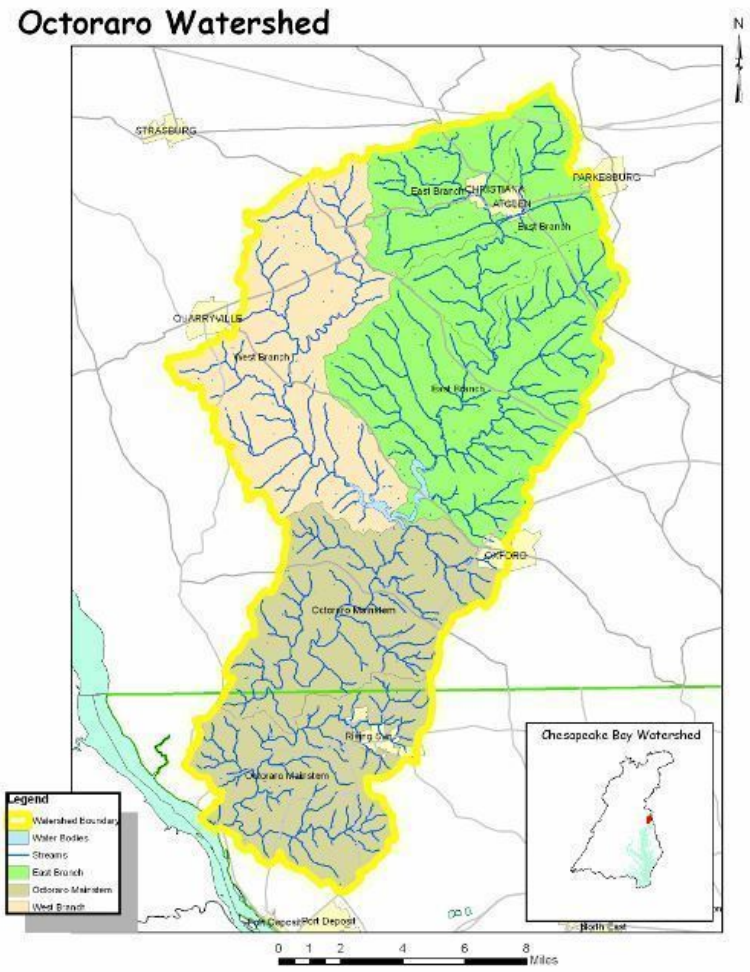
Octoraro River Cleanup

Mission Statement: To reduce amounts of nitrates, additives and lead in the Octoraro Watershed while ensuring waters are drinkable for future generations. To ensure that these plans for nutrient and pollution reduction are in place in both Northern Maryland and Southern Pennsylvania, by the year 2024

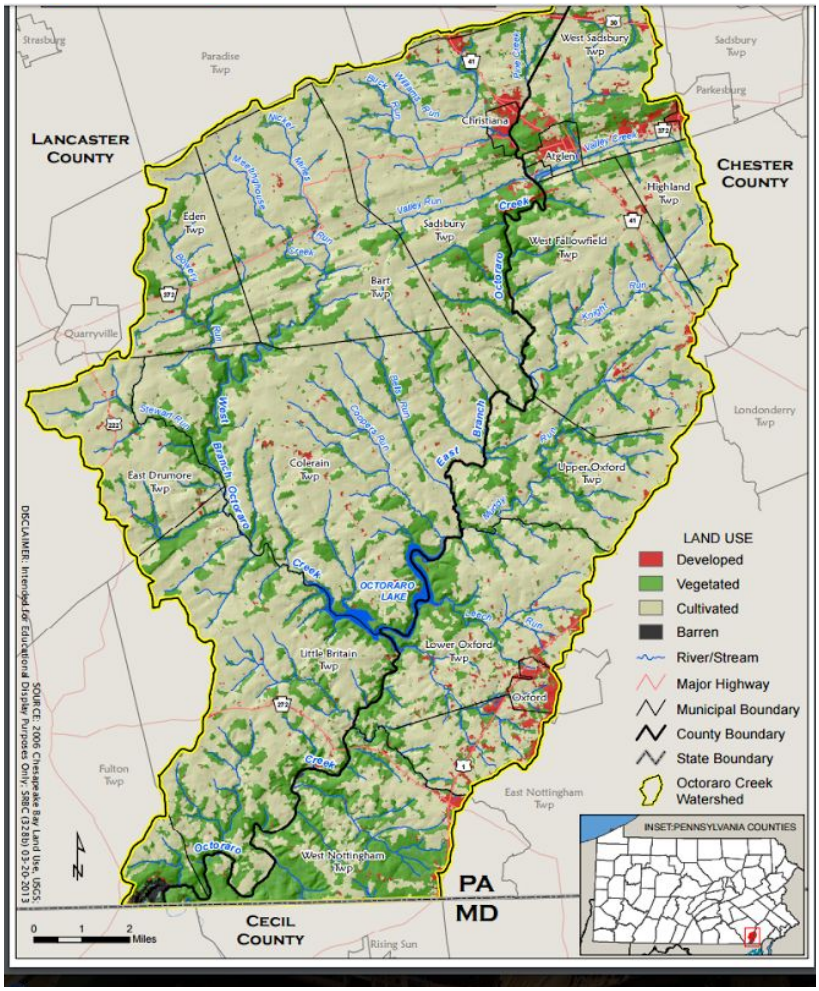
Background and History of Watershed

The Octoraro was once considered to be of pristine drinking quality, within the Chesapeake basin. The watershed nestled in the heart of Amish farm country was initially tapped in 1945 to bring quality drinking water to suburban Philadelphia (Kobel, 2017). Today the watershed provides drinking water for over 250,000 Pennsylvanians (Morelli, 2017). The pastoral landscape made the watershed an ideal alternative to the declining water quality of the Delaware, suffering from the detrimental effects of urbanization (CWA). Seventy years later, and the same aspects that made the Octoraro appealing, are now becoming the cause of significant problems. The landscape has undergone little change over the last hundred years, maintaining a firm agricultural base, consisting largely of Amish farmers. The watershed is largely undeveloped, with the exception of small pockets in the East and Northeast. Agriculture comprises 66% of land use (Rosetti). The dairy industry plays a huge role in the local economy, and also contributes greatly to the high levels of nitrate affecting the watershed. Seventy percent of farmers in the watershed are plain sect farmers, which stresses heavy manure application and high tillage (Morelli, 2017). Manure application to grain and vegetable crops can leach nitrates into groundwater, and livestock such as cows meandering into streams and poor livestock waste management can lead to nitrate buildup in surface



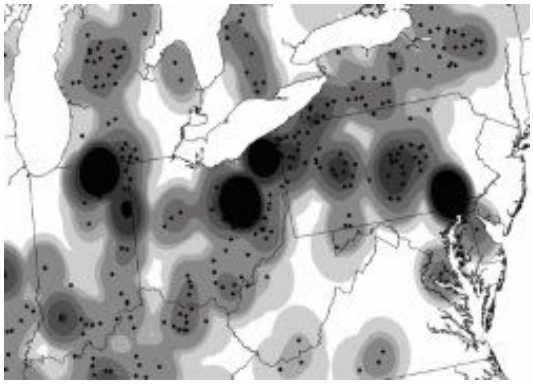
water. The Chester Water Authority once tapped the Octoraro as an alternative to the Delaware, and is now increasingly having to dilute the Octoraro with water from the Susquehanna, due to high levels of nitrate. This process can cost anywhere from $30,000 to $110,000 a month (Kobell, 2017).

The Octoraro Watershed is home to a unique culture within the U.S; the Pennsylvanian Dutch.



The Pennsylvania Dutch are the descendants of German speaking immigrants who settled Pennsylvania beginning in 1683 (Library Company).The Pennsylvania Dutch, also commonly referred to as the Amish. The Amish comprise a vast majority of the agriculture industry in the region. A majority of these farms are dairy farms. The Amish are an integral part of the agriculture and tourism economy of both Lancaster and Chester counties. Lancaster possesses the most dense distribution of the Amish population within Pennsylvania (Donnermeyer). The Octoraro Watershed falls directly within what would be considered “Amish Country” the area that consists largely of Amish farms, markets, and tourism.

As stated above seventy percent of the farmers within the region are plain sect farmers, that rely on traditional farming practices, such as heavy application of manure (Kobel, 2017). These practices contribute heavily to erosion and surface and groundwater contamination of nitrates. The Amish are traditionally slow to adopt new methods and technology, rather preferring to use methods and technology deemed as preserving their way of life (Brady, 2013). “Working with Plain Sect farmers requires a commitment to long-term dialogue. Many Amish question government agencies or others who may come seeking their help to improve local water quality to aid the restoration of the Chesapeake Bay, a body of water most Plain Sect farmers have never seen.” (Morelli, 2017). Agriculture comprises the majority of employment in the watershed (PA DCNR). Working with



and gaining the trust of the local Amish population is instrumental in reducing the level of nitrates found within the watershed.

Established Watershed and Environmental Protection Agencies and Organizations

Chesapeake Bay Program

The Chesapeake Bay Program is a regional partnership that oversees and directs the restoration and protection of the Chesapeake Bay area. The program is comprised of nine principal partners. The partners are the Chesapeake Bay Commission, the Commonwealths of Pennsylvania and Virginia, the District of Columbia, the states of Delaware, Maryland, New York, and West Virginia, and the Environmental Protection Agency (Program, C. B). Other partnerships include local governments, academic institutions, non-profit organizations, and federal and state agencies. The Bay Program carries out a multitude of programs and projects such as modeling, monitoring, quality assurance, resource land assessments, total maximum daily load reports, and watershed implementation plans.

Chester Water Authority

The Chester Water Authority is the primary provider of quality drinkable water to residents within and in close proximity to the Octoraro Watershed. The Authority dates back to 1866, when the City of Chester allowed the Authority to create a 1.5 million gallon reservoir, pumping water in from the Delaware. The original capacity of the plant, provided 800,000 gallons of water a day, to 67 customers. In 1948 the Authority began constructing a dam that would impound 2.8 billion gallons of water in the Octoraro Reservoir, and the Authority`s distribution facilities (CWA). After a mid-1960s drought, fears rose concerning whether a severe drought could affect the Octoraro water supply, and thus the Authority began the Susquehanna River Project (SRP). Completed in 1970, the SRP provided an additional 30 MGD of water that could be pumped by pipeline into the Octoraro Treatment Plant (CWA). This doubled the amount of water resources available to 60 MGD. The SRP originally used to provide additional water in times of drought, is now used to dilute water from the Octoraro Water to meet drinking water quality standards.

The Authority provides water to over 200,000 thousand people, businesses and industry. The Authority provides over 36 million gallons of water per day to its customers (2003). The Authority's water currently meets all the criteria established by the Pennsylvania Department of Environmental Protection (PA DEP), the United States Environmental Protection Agency (US EPA), and the American Water Works Association (AWWA). (CWA)

Octoraro Watershed Association

Founded in 1967 the Octoraro Watershed Association is dedicated to preserving the natural and historical resources of the watershed (OWA). The association works through voluntary action to carry out community engagement, and Amish outreach. The Association works with volunteers to provide stream cleanups, tree plantings, best management practice maintenance, and water quality monitoring.

Amish outreach consists of working through Amish liaisons, targeting Amish education efforts, Amish targeted brochures, and working with the bishops and churches (OWA).

In 1983 the OWA was crucial in the placement of 34 miles of streams in the Octoraro`s East and West branches, as well as the main stem of the Octoraro in the Pennsylvanian River Scenic Rivers Program (OWA). In 1986 the Association developed a task force and studied the problems of the watershed, and then made recommendations to the relevant towns and boroughs. In 1998 the Association created a Watershed Conservation Plan.

The Association heavily targets the partnership with watershed landowners in an effort to improve water quality. Partnership projects "seek to restore wildlife habitat, stabilize stream banks, and filter pollutants from watershed stream banks" (OWA). Association projects are continuously expanding to include new partners.

Mandates and Policies for the Octoraro Watershed Protection

The Octoraro Watershed covers 208 square miles. The watershed includes Cecil county Maryland, and fourteen townships and four boroughs in Lancaster and Southern Chester counties in Pennsylvania. Policy isn't typically implemented on a watershed basis, and thus leaves open the possibility for inconsistent policies to be implemented across different jurisdictions, leading to inefficient and ineffective management of the watershed. Due to the important economic, cultural, and environmental impacts of the Octoraro Watershed, measures have already been implemented to carry out policy and regulations across county and state lines. A few relevant regulations are listed below.

Maryland and Pennsylvania Nutrient Management Programs

The nutrient management programs of Maryland and Pennsylvania seeks to protect water quality in the Chesapeake Bay Basin and its tributaries by maintaining that all farmers, and urban land managers apply animal manure, fertilizers and any other nutrient sources in an environmentally conscious manner (Department of Agriculture). Nutrient management plans are generally required for any agriculture land use whether it pertain to cultivating crops, or raising cattle. Farmers are required to follow state nutrient management plans which specify safe amounts of fertilizers that may be applied to crops to generate sufficient yields, while ensuring minimal amounts of excess nutrients are impacting waterways (Department of Agriculture).

Octoraro Watershed Conservation Plan

In 2003 the Octoraro Watershed Association published its Octoraro Watershed Conservation Plan. The plan details the Watershed`s background, issues/concerns, land, biological, and cultural resources, and a variety of management options to address issues and concerns. The findings of the report established most of the research that would be used in the next decade in order to improve water quality, and served as the basis for any subsequent plans. The plan was established in order to serve as a guideline in meeting reductions detailed in the Bay TMDL (DCNR 2003).

The report found that 96% of land use was either farmland or woodland. The watershed hosted little industry, with farming providing the primary source of revenue for the area. Soil within the

watershed is highly suitable for agriculture. A variety of animals within the watershed have been designated various classifications of concern by the DCNR. In addition many invertebrates within the watershed are listed as endangered or threatened species. Three parks provide recreational activities such as fishing, boating, hunting, and hiking (DCNR 2003).

The three main targets outlined in the report are managing urban sprawl, reducing nonpoint source pollution, and improving stormwater management as the primary problems facing the Octoraro. These three issues are still problems being faced within the watershed today (DCNR 2003).

Four management and four secondary options were provided by the report to meet the needs of the watershed. The report sought to improve water quality in the Octoraro Creek and its tributaries, encourage environmentally sound municipal planning, promote recreational opportunities for watershed residents and visitors, and lastly protect and maintain the bridges of the watershed (DCNR 2003). The four secondary options were the enforcement of existing regulations, the employment of land management techniques for corridor preservation, the creation of forums for future discussion of corridor concerns, and the adoption of water withdrawal regulations in local municipalities (DCNR 2003).

PA DCNR Scenic Rivers

Scenic river designations by the PA DCNR provided guidelines for rivers depending on their designation. The Scenic Rivers designation covers 34 miles of streams within the Octoraro. The DCNR states "*Scenic* rivers shall be free-flowing and capable of, or under restoration, to support water-cased recreation, fish and aquatic life. The view from the river or its banks shall be predominantly wild, but may reveal some pastoral countryside. The segment may be intermittently accessible by road" (PDCNR).

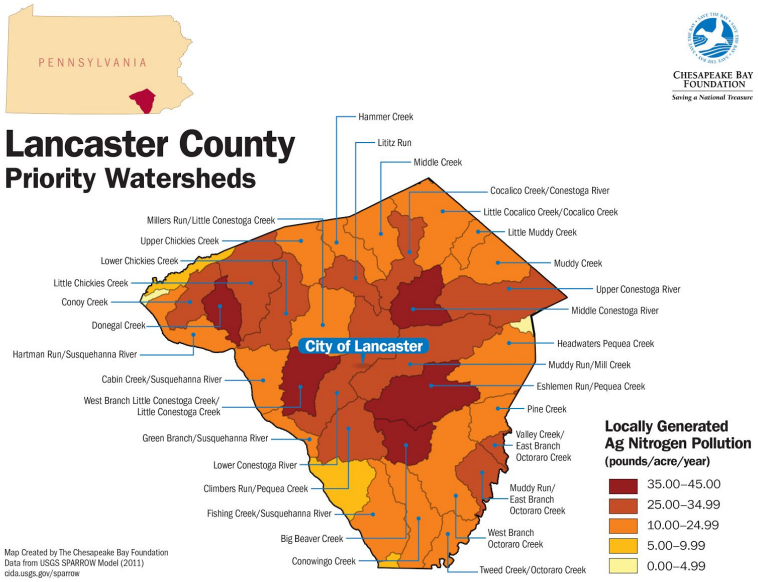
Current Problems/Issues facing the Octoraro Watershed:

Currently the most pressing issues facing the Octoraro Watershed are; 1) excessive nitrate levels found in ground and surface waters, 2/3) substantial amounts of fluoride(2) and lead (3) found in drinking water, 4) high accumulations of pollutants during long periods without rain. Each problem will be explained below, along with goals and objectives to create an outline for effective implementation.

Problem 1: Excessive nitrate contamination of ground and surface water

Nitrate pollution within the Octoraro Watershed is the most pressing issue the watershed currently faces**.** Nitrate pollution within the Octoraro comes from three main sources: cattle manure, fertilizers, and stormwater runoff (Judge 2015). Producing 10.8 billion gallons of milk annually from over 530,000 cows, Pennsylvania is ranked fifth in the nation for total milk production (Center for Dairy Excellence 2015). Of those 530,000 dairy cows in Pennsylvania, Lancaster county is home to 100,000 of them, about a fifth of Pennsylvania`s entire milk production (Crable 2015). Due to the high concentration of dairy farms in Lancaster county, manure management is of utmost importance. For this reason this report will focus on agriculture as the primary source of nitrate pollution. Cow manure makes excellent fertilizer for grain crops, however not all of the nitrate is absorbed by the crops, thus

allowing for nitrate loss to the environment. Excessive nitrate laden water can lead to the potentially deadly “blue baby syndrome” and has been linked to cancer, heart attacks, and birth defects (Kobell 2017). Excessive fertilizers and nitrates within streams can lead to algal blooms, which create oxygen dead zones within streams, severely adversely affecting fish. Nitrate levels vary with weather. During dry periods the watershed suffers from increased nitrates within groundwater, and during rainy period the watershed suffers from increased runoff from fertilizers (Kobell 2017).



Of the 1,600 farms in the watershed, seventy percent of the farmers are plain sect farmers. Plain sect farmers are Amish and Old Mennonite that practice traditional methods such as high tillage, excessive application of fertilizer and manure (Kobell 2017). Plain sect farmers, eschew government interaction and modern conveniences and farming methods. Traditionally plain sect farmers have been very reluctant to receive any local or federal funding to improve farming practices and pollution control, however they have showed a willingness to accept grants from non profits such as the Chesapeake Bay Foundation. The government is unable to force the plain sect farmers to take funds for such purposes, however the government is able to fine plains sect farmers should they be found in violation of pollution standards and nutrient programs (Kobell 2017).

Nitrogen is very prevalent in fertilizers and used more often than not excessively. Should soil lack nitrogen, crop yields tend to suffer. From a farmer's standpoint, if soil is nitrogen deficient, one dollar worth of nitrogen can potentially produce ten dollars` worth of crops. It's in the interest of the farmer to use excessive amounts of fertilizers containing nitrogen to ensure quality yields, rather than using less and risking crop failure (Haller)

Problem 1.1: Groundwater Contamination

Groundwater nitrate contamination is typically seen in agriculture dominated areas. Nitrates leach into groundwater from dairy and crop operations to produce nitrate laden groundwater. Nitrate laden groundwater poses an environmental and community health threat, as water with nitrates exceeding 10 mgs per liter are undrinkable, and causes various health problems in humans (McCasland). Nitrates from farm fertilizers leach into groundwater, make their way to the creek, and finally make their way to the Octoraro Reservoir used by the Chester water Authority's treatment plant. The Octoraro reservoir is the source of drinking water for over 250,000 Pennsylvanians (CWA 2015). Groundwater

nitrate concentrations frequently exceed the 10 mgs per liter limit for drinking water, eventually contaminating the Chester Water Authority`s reservoir causing the Authority to pump in water from the Susquehanna for dilution purposes (CWA 2015).

Nitrogen from fertilizers that is not absorbed by crops, or carried away by stormwater runoff eventually leaches into groundwater in the form of nitrates. Similarly manure from barnyards, storage operations, and from agricultural fields can leach into groundwater (McCasland). Best management practices such as minimizing the use of fertilizers used, collecting drainage water, better manure storage, and barnyard practices, can help reduce nitrates in groundwater.

The plain sect farmers traditionally tend to be reluctant to work with the government and receive funds to improve their practices. However increasing nitrate levels within groundwater, is leading to unsafe drinking water in many private wells, used by plain sect farmers. In 2009 the EPA tests multiple wells at Watson Run, 23 miles north of the Octoraro Reservoir, and found unsafe nitrate levels in many of the wells.

Problem 1.2: Surface Water Contamination

According to the Chester Water Authority`s 2014 and 2015 Water Quality Report, nitrate levels are slightly increasing within the reservoir as average results of nitrate yield 8.1ppm in 2014 to 8.2ppm in 2015 (CWA 2014, 2015). Overall the slight increase in nitrates suggests that current efforts are not being effective in the reduction of nitrates found in surface water. The EPA regulates that safe drinking water shall not exceed nitrates comprising 10ppm per liter of water. Seventy percent of samples taken from the West Branch of the Octoraro Watershed exceeded 9ppm, along with thirty percent of samples from the East Branch (Kobell 2017). Nitrate levels are reaching dangerously close levels within the watershed and the reservoir. There are various areas of improvement that can be taken within the watershed. An instrumental factor is the improvement of control runoff practices. Runoff from crop fields can carry nitrates from fertilizers into nearby streams thus contaminating the watershed. Poor manure storage by plain sect farmers, leads them to cover their agricultural fields with manure during the winter season, leading to excessive runoff, and nitrate pollution during the winter months. Municipalities within the watershed exacerbate the issue by using fertilizer as a means for treating frozen roadways when they've run out of road salt (Kobell 2017).

Best management practices are key to reducing surface water contamination. Practices such as improved manure storage will allow farmers to store their manure throughout the winter rather than covering their fields, and risking runoff nitrate pollution. Better barnyard management, fencing in and keeping cows out of streams can help reduce nitrate from directly entering streams. Planting more trees and vegetation along streams will serve to soak up nitrates from fertilizers that would have otherwise entered the stream (Kobell 2017). The collection of drainage water can prevent runoff and limit nitrates from entering streams. Currently there are sixteen waterways impaired by excessive nitrate levels. Meetinghouse Creek, Octoraro Creek, and the East/West branch of the Octoraro Creek are impaired for nutrients. The Octoraro watershed is listed as a priority area by the Pennsylvania Department of Environmental Protection (PDEP).

Goals: To significantly reduce nitrate loss from farming operations and the influx of nitrates into ground and surface water within Octoraro Watershed. To continuously meet EPA, Pennsylvania and Maryland standards for nitrates in drinking water.

Objectives:

Source Addressed: Agriculture

- Work extensively with the Octoraro Watershed Association to provide educational programs, and outreach while working towards establishing trust between local nonprofits and government with local plain sect farmers.
- Work with the Octoraro Watershed Association`s riparian buffer program to provide extensive buffers along streams in proximity to plain sect farmers.
- Work with state nutrient programs to provide extensive testing of plain sect farmer soil, and levy fines for infractions, to act as an incentive to adopt best management practices.

Source Addressed: Residential/Developed Areas

- Educate municipalities about the risk and harmful effects associated with employing fertilizers as a means for treating frozen roads in the absence of road salt.

Problem 2: High Levels of Fluoride

Fluoridation of drinking water is currently and has been endorsed by the American Dental Association since 1950, due to perceived public health benefits fluoridation provides in preventing tooth decay (American Dental Association 2017). Fluoridation is considered by the CDC one of the "ten great public health achievements of the twentieth century" for its role in the large reduction of cavities in the United States (CDC 2016). The Chester Water Authority received a permit from the Pennsylvania Environmental Protection Department granting the Authority the ability to fluoridate their drinking water (CWA 2015). Fluoridation is beneficial, however increased amounts of fluoride in drinking water may pose health risks to children under eight years of age (CDC 2011). In 2011 the U.S Department of Health and Human Services announced a reduction in the optimal level for community fluoridation from .7ppm to 1.2ppm to a maximum of .7ppm (CDC 2011).

The reduction of fluoridation was issued to combat fluorosis in young children. Fluorosis is a form of hypermineralized tissue that can potentially result in a wide range of visually detectable changes in tooth enamel (CDC 2011). Dental fluorosis or "molting" can occur if an infant ingests large amounts of fluoride. Infants are very susceptible to fluorosis due to low body weight and high fluid intake (CWA 2015). In 2015 the Chester Water Authority recorded an average fluoride levels at .6ppm with the highest result being .92ppm in drinking water, which is above the recommended level from the U.S Department of Health and Human Services (CWA 2015).

The Chester Water Authority is responsible for overseeing the addition of fluoride in drinking water that it provides to its customers. In order to mitigate fluorosis in children, the Authority must be more careful in the amounts of fluoride added to drinking water.

Goals: To reduce the amount of fluoride found water in the Octoraro Watershed to be used as drinking water, so that all tests yield results of fluoride levels remaining below the .7ppm maximum.

Objectives:

Source Addressed: Chester Water Authority

- Work extensively with the Chester Water Authority to reduce fluoride levels by providing fluorosis educational materials, and a reduction in the amount of fluoride added in drinking water.

Problem 3: High Levels of Lead

Lead has the potential to enter drinking water when service pipes and household plumbing containing lead begin to corrode. This occurs with various levels of frequency depending on the acidity of drinking water flowing through service pipes. The EPA created the Lead and Copper Rule (LCR) to address the corrosion of lead and copper into drinking water (EPA 2017). The LCR employs a tactic known as “corrosion control treatment” which means utility companies such as the Chester Water Authority must make drinking water less acidic to help mitigate corrosion that occurs as drinking water makes its way to consumers` taps (EPA 2017).

The Safe Water Drinking Act`s maximum contaminant level goal (MCLG) for lead in drinking water is zero (EPA 2017). Lead is a toxic metal that is detrimental to human health, and that can bioaccumulate in the human body over time. Exposure to lead negatively affects adults, children, and specifically pregnant women. Lead exposure to adults can lead to cardiovascular effects, increased blood pressure and incidence of hypertension ,decreased kidney function, reproductive problems (in both men and women) (EPA 2017). Lead exposure to pregnant women potential reduces the growth of the fetus and may lead to premature birth (EPA 2017). Lead exposure to children potential slows growth, increases the likelihood of hearing impairments, lower IQs, anemia, behavior and learning problems (EPA 2017) Children and infants are more susceptible to lead poisoning, considering young children and infants typically consume more water, and their bodies are actively developing, allowing for increased bioaccumulation of lead (Oram).

Drinking water provided by the Chester Water Authority in ninety percent of tests found lead levels of 12ppb, substantially above the recommended EPA MCLG. Potential remedies to reducing lead content within drinking water involves, reducing water acidity to mitigate short term lead consumption, and replacing all dated lead service pipes and household plumbing to ensure the reduction of long term lead consumption.

Goals: To significantly reduce the presence of lead in drinking water, and meet the maximum contaminant level goal of zero lead presence recommended by the EPA.

Objectives:

Source Addressed: Chester Water Authority/Municipalities

- Work with the Chester Water Authority to identify and replace all service pipes containing lead.
- Work with local municipalities and county governments to replace household plumbing that contains lead.
- Mandate the replacement of all pipes suspected of lead corrosion.

Problem 4: Increased pollution

During dry periods, a lack of rainwater and dilution, results in high levels of disinfection byproducts and ammonia from fertilizers to accumulate within the watershed. This causes the watershed to be virtually unusable for long stretches of time. The CWA plant can dilute the reservoir by pumping in water from the Susquehanna. This can cost between $30,000 and $120,000 a month to blend the water (Kobell, 2017)

Ammonia at concentrations of .053 to 22.3ppm present in streams are reported as toxic to freshwater organisms. In 2015 ammonia levels within the Octoraro Watershed were recorded at .6ppm (CWA, 2015). The ammonia molecule is a nutrient required for life, however in excessive amounts ammonia causes stress, increases the body's PH levels in aquatic life and alters their metabolism. Ammonia concentrations of .2ppm to 2ppm may cause skin, eye, and gill damage and is potentially lethal to many species of fish (Water Research Center). Fish hatcheries exposed to ammonia may suffer structural development and damage may occur in the gills, liver and kidneys (Water Research Center). Agriculture within the watershed is the primary source ammonia. Ammonia from fertilizers and manure, acts similarly to nitrates and leach into groundwater, and runoff contaminates streams. Potential remedies are listed above under the nitrate section.

Haloacetic acids appear in streams as a byproduct of disinfection chemicals used in drinking water. The maximum contaminant level for haloacetic acids (HAs) is 60ppb (CWA 2015). The Chester Water Authority recorded an average of 40ppb and highest result yielded a concentration of 73ppb (CWA 2015). HAs are generally low toxicity to humans and animals, however long term exposure to levels exceeding 60ppb can cause injury to reproductive systems, eyes, kidneys, liver, nerves, the brain, and are currently classified as possible carcinogens (ODHS, 2004). Animal studies suggest decreased fertility, spontaneous abortion, and an increased risk of cancer (ODHS, 2004). HAs are by products of disinfection chemicals employed by the Chester Water Authority, and thus the best management practice is reducing the use of chlorine as a disinfectant and employing charcoal filtration to ensure HAs don't exceed dangerous level.

Goals: To significantly reduce amounts of haloacetic acids, and ammonia within the watershed, and achieve recommended EPA standards.

Objectives:

Source Addressed: Agriculture

- Work extensively with the Octoraro Watershed Association to provide educational programs, and outreach while working towards establishing trust between local nonprofits and government with local plain sect farmers.
- Work with the Octoraro Watershed Association`s riparian buffer program to provide extensive buffers along streams in proximity to plain sect farmers.

Source Addressed: Chester Water Authority

- Work with the Chester Water Authority to determine levels of haloacetic acids that may be employed while ensuring that concentrations of HAs within drinking water don't reach hazardous levels.

Analysis of Best Management Practices

The adoption of Best Management Practices (BMP) are essential to ensuring that the Octoraro Watershed`s water remains drinkable. It is imperative that BMPs are effective in reducing levels of nitrate, fluoride, and pollutants, while being cost efficient to key stakeholders within the watershed. The Best Management Practices Verification Committee of the Chesapeake Bay Foundation is responsible for all elements of basin wide BMP verification framework, such as verification principles, protocols, review panel, among other procedures (Chesapeake Bay Foundation 2015). Management options that may be adopted are broadly defined under two categories by the Verification Committee, that are essentially cost effective measures, and non-cost effective measures.

Cost Effective Measures

- Nutrient Management Plans (NMPs): NMPs provide guidelines that offer farmers an understanding of responsible fertilizer utilization. NMPs if adopted by plain sect farmers have the potential to reduce nitrate runoff into nearby streams, and nitrate leaching into groundwater.

- Barnyard Management Plans (BMPs); BMPs will guide farmers on practices and methods that will keep livestock out and away from streams. BMPs have the potential to keep livestock waste out of streams, and thus minimize the hazards posed by animal waste.

- Riparian Buffer; The construction of riparian buffers along streams adjacent farming operation. Riparian buffers will absorb a significant amount nutrients such as nitrates, before they enter

streams due to runoff. Riparian buffers can be constructed to various degrees of width, and of native shrubs, grasses, and trees.

- Cover Crops; Cover crops can be planted directly after major harvests as a means to absorb any remaining nutrients that failed to be absorbed. Cover crops prevent excessive level of nutrients being transported during stormwater runoff.

- Plain Sect Outreach; Educating and building trust with plain sect farmers is paramount in ensuring that BMPs are adopted rather than ignored. Education will center on the hazards excessive nitrate levels have on human health and water quality.

- Additive Management Plans; Increased focus and management of water additives will alleviate high levels of fluoride and haloacetic acids within the watershed.

<u>High Budget Allocation</u>

- Manure Storage; Manure storage is paramount to preventing excessive levels of nitrate being transported from fields. Storage barns will provide plain sect farmers with areas to store unused manure for the upcoming growing season, rather than spreading manure on fields during winter.

- Road Salt; Ensure municipalities purchase enough road salt prior to winter, to ensure fertilizers are not used as a substitute for treating frozen roads.

- Service Pipe and Household Plumbing Replacement Plans (SPHPRPs); SPHPRPs are necessary in ensuring that all antiquated pipes containing lead are replaced ensuring customers have access to quality drinking water with no traces of lead.

Recommendations and Milestones for the Octoraro Watershed Cleanup
PSFs=Plain Sect Farmers, **MNPs=**Nutrient Management Programs

Recommendation	Issues	Partnership	Milestones
Create Riparian Buffers	P1.2 & P4	Octoraro Watershed Association	Employ riparian buffers on banks surrounding 50% of PSFs by 2024
Cover Crops	P1 & P4	Octoraro Watershed Association/PSFs	Use of cover crops on all plain sect farms by 2024
PSF Specific MNPs and more frequent testing	P1 & P4	Octoraro Watershed Association/PSFs/PDA	Establish PSF specific NMPs, with more frequent soil testing by 2024.
Promote Nitrate Education	P1 & P4	Octoraro Watershed Association/PSFs	Establish a PSF specific education program by 2019.
Water Additive Education/Reduction	P2 & P4	Chester Water Authority/Local Municipalities	Establish criteria for water additive amounts, and establish educational programs regarding potential harms by 2020.
Replace all antiquated pipes containing lead.	P3	Chester Water Authority, state government/local municipalities	Replace all antiquated service pipes/household plumbing by 2028.

Conclusions

The Octoraro River Cleanup (ORC) was developed to analyze and study the detrimental effects of stream impairments in the Octoraro Watershed, a subbasin of the Chesapeake Bay. The goal was to identify issues, analyze and provide recommendations for best management practices that seek to alleviate key issues harming water quality within the watershed.

The major problem faced in the Octoraro is nitrate pollution from agriculture to ground and surface water, causing algal blooms, and hazards in drinking water quality. Other issues facing the Octoraro include excess amounts of fluoride, lead, and pollutants found in drinking water, due to excess amounts of water additives, agriculture, and the corrosion of service pipes and household plumbing. All issues faced within the watershed are detrimental to both human, and environmental health.

There are a variety of established watershed protection entities working towards the improvement of the Octoraro Watershed, which are instrumental to the restoration of the watershed. We firmly propose increasing the pace and volume to which riparian buffers are created, the

introduction and use of cover crops, specific plain sect farmer nutrient management programs, and increased outreach and education targeting plain sect farmers, to reduce nitrate pollution. We recommend the Chester Water Authority take actions to become more stringent and careful concerning the amount of water additives placed in drinking water to reduce sometimes hazardous levels of fluoride and haloacetic acids. The replacement of all antiquated service pipes and household plumbing containing lead must be replaced to ensure prevention against lead poisoning. The reduction of nitrate pollution should be given the top priority. Applications of BMPs are key to solving many of the issues currently plaguing the Octoraro Watershed.

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