2014 Annual Status Report

Long Term 2 Enhanced Surface Water Treatment Rule Watershed Control Program Plan

Queen Lane Drinking Water Treatment Plant
Schuylkill River, Philadelphia, PA

Prepared by the Philadelphia Water Department

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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.

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List of Acronyms

BC	Berks Conservancy
BCCD	Berks County Conservation District
BMP	Best Management Practice
CAC	Citizens Advisory Council
CSO	Combined Sewer Overflow
DRBC	Delaware River Basin Commission
EPA	United States Environmental Protection Agency
EWS	Early Warning System
FWWIC	Fairmount Water Works Interpretive Center
LTCPU	Long Term Control Plan Update
LT2	Long Term 2 Enhanced Surface Water Treatment Rule
MS4	Municipal Separate Storm Sewer System
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
PADEP	Pennsylvania Department of Environmental Protection
PDE	Partnership for the Delaware Estuary
PEC	Pennsylvania Environmental Council
PWD	Philadelphia Water Department
SAN	Schuylkill Action Network
SAS	Schuylkill Action Students
SRHA	Schuylkill River Heritage Area
SRRF	Schuylkill River Restoration Fund
SWA	Source Water Assessment
SWPP	Source Water Protection Plan
WCP	Watershed Control Plan
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
USDA	United States Department of Agriculture

Section 1 Introduction

In April 2011, the Philadelphia Water Department (PWD) completed a Watershed Control Plan (WCP) and after receiving approval from the Pennsylvania Department of Environmental Protection (PADEP), the WCP went into effect December 2012. The WCP presents a comprehensive source water protection approach to reducing levels of infectious *Cryptosporidium* in finished drinking water (US EPA, 2006). The elements of the 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, Philadelphia's drinking water source. The following report documents PWD's progress towards WCP initiatives during 2014, the second year of the 5-year plan.

Section 2 Background

The US Environmental Protection Agency (EPA) published the first source water quality based drinking water regulation on January 5, 2006. The Long Term 2 Enhanced Surface Water Treatment Rule (LT2), a series of amendments 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 LT2 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 require 4-log, 5-log and 5.5 log removals, respectively. Public water systems using conventional treatment processes, coagulation, flocculation, sedimentation, 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.

PWD *Cryptosporidium* monitoring data categorized each of Philadelphia's three drinking water treatment plants (WTPs) into Bins. Baxter and Belmont 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. A timeline of critical LT2 events is shown in Table 1.

Table 1: LT2 WCP Timeline

Action	Due Date
Notification to State of intent to submit WCP	April 2010
WCP submitted to State	April 2011
State approved WCP	December 2012
Presentation of 2013 Annual Status Report due to State	*NLT January 2014
2013 Annual Status Report due to State	January 2014 (reoccurring annually through Jan 2018)
State approved 2013 Annual Status Report	May 2014
Sampling Plan for 2nd round of monitoring due	*NLT January 2015
2014 Annual Status Report due to State	*NLT January 2015
Second round of *Cryptosporidium* sampling scheduled to begin	April 2015
Watershed Sanitary Survey due to State	December 2015
Bin classification and supporting data from 2nd round of monitoring due to State	*NLT October 2017

*NLT – No later than

Section 3 2014 Progress towards Source Water Protection Program Initiatives

After recognizing the need for a watershed wide effort to improve and promote the health of the Schuylkill River watershed, PWD, EPA, PADEP, Delaware River Basin Commission (DRBC), and Partnership for the Delaware Estuary (PDE) formed the Schuylkill Action Network (SAN) in 2003. The SAN is comprised workgroups to address a number of watershed issues: acid mine drainage, agricultural runoff, stormwater runoff, pathogens and compliance, land protection, and education and outreach. 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.

In the WCP, PWD outlines ongoing and proposed initiatives from the Schuylkill River watershed Source Water Protection Plan (SWPP) that are relevant to the control of *Cryptosporidium* upstream of the Queen Lane intake. In the WCP, PWD identifies four categories of source water protection initiatives. The four categories include mitigation of *Cryptosporidium* from wastewater treatment plant (WWTP) effluent, agricultural runoff, and animal vectors, and education and outreach in the City and watershed wide. This section discusses the progress PWD has made towards each of the ongoing and proposed initiatives by category.

3.1 Wastewater Discharge/Compliance

Effluent from WWTPs upstream of the PWD Queen Lane intake is a source of *Cryptosporidium* in the watershed (PWD, 2002; PWD, 2011). Although approximately 2% of the Schuylkill River watershed is in Philadelphia, PWD plays a leadership and supporting role in multiple initiatives outside of the City of Philadelphia. These initiatives aim to reduce the risk of *Cryptosporidium* contamination from treated WWTP effluent and minimize the occurrence of raw sewage discharge. Ongoing and proposed initiatives in the City of Philadelphia and in the Schuylkill River watershed are detailed in Table 2 and Table 3, both reproduced from the WCP. Progress towards these initiatives is summarized in this section.

Table 2: Ongoing Wastewater Discharge/Compliance SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.1.1 Philadelphia's Act 537 Plan** Continue to regularly review and update Philadelphia's Act 537 Plan. The plan was last updated on February 27th, 2009.
	3.1.2 Combined Sewer Overflow (CSO) and Municipal Separate Storm Sewer System (MS4) National Pollutant Elimination System (NPDES) Permit Annual Report Continue to implement the initiatives outlined in the annual Combined Sewer Management and Stormwater Management Plans in order to fulfill the City's Stormwater and CSO permits. Ongoing initiatives include monitoring as part of the Defective Lateral Detection and Abatement Program and completion of the Main and Shurs Elimination project.
	3.1.3 Early Warning System Continue to maximize usage for the Early Warning System while maintaining the system's ongoing operations and maintenance needs.
Schuylkill River Watershed	**3.1.4 Provide Project Support for the Lehigh University *Cryptosporidium* Study** Continue to support Lehigh University's *Cryptosporidium* source tracking study by providing support in terms of sampling, elution, and project management and oversight.
	3.1.5 SAN Pathogens/Compliance Workgroup Continue to support efforts of the SAN Pathogens/Compliance Workgroup. The strategies for the 2014 SAN Pathogens/Compliance Workplan are as follows: 1) Improve discharger/water supplier communication of events and use of the Delaware Valley Early Warning System and PAWARN, 2) identify priority wastewater discharges/issues in the watershed and formulate action plans to address them, 3) provide support (financial, information, expertise, collaborative problem-solving) for partners/communities to implement projects that reduce priority discharges, and 4) provide a forum for partner and agency communication and coordination around discharge issues and the formulation of creative new ideas and approaches for solving related problems.
	3.1.6 Abate Wildcat Sewers Continue to support SAN in its efforts to identify and abate wildcat sewers throughout the Schuylkill River watershed.

Table 3: Proposed Wastewater Discharge/Compliance SWPP Initiatives

Project Location	Project Overview
Phila-delphia	**3.1.7 PWD Schuylkill River Watershed 10-Year Review** Develop a Source Water Assessment (SWA) update for the Schuylkill River by revisiting priorities established in the 2002 assessment and updating water quality analyses with recent data.
Schuylkill River Watershed	**3.1.8 Support *Cryptosporidium* Monitoring at Major WWTPs and Inclusion in NPDES Permits** Support/help develop an effluent monitoring plan for *Cryptosporidium* at major WWTPs in the Schuylkill River watershed. In conjunction with this effort, should *Cryptosporidium* monitoring be considered for incorporation into NPDES permits, PWD will support such an effort. However, in regard to *Cryptosporidium* monitoring, it is very important to PWD that the EPA promulgate an analytical method that takes into account critical factors such as recovery rates and sample variability. Track the progress of these initiatives by continuing to attend SAN Pathogens/Compliance workgroup meetings.
	3.1.9 Track Wastewater Related Changes in the Watershed Through continued participation in the SAN Pathogens/Compliance workgroup, help ensure that high-priority areas requiring regulatory enforcement action are identified and addressed. Areas of concern may be identified using the following measures to track wastewater related changes in the watershed. o Assist the workgroup in identifying high-priority municipalities in need of updated Act 537 Plans in the Schuylkill River watershed. Municipalities with outdated plans located in Zones A and B of the area of influence are especially relevant. o Assist the workgroup at continuing to align sewage facilities planning, or Act 537, enforcement with the wasteload management reports filed under Chapter 94. o In addition to the above two measures, track WWTP upgrades, new facilities and community sewer improvement projects (such as the sewering of new areas) by reviewing Part II Permits. o Track projects funded under government loan programs, such as PennVest.
	3.1.10 Wet Weather and High Flow Management Education for WWTP Operators Coordinate with SAN to provide wet weather and high flow management education to WWTP operators in a workshop format. Include overview of information that should be included in I & I abatement and high-flow maintenance plans.
	3.1.11 Research on WWTP Effluent and *Cryptosporidium* in Surface Waters Support future research initiatives surrounding the impact of WWTP effluent on *Cryptosporidium* surface water concentrations by partnering with research organizations and/or academic institutions

3.1.1 Philadelphia's Act 537 Plan

Act 537 is the Pennsylvania Sewage Facilities Act. The program addresses existing sewage disposal needs and future disposal needs through proper planning, permitting and design of sewage facilities. Philadelphia's Act 537 Plan was last updated in 2009.

3.1.2 Combined Sewer Overflow (CSO) and Municipal Separate Storm Sewer System (MS4) National Pollutant Elimination System (NPDES) Permit Annual Report

Each year, PWD summarizes its activities and programs pertaining to the maintenance of stormwater in combined and separate sewers in accordance with Philadelphia's CSO and MS4 NPDES permits. A major component of Philadelphia's CSO NPDES 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. The 2014 fiscal year report is available to the public on phillywatersheds.org.

3.1.3 Early Warning System

The Delaware Valley Early Warning System (EWS) is designed to improve the safety of the drinking water supply by providing real time water quality monitoring results and event notification to regional users. The system features include a notification system, a time of travel model, the Spill Model Analysis tool, real-time flow water quality data and a central website where users can access event information, analysis tools and data. In 2014, PWD launched the Tidal Spill Trajectory Tool developed using a $295,000 grant awarded to PWD by the Maritime Exchange for the Delaware River and Bay. The Tidal Spill Trajectory Tool is now fully available to EWS users and expands EWS capabilities to include predicting a contaminant spill path and contaminant plume arrival times at tidal intakes in the lower Delaware River.

The EWS server was relocated from a temporary hosting facility near Lancaster, Pennsylvania to a facility within the City of Philadelphia. The relocation increases EWS technical support staff access to the server in the event of a system outage, which ultimately improves the system's reliability.

3.1.4 Provide Project Support for the Lehigh University Cryptosporidium Study

Through the Lehigh University *Cryptosporidium* project, PWD and Lehigh University collaborate to develop sampling programs to better understand the occurrence, sources and vectors of *Cryptosporidium* in the Schuylkill River watershed. For almost a decade, Lehigh University has been contracted by PWD to support PWD's continuing research surrounding *Cryptosporidium* in Philadelphia's source water and watersheds. Sampling programs are also designed to answer research questions and improve and expand methods for field sample collection and laboratory analysis of *Cryptosporidium*. In past studies, PWD has provided sampling, project management

and oversight. Beginning in July 2013 and continuing through 2014, PWD staff members collected samples twice per month in Philadelphia. PWD regularly communicates with project partners at Lehigh to solve problems encountered in the field and lab, incorporate improvements and expand the project.

3.1.5 SAN Pathogens/Compliance Workgroup

The strategic goal of the SAN Pathogens/Compliance Workgroup is to improve NPDES compliance, reduce discharges from unsewered communities and prevent drinking water illness outbreaks. The SAN Pathogens/Compliance Workgroup has four strategies to address this goal: improve discharger and water supplier communication of events and use of EWS, identify priority wastewater discharges and issues in the watershed and formulate action plans to address them, 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 and the formulation of creative new ideas and approaches for solving related problems. PWD regularly attends quarterly SAN Pathogens/Compliance Workgroup meetings. The minutes for the meetings in 2014 are included in Appendix A.

3.1.6 Abate Wildcat Sewers

Wildcat sewers are sewer systems that discharge sewage directly into creeks and streams without any treatment at a waste water treatment facility. These systems discharge pathogens into the Schuylkill River watershed and can be a source of *Cryptosporidium*. PWD continues to support the SAN in efforts to identify and abate wildcat sewers through participation in the SAN Pathogens/Compliance Workgroup.

3.1.7 PWD Schuylkill River Watershed 15-Year Review

The Source Water Protection Program 15-Year Review focuses on the objectives defined in the SWPP and highlights program achievements towards these objectives. The 15-Year Review describes PWD Source Water Protection Program capabilities and responses to unplanned source water events. Water quality data from PWD's drinking water treatment intakes on the Schuylkill River from the last decade are included and observed for changing trends. Additionally, Schuylkill River watershed water quality data provided by other water utilities and sources is used to observe spatial trends in pH, temperature, TDS and iron and manganese. The draft is currently pending internal review.

3.1.8 Support Cryptosporidium Monitoring at Major WWTPs and Inclusion in NPDES Permits

PWD regularly attends the quarterly SAN Pathogens/Compliance Workgroup meetings. Through this involvement, PWD supports the development of monitoring for *Cryptosporidium* at major WWTPs. Although such efforts are still in the planning phase, PWD remains an active participant of the workgroup and related activities.

3.1.9 Track Wastewater Related Changes in the Watershed

Through the SAN Pathogens/Compliance Workgroup, PWD and the PADEP Southeast Regional Office initiated a data compilation effort in 2013. The intent of the project is to collect available information submitted to PADEP by upstream WWTPs. The compiled information will serve as a planning tool and will assist PWD in tracking wastewater related changes in the Schuylkill River watershed. In 2014, PWD compiled relevant information from Chapter 94 annual reports from the PA Southeast and south central regions. The data includes WWTP discharge flow rates, overload conditions and treatment technologies. PWD hopes to use this information to inform the Watershed Sanitary Survey which is scheduled to be submitted to PADEP in December 2015 under the LT2 Enhanced Surface Water Treatment Rule. In 2015, PWD will seek to connect with the PADEP Northeast Regional Office for Chapter 94 reports from WWTPs in Schuylkill and Lehigh counties. PWD will also work with the SAN Pathogens/Compliance Workgroup to gather other relevant sources of information such as NPDES Permits for WWTPs upstream. A map of the WWTPs in the Schuylkill River watershed is included in Appendix B and will be updated with data from this compilation effort in the future. A memo for the SAN Pathogen/Compliance Workgroup meeting summarizing the data compilation project and the information collected from Chapter 94 reports is included in Appendix C.

3.1.10 Wet Weather and High Flow Management Education for WWTP Operators

Providing a wet weather and high flow management workshop to WWTP operators and potentially reducing wastewater overflows in the Schuylkill River watershed during wet weather has been a long-term goal of the SAN Pathogen/Compliance Workgroup. However, the workgroup has met challenges with legal implications while planning the content for the workshop, which was expected to be held in 2014. The planning of the workshop is currently on hold.

3.1.11 Research on WWTP Effluent and Cryptosporidium in Surface Waters

In collaboration with Lehigh University in past years, PWD has funded and conducted research investigating the impact of WWTP effluent on the presence *Cryptosporidium* in the Wissahickon Creek watershed, a tributary to the Schuylkill River directly upstream of the PWD Queen Lane intake. Beginning in July 2013, Lehigh University and PWD began *Cryptosporidium* sample collection twice per month at the Schuylkill River, near the Queen Lane intake, and in the Monoshone Creek, a tributary to the Wissahickon Creek. Data was collected at these two locations through August 2014. *Cryptosporidium* was detected at both sites. In conjunction with this monitoring, Lehigh University is also developing a more cost effective alternative to the EPA sampling method that requires filtering a 10 liter volume of water for one *Cryptosporidium* sample. Lehigh University's method collects *Cryptosporidium* oocysts from biofilms grown in situ on glass microscope slides. In September 2014, *Water Online* published an article, "Do-It-

Yourself Crypto Detection," on Lehigh University's biofilm collection method for *Cryptosporidium* monitoring. The article is included in Appendix D.

Beginning in April 2015, PWD and Lehigh will tentatively be monitoring for *Cryptosporidium* alongside PWD's regulatory monitoring for LT2. Lehigh University will also collect ancillary data on watershed events upstream to complement PWD regulatory dataset. In preparation for this monitoring plan, from September 2014 through March 2015, PWD and Lehigh University will continue monitoring in the Monoshone Creek, prepare Standard Operating Procedures, optimize lab processes and further develop the project scope.

3.2 Agricultural Land Use and Runoff

Animal manure-laden runoff from agricultural land is a source of *Cryptosporidium* and pathogens in the Schuylkill River watershed (PWD, 2002; PWD, 2011). Much of PWD efforts to address agricultural runoff occur upstream of the PWD intakes because the agricultural land within the City of Philadelphia is minimal and best management practices (BMPs) have previously been installed at Northwestern Stables, Belmont Stables, Courtesy Stables, Monastery Stables and W.B Saul High School (PWD, 2011). Table 4 and Table 5 outline the ongoing and proposed SWPP initiatives that aim to reduce the impact of agricultural activities on water quality in the Schuylkill River watershed. This section explains the progress made in 2014 towards each initiative listed.

Table 4: Ongoing Agricultural Land Use and Runoff SWPP Initiatives

Project Location	Project Overview
Phila-delphia	*BMPs have been implemented at all agricultural sites within the City.*
Schuylkill River Watershed	**3.2.1 SAN Agriculture Workgroup**
	Continue to be an active participant in the SAN Agricultural Workgroup and support future efforts. The strategies for the 2014 SAN Agricultural Workplan are as follows: 1) support implementation of projects that demonstrate BMPs and/or creative solutions for agriculture in priority areas (with funding, information, expertise, collaborative problems, solving, etc.), 2) provide a forum for partner and agency communication and coordination around agricultural impacts and issues and the formulation of creative new ideas and approaches for solving related problems, 3) promote agricultural BMP successes and understanding of agricultural water quality issues and solutions to target audiences in the watershed through an educational/outreach program, and 4) monitor the impacts of agricultural BMP installations on stream water quality.

Table 5: Proposed Agricultural Land Use and Runoff SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.2.2 PWD In-City Agricultural BMPs**
	Develop a maintenance plan for PWD's in-city agricultural BMPs, which include Northwestern Stables, Belmont Stables, Courtesy Stables, Monastery Stables and the WB Saul High School project.
	3.2.3 Natural Lands Trust and Erdenheim Farm
	The National Lands Trust (NLT) is currently performing stream restoration on a tract of land on Erdenheim Farm, located in the Wissahickon watershed. The land is currently not being used for grazing, but may be used for this purpose in the future. PWD will consider future coordination with the NLT to install additional agricultural BMPs at the farm.
	3.2.4 Land Use in the Schuylkill River Watershed
	As part of the SWA update process, PWD plans to re-assess land use in the Schuylkill River watershed. To complete this update, the 2001 National Land Use Database will be used, along with more current information from the 2010 Census.

Schuylkill River Watershed	**3.2.5 Visual Assessments for the Agriculture BMP Projects** Coordinate with SAN to develop a maintenance and monitoring plan for the agricultural BMPs installed as a result of the parcel prioritization process. The maintenance plan may be centered on regular visual assessments to identify any problems or repair needs.
	3.2.6 Agricultural BMP Monitoring for *Cryptosporidium* PWD will explore the possibility of partnering with academic institutions on *Cryptosporidium*-related research. Relevant research may include monitoring to assess the efficacy of different agricultural BMPs at removing pathogens from runoff. PWD will also identify priority research needs that may be fulfilled in collaboration with Lehigh University.
	3.2.7 Promotion of SAN Agriculture Projects Through involvement in the SAN Agriculture Workgroup, PWD will continue to work with partners and state and federal officials to identify priority projects and available funding sources. For funding programs that already exist within the watershed, such as the United States Department of Agriculture (USDA) – Natural Resource Conservation Service (NRCS) conservation programs outlined in the 2008 Farm Bill, PWD will help promote drinking water protection, and *Cryptosporidium* contamination reduction, as a high-priority water quality improvement goal that requires adequate funding.
	3.2.8 CAFO Identification in the Watershed Through the SAN Agriculture Workgroup, PWD will work with partners to identify CAFOs located in the Schuylkill River watershed and assess the status of their NPDES permits.
	3.2.9 Schuylkill River Restoration Fund Grants for Agriculture BMP Projects Starting in 2012, PWD has committed SRRF dollars to be directed toward priority agricultural BMPs addressing pathogen-contaminated stormwater runoff from livestock operations. These projects will be selected on an annual basis through the established project selection processes. PWD's commitment through the SRRF will address priority stormwater and pathogen concerns while promoting the importance of watershed partnerships.

3.2.1 SAN Agriculture Workgroup

The strategic goal of the SAN Agricultural Workgroup is to maximize reduction and/or prevention of agricultural impacts to water quality. The SAN Agricultural Workgroup has four strategies to address this goal: support implementation of projects that demonstrate BMPs and creative solutions for agriculture in priority areas, provide a forum for partner and agency communication and coordination around agricultural impacts and issues and the formulation for creative ideas and approaches to solving related problems, promote agricultural BMP success and understanding of agricultural water quality issues and solutions to target audiences in the Schuylkill River watershed through education and outreach, and monitor the impacts of agricultural BMP installations on stream water quality. PWD regularly attended quarterly SAN Agriculture Workgroup meetings. The minutes for the meetings in 2014 are included in Appendix A.

3.2.2 PWD In-City Agricultural BMPS

In 2014, PWD met with Saul High School teachers, PDE and Destination Schuylkill River to discuss master planning for the school's campus. Saul High School is a public school with a focus in agricultural sciences. Saul is interested in incorporating BMPs to more effectively reduce the impact of agricultural runoff from the property on the watershed. Saul High School was identified by the Philadelphia Community Design Collaborative as a candidate for master planning. In July 2014, Saul High School invited community members and other stakeholders to be part of a task force for the pre-development planning of a master plan for the school's campus. PWD will serve on the Saul Task Force for the Community Design Collaborative. The first task force meeting was held in November 2014 and primarily served to prioritize concerns. Stormwater management and drinking water protection emerged as some of the top priorities to be incorporated into the planning.

3.2.3 Natural Lands Trust and Erdenheim Farm

Erdenheim Farm is located in Lafayette Hill on the Wissahickon Creek. Projects previously implemented at Erdenheim farm include the planting of a 14-acre native meadow, the stabilization of a meandering channel, and construction of a shallow stormwater basin and forebay, a basin constructed to allow sediment from incoming stormwater to settle before reaching the main stormwater basin. These projects intend to reduce erosion of Erdenheim Farm and detain stormwater prior to discharging to Wissahickon Creek. Additionally, a 96-acre parcel of Erdenheim Farm was purchased by Natural Lands Trust for preservation from development in 2009. In 2013, PWD reached out to Natural Lands Trust to express interest in collaboration on future projects at Erdenheim Farm.

3.2.4 Land Use in the Schuylkill River Watershed

USGS released the 2011 National Land Cover Dataset (NLCD) at the end of 2013. A map of the Schuylkill River watershed overlain by the 2011 NLCD is included in Appendix E.

3.2.5 Visual Assessments for Agriculture BMP Projects

PWD developed a field visual monitoring form, which was shared with the SAN Agriculture Workgroup in 2013. The field visual monitoring assessment will serve as a tool available to SAN Agriculture Workgroup members implementing and tracking projects on the ground.

3.2.6 Agricultural BMP Monitoring for Cryptosporidium

PWD has no current *Cryptosporidium* monitoring projects in agricultural areas. *Cryptosporidium* research will focus on collecting duplicate samples alongside the next two-year round of regulatory LT2 monitoring from April 2015 through March 2017. PWD will continue to look for potential future *Cryptosporidium* monitoring locations in agricultural areas of the Schuylkill River watershed where BMPs will be installed.

3.2.7 Promotion of SAN Agriculture Projects

PWD and PDE began developing a BMP guide for agricultural properties in the Schuylkill River watershed in 2013. The guide was completed in 2014 and introduced during the annual Agricultural BMP Tour in August. The guide, entitled *A Farmer's Guide for Healthy Communities*, includes the importance of managing runoff on agricultural properties, sample stormwater projects, spotlight farms with projects completed through the SAN and watershed partners, and funding resources for farmers interested in implementing projects on their own properties. *A Farmer's Guide for Healthy Communities* was distributed to SAN members and to all feed stores and granges in the Berks County area and some in Montgomery and Chester counties. The Davis farm, a recipient of a 2012 SRRF grant, also requested copies of the guide to use during school tours of the farm. The guide is available on the SAN website at www.schuylkillwaters.org/projects.cfm and is included in Appendix F.

3.2.8 CAFO Identification in the Watershed

Concentrated animal feeding operations (CAFOs) are agricultural operations where animals are confined in small land areas. CAFOs have the potential to contribute *Cryptosporidium* contaminated runoff to the Schuylkill River watershed. In 2014, PWD received updated CAFO data from PADEP including primary animals in the operations and number of animal equivalent units. An updated map is included in Appendix G of this report.

3.2.9 Schuylkill River Restoration Fund Grants for Agriculture BMP Projects

PWD contributes financial support to and participates in the SRRF grant selection process. PWD directly supported the award of SRRF grants to agricultural BMP projects at the A. Zimmerman Farm and the Martin Farm in 2014. In addition to identifying and advocating for high priority projects, PWD evaluates and supports other projects helping to select one additional farm to receive an SRRF grant for BMP implementation in 2014. The SRRF projects are discussed in more detail in Section 4.2.1.

3.3 Animal Vectors

Animals in the Schuylkill River watershed serve as mechanical vectors of *Cryptosporidium*, transferring viable oocysts from original hosts. Geese in particular are vectors, as identified in PWD and Lehigh University source tracking studies (Jellison et al., 2009; Jellison, 2010a). Table 6 and

Table 7 outline the SWPP ongoing and proposed initiatives that aim to reduce the impact of animal vectors near PWD's Queen Lane and Belmont intakes and expand implementation of animal vector control in the Schuylkill River watershed. This section explains the progress made in 2014 towards each initiative listed.

Table 6: Ongoing Animal Vectors SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.3.1 Belmont Meadow Extension and Intake Project** Maintain plantings at the site of the Belmont Meadow Extension/Intake project. Continue to monitor goose activity around the Belmont intake.
	3.3.2 Education and Outreach on Threat of Animal Vectors in the City Continue education/outreach efforts concerning the threat of animal vectors and the role they play in the cycle of pathogen contamination. These efforts may include working with Fairmount Park to expand existing programs, such as the dog waste program, and developing new programs that focus on the relationship between geese and drinking water quality.
Schuylkill River Watershed	**3.3.3 Lehigh University *Cryptosporidium* Source Tracking** Continue to support Lehigh's source tracking research to further identify and understand the animals that serve as mechanical vectors of *Cryptosporidium* in the watershed.

Table 7: Proposed Animal Vectors SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.3.4 Goose Measures at Fairmount Park Properties** Identify and implement appropriate goose control measures at Fairmount Park properties, including Peter's Island, and incorporate educational signage in these areas.
	3.3.5 Waterfowl Management at PWD Facilities Complete implementation of the USDA waterfowl management program at the Queen Lane WTP, Belmont WTP and Baxter WTP along with PWD's three WWTPs.
Schuylkill River Watershed	**3.3.6 Animal Vector Education and Outreach in the Watershed** As part of the Source Water Protection Program's education and outreach efforts, raise awareness of the threat animal vectors pose to our drinking water supplies. These efforts may focus on supporting Lehigh's efforts to publish scientific journal articles.

3.3.1 Belmont Meadow Extension and Intake Project

The goal of the Belmont meadow project is to deter non-native Canada geese, vectors for *Cryptosporidium*, from dwelling and feeding around the Belmont intake. This was achieved by installing fencing along Peter's Island, installing educational signage, and planting trees, shrubs, and two meadows. The project began in 1999 with the implementation of the Phase I meadow, and was completed in 2004 with the Phase II extension meadow. The plants create an inhospitable environment by obstructing the sight of the geese and increasing their fear of predators (PWD, 2011). In 2014, the Belmont meadow and intake plantings were maintained by Philadelphia Parks and Recreation to continue deterring geese from the area.

3.3.2 Education and Outreach on Threat of Animal Vectors in the City

In 2014, PWD continued education and outreach efforts concerning the management of animal vectors in the Schuylkill River watershed. In partnership with PDE, PWD annually hosts the Spokes Dog contest. Two dogs are selected to be the Philly's Best Friend Spokes Dog and serve for one year as ambassadors educating dog owners on the importance of picking up pet waste. Additionally, Penn Praxis, Philadelphia Parks and Recreation, Fairmount Park Conservancy and University of Pennsylvania Project for Civil Engagement collaborated on "The New Fairmount Park," a community vision and improvement plan for Fairmount Park in Philadelphia. The plan is complete, but no implementation timeline has been determined. PWD will continue to follow the plan status and look for opportunities to align source water goals with the plan, such as including education signage on geese as vectors of pathogens in Fairmount Park.

3.3.3 Lehigh University Cryptosporidium Source Tracking

PWD continues to support Lehigh University research into the prevalence of *Cryptosporidium* in the Schuylkill River watershed. Lehigh University has the capability to genotype *Cryptosporidium* species in field samples and assist PWD in tracking sources of *Cryptosporidium*. In 2014, PWD and Lehigh University outlined the scope of work for the next phase of research. Beginning in April 2015, PWD and Lehigh University will sample in conjunction with PWD's LT2 Round 2 sampling. These samples will be processed for genotyping and will serve as a complimentary data set to PWD's regulatory dataset. Development of the project scope for this next phase is in progress.

3.3.4 Goose Measures at Fairmount Park Properties

In 2014, under a PWD contract with the USDA, goose control measures were implemented at a number of Fairmount Park locations, including Pleasant Hill Park, FDR Park and Golf Course, Concourse and Centennial Park, and Peter's Island. Under this contract, geese are removed and eggs and nests are treated to reduce the population. This effort is discussed in greater detail in Section 4.5 of this report.

3.3.5 Waterfowl Management at PWD Facilities

In 2014, under a PWD contract with the USDA, goose control measures were implemented at PWD's three drinking WTPs, three WWTPs and Oak Lane Reservoir. Under this contract, geese are removed and eggs and nests are treated to reduce the population. Additional measures are taken to control other wildlife populations at PWD facilities. This effort is discussed in greater detail in Section 4.5 of this report.

3.3.6 Animal Vector Education and Outreach in the Watershed

PWD continues to support Lehigh University efforts in *Cryptosporidium* related research and the publishing of scientific articles by incorporating PWD source water protection goals into Lehigh University research goals. In September 2014, *Water Online* published an article, "Do-It-Yourself Crypto Detection," on Lehigh University's biofilm sample collection method for *Cryptosporidium*. The article is included in Appendix D. Additionally, PWD shares Lehigh University literature and research findings on deer and geese as vectors of human-infectious *Cryptosporidium* with upstream water utilities and SAN partners to support the implementation of animal vector control techniques.

3.4 Education and Outreach

Education and outreach initiatives are a critical component of PWD SWPP because point source discharges and land management throughout the Schuylkill River watershed influence water quality at the Queen Lane and Belmont intakes. Many education and outreach initiatives are implemented through PWD watershed partnerships, which are maintained by various programs within PWD. Table 8 and Table 9 outline the SWPP ongoing and proposed initiatives that maintain watershed partnerships and continue to promote the importance of source water protection. This section explains the progress made in 2014 towards each initiative listed.

Table 8: Ongoing Education and Outreach SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.4.1 Watershed Partnerships in the City** Remain an active participant in the watershed partnerships and begin integrating drinking water issues into the scope of work for the Wissahickon Watershed Partnership.
	3.4.2 Annual Water Quality Report Continue to submit a comprehensive annual water quality report that emphasizes critical source water issues and, in particular, educates customers as to the research initiatives and implementation strategies PWD is using to reduce the risk of *Cryptosporidium* contamination.
	3.4.3 Water Quality Council Continue to convene the Water Quality Council (WQC) to address water quality issues on a holistic basis. Utilize the committee as a forum for providing feedback to strengthen the WCP.
	3.4.4 Improve Environmental Quality of Philadelphia Fairmount Park System Continue to work with Fairmount Park to improve the environmental quality of the City's parks and streams through land management practices and BMP implementation.
	3.4.5 Maintain Fairmount Water Works Interpretive Center Continue to maintain the FWWIC and promote source water protection through the center's various exhibits and learning programs.
	3.4.6 Philly RiverCast Continue to operate Philly RiverCast and promote the web-based recreational warning system.
Schuylkill River Watershed	**3.4.7 Active Members of SAN Pathogens/Compliance and Agricultural Workgroups** Continue to be an active member of the SAN Pathogens/Compliance and Agricultural workgroups and support initiatives outlined in the annual workplans.
	3.4.8 Collaboration with Partnership for the Delaware Estuary Continue to collaborate with PDE on various education and outreach initiatives, including the publication of guidance materials and organization of public programs and meetings surrounding water quality concerns.
	3.4.9 Schuylkill River Restoration Fund Continue to support the SRRF to achieve implementation of BMPs at high-priority sites in the watershed.

Table 9: Proposed Education and Outreach SWPP Initiatives

Project Location	Project Overview
Philadelphia	**3.4.10 Implement In-City Source Water Programs in East Falls, Roxborough and Manayunk** Implement in-city source water programs in the East Falls, Roxborough, and Manayunk neighborhoods along the Schuylkill River. These programs will involve the implementation of stormwater management practices, storm drain labels and a dog waste control program. Through the programs, communities will become more involved in protecting their waterways as they develop a better understanding of the impacts of daily activities on their drinking water source.

3.4.1 Watershed Partnerships in the City

PWD supports a contract with the Pennsylvania Environmental Council (PEC) for regional watershed coordination partnerships for the City of Philadelphia. PEC coordinates the Watershed Alliance of Southeastern Pennsylvania including facilitating meetings for the Watershed Alliance and for the five individual watershed partnerships in the city, conducting a needs assessment for the Watershed Alliance members, promoting multi-municipal collaboration, identifying stormwater financing programs and maintaining the Watershed Alliance newsletter. PEC conducts outreach to upstream landowners on projects proposed in the Integrated Watershed Management and Act 167 Stormwater Management Plans (available at phillywaterheds.org) and coordinates this effort with the William Penn Foundation Upstream Suburban Cluster. PEC also facilitates the *Green Cities, Clean Waters* advisory committee meetings and e-newsletter.

PWD and the Pennsylvania Environmental Council are collaborating to pilot a new grant program, Soak It Up! Adoption. This program provides grants to civic organizations to help maintain green stormwater infrastructure. This infrastructure is designed under the *Green City, Clean Waters* initiative to reduce stormwater runoff captured in CSOs. Organizations receiving grants were asked to participate in an introductory training, monitor green stormwater infrastructure, collect trash and provide feedback on the site to PWD. Seven organizations successfully completed the approval process and received grants. More information is available in Philadelphia's Wet Weather Management Programs Annual Report for fiscal year 2014 available on phillywatersheds.org.

3.4.2 Annual Water Quality Report

PWD annually mails source water protection information to customers in the annual Drinking Water Quality Report. The most recent report published in 2014 shares information on the calendar year 2013 Schuylkill and Delaware River SWPPs, SAN projects, pharmaceuticals and *Cryptosporidium* source tracking. The report also includes sources for additional information on source water protection issues. Although the EPA does not require this breadth of information on source water protection to be included in the annual water quality report, PWD takes a proactive approach to customer education.

3.4.3 Water Quality Council

In 2001, the Water Quality Citizens Advisory Council (CAC) was formed by a merger of the Stormwater and the Drinking Water Quality CACs. The merger of the two CACs, into what is now referred to as the Water Quality Council, complements the WCP as a holistic approach to water quality issues (PWD, 2011). PDE currently facilitates the Water Quality Council committee meetings.

3.4.4 Improve Environmental Quality of Philadelphia Fairmount Park System

As described earlier in Section 3.3, Penn Praxis, Philadelphia Parks and Recreation, Fairmount Park Conservancy and University of Pennsylvania Project for Civil Engagement collaborated on "The New Fairmount Park." The planning process is now complete with no implementation timeline determined. PWD will continue to follow the plan status and look for opportunities to align source water goals with the plan.

3.4.5 Maintain Fairmount Water Works Interpretive Center

The Fairmount Water Works Interpretive Center (FWWIC) is a PWD educational center that presents the history of the Schuylkill River, and the influence of human activities on water quality and quantity through innovative exhibits and interactive educational programs. The Source Water Program is exploring opportunities to share PWD source water protection efforts with school teachers through the FWWIC Teacher Fellowship Program in 2015.

3.4.6 Philly RiverCast

PWD continues to promote and maintain Philly RiverCast. The website has received over 650,000 visits since its launch in 2005. In 2014, PWD incorporated a terms and conditions of use policy into the website.

3.4.7 Active Members of SAN Pathogens/Compliance and Agricultural Workgroups

PWD regularly attends quarterly SAN Pathogens/Compliance and Agricultural Workgroup meetings. The 2014 meeting minutes for both workgroups are included in Appendix A. Education and outreach was featured in several events hosted by the SAN Agriculture Workgroup in 2014. In August 2014, the SAN Agriculture Workgroup organized the annual Agricultural in Berks County. This tour was funded in part by PWD. PWD, PADEP and EPA staff members, as well as other members of the watershed community were invited to attend the tour. In 2014, PDE, PWD and the SAN Agriculture Workgroup completed the development of a guide, entitled *A Farmer's Guide for Healthy Communities*, detailed in Section 3.2.7. The guide and additional complimentary outreach materials including a PowerPoint and photos from the guide are available on the SAN website www.Schuylkillwaters.org. The Saucony Creek Brewing Company also continues to contribute a portion of each sale of its Stonefly India Pale Ale towards agricultural BMP projects in Berks County in the Schuylkill River watershed through the Berks Watershed Restoration Fund.

3.4.8 Collaboration with Partnership for the Delaware Estuary

PWD continued collaboration with PDE on a number of education and outreach initiatives. 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. In 2014, PDE coordinated the 2014 Philly's Best Friend Spokes Dog Competition, organized an annual clean water art contest for Philadelphia students receiving over 700 entries from 13 schools, and hosted the annual Coast Day at Penn's Landing in Philadelphia. Additionally, PDE aided coordination of the annual Schuylkill Scrub cleanup effort and collected photo entries for the Schuylkill Shots photo contest. PDE and the SAN launched the Schuylkill Students Street Art Contest in 2014 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. Workshops were hosted by PDE in 2014 to show volunteers how to survey streams for mussels and help researchers catalog freshwater mussels in the watershed.

3.4.9 Schuylkill River Restoration Fund

PWD continues to support the SRRF. In 2014, PWD staff participated in the review of grant applications and the selection of the recipients. PWD contributed $100,000 to the SRRF. The SRRF is discussed in more detail in section 4.2.1 of this report.

3.4.10 Implement In-City Source Water Programs in East Falls, Roxborough and Manayunk

First steps to implement source water programs in East Falls, Roxborough and Manayunk neighborhoods are in progress. Cook-Wissahickon Elementary School received a grant from SRRF in 2014 to install the second phase of a native meadow to enhance stormwater control and filtration and extend habitats of the nearby Fairmount Park. Additionally, as detailed in Section 3.2.2, PWD is serving on the Saul High School Task Force for the Community Design Collaborative which will assist the school in creating a master plan. Both schools are located in Roxborough and the projects will serve as demonstrations of source water protection and stormwater management for the students and surrounding community.

3.5 Additional 2014 Highlights

Outreach to Watershed Community

PWD supported the SAN annual meeting in November 2014 which drew watershed partners to participate in a day of presentations and discussion on the monitoring efforts occurring in the Schuylkill River watershed. PWD gave a presentation at the meeting that provided an overview of some of PWD monitoring efforts and water quality concerns in the Schuylkill River at Philadelphia that are addressed when BMPs are implemented upstream.

Venice Island

In November 2011, PWD broke ground on a $46 million construction project on Venice Island located between the Schuylkill River and the Manayunk Canal in the Manayunk neighborhood in Philadelphia. The main component of the project is a four million gallon underground

storage tank that temporarily stores diverted flow from a sanitary sewer during intense rain storms. When the rainstorm passes, wastewater in the storage basin is returned to the sanitary sewer where it flows to a PWD WWTP. The project also recognizes the recreational value of Venice Island replaced and augmented facilities demolished during construction of the storage tank. New amenities include a performing arts center, children's play area, renovated parking lot, and athletic courts. The storage basin is operating and the performing arts and recreation center opened to the public in October 2014.

Section 4 2014 Progress towards Watershed Control Program Plan Initiatives

In addition to the implementation of Source Water Protection Program (SWPP) initiatives, the Watershed Control Plan (WCP) includes implementation of structural and non-structural measures to physically reduce the loading of *Cryptosporidium* in the Schuylkill River watershed. These control measures address priority sources of *Cryptosporidium* identified to be wastewater effluent, agricultural land runoff, and animal vectors. The WCP control measures consist of the following: quantifying the water quality implications of UV installation at the Upper Gwynedd and Fleetwood WWTPs; supporting the installation of manure storage basins on at least five separate farms; supporting the installation of vegetated buffers on at least five farms; supporting the completion of at least five Comprehensive Nutrient Management Plans (CNMPs) at farms throughout the Schuylkill River watershed; implementing a riparian buffer to deter animal vectors at a selected site; and, implementing a PWD waterfowl management program. The WCP control measures and their implementation timeframe are summarized in Table 10 below.

Table 10: Watershed Control Program Plan Initiatives and Implementation Schedule

Project Type - Priority Source Addressed	Project	Implementation Timeframe			Project Lead and Partners
		Project Initiation	Construction Started	Project/ Construction Complete	
Structural - WWTP Effluent	UV Installation - Upper Gwynedd WWTP				N/A
Structural - WWTP Effluent	UV Installation - Fleetwood WWTP				N/A
Structural - Ag Land Use/Runoff	Farm - Manure Storage Basin #1	2012	2012	2013	NRCS, BCCD, BC, SAN Ag Workgroup Partners, PWD
	Farm - Manure Storage Basin #2	2013	2013	2014	
	Farm - Manure Storage Basin #3	2014	2014	2015	
	Farm - Manure Storage Basin #4	2015	2015	2016	
	Farm - Manure Storage Basin #5	2016	2016	2017	
	Farm - Vegetated Buffers #1	2012	2012	2013	
	Farm - Vegetated Buffers #2	2013	2013	2014	
	Farm - Vegetated Buffers #3	2014	2014	2015	
	Farm - Vegetated Buffers #4	2015	2015	2016	
	Farm - Vegetated Buffers #5	2016	2016	2017	
Non-Structural - Ag Land Use/Runoff	Nutrient Management Plans - 5 Farms	2012-2017	N/A	2017	NRCS, BCCD, SAN Ag Workgroup Partners, PWD
Structural - Animal Vectors	Riparian Buffer Plantings - 1 Site	2014	2014	2014	PWD, SAN Partners
Non-Structural - Animal Vectors	Waterfowl Management Program	2011	N/A	2017	PWD, USDA

4.1 UV Installation at Wastewater Treatment Plants

4.1.1 Upgraded Wastewater Treatment Plants

Since the development of the WCP, PWD has noted the progress of the Upper Gwynedd and Fleetwood WWTP upgrade projects. The Fleetwood UV disinfection system became operational in January 2013 (Fleetwood Borough, 2013). The Upper Gwynedd UV disinfection system became operational in 2011 (Environmental Engineering & Management Associates,

Inc., 2013). The North Wales WWTP closed and diverted flow to Upper Gwynedd in June 2013 (Carroll Engineering Corporation, 2013).

In the past, PWD has learned of UV disinfection system installations at wastewater plants in the watershed through township news sources and other publically available sources. In 2013, PWD and the Schuylkill Action Network (SAN) Pathogens/Compliance Workgroup initiated an effort to track wastewater in the Schuylkill River watershed and data collection continued through 2014 as described in Section 3.1.9 of this report. Through this effort, PWD will have a more complete understanding of the level of wastewater treatment upstream of the Queen Lane and Belmont intakes, and can better track upgrades to WWTPs such as UV disinfection.

4.1.2 *Cryptosporidium* Loading from Wastewater Treatment Plants

To estimate a range of *Cryptosporidium* loading from WWTP effluent in the Schuylkill River watershed, minimum and maximum loadings were calculated in the WCP using Equation 1 and Equation 2, respectively and are further detailed in Section 7.5.1.2 of Appendix A of the WCP (PWD, 2011). Average effluent discharge rates from WWTPs in the Schuylkill River watershed are taken from the 2008 *Schuylkill Action Network Pathogens Workgroup Study of Cryptosporidium Occurrence in Wastewater Treatment Plants*. Minimum and maximum estimates of oocysts per liter in WWTP effluent receiving secondary treatment are based on pooled values from literature, and in effluent receiving tertiary treatment, an additional log removal is assumed (Crockett, 2007). The results are summarized in Table 11.

Equation 1: Maximum Oocysts Loading from all Schuylkill River Watershed WWTPs:

$$\Sigma_{\text{all WWTPs in Schuylkill River watershed}} [\text{average effluent discharge rate} * 365 \text{ days} * \text{maximum oocysts per liter treated wastewater}] = \text{maximum oocysts per year discharged into Schuylkill River watershed}$$

Equation 2: Minimum Oocysts Loading from all Schuylkill River Watershed WWTPs:

$$\Sigma_{\text{all WWTPs in Schuylkill River watershed}} [\text{average effluent discharge rate} * 365 \text{ days} * \text{minimum oocysts per liter treated wastewater}] = \text{minimum oocysts per year discharged into Schuylkill River watershed}$$

Table 11: Schuylkill River Watershed Loading from WWTP Effluent

Schuylkill River Watershed Loading	Min Estimate (oocysts/year)	Max Estimate (oocysts/year)
WWTP Effluent	5.09E+09	6.51E+14

4.1.3 *Cryptosporidium* Loading Reduction from UV Installation at WWTPs

In the WCP, the range of potential *Cryptosporidium* inactivation and loading reduction from the addition of UV disinfection at two WWTPs, Upper Gwynedd and Fleetwood, is calculated using in Equation 1 and Equation 2 with average effluent discharge rates for only Upper Gwynedd and Fleetwood WWTPs and an assumed additional 3 log (99.9%) removal. The calculation is further detailed in Section 7.5.3.1 of Appendix A of the WCP (PWD, 2011). The

results of these calculations are presented in Table 12 and compared to the WCP target loading reduction in Section 5.

Table 12: Loading Reduction Estimates from UV Installation at WWTPs

Structural Control Measure	Min Potential Inactivation (oocysts/year)	Max Potential Inactivation (oocysts/year)
UV Installation - Upper Gwynedd	1.41E+08	1.80E+13
UV Installation - Fleetwood	2.61E+07	3.34E+12

4.2 Agricultural Best Management Practices

In the WCP, PWD outlines a number of actions to reduce *Cryptosporidium* in the Schuylkill River watershed from agricultural runoff. These include five manure storage basins and five vegetated buffers on separate farms. PWD contributions to the Schuylkill River Restoration Fund (SRRF) and involvement in the SAN Agriculture Workgroup are the main vehicles for identifying projects and implementing them. Projects funded by the SRRF and the SAN partners are described in the following sections.

4.2.1 Schuylkill River Restoration Fund Farms

In 2006, Exelon, SAN, and the Schuylkill River Heritage Area (SRHA) established the Exelon Restoration Fund, now the SRRF. The SRRF provides grants to support projects that improve and protect water quality in the Schuylkill River watershed. Initially, Exelon provided all the funding to fulfill a financial requirement in their DRBC docket for the Wadesville Mine Demonstration Project. Beginning in 2009, PWD became the second yearly contributor to the SRRF. Partnership for the Delaware Estuary (PDE) became a donor in 2010 and Aqua PA followed in 2012. Members of the SAN serve as technical experts in the grant selection process to support the review of project applications for their benefit to the Schuylkill River watershed. SRHA, managed by the nonprofit Schuylkill River Greenway Association, oversees the SRRF and distributes grant money.

PWD has been part of the grant recipient selection process since the creation of the SRRF. Since 2009, PWD has contributed $100,000 annually to the SRRF. As a contributor to the SRRF, one to two project applications per year are deemed high priority to PWD. These projects are advocated for by PWD in grant award deliberations.

In 2014, three farms received funding from the SRRF. The PWD high priority projects in 2014 were agricultural best management practice (BMP) installation at the Martin farm and the A. Zimmerman farm. In addition, PWD also evaluated and supported one additional agricultural BMP project at the Rice farm. Farms receiving SRRF grants also receive match funding and project support from other SAN and watershed partners including Natural Resource Conservation Service (NRCS), Berks Conservancy (BC), Berks County Conservation District (BCCD), local townships and water suppliers. The three SRRF farm projects are described here in detail.

Martin Farm

The Martin farm is a 2014 PWD high priority project and is located in the Saucony Creek sub-watershed. The Martin farm received an SRRF grant for a three-year BMP implementation project.

Figure 1: Martin Farm Project

Prior to the BMP project, the Martin farm, like many farms in the area, stored manure in an earthen lagoon. Figure 1(a) shows the earthen lagoon in a Google satellite image of the farm. Earthen lagoons can leak and contaminate groundwater and surface water sources. The karst and limestone geology in the area allow ground water to flow more rapidly though the subsurface making nearby surface waters vulnerable to contaminated groundwater. Additionally, the barnyard area was not sloped towards the lagoon, and rainwater on the site would become contaminated with nutrients and pathogens and flow off site. Figure 1(b) shows contaminated water leaching into the ground. The BMP implementation project will include the installation of an in ground liquid concrete manure storage basin, a waste transfer system, and barnyard and stormwater controls. The manures storage basin will provide 6 months of storage capacity. This makes it possible for the farmer to only apply manure as fertilizer to the fields twice per year at optimal nutrient absorption times rather than more frequently as old storage facilities quickly reached capacity. The project also includes animal use areas that will be sloped towards the storage basin to capture manure and contaminated stormwater runoff. Figure 1(c) depicts concrete animal areas sloping towards a manure storage basin. Rain gutters

will keep clean rainwater from building roofs away from manure and directed off site as show in Figure 1 (d). Construction is expected to be completed by December 2014.

A. Zimmerman Farm

The A. Zimmerman farm is a 2014 PWD high priority project, and is located also in the Saucony Creek sub-watershed. The Zimmerman family farm is a dairy farm operated by L. Zimmerman and a heifer farm operated by A. Zimmerman. The A. Zimmerman farm received an SRRF grant in 2014 for Phase I of a four-year BMP implementation project. Future phases II and III will address BMP implementation at the L. Zimmerman Farm.

Figure 2: A. Zimmerman Farm Project

Manure at the A. Zimmerman farm was previously stored in uncovered piles on the farm as shown in Figure 2(a). Nutrient and pathogen laden rainwater runoff from these piles leaches into the groundwater. Like the Martin farm, the Zimmerman family farm does not have a surface water tributary to the Saucony Creek However, the karst and limestone geology allow ground water to flow more rapidly though the subsurface making nearby surface waters vulnerable to contamination. This BMP implementation project includes the construction of two dry manure storage areas with concrete floors and walls, shown in Figure 2(b). The project will also include barnyard runoff and stormwater controls to control contaminated runoff and direct clean water off site. Project construction is expected to be completed by the end of 2014.

Rice Farm

The Rice farm is located Maiden Creek watershed. An unnamed tributary to the Maiden Creek flows through the property. The Rice farm received an SRRF grant in 2014 for Phase I of a four-year BMP implementation project.

Figure 3: Rice Farm Project

Prior to this BMP implementation project, manure from the Rice Farm was stored in an earthen lagoon. The earthen lagoon, show in Figure 3(a) was located adjacent to a wetland and tributary to the Maiden Creek watershed. Additionally, animal use areas were sloped towards the wetland area and had no concrete or curbing to hold contaminated runoff onsite. The project includes the construction of a 6-month heifer dry manure storage structure and a 6-month liquid manure storage basin. The liquid manure storage basin, show in Figure 3(b) is particularly unique. The Rice family uses sand as bedding for some of their animals. Although desirable for the animals, sand can inundate the manures storage facility. A ramp now allows easy access for sand removal after the manure has been removed and applied to the fields. The project also includes a concrete animal area with curbing, barnyard controls, rain gutters and lined outlets to control contaminated stormwater runoff and direct clean rainwater off site. Phase I is expected to be completed by December 2014.

4.2.2 *Cryptosporidium* Loading from Agricultural Land

To estimate a range of *Cryptosporidium* loading from agricultural land runoff in the Schuylkill River watershed, minimum and maximum loadings were calculated in the WCP using the runoff method and the animal population method detailed in Section 7.5.1.1 in Appendix A of the WCP (PWD, 2011). To estimate the *Cryptosporidium* loading using the agricultural runoff method, the estimated number of oocysts from two agricultural land use types (pasture/hay and row crops) are summed. The method uses agricultural land acreage in Queen Lane's Zone B (PWD, 2002), event mean concentrations of *Cryptosporidium* (PWD, 2006), rainfall in Hamburg, Pennsylvania (World Climate), and the average of high and low runoff coefficients for the two land use types (McCuen, 2004). The runoff method is described by Equation 3. To estimate the *Cryptosporidium* loading using the animal population method, the estimated number of oocysts from beef cattle, dairy cattle, and calves, swine, sheep and horses are summed using numbers of animals in the watershed (USDA, 2002) multiplied by infection prevalence and oocyst shedding rates from available literature sources as noted in Appendix I. The animal population method is described by Equation 4. The results are summarized in Table 13.

Equation 3: Agricultural Runoff Method (Minimum Estimate):

$\Sigma_{\text{pasture/hay and row crop land use types}}$ *[Acres agricultural land * event mean concentration for Cryptosporidium * rainfall per year * average runoff coefficient] = oocysts per year introduced to Schuylkill River watershed*

Equation 4: Animal Population Method for Farm BMP Projects (Maximum Estimate):

$\Sigma_{\text{dairy cattle, beef cattle, calves}}$ *[number of animal type * estimated prevalence of infection in animal type* oocysts shed per day per animal*365 days]*
$+ \Sigma_{\text{swine, sheep, horses}}$ *[number of animal type* estimated prevalence of infection in animal type* animal mass*weight of manure per day per weight animal*365 days*oocysts per weight manure] = oocysts per year introduced to Schuylkill River watershed*

Table 13: Schuylkill River Watershed Loading from Agricultural Land Runoff

Schuylkill River Watershed Loading	Min Estimate (oocysts/year)	Max Estimate (oocysts/year)
Agricultural Land Use	6.65E+12	7.75E+14

4.2.3. *Cryptosporidium* Loading Reduction from Agricultural BMP Projects

To estimate the Schuylkill River watershed *Cryptosporidium* loading reduction from the agricultural BMPs installed, the WCP follows a set of assumptions. First, a "standard" farm with several set parameters is assumed. All assumptions were confirmed as appropriate for the Schuylkill River watershed with local agricultural management experts, Larry Lloyd from BC and Nick Ramsey from NRCS. The characteristics of the standard farm are as follows:

- 120 acre dairy farm
- 80 cows (includes heifers) and 10 calves

Second, *Cryptosporidium* removal rates of 2 log (99%) and 100% are assumed for vegetated buffers and manure storage basins, respectively. Additional information may be found in Section 7.5.3.2 in Appendix A of the WCP (PWD, 2011).

Using the assumed "standard" farm characteristics, *Cryptosporidium* removal rates by BMPs and the same methods described for the estimation of the Schuylkill River watershed *Cryptosporidium* loading from agricultural runoff, minimum and maximum estimates for the impact of five manure storage basins and five vegetated buffers are calculated in the WCP, Table 14.

Table 14: *Cryptosporidium* Loading Reduction Estimates from Agricultural BMPs

Structural Control Measure	Estimated Min Reduction (oocysts/year)	Estimated Max Reduction (oocysts/year)
Manure storage basins – 5 farms	1.10E+10	1.20E+13
Vegetated buffers – 5 farms	1.09E+10	1.19E+13

In 2014, two manure storage basins were installed with PWD's support. The characteristics of the farms are:

Martin Farm

- 96 acre dairy farm
- 100 cows (including heifers) and 11 calves (ages 0-6 months)

A. Zimmerman Farm

- 68 acres heifer operation farm
- 244 cows (heifers only) and 81 calves (0-6 months)

The *Cryptosporidium* loading reduction per year is estimated for the Martin Farm and the A. Zimmerman Farm using the agricultural runoff and the animal population methods described in Equation 3 and Equation 4, respectively. For the agricultural runoff method, the number of acres of agricultural land in the watershed is replaced with the acreage of each farm. For the animal population method, the number of farm animals in the watershed is replaced with the animal population method, the number of farm animals in the watershed is replaced with the number of dairy cattle and calves at each farm because the Martin farm is primarily a dairy farm and A. Zimmerman farm is primarily heifers. Heifers are young female cows that have not born a calf. In the *Cryptosporidium* loading reduction calculations, heifers are assumed to be between six months and two years of age. The results of these calculations are presented in Table 15 and compared to the WCP target loading reduction in Section 5.

Table 15: Loading Reduction Estimates from Manure Storage Basins Implemented

Structural Control Measure	Estimated Min Reduction (oocysts/year)	Estimated Max Reduction (oocysts/year)
Martin manure storage basin	1.76E+09	2.65 E+12
A. Zimmerman manure storage basin	1.25E+09	1.95E+13

4.2.4 SAN Ag BMPs

Outside the SRRF, many other SAN partners contributed to the implementation of agricultural BMPs in the watershed in 2014 including NRCS, BC, BCCD. Table 16 estimates the number of agricultural BMPs implemented in 2014.

Table 16: Ag BMPs Implemented in 2014 through SAN partners

Ag BMPs Implemented in 2014 through SAN Partners*				
Comprehensive Nutrient Management	Manure Storages	Riparian Buffers (Acres)	Barnyard Repairs/ Heavy Use Areas	Stream Crossings
1	7	0	6	6

*These counts represent the number of projects completed with NRCS involvement. NRCS is responsible for much of the engineering required to complete the design and construction of many of the BMPs. However, additional projects were completed by other SAN partners making these counts a conservative estimate.

4.3 Comprehensive Nutrient Management Plans

Supporting the implementation of five Comprehensive Nutrient Management Plans (CNMPs) is another PWD action item outlined in the WCP. Manure management issues at farms are often addressed through the nutrient management plan process led by NRCS. The SAN and NRCS consider the completion of a CNMP, which includes a nutrient management plan and a conservation plan, at a farm a criteria for funding eligibility in the Schuylkill River watershed. As outlined in the WCP, PWD plays a role in the completion of CNMPs by supporting the implementation of agricultural BMPs, and working to ensure adequate resources are available to complete additional CNMPs. The farms that received SRRF grants had a CNMP in place prior to receiving the grants 2014. Additionally, NRCS implemented one CNMP in 2014.

4.4 Riparian Buffer Plantings

PWD is committed to helping implement one riparian buffer in the Schuylkill River watershed as part of the WCP. The site has not been determined as of 2014, but will be an animal vector impacted site with potential to affect water quality at the Queen Lane intake. However, through the SRRF and the SAN, a number of other riparian buffers have been planted throughout the watershed.

4.4.1 SRRF Riparian Buffer Plantings

The SAN members and high school students at Upper Perkiomen High School planted a riparian buffer along the portion of the Perkiomen Creek on the school's property. The project was funded as part of the 2013 SRRF grants, but implemented in 2014. There were no applications to the SRRF in 2014 for riparian buffer plantings.

4.4.2 SAN Riparian Buffer Plantings

Through TreeVitalize, over 1700 trees were planted on 12 acres in the Schuylkill River watershed throughout Montgomery, Chester and Philadelphia counties. With new funding in the watershed from the William Penn foundation, more buffer plantings are anticipated in future years with the help of SAN partners Stroud Water Research Center and BCCD.

4.5 Waterfowl Management

To address animal vectors of *Cryptosporidium*, PWD is committed to geese management through the WCP. PWD has active contracts with the United States Department of Agriculture (USDA) for geese management at Fairmount Park properties and PWD facilities. Geese management is conducted at Fairmount Park properties including Peter's Island, Pleasant Hill Park and Concourse and Centennial Park. Geese management is also conducted at PWD facilities including the Belmont WTP, Queen Lane WTP, Baxter WTP, Southeast WWTP, Southwest WWTP, Northeast WWTP, and Oak Lane Reservoir.

On Fairmount Park properties, the geese are dispersed or removed from the site. At PWD facilities, geese are dispersed using a range of harassment techniques including physical harassment, pyrotechnics, lasers and paintball guns. At all locations nests and eggs are treated with 100% food grade corn oil that stops embryo development by preventing air from passing through the shell.

The numbers of geese removed and dispersed and nests and eggs treated October 2013 through September 2014 at Fairmount Park properties are shown in Figure 4**Error! Reference source not found.**. A total of 13 Canada goose nests containing 61 eggs were treated, 190 geese were removed and 27,621 geese were dispersed from Fairmount Park properties. The numbers of geese dispersed and nests and eggs treated from October 2013 through September 2014 at PWD facilities are shown in

Figure 5. A total of 25 Canada goose nests containing 215 eggs were treated, and 6,845 were dispersed from PWD facilities.

From the data collected between 2011 and 2014, it is apparent that the geese management strategies implemented by PWD through contracts with the USDA are impacting goose populations, particularly at Peter's Island. Peter's Island is located directly upstream of Belmont WTP intake and offers prime breeding habitat for geese. In the past four years, PWD has observed a decrease in the number of eggs and nests and the number of geese removed from this site. In 2011, 499 eggs were treated in 90 nests, and in 2014, the number of eggs and nests decreased to 55 eggs treated in 12 nests. Additionally, 235 geese were removed from Peter's Island in 2012, and 27 geese were removed in 2014.

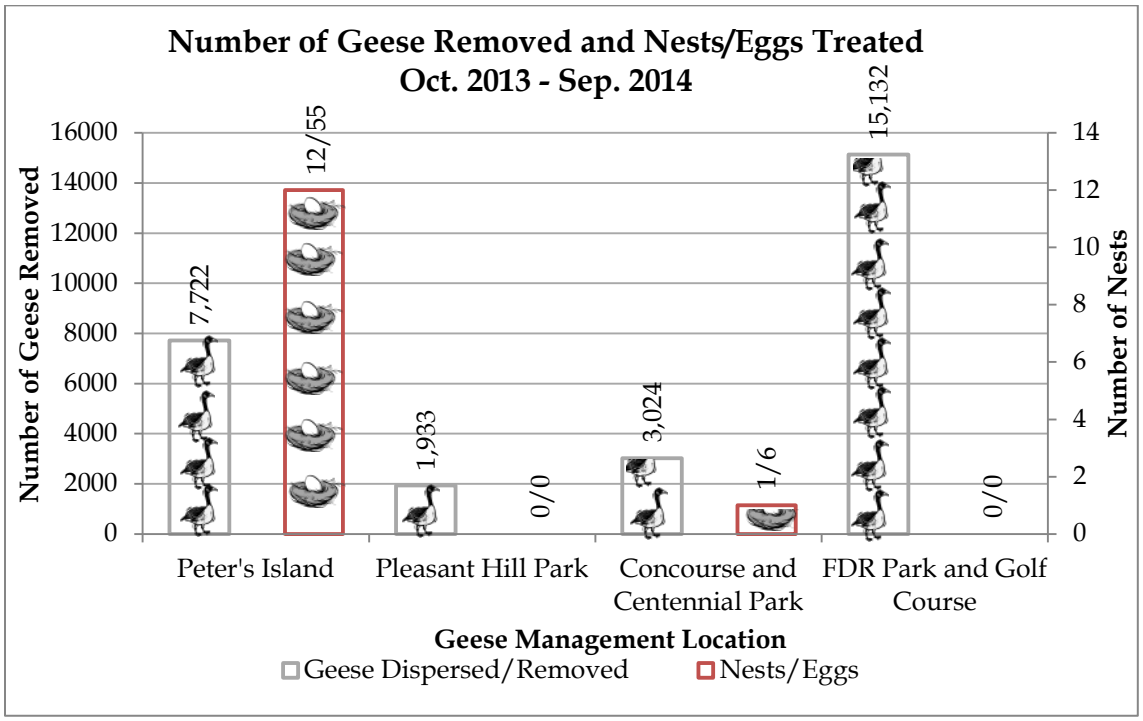


Figure 4: Geese Management at Fairmount Park Properties October 2013 through September 2014

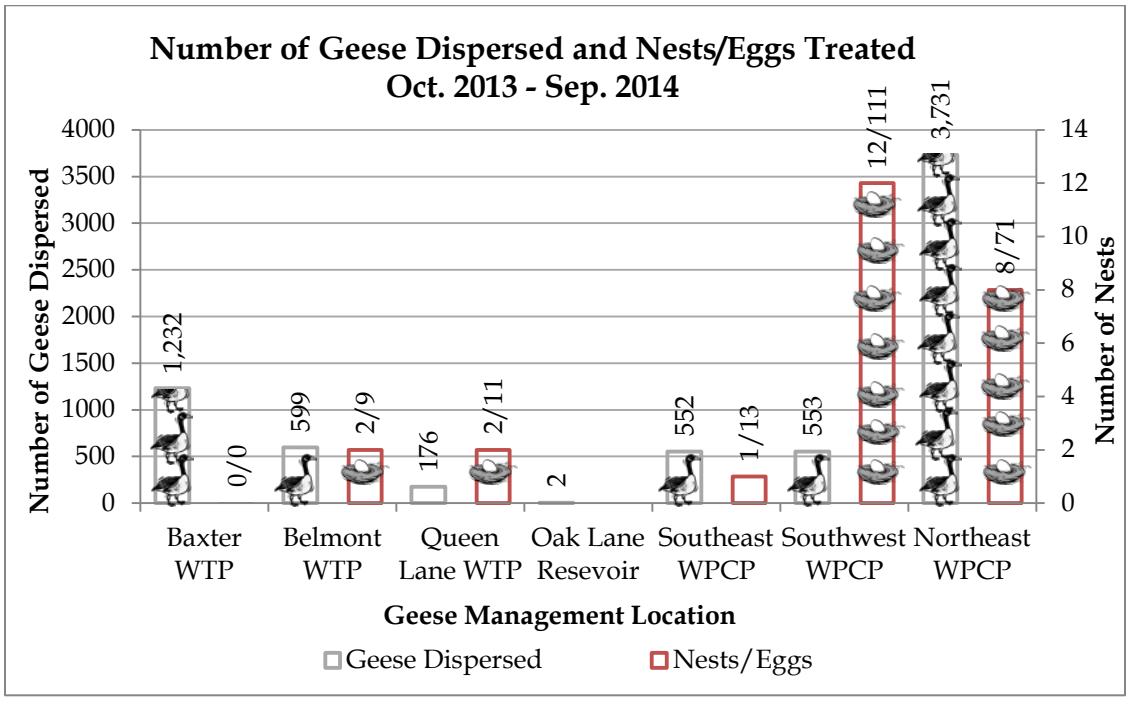


Figure 5: Geese Management at PWD Facilities October 2013 through September 2014

Section 5 2014 Watershed Control Plan Progress

5.1 Watershed Control Plan Project Summary

PWD has been a part of many projects and partnerships that support the WCP. Below is a summary of the action items PWD committed to as WCP deliverables and the progress made thus far. The UV installation projects upstream of the Queen Lane intake at Upper Gwynedd WWTP and Fleetwood WWTP, which PWD has followed through publically available information, are both fully operational, as reported in the 2013 Annual Status Report. PWD directly contributed to the SRRF, which awarded grants to support the construction of two manure storage basins at two separate farms in the Schuylkill River watershed in 2014. One new farm implemented a CNMP through NRCS in 2014. Geese were removed and nests and eggs treated at Fairmount Park properties and PWD facilities. The WCP progress in 2014 is summarized in Table 17.

After the completion of the second year of the WCP program, PWD has supported the implementation of four manure storage basins. The SRRF is the primary vehicle through which PWD can support projects on farms with the needed expertise and matching funds from partners. PWD has not had the opportunity to support riparian buffers on farms in the last two years through the SRRF. The NRCS, Berks Conservancy and the Berks County Conservation district take a holistic approach when implementing BMPs to control animal waste and stormwater on a farm. The BMPs include a riparian buffer for stream reaches on the property. Many of the farms entering into contracts for BMP projects do not have streams directly on the property. However, this does not make waste and stormwater management less important on the site. With earthen lagoons as manure storage basins, the groundwater is at risk for contamination. If groundwater on the site becomes contaminated, the karst and limestone geology in the Berks County area, which allows ground water to move quickly in the ground, will make nearby surface waters vulnerable to contamination as well. Additionally, PWD calculations presented in Section 4.2.3 assume manure storage basins contain 100% of *Cryptosporidium* on site, and riparian buffers filter 99% of *Cryptosporidium* from stormwater before it enters the stream. For this reason, PWD considers both manure storage basins and riparian buffers on farms in Berks County essentially equal in benefit to the watershed. PWD is always looking for opportunities to contribute to riparian buffers on farms, but will support manure storage basin SRRF grant requests in their place if no buffers are requested.

Table 17: WCP Project Progress Summary

	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	Under Construction
	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	Under Construction
	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		
	Farm BMP		
	Nutrient Management Plans		
	Riparian Buffer Planting		
	Waterfowl management		
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	

* There is an alteration to the original timeline described in Table 10. In both 2013 and 2014, PWD had the opportunity to contribute to a second manure storage basin project instead of a vegetated buffer at a farm.

5.2 *Cryptosporidium* Watershed Loading and Target Reduction

The WCP initiatives described in Section 4 have the potential to reduce the total loading of *Cryptosporidium* to the Schuylkill River. In order to quantitatively assess the impact of PWD projects and their potential to reduce the total loading of *Cryptosporidium* to the Schuylkill River, a series of calculations are performed (Sections 4.1 and 4.2). The calculations described serve as a preliminary step in developing a quantitative method to assess *Cryptosporidium* loading from priority sources in the Schuylkill River watershed. The methods used are based on assumptions and values found in published scientific literature. Due to a lack of scientific agreement regarding the methodology and accuracy of quantitative assessments of *Cryptosporidium* sources, the results should not be used to make absolute conclusions. The uncertainties associated with quantifying total *Cryptosporidium* loading across the Schuylkill River watershed, and reductions in that loading caused by the implementation of priority projects, highlight the need for continued and expanded *Cryptosporidium* research.

The WCP estimates a range of total *Cryptosporidium* loading in the Schuylkill River watershed comprised of contributions from priority sources: WWTP effluent, agricultural land runoff and stormwater runoff. The maximum and minimum *Cryptosporidium* loading from WWTP effluent was estimated using Equations 1 and 2 and the method summarized in Section 4.1.2. The maximum and minimum *Cryptosporidium* loading from agricultural land use runoff was estimated using Equations 3 and 4 and the method described in Section 4.2.2.

To estimate the *Cryptosporidium* loading from stormwater runoff, the estimated number of oocysts from three land use types (commercial/industrial/transportation, high density residential and low density residential) are summed. The method used urban land acreage in Queen Lane's Zone B (PWD, 2002), event mean concentrations of *Cryptosporidium* (PWD, 2006), rainfall in Hamburg, Pennsylvania (World Climate), and the average of high and low runoff coefficients for the land use types (McCuen, 2004). The results are summarized in Table 18.

Equation 5: Estimate of Oocyst Loading from Stormwater Runoff:

$$\Sigma_{\text{urban land use types}} [\text{number of acres of land use} * \text{event mean concentration for Cryptosporidium} * \text{rainfall per year} * \text{average rainfall coefficient}] = \text{oocysts per year introduced to Schuylkill River watershed}$$

Table 18: Schuylkill River Watershed Loading from Stormwater Runoff

Schuylkill River Watershed Loading	Estimate (oocysts/year)
Stormwater Runoff	1.14E+12

The methods used to perform the estimates of the total *Cryptosporidium* loading to the Schuylkill River watershed from priority sources are summarized in Table 19.

Table 19 Calculation Methods for Annual *Cryptosporidium* Loading Estimates

Schuylkill River Watershed Loading	Minimum Loading Estimate Method	Maximum Loading Estimate Method
WWTP Effluent	Minimum values for oocysts/liter in secondary effluent based on pooled values from various sources of literature documented in Crockett 2007. Oocyst concentrations are multiplied by average daily flow rates at each of the 72 WWTPs in the Schuylkill River watershed. Tertiary systems are assumed to have an additional 1 log removal.	Maximum values for oocysts/liter in secondary effluent based on pooled values from various sources of literature documented in Crockett 2007. Oocyst concentrations are multiplied by average daily flow rates at each of the 72 WWTPs in the Schuylkill River watershed. Tertiary systems are assumed to have an additional 1 log removal.
Agricultural Land Use	Method multiplies agricultural land area, runoff volumes, and *Cryptosporidium* event mean concentration, similar to the 2002 Source Water Assessment (SWA) approach.	Method estimates infected livestock populations for the Schuylkill River watershed and oocyst shedding rates for each category of livestock.
Stormwater Runoff	Method multiplies various land cover areas, runoff volume and *Cryptosporidium* event mean concentrations for urban/developed land, similar to the 2002 SWA approach.	
TOTAL LOADING	Summation of minimum estimates of Schuylkill River watershed *Cryptosporidium* sources.	Summation of maximum estimates of Schuylkill River watershed *Cryptosporidium* sources.

Upon determining an estimated range for the total Schuylkill River watershed *Cryptosporidium* loading, an attempt is made to establish a loading reduction target by comparing the observed average concentration of 0.076 oocysts/L at the Queen Lane intake during the Long Term 2 Enhanced Surface Water Treatment Rule (LT2) monitoring period (2001- 2003) to a desired Bin 1 concentration of 0.074 oocysts/L. The ratio of the maximum Bin 1 concentration to the observed concentration at the intake, 0.074/0.076 is used to calculate a target *Cryptosporidium* loading reduction of 2.7% in five years. Multiplying the estimated minimum and maximum total Schuylkill River watershed *Cryptosporidium* loadings by 2.7% yields minimum and maximum target reductions. The minimum target reduction is 2.11E+11 oocysts per year, and the maximum target reduction is 3.85E+13 oocysts per year.

As the WCP is implemented, project impact is assessed using the same approaches used to estimate the total Schuylkill River watershed *Cryptosporidium* loading. Schuylkill River watershed *Cryptosporidium* loading reductions from control measures implemented in 2013 and 2014 are estimated for UV installation at two WWTPs, and the construction of four manure storage basins at separate farms, Sections 4.1.3 and 4.2.3, respectively. The potential for reducing the total Schuylkill River watershed *Cryptosporidium* loading is then compared to the

range of target reductions established. Schuylkill River watershed loadings, target loading reduction and loading reductions from control measures are summarized in Table 20.

By summing the estimated impacts of UV installation at two WWTPs and BMP implementation at four farms, total estimates of *Cryptosporidium* loading reduction in year one and two of the PWD WCP are calculated. The impact of control measures implemented both in 2014 and over the life of the WCP is estimated to potentially account for 1.4% to 58% and 3% to 131%, respectively, of the target reduction goal. As previously mentioned, the estimates serve as a preliminary step in developing a quantitative assessment of Schuylkill River watershed *Cryptosporidium* loading reduction, and uncertainties in the method emphasize the need for further research.

Table 20: Schuylkill River Watershed *Cryptosporidium* Loading Reduction (2.11E+11 to 3.85E+13 Oocysts per Year) Summary

	Schuylkill River Watershed Loading	Minimum Estimate (oocysts/year)	Maximum Estimate (oocysts/year)		
Total Loading from Watershed	WWTP Effluent	5.09E+09	6.51E+14		
	Agricultural Land Use	6.65E+12	7.75E+14		
	Stormwater Runoff	1.14E+12	1.14E+12		
	TOTAL LOADING	7.80E+12	1.43E+15		
	WCP Structural Control Measure	**Minimum Potential Reduction (oocysts/year)**	**Maximum Potential Reduction (oocysts/year)**	**Minimum Reduction as % of Minimum Target Reduction**	**Maximum Reduction as % of Maximum Target Reduction**
2013	Upper Gwynedd WWTP UV Installation	1.41E+08	1.80E+13	0.07%	46.80%
	Fleetwood WWTP UV Installation	2.61E+07	3.34E+12	0.01%	8.70%
	Manure Storage Basin at Havens Farm	1.83E+09	4.82E+12	0.87%	12.51%
	Manure Storage Basin at Leid Farm	1.37E+09	2.17E+12	0.65%	5.63%
2014	Manure Storage Basin at Martin Farm	1.76E+09	2.65E+12	0.83%	6.88%
	Manure Storage Basin at A. Zimmerman Farm	1.25E+09	1.95E+13	0.59%	50.68%
2015	Farm BMP				
	Farm BMP				
2016	Farm BMP				
	Farm BMP				
2017	Farm BMP				
	Farm BMP				
5-Year Target Reduction	2.7% of Total Schuylkill River Watershed Loading	2.11E+11	3.85E+13	100%	100%
Cumulative Loading Reduction	WWTP UV Installation	1.67E+08	2.14E+13	0.08%	55.50%
	Farm BMPs	6.21E+09	2.91E+13	2.94%	75.70%
	TOTAL LOADING REDUCTION	6.38E+09	5.05E+13	3.02%	131.20%

Section 6 Expectations for 2015

In 2015, PWD will continue efforts toward goals outlined in the WCP. These include continuing addressing WWTP effluent, agricultural land runoff and animal vectors as priority sources of *Cryptosporidium*, as well as expanding education and outreach in the watershed through SWPP initiatives. It also includes completed WCP actions that specifically reduce *Cryptosporidium* the watershed. Specific focus will be on the following:

- Continued partnership with SAN for project facilitation and collaboration
- Continued support for research surrounding *Cryptosporidium* in Philadelphia's source water and watersheds in collaboration with Lehigh University.
- Continued funding towards SAN administration and the SAN Coordinator position
- A $100,000 contribution to SRRF for 2015 project grants
- Involvement with the SAN Pathogens/Compliance Workgroup to track wastewater discharge related changes in the watershed
- Involvement with the SAN Agriculture Workgroup to identify and contribute to CNMP and agricultural BMP implementation in the watershed
- Geese management at Fairmount Park properties and PWD facilities

References

American Society of Agricultural Engineerings. 2003. *Manure Production and Characteristics*. ASAE D384.1, St. Joseph, MI.

Carroll Engineering Corporation. 2013. *Municipal Wasteload Management North Wales Water Authority Wastewater Treatment Plant Annual Report Calendar Year 2012*.Print. Obtained through communication with PA DEP Southeast Regional Office.

Cox, Peter; Griffith, Merran; Angles, Mark; Deere, Daniel; & Ferguson, Christobel. (2005) *Concentrations of Pathogens and Indicators in Animal Feces in the Sydney Watershed*. Applied Environmental Microbiology. 71 (10):5929.

Crockett, C.S. 2007. "The Role of Wastewater Treatment in Protecting Water Supplies Against Emerging Pathogens." *Water Environment Research* 79.3: 221-32. Print.

Duzinski, Phil. 2008. *Schuylkill Action Network Pathogens Workgroup Study of Cryptosporidium Occurrence in Wastewater Treatment Plants.* Rep. Print.

Environmental Engineering & Management Associates, Inc. 2013. *Upper Gwynedd Township, Chapter 94 Municipal Wasteload Management, Annual Report 2012.* Print. Obtained through communication with PA DEP Southeast Regional Office.

Fayer, Ronald; Santin, Mónica; Trout, James M.; Greiner, Ellis. 2006. Prevalence of species and genotypes of *Cryptosporidium* found in 1–2-year-old dairy cattle in the eastern United States. Veterinary Parasitology, 135(2):105-112.

Jellison, Kristen L., Amy E. Lynch, and Joseph M. Ziemann. 2009. "Source Tracking Identifies Deer and Geese as Vectors of Human-Infectious *Cryptosporidium* Genotypes in an Urban/Suburban Watershed." *Environmental Science and Technology* 43.12: 4267-272. Print.

Jellison, Kristen. 2010a. *Detection and Genotyping of Cryptosporidium Spp. Oocysts in Water and Geese Faces in the Wissahickon Watershed: September 2008-May 2010*. Rep. Lehigh University, Department of Civil and Environmental Engineering, Bethlehem, PA. Print.

Johnson, E.; Atwill, E.R.; Filkins, M.E.; & Kalush, J. 1997. *The prevalence of shedding of Cryptosporidium and Giardia spp. Based on a Single Fecal Sample Collection from each of 91 Horses used for Backcountry Recreation*. Journal of Veterinary Diagnostic Investigation. 9.1:56-60. Print.

Fleetwood Borough. 2013. Fleetwood Borough Council Meeting Minutes. Web. www.fleetwoodboro.com/page3.html.

R.H. McCuen. 2004. *Hydrologic Analysis and Design*. Prentice Hall, Upper Saddle River, New Jersey, 07458, 3rd edition.

Philadelphia Water Department (PWD). 2002. *Belmont & Queen Lane Treatment Plant Source Water Assessment Report (PWSID #1510001)*. Publication.

Philadelphia Water Department (PWD). 2006. *The Schuylkill River Watershed Source Water Protection Plan, Belmont & Queen Lane Surface Water Intakes (PWSID #1510001)*. Publication.

Philadelphia Water Department (PWD). 2011. *Long Term 2 Enhanced Surface Water Treatment Rule Watershed Control Program Plan*. Publication.

United States Environmental Protection Agency (US EPA). 2006. *Federal Register: 40 CFR Parts 9, 141, and 142 National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule; Final Rule*. 3rd ed. Vol. 71. Print.

United States Department of Agriculture (USDA). 1993. *Cryptosporidium* is Common in Dairy Calves: National Dairy Heifer Evaluation Project. Web. http://www.aphis.usda.gov/animal_health/nahms/dairy/

U.S. Department of Agriculture (USDA). 2002. *2002 Census of Agriculture.* Publication.

World Climate. "Hamburg, Berks County, Pennsylvania USA Average Rainfall." Web. http://www.worldclimate.com/cgi-bin/data.pl?ref=N40W075+2300+363632C

Appendix A: SAN Pathogens/Compliance and SAN Agriculture Workgroups 2014 Meeting Minutes

SAN PATHOGENS/COMPLIANCE WORKGROUP FIRST QUARTER MEETING

Schuylkill Action Network Pathogen/Compliance Meeting Minutes
March 5, 2014

In Attendance:
EPA Region 3 - Chuck Kanetsky
Pennsylvania DEP – Joe Hebelka (Central), Steve O'Neil (SERO)
Philadelphia Water Department –Elizabeth Couillard
Partnership for the Delaware Estuary – Tom Davidock
Aqua Pa – Bob Kahley
Jesse Goldberg – Miller Environmental, Inc.
PENNVEST – Tess Schlupp

Minutes
Minutes from the December 11, 2013 meeting were reviewed and approved.

Workgroup Chair
Joe Hebelka will act as workgroup lead until a Co-chair replacement for the soon to be retired Chuck Kanetsky can be identified.

I. 2014 Workplan
The group reviews the 2014 workplan and incorporated proposed changes. The group discussed the source water notifications.

- STREATEGY 1:
    - The Berks EMA is interested in participating in the EWS. RAWA is working with them on notifications and can incorporate this into their discussions. This was discussed with the national focus on SWP because of the WV spill. New laws and regulations are being proposed in WV.
    - SE DEP is looking at ways to automate calls to utilities for pre-notification of possible problems. SE DEP said that power outages identified some problems. Suppliers should be calling EMA instead of PECO directly.
    - RAWA concerned about lack of notifications from DEP Reading Office. Referenced Kutztown sludge spill.
    - Groups discussed options for improving notification to water suppliers. Discussion focused on potential regs. that would require notification for various situations.
    - Discussed finding ways to increase usage of the EWS. One idea was ID Cards with call-in info. Joe will also reach out to Cathy Port to help identify solutions for regional office.

  - Joe suggested looking at tabletop exercises between two different regions
  - RAWA Holding two EMA and discharger training on March 26th, May 28th.
  - Possible hold county EMA specific training or participate in larger workshop such as PENNTECH
- Strategy 2: Updated
- Strategy 3: Updated
  - Discussed the High Flow Maintenance plan training. Still waiting on legal input. Won't be ready by 2Q 2014. We need to get this training right rather than rush it. Needs to deal with complicated issues with bypass limits and regulations. Moved to Q4 2014.
  - Pennvest interested in getting more projects. Tess mentioned that she would be willing to help facilitate discussion on new and innovative programs for SRF funding.
  - Jesse mentioned that Reading would be a good candidate for stormwater NPS Pennvest funding.
  - Joe asked if there was a Montgomery version of the Berks Water and Sewer Committee. Steve mentioned noting specific, but there is a infrastructure group that meets about general infrastructure issues.

II. SAN Annual Progress Report

- At printer and will be ready in approximately 1 week (in time for Schuylkill Congress).

III. Wet Weather Workshop

- Steve reported this is still a work in progress; discussions ongoing with Central Office and attorneys.

IV. Schuylkill Watershed Control Plan

- Chapter 94 data collection and spreadsheet
  - PWD discussed the data that was collected with the DEP SE Regional office. A lot of info was pulled to the extent possible. PWD plans to continue collecting data for SC Region. Not all reports are the same, which makes collection of data challenging.
  - The Hydrologic Loading data was also collected for this project.
  - The compliance and enforcement info, which was suggested by the workgroup as a possible data target, but we need to determine how to collect it.
    - Bypass flows should be reported in annual reports for WWTP
    - Question about how to report I&I information
    - Enforcement action: Can identify if there is a corrective action underway
    - Report will be updated every 5 years, with incremental updates when needed.

V. Quarries

- No update. Jessie will continue to investigate issue with DEP and EPA. Problem reported is that discharge is reported as being under limits, but is still causing TSS issues in the Maiden Creek. EPA Is involved and looking into it.

VI. Watershed Updates

- DBCD Dockets: Meeting on March 11th
- Disaster Management Training: Offered through DHS/FEMA. DEP was in communication with them about pursuing one in SE PA.
- Stormwater PRWA Course: Joe presented info

- Joe presented news headlines; noted Reading Eagle articles no longer readily available due to a required subscription.
- Chuck's final words; the workgroup members thanked him for his leadership and wished him well in his retirement. Chuck indicated that Beth Garcia most likely will be the EPA representative.

The next meeting will be held on June 18, 2014 at the PADEP Reading District Office.

SAN PATHOGENS/COMPLIANCE WORKGROUP SECOND QUARTER MEETING

Schuylkill Action Network Pathogen/Compliance Meeting Minutes
June 18, 2014

In Attendance:
EPA Region III – Beth Garcia (via phone)
PA DEP – Joe Hebelka (Central Office)
Partnership for the Delaware Estuary – Tom Davidock (SAN Coordinator)
Aqua PA – Bob Kahley
Miller Environmental Inc. – Jesse Goldberg
Philadelphia Water Department – Beth Couillard

Minutes from 3/5/2014 Workgroup Meeting – minor revisions as discussed.

I. 2014 Workplan

- The workplan was updated with feedback from the workgroup. The plan has been uploaded to the SAN website and can be downloaded by members.

II. Act 537 plans

- The group discussed the review of existing act 537 plans. We should take a look at this information regularly and see if there are any areas that we should be trying to address. We will review plans for the next meeting to identify priority areas.

III. High Flow Maintenance Plans Workshop

- No update- still waiting on guidance from DEP on legal issues.

IV. Schuylkill Watershed Control Plan

- The PWD annual status report has been approved.
- Progress is being made on Chapter 94 data gathering. The PWD has compiled info for the DEP SC region, which is in addition to the information that they compiled for the DEP SE region last year. PWD has this info available and can share with the group.

V. Quarries

- Jesse reported on RAWA's progress with the Quarry. There has been no remedy for the problem, but DEP leadership has been informed of the problem via a letter from the water authority. The workgroup discussed their ability to send a letter, but decided that it was unable to do since regulatory representatives are members of the workgroup.

VI. Watershed News

- DRBC Dockets for June 10th meeting
  - (Joe reported on this)
- BCWSA Activities
  - Disaster Management Training: The BCWSA is holding a Disaster Management Training for water utilities and municipal representatives on July 30th. Joe presented information on the training and the SAN was asked to share it with its members.
- Emergency Response Hotline for South-central Regional Office will be Changing
  - The emergency number was changed. The new number is 1-866-825-0208
- News Articles
  - Joe presented news articles from around the region.

VII. Other Items and next meeting date -

- DVEWS: No update

Next Meeting: September 10, 2014 at the PADEP Reading District Office.

SAN PATHOGENS/COMPLIANCE WORKGROUP THIRD QUARTER MEETING

Schuylkill Action Network Pathogen/Compliance Meeting Minutes
September 10, 2014

In Attendance:
Joe, Tess, Bob, Eric, Jesse, Tom, Megan, Beth, Cathy Port (Phone: SCRO) Scott and Joe (Phone: Bethlehem Office)

Minutes from 6/18/2014 Workgroup Meeting - No comments on the notes- S

I. 2014 Workplan

- 4Q 2014: We discussed holding an EWS training. Berks EMA expressed interest. Possibly hold it in Berks at the EMA training center. WE need to reach out to Brian Gutshall. Joe inquired with NERO about their participation. They will check to see who would be interested.
- Bob asked about SAN's involvement with the EWS. Bob mentioned that Aqua PA desires to develop a system for their other service areas outside of the Schuylkill. Joe presented some additional info on other state systems that they can look at as well.
- 3Q 2014: Discuss noncompliance screen data. Eric mentioned that there really hasn't been much out there in Berks. No report from NERO. SERO wasn't at the meeting.

II. Act 537 plans

- July: Secretary of DEP supported on-lot initiative, which will identify new technologies, and appointed members to advisory committee to move it forward.

- Meeting was held with SERO to look at plants greater than 20 years old. It provided some preliminary info, which wasn't acted on recently. SCRO provided some info over email prior to the previous Pathogen Workgroup meeting.
- Joe provided will make this info available to PWD and RAWA. Joe asked if the NERO would be willing to do something similar. PWD is compiling the data, which will include mapping. The discharges can be downloaded in KML or GIS files from PASDA.

III. High Flow Maintenance Plans Workshop

- There hasn't been much of an update on this from Steve O'Neill. There hasn't been much progress on this in the past several months. We need to still get DEP approval on moving this forward.
- Jesse said that it may be better to identify a project that will benefit everybody. An example is Pharmaceutical outreach. Possibly a sampling project in the watershed.
- Other Item: EPA developed guide on waste water flooding. Flood Resilience tool was developed. Not necessarily targeted at plants.

IV. Schuylkill Watershed Control Plan & PWD Chapt. 94 File Review

- PWD gave an update on their report project. PWD compiled report data from SERO and Berks County. PWD would like to also do this in the NERO. Beth passed out a spreadsheet of compiled plant information. There is a significant amount of plant details pulled from the Chapter 94 report. The PWD will make the electronic version of this report to the workgroup. They also provided a draft memo of the project that describes the goals and next steps.
- There is still some information that is needed, but the majority has been compiled. The PWD is working with SERO and SCRO to fill in the gaps. The plan is to update the report every 5 years.

V. William Penn Foundation clusters

- Tom provided a quick update on the WPF clusters. In the MS, grants have been awarded for Ag restoration projects in the Maiden Creek Watershed (BCC) and Tulpehocken (Stroud). Monitoring is underway in the MS. Volunteer training is starting up tomorrow for the Schuylkill Highland Cluster.

VI. Watershed News

- DRBC WWTP Dockets for September 9th meeting
  - Joe reported on new/revised Dockets: Knoll Industrial WW treatment, Upper Merion Twp, New Hanover, Upper Hanover, Straustown, City of Reading.
  - Tes reported on the City of Reading Progress. She mentioned that she can help set up a tour for the Workgroup if interested. Joe will place it on next year's workplan.
- DVEWS
  - Joe mentioned the fertilizer spill that was reported on in Chester County. Killed fish for about 150 yards.
  - Joe asked Eric if the Berks WW plants were familiar with the DVEWS. HE said that some are and that they know to call the DEP Emergency Update.
- BCWSA Activities

    - The BCWSA held the Emergency Management Training in July. Jesse mentioned that they are sharing similar information with facilities within their service area.
- News Articles
    - Joe presented his news articles

Next meeting date: December 10, 2014 10 AM at Reading District PADEP Office
SAN Annual Meeting – November 14th, 2014

SAN PATHOGENS/COMPLIANCE WORKGROUP FORTH QUARTER MEETING

Schuylkill Action Network Pathogen/Compliance Meeting Minutes
December 10, 2014
PADEP – Reading District Office

In Attendance:
Joe Helbelka, PADEP
Tess Schlupp, PENNVEST
Virginia Vassalotti, PDE
Lyn O'Hare, for WBWA
Jesse Goldberg, RAWA / Miller Environmental
Kelly Anderson, PWD
Beth Couillard, PWD
Meghan Cash, PWD
Bob Kahley, Aqua PA
Beth Carcia, EPA (via phone)

I. PDE SAN Fellow, Virginia Vassalotti
II. Minutes from 9/10/2014 Workgroup Meeting
- Minutes were handed out and are available online.

III. Review 2014 Work Plan/Update 2015 Work Plan
- Tess suggested a tour of Reading WWTP for next work plan.
- We will revisit updating work plan at next meeting.

IV. PWD – Chapter 94 Report Reviews
- Beth C. said that reporting from DEP Regional offices is almost complete. The SE and SW regional office reports are done and they still need NE regional office report. We explored the idea of having an intern or fellow (maybe Virginia?) make copies of the NE regional office reports. Or if there was a way to get the reports to Bethlehem offices, someone could make the trip up there to make the copies.

V. Delaware Valley EWS (DES becoming a part of)
- Kelly suggested holding an EWS training in the Spring at the Berks County Water and Sewer Association Conference. Beth G. offered to help with tech support for a webinar.
- Kelly also suggested having a "EWS Champion" or expert person for people to contact if they are unsure of if an event should be entered into the system.

VI. PWD Schuylkill Watershed Control Plan

- An update is due at the end of January. Kelly has been having a hard time getting information from NRCS. Tom suggested getting in touch with Barry Evans at Stroud (mapsheds) and will introduce Beth C. and Kelly to him.

VII. Act 537 Plans

- No one in the DEP SC office is currently working on 537 plans – no update.

VII. High Flow Maintenance Plans Workshop

- Joe followed up with Steve O'Neil – plans are still on hold as of now.

IX. BCWSA Activities

- Solid Waste Authority does a pharmaceutical takeback program.
- RAWA has a contract with Stroud to electrofish the Maiden Creek in hopes of finding trout to reclassify the stream as either high quality or exceptional value. This is part of the PA Fish and Boat Commission un-assessed water program.

X. William Penn Foundation Clusters

- The next round of grants for project implementation opens in early 2015.
- Tom mentioned that the Academy of Natural Sciences is putting together a "wish-list" of monitoring items to submit to the WPF. Let ANS know if you have any items to add to their wish-list.
- There will be an all-cluster meeting in the Poconos on Thursday, January 15 – Friday, January 16.
- Tom talked about Stroud's Wiki Watershed tool and how Stroud received funding from the National Science Foundation and the WPF to update their website. There are 3 components to the website: 1) Model my Watershed (funded by WPF); 2) Monitor my Watershed; and 3) Manage my Watershed. Stroud is visiting all of the WPF clusters to present the tool and receive feedback from the clusters.

XI. Watershed News

- Jesse brought up a Superfund site on the Maiden Creek, in the City of Reading, where there used to be a battery disposal site. The ground adjacent to the creek has extremely high levels of lead.
- The Growing Greener grant announcement is still on hold.

XII. Other Items

- Jesse is interested in holding an education and outreach workshop on emerging pathogens and getting in touch with Vicki Blazer, USGS as a possible presenter. An idea for the target audience is water suppliers, but has yet to be confirmed.
- Kelly talked about the 40th anniversary of the Safe Water Drinking Act meeting in DC that was held on December 9th. The two main challenges in the future that we'll see relating to source water protection are emerging pathogens and climate change.

XIII. SAN Annual Meeting Wrap-Up

- Presentations posted on SAN Website at: http://www.schuylkillwaters.org/projectsDetail.cfm?pid=89

XIV. Next Meeting Date

- Wednesday, March 11th 10:00 AM – 12:00 PM at PA DEP Reading Office

XV. WWTP Dockets for DRBC December 9th meeting

- available online: http://www.state.nj.us/drbc/meetings/upcoming
- Fleetwood Borough Authority WWTP (Willow Creek)
- Maiden Creek Township Authority WWTP (Willow Creek)
- Pottstown Borough Authority WWTP (Schuylkill River)

- Pottstown Borough Authority Filtration Plant Withdrawal and NPDES discharge permit (Schuylkill River)
- Giorgio Foods Inc. WWTP (Willow Creek)

SAN AGRICULTURE WORKGROUP FIRST QUARTER MEETING

Schuylkill Action Network Agriculture Workgroup
02.12.14 Meeting Notes

Attendees:
Beth Couillard, Phila Water Dept.
Kristen Saacke Blunk, Headwaters LLC/NFWF
Lamonte Garber, Stroud Water Research
Ross Stowell, Berks Conservation District Associate Director
Christine Esterline, Berks Conservation District
Jesse Goldberg, Miller Environmental/RAWA
Beth Garcia, Environmental Protection Agency
Chuck Kanetsky, EPA Environmental Protection Agency
Nick Ramsey, Natural Resources Conservation Service
Kate Keppen, Berks Conservation District
Larry Lloyd, Berks Conservancy
Kimberly Fies, Berks Ag Land Preservation
Bill Angstadt, Angstadt Consulting
Joe Hebelka, Dept of Environmental Protection-Central Office
Tom Davidock, Partnership for the DE Estuary/SAN Coordinator
Chip Bilger, Western Berks Water Authority
Lyn O'Hare, SSM Group

Review of November 2013 Meeting Notes – no corrections
Special Presentation – PENNVEST Kopfer/Havens Project - Kate

I. **Update on grant requests/funding efforts**

- William Penn Foundation/Middle Schuylkill Cluster – Planning grant is in place, the NFWF proposals for projects are due in March.
- Berks Watershed Restoration Fund – Funding supported by RAWA, WBWA, Kutztown Borough, and Saucony Creek Brewery. Saucony Creek donated $4,300 through sales of Stonefly IPA.
- Fish & Boat projects - Cacoosing and Hospital Creek dams are budgeted; Bushong will be assessed.
- Coldwater Heritage grant – RAWA submitted proposal for Furnace Creek E&S/signs/macro survey; conference scheduled for late February.
- USDA-Regional Conservation Partnership Program. NRCS said that the new program takes funding from several other programs and consolidates it. More details when available. Bill suggested that the DE Estuary be nominated as a critical area, PDE will follow up.

- Farm Bill/EQIP – 2014 Farm Bill signed; NRCS finished project rankings.
- Growing Greener Ag BMP grant – Stroud received funding for Farm Stewardship Program, which offers vouchers to farmers for installing BMPs. Farmer meetings scheduled for 3/31 in Shartlesville, and 4/2 in Myerstown.
- Schuylkill River Restoration Fund –2014 grant round Letters of Intent due March 28. Full application due May 29.
- Water Resource Education Network - 2014 proposals due March 21.

II. **Projects in Progress**

- Schuylkill River Restoration Fund – Conservancy completed 2013 projects; 2014 grant
- Maiden Creek/Tulpehocken watershed monitoring program (WPF) – Selected MC points; meeting to determine Tully points.
- RAWA invasives removal – Japanese Hops removal in Willow Creek targeted for late summer.
- Willow Creek – one year on Fish & Boat grant; Maiden Creek Authority tree planting.
- Wyomissing Creek Watershed Coalition (Coldwater Heritage) – Plan is complete, now considering implementation strategies.
- PWD Watershed Control Plan – annual report is completed; source water assessments in progress, to be finished in Spring quarter.
- BCCD Topton Creek/Reading HS – both projects in the contract process; Reading HS green infrastructure energy audit is scheduling for April.
- EPA 319 Implementation Plan – awarded through William Penn Foundation for Maiden Creek focus area, to start in Spring 2014.

III. **Education/Outreach**

- Berks Conservation District – Innovative Ag Workshop postponed to Feb 20
- PWD/PDE – Ag Education materials – Ag guide on BMPs scheduled for spring 2013; members asked for feedback ASAP.
- Schuylkill Acts & Impacts program – Schuylkill Headwaters has the application for students; donations for scholarships still welcome.
- SAN Progress Report – in progress, target distribution date in March.

IV. **Planning**

- 2014 Ag Workplan – Reviewed the suggested changes for this year, any comments or additions to Tom Davidock by Feb 28.
- SAN is considering starting a Funding subcommittee, more details in the future.
- SAN Scholastic Awards – 3 regional awards for May presentations. Applications will be placed on the website.

V. **Other Workgroup Updates**

- Schuylkill Action Students – Robeson Elementary is completed; Kutztown Middle will finish in spring. Conrad Weiser Middle will be building a rain garden for the program.

VI. **Other**

- Berks Conservancy requested a letter from the Ag Workgroup in support of the NFWF grant proposals due March 6.
- A cover crop program in NJ has a special fund of $400,000.
- PA Conservation Innovation Grants has Brooke Rosenbaum as coordinator.

Next Meeting: WEDNESDAY MAY 14, 2014 – 10:00 AM at the Berks Agricultural Center**.**

SAN AGRICULTURE WORKGROUP
SECOND QUARTER MEETING

Schuylkill Action Network Agriculture Workgroup
05.14.14 Meeting Notes

Attendees:
Tom Davidock, Partnership for the DE Estuary/SAN Coordinator
Jineen Boyle, DEP-Southcentral Region
Lyn O'Hare, SSM Group/Workgroup Chair
Beth Couillard, Philadelphia Water Dept
Kate Keppen, Berks County Conservation District
Ashton Hogarth, SSM Group
Tess Schlupp, PENNVEST
Larry Lloyd, Berks Conservancy
Ross Stowell, Concerned Citizen
Bob Kahley, AquaPA
Beth Garcia, EPA Region III
Dan Greig, Berks County Conservation District
David Wise, Stroud Center
Damian Painter, Lehigh County Conservation District
Jesse Goldberg, RAWA/Miller Environmental
Joe Hebelka, DEP-Central Office
Christine Esterline, Berks County Conservation District
Christine Ziegler Vish, NRCS
Derek Rice, NRCS

Review of February 2014 Meeting Notes

I. Update on grant requests/funding efforts

- Berks Watershed Restoration Fund – RAWA and Kutztown Boro support Conservancy with funds; WBWA provides project dollars through golf event
- USDA programs – Ross working on programs and funding in June; contracts will be starting soon; some current staffing shortages
- Schuylkill River Restoration Fund – Conservancy and BCCD submitting applications by May 28 deadline; projects include Zimmerman farm; David Rice. SRRF used as cost share with other funds.
- Growing Greener – new grant round in July; Upper Maiden is a priority watershed; check with Jineen for pre-approval discussion before submitting application.
- Conservancy will submit for funding for Angelica Park through Schuylkill Highlands CLI
- Possible Enviro Ed grant with Twin Valley/Commissioners
- DCED has watershed related grants through Act 13's Commonwealth Financing Authority (CFA).

II. Projects in Progress

- William Penn Foundation/NFWF – PDE/Conservancy/Stroud – waiting for notification on submitted projects; watershed monitoring program is in progress
- Growing Greener Ag BMP grant – Stroud received $400,000 for projects in Berks and Chester;, working on contract
- Fish & Boat -Conservancy – Hospital Creek dam may be repaired; City of Reading doing analysis on Bushong dam.
- RAWA invasives removal – Japanese Hops in Willow Creek; plan for Maiden Creek Twp with RAWA
- Wyomissing Creek Watershed Coalition (Coldwater Heritage) – BCCD and committee are prioritizing projects; monitoring through 319 program.
- PWD Watershed Control Plan – Received verbal approval from DEP
- BCCD Topton Creek/Reading HS – BCCD is working on bid process and contracts
- EPA 319 Implementation Plan – PDE plans to develop plan with William Penn Foundation grant. WIP plan for Maiden Creek; meeting later in summer.
- WBWA Pathogens Reduction Plan – SSM Group will be starting a plan updating studies from the Tulpehocken, and working with Ag partners on reductions of pathogens PSOCs.

III. Education/Outreach

- PWD/PDE – Ag Education materials – Ag guide to be printed in June; PWD plans a conference call with utilities
- Schuylkill Acts & Impacts application – Schuylkill Headwaters – Event planned for June; several water suppliers have donated funds for student scholarships.
- Stroud will be placing an ad in the Lancaster Farming paper for workshops; presentations to Granges and Trout Unlimited
- PA Land Trust Association – Conservancy was a sponsor/host; several workgroup partners were presenters at workshop.

IV. Planning

- SAN Picnic – June - TBD

V. Other Workgroup Updates

- Schuylkill Action Students projects to be completed in June

VI. Other

- DEP-Southcentral Region has a new after-hours emergency number: 866-825-0208
- RAWA had tree planting at Lake Ontelaunee
- Western Berks and RAWA were sponsors at the Berks County Envirothons
- Schuylkill Sojourn – Tom will be doing presentation during the Tuesday in Pottstown
- PACD website upgraded with lots of new resources
- PENNVEST funding available – YouTube videos provide guidance for submitting applications; good outreach
- REAP has approximately $10M for Ag BMPs. Stroud is considering the Swatara watershed.
- Rosetree Consulting – 4R Alliance – fertilizing workshop
- BCCD/NRCS will split cost of new staff member to work on programs.
- BCCD plans a new GIS geodatabase
- Environmental Quality Board voted to not upgrade the Perkiomen Creek designation

Next Meeting: WEDNESDAY AUGUST 6 – 10:00 AM at the Berks Agricultural Center

SAN AGRICULTURE WORKGROUP
THIRD QUARTER MEETING

Official August 6, 2014 meeting minutes were unfortunately lost. Below are the meeting agenda and unofficial notes taken by PWD Source Water.

Schuylkill Action Network Agriculture Workgroup
08.06.14 Meeting Agenda

INTRODUCTIONS/NEW MEMBERS
Review of May 2014 Meeting Notes

I. Update on grant requests/funding efforts
- Berks Watershed Restoration Fund – Conservancy
- USDA programs – NRCS
- Schuylkill River Restoration Fund – Conservancy
- Growing Greener – new grant round
- Other applications/proposals

II. Projects in Progress
- William Penn Foundation/NFWF – PDE/Conservancy/Stroud
- William Penn watershed monitoring program – PDE/Conservancy/Miller/Stroud
- Growing Greener Ag BMP grant – Stroud
- Fish & Boat (Cacoosing, Hospital Creek, Bushong dams) - Conservancy
- RAWA invasives removal – Japanese Hops in Willow Creek
- Willow Creek – Conservancy
- Wyomissing Creek Watershed Coalition (Coldwater Heritage) – BCCD
- BCCD Topton Creek/Reading HS – BCCD
- EPA 319 Implementation Plan for Maiden Creek – PDE
- WBWA Pathogens Reduction Plan
- Other

III. Education/Outreach
- PWD/PDE – Ag Education materials – Ag guide on BMPs available
- Schuylkill Acts & Impacts follow-up – Schuylkill Headwaters

IV. Planning

V. Other Workgroup Updates
- Schuylkill Action Students projects

VI. Other
- Planning Commission – New Exec Director

Schuylkill Action Network Agriculture Workgroup
08.06.2014 UNOFFICAL MEETING NOTES (PWD)

I. Update on Grant Requests/Funding Efforts
- USDA programs – NRCS:

- 2014 EQIP sign up; 35-40 contracts in Berks and Schuylkill; $1.5 million for 2014
- 10 NWQI contracts- Maiden and Saucony Watersheds
- RCPP submittals have been ranked and reviewed but selections have nto been made
- Some SAN Ag groups submitted applications
- RCPP proposal from Stround into state pool- Chester Co Delaware portion
- Schuylkill River Restoration Fund
    - Rice (Berks Conservancy); Martin (Berks Conservancy); Zimmerman (Berks County Conservation District
- Growing Greener grants
    - Grants received, to be announced in fall
    - 2 Ag BMP applications in Berks (BCCD); one is a stream bank stabilization and the other is a 3 farm package
    - Available $ undefined – 15-20 million includes Act 13 funds ($5 million from gas extraction
- Other applications/proposals
    - CREP – riparian buffers open
    - NFWF - BC awarded $250 towards BMPs (Rice, Martin, Souder, Burkholder and Zimmerman)

II. Projects in Progress

- William Penn watershed monitoring program – PDE/Conservancy/Miller/Stroud
    - Annual macro, quarterly chemical
    - Not ICE protocol, macro- Stroud method
    - Miller – Maiden Creek
    - Stroud- Tulpehocken
- Wyomissing Creek Watershed Coalition – BCCD
    - Ranking BMPs by parameter
    - Raingardens and basin retrofits – low cost
- BCCD Topton Creek/Reading HS
- Summary from NRCS
    - 50% of Saucony Creek headwaters farms addressed (above Kutztown)
    - Below Kutztown - Less livestock in general (more crops) but some farms are being addressed.
    - One more good year in Saucony Creek at least
    - Community environmental project – municipalities want visibility to the public and low cost
- WBWA Pathogens Reduction Plan
    - Collected plans and research (10-15 years) – state of the watershed
- Grant for riparian buffer (BC) – Tulpehocken unnamed funder (foundation in Lehigh county); only BMP, no formal report

III. Project Database

- Allow all to input and access data; include monitoring data; work with WP to expand
- WP wants to also bring in water quality database and modeling work and develop app to upload field data to geo-database

IV. Other

- Kutztown long term water quality well data – nutrient reductions are evident (SSM), tie in project implementation to nutrient data

- Western Berks will soon be taking data at Blue Marsh

Next Meeting: November 5, 2014 10am, Berks County Agricultural Center

SAN AGRICULTURE WORKGROUP
FORTH QUARTER MEETING

Schuylkill Action Network Agriculture Workgroup
11.05.14 Meeting Notes

Attendees:
Cheryl Auchenbach, Berks County Planning Commission
Virginia Vassalotti, Partnership for the DE Estuary
Nick Ramsey, NRCS
Kimberly Fies, BC Ag Land Preservation
William Ryan, Berks Conservancy
Larry Lloyd, Berks Conservancy
Jesse Goldberg, Miller Environmental
Jineen Boyle, DEP-Southcentral Office
Lamonte Garber, Stroud
Ross Stowell, Concerned Citizen
Tom Davidock, Partnership for the DE Estuary
Meghan Cash, Phila Water Dept
Beth Couillard, Phila Water Dept
Joe Hebelka, DEP-Central Office
Lyn O'Hare, SSM Group

I. Update on grant requests/funding efforts

- Berks Watershed Restoration Fund – Conservancy has received financial support from RAWA, Boro of Kutztown, and WBWA for cost-assistance in Ag BMPs. Scheduling meeting with Saucony Creek Brewery for funding.
- USDA programs – NRCS - $1.4M in projects in the area, the NWQI watershed focus (Upper Maiden & Saucony) has really helped with funding; 2015 signups ongoing, need some applicants, and ranking starts early 2015. Announcement on RCPP funding should be coming soon, No open enrollment for CREP.
- Schuylkill River Restoration Fund – Conservancy - Hope to finish Nickle project, have permits. Working on Zimmerman Phase I with the BCCD and NRCS; ongoing work with David Rick and Earl Martin farms. New guidelines for SRRF grants coming after January, hopefully new funders
- Growing Greener – grant awards expected in November-December. Approximately $17-$18M
- National Fish & Wildlife Fund – Conservancy plans grant application in January to assist with Zimmerman farm project
- Water Resources Education Network – RAWA working on grant request

II. Projects in Progress

- William Penn Foundation/NFWF – PDE/Conservancy/Stroud – starting volunteer monitoring initiative with Schuylkill Stewards in Highlands cluster, several people from Berks have participated. Stroud working on Ag buffer projects in Chester County;
- William Penn watershed monitoring program – PDE/Conservancy/Miller/Stroud – Academy of Natural Sciences developing storage database for cluster partners; Middle Schuylkill partners working on chemical and macro baseline monitoring
- Growing Greener Ag BMP grant – Stroud – outreach in winter for Tulpehocken projects
- Fish & Boat – Conservancy working with American Rivers - - City of Reading and Trout Unlimited will proceed to move forward with Bushong dam removal; still hopeful for Cacoosing & Hospital Creek dam removals; Angelica Creek for buffer monitoring
- Conservancy Fall Plantings – Conservancy planted buffer along Tully at WBWA property; Angelica Creek monitoring site
- Willow Creek – Conservancy - RAWA removing invasives – 1 mi buffer in residential area
- Wyomissing Creek Watershed Coalition (Coldwater Heritage) – BCCD – members working on priorities for restoration areas
- BCCD Topton Creek/Reading HS – No Report
- EPA 319 Implementation Plan for Maiden Creek – PDE – scheduling meeting with Stroud on developing plan; identify a subwatershed like Moselem-Ontelaunee for pilot using the MapShed model; funded by WPF; 319 dollars extended til 2016.
- Kutztown Well Data – trending nitrates, include all deep wells for comparison
- Trout Unlimited/RAWA – looking at stream reclassification in Upper Maiden Creek

III. Education/Outreach

- PWD/PDE – Ag Education materials – Ag guide on BMPs available; distributed to Granges and feed stores in Berks; PowerPoint on SAN Ag website page
- Hay Creek Outreach event with Conservancy
- Conservancy's State of the Environment breakfast scheduled for November 13 at Crowne Plaza
- Before & After photos of the SAN Ag projects are on the website
- William Penn Foundation staff interested in a tour for assessing their program
- EPA's Source Water Collaborative Toolkit will be out soon
- Berks County Commissioners discussed a resolution for Clean Water
- John Jackson of Stroud has a presentation on road salt on Nov 5
- River otters discovered at Lake Ontelaunee, confirmed by Game Commission – need very good water quality for habitat

IV. Planning

- Annual Conference – Friday November 14 at RACC

V. Other Workgroup Updates

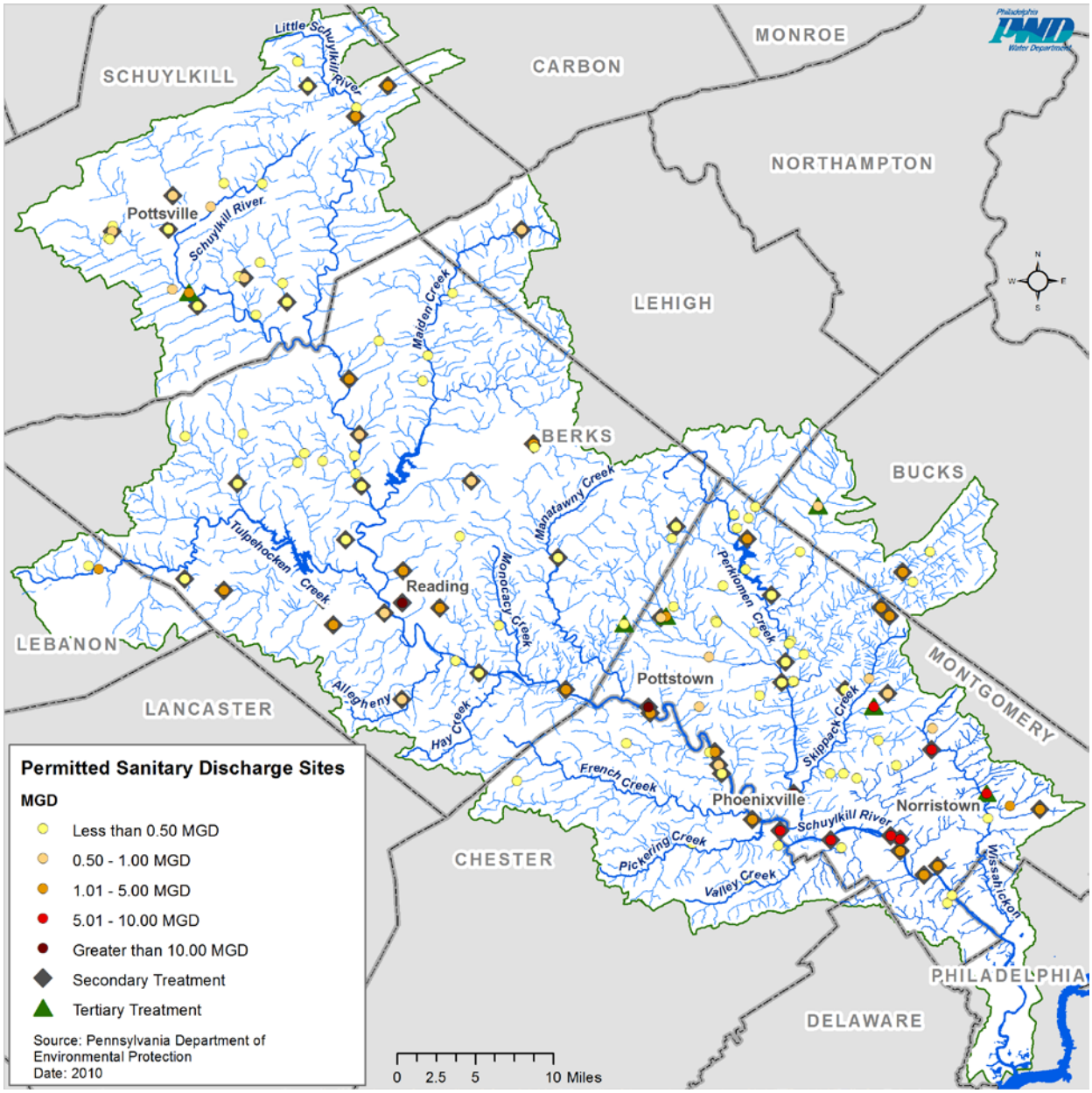
- Schuylkill Action Students projects
- Stormwater group meets on 11/6 at 2:00 PM
- Land Collaborative meeting in December
- Pathogens meeting December 10

VI. Other

- Thanks to Matt Ehrhart for nominating SAN for the Penn State Ag Council's "Leadership in Action" award!

Next Meeting: Wednesday February 11, 2015, 10:00 AM at Berks County Ag Center

Appendix B: WWTPs in the Schuylkill River Watershed Map



Appendix C: Chapter 94 Data Compilation Project Memo

Project Update Memo
SAN Pathogens Workgroup
Schuylkill River Watershed WWTP Data Compilation Project
PA DEP Reading District Office
Wednesday, December 10, 2014 10:00 AM – 12:00 PM

Project Purpose

The purpose of the Schuylkill River Watershed WWTP Data Compilation Project is to create a watershed planning tool for the SAN Pathogens Workgroup. The project will take the form of a spreadsheet or database that contains information and data on individual wastewater treatment plants (WWTPs) from Chapter 94 reports submitted to the Pennsylvania Department of Environmental Protection (PADEP) annually.

Chapter 94 of the *Pennsylvania Code* 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 (Section 94.3, Chapter 94 Municipal Wasteload Management, *Pennsylvania Code*, www.pacode.com). 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.

Project Progress

In fall 2013, a sub-committee of the SAN Pathogens Workgroup outlined the Schuylkill River Watershed WWTP Data Compilation Project. PWD staff reviewed and compiled data into a spreadsheet from the 2012 Chapter 94 reports provided by PADEP Southeast Regional Office (SERO) and PADEP Reading District Office (2013 Chapter 94 reports for WWTPs in Lebanon County). To date, the project includes information for all WWTPs that submit Chapter 94 reports to PADEP in Philadelphia, Berks, Lebanon, Montgomery, Bucks and Chester counties.

The spreadsheet contains basic information on each WWTP facility:

- WWTP facility name and address
- Authority and mailing or office address
- NPDES permit number and current permit issue and expiration dates
- Municipalities served
- County
- Sub watershed and receiving waters for WWTP effluent

The following facility details are documented:

- WWTP treatment process as described in the Chapter 94 report

- Permitted flow and design organic capacity
- 2012 annual average flow and organic loading
- Other permitted limits from the WWTP's NPDES permit (if listed in the Chapter 94 report)
- UV disinfection (Yes/No)
- I&I abatement program (Yes/No)
- Industrial pretreatment (Yes/No)
- Hydraulic or organic overload conditions in 2012
- Projected hydraulic or organic overload conditions in the next 5 years (Yes/No)
- Number of SSO events or bypass mode in 2012

Additional data is needed to complete the Schuylkill River Watershed WWTP Data Compilation Project for the Schuylkill River watershed:

- WWTPs located in counties under the PADEP Northeast Regional Office (NERO) should be included to fully represent the Schuylkill River watershed. Through the SAN Pathogens workgroup, an appropriate contact at PADEP NERO should be established and provided this memo and the project spreadsheet.
- Many of the Chapter 94 reports documented NPDES permit discharge limits. Obtaining NPDES permit copies, if possible, for the other WWTP would complete this information for all WWTPs.

Currently, the goal is to update the spreadsheet every five years. Hydraulic and organic loadings projections for each plant and the issuance of NPDES permits are in line with this time frame.

Project Application

The SAN Pathogen workgroup will have access to this document. As a watershed planning tool, this document could be used for any of the following:

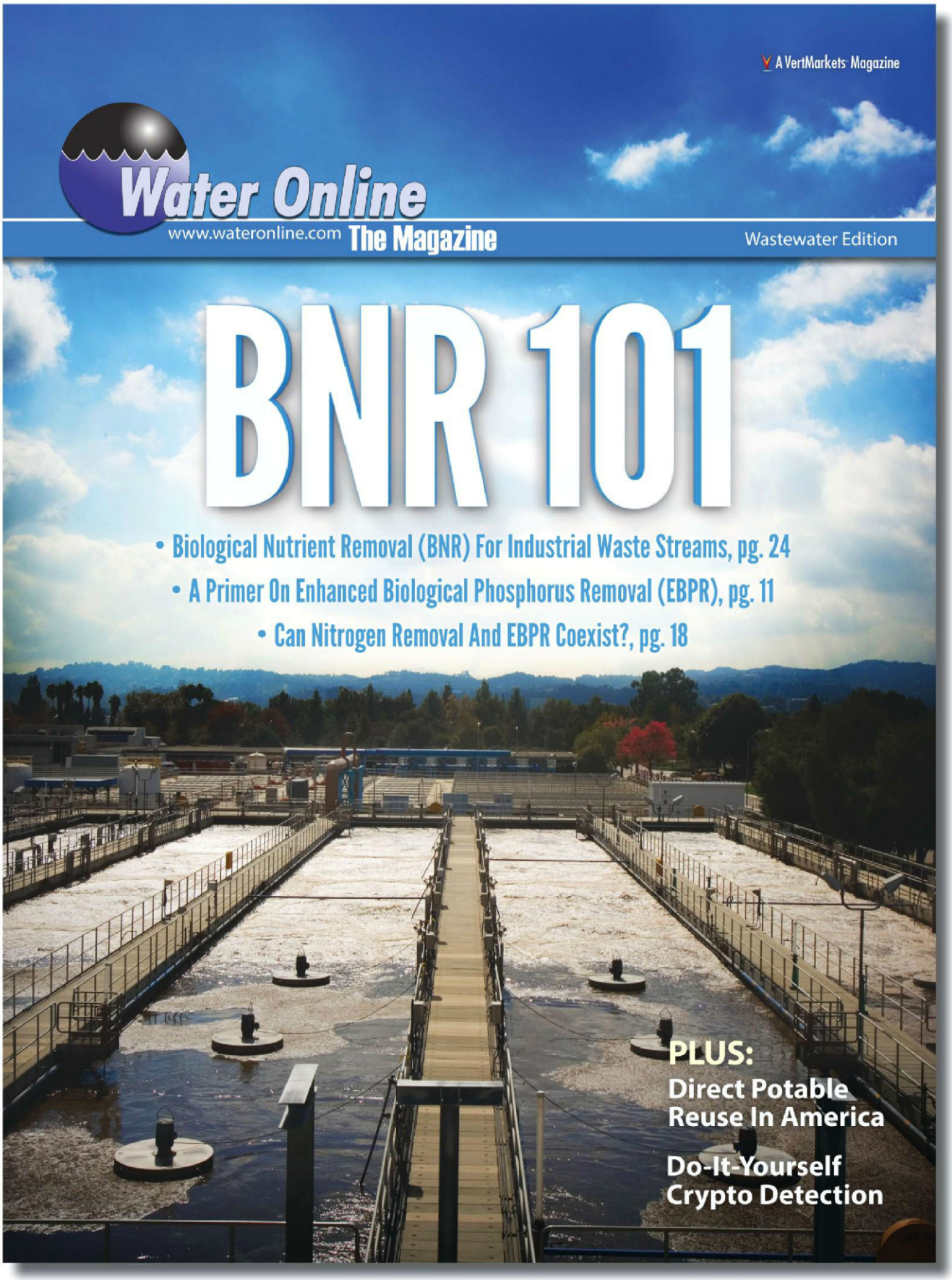
- To promote a holistic view of WWTP discharge in the Schuylkill River watershed
- To serve as a quick reference to SAN Pathogen workgroup members when WWTP discharge related events are reported on EWS
- To encourage the sharing of specific WWTP related events and news in the watershed
- To provide an informational tool for water utilities assessing source water protection planning strategies related to upstream point sources.

For detailed data and information representation questions contact the Philadelphia Water Department Source Water Protection Program:

Beth Couillard
Environmental Engineer
(215) 516-9141
elizabeth.couillard@phila.gov

Kelly Anderson
Program Manager
(215) 685-6245
kelly.anderson@phila.gov

Appendix D: *Water Online* Article, "Do-It-Yourself Crypto Detection"


A VertMarkets Magazine
Water Online
www.wateronline.com
The Magazine
Wastewater Edition
BNR 101
• Biological Nutrient Removal (BNR) For Industrial Waste Streams, pg. 24
• A Primer On Enhanced Biological Phosphorus Removal (EBPR), pg. 11
• Can Nitrogen Removal And EBPR Coexist?, pg. 18
PLUS:
Direct Potable Reuse In America
Do-It-Yourself Crypto Detection

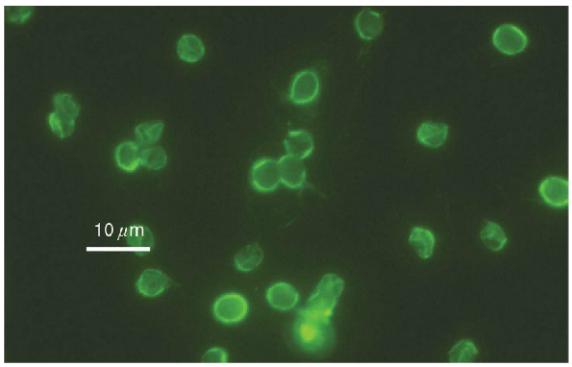
Do-It-Yourself Crypto Detection

Learn how to construct a simple and inexpensive tool for detecting cryptosporidium in your watershed – and why it's important.

By Kevin Westerling, chief editor, Water Online

As advanced as monitoring has become, cryptosporidium (crypto) has seemingly slipped through the cracks. The accepted U.S. EPA method of detection, mandated by the Long Term 2 Enhanced Surface Water Treatment Rule (LT2), is to catch oocysts (the infectious dormant form of crypto) in capsule filters. It is neither simple nor cheap — and not terribly accurate, considering its cost. So what if you could build a better crypto trap?

A new, do-it-yourself crypto detection system has been developed by researchers at Lehigh University through a project funded by the Philadelphia Water Department (PWD) and tested in Philadelphia area waters, with promising results. So far, the "homemade" alternative to the current standard (EPA Method 1623) has provided very comparable detection results, but at a fraction of the cost. This allows for more units to be deployed throughout the watershed, possibly providing utilities an additional tool for detecting cryptosporidium.



Oocysts have an intense apple green color under immunofluorescence imaging and measure four to six microns in diameter. (Credit: H.D.A. Lindquist, U.S. EPA)

Researcher Kristen Jellison, associate professor at Lehigh's Department of Civil & Environmental Engineering, calls the device a "biofilm sampler." It is simply a box containing microscope sample slides — at a cost of roughly $3 each — that is placed in a body of water at the location of interest. Jellison, who holds a Ph.D. from MIT and a B.S. from Cornell University, had done past work, along with others, in proving that biofilms are good receptors of oocysts, but the PWD pilot study marks the first time biofilms (which grow on the slides) have been used to monitor crypto in a watershed.

"It's a very easy way to see if crypto are present in your watershed and where, without spending hundreds of dollars on the filters," said Jellison.

Standard Filter Performance Problems

As the next round of LT2 approaches — monitoring for large facilities (serving at least 100,000 people) begins in April 2015 — utilities of all sizes may recollect the pain points from using EPA Method 1623 in the initial round. The capsule filters are prone to clogging in turbid conditions, which often necessitates a second filter to collect the required 10 liters of water for a valid sample. At $100 or more per filter, per sample, anything beyond the bare minimum gets expensive.

"It racks up really quickly," stated Jellison. "A utility with a smaller budget is limited as to how often and how many different locations they can sample."

Furthermore, the results of the EPA method are quite variable. In one study (McCuin and Clancy, 2003), oocysts were seeded in both clean tap water and raw source water, then repeatedly tested using EPA Method 1623. The range of recoveries — or how many oocysts were detected compared to the known quantity put in — was 23.5 to 71.2 percent for the tap water, and 19.5 to 54.5 percent for the raw water. The high incidence of undetected oocysts means that crypto presence could be greater than tests indicate.

"With recoveries so variable, it becomes questionable if you don't detect anything," Jellison noted. "Is it because it really wasn't there, or because you only had a 30 percent recovery? You may or may not catch it."

The method can also be misleading in that it only provides a "snapshot" of place and time. The oocysts you gather in 10 liters of water at a single collection point, over the course of time it takes to collect a sample (perhaps 30 minutes), is almost coincidental. As Jellison pointed out, "You could have had an oocyst in there the day before or the hour after you leave, or even while you were there, but not in your 10-liter sample."

The biofilm sampler improves on at least two of these pain points, creating the opportunity for better understanding of crypto occurrence in a waterbody.

Biofilm Sampler Vs. Filter

The first advantage is cost. Because the biofilm sampler's materials are so much cheaper than the filters required under LT2 guidelines, many samplers can be constructed and used for monitoring throughout the watershed.

A second advantage is that the biofilm samplers can stay in the watershed for any length of time, which is a matter of convenience, opportunity (to catch more oocysts), and local factors. There is no optimal duration period established for the biofilm samplers; it may be variable according to

location, weather, and source water. At PWD, Jellison and colleagues replaced the biofilm sampler every two weeks simply to coincide with the EPA-approved filter sampling.

As both the biofilm samplers and the filters were drawn from the watershed at the same time, results of the samples were compared. Samples were routinely taken in the source water prior to entering the intake of the PWD water treatment plant (WTP) and from a location farther upstream. Over the course of a full year (July 2013 to July 2014), the frequency of detection was remarkably similar (see Table 1).

Table 1. The biofilm sampler and EPA-approved filter method returned a similar frequency of oocyst detection at two collection points.

	Water Source
Biofilm Sampler	46% positive (18/39)
Filter (EPA) Method	43% positive (17/40)

This comparison study suggests that, with regard to oocyst detection, the biofilm method is on par with the EPA-approved filter method. The pilot project did not include the seeding of oocysts and therefore does not speak to the variability of recovery — an established flaw with the filter method, but a complete unknown with the biofilm method. Volume concentrations of the water passing through the biofilm sampler are another unknown.

It's because of the many as-yet unknowns that Jellison calls biofilm sampling a "long way" from becoming EPA-approved. Outside of LT2 testing, however, biofilm samplers can have significant impact.

"It's cheaper, so you can sample in more locations at a higher frequency, over longer spans of time, and really understand where the sources of crypto are in your watershed," summarized Jellison.

In other words, instead of the snapshot image, water quality managers can now get the big picture. By obtaining relative data on oocyst concentrations — where and when they appear — mitigating actions such as source water protection plans or the installation of best management practices (BMPs) can be developed in areas where they will be most effective.

How To Build A Biofilm Sampler

To start monitoring oocysts and the threat of cryptosporidium in your own watershed, you need only a sturdy container and standard microscope slides. The container will need two open sides to permit water flow, as well as slots to hold the slides in place; mesh or a similar material should also be used to cover the open sides and prevent large debris from breaking the slides (see Figure 1).

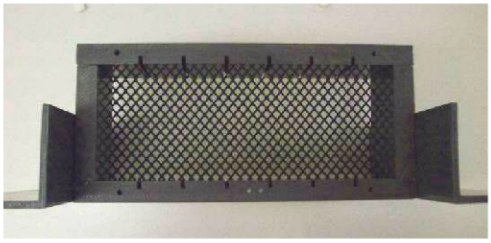


Figure 1. The simple construction of the PWD biofilm sampler includes slots for six slides and protective mesh siding.

The PWD team utilized two weighted PVC pipes to keep the units submerged in the watershed (see Figure 2), but they collected samples from the source water just prior to the WTP intake by hanging the biofilm sampler from a rope off a dock.

Figure 2. Weighted PVC pipes help keep the biofilm samplers in place.

Once the biofilm sampler is retrieved, the slides are simply scraped to remove the biofilms; by contrast, the second step of the standard method requires the filtered content to be eluted. The remaining steps are exactly the same as with the filter method under EPA Method 1623: immunomagnetic separation (IMS) followed by immunofluorescent microscopy (IFA) — steps familiar to any utility that has done previous crypto/LT2 monitoring.

The Future Of Crypto Detection

The next step on the road toward validation for the biofilm filter is to have more utilities try it out in the field to help gather information, work out the kinks, and develop best practices. A sticking point, so to speak, is how biofilms behave in different areas.

"Is any biofilm going to be equally sticky for cryptosporidium, or are there specific things about the biofilm that make crypto more or less likely to attach? That's what we need to figure out," Jellison explained.

She has already made some inroads, finding that "rough" biofilms catch more oocysts than smooth ones, as they tend to get caught in the crevices. Ultimately, she hopes to develop a synthetic surface that can be used anywhere, with a known attachment efficiency. Until then, she welcomes the participation of others and is optimistic that there will be benefit for other "do-it-yourselfers."

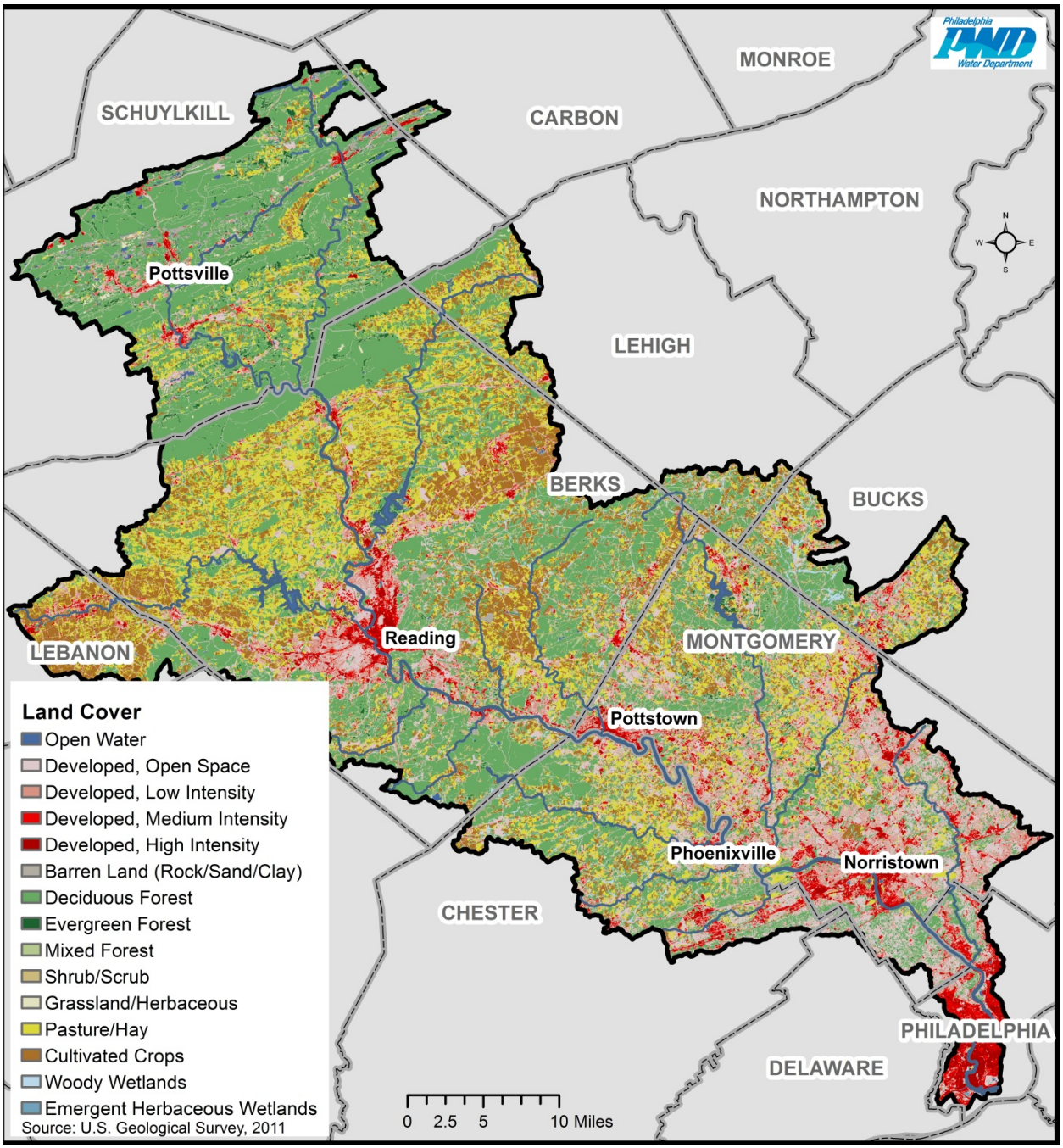
"I think it's absolutely worth trying," she said. "And based on what we see here [in Philadelphia], I think it will give good information. If other people want to use it in their watersheds and share their findings, I see that as a really useful collaboration on both ends."

For more information (or collaboration), contact Kristen Jellison at kjellison@lehigh.edu. ■

Reference

McCuin, R.M. and J.L. Clancy. 2003. Modifications to USEPA methods 1622 and 1623 for detection of Cryptosporidium oocysts and Giardia cysts in water. Applied and Environmental Microbiology 69:267-274.

Appendix E: Schuylkill River Watershed Land Cover Map



Appendix F: *A Farmer's Guide for Healthy Communities*

WORKING TOGETHER FOR FRESH FOOD, CLEAN WATER & A STRONG FUTURE

A FARMER'S GUIDE FOR HEALTHY COMMUNITIES

An Introduction to Agricultural Stormwater Best Management Practices (BMPs)

INTRODUCTION

Every time it rains, rainwater carries loose soil, animal waste, litter, etc., into nearby streams.

As farmers, you are more in touch with nature and our waterways than most people. That connection between land and water is and always has been vital to the production of healthy and abundant food.

Since passage of the Clean Water Act in 1972, Americans have made tremendous progress in cleaning up waterways by controlling pollution from industries and sewage treatment plants. Today our biggest challenge is controlling pollution from the smaller, more spread out pollution sources coming from our homes, yards, parking lots, commercial properties, roadways, farms, and anywhere rainwater flows over developed land. Imagine the path taken by a drop of rain from the time it hits the ground to when it reaches a pond, river, lake, bay or the ocean. Any pollutant it picks up (like leaky motor fluids and dog waste) along the journey can become part of the problem. Scientists call this *stormwater runoff pollution*.

Many of our waterways have become much healthier over the past 4 decades. However, approximately 40 percent of our surveyed rivers and lakes are still not clean enough for fishing or swimming. In order to achieve the goal of clean water, schools, businesses, farmers, local residents, and municipalities must manage stormwater in a manner that will restore our waterways. This guide, specifically for farmers, provides steps and actions you can take to improve stormwater management on your property. These storm-water management projects can help you save money, protect our critical drinking water sources, and prevent future problems from occurring. Clean water is everyone's responsibility. Check out this guide to see what you can do to help.

Similar guides to this one have been created for commercial properties, homeowners and school campuses. They can be downloaded at *www.DelawareEstuary.org*.

MAP DEL E

Since passage of the Clean Water Act, the Delaware Estuary, the tidal portion of the Delaware River, has become much healthier.

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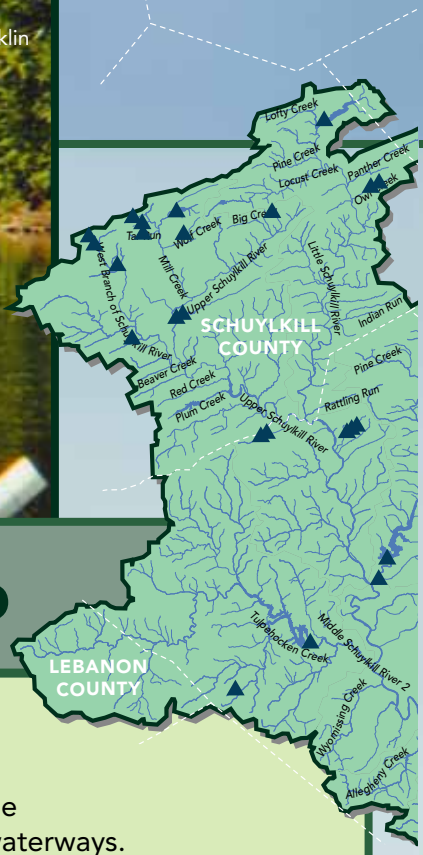
OF THE
AWARE
STUARY

Just like us, fish need oxygen to breathe. Soil and pollution in the water can choke fish.

Photo credit: Cindy Conklin



KEEPING SOIL & NUTRIENTS ON THE LAND

As rain or melting snow drains off the land, it can pick up loose soil, animal waste, excess fertilizers, herbicides, and pesticides. Keeping these materials on the land saves money and stops them from polluting local waterways.

Most developed properties have buildings that are designed to quickly direct water away from the site, causing many of our local waterways to suffer from flash flooding on rainy days. Many communities are trying to reduce the impacts of this stormwater runoff by changing parks, roadways, schools, homes, and even commercial properties so they can absorb, slowly filter, and cleanse as much polluted rainwater as possible. The goal is to handle rainwater more naturally, and in the process, assure clean and reliable water for fishing, swimming, drinking, and growing crops!

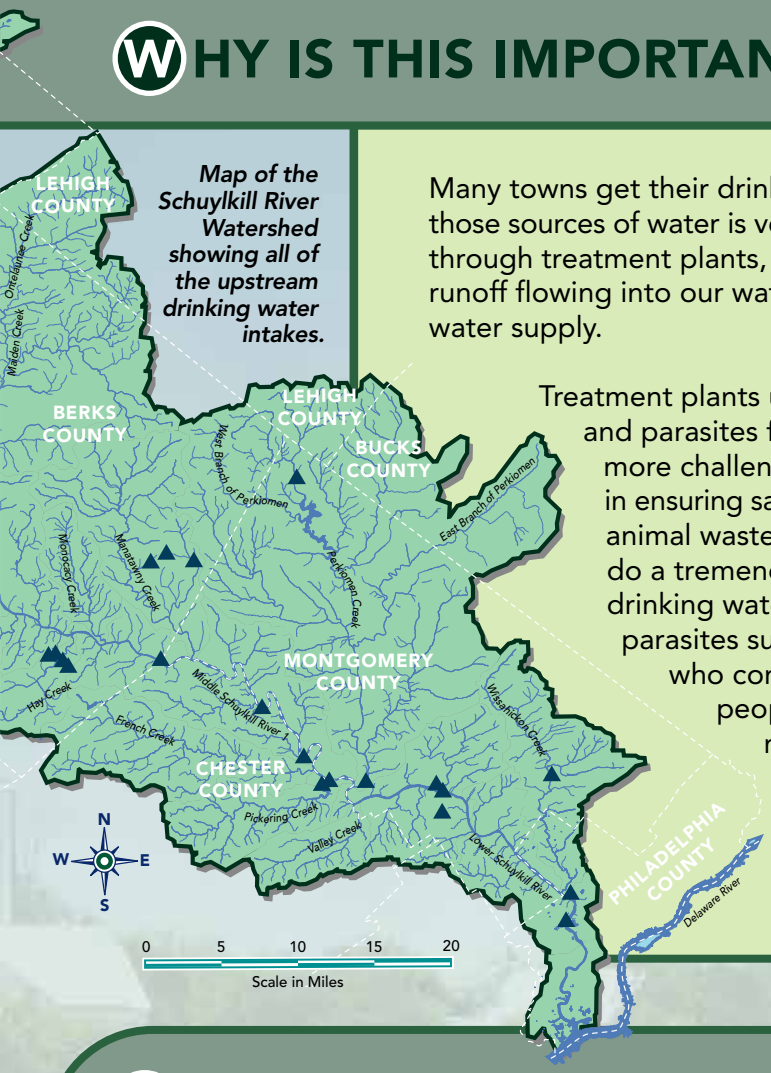
On farm properties, crop fields and pastures can do a great job at preventing flooding, acting like sponges when it rains. However, during certain times, without a good cover crop, a lot of valuable soil can get washed away into local creeks.

Pollutants Found in Stormwater Runoff:

- Dog Waste
- Engine Fluids
- Fertilizers
- Herbicides
- Loose Dirt
- Motor Oil
- Pesticides
- Road Grit
- Litter
- Road Salt

Rotational grazing and fencing can go a long way toward reducing soil erosion.

WHY IS THIS IMPORTANT TO DRINKING WATER?



Map of the Schuylkill River Watershed showing all of the upstream drinking water intakes.

Many towns get their drinking water from local rivers and creeks, so protecting those sources of water is very important. Water is pulled directly from streams, runs through treatment plants, and is distributed to customers. Polluted stormwater runoff flowing into our waterways threatens the purity and affordability of our water supply.

Treatment plants usually do a terrific job at removing harmful bacteria and parasites from the stream source, but some parasites can be more challenging to treat. Livestock owners can play a crucial role in ensuring safe drinking water for downstream neighbors by keeping animal waste out of streams. Even though water utility companies do a tremendous job supplying their customers with clean safe drinking water, sometimes very small amounts of bacteria and parasites such as *Cryptosporidium* can remain. A healthy person who contracts the parasite will recover in a week or two, but people with weakened immune systems are at risk for a more dangerous infection. In the Delaware Valley millions of people rely on their upstream neighbors to help keep the waterways clean.

GETTING YOUR FEET WET

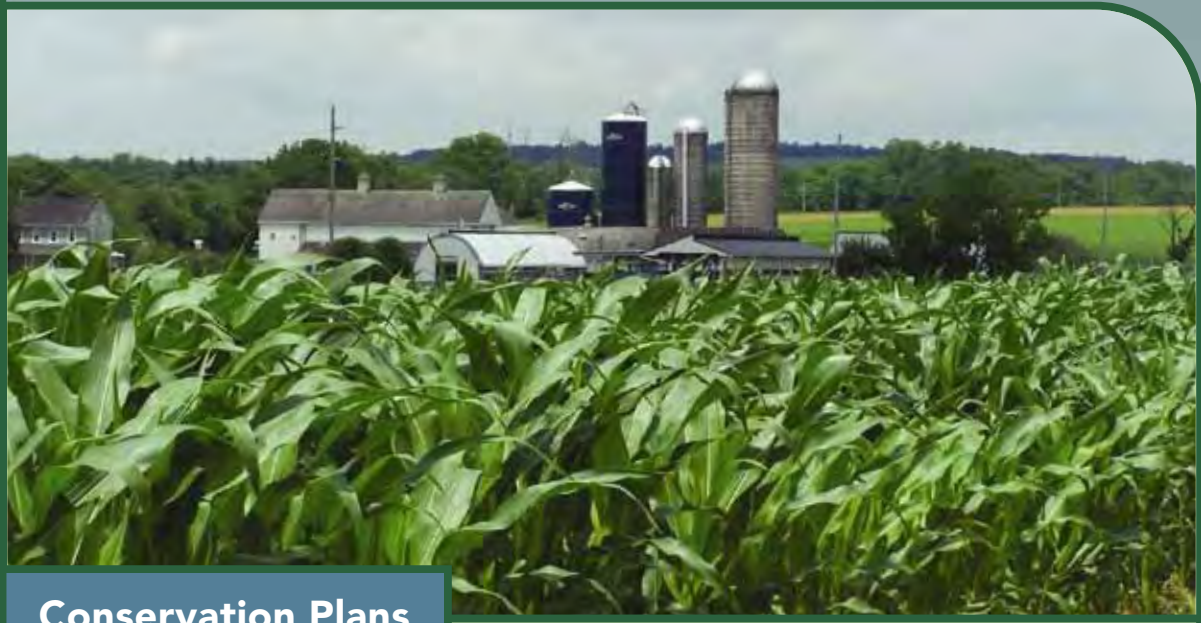
Learning how your property handles rain will guide you to various options to manage your runoff in the best ways possible. With this in mind you may find it helpful to look around outside while it is raining. Take a few minutes to watch how the water flows across your property.

Many property owners are initially concerned that changing the way they handle rainwater can cause flooding or mosquito problems. A good design, proper construction, and regular maintenance can do the opposite. Make sure your design professional and contractor are experienced with stormwater management design and installation. Most conservation districts and agencies like Natural Resources Conservation Service (NRCS) have access to engineers who can design these projects. This guide contains a wide variety of improvements (agricultural stormwater best management practices or BMPs) owners can make to their farms to help reduce stormwater runoff, as well as an example farm on pages 12-13.

Approximately 15 million people get their drinking water from the Schuylkill and Delaware Rivers. Everything we do on the land can end up in the water.

Photo credit: Shaun Bailey

SAMPLE STORMWATER PROJECTS



Developing a conservation plan is a great way to learn about potential resources available to offset costly upgrades.

A Conservation Plans

A conservation plan (aka farm plan) is a combination of land uses and farming practices that protect and improve soil productivity and water quality. The purpose of a conservation plan is to prevent deterioration of natural resources on the farm. The plans are designed to be both technically and economically feasible for the farmer. Conservation plans are usually voluntary. Check with your local conservation specialist to see if there are any planning requirements in your county. The landowner helps identify resource issues, makes all of the decisions, and implements projects when it best fits.

Conservation plans also improve animal health and productivity.

There are many benefits to working with the United States Department of Agriculture (USDA), your local Conservation District and/or Conservancy professionals (see page 22 for local conservation contacts) to develop a conservation plan that will:

- Improve animal health and productivity
- Increase crop growth and yield
- Assist in meeting regulatory requirements
- Save money over the long term
- Increase property value
- Improve the farm for future generations

A side benefit of developing a conservation plan is that your local conservation partners will be familiar with potential projects for your property and can keep a look out for funding sources that may be able to offset some of the costs.

Nutrient management plans improve the farm and safeguard nature for future generations.

B Nutrient Management Plans

A nutrient management plan is designed to help farmers use fertilizers and/or manure effectively and efficiently. The purpose is to supply crops with the optimum amount of nutrients at the right time, while preventing runoff pollution into local streams and contamination of groundwater. In addition to being good for the environment, smart fertilizer application and management is good for business and will help you save money.

The law requires manure management plans for all farming operations that generate or apply manure. The livestock operation owner is responsible for development, implementation and maintenance of the plan. However, assistance with developing and implementing the plan is readily available from local conservation partners, such as the County Conservation District, NRCS, local nonprofits, and private engineering firms.

There are four required components to a nutrient management plan:

1. Proper manure handling, transfer and storage
2. Correct spreading of manure on cropland
3. Appropriate land management that protects water quality and prevents soil erosion
4. Good record keeping that documents land practices

A nutrient management plan is especially important for farms with livestock. Animal waste contains parasites, bacteria, phosphates and nitrogen. While animal waste is beneficial on the fields, when handled improperly, these substances are known to cause disease and even death among humans and livestock. Phosphates and nitrogen also promote algae growth which can clog irrigation filters and cause fish kills in local streams.

Farmers completing a nutrient management plan will:

- Increase crop growth and yields
- Reduce need and cost of chemical fertilizers
- Prepare for expansion
- Assess risks and reduce liability
- Look favorable to lending institutions and insurance companies
- Decrease polluted runoff into local waterways for current and future generations.

Nutrient management plans can help farms increase yields and reduce fertilizer costs.

Animal waste can carry disease-causing parasites.

SAMPLE STORMWATER PROJECTS

C Making the Most of Manure

With growing numbers of people interested in small-scale organic farming, a market has been created for selling cow, chicken, horse, and even llama manure.

Like making lemons into lemonade, animal "waste" when handled properly can be an incredible asset to the farm. When handled incorrectly, animal waste becomes a liability and can cause illness in livestock, humans and wildlife and fish in nearby streams.

Storage is the key to reusing manure and saving on chemical fertilizers. There are mainly two types of storage, depending on the physical consistency (solid or liquid) of the manure, and the future plans for using it. Dry or solid manure storage is usually a concrete pad with three walls and a roof where the manure can be piled up. The concrete pad, walls, and roof are designed to prevent rainwater from washing away any of the manure into local streams. Liquid manure should be stored in either a tank, lined pit or lined pond to help prevent contamination of well water. Other holding structures should be designed to store contaminated rainwater runoff, used bedding, wastewater from animal production units, dairy wash water, and other diluted wastes.

Ideally, a storage structure should be able to hold at least 6 months of manure. This amount of storage ensures that the manure can be spread on the fields at the proper time to increase crop yields and reduce storm water runoff pollution.

Rotational grazing is another way farmers can reduce stormwater runoff pollution, reduce soil erosion, and improve herd health. Recent studies have found that although confined cows produce more milk, rotational grazing is more profitable due to reduced feed, labor, fuel and veterinary expenses.

Penn State offers a Precision Dairy Technology program which shows how to meet livestock nutrient requirements more accurately, therefore reducing excess nutrients in the manure. This not only saves feed costs but also helps reduce potential pollution. For more information visit *http://extension.psu.edu/animals/dairy/courses.*

This new structure is designed to store manure for several months.

This farm has a liquid manure storage tank on the left and a dry manure storage facility on the right.

D Working the Land

A pipe outlet terrace allows water to flow into the pipe rather than creating gullies.

Soil is such a valuable asset on the farm that it is vital we keep it in the fields and out of our waterways. There are a variety of improvements that can be made to do so.

Switching to no-till or less tillage can help keep soil in place while saving money on labor, fuel, irrigation, and machinery costs. However when switching over, gullies may form that usually would be smoothed over each year by tilling. These gullies will erode and get deeper each year unless a more stable and permanent drain-way is created.

Cover crops can also be helpful. With no-till, cover crops can be used to keep the weeds down, increase the nutrients in the soil, and prevent soil loss.

On sloped areas, terraces can be designed to allow the field to be grazed or farmed. These terraces look like long, wide steps across a hillside and can help prevent erosion, gullies and polluted runoff.

Depending on the layout of the farm, no-till farming, cover crops, and terraces or a combination of all three can be used to save you money, make the most of your farmland, and keep the local streams and lakes clean and thriving.

For technical expertise on what might work best on your land see page 22 to find the Agricultural Specialist in your county.

Two cisterns at the Schuylkill Center for Environmental Education in Philadelphia, PA capture runoff from the education building roof.

E Rainwater Capture & Reuse

Cisterns, tanks and other large containers are designed to capture and store rainwater from rooftops. They temporarily hold the rain, helping local streams and sewer systems to be less overwhelmed on rainy days. These containers may be above or below ground, and they may drain by gravity or a pumping system.

Stored water can be used to irrigate crops, slowly released to a natural area where it can soak into the ground, or be reused in some other manner on the farm. Reusing rainwater can help reduce a water bill for those on a public system or conserve well water when the weather gets dry. A cistern can be directly connected to the plumbing. However, plumbing for non-potable (not drinkable) rainwater reuse should be separate from potable (drinkable) plumbing. Some examples are for washing clothes, taking showers, flushing toilets, or various other needs based on the property.

To reduce flooding in local waterways, full cisterns should be slowly emptied prior to rain. This allows them to hold the greatest volume of water when the streams will be at their highest. For more information on reusing rainwater, visit the Delaware Valley Green Building Council's website ***www.DVGBC.org***.

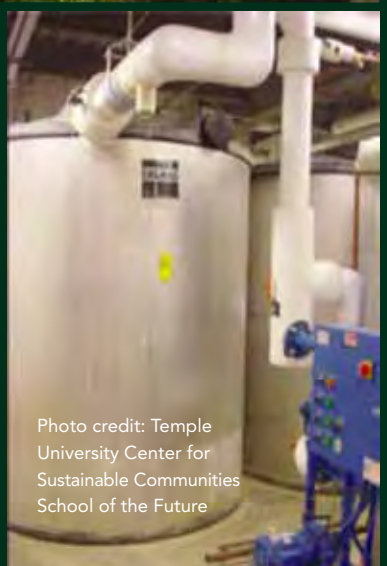


Photo credit: Temple University Center for Sustainable Communities School of the Future

A rainwater catchment system.

SAMPLE STORMWATER PROJECTS

F Protecting the Streams

Many farmlands were selected because of their rich soil and easy access to fresh water. However, when livestock are given unlimited access to streams, the quality of the water can quickly degrade. There are a couple of simple projects that can be done to protect streams.

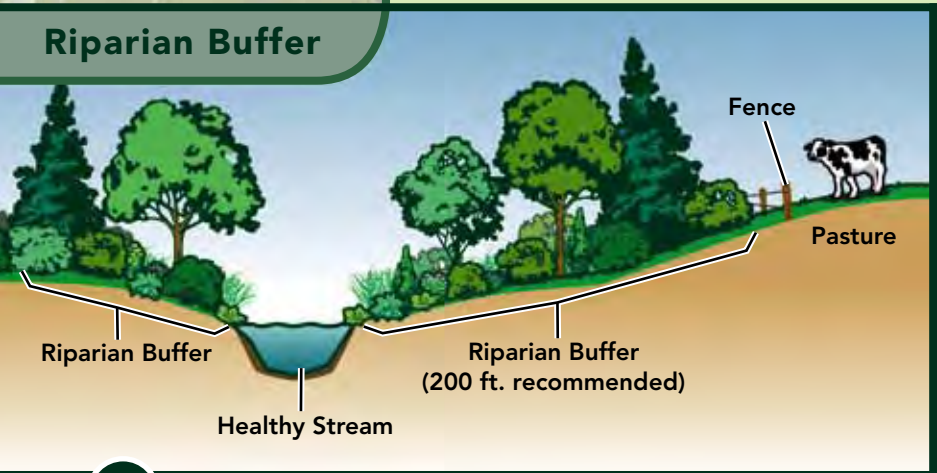
A cattle stream crossing with a healthy buffer.

People in the environmental field frequently use the term "riparian buffer." They are referring to a strip of land with native grasses, shrubs, and trees along a stream. The plants slow down, soak in, and filter fertilizers, pesticides, herbicides, loose soil, engine fluids and any other materials running off the land when it rains. Forested buffers provide more benefits to the stream than grass buffers. Trees help shade the waterway, keeping it cooler in the summer. This reduces the excessive growth of bacteria and algae that can harm fish and wildlife, as well as contaminate drinking water. These plants with their strong roots help slow down the flow of water, stabilize the banks, reduce erosion, and decrease flash flooding while improving habitat for fish and wildlife.

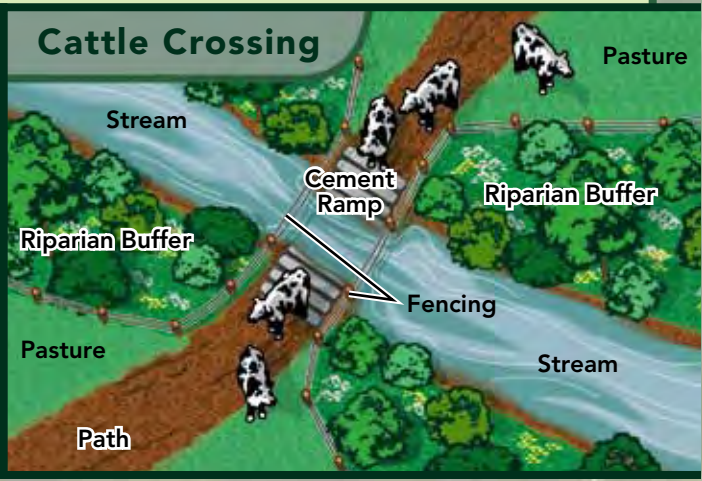
A good buffer won't be good for very long without fencing to keep livestock out. Buffer fencing also benefits the farmer through potential income from a conservation buffer contract, improved herd health, better pasture management and cleaner drinking water for livestock. During the development of the Conservation Plan, new or different watering systems will offset stream access for animal watering. Depending on the layout of the farm, stream crossings for livestock may still be necessary. Specially engineered cattle crossings have many benefits:

- Reducing streambed and stream bank erosion
- Preventing cattle and equipment from getting stuck
- Improving water quality
- Allowing for more uniform grazing of fields

Riparian Buffer



Cattle Crossing



G Around the Barnyard

There just seems no way around the fact that hooves, the ground and rain always make mud. Barns, shelters or anywhere livestock spend the bulk of their time, especially during the non-growing season, should have rainwater diverted around them. Gutters, downspouts, splash blocks and other types of drainage systems are tools used to control the direction that rainwater travels. The goal is to keep the rainwater away from mud and animal waste, so it can flow free of pollution into nearby ponds or streams. Gutters and other effective drainage systems can also help preserve the life of wood building supports and concrete foundations.

Loose soil and animal waste pollute local streams when they run off during rainy days.

Milking facility wash water also needs to be managed properly. This water contains animal waste, milk, mud, and cleaning chemicals. Ideally, wash water should be drained into a liquid manure storage tank and applied as fertilizer. Liquid manure storage tanks need to be designed to contain enough material so that they don't need to be emptied until the crops are ready to uptake the most nutrients, rather than spread because the tanks are full. If the material is spread during the non-growing season, rain and melting snow will just carry it into local waterways.

Downspouts should convey water to the downhill corner of the livestock area so the water bypasses areas with waste.

All fertilizers, pesticides, herbicides, cleaning fluids, gasoline, motor fluids, etc., need to be kept in a safe, dry location out of the pathway of rain or flood prone areas. Hold annual trainings so that workers know how to avoid and properly clean up a spill if one happens. Transferring any of these substances should be done in an area that can contain a spill, far away from streams, wells, storm drains or drainage paths. Any hazardous materials should be disposed of correctly at a collection center.

Focus on keeping clean water clean — don't allow rainwater to run through barnlots or areas where animals gather.

SAMPLE STORMWATER PROJECTS

H Around the House

There are many improvements we can all make in and around our homes to help protect our local natural areas and waterways.

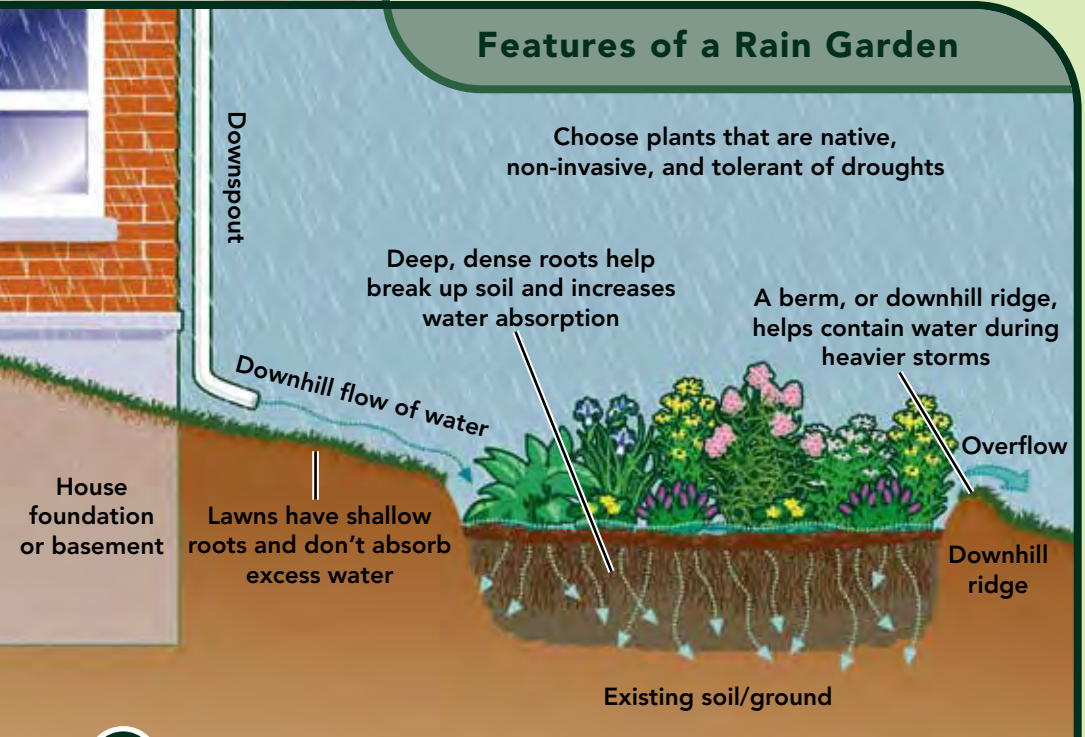
Service your car and machinery regularly to prevent oils and other fluids from leaking onto the ground so they don't wash away into local waterways or make their way into your well. Recycle motor oil and antifreeze at participating service stations.

Choose water based paints and wash brushes in your sink with water. Reuse and recycle paint thinner, which is a hazardous material. Do not pour it down your drain or into a storm drain.

Minimize the use of toxic substances such as mothballs, drain and oven cleaners, and many other products. Substitute with products that use non-toxic ingredients whenever possible. Consider implementing Integrated Pest Management (IPM) practices to minimize the use of toxic and/or chemical-based cleaning products, pesticides, fertilizers, and herbicides, thus reducing the release of harmful chemicals into the waterways. For more information, visit PA IPM Program at ***http://extension.psu.edu/pests/ipm***.

Plant more native trees. Roots not only provide an anchor to stop soil erosion but also increase the amount soil absorbs rainwater. Trees also clean the air, regulate temperature, reduce carbon dioxide, and can increase your property value.

Features of a Rain Garden



Plant a rain garden. A rain garden contains specially chosen plants designed to help collect rainwater from hard surfaces, such as roofs and driveways. The garden should be in an excavated or naturally low spot. The bottom layer is filled with stone to provide an area for the water to pool. The land around the rain garden is sloped so that the rainwater will naturally flow in from the nearby hard surfaces. Water-loving native plants are used in the garden to help slow down, soak up and filter the rainwater while the plant roots help it percolate deep into the ground.

I Farmland Preservation

Compared to more developed properties with a lot of paved areas, farmland allows rainwater to soak into the ground. This can reduce flash flooding in nearby streams and help replenish ground water. Many counties have funding available to reduce the loss of farmland to development and preserve the natural and historical character of an area.

Depending on the soil condition, location and value of the land, your property may be eligible for your county's farmland preservation program. One such way is through an agricultural conservation easement. This varies from county to county, but in many cases the landowner is financially compensated for some or all of the development rights of the property or the difference between the market value and the agricultural value of the property. The farmer retains full rights and ownership of the land. The conservation easement legally restricts the property to be used for agricultural purposes only. Future owners are also legally bound to the conservation agreement.

Consider creating a farmland preservation easement to protect your farm for future generations.

Agricultural conservations easements are beneficial in many ways:

- Ensuring that a family's farmland will be protected for future generations
- Compensating farmers so that farming remains profitable
- Protecting natural resources such as water, air, and good soil
- Preserving the historic character as well as scenic vistas of an area
- Decreasing the farmers tax burden
- Reducing the potential flooding that could be created through development

AN EXAMPLE FARM

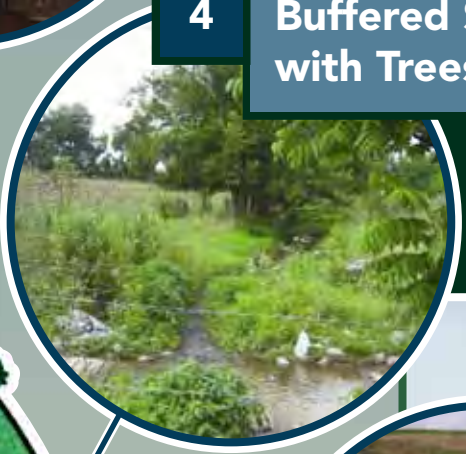
This farm shows many of the stormwater projects listed in the previous pages:

1. Liquid Manure Storage
2. Dry Manure Storage
3. Down Spouts & Gutters on Buildings
4. Buffered Stream with Trees & Fencing
5. Stream Crossing
6. Cisterns & Rain Barrels

3 Downspouts & Gutters on Buildings

See "Around the Barnyard" on page 9 for more information.

4 Buffered Stream with Trees & Fencing



See "Protecting the Streams" on page 8 for more information.

5 Stream Crossing

See "Protecting the Streams" on page 8 for more information.

Illustration by Frank McShane

SPOTLIGHT FARM

Davis Farm

Good for the Farm:

- Reduced chemical fertilizers cost
- Healthy livestock
- Safer well water

The Davis farm is located in Berks County, PA. It has been said that Berks County has some of the finest soil in the world. Teresa and Luther Davis's farm borders a small unnamed stream that flows into the Maiden Creek. The Maiden flows into the Schuylkill, just upstream of Reading. This water serves as the source of drinking water for not only Reading but also downstream for the City of Philadelphia. It's not hard to imagine that the water in these rural streams can have a big impact on many people downstream.

If this was a TV show, it would be called "Extreme Stormwater Makeover." The Davises, in collaboration with the Berks County Conservancy, Philadelphia Water Department, Schuylkill Action Network, Schuylkill River Heritage Area, Maiden Creek Watershed Association, Berks Watershed Restoration Fund, Reading Area Water Authority, and Natural Resources Conservation Service have taken on a variety of large and small projects to help keep the waterways clean and their farm productive.

On the other side of this gate is where all the liquid manure is stored.

The round concrete structure holds manure until it is needed to fertilize the crops, which reduces the amount of treatment the Philadelphia Water Department may have to do to provide clean and safe drinking water downstream.

The projects consisted of:

1. Construction of a liquid manure storage tank, as well as a dry manure storage facility. These structures allow the optimum amounts of nutrients to be supplied to crops at the right time, while preventing runoff pollution into local streams as well as contamination of groundwater.
2. Installation of fencing, which allows the plants along the stream to grow, creating a buffer. These plants and their strong roots will help slow down, soak in, and filter any rainwater runoff coming off the farm while helping to prevent erosion along the stream bank.
3. Installation of downspouts and culverts around the buildings. This results in steering away the rainwater from areas containing manure so that the water is clean as it runs off into the stream.
4. Lastly, creation of a path and cattle crossing as well as regrading a very steep slope. These changes will help prevent erosion and loss of fine Berks soil!

Good for the Community:

- Clean drinking water for Pennsylvania residents, from Reading to Philadelphia
- Healthy wildlife and fish in local streams
- Viable local farms

Cattle crossings help reduce soil loss, protects water quality and prevents cattle and equipment from getting stuck.

SPOTLIGHT FARM

Henry Got Crops Urban CSA

Urban farms help bring fresh vegetables to the City.

HENRY GOT CROPS
CSA Farm Partnership
W. B. Saul High School Weavers Way Farm
Fairmount Park

Weavers Way Co-op, Weavers Way Community Programs and W.B. Saul Agricultural High School collaborate in an urban Community Supported Agriculture (CSA) farm. The farm is on the grounds of Saul High School on Henry Avenue in the Roxborough neighborhood of Philadelphia, on Fairmount Park owned land. Weavers Way Co-op Farm is responsible for the production aspects of the CSA, and Weavers Way Community Programs work in conjunction with Saul's twelve agricultural teachers to provide a complete Career and Technical Education Program.

Good for the Farm:

- Strong community participation
- Students help promote and work the farm
- Dependable customer base

"Henry Got Crops" was started in 2009 and is run in collaboration with teachers at Saul. The project not only serves as an educational and career-building opportunity for students, but also brings food to the community. The farm is located right on campus, and students learn about and participate in small-scale, organic vegetable growing. This is one of the first high school-based CSAs in the country. There are many opportunities for student involvement. These opportunities range from hands-on work in the fields to helping with community outreach and newsletter-writing, to conducting applied research, budgeting and planning. In addition more than 100 families now participate in the Henry Got Crops CSA.

Good for the Community:

- Locally available fresh organic food
- Hands on educational opportunity for students
- Clean safe drinking water

The Philadelphia Water Department worked with all these partners to complete several projects to reduce polluted runoff from the farm. This was an important project because the Wissahickon Creek runs along the farm. The Wissahickon then empties into the Schuylkill just upstream of where the City pumps out water to provide drinking water for over a million people.

To help keep the waterways free of harmful pathogens and pollution, a combination of agricultural and urban stormwater projects were constructed. Wetland swales connect a series of long pools, which capture polluted runoff from the school roofs and parking lots as well as runoff from the livestock and farming areas. These pools slow down the water and allow it to soak in, settle out and filter before it flows into the sewer or directly into the Wissahickon Creek. The Philadelphia Water Department is excited to do more projects like these that benefit the farm and benefit the community.

SPOTLIGHT FARM

Weaver Organic Valley Farm

The Weaver Homestead is a 109-acre dairy farm in Berks County, Pennsylvania. The farm milks about 25 Jersey cows. The Weavers both grew up on farms and started out with a conventional confinement dairy. They became concerned about the chemicals being used and how they could affect their family, the cows, the land, and their waterways.

Many farmers switch to organic farming for financial reasons, but the Weavers changed because they saw how the chemicals applied to the land were so closely connected to the food they ate and sold. Now that the cows are less confined and able to graze, the local veterinarian rarely visits the Weaver Homestead.

Not only has the Weaver Homestead gone organic, they have also completed several projects to reduce polluted runoff into the nearby Maiden Creek. An in-ground manure storage tank was constructed. This allows them to store large quantities of manure to use later as fertilizer in the fields. Having plenty of storage space ensures that the manure can be spread on the fields at the proper time to increase yields and reduce storm water runoff pollution. They have also installed several barnyard stormwater controls to divert rainwater away from areas with mud and animal waste. These projects were constructed through support from Berks County Conservancy, the Schuylkill River Restoration Fund, NRCS, Berks Watershed Restoration Fund, Reading Area Water Authority, Borough of Kutztown, Schuylkill Action Network, and the Philadelphia Water Department.

Good for the Farm:

- Healthy livestock and lower veterinary bills
- More flexibility to use manure as fertilizer when needed
- Protected farm and water for future generations

Good for the Community:

- Fresh, tasty organic milk
- Clean drinking water sources
- Healthy wildlife and fish in local streams

An in-ground liquid manure tank during construction.

FARM TO TABLE MOVEMENT

In recent years, a whole host of terms have been created, all geared toward creating a balance between society's food needs and the natural environment. This "sustainable agriculture" is really about good, long-term planning since farming relies so heavily on the natural environment for good soil, healthy pollinators and clean water.

One aspect of sustainable agriculture is the "Farm to Table Movement" which encourages people to buy their food and other agricultural products from places that produce them locally.

There are many benefits such as:

- Supports local economies. Locally-owned companies tend to give back a higher percentage to causes in their communities as well.
- Reduces the amount of air pollution created through transportation and refrigeration.
- Increases the freshness of the food.
- Decreases the likelihood of severe water and air pollution issues due to overcrowded factory farming.
- Keeps all the jobs related to the food supply chain in your community.

Good agricultural practices mean good local seafood too. Next time you're eating out ask for Delaware Bay Oysters!

vertical farming
farm to fork
locavor
urban farming
CSA
sustainable agriculture
organic farming
farm to table
community-supported agriculture
localvor
food miles
slow food
invasivor
foodshed
locally grown
low carbon diet

FARM TO PINT MOVEMENT

Many scientists use the presence of insects and other creatures in our waterways to determine the health of the water in the stream. A water sample just takes a snapshot of the water at that moment in time, but looking at the creatures that are able to survive in the stream shows us how the stream has been doing for months and even years.

The stonefly larvae (young) can only survive in streams with the purest water. Even a small amount of polluted runoff will make the area unlivable for the stonefly. In honor of this clean water creature, the Saucony Creek Brewing Company created Stonefly IPA. The beer was a collaborative effort with the Schuylkill Action Network, a group of organizations, agencies, and environmental professionals with the goal of a clean and healthy Schuylkill River. A portion of the proceeds is donated to the Berks Watershed Fund. This Fund has helped pay for several agricultural pollution prevention projects. Since beer is over 90% water, many local breweries want to do their part to help keep our waterways clean.

Saucony Creek Brewing Company currently has a "Berks only" beer in the works which will be made from hops, water, grains and all other ingredients grown only in Berks County, Pennsylvania.

Stoneflies can only survive in the purest waterways.

Members of the Schuylkill Action Network with the owner of Saucony Creek Brewing Company after receiving the SAN MVP Award for clean water.

Protecting clean water one gulp at a time!

COST SHARE & ASSISTANCE PROGRAMS

There is an array of local, state and federal funding as well as technical expertise available. A good starting point to finding out about these resources is to contact your local Agricultural Specialist at your county's Conservation District (see page 22). Most conservation districts provide funding through conservation cost-share programs for projects involving the management of nutrients on a farm. This can include manure storage structures, gutters on barns, stream fencing for pastures, and other practices included in this guidebook. These specialists will be able to assist you in determining which type of project would be best suited for your farm and what resources are available to get you started.

GETTING STARTED

As you know, every farm is different and has its own specific needs. However, over the years, our local conservation partners have become very good at working together with farms to find creative solutions to help farmers protect the environment while maintaining a productive and profitable farm. Below are some typical steps that you may go through to start this process.

STEP 1 Start with a Plan

Most of the projects described above start with a conservation or nutrient management plan. If you don't have one or if they're old or outdated, they will work with you to find the resources, expertise, and even the funding to develop these plans for your farm.

STEP 2 Designing the Projects

The conservation or nutrient management plans will most likely suggest some different projects and practices that will help to keep the farm productive while protecting our waterways. Some of the projects can be simple changes to the way that you do things while others may be pretty big construction projects which will require engineer certified designs. Luckily, there are some great services available to provide these. If this is too daunting for you to handle or pay for on your own, which is the case for many farmers, your local Agricultural Specialist will typically get the NRCS involved in the process. Not only can they provide free engineering and design assistance, they have many programs available that will help cover some of the installation expenses.

STEP 3 Installing the Projects

While some of the projects outlined in your plan may be simple and inexpensive, others can be quite the opposite and may be a pretty big capital expense for the farm. Some good news is that most of these projects are investments for your business and will help you become more efficient and profitable. Additionally, there are many public and private programs that can be used to cover some or even all of the expenses of these projects. If partnering with NRCS, various programs offer cost-share options for installing conservation projects, such as manure storage structures, grazing and feeding pads, barnyard controls, stream bank fencing, and other practices. While the NRCS programs may cover half or even more of the project expenses, what remains may still be a really big price tag for many farmers. This is where local nonprofit partners step in. Realizing that we all have to work together for clean water, many different public and private groups offer grants to help farmers install these projects.

To get started and learn more:

Call:

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Stormwater Farm Projects	Typical Cost Ranges
Conservation & Nutrient Management Plan (Includes soil testing and fertilizer rates recommendations)	**$4,000 - $5,000 per farm**
Cattle Crossing (Costs vary depending on length and width of crossing and presence and condition of floodplain)	**$3.70 - $6.50 per square foot**
Gutters & Downspouts (Dependent on fascia presence and condition)	**$2.25 - $4.50 per foot**
Stream Bank High Tensile Fencing (Dependent on number of strands and corners)	**$0.80 - $1.93 per foot**
Buffer Plants (100 plants per acre depending on size, availability, and type of plants. Labor, shipping, and handling are extra)	**$3,000 per acre**
Stabilization Seeds (Dependent on species of seed and diversity desired)	**$50 - $500 per acre**
Liquid Manure Storage Tank (Based on site conditions, excavation, footer drain, safety fence, waste transfer pipe size and length, scrape alley, milk house waste, etc.)	**$60,000- $175,000***
Dry Storage Structure (Based on a roofed dry storage, $18 - $40 per square foot with contingency dependent on existing site conditions and excavation. Estimate does not include animal housing structure associated with need for storage)	**$10,000 - $50,000***
Rainwater Harvesting	**$50 per 50 gallon barrel or $550 - $2300+ per 1,000 gallon cistern**
Barnyard Controls (Dependent on existing conditions, size, and amount of curbing; assuming no roofing)	**$3.50 - $12 per square foot**

The sample costs include materials, permitting, engineering, design and installation, but can vary depending on site constraints or any unforeseen issues.

COUNTY CONSERVATION DISTRICTS

DELAWARE CONSERVATION DISTRICTS

New Castle Conservation District
www.newcastleconservationdistrict.org
302-832-3100

Kent Conservation District
www.kentcd.org
302-741-2600

Sussex Conservation District
www.sussexconservation.org
302-856-3990 x 3

NEW JERSEY CONSERVATION DISTRICTS

Burlington County Soil Conservation District
www.bscd.org
609-267-7410

Camden County Soil Conservation District
www.camdenscd.org
856-767-6299

Cape Atlantic Conservation District
www.capeatlantic.org
609-625-3144

Cumberland-Salem Conservation District
www.cumberlandsalemsoil.com
856-451-2422

Gloucester County Soil Conservation District
www.gloucesterscd.org
856-589-5250

Mercer County Soil Conservation District
609-586-9603
www.mercerscd.org

PENNSYLVANIA CONSERVATION DISTRICTS

Berks County Conservation District
www.berkscd.com
610-372-4657

Bucks County Conservation District
www.bucksccd.org
215-345-7577

Chester County Conservation District
www.chesco.org
610-925-4920

Delaware County Conservation District
www.delcocd.org
610-892-9484

Montgomery County Conservation District
www.montgomeryconservation.org
610-489-4506

Schuylkill County Conservation District
www.schuylkillcd.org
570-622-3742 x 5

STATE PROGRAMS

Delaware Dept. of Agriculture – Nutrient Management Program
www.dda.delaware.gov
302-698-4556

New Jersey Dept. of Agriculture – Animal Waste Management
www.state.nj.us/agriculture
609-292-8856

Pennsylvania Dept. of Agriculture – Nutrient Management Program
www.agriculture.state.pa.us
717-705-3895

Delaware
State Office 302-678-4250

New Jersey
State Office 609-587-0904

Pennsylvania
State Office 717-237-2117

- Berks County 610-372-4655
- Bucks/Montgomery/Philadelphia Counties 215-453-9527
- Chester/Delaware Counties 610-696-8750
- Schuylkill County 570-622-1555

FEDERAL PROGRAMS

United States Department of Agriculture (USDA) Conservation Reserve Enhancement Program (CREP) is an offshoot of the Conservation Reserve Program (CRP), the country's largest private-land conservation program. Administered by the Farm Service Agency (FSA), CREP targets high-priority conservation issues identified by local, state, or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, land owners are paid an annual rental rate. Participation is voluntary, and the contract period is typically 10–15 years, along with other federal and state incentives as applicable per each CREP agreement. For further information about the program visit www.fsa.usda.gov. Additionally the USDA Natural Resources Conservation Service (NRCS) offers many conservation programs through the Farm Bill. For a complete description of offered programs visit www.nrcs.usda.gov

OTHER RESOURCES

Berks County Conservancy initiated the **Berks Watershed Restoration Fund** to link businesses and individuals who benefit from a safe reliable water supply with farmers and landowners who are looking to incorporate BMPs into their operations. For more information visit ***www.berks-conservancy.org*** or call **610-372-4992**.

Penn State Extension provides a holistic approach to educating people on the various issues surrounding nutrient management. For more information visit ***www.extension.psu.edu***.

Pennsylvania Infrastructure Investment Authority (PENNVEST) Nonpoint Source Program provides low interest loans and grants for agricultural runoff, urban stormwater, abandoned mine drainage and brownfield stormwater projects across the state. Construction costs, engineering, legal and administration costs for a project are all eligible for PENNVEST NPS funding. For more information about the NPS Program visit ***www.pacd.org*** or call **717-238-7223 ext. 11**.

Rutgers New Jersey Agricultural Experiment Station delivers wide-ranging educational programs in the areas of agriculture, fisheries, urban and community outreach, youth development, food, nutrition and health, and related areas of economic and workforce development across New Jersey. For more information visit ***www.njaes.rutgers.edu***.

Schuylkill River Restoration Fund provides grants to government agencies and non-profit organizations for projects that improve the quality of water in the watershed. The grants focus on three major sources of pollution: stormwater run-off, agricultural pollution and abandoned mine drainage. For more information visit ***www.schuylkillriver.org/restoration_fund.aspx***.

Stroud Water Research Center enables businesses, policymakers, landowners and individuals to make informed decisions that affect water quality and availability around the world through freshwater research, education and watershed restoration programs. For landowner assistance call **610-268-2153 ext. 310**.

University of Delaware Cooperative Extension connects the public with university knowledge, research and resources to address youth, family, community and agricultural needs. For more information visit ***www.extension.udel.edu*** or call **302-831-2501**.

NOTES

SUPPORT PROVIDED BY:

Schuylkill Action Network – Protecting Schuylkill Waters
Members of the Schuylkill Action Network share information, expertise, and technology to help each other achieve a shared vision of clean water and a healthy environment for the Schuylkill River and its tributaries.
www.SchuylkillWaters.org

Philadelphia Water Department (PWD) supplies drinking water, wastewater and stormwater treatment services to the City and many suburban communities. The Department actively promotes good stewardship for the Delaware Estuary through its day-to-day water and wastewater operations, its nationally recognized Office of Watersheds programs, and its award winning Public Education programs. In addition, PWD's Source Water Protection Program takes a holistic watershed approach to drinking water protection, coordinating source water protection efforts throughout the Schuylkill and Delaware River watersheds.
www.phila.gov/water
1-215-685-6300

Partnership for the Delaware Estuary — A National Estuary Program is a non-profit organization established in 1996 with a mission to lead science-based and collaborative efforts to improve the tidal Delaware River and Bay. The Estuary, where fresh water and salt water mix, is also known as the tidal portion of the Delaware River and its tributaries, including parts of Pennsylvania, New Jersey and Delaware. It is one of twenty-eight congressionally designated National Estuary Programs in the country working to improve the environmental health of the nation's estuaries.
www.DelawareEstuary.org
1-800-445-4935

To get started and learn more:

Call:

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Special thanks to Larry Lloyd
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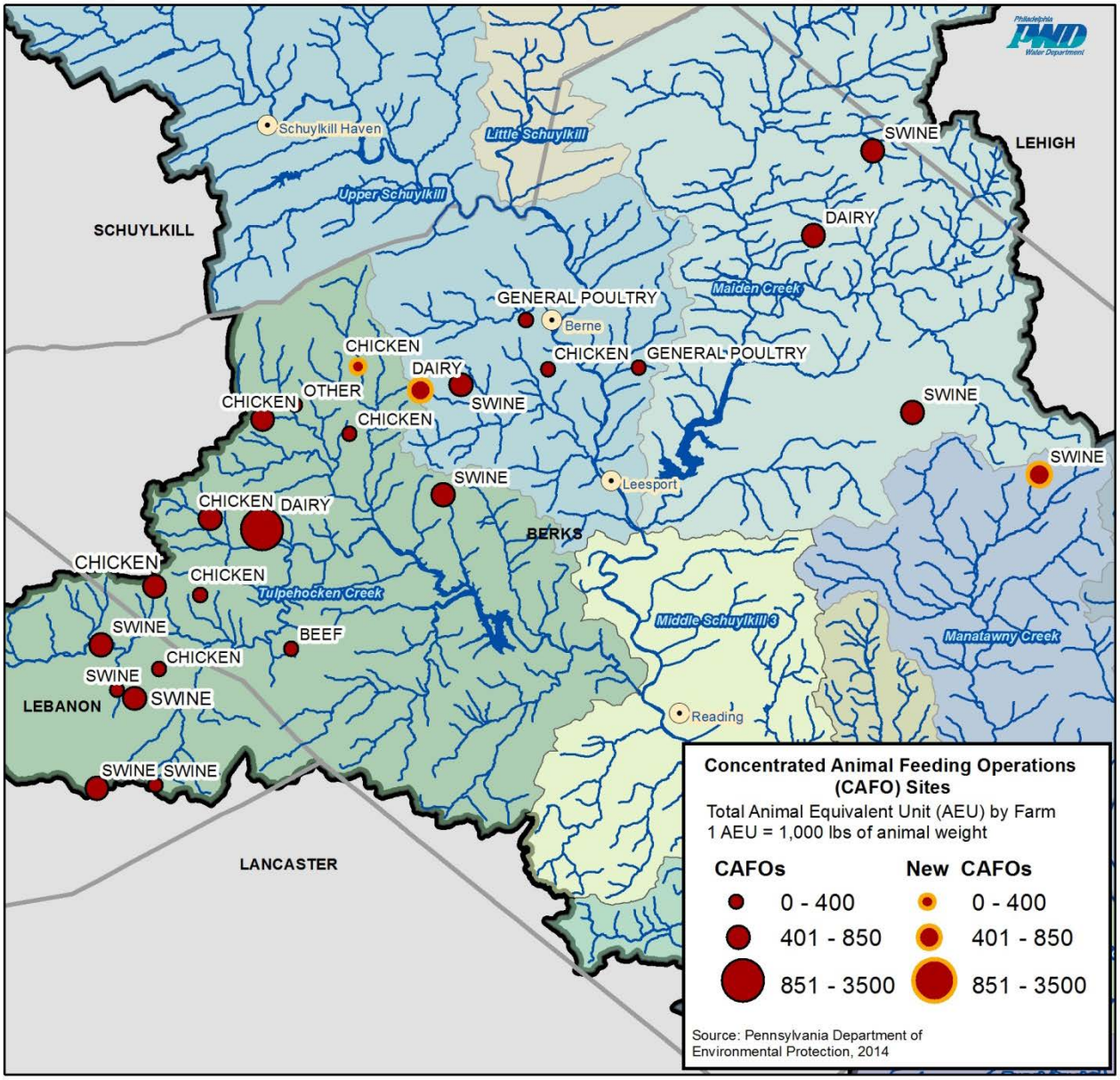
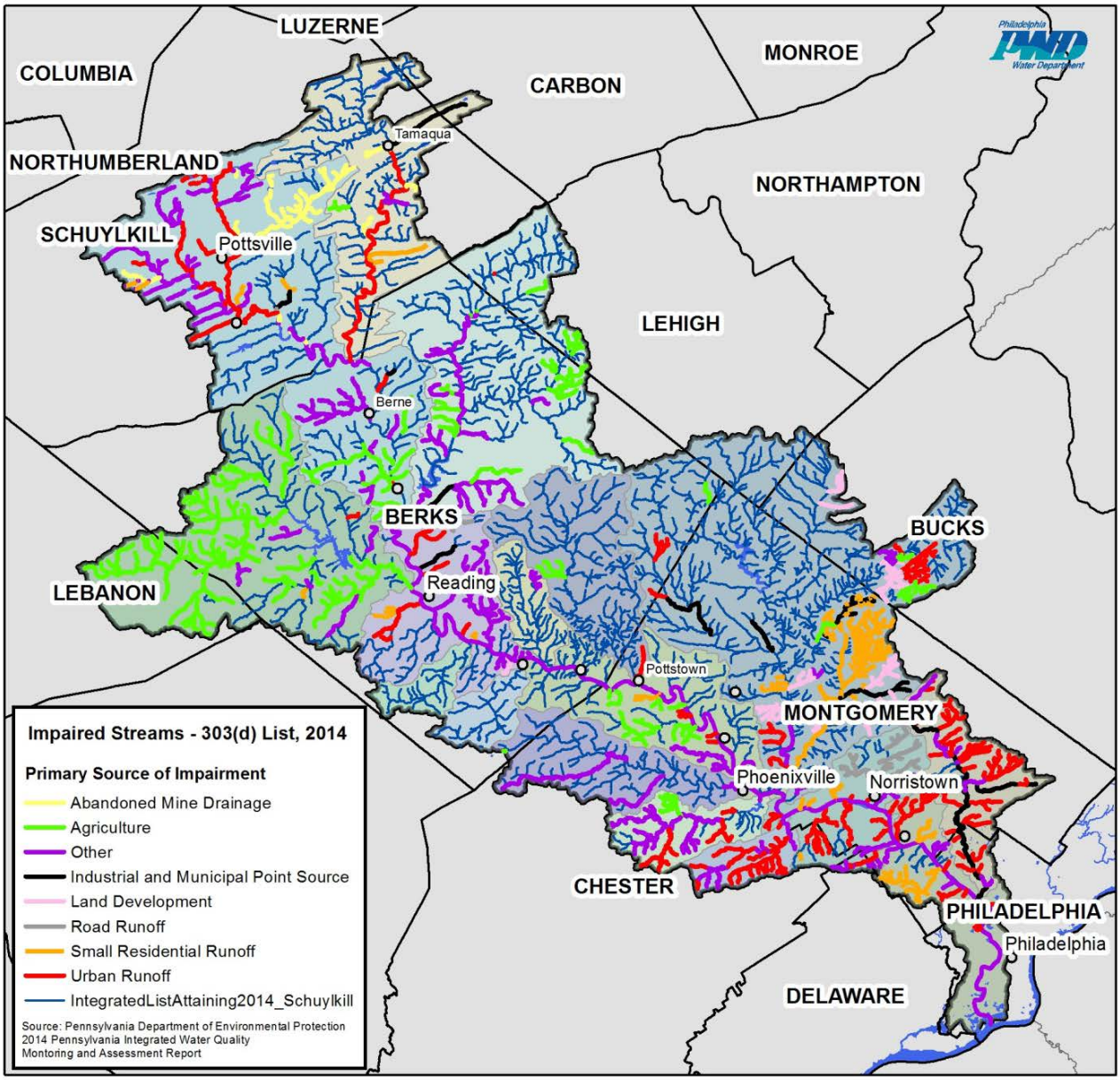
Teresa and Luther Davis,
Mr. Weaver,
Saul High School,
and Henry Got Crops CSA

Designed by Frank McShane
Printed on Recycled Paper

Appendix G: CAFOs in the Schuylkill River Watershed Map



Appendix H: 303(d) List Map of Impaired Streams



This map shows the primary source of impairment for streams on the 2014 303(d) list. No streams listed as impaired in 2012 were delisted in 2014 in the Schuylkill River watershed.

Appendix I: Additional Literature Sources for *Cryptosporidium* Loading Estimates

	beef cattle, dairy cattle, calves	swine, sheep, horse
Estimated Prevalence of Infection in Animals	(Cox et al., 2005); (Fayer et al., 2006); (USDA, 1993)	(Cox et al., 2005); (Johnson et al., 1997)
Cryptosporidium oocysts per day per animal	(Atwill et al., 2003)	--
Cryptosporidium oocysts per weight feces	--	(Cox et al., 2005)
Weight manure per day per animal	--	(ASAE, 2003)