUYLKILL RIVER WATERSHED

The 2010 census block GIS layer was overlaid the public water supplier area layer, and the 2010 population outside community water supply service areas was assumed to have private domestic groundwater wells. For each sub-watershed, the 2010 census population within community water supplier service areas was subtracted from the total population in that sub-watershed.

A number of community water suppliers were not included in the GIS layer of service areas. These community water suppliers were identified in the EPA Safe Drinking Water Information System (SDWIS) database. All drinking water suppliers located in Montgomery, Berks, Chester, Bucks, Lehigh, Lebanon and Schuylkill counties were downloaded from an EPA SDWIS search in March 2015. The EPA SDWIS database does not include information on water supplier location beyond the county level. Locations of individual water suppliers were determined by hand using Google Maps, Google Search, water supplier

websites, source water assessments and other publically available resources. The list was then narrowed down to water suppliers in the Schuylkill River watershed using GIS. The community water suppliers identified from the SDWIS search was compared with community water suppliers included in the service area map. The population served community water suppliers not represented on the service area map was added to the census-derived population in community water supply service areas by sub-watershed. The results are included in Table 3-7. An estimated 2010 population of 236,521 is served by private domestic wells.

TABLE 3-7: POPULATION IN 2010 ON PRIVATE HOUSEHOLD DRINKING WATER WELLS

Sub-Watershed	Census	Map Derived Population on Community Water Supply	Additional Population on Community Water Supply	Estimated Population on Private Wells
Allegheny Creek	5,058	98	0	4,961
French Creek	29,021	17,465	245	11,310
Hay Creek	6,107	3,169	156	2,782
Little Schuylkill	23,968	15,641	80	8,247
Lower Schuylkill	72,981	71,331	0	1,650
Maiden Creek	46,285	23,776	1,501	21,008
Manatawny Creek	32,819	14,136	214	18,468
Middle Schuylkill 1	142,778	139,371	250	3,158
Middle Schuylkill 2	106,575	77,970	125	28,480
Middle Schuylkill 3	201,136	187,744	75	13,317
Monocacy Creek	5,253	824	116	4,313
Perkiomen Creek	269,650	209,629	615	59,406
Pickering Creek	23,473	17,904	0	5,569
Tulpehocken Creek	76,147	47,644	394	28,109
Upper Schuylkill	84,497	57,586	1,575	25,336
Valley Creek	24,324	24,085	0	239
Wissahickon Creek	109,643	109,475	0	168
Total	**1,259,713**	**1,017,846**	**5,346**	**236,521**

Note: Excludes Philadelphia County

The estimated population on private wells was then multiplied by an average water use of 80 gallons per day per person. This water use per capita value was used in the Schuylkill River Hydrology and Consumptive Use report and originally selected based on considerations in the PADEP State Water Plan Update water budget methodology (PWD, 2010). The use factor resulted from a survey of 21 public water suppliers in the Lehigh River by Camp, Dresser and McKee and DRBC (Stuckey, 2008). The results are displayed in Table 3-8. An estimated total of 18.9 MGD is withdrawn for potable water supply from private wells. Assuming 85% of the potable water withdrawn from private domestic wells becomes wastewater, and 15% goes to outside use, the volume of wastewater discharged to septic systems is 16.1 MGD and is calculated by sub-watershed in Table 3-8.

TABLE 3-8: ESTIMATED AVERAGE DAILY VOLUME WITHDRAWN BY PRIVATE WELLS AND DISCHARGED TO SEPTIC SYSTEMS

SUB-WATERSHED	ESTIMATED POPULATION ON PRIVATE WELLS	VOLUME WITHDRAWN BY PRIVATE WELLS (MGD)*	VOLUME DISCHARGED TO SEPTIC SYSTEMS (MGD)*
Allegheny Creek	4,961	0.397	0.337
French Creek	11,310	0.905	0.769
Hay Creek	2,782	0.223	0.189
Little Schuylkill	8,247	0.660	0.561
Lower Schuylkill	1,650	0.132	0.112
Maiden Creek	21,008	1.681	1.429
Manatawny Creek	18,468	1.477	1.256
Middle Schuylkill 1	3,158	0.253	0.215
Middle Schuylkill 2	28,480	2.278	1.937
Middle Schuylkill 3	13,317	1.065	0.906
Monocacy Creek	4,313	0.345	0.293
Perkiomen Creek	59,406	4.752	4.040
Pickering Creek	5,569	0.446	0.379
Tulpehocken Creek	28,109	2.249	1.911
Upper Schuylkill	25,336	2.027	1.723
Valley Creek	239	0.019	0.016
Wissahickon Creek	168	0.013	0.011
Total	**236,521**	**18.9**	**16.1**

Note: Excludes Philadelphia County

**Based on assumption of 80 gallons per person per day and 85% of water withdrawn becomes wastewater*

This estimate of discharge to septic systems excludes Philadelphia County. More detailed data on septic systems in Philadelphia County was available. Figure 3-4 shows a map of the 419 septic systems located upstream of Queen Lane WTP. The assumptions made to calculate the estimated wastewater discharge to septic systems in Philadelphia are listed below.

- The average household size in Philadelphia is 2.45 people from the 2010 US Census.
- The average daily withdrawal from the private household wells is 80 gallons per day per person.
- 85% of potable water withdrawn from private domestic wells becomes wastewater.

The discharge of wastewater to septic system in Philadelphia County upstream of Queen Lane, calculated by sub-watershed in

Table 3-9, is 0.7 MGD. The discharge in Philadelphia is added to the discharge in the remainder of the Schuylkill River watershed in Table 3-10. The total estimated discharge to septic systems is 17.0 MGD.

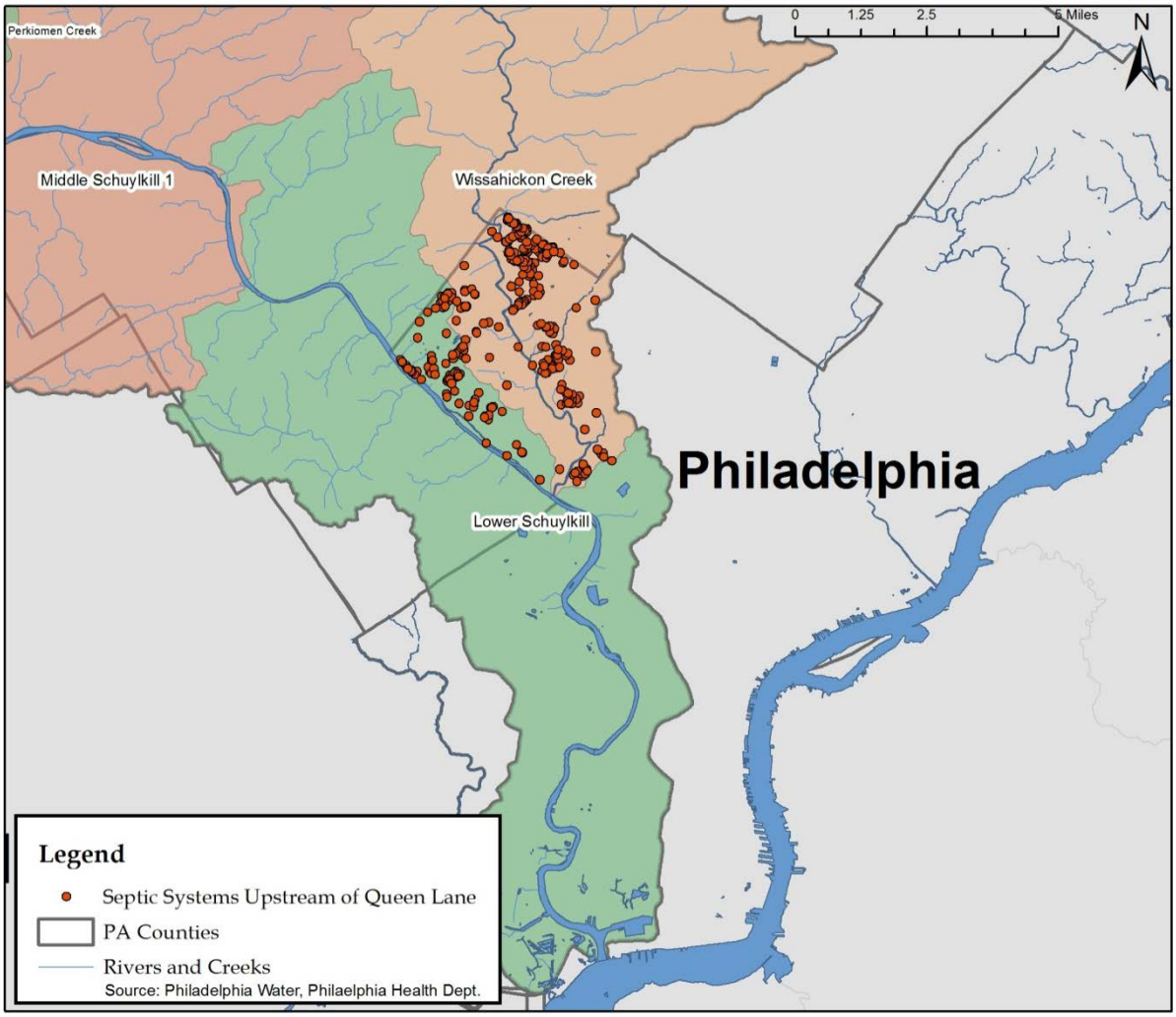


FIGURE 3-4: MAP OF SEPTIC SYSTEMS IN PHILADELPHIA COUNTY UPSTREAM OF QUEEN LANE WATER TREATMENT PLANT

TABLE 3-9: ESTIMATED WASTEWATER DISCHARGED TO SEPTIC SYSTEMS IN PHILADELPHIA COUNTY UPSTREAM OF QUEEN LANE

SUB-WATERSHED	SEPTIC SYSTEMS UPSTREAM OF QUEEN LANE WATER TREATMENT PLANT	AVERAGE HOUSEHOLD SIZE IN PHILADELPHIA	WATER SUPPLIED TO HOUSEHOLDS WITH SEPTIC SYSTEMS* (MGD)	DISCHARGE (MGD)
Wissahickon Creek	287	2.45	0.56	0.48
Lower Schuylkill	132	2.45	0.26	0.22
Total	**419**	**2.45**	**0.82**	**0.70**

**Based on 80 gallons per person per day and 85% of water withdrawn becomes wastewater*

TABLE 3-10: TOTAL ESTIMATED WASTEWATER DISCHARGED TO SEPTIC SYSTEMS

SUB-WATERSHED	VOLUME DISCHARGED TO SEPTIC SYSTEMS (MGD)*
Allegheny Creek	0.337
French Creek	0.776
Hay Creek	0.189
Little Schuylkill	0.561
Lower Schuylkill	0.332
Maiden Creek	1.523
Manatawny Creek	1.256
Middle Schuylkill 1	0.215
Middle Schuylkill 2	1.937
Middle Schuylkill 3	0.901
Monocacy Creek	0.293
Perkiomen Creek	4.043
Pickering Creek	0.379
Tulpehocken Creek	1.911
Upper Schuylkill	1.804
Valley Creek	0.016
Wissahickon Creek	0.490
Total	**17.0**

Note: Includes Philadelphia County

**Based on 80 gallons per person per day and 85% of water supplied is discharged*

This estimation method presents a number of limitations and the accuracy of the results is uncertain. The absences of detailed septic system data requires large assumptions to be made. In calculating the potable waters use by private domestic wells, the method uses water supplier service areas and populations from the 2010 US Census. The mapped public water supplier service areas may include individual buildings or neighborhoods that are served by private wells. Additionally, although it was assumed that households with private domestic wells also have septic systems, there are also households with private domestic wells that are connected to the public sewer system and households supplied by public water suppliers that discharge wastewater to septic systems. The number of septic systems was available for Philadelphia County. However, these systems use a range of technologies and are in varying states of repair.

It is not possible to determine the risk of pathogen contamination to the Schuylkill River watershed from septic system discharge. Although wastewater entering septic systems likely contains pathogens and possibly *Cryptosporidium*, the design, siting, and condition of the septic system will ultimately determine if these pathogens reach the groundwater or eventually surface water sources.

3.2 Agricultural Land Use Runoff

3.2.1 Agricultural Land Cover

Land cover data from the 2011 NLCD are described in detail in Section 2.1.4. PWD considered pasture/hay and cultivated crops land cover from the NLCD agricultural land use. The Schuylkill River watershed is 28% (535 square miles) agricultural land cover including pasture/hay and cultivated crops. This is slightly less than the agricultural land cover in 2001 and 2006; 28.7% and 28.3%, respectively. The agriculture land cover in the Schuylkill River watershed has decreased by nearly ten square miles in pasture/hay and nearly five square miles of cultivated crops. Each sub-watershed had a decrease in agricultural land since 2001, with the exception of the Little Schuylkill watershed, which had a slight increase. The sub-watersheds with the largest proportion of agricultural land cover include the Maiden, Tulpehocken and Monocacy Creek sub-watersheds, which are each approximately 50% agricultural land cover.

3.2.2 Livestock Populations

Livestock populations were used to calculate the total loading of *Cryptosporidium* oocysts to the Schuylkill River watershed in the WCP. The assumptions and calculations are detailed in Section 4.2.2 of the WCP 2014 and 2013 Annual Status Reports. Livestock populations are available by county from the USDA Pennsylvania Census of Agriculture published every five years. To estimate the population of certain livestock groups in the Schuylkill River watershed, the total population of each livestock group in each county was multiplied by the percent of that county within the Schuylkill River watershed. The percent land area of each county in the Schuylkill River watershed is shown in the second column of Table 3-11. The percent land area of the Schuylkill River watershed in each county is shown in the third column. Montgomery, Berks and Schuylkill counties comprise more than 75% of the Schuylkill River watershed land area. This simple estimation method does not take into account the actual locations of the farms on which these livestock are kept. It assumes each livestock group is evenly distributed throughout the county.

TABLE 3-11: PERCENT COUNTY LAND AREA IN SCHUYLKILL RIVER WATERSHED

COUNTY	% COUNTY LAND AREA IN SCHUYLKILL WATERSHED	% SCHUYLKILL WATERSHED LAND AREA IN COUNTY
Berks	87.2%	39.5%
Bucks	11.9%	3.9%
Carbon	1.9%	0.4%
Chester	22.9%	9.1%
Delaware	1.3%	0.1%
Lancaster	0.01%	0.01%
Lebanon	14.7%	2.8%
Lehigh	20.2%	3.7%
Montgomery	82.8%	21.1%
Philadelphia	32.2%	2.4%
Schuylkill	41.5%	17.0%

Several livestock groups are known to have potential to contribute the *Cryptosporidium* loading to the watershed through runoff from agricultural land (PWD, 2011). Table 3-12, Table 3-13, and Table 3-14 show the estimated population of cattle/calves, hogs/pigs and sheep/lambs, respectively, by county in the Schuylkill River watershed for each Census of Agriculture year since 1987. The population change and percent change in each county from 2007 to 2012 are also shown in the furthest right columns.

The overall cow and calf population in the Schuylkill River watershed increased by approximately 12%, or over 10,000 cattle/calves, from 2007 to 2012. There were an estimated nearly 70,000 cattle/calves in Berks County in the Schuylkill River watershed in 2012. This population has increased by over 10,000 cattle/calves, or 18.4%, since the last Census of Agriculture in 2007. Cow and calf populations have also increased in other counties including Bucks, Carbon, Lancaster, Lebanon, Lehigh and Schuylkill counties in the Schuylkill River watershed by a total of less than 1,000. Cow and calf population has decreased in Montgomery and Chester counties by over 1,000 from 2007 to 2012.

TABLE 3-12: SUMMARY OF COWS AND CATTLE FOR COUNTIES LOCATED IN THE SCHUYLKILL RIVER WATERSHED, 1987-2012

COUNTY	CATTLE AND CALVES						POPULATION CHANGE 2007 TO 2012	% CHANGE IN POPULATION 2007 TO 2012
	1987	1992	1997	2002	2007	2012		
Berks	60,149	56,892	55,066	52,481	58,368	69,132	10,764	18.4%
Bucks	1,421	1,191	1,189	917	769	832	63	8.2%
Carbon	24	24	31	19	20	27	7	35.6%
Chester	12,475	11,635	11,603	9,592	9,322	9,031	-291	-3.1%
Delaware	16	5	6	1	--	--	--	--
Lancaster	--	--	33	33	35	37	2	4.6%
Lebanon	7,058	7,168	7,688	7,731	8,345	8,698	353	4.2%
Lehigh	1,116	803	967	737	721	780	59	8.1%
Montgomery	9,650	6,447	7,550	5,915	3,523	2,743	-780	-22.1%
Philadelphia	--	--	--	--	--	--	--	--
Schuylkill	4,463	5,171	5,640	4,469	4,985	5,293	308	6.2%
Total	**96,372**	**89,336**	**89,773**	**81,895**	**86,087**	**96,572**	**10,485**	**12.2%**

The population of hogs and pigs decreased in the Schuylkill River watershed by approximately 4.8%, or 4,600 hogs/pigs, from 2007 to 2012. The largest estimated population of hogs and pigs, almost 58,000 in 2012, is in Berks County. This population has decreased by nearly 4,000 hogs/pigs, or 6.4%, since the last Census of Agriculture in 2007. The hog and pig population has also decreased in the Carbon, Lehigh and Montgomery counties, with Montgomery County seeing the greatest decrease of about 4,100 hogs/pigs from 2007 to 2012 in the Schuylkill River watershed. Hog and pig populations have increased in Bucks, Chester, Lancaster, Lebanon, and Schuylkill counties. Chester County had the greatest increase of about 2,100 hogs/pigs in the Schuylkill River watershed from 2007 to 2012.

TABLE 3-13: SUMMARY OF HOGS AND PIGS FOR COUNTIES LOCATED IN THE SCHUYLKILL RIVER WATERSHED, 1987-2012

COUNTY	HOGS/PIGS						POPULATION CHANGE 2007 TO 2012	% CHANGE IN POPULATION 2007-2012
	1987	1992	1997	2002	2007	2012		
Berks	41,095	54,973	56,062	53,631	62,072	58,083	-3,989	-6.4%
Bucks	553	204	83	185	47	63	16	34.7%
Carbon	24	23	18	5	3	1	-2	-59.5%
Chester	2,980	2,715	540	2,946	4,198	6,286	2,088	49.7%
Delaware	--	--	0	--	--	--	--	--
Lancaster	42	48	45	49	45	48	3	5.7%
Lebanon	7,257	10,973	13,529	16,575	14,691	14,973	282	1.9%
Lehigh	2,424	1,693	1,367	585	833	427	-406	-48.7%
Montgomery	8,050	5,571	7,633	3,974	6,536	2,419	-4,117	-63.0%
Philadelphia	--	--	--	--	--	--	--	--
Schuylkill	5,978	9,609	8,073	9,079	8,356	9,839	1,483	17.7%
Total	**68,405**	**85,809**	**87,349**	**87,028**	**96,782**	**92,139**	**-4,643**	**-4.8%**

The population of sheep and lambs decreased in the Schuylkill River watershed by approximately 7%, or 330 sheep/lambs, from 2007 to 2012. The largest estimated population of sheep and lambs, about 2,000 in 2012, is in Berks County. This population has decreased by approximately 150 sheep/lambs, or 7.3%, since the last Census of Agriculture in 2007. The sheep and lamb population has also decreased in the Bucks, Carbon, Chester, Lehigh, and Schuylkill counties. Sheep and lamb populations have increased in Lebanon and Montgomery counties. Montgomery County had the greatest increase of less than 100 sheep/lambs in the Schuylkill River watershed from 2007 to 2012.

TABLE 3-14: SUMMARY OF SHEEP AND LAMBS FOR COUNTIES LOCATED IN THE SCHUYLKILL RIVER WATERSHED, 1987-2012

COUNTY	SHEEP/LAMBS						POPULATION CHANGE 2007-2012	% CHANGE IN POPULATION 2007-2012
	1987	1992	1997	2002	2007	2012		
Berks	2,377	2,100	1,671	1,725	2,165	2,007	-158	-7.3%
Bucks	208	307	173	229	276	228	-48	-17.5%
Carbon	5	4	10	5	11	4	-7	-61.4%
Chester	702	784	493	654	694	623	-71	-10.2%
Delaware	--	2	--	1	2	2	0	0.0%
Lancaster	1	1	1	1	1	1	0	0.0%
Lebanon	335	273	184	240	259	297	38	14.7%
Lehigh	202	235	187	208	250	144	-106	-42.5%
Montgomery	607	653	662	1,400	802	884	82	10.2%
Philadelphia	--	--	--	--	6	--	--	--
Schuylkill	395	208	51	129	179	124	-55	-30.9%
Total	**4,833**	**4,566**	**3,432**	**4,593**	**4,645**	**4,313**	**-332**	**-7.1%**

Horse population in the Schuylkill River watershed was included in the estimation of total watershed loading from agricultural runoff in the WCP. This livestock group is not detailed in the WCP report, but populations of horses and ponies by county in the Schuylkill River watershed are included here (Table 3-15). The population of horses and ponies increased in the Schuylkill River watershed by approximately 14%, or 960 horses/ponies, from 2007 to 2012. The largest estimated populations of horses and ponies, ranging from about 270 to 320 in 2012 are in Berks, Chester and Montgomery counties. These populations have each increased by about 14 to 20% since the last Census of Agriculture in 2007. The horse and pony population has also increased in Bucks, Lebanon, Lehigh, and Philadelphia counties. Horse and pony populations have decreased slightly in only Carbon and Schuylkill counties. Since horse and pony populations were not detailed in the WCP, an additional column showing the percent change in livestock populations from 1987 to 2012 was included. Every county, with the exception of Carbon and Delaware counties, observed an increase in population of this livestock group. Several counties increased populations by over 100%.

TABLE 3-15: SUMMARY OF HORSES AND PONIES FOR COUNTIES LOCATED IN THE SCHUYLKILL RIVER WATERSHED, 1987-2012

COUNTY	HORSES/PONIES						POPULATION CHANGE 2007-2012	% CHANGE IN POPULATION 2007-2012	% CHANGE IN POPULATION 1987-2012
	1987	1992	1997	2002	2007	2012			
Berks	1,249	933	1,302	1,988	2,251	2,570	319	14.2%	105.8%
Bucks	187	154	177	302	356	386	30	8.3%	106.4%
Carbon	2	2	2	4	3	2	-1	-24.5%	-5.8%
Chester	1,122	991	1,212	1,968	1,791	2,060	269	15.0%	83.6%
Delaware	5	3	3	2	4	4	0	3.3%	-23.8%
Lancaster	1	1	1	2	2	2	0	5.1%	61.8%
Lebanon	107	132	135	257	309	314	4	1.4%	193.1%
Lehigh	151	114	150	288	160	241	81	50.3%	58.9%
Montgomery	694	1,020	844	1,439	1,465	1,745	280	19.1%	151.4%
Philadelphia	--	--	19	--	31	38	7	0	--
Schuylkill	124	178	209	434	370	337	-32	-8.8%	171.0%
Total	**3,643**	**3,528**	**4,054**	**6,684**	**6,742**	**7,699**	**957**	**14.2%**	**111.3%**

3.2.3 Confined Animal Feeding Operations (CAFOs)

Animal Feeding Operations (AFOs) and Confined Animal Feeding Operations (CAFOs), as defined by the EPA, are agricultural operations where animals are kept and raised in confined situations. CAFOs have more than 1000 animal equivalent units (AEUs) confined on site. There are a number of CAFOs located in the Schuylkill River watershed in Berks and Lebanon counties primarily in the Tulpehocken, Middle Schuylkill 2 and Maiden Creek watersheds. PWD tracks the location and size of these operations through data available from the PADEP Bureau of Conservation and Restoration. Figure 3-5 shows the CAFOs in the Schuylkill River watershed in 2015. There are 24 CAFOs: 15 in the Tulpehocken, 6 in the Upper Schuylkill, 2 in the Maiden and 1 in the Manatawny Creek sub-watershed. The size of a CAFO is

reported in AEU. There are two newly reported CAFOs since PWD last updated the map in 2014 or the WCP Annual Status Report: a CAFO with primarily ducks and 168 AEUs, and a CAFO with primarily chickens and 417 AEUs. These new CAFOS are outlined in blue in the map in Figure 3-5.

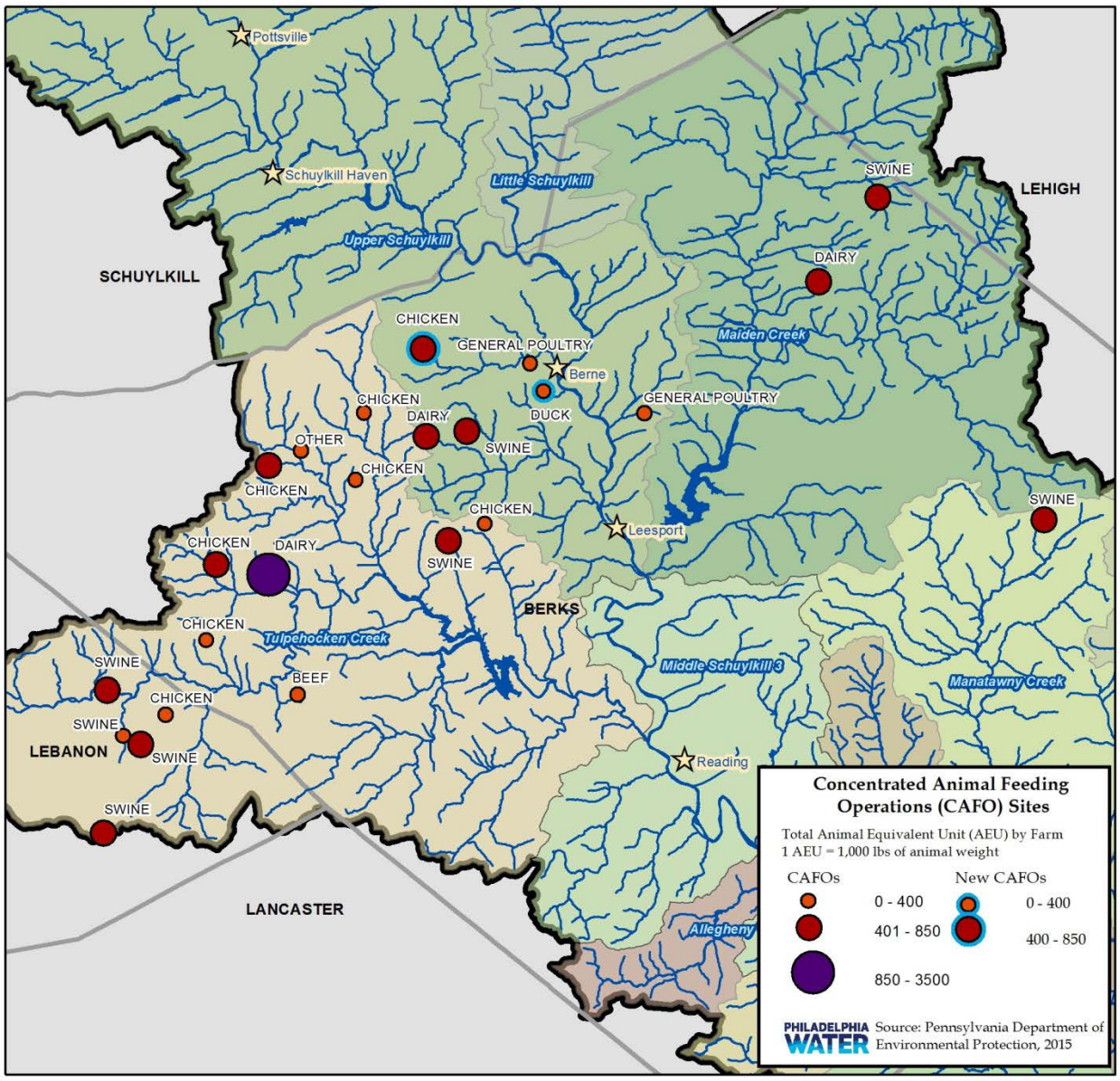


FIGURE 3-5: MAP OF CAFO LOCATIONS IN THE SCHUYLKILL RIVER WATERSHED

3.3 Wildlife

In the WCP, PWD recognized Canada geese as a priority source of *Cryptosporidium* in the watershed. Canada geese are abundant in the region and within the City of Philadelphia. Through a source tracking research project with Lehigh University, detailed in Section 5.4, geese were identified as mechanical vectors of *Cryptosporidium*. In the absence of data specific to the Schuylkill River watershed, it is difficult to track changes in resident geese populations or draw conclusions on a watershed scale. This section provides a brief history of the management of Canada geese populations in the eastern portion of North America, and population estimates for the state of Pennsylvania.

Wildlife managers recognize two distinct populations of Canada geese on the Atlantic coast of North America: migrant Canada geese and "resident" Canada geese population. The migrant Atlantic Population nests throughout the Canadian province of Quebec and especially along Ungava Bay and on the Ungava Peninsula on the eastern shore of the Hudson Bay. The Atlantic Population migrates south to spend winters in the United States from New England to South Carolina with the largest populations occurring in the Delmarva Peninsula (USFWS, 2014).

Resident Canada geese populations nest in southern Quebec, the southern Maritime provinces of Canada and the US states in the Atlantic Flyway (USFWS, 2014). The Atlantic Flyway is the migration path that follows the Atlantic coast of North America and the Appalachian mountains. Resident Canada geese are largely nonmigratory but may shift slightly south during winter (USFWS, 1997). After the arrival of the Europeans in North America, the original population of resident geese became locally extinct. The current population of resident geese was introduced beginning in the early 1900s with the release of Canada geese from private individuals. Furthermore, live hunting decoys were outlawed in 1935, and the release of captive Canada geese flocks followed. From the 1950s to the 1980s, U.S. wildlife management agencies in the Atlantic Flyway states introduced populations through relocation and stocking programs primarily in rural areas (USFWS, 2005).

The Migratory Bird Treaty Act of 1918 protects migratory birds making it illegal to hunt, take, possess, sell, purchase, and transport migratory birds, including Canada geese, without a permit. However, due to hunting pressures and poor gosling survival in the early 1990s, the migratory Atlantic Population declined more than 75% in less than a decade from 1988 to 1995. This led to a ban on sport hunting of the Atlantic Population of Canada geese in 1995 in the U.S. and Canadian provinces of Ontario and Quebec. Due to similar appearance and regional overlap during migration of the Atlantic population, the two populations of Canada geese proved difficult to manage independently (USFWS, 1997). Resident Canada geese generally have an abundance of preferred habitat, low numbers of predators, and tolerance of disturbances from human activity. Without harvest pressure, these populations increased dramatically (USFWS, 2005).

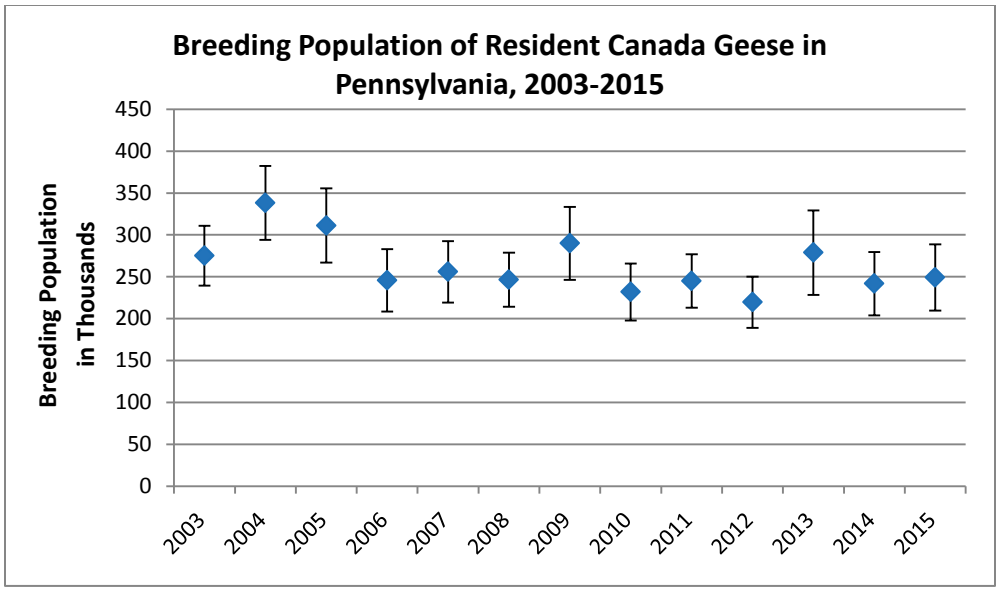
In Pennsylvania, the Game Commission implemented special hunting seasons to address the increasing populations of resident Canada geese in the early 1990s. These seasons include early September and late winter when the migratory geese are largely not present. Harvests during the special hunting seasons were increasingly successful. Although hunting resident geese for sport proved an effective management technique in rural areas, it did not address issues in suburban and urban areas where

hunting is not an option. An effective management of resident geese in the more populous regions of the state was needed (Dunn, 2000).

In 2005, the US Fish and Wildlife Service (USFWS) completed an Environmental Impact Statement for resident Canada geese that evaluated management technique options for states and proposed a plan of action. The plan of action called for an Integrated Damage Management and Population Control approach. This recommendation included authorizing trapping, relocation and culling programs for resident Canada geese and egg and nest destruction to control resident goose populations while protecting migrant geese such as the Atlantic Population. This strategy would be applied at airports to address safety concerns, on agricultural properties to avoid crop damage, and in cases when geese are a threat to public health. Additionally, the action plan included expanded hunting seasons authorized under the Migrant Bird Treaty to further target resident Canada Geese populations (USFWS, 2005). The Final Environmental Impact Statement: Resident Canada Goose Management is available online at www.fws.gov.

The USFWS compiles population survey results from individuals and organizations on the status of waterfowl in the United States. The population the Atlantic Population of Canada geese is estimated based on a spring survey of the Ungava Peninsula. The study estimates a total population of breeding pairs and grouped birds of 785,600. The resident geese population in the Atlantic Flyway is estimated in the spring through the Atlantic Flyway Breeding Waterfowl Plot Survey. A breeding population of 1,084,900 and 951,000 were estimated in spring 2013 and spring 2014, respectively. These estimates are similar to the long-term (1993-2014) average, which has declined by 2% on average each year since 2005 (USFWS, 2014). Further detail on these survey and estimation methods, their limitations, and confidence intervals is available in the Waterfowl Population Status in 2014 report. The Atlantic Flyway Breeding Waterfowl Plot Survey also provides resident Canada geese population estimates by state. In the monitoring effort, 1,500 one square kilometer plots across participating states it the Atlantic Flyway are surveyed. The results are available on an online database from the USFWS at migbirdapps.fws.gov. A breeding population of 278,900, 241,700 and 249,200 resident Canada geese was estimated for the state of Pennsylvania in 2013, 2014 and 2015, respectively. Figure 3-6 shows the breeding population of resident Canada geese estimated each year from 2003 to 2015. Error bars show one standard deviation. These estimates do not indicate a significant increase or decrease since 2005.

FIGURE 3-6: BREEDING POPULATION OF RESIDENT CANADA GEESE IN PENNSYLVANIA, 2003-2015



Source: U.S. Fish and Wildlife Service Atlantic Flyway Breeding Waterfowl Plot Survey

3.4 Significance of Potential Sources of Pathogens in the Watershed

3.4.1 Wastewater Discharges

The WCP identified WWTP effluent as a priority source of *Cryptosporidium* in the Schuylkill River watershed. In the WSS, PWD identifies 152 WWTPs discharging a total of 109 MGD to the watershed. These plants discharge average flows ranging from 200 gallons per day to about 14 MGD. The *Cryptosporidium* loading to the watershed from WWTP effluent was estimated in the WCP. To demonstrate the effect of implementing UV disinfection at WWTPs, a revised estimated *Cryptosporidium* loading to the watershed from WWTP effluent is summarized in Table 3-16. This estimation method was used in the WCP to determine *Cryptosporidium* loading to the Schuylkill River watershed and is summarized in detail in Section 4.1.2 of the 2014 Annual Status Report (PWD, 2014). The loading estimate in the WCP cannot be directly compared to the loading estimated in this report because PWD has access to additional information on WWTP discharges and UV treatment technology upstream that was not available during the development of the WCP. With this method, loading values are calculated using estimated concentrations of oocysts in WWTP effluent and the WWTPs average flows included in this report. Minimum and maximum estimates of oocyst concentrations in WWTP effluent receiving secondary treatment are based on pooled values from literature (Crockett, 2007). Tertiary treatment was taken into consideration in the WCP, but not in this report in order to isolate the estimated significance of UV disinfection to *Cryptosporidium* reduction in the watershed.

To establish a baseline *Cryptosporidium* loading, it was first assumed all WWTPs in the Schuylkill River watershed use conventional treatment with no UV disinfection. This baseline loading range is 4.68E+09 to 5.98E+14 oocysts per year. This report identifies 32 WWTPs, a total average flow of 27.8 MGD, with UV disinfection systems. For WWTPs with UV disinfection, 99.9% *Cryptosporidium* inactivation was assumed decreasing the estimated *Cryptosporidium* loading total by approximately 25% to a range of

3.49E+09 to 4.4E+14 oocysts per year. However, as explained in Section 3.1.1.2, it is important to note that inactivated *Cryptosporidium* oocysts are still counted in the Method 1623 for LT2ESWTR.

The purpose of this estimate is to demonstrate the potential significance of the implementation of UV disinfection at WWTPs to the *Cryptosporidium* loading in the watershed. It does not represent the reduction in *Cryptosporidium* loading in the watershed since the initiation of the WCP in 2012 because the date of UV disinfection implementation for each WWTP is not known and many existed prior to 2012. PWD will continue to track WWTP upgrades upstream, particularly UV disinfection installations.

TABLE 3-16: QUANTITATIVE SUMMARY OF UV DISINFECTION IMPACT ON *CRYPTOSPORIDIUM* LOADING ESTIMATES

	TOTAL AVERAGE FLOW (MGD)	NUMBER OF WWTPS	MINIMUM ESTIMATE (OOCYSTS/YEAR)	MAXIMUM ESTIMATE (OOCYSTS/YEAR)
Cryptosporidium Loading Total baseline (assumes secondary treatment with no UV disinfection at all WWTPs)	109.2	152	4.68E+09	5.98E+14
Cryptosporidium Loading Reduction from UV Disinfection (accounts for WWTPs with UV disinfection)	27.8	32	1.19E+09	1.52E+14
Cryptosporidium Loading Total with UV Disinfection Systems	109.2	152	3.49E+09	4.46E+14
Percent Difference			**-25.4%**	

CSOs and illegal 'wildcat' discharges can contribute pathogens to the Schuylkill River watershed as well. The significance of the pathogens contributed to the watershed from these discharges is not well known as there is limited data on the discharge quality and quality. The discharges located in PWD's WTP intake zone A, which include CSOs in Norristown and Bridgeport, are of most significance. PWD continues to track available data on CSO and wildcat sewer discharges in the watershed.

3.4.2 Agricultural Land Use Runoff

In the WCP, PWD uses two methods to estimate the *Cryptosporidium* loading to the watershed from agricultural land. Both methods are detailed in Section 4.2.2 of the 2014 WCP Annual Status Report (PWD, 2014). The first estimation method is a runoff calculation using land cover, a method with significant limitations. Although the NLCD shows a slight decrease in agricultural land cover in the watershed, this information does not account for changes in animal population density or the conservation and nutrient management practices employed on individual farm properties, which have significant potential impacts on the *Cryptosporidium* loading to the waterways. Therefore, PWD does not expect a meaningful change in *Cryptosporidium* loading to the watershed based on 2011 NLCD data.

The second method used to estimate the *Cryptosporidium* loading to the watershed from agricultural land is based on animal populations. This method also has significant limitations. The *Cryptosporidium* loading by this method is calculated using animal populations from the Census of Agriculture, and

estimated prevalence of infection in livestock types and number of *Cryptosporidium* oocysts shed per year per animal from literature sources. As with the first calculation method, this method does not take into account conservation and nutrient management practices on individual farms. Additionally, much uncertainly is associated with the numbers of *Cryptosporidium* oocysts shed per year per animal from literature as the actual rates may vary by region and individual farm.

Although it is difficult to assess changes in *Cryptosporidium* loading from agricultural sources, conclusions meaningful to WCP strategies can still be made. Cattle and calves are known sources of *Cryptosporidium* and have the greatest populations in the watershed when compared to pigs/hogs, sheep/lamps and horses/ponies. The Schuylkill River watershed had a 12.2% increase in cattle and calves from 2007 to 2012. Berks County has the greatest population of cattle and calves, nearly 70,000. Chester County had the next greatest population of cattle and calves, but an order of magnitude fewer than that of Berks County. It is evident from the distribution of livestock in the Schuylkill River watershed that Berks County continues to be the highest priority area for implementation of agricultural BMPs. PWD will continue to partner with NRCS, Berks Conservancy, Berks County Conservation District and other stakeholders to address this priority source of *Cryptosporidium* in the watershed.

3.4.3 Wildlife

Although the significance of Canada geese and other wildlife as potential sources of *Cryptosporidium* cannot be quantified, PWD focuses efforts to control geese populations in priority source water areas. PWD participates in a program through the USDA to reduce geese populations at PWD facilities and park properties and implements and maintains riparian buffers to deter geese and filter runoff near drinking water intakes. These efforts are detailed in the WCP annual status reports.

3.4.4 Relative Significance of Potential Sources of Pathogens

In the WCP, PWD identified three priority sources of *Cryptosporidium*: WWTP effluent, runoff from agricultural land and wildlife. Based on estimated *Cryptosporidium* loadings, WWTP effluent contributes the greatest loadings. The larger discharges with no UV disinfections systems are of greatest concern. Runoff from agricultural land was estimated as the second greatest contributing source. The most uncertainty is associated with *Cryptosporidium* loadings from wastewater from wildcat sewers and CSOs and from wildlife. With no jurisdiction outside of Philadelphia including over upstream WWTPs, PWD takes a partnership approach to addressing *Cryptosporidium* and pathogens in the Schuylkill River watershed. PWD believes these sources identified in the WCP still represent the highest priorities in the watershed and will continue to track WWTP upgrades upstream, support BMPs that reduce *Cryptosporidium* loadings on agricultural properties, and deter wildlife from priority areas in the City. These efforts are detailed in Section 4.3.

3.5 Anticipated Changes in Sources of Pathogens

3.5.1 Wastewater Discharges

PWD continually tracks changes in wastewater discharges upstream. In addition to compiling updated information and data on WWTP discharge volumes and treatment technologies, PWD looks at wastewater treatment planning in the watershed to anticipate changes in WWTP discharges upstream.

Municipalities treating wastewater are required plan for sewage disposal needs under Act 537. To address financial needs, PENNVEST awards low interest loans and grants for WWTP projects and upgrades. The following sections summarize the status of Act 537 plans for municipalities in the watershed, and the recently awarded PENNVEST loans and grants for wastewater projects in the Schuylkill River watershed.

3.5.1.1 Act 537 Planning

Under the Act 537 Program, municipalities are required to develop and implement a plan that addresses the sewage disposal needs and accounts for future land development and sewage disposal needs. PADEP reviews and approves the Act 537 plans and all subsequent revisions.

PADEP provides an updated list of Act 537 plans and plan ages on their website. The list version used in this report was updated on January 1, 2015. There are 228 municipalities with Act 537 plans and land area in the Schuylkill River watershed. The oldest plans were developed in 1967. Table 3-17 is a summary of Act 537 plan age for municipalities with land area in the Schuylkill River watershed.

TABLE 3-17: SUMMARY OF ACT 537 PLAN AGE FOR MUNICIPALITIES WITH LAND AREA IN THE SCHUYLKILL RIVER WATERSHED

YEAR OF PLAN	1967-1975	1976-1985	1986-1995	1996-2005	2006-2014
Number of Act 537 Plans	28	7	28	81	84

Figure 3-7 is a map of the Schuylkill River watershed. Municipalities are outlined in the map and colored based on Act 537 Plan age. Red indicates municipalities with the oldest Act 537, older than 40 years, and green indicates municipalities with the newest Act 537 plans, updated within the past 10 years.

Through PADEP partners in the Schuylkill Action Network (SAN), detailed in Section 4.3.1, PWD was able to learn more about the status of some of the oldest Act 537 plans in Montgomery, Chester, Bucks, Berks and Lebanon Counties. Many municipalities with Act 537 plans completed before 1975 are in compliance. The municipality is either built out, or there are no known issues or development pressures. Others are in the process of an Act 537 plan update. PADEP has requested an updated Act 537 plan from some municipalities.

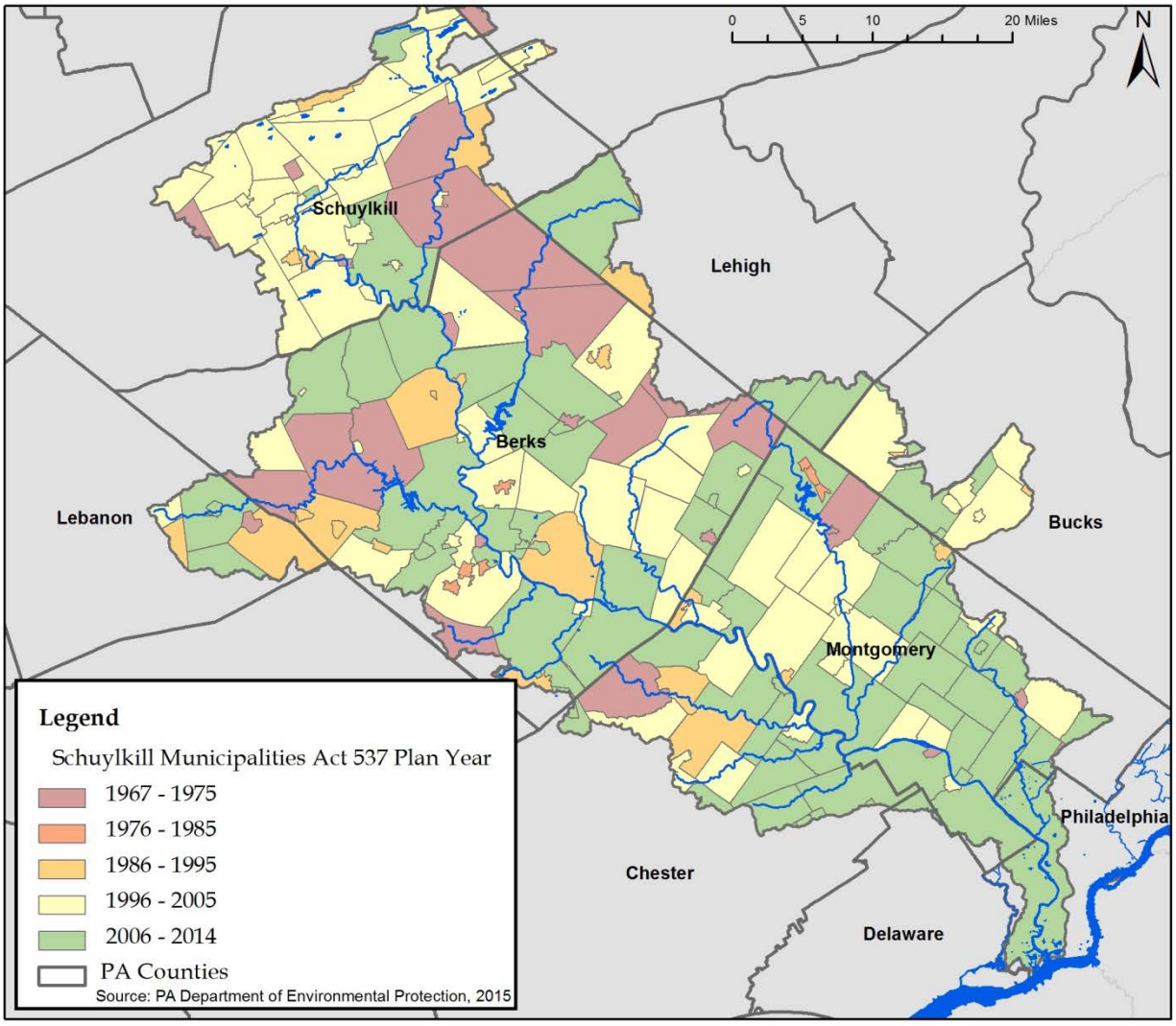


FIGURE 3-7: MAP OF ACT 537 PLAN AGE FOR SCHUYLKILL RIVER WATERSHED MUNICIPALITIES

3.5.1.2 PENNVEST

PENNVEST provides low cost financial assistance for sewer, stormwater and drinking water projects in Pennsylvania. A number of townships and municipal authorities in the Schuylkill River watershed were awarded PENNVEST funding for sewerage facility improvements or upgrades since the development of the WCP.

These projects include construction of new sewage collection systems and wastewater treatment plants, and upgrades and expansions to existing wastewater treatment plants and are detailed in Table 3-18. Projects improve groundwater and surface water quality by eliminating malfunctioning on-lot septic systems or wildcat sewers and preventing untreated sewage contamination of ground and surface waters in these Schuylkill River watershed project areas.

TABLE 3-18: PENNVEST WASTEWATER PROJECTS 2011-2015

PROJECT NAME	APPROVAL DATE	LOAN; GRANT	COUNTY	DESCRIPTION	PENNVEST AWARD STATUS	SOURCES
Geigertown Area Joint Authority - Sanitary Sewer Project	22-Apr 2015	$1,997,810; $3,335,428	Berks	Construction of more than six miles of new sewage collection lines and installation of other facilities to serve 108 households and eliminate the use of malfunctioning on-lot septic systems that are contaminating local drinking water wells.	Approved	PENNVEST; PRNewswire 22 Apr 2015
Reading City - Fritz Island WWTP Liquids Treatment Facilities Upgrade	22-Apr 2015	$84,586,034; $0	Berks	Upgrade to sewage treatment plant and related facilities to eliminate the threat of wet weather discharges of untreated sewage into the Schuylkill River.	Approved	PENNVEST; PRNewswire 22 Apr 2015
Reading City - 6th and Canal Street Force Main	25-Apr 2012	$10,013,950; $0	Berks	Construction of a new force main and make other improvements to the city's collection system to eliminate raw sewage discharges into the Schuylkill River.	Interim	PENNVEST; PRNewswire 25 Apr 2012
Richmond Township - Virginville System and WWTF	26-Oct 2011	$1,095,351; $631,849	Berks	Construction of a new sewage treatment system to eliminate the use of malfunctioning on-lot septic systems that are contaminating streams that flow into Lake Ontelaunee.).	Disbursement	PENNVEST; PRNewswire 26 Apr 2011
Schuylkill County Municipal Authority - Deer Lake Sanitary Sewer System Expansion and Upgrades	20-Jul 2011	$12,454,430; $1,545,570	Schuylkill	Upgrade and expansion of wastewater treatment plant, construction of several miles of sewage collection lines and elimination of several small, inadequate treatment plants to eliminate discharges from wildcat sewers and malfunctioning on-lot septic systems into local receiving streams and provide treatment capacity for local development.	Interim	PENNVEST; PRNewswire 20 Apr 2011; SCMA
Perry Township Municipal Authority - Mohrsville Road Low Pressure Sewer System	9-Nov 2010	$1,825,378; $0	Berks	Construction of a new sewage collection and conveyance system to serve areas of the township where malfunctioning on-lot septic systems are discharging raw sewage into the Schuylkill River.	Final Amortization	PENNVEST; PRNewswire 9 Nov 2010
Port Clinton Boro - Sewer collection and conveyance system	20-Jul 2010	$0; $265,900	Schuylkill	Design of a new sewage collection system to deliver sewage to the Hamburg Municipal Authority Wastewater Treatment Plant and eliminate malfunctioning on-lot septic systems and wildcat sewers that are contaminating Rattling Run,	Paid in Full	PENNVEST; PRNewswire 21 Jul 2010

				the Little Schuylkill River and the Schuylkill River.		
Lehigh County Authority - Western Weisenberg Township Wastewater Treatment Plant	20-Jul 2010	$2,931,170; $0	Lehigh	Replacement of the Arcadia West Industrial Park wastewater treatment plant with a new plant and sewage conveyance system that will provide adequate service to both the existing industrial park and allow its expansion.	Final Amortization	PENNVEST; PRNewswire 21 Jul 2010
Maxatawny Township Municipal Authority - Area A Sanitary Sewer	20-Jul 2010	$3,359,551; $0	Berks	Construction of a new treatment plant and sewage collection system to serve 295 households and eliminate the use of malfunctioning on-lot septic systems that are discharging untreated waste and contaminating local drinking water wells.	Final Amortization	PENNVEST; PRNewswire 21 Jul 2010

3.5.2 Agricultural Land Use Runoff

Significant federal funds are committed to areas in the Schuylkill and Delaware River watersheds over the next years. The USDA offers funding to farmers through the Environmental Quality Incentives Program (EQIP) with the Maiden and Saucony Creek watersheds, tributaries to the Schuylkill River watershed in Berks County, named priority for the National Water Quality Incentive (NWQI) funding pool under EQIP. Through the SRRF, PWD has leveraged grants for a number of agricultural BMP projects with funding secured through EQIP. In 2014, the NRCS introduced the Regional Conservation Partnership Program (RCPP). The RCPP focuses on public-private partnerships encouraging businesses, communities and non-governmental organizations to invest in conservation and water quality initiatives and commits $12 billion nationally over five years. With Stroud Water Research Center as the leading partner, $1.5 million went to Berks and Chester counties in Pennsylvania to reduce nutrient and sediment in surface and groundwater and improve fish and wildlife habitat in 2015. More information on the RCPP is available at online at www.nrcs.usda.gov/.

Additionally, in 2013, William Penn Foundation Delaware River Watershed Initiative (DRWI) announced a multi-year investment to protect and restore watersheds that provide a critical drinking water source. The William Penn Foundation prioritized eight sub-watershed areas, 'clusters.' The Schuylkill Highlands Cluster focuses on land conservation in areas of Berks and Chester counties. Work in this cluster has aligned with the goals of the SAN Watershed Land Collaborative workgroup. The Middle Schuylkill Cluster includes the Maiden, Manatawny and Tulpehocken creek watersheds and focuses on agriculture restoration. Work in this cluster has aligned with the priorities of the SAN Agriculture Workgroup. Grants are leveraged with funding from the NRCS, the SRRF and other sources to implement agricultural BMPs on farms. For more information on the DRWI, visit www.williampennfoundation.org/what-we-fund-watershed-protection.

The NRCS and the William Penn Foundation are critical partners in working towards restoring and protecting the Schuylkill River watershed. The recent commitment of these federal and private resources will support agricultural improvements in upcoming years at a greater number of farms, reducing runoff contaminated with nutrients, sediment and pathogens to waterways. With strong partners working towards this common goal, water quality improvements are anticipated and may be fully realized over years and decades to come.

3.5.3 Wildlife

The available data on Canada geese populations is not specific to the Schuylkill River watershed. However, it is evident that high populations of resident Canada geese are a widespread issue in urban and suburban areas. In addition to controlling geese populations at priority areas in Philadelphia, PWD continues to share the results of the Lehigh University source tracking research with upstream water suppliers and other watershed organizations to communicate the importance of managing geese populations in drinking water supply areas to protect water quality.

Section 4. Watershed Control and Management Practices

Identification of watershed control and management practices is the third component of a watershed sanitary survey as described in the 1993 Watershed Sanitary Survey Guidance Manual from the AWWA Nevada-California Section. This section summarizes the PWD watershed management both within the City limits and upstream of Philadelphia, as well as watershed management practices of other agencies and organizations in the watershed.

4.1 PWD Watershed Management Practices

4.1.1 Watershed Management in Philadelphia

In 1999, PWD integrated three historically separate programs - Combined Sewer Overflow, Stormwater Management and Source Water Protection – to form the Office of Watersheds (OOW) within the PWD Planning and Environmental Services division. The intention of this reorganization was to optimize resources allocated to controlling Philadelphia's sewer discharges, protect drinking water resources, achieve regulatory compliance, and effectively manage the watersheds within the City limits.

OOW is tasked with monitoring and managing Philadelphia watersheds. OOW houses PWD stormwater management and combined sewer overflow National Pollutant Discharge Elimination System (NPDES) permit compliance programs. A major component of Philadelphia's CSO permit requirements is the implementation of the Long Term Control Plan Update (LTCPU), *Green City, Clean Waters. Green City, Clean Waters* is a 25-year plan with a green stormwater infrastructure-based approach to reduce pollutants discharged by the combined sewer system. OOW studies streamflow and water quality in Philadelphia watersheds by monitoring Philadelphia streams, including maintaining a series of gaging stations in the City in partnership with the USGS. Hydrodynamic and water quality models for Philadelphia waterways are developed and validating in OOW. OOW also identifies and implements projects for waterway restoration and enhancement. The Ecological Restoration Unit at PWD is working on a number of projects that will manage stormwater and restore stream banks upstream of the Queen Lane WTP intake. In 2015, a stream channel improvement project at Gorgas Run, a tributary to the Wissahickon Creek, will stabilize the stream banks, improve flow, and prevent erosion problems and large amounts of sediment from being carried downstream. Additionally, a study at Cresheim Creek is underway exploring the feasibility of a dam removal and additional stream bank improvements in the vicinity. Through outreach and partnerships, OOW coordinates with local watershed community groups and engages Philadelphia residents and businesses to be stewards of the Philadelphia watersheds. More information on the projects and programs within OOW is available at www.phillywatersheds.org.

The PWD Source Water Protection Program within OOW studies water quality and quantity, land use and other influences on the drinking water supply upstream of Philadelphia. Philadelphia's drinking source watershed includes approximately 2,000 square miles of the Schuylkill River watershed and 8,100 square miles of the Delaware River watershed. The Source Water Protection Program takes a partnership approach to watershed management because over 98% of the Schuylkill River watershed is outside of Philadelphia's jurisdiction. Shortly after being established in 1999, PWD Source Water

Protection Program embarked on a state mandated Source Water Assessment (SWA), detailed in the following section.

4.1.2 Source Water Assessment

The 1996 Safe Drinking Water Amendments required all water suppliers to complete a Source Water Assessment (SWA). The purpose of the SWA was to identify potential sources of contamination in the Schuylkill River watershed, determine the vulnerability of the water supply to those potential sources, and make the information available to the public. To complete the SWA for PWD and other drinking water suppliers in the Schuylkill River watershed, the Pennsylvania Department of Environmental Protection (PADEP) coordinated among water suppliers, watershed organizations and stakeholders. PWD, as PADEP's primary contractor in developing the multiple SWAs, partnered with Pennsylvania American Water Company and Suburban Water Company, now Aqua Pennsylvania, to form the Schuylkill River Source Water Assessment Partnership. The Partnership completed a SWA for 42 surface water intakes in the Schuylkill River watershed.

The SWA included several parts. First, the Schuylkill River watershed was delineated into three zones. The three zones indicate the potential time it would take for a source located in that zone to flow down a river and contaminate a public water supply intake. Next, an inventory of point sources was conducted from PCS-ICIS, Resource Conservation and Recovery Act and the Comprehensive Environmental Response Compensation and Liability Act Information Systems, Toxic Release Inventory, above ground storage tanks, and facilities identified by water suppliers' self-assessment under the Source Water Assessment Program. The non-point sources were accounted for by determining the contaminant loadings from sub-watersheds using the Schuylkill Runoff Loading Model (SRLM). For more detailed information on the point source inventory and the SRLM methodology, refer to Sections 2.2.2 and 2.2.3 of the 2002 SWA, respectively. Once all point sources and non-point sources were compiled, the Partnership conducted a susceptibility analysis. After a series of multi-criteria screenings, point and non-point sources were pooled and ranked both by specific ten specific contaminant categories and all contaminant categories combined. Both the combined contaminant and contaminant specific analysis resulted in a final ranking of sources by order of priority. The sources on the final ranked lists were designated into groups A, B and C for high, moderately high and moderate priority. For more details on the screening for individual types refer to Section 2.2.4 and 3.2.4 in the 2002 SWA.

An important aspect of the SWA process was the involvement of the public. The Partnership established a Technical Advisory Group (TAG) to establish communication between stakeholders and the Partnership and to assist in gathering information throughout the watershed. Public meetings were also conducted to attempt to involve and educate interested citizens. The Partnership held 25 TAG and public meetings to obtain information on what potential sources were of most concern to the watershed stakeholders. Additionally, the TAG gave input into the assessment technologies and criteria used. A SWA website was established as a location where information on the assessment process and results could be accessed.

The SWA made a series of recommendations documented in reports specific to each water supplier and their intakes. The recommendations include general issues to be addressed at a watershed wide level,

such as identification of grant funding and development of a watershed wide organization to improve coordination of restoration efforts. The SWA recommended protection and preservation of priority land to reduce the impacts of future development, and reduction of impacts from sewage discharge, stormwater runoff, acid mine drainage, agriculture, erosion and sedimentation, wildlife, spills and accidents. Improved public education, data and information collection and coordination, and water quality monitoring were also recommended. The detailed analysis of potential sources of contamination for each of PWD's water supply intakes, Belmont and Queen Lane on the Schuylkill River, identified regional and location specific recommendations. Location specific efforts would target the priority corridor of the Schuylkill River from Reading to Philadelphia and the Wissahickon Creek. One of the regional recommendations included the development of a coordinated regional Source Water Protection Plan which would incorporate and expand on the conclusions and recommendations of the SWA.

4.1.3 Source Water Protection Plan and Program

The Source Water Protection Plan (SWPP), completed in 2006, builds on the results of the SWA by further prioritizing the potential sources of contamination to the water supply previously identified. As part of the SWPP, a build out model was completed for the Schuylkill River watershed using the EPA Source Water Management Model (SWMM) and available county zoning data. The build out analysis concluded that the developed area and impervious cover in the watershed could increase significantly in a period of 50 to 100 years. This would increase stormwater runoff and consequently the loading of priority pollutants deposited into waterways in the Schuylkill River watershed. Additionally, projected increases in population would result in additional sewage treatment plants and point source discharges to the Schuylkill River and its tributaries.

Using results from the SWA, the SWPP takes priority sources for individual intakes and further prioritizes them based on impact to the Schuylkill River watershed as a whole. While the SWA examined ten parameters, the SWPP selected the five pollutants of primary concern: *Cryptosporidium*, fecal coliform, nutrients, total organic carbon and turbidity. For point sources, the prioritization method in the SWPP focused on NPDES permit point sources as the SWA concluded those to be the greatest threat to water quality according to the susceptibility analysis. During the SWA process, a susceptibility analysis was completed for each public water supply intake in the Schuylkill River watershed. High, moderately high and moderate priority sources for each of the specific intakes assessed were selected for further prioritization. To identify sources with the greatest impact to the Schuylkill River watershed as a whole, new weighting criterion was used to rank the selected sources. After separate analysis of point and non-point sources, the top 100 sources for each of the five primary concern pollutants as well as the combined parameters were identified. For further details on the prioritization method, refer to Section 3.1 of the Source Water Protection Plan (PWD, 2006). Although, acid mine drainage, CSO and SSO sources were not considered in this analysis, they were identified as primary concerns in the SWA and would be incorporated in the SWPP objectives.

In the SWPP, PWD and the Schuylkill Action Network (SAN) (formerly the SWA Partnership) identified potential projects to be completed in the watershed. The projects targeted restoration and protection efforts in specific areas based on the prioritization analysis in the SWA and SWPP as well as the PADEP

303 (d) stream assessments, project location on streams with TMDLs, and the Little Schuylkill River and Upper Schuylkill River Assessment Reports prepared by L. Robert Kimball & Associates, which linked acid mine drainage sources to metal loadings in the Schuylkill River watershed. The SWPP presents seven objectives and addresses them by recommending projects and future work for the PWD Source Water Protection Program:

> *Objective 1: Establish the Schuylkill Action Network as a permanent watershed-wide organization charged with identifying problems and prioritizing projects and funding sources to bring about real improvement in water quality throughout the Schuylkill River watershed.*
>
> *Objective 2: Create a long-term, sustainable fund to support restoration, protection, and education projects in the Schuylkill River watershed.*
>
> *Objective 3: Increase public awareness of the Schuylkill River watershed's regional importance as a drinking water source.*
>
> *Objective 4: Initiate changes in polices and decision-making that balance and integrate the priorities of both the Safe Drinking Water Act and Clean Water Act.*
>
> *Objective 5: Establish the Early Warning System as a regional information sharing resource and promote its capabilities for water quality monitoring and improving emergency communication.*
>
> *Objective 6: Reduce point source impacts to water quality.*
>
> *Objective 7: Reduce non-point source impacts to water quality (PWD, 2006).*

Since the completion of the SWA and the SWPP, the Source Water Protection Program and Office of Watersheds at PWD, as well as watershed partners, have strived to address each of these objectives. Major accomplishments have been made towards each of the objectives through a partnership watershed management approach. Program highlights, particularly those addressing *Cryptosporidium* and pathogens in the watershed are described in Section 4.3.

4.2 Watershed Management outside PWD Jurisdiction

With a large portion of the Schuylkill River watershed outside the jurisdiction of Philadelphia, PWD Source Water Protection Program takes a partnerships approach to source water protection. PWD considers the policies and practices of other agencies, organizations, and municipalities upstream critical to effective watershed management and depends on the development and enforcement strategies that promote and protect upstream waterways. This section briefly summarizes the policies and practices that PWD considers particularly important to source water protection. These agencies and organizations are well represented in the SAN, through which PWD is able to work with partners addressing priority issues in the watershed.

4.2.1 Ambient Water Quality and Wastewater Discharges

The Clean Water Act passed in 1972 sets the framework for regulation of water quality in surface waters and discharges of pollutants. The Pennsylvania Department of Environmental Protection established

water quality standards for surface waters in Pennsylvania that meet the requirements of the Clean Water Act. These standards are included in Chapter 93, *Water Quality Standards*, Title 25 *Environmental Protection* of the Pennsylvania Code, a publication with all rules and regulations from the government of Pennsylvania. Chapter 93 defines critical uses for Pennsylvania waterways for aquatic life, water supply, recreation and fish consumption, special protection and navigation. The main stem of the Schuylkill River has multiple designated uses: warm water fishery, migratory fishes, and potable water supply. Based on these designations, a set of water quality criteria applies to the waterway. Chapter 93 Water Quality Standards inform the NPDES permitting process.

There are hundreds of municipal and industrial wastewater dischargers upstream of Philadelphia on the Schuylkill River. Wastewater issues upstream of the City are out of Philadelphia's jurisdiction to address. PWD relies on the crucial role PADEP, EPA and DRBC play in ensuring upstream wastewater treatment facilities and collections systems are adequate to protect downstream water quality. PADEP issues and enforces NPDES permits for discharging facilities. DRBC requires an application from wastewater discharges in the Delaware River Basin to obtain an approved docket.

PADEP also addresses sewerage-related issues posing a threat to water quality through the Act 537 Program, and Chapter 94, *Municipal Wasteload Management*, Title 25 *Environmental Protection* of the Pennsylvania Code. Act 537 plan ages in the Schuylkill River watershed are detailed in Section 3.5.1.1 of this report. Chapter 94 requires owners of sewage facilities to plan, manage, and maintain sewage facilities in order to: anticipate and prevent overloading of a facility, limit additional connections to an overloaded facility, prevent the introduction of pollutants into the system that interfere with the treatment process or pass through a facility untreated, and improve reclamation and recycling of wastewaters and sludges. The PADEP reviews annual Chapter 94 reports from sewerage facilities and ensures there is adequate time to address operation and maintenance issues and plan for needed additions. Sewerage facilities that regularly experience hydraulic overloads are tracked, the causes assessed, and actions taken to resolve these issues.

PWD strongly values these enforcement efforts from EPA, PADEP and DRBC. These agencies are active leaders in the SAN, and PWD plans to continue working with government agencies and other organizations through the SAN to identify and address sources of pathogen contamination in the Schuylkill River watershed.

4.2.2 Stormwater Regulations

The Pennsylvania Stormwater Management Act of 1978 (PA Act 167) requires each county in Pennsylvania to adopt a stormwater management plan for each designated watershed within that county. The stormwater management plan provides a mechanism for municipalities within a watershed to plan for and manage expected increases in stormwater from increased development and land use change. The purpose of the stormwater management plan is not to address current flooding and stormwater issues, but to anticipate future issues and plan for proper management. Municipalities are then required to adopt ordinances to regulate future development consistent with the stormwater management plan.

The NPDES Municipal Separate Storm System (MS4) Regulations seek to prevent polluted stormwater runoff from entering municipal storm sewers and discharging to creeks without treatment. Operators of MS4s are required to obtain an NPDES permit and develop a stormwater management program to implement stormwater BMPs. The first phase, passed in 1990, required municipalities with populations of 100,000 or greater to obtain an NPDES permit for their stormwater outfalls. The second phase, passed in 1999, required small MS4s to obtain NPDES coverage for stormwater discharges.

PADEP and municipalities with MS4s participate in the SAN stormwater workgroup. The SAN allows PWD and these watershed stakeholders to share information and strategies for developing and implementing stormwater management strategies that protect downstream water quality and meet regulatory requirements.

4.2.3 Mining Reclamation

Abandoned mine drainage (AMD) impacts water quality in the Schuylkill River headwaters. The PADEP Bureau of Abandoned Mine Reclamation oversees the Abandoned Mine Reclamation Program in the state of Pennsylvania. The Bureau is responsible for addressing mine fires, mine subsidence, dangerous highwalls, open shafts and portals, mining-impacted water supplies and other hazards resulting from the historical coal mining practices in regions of Pennsylvania. PWD relies on PADEP's efforts in resolving abandoned mine drainage impacts on water supplies. Representatives from the Bureau of Abandoned Mine Reclamation participate in the SAN AMD workgroup. Through the SAN, PWD stays informed on AMD in the Schuylkill River watershed and can support projects addressing water quality issues.

4.2.4 Recreational Activities and Management

The Schuylkill River Heritage Area (SRHA) leads programs that promote recreation in the Schuylkill River watershed. The Schuylkill River received National Heritage Area designation from the U.S. congress in 2000 and Pennsylvania Heritage Area designation by the Department of Conservation and Natural Resources in 1995. National Heritage Areas, including the Schuylkill River Heritage Area, work to revitalize and restore the region through natural and cultural resource preservation, education, recreation, community revelation and heritage tourism. More information is available at schylkillriver.org. The SRHA is managed a by the nonprofit Schuylkill River Greenway Association. Recreation is also permitted in the Blue Marsh Reservoir. The Army corps of Engineers (ACE) manages the Blue Marsh Recreation Area. Although recreation is not a current SAN priority, both the SRHA and the ACE are represented in the network. The SRHA is an active leader in the SAN, and plays a critical role in administering the Schuylkill River Restoration Fund, detailed in Section 4.3.2. The SAN is in the process of completing a new five-year strategic plan for 2016-2020, and is exploring ways to formally incorporate recreational priorities and groups.

4.2.5 County Planning

The Pennsylvania Municipalities Planning Code gives municipalities and counties in Pennsylvania the authority to land planning in their locality. The Planning code gives options for creating a planning governing body and provides guidelines for planning, zoning, and land development. County planning commissions play a vital role in comprehensive county planning for counties in the Schuylkill River watershed. These responsibilities can include trail, park and open space planning; environmental

protection; community revitalization and economic development; transportation and corridor planning; subdivision and land development and zoning ordinance review under Act 247; sewerage facility changes and Act 537 plan review; mapping; and data analysis and dissemination. PWD works with many of the county planning commissions through the SAN workgroups.

4.2.6 Natural Resource Conservation

The county conservation districts have a vital role in the conservation of resources in the Schuylkill River watershed. The Pennsylvania conservation districts are supported by the State Conservation Commission, housed under the PA Department of Agriculture. Conservation districts provide programs for erosion and sediment control, watershed protection and nutrient management. Erosion and sediment controls are required under Title 25 Pa. Code Chapter 102. According to the State, Chapter 102 serves to protect surface waters of the Commonwealth through the utilization of Best Management Practices (BMPs) that minimize accelerated erosion and sedimentation during earth disturbance activities, and manage post construction stormwater runoff after earth disturbance activities. County conservation district watershed specialists provide watershed organizations with watershed assessment, technical assistance, procurement of funding and education and outreach to support restoring and protecting water resources. This can include streambank stabilization, invasive species removal and native landscaping. Nutrient management is required under Pennsylvania's Nutrient Management Act (Act 38). Agricultural operations that meet the animal population density threshold are required to develop and implement a Nutrient Management Plan. Farms with smaller animal populations are encouraged to voluntary adopt a plan. Nutrient Management Plans can improve water quality, reduce fertilizer cost, and improve animal health.

Conservation Districts have many more programs to support the conservation of natural resources. PWD works with a number of county conservation districts through the SAN particularly with the Berks County Conservation District addressing soil conservation and nutrient management and watershed protection on Berks County farms. For more information on support provided by the conservation districts in the Schuylkill River watershed visit the websites of Berks County Conservation District (berkscd.com), Montgomery County Conservation District (montgomeryconservation.org), Schuylkill Conservation District (schuylkillcd.org), Lehigh County Conservation District (lehighconservation.org), and Chester County Conservation District (chesco.org).

US Department of Agriculture Natural Resource Conservation Service (NRCS) also plays a crucial role in resource conservation. NRCS provides services including conservation and nutrient planning, technical services for the implementation of BMPs on agricultural properties, and procurement of federal funding and resources. NRCS is an active partner in the SAN Agriculture workgroup. Funding sources from the Environmental Quality Incentives Program (EQIP) and the Regional Conservation Partnership Program (RCPP) (Section 3.5.2) support projects in the Schuylkill River watershed. For more information on NRCS programs in Pennsylvania, visit www.nrcs.usda.gov/wps/portal/nrcs/site/pa/home.

4.2.7 Water Withdrawals

DRBC implements a water conservation program that manages water withdrawals in the Delaware River Basin. The program includes conservation policies to reduce water demand in the basin and requires

water purveyors with projects having a substantial effect on the water resources of the basin to submit a permit application to DRBC. For all withdrawals over 100,000 gallons per day, metering and reporting of withdrawals and implementation of a leak detection and repair system are required. The program sets conservation and performance standards for plumbing fixtures. It also requires permit applicants to submit a conservation plan.

4.2.8 Reservoir Management

The ACE operates Blue Marsh Reservoir and Dam, located on the Tulpehocken Creek, a tributary to the Schuylkill River upstream of Reading. Constructed between 1976 and 1979 and fully operational in October 1979, Blue Marsh Dam was authorized by Congress for flood control, water supply, water quality and recreation. DRBC maintains a water quality pool in Blue Marsh Reservoir and authorizes releases to maintain water quality downstream particularly during periods of low flow.

4.3 PWD Coordination for Watershed Management

After the initial SWA and SWPP, the PWD Source Water Protection Program has made significant progress towards addressing the objectives laid out in the SWPP. This section highlights major accomplishments of the Source Water Protection Program and management strategies in place to address *Cryptosporidium* and pathogens in the watershed.

4.3.1 Schuylkill Action Network

After the completion of the SWA, PWD recognized the need for watershed-wide efforts to improve and promote the health of the Schuylkill River watershed. The Schuylkill River has a diverse watershed affected by a range of pollution sources: abandoned mine drainage primarily in the headwaters, agricultural runoff in the central region, and urban stormwater runoff in the most populous region near Philadelphia and the confluence with the Delaware River. To transition from assessment to protection of the watershed, PADEP, EPA, PWD, DRBC and the Partnership for the Delaware Estuary (PDE) formed the SAN in 2003 with the intention of it becoming a permanent organization. The SAN is a watershed-wide organization with a mission to improve the water resources of the Schuylkill River watershed. Partners in the SAN include state agencies, local watershed organizations, land conservation organizations, businesses, academics, water suppliers, local and state governments, regional agencies, and the federal government. With the power to transcend regulatory and jurisdictional boundaries, the SAN implements protective measures throughout the Schuylkill River watershed.

SAN members are organized into of a number workgroups, and the organization is led by an Executive Steering Committee. The Executive Steering Committee provides feedback and direction for workgroups and ensures partners are in support of SAN projects. The Planning Committee supports the goals of the Executive Steering Committee leading strategy development and implementation, workshops, web services, communication and events. The Executive Steering Committee and Planning Committee are made up of members from EPA, PADEP, PWD, PDE, DRBC, and SRHA. The other workgroups directly address issues including abandoned mine drainage, agricultural runoff, stormwater, pathogens, land use, and education and outreach, and implement projects. SAN progress reports and detailed information on SAN projects, initiatives and upcoming events are available on the SAN website: schuylkillwaters.org.

PWD provides ongoing financial support for the SAN. PWD participates in many projects led by these workgroups, but because the Schuylkill River watershed is a diverse watershed affected by a range of pollution sources, PWD looks to the expertise of SAN partners to achieve certain watershed protection goals and WCP objectives. The SAN Agriculture and SAN Pathogens/Compliance Workgroups are particularly important to the WCP because they address potential sources of *Cryptosporidium* in the watershed. To further support this effort, PWD continues to contribute funding to the administration of SAN through a contract with PDE to support the SAN coordinator position and SAN workgroup leadership.

4.3.2 Schuylkill River Restoration Fund

The Schuylkill River Restoration Fund (SRRF), established in 2006, provides grants to support environmental projects that improve and protect water quality in the watershed. Initially, Exelon provided all funding for the projects. Beginning in 2010, PWD became the second annual contributor to the SRRF. PDE became a contributor in 2011, Aqua Pa followed in 2012, and MOM's Organic Market began contributing in 2014. Government agencies, non-profits, businesses and other organizations with projects ready for implementation apply to the SRRF and are responsible for project execution, monitoring and documentation. Members of the SAN serve as technical experts for grant recipient selection to ensure applicant projects will be beneficial to the Schuylkill River watershed. SRHA oversees the SRRF and distributes grant money. The SRHA encompasses the region of the Schuylkill River watershed, and is managed by a nonprofit, the Schuylkill River Greenway Association.

Since the SRRF was established, over $2 million has been collected and grants have been awarded to 62 projects. In 2011, Land Protection Transaction Grants were introduced as a part of the SRRF. This allows matching grants to be awarded up to $4,000 each for conservation easements or other land protection transactions. Grant recipients from the SRRF are selected by a committee comprised of representatives from Exelon, DRBC, PWD, EPA, DEP, PDE, SRHA and SAN. Projects address contamination from AMD, agriculture and stormwater runoff.

The SRRF is the mechanism through which PWD is able to contribute to projects that support WCP goals. PWD addresses *Cryptosporidium* in the watershed both by implementing Source Water Protection Program (SWPP) initiatives and WCP specific structural and non-structural control measures in the watershed. One of the WCP control measures includes supporting the installation of manure storage basins and vegetated buffers on farms throughout the Schuylkill River watershed. The SRRF receives a several applications each year for implementation of agricultural BMPs on farms. Typically, these applicants are seeking funding to match contributions from other watershed partners including NRCS, the conservation district, local municipalities and water suppliers, and watershed non-profit organizations.

4.3.3 Watershed Control Plan

In December 2011, PADEP approved PWD's WCP as a back-up credit towards compliance with LT2ESWTR. The WCP identifies potential and actual sources of *Cryptosporidium* in the designated area of influence, which includes the entire Schuylkill River upstream of Philadelphia. The WCP discusses the effectiveness and feasibility of various control measures, establishes a set of goals for implementation

and presents a quantitative assessment of the measures to be taken. The WCP focuses on three priority sources of *Cryptosporidium*- wastewater discharge and compliance, agricultural land use runoff, and animal vectors- and education and outreach. PWD addresses *Cryptosporidium* in the watershed both by implementing Source Water Protection Program initiatives and WCP specific structural and non-structural control measures in the watershed. Control measures implemented though the WCP program are described in Section 4.4.

Education and outreach to support the WCP is implemented through PWD's continued collaboration with the Partnership for the Delaware Estuary (PDE). Initiatives include engaging Philadelphia residents in the prevention of stormwater pollution to the Schuylkill and Delaware Rivers and facilitating coordinated action, communication and projects for the SAN. PDE coordinated the Philly's Best Friend Spokes Dog Competition to educate citizens on the importance of picking up pet waste. PDE also organizes an annual clean water art contest for Philadelphia students, and hosts the annual Coast Day at Penn's Landing in Philadelphia. Additionally, PDE aids coordination of the annual Schuylkill Scrub cleanup effort and collects photo entries for the Schuylkill Shots photo contest. In 2014, PDE and the SAN launched the Schuylkill Students Street Art Contest for which students designed an environmentally themed street art sticker. The winning stickers were installed on storm drains to educate the public on storm drain pollution.

4.3.4 Delaware Valley Early Warning System

The Delaware Valley Early Warning System (EWS) is designed to improve the safety of the drinking water supply by providing event notification to subscribers. The coverage area includes the Schuylkill and Delaware River watersheds from the Delaware Water Gap to Wilmington, Delaware. The user base forms the EWS partnership and is comprised of water suppliers, industries, PADEP, and other state and federal regulatory agencies. As of 2015, there are more than 300 users representing 50 organizations. Figure 4-1 shows a map of the industry and public water system subscribers.

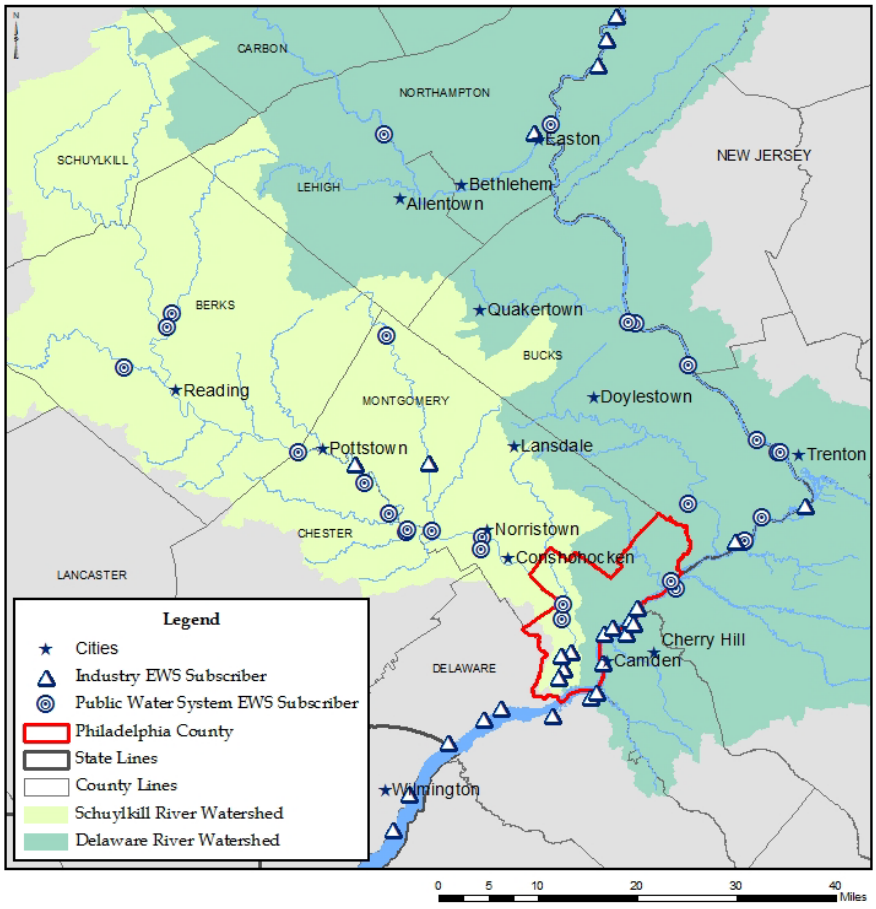


FIGURE 4-1: EARLY WARNING SYSTEM INDUSTRY AND PUBLIC WATER SYSTEM SUBSCRIBERS

The EPA and PADEP funded the project start up in 2002, and EWS went online in 2004. PWD as the technical host underwrites the costs of system enhancement and expansion as well as repairs and upgrades for the system components. A portion of the operations and maintenance costs is paid for by an annual subscriber fee that takes into consideration the annual average quantity of water withdrawn by each subscriber and the watershed drainage area upstream of their intake. EWS provides subscribers with an advanced communication tool that includes a notification system, time of travel model, Spill Model Analysis Tool, real-time water quality data and a central website where users can access event information, analysis tools and data. A Port Security Grant, awarded in 2011 from the Federal Emergency Management Agency (FEMA) through the Department of Homeland Security, provided funding for PWD to enhance and upgrade the EWS. Updated mapping tools were fully integrated into EWS in 2013 followed by the Tidal Spill Trajectory Tool in 2014.

Although the technical components of EWS allow subscribers to easily and rapidly communicate with upstream and downstream systems users, the EWS partnership makes the system invaluable. Only subscribers have access to the EWS. Subscribers know one another and are empowered to directly communicate during emergency events that affect more than one organization. The EWS Steering Committee, which oversees the development, enhancement, maintenance, and expansion of the

system, holds annual meetings where users can provide feedback on their experiences and meet face to face. As an integrated drinking water, wastewater and stormwater utility, PWD recognizes that accidents are inevitable. Some of these events, such as wastewater spills, sewerage line ruptures or discharges of wastewater bypassing treatment, have the potential to contain high levels of pathogens. Rapid communication and planning are critical for mitigating adverse effects. The confidence that emergency responders, regulators and dischargers have in reporting accidents to the system drives the success of EWS and provides a valuable watershed-wide partnership.

4.4 Recommended Control Measures

The WCP identified recommended control measures to address *Cryptosporidium* and pathogens in the watershed. The WCP control measures include supporting the installation of manure storage basins and vegetated buffers on ten farms throughout the Schuylkill River watershed, implementation of a Comprehensive Nutrient Management Plan at five farms, planting of a riparian buffer to deter animal vectors at a select site, and execution of waterfowl management program at priority locations in Philadelphia. Table 4-1 summarizes the WCP control measure project type, description and status for each year of the WCP. PWD completed the third year of implementation in December 2015. To date, PWD has tracked the installation of UV at the Upper Gwynedd and Fleetwood WWTPs, and supported watershed partners in the installation of six manure storage basins and implementation of seventeen CNMPs. Additionally, at Fairmount park properties and PWD facilities, animal vectors of *Cryptosporidium*, specifically geese, have been removed and goose eggs have been treated throughout each year of the WCP plan implementation. PWD is committed to implementation the remainder of the control measures outlined in the WCP during the next two years of the WCP implementation.

For the past decade, PWD has supported *Cryptosporidium* monitoring and source tracking research with Lehigh University. PWD and Lehigh University have monitored *Cryptosporidium* in streams in Philadelphia source watershed and studied the effects of wastewater discharges, agricultural land use and animal vectors on the presence of Cryptosporidium in the waterways and the associated and public health risk. Findings from this research have influenced the control measures selected in the WCP. For example, Lehigh University identified geese as vectors of *Cryptosporidium* in Philadelphia's source watershed. PWD will continue and expand this research project and use research findings to inform future watershed management strategies for migrating *Cryptosporidium* and pathogens.

TABLE 4-1: WCP PROJECT PROGRESS SUMMARY FROM 2014 WCP ANNUAL STATUS REPORT

	WCP PROJECT TYPE	PROJECT DESCRIPTION	PROJECT STATUS
2013	WWTP Upgrade	UV installation at Upper Gwynedd WWTP	Fully Operational
	WWTP Upgrade	UV installation at Fleetwood WWTP	Fully Operational
	Farm BMP	Manure storage basin at Havens Farm	Complete
	Farm BMP	Manure storage basin at Leid Farm	Complete
	Nutrient Management Plans	4 Comprehensive Nutrient Management Plans	Complete
	Riparian Buffer Planting	--	--
	Waterfowl management	Geese removed and eggs treated at Fairmount Park properties and PWD facilities 2013	Complete/Ongoing
2014	Farm BMP	Manure storage basin at Martin Farm	Complete
	Farm BMP	Manure storage basin at A. Zimmerman Farm	Under Construction
	Nutrient Management Plans	1 Comprehensive Nutrient Management Plan	Complete
	Riparian Buffer Planting	--	--
	Waterfowl management	Geese removed and eggs treated at Fairmount Park properties and PWD facilities 2014	Complete/Ongoing
2015	Farm BMP	Manure storage at Donald Rice Farm	Scheduled for Spring 2016
	Farm BMP	Manure storage at Dalton Biehl	Under Construction
	Nutrient Management Plans	12 Comprehensive Nutrient Management Plans	Complete
	Riparian Buffer Planting	--	--
	Waterfowl management	Geese removed and eggs treated at Fairmount Park properties and PWD facilities 2014	Complete/Ongoing
2016	Farm BMP		
	Farm BMP		
	Nutrient Management Plans		
	Riparian Buffer Planting		
	Waterfowl management		
2017	Farm BMP		
	Farm BMP		
	Nutrient Management Plans		
	Riparian Buffer Planting		
	Waterfowl management		

WCP Completion Requirement Check	WWTP Upgrades	Track UV Installation at 2 plants
	Farm BMPs	Manure storage basins -5
		Vegetated buffers - 5
	Nutrient Management Plans	Nutrient Management Plans -5
	Riparian Buffer Planting	Sites - 1
	Waterfowl management	Years - 5

Section 5. Water Quality Compliance

A discussion of the water quality at the water supply system intake is the fourth component of a watershed sanitary survey as described in the 1993 Watershed Sanitary Survey Guidance Manual from the AWWA Nevada-California Section. This section briefly summarizes drinking water regulations and Philadelphia's source water quality pertaining to microbial contaminants, and describes PWD's ability to meet these compliance obligations.

5.1 Drinking Water Regulations

The objective of the Safe Drinking Water Act (SDWA), originally passed by congress in 1974, is to protect public health by regulating the national water supply. The SDWA establishes national health-based drinking water contaminant levels to protect against natural and anthropogenic water contaminants that pose risks to public health. The SDWA was amended in 1986 and 1996 to extend protective barriers outside of treated drinking water to include source water protection, treatment plant operator training, funding for water system improvements, and customer information requirements. The Commonwealth of Pennsylvania, through PADEP, has the authority to enforce the SDWA within Pennsylvania. PADEP is also authorized to promulgate and enforce more stringent drinking water standards than the SDWA. This section describes PWD regulatory obligations and compliance under the SDWA pertaining to microbial contaminants and risks.

5.1.1 Surface Water Treatment Rules

5.1.1.1 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated by the EPA in 1989 and effective December 1990 with the objective of further protecting public health from microbial contaminants such as viruses, *Legionella* bacteria, and *Giardia*. The rule sets a maximum contaminant level goal (MCLG) of zero for *Legionella*, *Giardia*, and viruses.

Prior amendments to the SDWA in 1986 allowed for the establishment of treatment technique (TT) requirements when it is not feasible to measure biological contaminants, which the SWTR applied to turbidity. The turbidity MCL of 1 NTU at the point in the system after treatment and before the distribution system in the 1976 SDWA was removed and replaced with a TT requirement for 3 log (99.9%) and 4 log (99.99%) removal/inactivation of *Giardia* and viruses, respectively. The SWTR specified a disinfection residual of greater than or equal to 0.2 mg/L after treatment.

In 1989 the PADEP made treatment turbidity regulations more stringent than that of the EPA, where the number of combined filter effluent (CFE) samples greater than 0.5 NTU cannot exceed 5% of all monthly samples and at no time can exceed 2 NTU. Under the SWTR, a heterotrophic plate count must be taken when chlorine residual is less than 0.02 mg/L (non-detection).

5.1.1.2 Interim Enhanced Surface Water Treatment Rule

The Interim Enhanced Surface Water Treatment Rule (IESWTR) was promulgated by the EPA in December 1998, and went into effect in January 2002. The IESWTR builds on the SWTR TT approach by creating more stringent CFE turbidity standards and establishing a new individual filter effluent (IFE) turbidity monitoring requirement to address *Cryptosporidium*. The IESWTR reduces the CFE turbidity standard to 0.3 NTU in 95% of samples taken at least once every 4 hours, with no single sample exceeding 1 NTU. Recognizing that the CFE may mask the performance of an individual filter, a maximum IFE turbidity of 0.5 NTU was established. The IFEs require continuous monitoring in 15 minute intervals with no two consecutive measurements exceeding 0.5 NTU, with the exception of the first 4 hours returning to service. The turbidity standards enacted through IESWTR assure that conventional filtration systems will be able to provide 2-log (99%) *Cryptosporidium* removal.

5.1.1.3 Long-Term 2 Enhanced Surface Water Treatment Rule

In January 2006 the first regulation based on source water quality, the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), was promulgated by EPA and made effective on March 2006. LT2ESWTR requires public water systems with surface water sources or groundwater sources influenced by surface water to monitor for *Cryptosporidium* at all intakes for two years. The results of the monitoring period categorize the public water system into one of four 'Bins.' PWD Belmont and Baxter WTPs were categorized into Bin 1, and Queen Lane was categorized into Bin 2. LT2ESWTR Bin classifications are detailed in Section 1.1 of this report.

To meet LT2ESWTR requirements based on Bin status, PWD achieved the additional 1-log removal credit by meeting CFE and IFE turbidity TT at the Queen Lane WTP for 0.5-log credit each. The CFE 0.5-log credit is earned through achieving turbidity less than or equal to 0.15 NTU in at least 95% of CFE samples taken every 4 hours at the Queen Lane WTP. To achieve the IFE 0.5-log credit, turbidity must be less than 0.15 NTU in at least 95% of monthly individual filter samples taken continuously in 15 minute intervals, excluding a 15 minute period after filter backwash. No IFE can have a measured turbidity greater than 0.3 NTU in two consecutive measurements taken 15 minutes apart. PWD meets these requirements for Queen Lane at all three WTPs. PWD receives 0.5-log back up credits for development and implementation of its WCP. PWD Source Water Protection Program is responsible for carrying out the watershed protection efforts detailed in the Watershed Control Plan.

5.1.2 Total Coliform Rule

The Total Coliform Rule (TCR) of 1989, made effective in December 1990, established a maximum contaminant level (MCL) based on the presence or absence of total coliform in the distribution system. Under this rule no more than 5% of monthly samples may test positive and all positive routine samples require the collection and analysis of at least three follow up or "repeat" samples. One repeat sample must be collected from the same location as the positive routine sample, one must be taken within five service connections upstream and one within five service connections downstream of the original location. A total coliform positive repeat sample will also trigger another set of repeat samples as previously described.

Routine or repeat samples that test positive for total coliform must be analyzed further for fecal coliform or *E. coli*. A monthly MCL violation occurs when more than 5% of both routine and repeat samples in the same calendar month test positive for total coliform. An acute MCL violation occurs if a routine sample tests positive for fecal coliform or *E. coli* and one of the required repeat samples tests positive for total coliform, or when a repeat sample tests positive for either fecal coliform or E. coli.

Under the TCR, PWD is required to obtain 360 samples from the distribution system per month, not including repeat samples. PWD collects approximately 500 samples per month from 74 sampling locations throughout the distribution system.

PWD is in compliance with the TCR, distribution system water quality samples are an order of magnitude below the MCL of 5% positive coliform detections. At the time of this draft, the TCR is being revised by PADEP. However, the 1989 TCR will remain in effect through March 2016.

5.2 Existing Water Quality

The EPA uses several indicators for the presence of microbial contaminants including fecal coliform, *E. coli*, and turbidity. This section provides a brief summary of these parameters in PWD water supply for a 10-year period. Figure 5-1 shows the legend for the boxplots presented later in this section, as they deviate from the standard boxplot format. For each year, a bold line represents the median, upper and lower limits of the box represents the 25th and 75th percentile, the upper and lower whiskers represent the 5th and 95th percentile and circles represents the outliers, which are data points below the 5th percentile or above the 95th percentile.

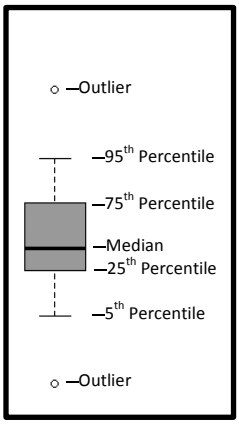


FIGURE 5-1: LEGEND FOR BOXPLOT FIGURES

5.2.1 Fecal Coliform and *E. coli*

The EPA uses several indicators for the presence of microbial contaminants including fecal coliforms and *E. Coli*. The presence of fecal coliform and *E. Coli* indicate the water may be contaminated with human or animal waste containing microbial organisms such as bacteria, viruses and protozoans that may cause gastrointestinal illness, and pose significant health risks for young children and immune-compromised individuals.

The national drinking water standard goal for fecal coliform and *E. coli* in any drinking water sample is zero. This is typically achieved through the conventional drinking water treatment process. Further requirements for the testing of fecal coliforms and *E. coli* in drinking water samples is specified under the Total Coliform Rule detailed in Section 5.1.2. PA Code Chapter 93 regulates fecal coliforms as total coliforms. *E. coli* is not regulated under the PA Code Chapter 93 described in Section 4.2.1.

Summary statistics for a 10-year period of fecal coliforms and *E. coli* at Queen Lane WTP intake are presented in Table 5-1 and

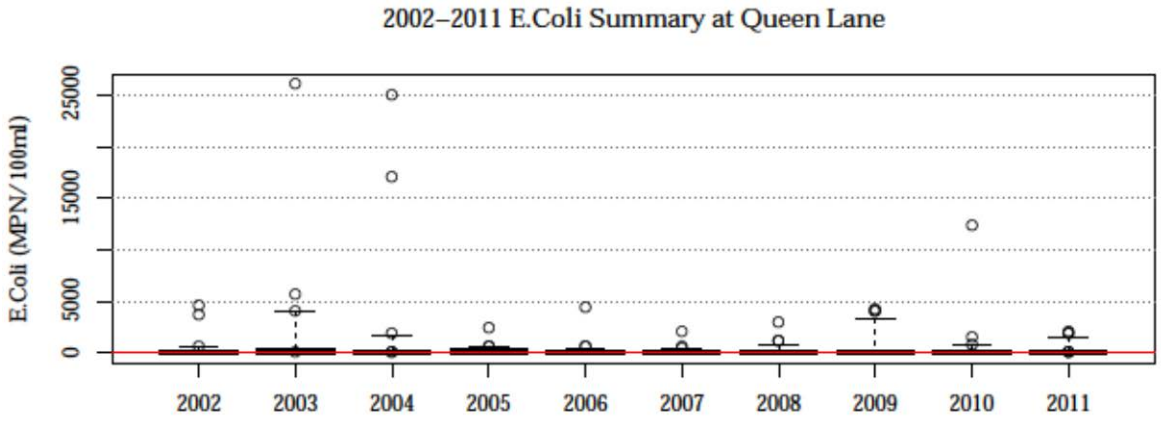


Figure 5-3: 10- Box plot summary of *E. coli* concentration at Queen Lane WTP Intake

The median concentration of fecal coliforms measured between 2002 and 2011 was 150 fecal coliforms per 100 ml at Queen Lane WTP intake. The concentration of fecal coliforms ranged from a minimum of less than 10 to a maximum of 57,000 fecal coliforms per 100 ml. The annual median concentration of E. coli measured from 2002 to 2011 was 110 per 100 ml (in MPN/100ml). The concentration of E. coli ranged from a minimum of less than 10 to a maximum of 26,000 E. coli /100 ml. This ranges of both fecal coliforms and E. coli detected span several orders of magnitude, which can be attributed to higher levels of bacteria in the rivers during rainfall events..

TABLE 5-1: 10-YEAR SUMMARY OF RAW WATER FECAL COLIFORM CONCENTRATION AT QUEEN LANE WTP

QUEEN LANE WTP INTAKE: FECAL COLIFORM (#/100 ML)				
DATE RANGE	**MIN**	**MAX**	**MEDIAN**	**# SAMPLES**
2002-2011	<10	57000	150	512

TABLE 5-2: 10-YEAR SUMMARY OF RAW WATER FECAL COLIFORM CONCENTRATION AT QUEEN LANE WTP

QUEEN LANE WTP INTAKE: E. COLI (MPN/100 ML)				
DATE RANGE	**MIN**	**MAX**	**MEDIAN**	**# SAMPLES**
2002-2011	<10	26000	110	516

Boxplot summaries of fecal coliform of *E. coli* for the same time period at Queen Lane WTP intake are presented in Figure 5-2 and Figure 5-3. The period between 2002 and 2011 was selected for this summary analysis due to a change in maximum reporting limit for *E. coli* in 2012.

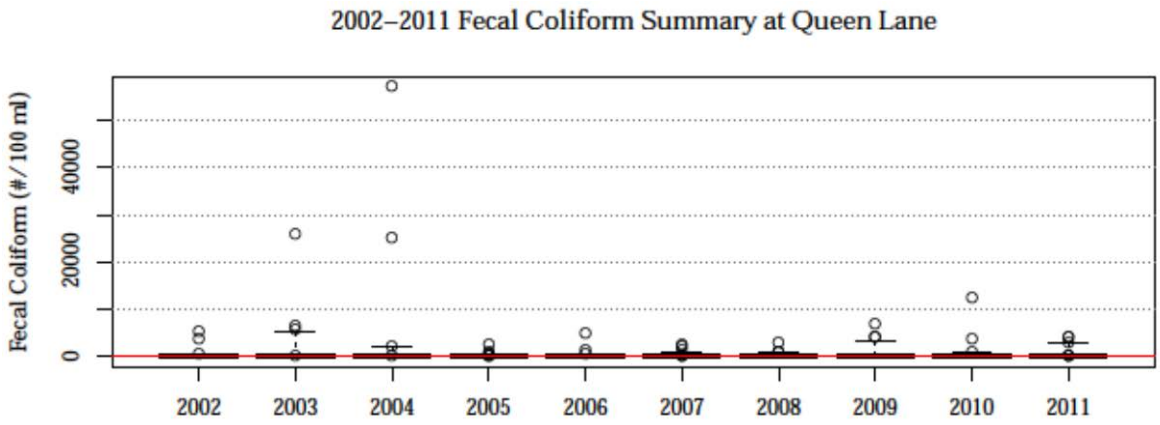


FIGURE 5-2: BOX PLOT SUMMARY OF FECAL COLIFORM LOAD AT QUEEN LANE WTP INTAKE

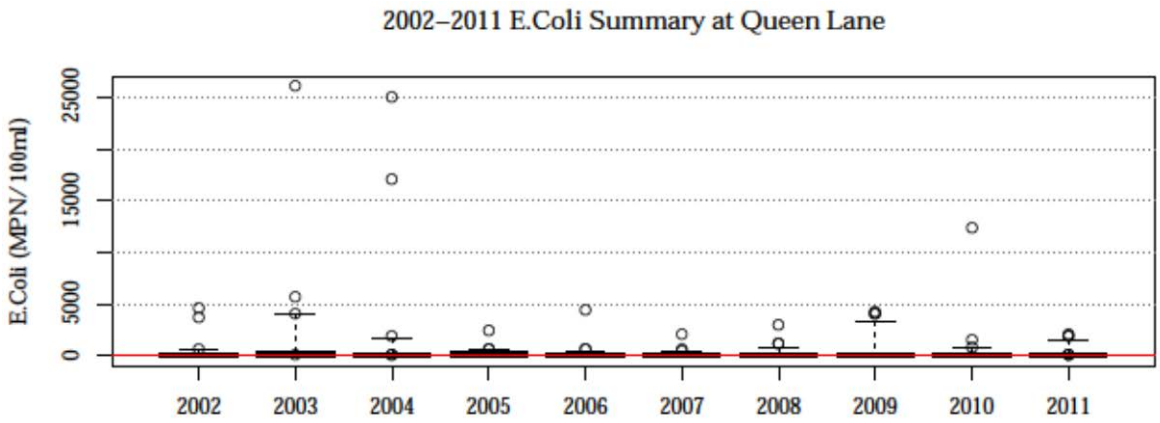


FIGURE 5-3: 10- BOX PLOT SUMMARY OF *E. COLI* CONCENTRATION AT QUEEN LANE WTP INTAKE

The median concentration of fecal coliforms measured between 2002 and 2011 was 150 fecal coliforms per 100 ml at Queen Lane WTP intake. The concentration of fecal coliforms ranged from a minimum of less than 10 to a maximum of 57,000 fecal coliforms per 100 ml. The annual median concentration of E. coli measured from 2002 to 2011 was 110 per 100 ml (in MPN/100ml). The concentration of E. coli ranged from a minimum of less than 10 to a maximum of 26,000 E. coli /100 ml. This ranges of both fecal coliforms and E. coli detected span several orders of magnitude, which can be attributed to higher levels of bacteria in the rivers during rainfall events.

5.2.2 Turbidity

Turbidity is a measure of the light that penetrates a sample of water and therefore is an indicator of the presence of light blocking fine particles. Turbidity is caused by runoff from roads, construction, erosion and agriculture and increases significantly during rainfall events. The particles that increase turbidity in water provide a growth site for bacteria and other microbial pathogens including *Giardia* and

Cryptosporidium. Turbidity can also interfere with the disinfection process important for eliminating illness-causing microbial contaminants.

Table 5-3 summarizes the turbidity measured in samples collected at Queen Lane intake from 2005 to 2014, and Figure 5-4 shows a box plot summary of the turbidity each year at Queen Lane. The median level of turbidity in the raw water at Queen Lane during this 10-year period was 3.3 NTU. The maximum measurement of turbidity was 147 NTU at Queen Lane intake, approximately two orders of magnitude larger than the medians. This observation was also made in the 2002 Source Water Assessment and attributed to the dramatic increase in turbidity during rain events. Turbidity is regulated under the SWTR and is used as a performance measurement at Queen Lane WTP under LT2ESWTR. These rules are further detailed in Section 5.1.1.

TABLE 5-3: 10-YEAR SUMMARY OF RAW WATER TURBIDITY AT QUEEN WTPS

QUEEN LANE WTP INTAKE: TURBIDITY (NTU)					
DATE RANGE	MEAN	MIN	MAX	MEDIAN	# SAMPLES
2005-2014	7.3	0.9	147.0	3.3	562

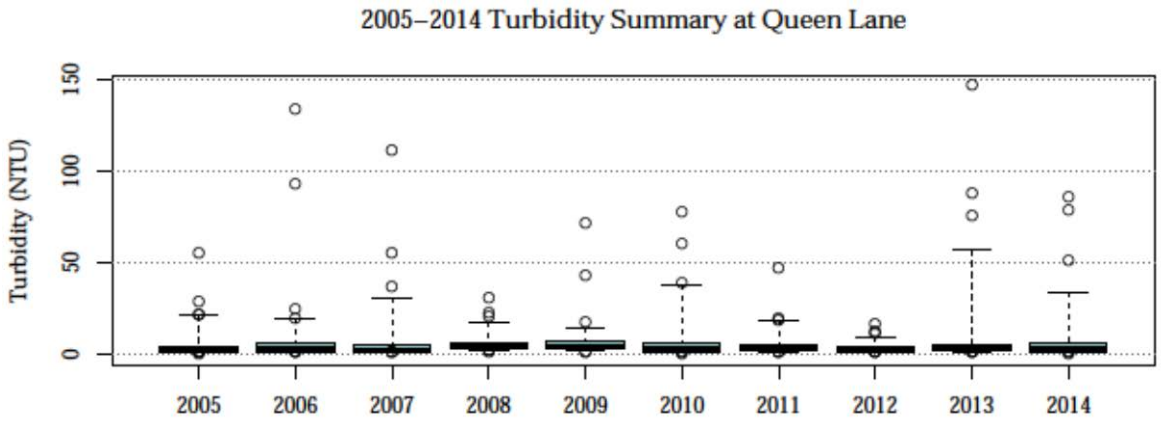


FIGURE 5-4: BOX PLOT SUMMARY OF TURBIDITY AT QUEEN LANE WTP INTAKE

5.3 Evaluation of Ability to Meet Drinking Water Regulations

PWD is committed to maintaining the highest possible drinking water quality. To reduce the risk of illness from microbial contamination, PWD maintains treated drinking water turbidity levels that exceed federal and state standards and has received the 10 Year Director's Award from the Partnership for Safe Water. PWD communicates information on drinking water quality to its customers through the Annual Water Quality Report.

5.3.1 Partnership for Safe Water

PWD has been a member of the Partnership for Safe Water (PSW) Treatment Optimization Program for more than 15 years. On January 2, 1996, PWD signed the Partnership Agreement with EPA to show commitment to the PSW Treatment Optimization Program. Through voluntary program participation, PWD works to further reduce the potential health risks from *Cryptosporidium*, *Giardia*, and other microbial contaminants by assessing and continuously improving treatment plant filtration performance.

PWD signed a similar agreement with the Pennsylvania Department of Environmental Protection (PADEP) in July of 1998 to show commitment to achieving and maintaining the highest possible drinking water quality.

Phase I of the Treatment Optimization Program was completed in 1996, with the signing of the PSW Participation Agreement. In 1998, PWD submitted baseline turbidity data for Phase II, and established a Steering Committee and Partnership Task Force to guide the self-assessment process. Inspection and evaluation teams visited each WTP and wrote a detailed report provided to the plant manager. A workshop was held on October 29, 1996 to review and prioritize potential and actual limiting factors cited by the inspection and evaluation teams. The final Phase III Self-Assessment report of the Queen Lane, Baxter, and Belmont WTPs was submitted to PSW in September 1998.

Since 1998, PWD average finished water turbidity has been at or below 0.06 NTU. PWD received the EPA Director's Award in 1999 for the completion of the Phase III self-assessment. In 2008, the Baxter, Queen Lane, and Belmont WTPs were honored by the EPA and PADEP with the 10 Year Director's Award for achieving and maintaining turbidity levels less than 0.1 NTU for ten years.

5.3.2 LT2ESWTR Removal Credits

As a result of LT2ESWTR Round 1 sampling, Queen Lane received a Bin 2 classification as explained in Section 1.1. Since Queen Lane uses conventional treatment processes, and automatically receives a 3-log removal credit, an additional 1-log removal credit is required. PWD achieved the additional 1-log removal credit by meeting CFE and IFE turbidity TT at the Queen Lane WTP for 0.5-log credit each, detailed in section 5.1.1.3. Queen Lane WTP was required to comply with these requirements beginning April 1, 2012. Two violations occurred within the first two months. In both situations, the turbidimeter was not properly set to taking readings. PADEP was notified, and Queen Lane has been in full compliance since that time.

5.3.3 Annual Water Quality Report

Every year, the Philadelphia Water Department distributes the annual Drinking Water Quality Report to all customers. This is required of all water utilities by the Federal Safe Drinking Water Act, and it provides the customer with information on the quality of their drinking water. The EPA requires certain fundamental information to be in this report. It must include the source of the drinking water, the susceptibility to contamination of that source, the level of contaminants in the drinking water and the EPA health standards for comparison, the likely source of contaminants, the potential health effects of any violations and the system's actions to restore safe drinking water, a message to vulnerable populations on avoiding *Cryptosporidium*, education information on nitrate, arsenic and lead if a concern to the system, and additional sources of information. Water systems may also enhance their reports with consumers with other additional information pertaining to their drinking water.

Although extensive information about PWD's source water protection efforts is available to the public online and through reports posted on the website, for the customer not actively seeking information about their drinking water, PWD provides source water protection information straight to the customers through the annual drinking water quality report. The most recent report, published in 2015 shares

information on the Schuylkill and Delaware River Source Water Protection Plans, pharmaceuticals, source tracking of *Cryptosporidium,* and the Partnership for Safe Water. The report also includes locations of where to find additional information on the issues covered. Although the EPA does not require such a breadth of information on source water protection to be in the annual water quality report, PWD takes a proactive approach to customer education.

5.4 Recommended Water Quality Monitoring Program

The PWD Bureau of Laboratory Services (BLS) is a state-of-the-art laboratory that performs a variety of water quality analyses on samples collected from the water supply, drinking water treatment plants, distribution system and wastewater treatment plants. BLS is comprised of several specialized laboratories including the:

- Organics Laboratory – analyzes for different classes of organic compounds
- Inorganics Laboratory – analyzes for a full suite of general water quality parameters, trace metals and nutrients
- Aquatic Biology Laboratory – expertise in microbiology, biology, and algae
- Materials Engineering Laboratory and Materials Analysis Section – expertise in performing quality testing of materials comprising PWD infrastructure
- Quality Assurance Unit - ensures the proper execution of analytical methods and accuracy of results
- Watershed Team – responds to fish kills and conducts evaluations of the water quality and ecological conditions in the watershed
- Cross Connection Control Program – responds to potential contamination associated with cross connections and maintains records and back flow protections

BLS has extensive knowledge in water quality monitoring. Recommended monitoring projects from all divisions of PWD can be implemented through BLS.

Additionally, PWD maintains contracts with local universities for additional water quality monitoring and method development. For a decade, Lehigh University has been contracted by PWD to support continuing research to better understand the occurrence, sources and vectors of *Cryptosporidium* in Philadelphia's source water. Sampling programs are designed to answer research questions and improve and expand methods for field sample collection and laboratory analysis of *Cryptosporidium*. In 2015, PWD expended the research project to the Schuylkill River watershed. PWD and Lehigh University are partnering with upstream water suppliers to look at genotypes of *Cryptosporidium* oocysts detected at locations in Berks, Montgomery and Philadelphia counties. The project will also document watershed conditions including rainfall, streamflow, and WWTP flow and overflow events as available to correlate with *Cryptosporidium* sample results. Additionally, PWD has a contract with Temple University to identify compounds that can be used as wastewater tracers in streams to better understand sources of wastewater discharges in Philadelphia's source watershed. Contracts with universities allow PWD to remain at the forefront of water quality issues and develop laboratory methods that can later be adopted by BLS.

Section 6. Conclusion and Recommendations

Priority sources of *Cryptosporidium* and pathogens in the Schuylkill River watershed upstream of Philadelphia were identified in the WCP. For the 2015 WSS, PWD compiled updated data from a number of publically available data sources on WWTPs, CSOs, wildcat sewers, sewerage planning, agricultural land cover, and livestock populations. Through the SAN, PWD collects additional detailed data on priority sources outside PWD jurisdiction including changes in WWTP flows and system upgrades. After review of the data collected for the 2015 WS, PWD believes wastewater discharges, runoff from agricultural land and wildlife continue to be priority sources.

The first priority source is discharges from WWTPs. There are 152 WWTP discharging 109 MGD to the Schuylkill River watershed upstream of Philadelphia. Of these, at least 33 WWTPs discharging a total of 27.8 MGD use UV disinfection. Although PWD does not have jurisdiction over upstream WWTPs, PWD will continue to track changes flow and treatment technology of upstream dischargers in partnership with the SAN pathogens workgroup. CSOs, wildcat sewers and discharge to septic system may also contribute Cryptosporidium and pathogens to the watershed. However, with limited data, there is much great uncertainty associated with these sources.

The second priority source is runoff from agricultural land use. The Schuylkill River watershed is 28% agricultural land cover. Although this is a slight decrease since 2001, there was an approximately 12% and 111% increase in livestock population in cows and horses, respectively. PWD will continue to prioritize agricultural BMP projects that manage stormwater and reduce pathogens and other contaminants from entering the waterways by leveraging funding with watershed partners through the SRRF. Additional, designated funding in the watershed from the DRWI and the NRCS-RCPP is also expected to increase support and implementation of agricultural BMPs.

The third priority source is from wildlife. PWD identified geese as mechanical vectors of *Cryptosporidium* in a source tracking study with Lehigh University. Although watershed-specific data is not available to track changes in geese populations, PWD manages populations at priority areas in the city and communicates the importance of managing geese populations in drinking water supply areas to protect water quality.

Two years remain in the current WCP. After completion of the first WSS, PWD recommends continuing the following:

- Taking a partnership approach to achieve WCP goals. The Schuylkill Action Network will continue to act as the forum for watershed partners to discuss, promote, and achieve a variety of source water protection related goals.
- Utilizing the SAN Pathogens workgroup as a forum for tracking changes and upgrades in WWTP discharges upstream of Philadelphia
- Contributing funding to the SRRF to implement WCP control measures including agricultural BMPs on farms

- Working with Lehigh University to identify sources of *Cryptosporidium* and correlate watershed data with research sample results

PWD makes the following new recommendations:

- Track availability of updates for publically available data sources used in source water protection planning, particularly as it pertains to regulatory reporting timelines

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Appendix

TABLE A-1: LIST OF WWTP FACILITIES IN SCHUYLKILL RIVER WATERSHED

FACILITY	PERMIT #	COUNTY	SUB-WATERSHED	AVERAGE FLOW (MGD), SOURCE		PERMITTED FLOW (MGD), SOURCE	
Maidencreek Twp. STP	PA0070271	Berks	Allegheny Creek	0.5060	1	0.8000	1
Chapman, Dave	PA0051951	Chester	French Creek	0.0002	*	0.0004	3
Coaldale-Lansford-Summit Hill	PA0026476	Schuylkill	Little Schuylkill	1.7620	1	1.6500	3
Jones Grille (formerly White Diner)	PA0060739	Schuylkill	Little Schuylkill	0.0020	*	0.0040	3
Marian High School	PA0061310	Schuylkill	Little Schuylkill	0.0179	*	0.0350	3
New Ringgold, Borough of, Wastewater Treatment Facility	PA0064157	Schuylkill	Little Schuylkill	0.0140	1	0.0400	3
Northeastern Schuylkill JMA	PA0063878	Schuylkill	Little Schuylkill	0.1068	1	0.2450	3
Tamaqua Borough Auth. STP	PA0027006	Schuylkill	Little Schuylkill	1.7200	1	2.6000	3
Conshohocken Boro Auth	PA0026794	Montgomery	Lower Schuylkill	1.1000	1	2.3000	1
Mayall SRSTP	PAG040195	Montgomery	Lower Schuylkill	0.0002	*	0.0004	3
Whitemarsh Twp Auth	PA0026298	Montgomery	Lower Schuylkill	1.1280	1	4.0000	1
Wulff SRSTP	PAG040192	Montgomery	Lower Schuylkill	0.0002	*	0.0004	3
Adams, James and Sandra	PAG043839	Berks	Maiden Creek	0.0002	*	0.0004	3
Christman, Dennis	PA0088021	Berks	Maiden Creek	0.0031	2	0.7850	3
Fleetwood Borough STP	PA0021636	Berks	Maiden Creek	0.3523	1	0.7000	1
Karol K Schmick	PA0065234	Lehigh	Maiden Creek	0.0003	*	0.0005	3
Kutztown Borough STP	PA0031135	Berks	Maiden Creek	0.7790	1	1.5000	1
LCA-Arcadia West	PA0064149	Lehigh	Maiden Creek	0.0136	1	0.0400	3
Lenhartsville Boro	PA0246921	Berks	Maiden Creek	0.0139	1	0.0508	1
Lynn Twp (STP or MA)	PA0070254	Lehigh	Maiden Creek	0.0630	1	0.1600	3
Lyons Boro Mun Auth	PA0085171	Berks	Maiden Creek	0.1580	1	0.3000	1
Maxatawny Twp Mun Auth WWTP	PA0260151	Berks	Maiden Creek	0.0370	1	0.1400	1
Richmond Township - Virginville WWTP	PA0260975	Berks	Maiden Creek	0.0118	*	0.0230	3
SFS Adams, James & Sandra	PAG043839	Berks	Maiden Creek	0.0002	*	0.0004	3
SFS Bunner, Linda & Robert Michael	PAG043512	Berks	Maiden Creek	0.0002	*	0.0004	3
Berks-Montgomery Morysville STP	PA0023540	Berks	Manatawny Creek	0.2050	1	0.3800	1
Oley Twp. STP	PA0024961	Berks	Manatawny Creek	0.1760	1	0.4000	1
Ruscombmanor Twp WWTP	PA0085782	Berks	Manatawny Creek	0.0135	1	0.0700	1
SFS Shaner, Anna & Scott	PA0261858	Berks	Manatawny Creek	0.0002	*	0.0004	3
Brandywine Realty Trust	PA0058467	Montgomery	Middle Schuylkill 1	0.0009	*	0.0018	3
Bridgeport Borough STP	PA0020397	Montgomery	Middle Schuylkill 1	0.5030	1	0.9000	1
E. Norriton-Plymouth Joint Auth.	PA0026816	Montgomery	Middle Schuylkill 1	5.1300	1	8.1000	1
Freedom's Foundation at Valley Forge	PA0050482	Chester	Middle Schuylkill 1	0.0020	2	0.0189	3
Norristown Mun Waste	PA0027421	Montgomery	Middle Schuylkill 1	4.8400	1	9.7500	1
Paul, Peter	PA 0054771	Montgomery	Middle Schuylkill 1	0.0002	*	0.0004	3

U Merion Mun Utility Auth - Matsunk WPCC	PA0026085	Montgomery	Middle Schuylkill 1	3.0500	1	5.5000	1
U Merion Mun Utility Auth - Trout Run	PA0026131	Montgomery	Middle Schuylkill 1	2.2600	1	6.0000	1
Valley Forge Sewer Auth	PA0043974	Chester	Middle Schuylkill 1	6.0860	1	9.2000	1
Amity Twp STP	PA0070351	Berks	Middle Schuylkill 2	0.8970	1	2.2000	1
E Vincent Twp Mun Auth	PA0050466	Chester	Middle Schuylkill 2	0.1570	1	0.5000	1
Eves, Barry & Kristen	PA0056511	Montgomery	Middle Schuylkill 2	0.0002	*	0.0004	3
Limerick Twp Mun Auth - King Road	PA0051934	Montgomery	Middle Schuylkill 2	0.7560	1	1.7000	1
Limerick Twp Mun Auth - Possum Hollow Run	PA0058041	Montgomery	Middle Schuylkill 2	0.2160	1	0.7000	1
N Coventry Mun Auth	PA0025437	Chester	Middle Schuylkill 2	0.7450	1	2.0100	1
Phoexnixville Boro STP	PA0027154	Chester	Middle Schuylkill 2	1.5020	1	4.0000	1
Pottstown Boro Auth	PA0026786	Montgomery	Middle Schuylkill 2	5.0910	1	12.8500	1
Royersford Boro	PA0021512	Montgomery	Middle Schuylkill 2	0.4630	1	0.7000	1
SFS Moyer, Debra	PAG043538	Berks	Middle Schuylkill 2	0.0002	*	0.0004	3
Slawecki SRSTP	PAG040197	Montgomery	Middle Schuylkill 2	0.0003	*	0.0005	3
Spring City Boro	PA0028614	Chester	Middle Schuylkill 2	0.3570	1	0.3450	1
Alsace TWP - Alsace Manor STP	PA0246956	Berks	Middle Schuylkill 3	0.0225	1	0.0710	1
Antietem Valley Mun. Auth.	PA0026646	Berks	Middle Schuylkill 3	0.8685	1	1.2250	1
Berks County - Berks Co WWTP	PA0033995	Berks	Middle Schuylkill 3	0.2640	1	0.5000	1
Birdsboro Borough STP	PA0021709	Berks	Middle Schuylkill 3	0.4400	1	1.3500	1
Daniel Boone Homestead	PA0051641	Berks	Middle Schuylkill 3	0.0030	2	0.0080	3
Exeter Twp. STP	PA0026972	Berks	Middle Schuylkill 3	3.0770	1	7.1000	1
Reading Regional Airport Auth STP	PA0028720	Berks	Middle Schuylkill 3	0.1015	1	0.4200	1
Reading, City of STP	PA0026549	Berks	Middle Schuylkill 3	13.8370	1	28.5000	1
Robeson Twp. STP	PA0051900	Berks	Middle Schuylkill 3	0.1200	1	0.3000	1
SFS Heist, Robert	PAG043650	Berks	Middle Schuylkill 3	0.0003	*	0.0005	3
SFS Rotskiske, Walter & Nancy	PAG043931	Berks	Middle Schuylkill 3	0.0002	*	0.0004	3
Spring Twp. STP	PA0043052	Berks	Middle Schuylkill 3	1.0460	1	1.2800	1
Wyomissing Valley STP	PA0026638	Berks	Middle Schuylkill 3	2.4895	1	4.0000	1
Neighborhood Homeowners Assoc.	PAG043918	Berks	Monocacy Creek	0.0010	*	0.0020	3
PA Historical & Museum Comm	PAG053543	Berks	Monocacy Creek	0.0041	*	0.0080	3
SFS Souder, Michael (formerly Templin)	PAG043614	Berks	Monocacy Creek	0.0003	*	0.0005	3
SFS McGee, Kevin	PA0261866	Berks	Monocacy Creek	0.0002	*	0.0004	3
SFS Straka Terri	PA0261840	Berks	Monocacy Creek	0.0002	*	0.0004	3
Alpha SFSTP	PA0244350	Bucks	Perkiomen Creek	0.0002	*	0.0004	3
Amarnek SRSTP	PAG040128	Montgomery	Perkiomen Creek	0.0003	*	0.0005	3
Bally Borough STP	PA0022543	Berks	Perkiomen Creek	0.2530	1	0.5000	1
Berks-Mont. M.A. West Swamp Creek	PA0024180	Montgomery	Perkiomen Creek	1.4030	1	2.3000	1
Blair Residence	PAG040167	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Boyertown Boro	PA0024376	Berks	Perkiomen Creek	0.4083	1	0.7500	1
Candlewyck Estates Homeowners	PA0057673	Montgomery	Perkiomen Creek	0.0008	*	0.0016	3
E Rockhill Twp	PA0056847	Bucks	Perkiomen Creek	0.0746	1	0.1130	1
Eastman, Roger	PA0058823	Montgomery	Perkiomen Creek	0.0003	*	0.0005	3

Ferrence, Todd	PAG040145	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Franconia WWTP	PA0244295	Montgomery	Perkiomen Creek	0.0767	*	0.1500	3
Frederick Mennonite Community	PA0050989	Montgomery	Perkiomen Creek	0.0221	2	0.0499	3
Godshall, Perry & Claudia	PA0054046	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Green Lane-Marlborough Joint Auth.	PA0050521	Montgomery	Perkiomen Creek	0.1930	1	0.2000	1
Hilltown Twp Water & Sew Auth	PA0058271	Bucks	Perkiomen Creek	0.0880	1	0.1500	1
Lattanzi, Marc & Elizabeth	PAG040083	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Linh Quang Buddhist Temple WWTP	PA0244589	Montgomery	Perkiomen Creek	0.0004	2	0.0007	3
Litka-Mistic SRSTP	PAG040175	Montgomery	Perkiomen Creek	0.0003	*	0.0005	3
Long SRSTP	PAG040194	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Long, George	PA0057215	Montgomery	Perkiomen Creek	0.0002	*	0.0004	3
Lwr Frederick Twp. STP	PA0050105	Montgomery	Perkiomen Creek	0.1263	1	0.2000	1
Lwr Perkiomen Valley Reg Sew - Oaks	PA0026964	Montgomery	Perkiomen Creek	7.3900	1	14.2500	1
Lwr Salford Twp Auth Mainland WWTP	PA0056413	Montgomery	Perkiomen Creek	0.6530	1	0.9000	1
Lwr. Salford Twp Auth Harleysville WWTP	PA0024422	Montgomery	Perkiomen Creek	0.4000	1	0.5920	1
Macoby WWTP	PA0055875	Montgomery	Perkiomen Creek	0.0990	1	0.4000	1
Marlborough Elementary School STP	PA0050911	Montgomery	Perkiomen Creek	0.0029	2	0.0043	3
Milford-Trumbauersville Area Sewer	PA0042021	Bucks	Perkiomen Creek	0.5120	1	0.8000	1
MM Seylar Elementary School	PA0058289	Bucks	Perkiomen Creek	0.0026	*	0.0050	3
New Hanover Twp Auth	PA0057819	Montgomery	Perkiomen Creek	0.5320	1	1.9250	1
New Hanover Upper Frederick Elementary School	PA0033880	Montgomery	Perkiomen Creek	0.0034	2	0.0100	3
Pennridge WWT Auth	PA0020460	Bucks	Perkiomen Creek	3.1480	1	5.4100	1
Schwenksville Borough Auth.	PA0020303	Montgomery	Perkiomen Creek	0.1938	1	0.3000	1
Smith, William	PAG040081	Montgomery	Perkiomen Creek	0.0003	*	0.0005	3
Souderton Boro	PA0021857	Montgomery	Perkiomen Creek	1.1110	1	2.0000	1
Telford Boro Auth	PA0036978	Montgomery	Perkiomen Creek	0.7090	1	1.1000	1
U Frederick Twp - Perkiomen Crossing	PA0054810	Montgomery	Perkiomen Creek	0.0380	1	0.0480	1
U Frederick Twp & Ivy Ridge	PA0057061	Montgomery	Perkiomen Creek	0.0076	1	0.0215	1
U Gwynedd/Towamencin Mun. Auth.	PA0039004	Montgomery	Perkiomen Creek	4.0330	2	6.5000	4
U Hanover Auth	PA0012891	Montgomery	Perkiomen Creek	0.0480	1	0.0980	1
U Montgomery Joint Auth	PA0020532	Montgomery	Perkiomen Creek	1.2410	1	2.0000	1
U Salford Twp - Farmhouse	PA0057606	Montgomery	Perkiomen Creek	0.0002	2	0.0008	3
U Salford Twp - Twp Park	PA0058025	Montgomery	Perkiomen Creek	0.0008	*	0.0015	3
Washington Twp Mun Auth	PA0086142	Berks	Perkiomen Creek	0.1420	1	0.2500	1
Worcester Twp - Berwick Place STP & Sew Sys	PA0055671	Montgomery	Perkiomen Creek	0.0770	1	0.1500	1
Worcester Twp - Valley Green WTP	PA0050393	Montgomery	Perkiomen Creek	0.0980	1	0.2200	1
Dzedzy, Frank	PA0053546	Chester	Pickering Creek	0.0002	*	0.0004	3
Bernville Borough Auth.	PA0024023	Berks	Tulpehocken Creek	0.2338	1	0.4500	1
Jackson Township Authority WWTP	PA0248185	Lebanon	Tulpehocken Creek	0.1720	1	0.5000	1

Myerstown Sewer Auth.	PA0021075	Lebanon	Tulpehocken Creek	1.3550	1	2.0000	1
North Heidelberg STP	PA0033766	Berks	Tulpehocken Creek	0.0494	2	0.1000	3
Robesonia-Wernersville STP	PA0031062	Berks	Tulpehocken Creek	0.7400	1	1.4000	1
Sinking Springs Borough STP	PA0028649	Berks	Tulpehocken Creek	0.5683	1	1.0000	1
Strausstown Boro	PA0246611	Berks	Tulpehocken Creek	0.0233	1	0.0650	1
U Bern Twp	PA0088251	Berks	Tulpehocken Creek	0.0290	1	0.1550	1
Womelsdorf Boro. STP	PA0028975	Berks	Tulpehocken Creek	0.2532	1	0.4750	1
Blue Mountain School District	PA0061760	Schuylkill	Upper Schuylkill	0.0061	*	0.0120	3
Centerport Boro Mun Auth	PA0085669	Berks	Upper Schuylkill	0.0330	1	0.0600	1
Centre Twp Jordan Crossing WWTP	PA0087581	Berks	Upper Schuylkill	0.0088	1	0.1600	1
Centre Twp Mun Auth - Dauberville	PA0086771	Berks	Upper Schuylkill	0.0409	*	0.0800	3
Centre Twp Mun Auth - Hillcrest	PA0246654	Berks	Upper Schuylkill	0.0115	1	0.0250	1
Centre Twp Mun Auth - Kingsgate	PA0086525	Berks	Upper Schuylkill	0.0088	1	0.0120	1
Cressona Borough Auth.	PA0024015	Schuylkill	Upper Schuylkill	0.3220	1	0.7200	3
Greater Pottsville Area Sewer Auth - Main Plant	PA0043885	Schuylkill	Upper Schuylkill	5.1100	1	8.2000	3
Hamburg Mun. Auth.	PA0021601	Berks	Upper Schuylkill	0.5960	1	1.5000	1
Irish Creek Village	PA0052400	Berks	Upper Schuylkill	0.0051	2	0.0090	3
Leesport Borough STP	PA0070149	Berks	Upper Schuylkill	0.2991	1	0.5000	1
McClure, Wayne	PA0063193	Schuylkill	Upper Schuylkill	0.0002	*	0.0004	3
Mik-Joan Inc	PA0061212	Schuylkill	Upper Schuylkill	0.0026	*	0.0050	3
Minersville Sewer Auth.	PA0027693	Schuylkill	Upper Schuylkill	0.4300	1	1.0000	3
Orwigsburg, Borough of, Mun. Auth.	PA0021547	Schuylkill	Upper Schuylkill	0.5100	1	0.9000	3
Plum Creek Municipal Authority (formerly Lake Wynanoah)	PA0061328	Schuylkill	Upper Schuylkill	0.0166	*	0.0325	3
Sammy's Mobile Home Park	PA0062634	Schuylkill	Upper Schuylkill	0.0036	*	0.0070	3
Schuylkill County Municipal Authority - Branch/Cass WWTP	PA0064068	Schuylkill	Upper Schuylkill	0.1670	1	0.4500	3
Schuylkill County Municipal Authority - Deer Lake WWTP	PA0042170	Schuylkill	Upper Schuylkill	0.2030	1	1.0000	1
Schuylkill Haven, Borough of	PA0029017	Schuylkill	Upper Schuylkill	1.0330	1	2.8000	4
Schuylkill Valley Sew Auth	PA0064211	Schuylkill	Upper Schuylkill	0.2040	1	0.5500	3
Seiders Hill, Inc.	PA0063096	Schuylkill	Upper Schuylkill	0.0460	*	0.0900	3
Shoemakersville Borough	PA0024074	Berks	Upper Schuylkill	0.2974	1	0.7500	1
St. Clair Sewer Auth.	PA0025224	Schuylkill	Upper Schuylkill	0.4660	1	0.7500	1
Historic Salem Village Homeowners Assc	PA0056731	Chester	Valley Creek	0.0009	*	0.0017	3
Abington Twp. STP	PA0026867	Montgomery	Wissahickon Creek	2.9060	1	3.9100	1
Ambler Municipal STP	PA0026603	Montgomery	Wissahickon Creek	3.8270	1	6.5000	1
U Gwynedd Twp	PA0023256	Montgomery	Wissahickon Creek	2.9160	1	5.7000	1
Upper Dublin Twp WWTP	PA0029441	Montgomery	Wissahickon Creek	0.6530	1	1.1000	1

(1) Chapter 94 Reports (report for 2012, 2013 or 2014)

(2) eDMR (2014 average flow)

(3) EPA PCS-ICIS database

(4) NPDES permit

* Annual flow estimated based on median proportion of average flow in permitted flow

TABLE A-2: LIST OF COMMUNITY WATER SUPPLY SYSTEMS IN THE GIS WATER SUPPLIER SERVICE AREA LAYER

COMMUNITY WATER SUPPLY	COUNTY
AQUA PA FLYING HILLS	Berks
AQUA PA GEIGERTOWN	Berks
AQUA PA HILLCREST ESTS 2	Berks
AQUA PA STONECROFT VLG	Berks
BALLY MUNI WATERWORKS	Berks
BERKLEIGH HEIGHTS MHP	Berks
BERN TWP MUNI AUTH	Berks
BERNVILLE BORO WATER SYS	Berks
BETHANY CHILDRENS HOME	Berks
BIRDSBORO MUNI AUTH	Berks
BLUE MOUNTAIN WATER COOP	Berks
BOYERTOWN MUNI WATERWORKS	Berks
E AND Y FARM APTS	Berks
FLEETWOOD BORO	Berks
GEISINGERS SUBURBAN ACRES MHP	Berks
GREEN ACRES MHP	Berks
HAMBURG BORO MUNI AUTH	Berks
HEREFORD ESTATES MHP	Berks
HICKORY FARM MHP	Berks
HIGHLAND ESTATES MHP	Berks
IRISH CREEK VILLAGE MHP	Berks
KEYSTONE EAST LINCOLN WOOD MHP	Berks
KUTZTOWN MUNI WATERWORKS	Berks
LAUREL HEALTH RESOURCES	Berks
LAZY K CAMPGROUND	Berks
LEESPORT MUNI WATERWORKS	Berks
LEMAKEDE MOBILE COURT	Berks
LENAPE HILLS MHP	Berks
LYONS BORO MUNI AUTH	Berks
MAIDENCREEK TWP WATER AUTH	Berks
MAXATAWNY TWP MUNI AUTH	Berks
MEADOWBROOK WATER SYSTEM	Berks
MILLER MOBILE HOME PARK	Berks
MOUNTAIN SPRINGS MHP	Berks
MOUNTAIN VILLAGE ESTATES MHP	Berks
MT PENN WATER SYS	Berks
MUHLENBERG TWP WATER AUTH	Berks
NORTH HEIDELBERG WATER SYS	Berks
OLEY TWP MUNI AUTH	Berks
ONTELAUNEE TWP MUNI AUTH	Berks
PA AMER WATER CO GLEN ALSACE DIST	Berks
PA AMER WATER CO PENN DIST	Berks
PERRY TWP MUNI AUTH	Berks

PLEASANT HILLS MHP	Berks
READING AREA WATER AUTH	Berks
SHADY LANE MHP	Berks
SHILLINGTON MUNI AUTH	Berks
SHOEMAKERSVILLE BORO	Berks
SITTLERS MHP	Berks
TEEN CHALLEGE TRAINING CTR	Berks
TOPTON BORO WATER SYS	Berks
URBAN ACRES MHP	Berks
VALLEY VIEW MHP WERNERSVILLE	Berks
VALLEY VIEW TRAILER PARK BLANDON	Berks
VILLAGE AT SUMMIT CREST	Berks
WASHINGTON TWP MUNI AUTH BERKS CNTY	Berks
WERNERSVILLE MUNI AUTH	Berks
WEST READING BORO	Berks
WILL O HILL APTS	Berks
WOMELSDORF ROBESONIA JT AUTH	Berks
WOODLAND MHP	Berks
WYOMISSING BORO	Berks
BEDMINSTER MUNI AUTH	Bucks
DUBLIN BORO	Bucks
HILLTOWN TWP W AND S AUTH	Bucks
MILFORD TWP WATER AUTH	Bucks
PERKASIE BORO AUTH	Bucks
QUAKERTOWN MUNI WATERWORKS	Bucks
QUAKERVIEW MHP	Bucks
RICHLAND MEADOWS MHP	Bucks
RICHLAND TWP QUAKER MILL EST	Bucks
TRUMBAUERSVILLE MUNI WATERWORK	Bucks
LANSFORD COALDALE JT WATER AUTH	Carbon
SUMMIT HILL MUNI WATER AUTH	Carbon
CAMPHILL SPECIAL SCH BEAVER RUN	Chester
CAMPHILL VILLAGE U S A INC	Chester
COVENTRY MANOR NURSING HOME	Chester
COVENTRY TERRACE MHP	Chester
ELVERSON WATER CO INC	Chester
MALVERN COURTS INC MHP	Chester
NORTH COVENTRY WATER AUTH	Chester
PA AMER WATER CO HOME SYS PHOENIXVILLE DIST	Chester
PHOENIXVILLE MUNI WATERWRKS	Chester
RIDGLEA	Chester
RIVEREDGE RENTALS	Chester
STONY RUN MHP	Chester
WARWICK WATERWORKS ASSN	Chester
WEST VINCENT TWP ST STEPHENS G	Chester
WETHERILL ESTATES	Chester
COUNTRY ACRES MHP	Lebanon
GREEN ACRES MHP	Lebanon

HEIDELBERG TWP MUNI AUTH	Lebanon
LEBANON CITY WATER AUTH	Lebanon
MYERSTOWN WATER AUTH	Lebanon
NEWMANSTOWN WATER AUTH	Lebanon
RICHLAND BORO WATER	Lebanon
TWIN MAPLES MHP	Lebanon
GRIMS MHP	Lehigh
LEHIGH CNTY AUTH NLSA MADISON NORTH DIV	Lehigh
LEHIGH CNTY AUTH PINE LAKES DIV	Lehigh
LEHIGH CNTY AUTH UPPER MILFORD CENTRAL DIV	Lehigh
AMBLER BORO WATER DEPT	Montgomery
AQUA PA MAIN SYS	Montgomery
AQUA PA PERKIOMEN TWP	Montgomery
AQUA PA PERKIOMEN WOODS	Montgomery
AUDUBON WATER CO	Montgomery
AVANTE APTS	Montgomery
COLLEGEVILLE PARK WATER ASSN	Montgomery
COLLEGEVILLE TRAPPE JT PUBLIC	Montgomery
EAST GREENVILLE BORO WATER DEPT	Montgomery
FREDERICK MENNONITE COMMUNITY	Montgomery
GRATERFORD STATE CORR INST	Montgomery
GREEN HILL MHP	Montgomery
HORSHAM W AND S AUTH	Montgomery
NORTH PENN WATER AUTH	Montgomery
NORTH WALES WATER AUTH	Montgomery
OAK GROVE PARK AND SALES INC	Montgomery
PA AMER WATER CO HOME SYS DIST	Montgomery
PA AMER WATER CO NORRISTOWN DIST	Montgomery
PARKHOUSE PROVIDENCE POINTE	Montgomery
PERKIOMEN CROSSING	Montgomery
PLEASANT RUN MHP	Montgomery
POTTSTOWN WATER AUTH	Montgomery
RED HILL WATER AUTH	Montgomery
SCHWENKSVILLE BORO WATER DEPT	Montgomery
SHANERS MHP	Montgomery
SPRUCE COURT APARTMENTS	Montgomery
ST GABRIELS HALL	Montgomery
ST LUKE KNOLLS APT	Montgomery
SUPERIOR WATER CO CTR POINT	Montgomery
SUPERIOR WATER CO IVY RIDGE	Montgomery
SUPERIOR WATER CO WINDING CREEK	Montgomery
TELFORD BORO AUTH	Montgomery
UPPER HANOVER AUTH	Montgomery
WINDHAVEN MOBILE HOME ESTATES	Montgomery
YERKES WATER ASSN	Montgomery
PHILADELPHIA WATER DEPT	Philadelphia
AQUA PA PINES PARTNERS	Schuylkill
AUBURN MUNI AUTH	Schuylkill

BLYTHE TWP MUNI AUTH	Schuylkill
COUNTRY HILL APT	Schuylkill
DEER LAKE CITIZENS ASSN	Schuylkill
FRIEDEN ASSN MHP	Schuylkill
HAPPY VALLEY MHP	Schuylkill
HAZLETON CITY AUTH DELANO AND PARK PLACE	Schuylkill
KLINE TWP MUNI AUTH	Schuylkill
MARY D COMM ASSN	Schuylkill
MINERSVILLE MUNI WATER AUTH	Schuylkill
MOREA CITIZENS WATER CO	Schuylkill
ORWIGSBURG MUNI WATERW	Schuylkill
PA AMER WATER CO FRACKVILLE DIST	Schuylkill
PA AMER WATER CO LAUREL RIDGE DIST	Schuylkill
PINE TERRACE MHP	Schuylkill
PLUM CREEK MUNI AUTH	Schuylkill
PORT CLINTON WATER ASSN	Schuylkill
SCHUYLKILL CNTY MUNI AUTH	Schuylkill
SCHUYLKILL CNTY MUNI AUTH PINEBROOK	Schuylkill
SCHUYLKILL HAVEN BORO	Schuylkill
TAMAQUA AREA MUNI WATER AUTH	Schuylkill
THE PINES AT WEST PENN	Schuylkill

TABLE A-3: LIST OF COMMUNITY WATER SUPPLIERS FROM SDWIS SEARCH

WATER SYSTEM NAME	COUNTY SERVED	POPULATION SERVED	SUB-WATERSHED
ABRAXAS ACADEMY	BERKS	156	Hay Creek
ACORNS MHP	BERKS	50	Manatawny Creek
AQUA PA EAST POINTE	BERKS	75	Middle Schuylkill 3
ASHWOOD APARTMENTS	CHESTER	75	Middle Schuylkill 2
BERKS LEISURE LIVING	BERKS	49	Tulpehocken Creek
BIG O MOBILE HOME PARK	LEHIGH	64	Manatawny Creek
BUCKS RUN APARTMENTS	BUCKS	130	Perkiomen Creek
CAMP HILL SOLTANE	CHESTER	100	French Creek
CAMPHILL SPEC SCH BEAVER FARM	CHESTER	45	French Creek
CHRISTMAN LAKE WATER SYSTEM	BERKS	80	Maiden Creek
KEYSTONE COURT	CHESTER	116	Monocacy Creek
LEHIGH CNTY AUTH ARCADIA WEST DIV	LEHIGH	1392	Maiden Creek
MOHRSVILLE WATER ASSN	BERKS	375	Upper Schuylkill
NEW LIFE YOUTH&FAMILY SERVICES	MONTGOMERY	57	Perkiomen Creek
PARK PLACE COURT LLC	BERKS	29	Maiden Creek
PAW GOLDEN OAKS	BERKS	100	Manatawny Creek
PAW WILDCAT PARK	SCHUYLKILL	80	Little Schuylkill
SK PROPERTIES LP MISTY MEADOWS	BERKS	60	French Creek
UNION GREENE	BERKS	50	Middle Schuylkill 2
UPPER LAWN MHP	LEBANON	345	Tulpehocken Creek
VALLEY FORGE CROSSING MHP	MONTGOMERY	250	Middle Schuylkill 1
VALLEY RUN WATER SYSTEM	BERKS	375	Perkiomen Creek
VILLAGE OF PLEASANT HILL	BERKS	1200	Upper Schuylkill
WARWICK MOBILE HOME PARK	CHESTER	40	French Creek
WOODED RIDGE DEVELOPMENT	MONTGOMERY	53	Perkiomen Creek