Red Clay Creek Action Plan (RCCAP)

An Extensive Watershed Management Proposal

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Mission Statement

The Red Clay Creek Action Plan (RCCAP) aims to achieve quality standards that are high enough to make the Red Clay Creek fishable by the year 2030.

Background

The Red Clay Creek is a 54 square mile watershed located in Delaware and Pennsylvania. The Red Clay is a tributary located within the 565 square mile Christina Basin. The Christina Basin flows into the Delaware River Basin and eventually into the Atlantic Ocean. The Red Clay is a free-flowing stream. It passes through six municipalities in Pennsylvania and unincorporated areas in Delaware. Forests, agricultural, and urban uses are the primary land uses within the Red Clay Watershed. (Delaware Watersheds, para. 1) The population of the watershed is almost 50,000. In 2005, Delaware created the Red Clay Valley Scenic Byway to recognize the environmental significance of the creek. Hoopes Reservoir, Delaware's largest water storage reservoir, is located in the Red Clay Creek watershed.

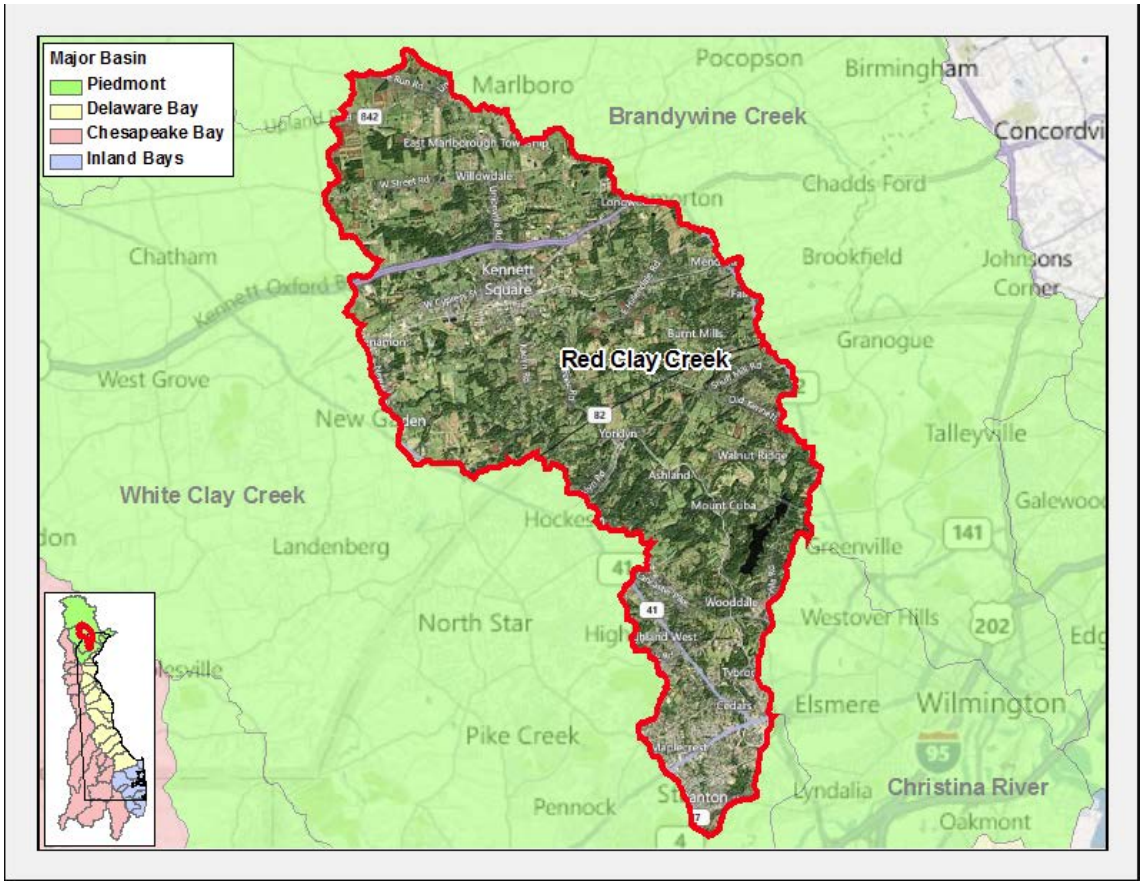

Figure 1: Map of Red Clay Creek

History

The Lenape Tribe inhabited the Red Clay Creek before European colonization. (Native languages para. 1) During the colonial and revolutionary eras, multiple mills and small factories sprung up along the banks of the Red Clay. This industry continued well into the 19th and 20th centuries. (Yorklyn Village para. 2) Yorklyn, DE, is home to the most famous mill on the Red Clay, the Garrett Snuff Mill. The Wilmington-Western railroad was constructed adjacent to the Red Clay to help move supplies and goods from Yorklyn to Wilmington. Many of these mills dumped their waste directly into the Red Clay.

Figure 2: Garrett Snuff Mill

Agricultural uses have dominated the upper Red Clay. It has remained that way since the colonial era. Around 150 years ago, farmers near Kennett Square began experimenting with mushroom production. The endeavor was highly successful, and Kennett Square has dubbed itself "The Mushroom Capital of the World." Some agricultural uses for the Upper Red Clay are mushroom production, corn, soybeans, and pasture lands.

In the early 1900s, engineers from the City of Wilmington were looking to build a large reservoir in the surrounding countryside. They settled on a 8000-foot long valley located in the

Red Clay Creek Watershed. Completion of the Hoopes Reservoir occurred in 1932. The reservoir is 187 acres in area and holds nearly 500,000,000 ft^3 of drinking water. (City of Wilmington para. 8) Most of the water in the reservoir is pumped up from the Brandywine River and does not directly come from the Red Clay Creek.

Figure 3: Hoopes Reservoir in 1933

Rabid urban development began to occur in the lower Red Clay watershed in the middle of the 20th century. The areas surrounding Kirkwood Highway (SR-2) are where most of the urban development has occurred. This roadway is one of the main connectors between Wilmington and Newark, Delaware. Primary land uses for this region are commercial and residential homes. This urbanization happened quickly and even recklessly at some points. Developers constructed the neighborhood of Glenville right at the mouth of the Red Clay. The community was frequently flooded, and homeowners had to be bought out after a flood caused by Hurricane Floyd in 1999.

In 2005, Delaware created the Red Clay Valley Scenic Byway. The primary purpose of this network is to recognize and maintain the remaining environmental significance of the creek. The central portion of the watershed is still heavily forested and undeveloped. Preserving this land has become critical to the State of Delaware.

Problems

The Red Clay Creek Action Plan (RCCAP) centers around three main problems that affect the water conditions. These are just a few of the main issues regarding the watershed and are by no means the only problems with it, but it presents a solid starting point for optimal success.

Table 1: Descriptions and Causes of Problems in The Red Clay Creek

Problem	Description	Causes
P1: Stormwater Runoff	Land use within the Red Clay Creek is 27% suburban or urban. This percentage will increase if there is more human development within the Red Clay Creek watershed.	Impervious surfaces and increased human development. Poor drainage system along roads
P2: Nutrients from agricultural activities	The headwaters of the Red Clay Creek watershed are dominated by agricultural land uses. Most notably, mushroom production, soybeans, and pastoral land.	Nitrogen and Phosphorus are frequently used as a fertilizer to increase the production of crops. They can also be found in animal manure.
P3: Large amounts of Harmful Contaminants	Samples taken from Red Clay Creek indicate higher levels of PCBs, zinc, chlorinated pesticides, and dioxin are present in the environment than what is advised under the clean water act of 1972.	Improper disposal of electrical equipment (PCBs) Mining, smelting metals, and steel production (zinc) Pesticide use (chlorinated pesticides) waste -burning incinerators and backyard fire pits (dioxins)

P1: Stormwater Runoff

Impervious surfaces are one of the primary causes of increased stormwater runoff in human developments. These types of surfaces make it exceedingly difficult for rain to percolate into the soil. Impervious surfaces also allow rainfall to decrease their time of concentration to

streams and rivers. These two issues lead to excessive flooding, contaminants flowing directly into streams, and property damage. The Red Clay Creek has a handful of suburban/urban areas. The largest areas are the southern region of the watershed near Stanton and Kirkwood Highway (SR 2) and the Kennett Square area. These suburban/urban areas may increase in size over the coming decades leading to larger areas of impervious land.

P2: Excessive Nitrogen & Phosphorus use in agriculture

Excessive nutrients are a common issue found on agricultural lands. Nutrients help plants grow quicker and more prominent. Naturally, farms would like to use as much nitrogen as possible to increase their crop yield. Farmers frequently use too much nitrogen such that high amounts are leaked into the watershed through stormwater runoff. The issue is that nutrients allow algal blooms to grow as well. Algal blooms use up dissolved oxygen found in streams which causes fish to suffocate. Many fish end up dying. A study done by DNREC showed that 74% of the Red Clay Creek had high nitrogen levels while 24% of the watershed had moderate nitrogen levels. While phosphorus exceeds EPA recommendations for 90% of tests. (DNREC Red Clay Watershed Report)

P3: Large Amounts of Harmful Contaminants

The Red Clay Creek Watershed is on the 303d list of impaired waters and has State of Delaware Fish Consumption Advisories for PCBs, dioxin, and chlorinated pesticides. (DNREC (305(b)) Report pp. 19) This means that there are high enough levels of these contaminants to raise concern and make the waters unfishable. Many of these harmful contaminants are ultimately contaminating and killing a lot of the aquatic life in the creek. The Red Clay Creek eventually flows into the White Clay and ends up in the Christiana River. The contaminants ending up in the Red Clay Creek affect more water bodies and contaminate the fish in downstream rivers.

Goals

G1: Reducing Stormwater Runoff

To reduce the amount of stormwater runoff, it's a good idea to balance the rapid growth of impervious surfaces and urbanization with adequate stormwater management practices. This will result in the absorption of rainwater into soils and vegetation rather than turning into dangerous runoff. Educating the public on the dangers of polluted runoff could potentially increase the initiative to reduce stormwater runoff. Reducing litter, picking up after your pets, and driving less help minimize pollutants in stormwater runoff.

G2: Reducing Nutrient levels

The goal for this issue will be to get the majority of the Red Clay Creek watershed to reduce nutrient levels to moderate. This can be accomplished through monitoring techniques and working directly with farmers in the upper portion of the watershed. Containing the harmful pesticides and keeping them from ending up in the water sources is ideal. We should also help farmers find better nitrogen and phosphorus alternatives and more efficient fertilization practices while giving them helpful feedback on the health of the watershed. BMPs or other mitigation tactics could be used if the problem persists.

G3: Reducing Harmful Contamination

The goal for harmful contamination in the form of PCBs, zinc, chlorinated pesticides, and dioxins is to reduce these contaminants to a level below that of the "State of Delaware Fish Consumption Advisories." This will open up the area to fishers and improve the aquatic life that calls the creek home. The water in the creek ultimately ends up in the Christina River, which then flows into the Delaware River and then works its way into the Atlantic Ocean. Reducing suburban/urban use of pesticides and other contaminants used on their lawns, cars, etc., will limit the number of pollutants entering the creek through stormwater runoff. The Red Clay Creek may seem like a small sample size, but reducing the harmful contaminants in the stream will improve the health of hundreds of miles of water.

Figure 4: Wooddale Covered Bridge Over Red Clay Creek, No. 5, New Castle County

Existing Organizations

Brandywine-Red Clay Alliance - The Brandywine Red Clay Alliance is a nonprofit organization specializing in watershed conservation and environmental education. (The Brandywine Red Clay Alliance website) A non-profit based on the Brandywine River combined with a nonprofit organization based on Red Clay in 2015 to form the Brandywine-Red Clay Alliance. The group was nearly 100 years of experience working within the two watersheds.

They frequently organize volunteers, work with students, and actively work to improve the Red Clay Creek and the Brandywine River's water quality.

Chester County Ag Council (CCHC) - The CCHC is a prominent agricultural alliance located in the Red Clay Creek Watershed headwaters. Their primary objective is to help farmers conduct their business and to address agricultural issues. (Chester County Ag Council para. 2)

Delaware Department of Natural Resources (DNREC) and Pennsylvania Department of Environmental Protection (DEP)- These two organizations are the state environmental agencies of Delaware and Pennsylvania. Both are tasked with protecting and rehabilitating Red Clay Creek. DNREC has expressed the importance of maintaining the Red Clay in the recent past.

New Castle County and Chester County - The two counties that the Red Clay flows through. They similarly have an interest in the Creek's water quality. New Castle County has a cost-sharing water quality program that reduces the cost of water management devices.

Christina Basin Clean Water Partnership (CBCWP) - The goals of the CBCWP align with our own: to attain fishable, swimmable, and potable statuses for the Red Clay Creek. Valued at nearly $300 million per year, the Christina Basin receives financial help from watershed financing such as surcharges and fees all through the CBCWP. The CBCWP also has watershed governance initiatives that increase education and outreach, create restoration plans, provide stakeholder progress reports, and join relevant municipalities across Delaware and Pennsylvania.

Environmental Protection Agency (EPA) - The federal agency responsible for environmental stewardship and protection. The EPA tends to aid state and local environmental agencies and recommend Total Maximum Daily Loads (TMDLs) for contaminants. They also give out grant money for worthwhile projects and collect data on their own.

Existing Regulations

National Pollutant Discharge Elimination System (NPDES) - NPDES is a federal permit program that addresses water pollution by regulating point sources that discharge pollutants to waterways in the United States. (EPA para. 1) The Clean Water Act of 1972 is where this permit program comes from. Essentially no point source allowed to pollute a US waterway without a NPDES permit. Each permit contains limits on what can be discharged, monitoring and reporting requirements, and other provisions to ensure that the point source pollution is not hurting the waterway.

Section 303(d) of The Clean Water Act & TMDLs - This portion of the CWA says that states must develop a list of impaired waterways and develop TMDLs for each polluted waterway. (EPA para. 2) A TMDL is the maximum allowable load for a particular contaminant with a margin of safety built-in. DNREC and Pennsylvania's DEP frequently complete 303(d)s for the Red Clay Creek. They are a convenient way to monitor the progress of this action plan.

Management Strategies

Stormwater Runoff and Pollution

Rain Barrels: Rain barrels are an urban stormwater runoff technique commonly used in residential settings. In older urban environments, rainwater will travel from the roof of a home, through a downspout, into a gutter, and then into a stream. Multiplying this process by hundreds or thousands of homes creates a devastating amount of runoff for a stream. Rain barrels are designed to stop the rooftop runoff process. Fifty-gallon barrels can be placed at the bottom of downspouts to collect rain from roofs. The rainwater can then be released after a storm or saved and used for gardening purposes. Rain barrels are inexpensive and relatively easy to maintain and install. A cost-sharing plan and an educational program run by New Castle County could boost the use of rain barrels in the lower Red Clay Creek Watershed.

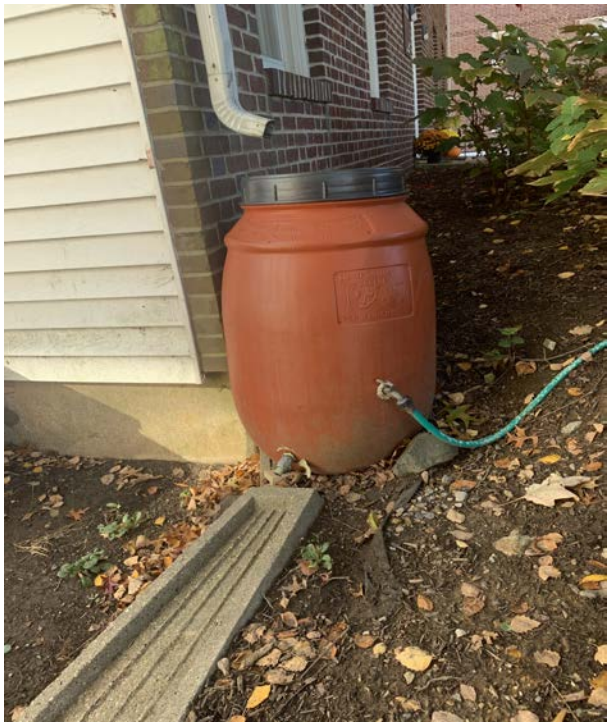

Figure 5: Example of a rain barrel

Bioretention Areas & Rain Gardens: These two stormwater BMPs allow stormwater runoff to pool in local low points. Once at the low point, stormwater can be filtered through native vegetation and is stripped of many harmful pollutants. (Massachusetts para. 1-3) Afterward, the runoff slowly infiltrates towards the closest stream. Overall, bioretention areas and rain gardens do a great job of preventing flooding and removing detrimental contaminants from urban runoff. There is plenty of room to add these features to the existing commercial and residential areas along Kirkwood Highway. The primary issue with these features is that they can be costly to design and create.

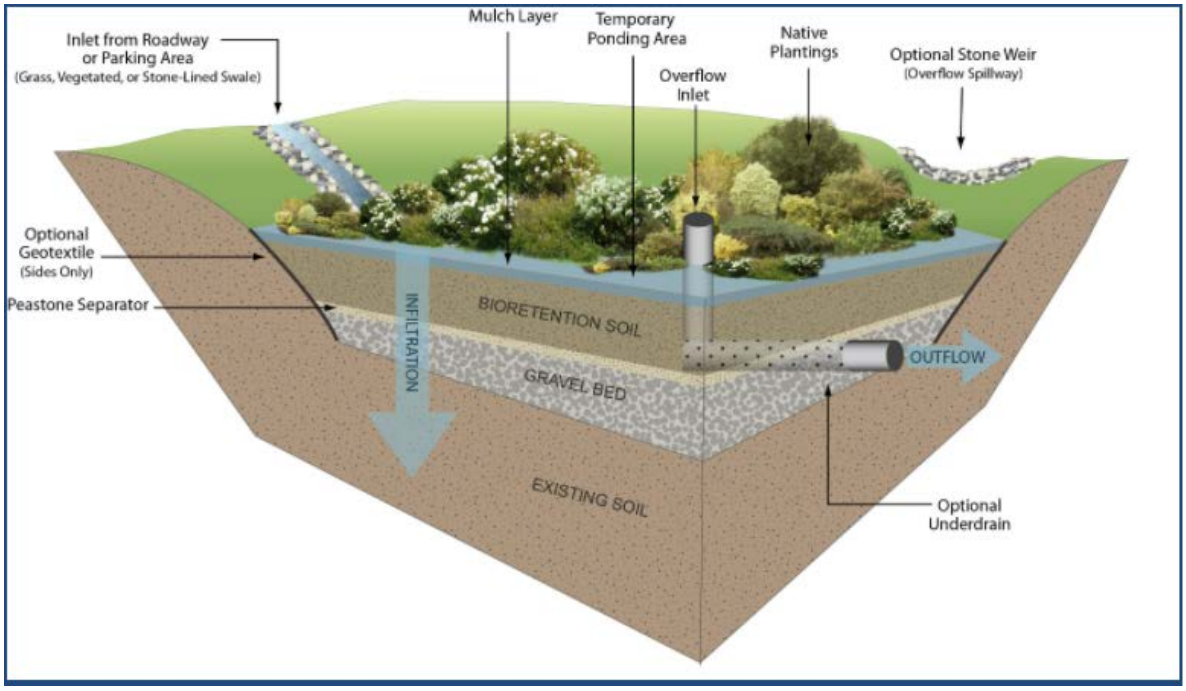

Figure 6: Example of a Bioretention Basin

Agricultural Pollution

Open Communication with Farmers: Some farmers are unaware of the amount of nutrient pollution from agricultural uses, yet many understand the importance of climate change and having clean rivers. Friendly dialogue with data and moderately different farming techniques can help farmers be more conscious about the number of nutrients reaching their local headwaters.

Cover Crops: Cover Crops are a common agricultural practice used to extract excess nutrients. The general idea is that farmers can plant winter crops after the fall harvest to use up the existing nutrient load. Some common cover crops include winter wheat and rye. Some farmers in the Red Clay Watershed already use cover crops. But others find that it isn't economically viable. New Castle County recently enacted a plan where they are willing to pay up to 75% of the cost of cover crops if farmers meet certain requirements. (New Castle County para. 7) This plan is highly aggressive and should allow farmers to make a decent profit off of cover crops. Farmers could surely lower nutrients in the Red Clay Watershed if Chester County took a similar approach.

Conservation Tillage: Cropland holds phosphorus and other nutrients even after the crops are harvested. Before each planting season, the soil must be tilled and loosened. A considerable amount of tilled soil washes away during runoff events, which leads to polluted waterways. Conservation tillage calls for only 70% of residue cover to be tilled during a planting season. (Minnesota Pollution Control Agency pp. 154-156) When combined with other

management practices, conservation tillage can reduce phosphorus levels in streams by more than 30%. Some drawbacks of conservation tillage are that it does not limit the amount of phosphorus used by farmers, and it has negligible impacts on nitrogen levels.

Contaminant Pollution

Forest Buffers: Forest buffers are trees, shrubs, bushes, and other vegetation adjacent to a river. This growth allows waterways to stay clean. They prevent pollution from entering the channel and also stabilize the river bank. These are both crucial to maintaining a healthy stream, creek, or river. The root systems and soil act as a sort of sponge that absorbs pollutants and helps them soak into the forest floor. (Drotter, S. para. 1-10) For pollutants that are nutrients to the vegetation, the roots can absorb them and help them grow. In addition to preventing contaminants from seeping into the water, the forest buffers also provide shade to the waterway. The canopies help to keep the water cool in the summer months. Cooler water prevents the growth of harmful algae blooms which can harm sensitive species living in the river.

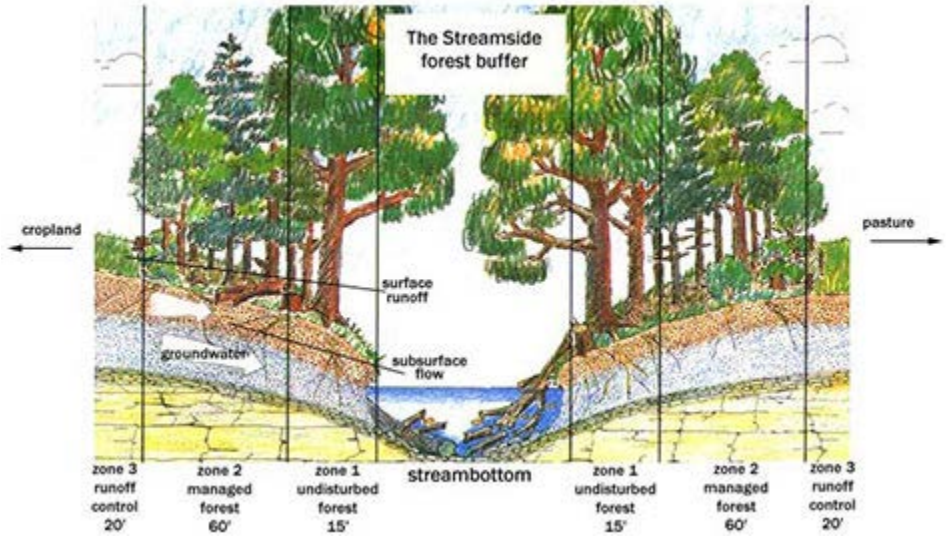

Figure 7: Section view of forest buffer

Conclusion

The Red Clay Creek is a 54 square mile watershed located in Delaware and Pennsylvania. The Red Clay is a tributary located within the 565 square mile Christina Basin.The Christina Basin flows into the Delaware River Basin and eventually into the Atlantic Ocean. The main problems in this watershed are due to rapid urbanization and large amounts of farmland. The three main issues in this watershed are caused by stormwater runoff, nutrients entering the water from agricultural activity, and large amounts of harmful contaminants. The Red Clay Creek Action Plan (RCCAP) aims to achieve quality standards that are high enough to make the Red Clay Creek fishable by the year 2030. We plan to accomplish this through a number of strategies, and by working along other organizations to meet and exceed the set standards.

To mitigate the effects of stormwater runoff in impervious areas, we intend to balance the rapid growth of impervious surfaces and urbanization with adequate stormwater management practices. This includes rooftop collection with rain barrels and better drainage systems with bioretention areas and rain gardens. These will help to reduce the amount of water entering during a storm and repurpose that water, as well as to reduce the incoming contaminants entering the watershed. To limit the agricultural effects and reduce the nutrients entering the watershed, we plan to have an open dialog with farmers about their farming practices. Encouraging proper fertilization, the includement of cover crops, and conservative tilling can help reduce the number of nutrients coming from the agricultural runoff. Finally, we hope to minimize the harmful contamination in the form of PCBs, zinc, chlorinated pesticides, and dioxins from entering the watershed by implementing forest buffers along the streams. These will help to absorb these harmful contaminants as well as excess nutrients coming into the stream. It will also provide bank stability and shade to protect from erosion and algal blooms.

There are a number of efforts and organizations, federal, state, and local, already in place to protect watersheds in Delaware, including Red Clay. These organizations are used as a reference and guidance for our plan. They are the: Brandywine-Red Clay Alliance, Chester County Agricultural Council, Delaware Department of Natural Resources (DNREC) and Pennsylvania Department of Environmental Protection (DEP), Christina Basin Clean Water Partnership (CBCWP), and the Environmental Protection Agency (EPA). These organizations help to regulate and reduce the pollutants in the waterways. The National Pollutant Discharge Elimination System (NPDES) is a federal permit program that addresses water pollution by regulating point sources that discharge pollutants to waterways in the United States. Section 303(d) of The Clean Water Act & TMDLs is a portion of the CWA that says states must develop a list of impaired waterways and develop Total Maximum Discharge Limits(TMDLs) each polluted waterway. A TMDL is the maximum allowable load for a particular contaminant with a margin of safety built-in as well.

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