# Lower West Branch Red Clay Creek Watershed Restoration Plan

**New Garden Township, Kennett Square Borough, and Kennett Township**
**Chester County, Red Clay Watershed, Pennsylvania**

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## 1.0 INTRODUCTION

Brandywine Red Clay Alliance (BRC), a leader in watershed restoration and environmental education for over 75 years, has identified the Lower West Branch Red Clay Creek, an impaired stream, as a sub-watershed area that needs focused, holistic restoration. To aid in identifying the areas within the watershed where restoration work would be most effective, BRC partnered with Clauser Environmental LLC to complete a detailed watershed assessment (Clauser and Clauser, 2023). Water quality sampling was conducted at 11 sample sites throughout the watershed. Samples were taken along both the mainstem Lower West Branch Red Clay Creek and its tributaries. All of the samples were impaired for habitat and/or macroinvertebrate life. Index of biotic integrity (IBI), total nitrogen, and total phosphorus values throughout the watershed were comparable to the values presented for a sample site in West Branch Red Clay Creek near Kennett Square in the Chester County Water Conditions 2021 Report (2022). Water quality data are presented in detail in the Lower West Branch Red Clay Creek Assessment Report (Clauser and Clauser, 2023). With the reach level scientific knowledge of the watershed from the watershed assessment available to serve as a foundation, this detailed restoration plan for the Lower West Branch Red Clay Watershed was prepared to address the specific areas of impairment. As the solutions outlined within this restoration plan are implemented, substantial progress will be made in restoring this sub-watershed of the Brandywine Christina Basin.

The Lower West Branch Red Clay Creek has a Pennsylvania Code, Title 25, Chapter 93 water quality designation of Cold-Water Fishery/Migratory Fishery (CWF/MF) and is not listed by the Pennsylvania Fish and Boat Commission as a stream that supports the natural reproduction of trout (PFBC, 2022). While this work targets the Lower West Branch Red Clay Creek watershed, BRC's project partners are simultaneously focusing on work within the Upper West Branch Red Clay Creek Watershed. That work is being led by Brandywine Conservancy, Chester County Conservation District, and Stroud Water Research Center and includes a variety of projects focused on riparian buffer enhancements and "whole farm" conservation initiatives. The projects identified here will extend and enhance the impact of improving water quality in the Upper West Branch so that the upstream benefits may be carried downstream to positively impact the rest of the Red Clay Watershed.

Within the watershed, the main forms of land use include residential developments, shopping centers, forested corridors and woodlots, and agricultural areas. Also located within the watershed are BRC's Chandler Mill Nature Preserve, Herb Pennock Park, and Hartefeld National Golf Course. The agricultural areas consist of farm fields, horse pastures, and mushroom houses. While the Lower West Branch Red Clay Creek is mainly surrounded by a forested corridor as it navigates the matrix of areas throughout the watershed, there are many instances where the banks of the stream and its tributaries are mowed to the edge or flow through a stream enclosure in a developed area.

The Lower West Branch Red Clay Creek Watershed project area includes approximately 9.58 square miles of watershed and 20.93 miles of stream. The site stretches from the Kennett Oxford Bypass to the confluence with the East Branch Red Clay Creek which is

just north of the Pennsylvania/Delaware border. The Lower West Branch Red Clay Creek Watershed is listed by the Pennsylvania Department of Environmental Protection (DEP) on its 303(d) list of impaired stream reaches (DEP 2022). DEP identifies the overall watershed impairments as agricultural pathogens, nutrients (organic enrichment/ low dissolved oxygen), polychlorinated biphenyls (PCBs), and siltation. In the spring and summer of 2022, BRC worked with Clauser Environmental, LLC to develop an assessment report to determine baseline conditions and targeted sources of impairment within the watershed. The watershed assessment confirmed the DEP listed impairments and determined that restoration projects should focus first on the headwater areas and then move downstream. Best Management Practices (BMPs) that are suggested for installation within the watershed include floodplain restoration, wetland construction, riparian buffer plantings, stormwater management structures, streambank stabilization, invasive species removal, and agricultural improvements.

## 2.0 Pre-Assessment Outreach

As part of outreach for this project, concerns from municipalities, landowners, and conservation organizations were heard before completing field observations. BRC's Watershed Conservation Director, Brian Winslow, arranged these meetings and was often accompanied by Dr. Aaron Clauser, Clauser Environmental, LLC. Meetings were held with the three municipalities in the watershed, the Borough of Kennett Square, Kennett Township, and New Garden Township. The meetings focused on common concerns about road flooding, erosion and sedimentation around road culverts, stormwater detention basin operation and maintenance, streambank erosion along roadsides, and potential projects that may reduce sediment pollution. Municipalities should collaborate with BRC and other conservation organizations to coordinate projects in riparian zones, detention basins, and roads. Often, best practices in stream bank stabilization and green stormwater infrastructure can reduce future stream erosion. This protects infrastructure and helps reduce sediment pollution.

Meetings were also held with conservation organizations including Chester County Conservation District, Chester County Water Resources Authority, Chester County Planning Commission, and BRC's Land Preservation Department. In these meetings, information on known development projects in the watershed, areas of concern for water quality, and priorities for land preservation was shared. In particular, the Conservation District noted that agricultural runoff from mushroom farms is a concern. The District has been working with farming operations to address this issue. Cooperative work should continue to address the agricultural runoff, especially from smaller operations. Water quality data was shared by the Chester County Water Resources Authority through their work at USGS sampling sites in the watershed. The Conservation District is partnering with BRC and the Keystone 10 Million Trees Initiative to distribute free trees to landowners in Chester County to help improve riparian buffers. This program could potentially provide trees to landowners in the watershed.

The team met with Kennett Trails Alliance (KTA), a partner in the NFWF grant that is funding a portion of the watershed assessment and restoration plan. KTA provided maps of current and future trail projects along the stream, surveys, and wetland delineations.

KTA has identified ecological uplift work (such as stream restoration and buffer plantings) along the greenway recreational trail as a priority and will continue to coordinate plans with BRC. In many cases, completing high and medium priority stream restoration and buffer planting projects before trail improvements could prove beneficial.

Summary of key recommendations from the completed pre-assessment outreach:

1. Prioritize land preservation and stewardship practices on key parcels.
2. Work with municipalities and landowners to implement green stormwater infrastructure and inspect existing infrastructure, especially stormwater detention basins, so that it may be retrofitted with a water quality-focused approach where applicable.
3. Implement agricultural best management practices and conservation plans to protect water quality.
4. Develop a riparian buffer and lawn-to-meadow conversion plan to improve riparian buffers.
5. Work with landowners and municipalities to address areas identified as medium and high priority for streambank stabilization, restoration, and floodplain connection.
6. Work with conservation partners, county agencies, and state agencies to continue monitoring water quality and revise the restoration plan accordingly.

## 3.0 METHODOLOGY

To determine the areas within the Lower West Branch Red Clay Creek Watershed in need of the most attention, Brian Winslow of Brandywine Red Clay Alliance and Aaron Clauser, PhD of Clauser Environmental, LLC conducted stream walks on November 14, 17, and 18, 2022 and March 2, 2023. Photographs, field notes, and GPS coordinates were collected at areas identified as points of interest. Where access was not permitted, impacted areas were identified by conducting windshield surveys from roadways and reviewing aerial photography provided by the Chester County GIS Department. Sources of impairment were identified at the parcel level.

Clauser Environmental, LLC located the points of interest within the watershed using a Trimble Geo7X Global Positioning System (GPS) receiver with H-Star and Floodlight enabled decimeter accuracy configuration during the site visits. The instrument smart settings were used per the manufacturer's recommendation. Logging interval was set at 1 second with typically a minimum of 30 readings collected at each point. Data collected in the field was downloaded to a personal computer for differential correction using GPS Pathfinder Office software (Version 5.6). Correction files were obtained from dedicated base stations located in Schuylkill Haven, Williamsport, Wilkes-Barre, and York, Pennsylvania. Mission planning, parameter settings, and post-processing typically allow an accuracy of less than 10 centimeters (Trimble Navigation 2014). Cost estimates were prepared based on recent projects completed by Clauser Environmental, LLC. The included cost estimates provide an order-of-magnitude idea of the potential costs to implement the proposed watershed solutions.

## 4.0 WATERSHED PROBLEMS AND SOLUTIONS

This section focuses on the sources and causes of impairment within the Lower West Branch Red Clay Creek Watershed and potential restoration practices that can be completed to address the noted impacts for high and medium priority areas. Low priority restoration projects are included in Appendix B. Each impacted segment identification number can be cross-referenced with its approximate location on the map in Appendix A.

### *4.1 High Priority Projects:*

**Riparian Buffer Enhancements Throughout Watershed:**

Throughout the watershed, there are significant stretches of stream that lack healthy riparian buffers (Appendix F). Riparian buffers play a large role in water quality by creating natural filtration for water runoff into the streams, stabilizing streambanks, absorbing floodwaters, and providing vital habitat for wildlife. Within the Lower West Branch Red Clay Creek Watershed, streamside forests historically provided leaf litter that served as the foundation of the food chain for the bulk of the aquatic community. As forests were cleared and replaced with fields, pastures, mowed lawns, and impervious areas, water quality and the aquatic community suffered. Throughout the watershed, invasive plant species including multiflora rose (*Rosa multiflora*), poison hemlock (*Conium maculatum*), Japanese hops (*Humulus japonicus*), Japanese stilt grass (*Microstegium vimineum*), Japanese knotweed (*Reynoutria japonica*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*) and tree of heaven (*Ailanthus altissima*) have become established within the riparian zone and have provided substantial competition for the native plant species that are necessary for the diverse wildlife that rely on the watershed.

**Solution:**

Throughout the watershed, approximately 6.78 stream miles are identified as potential locations for riparian buffer enhancement projects. Within those areas, mowing and grazing should be stopped or at least limited to minimize impacts to the stream community. The application of fertilizers and pesticides should be limited to only what is essential to decrease potential water quality impacts. Landowners within the identified areas should be encouraged and assisted in the planting of native trees and shrubs. Invasive species should be managed. While the wider the riparian buffer the better for the environment, the first thirty-five feet from the edge of the stream is typically considered the most crucial for maintaining water quality.

## Impacted Stream Segment #5-6:

Along this stretch of stream, substantial legacy sediment has built up since colonial times and has disconnected the floodplain. The streambanks are undercut and actively eroding in over 60 percent of this stream section. The eroding streambanks average 4 feet high. Throughout this stretch of stream, portions of the riparian zone are mowed to the top of the streambanks.

## Solution:

This stream section requires a holistic approach to restoration. The most effective way to restore this section of the stream would likely include reconnecting the floodplain through the removal of legacy sediment to create an active floodplain bench. Within the created active floodplain, pockets of wetlands could be created to aid in retaining flooding flows and filtering pollutants. Grading the streambanks to a stable slope would minimize additional erosion and allow for native vegetation to be planted to help secure the streambanks. Instream structures such as log vanes and root wads should be installed to create fish habitat and reduce near-bank friction during vegetation establishment. Riparian buffer enhancements including native plantings, invasive species removal, and minimizing mowing along the stream will help to strengthen the streambanks and increase biodiversity along the stream channel.

**Impacted Stream Segment #15-16:**
Upslope of this section of the stream, there is a roadway and residential area that drains to the stream without control. The stormwater carries pollutants such as fertilizers, pesticides, oils, and salts to the stream without filtration. The upslope inlets require maintenance, as they are currently partially eroded. Within the stream section, a stormwater channel is actively eroding and is approximately 3-4' deep.

**Solution:**
The upslope stormwater system requires routine maintenance and the potential replacement of some inlets by the municipality. Within the residential area, the installation of rain gardens and rain barrels should be encouraged. Downstream, a regenerative stormwater channel should be established. The regenerative channel should include grade breaks such as rock structures that will allow water to collect within pockets that are planted with native vegetation and filled with sand and compost. The stormwater discharging through the upgraded conveyance will be filtered to aid in pollution reduction. A portion of the retained water will infiltrate into the groundwater while some of the stormwater slowly seeps out of the sand and compost mixture into the channel over an extended time. When established, the regenerative stormwater channel will improve water quality, decrease flooding flows, and aid in recharging the groundwater.

**Impacted Stream Segment #26-27:**

The streambanks in this segment are approximately 4 feet high and actively eroding. The active erosion is contributing sediment to the stream system that degrades the aquatic habitat and water quality on the site and downstream. The riparian buffer is minimal along this section of the stream and limits the available habitat within the stream corridor. This segment of the stream has been the site of previous buffer plantings. Despite these plantings, the area is currently dominated by invasive Japanese hops (*Humulus japonicus*).

**Solution:**

The area along this section of stream is well suited for wetland creation. The creation of wetlands in addition to floodplain reconnection would help to mitigate future flooding and protect the stream channel from future erosion. The invasive Japanese hops (*Humulus japonicus*) should be removed and replaced with native vegetation including the expansion of the riparian buffer. The proposed multi-use trail system upgrades in the watershed will include work within the riparian zone of this stream section and surrounding areas. Kennett Trails Alliance should be actively involved with coordination related to the restoration of this area so the stream and riparian improvements complement the proposed work on the trail system.

**Impacted Stream Segment #28-29:**
Along this segment of the stream, the riparian zone has been mowed to the top of the streambank. The streambanks are actively eroding legacy sediment and are 4-5' high throughout the reach. The active floodplain is disconnected from the deeply incised creek channel.

**Solution:**
Restoration of this stream section should focus on reconnecting the active floodplain to the stream channel. The streambanks should be graded to a stable slope of 4:1 or flatter and planted with native vegetation. The use of instream structures such as rock and log structures will improve fish habitat and protect the restored streambanks as the vegetation becomes established. The installation of floodplain wetlands should be evaluated. Enhancement of the riparian buffer should be accomplished through the elimination of mowing and planting native tree and shrub species.

## Impacted Stream Segment #71-76:

The upstream portion of this segment begins at the Thompson Street crossing. The area contains substantial amounts of legacy sediment that is being impacted by stormwater from the upslope commercial and residential developments. The stream channel is incised with streambanks that are 3 to 5 feet high and actively eroding. The eroding streambanks discharge nutrients and sediment to the stream channel that impacts water quality on the site and downstream. At point 73, a breached dam blocks the flow of the stream through the channel and is exacerbating the erosion of the streambanks in that area. Though there has been a riparian buffer planting in the downstream area of the segment, invasive species are prevalent and have overtaken most of the planted trees. Restoration of this area should address a lack of floodplain connection and the dominance of invasive species including Japanese hops (*Humulus japonicus*) and reed canary grass (*Phalaris arundinacea*).

## Solution:

Restoration of this stream segment should focus on a large-scale floodplain restoration and wetland creation project. The project should be designed to absorb and filter flooding flows from the upslope developed areas. As the floodplain is restored, the streambanks should be pulled back to a stable slope and planted with native vegetation. Instream structures such as log vanes, rock deflectors, and root wads should be installed to create fish habitat and protect the streambanks during vegetation establishment. The use of fluvial geomorphology during the site analysis and natural stream design techniques is critical to creating a sustainable, resilient restoration project in this area. Throughout project establishment, a rigorous invasive species management plan should be implemented to sustain the newly planted riparian zone.

## Impacted Stream Segment #77-79:

The streambanks are 3 to 4 feet high and are actively eroding throughout this segment of the stream. In some areas of the segment, the riparian zone is mowed to the top of the streambank. Along this section of the stream, the floodplain is disconnected and invasive Japanese hops (*Humulus japonicus*) and reed canary grass (*Phalaris arundinacea*) dominate the riparian zone and have outcompeted and killed many of the native trees that were planted in this area.

## Solution:

Restoration of this stream segment should focus on restoring the floodplain, stabilizing the stream channel, controlling invasive species, and establishing native trees and shrubs within the riparian zone. New plantings should be completed with a long-term maintenance plan in place to limit the impacts of the invasive species that currently dominate the riparian zone. With a restored floodplain and stream channel, floodwaters from the upslope developed areas may be dissipated and absorbed. From a water quality standpoint, the newly created floodplain that has a vegetated slope to the stream channel would allow sediment and contaminants a place to settle out where they can be broken down by the sun and ecological processes.

## Impacted Stream Segment #104-106:

This segment consists of the portion of Bucktoe Creek that flows through White Feather Farm as well as the downstream portion of Agnew Run. Within this section of the stream, the streambanks are actively eroding and are currently 3-4' high. In a portion of the site, a lawn is mowed to the top of the streambank. The riparian zone includes trails for farm visitors to walk along the stream.

## Solution:

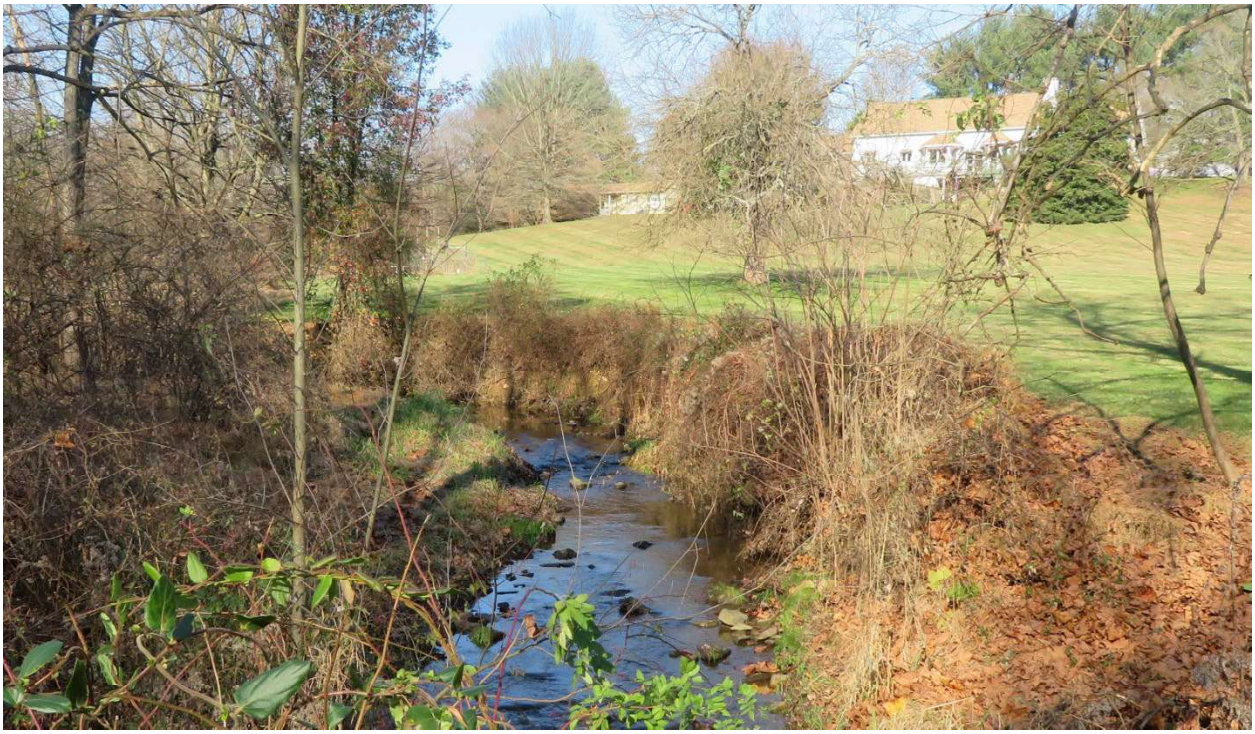
The design and permitting of the restoration of this section of the stream is already completed, and a portion of the construction funding has been secured. A grant for the balance of the construction funds is under review. Throughout this section of the stream, streambank stabilization, riparian buffer enhancement, and removal of invasive species are planned. The streambank stabilization will incorporate native plantings and instream structures that were designed with a natural stream design approach. The completion of this project should be leveraged as a matching project for future restoration work in other sections of the watershed.

## Impacted Stream Segment #106-107:

Throughout 50% of this reach, the streambanks are actively eroding legacy sediment and are approximately 3-4' high. The floodplain is disconnected. There are only patches of riparian buffer throughout the stream segment, and all other areas are mowed. The streambank erosion is progressing in the direction of sewer manholes just upstream of the Sharp Road stream crossing.

## Solution:

A combination of streambank stabilization and reconnection of the floodplain is necessary for the restoration of this stream segment. As the floodplain is excavated, wetland pockets should be installed to aid in filtering contaminants, retaining floodwaters, and recharging the groundwater. Streambank stabilization work should include natural stream design techniques to install instream structures for fish habitat and bank protection during the establishment of native plantings. The native plantings should include native grasses and forbs, live stakes from the water's edge to the top of the streambank as well as trees and shrubs throughout the riparian zone to improve the stream buffer.



**Impacted Stream Segment #110-112:**
Throughout this stream section, the 3 to 4 feet high streambanks are actively eroding. The stream channel is disconnected from the floodplain by sediment that settled in this lower gradient area during the backwater flooding conditions created when Bucktoe Creek enters The Lower West Branch Red Clay Creek during flooding conditions.

**Solution:**
This stream segment is a high priority due to the potential for floodplain wetland creation on land that is already being used for conservation. Restoration of the area should include creating multiple wetland cells that provide wildlife habitat, improve water quality, help recharge the groundwater, and aid in absorbing flooding flows. Work along the stream channel should focus on connecting the stream to the newly created wetland cells, expanding the floodplain capacity, and grading actively eroding streambanks to a stable slope. The wetland cells, floodplain grading areas, and restored streambanks should be planted with native vegetation and maintained to limit the establishment of invasive species. Instream structures such as log vanes and root wads should be thoughtfully installed where they will improve fish habitat and aid in stabilizing streambanks during vegetation establishment.

## Impacted Stream Segment #134-135:

This stream section includes a small unnamed tributary that flows through the South Mill Champs mushroom farm. The tributary receives substantial stormwater discharges from the farm's rooftops and paved areas as well as the Borough of Kennett Square upstream of this stream section. Any work to address stormwater in this tributary should be considered part of this high priority project. Within the stream segment, several potentially undersized stream crossings restrict the flow of water within the channel and likely contribute to the flooding of the mushroom farm facilities during large storm events. The flooding has caused substantial damage and is a concern for downstream water quality as well as the local economy. The stream channel is mowed to the stream edge. Additionally, a swale that is dominated by invasive species discharges stormwater to the stream from the south.

## Solution:

Restoration of this stream section should begin with an assessment of the existing stream crossings on the site. Where feasible, the stream crossings should be upgraded to reduce the role they play in flooding the site. In the headwaters and on the site, stormwater should be managed to decrease the rate and volume of flow to the tributary. On the South Mill Champs Site, a constructed stormwater basin with water quality features should be installed and additional stormwater retrofit projects should be evaluated. Along the stream channel, grading to create floodplain capacity and stable, vegetated streambanks should be completed. The riparian zone should then be planted with native vegetation. Within the stormwater swale that discharges to the stream from the south, a regenerative stormwater conveyance installation that retains and filters stormwater through a compost/ sand bed between constructed riffle areas should be installed.

## *4.2 Medium Priority Projects:*

### Impacted Stream Segment #7-8:

In this section of the stream, the banks are actively eroding and are 4-10 feet high. Although evidence of past dumped riprap remains along the base of Pemberton Road, the roadway base is actively eroding. The riparian zone along this stretch of stream is dominated by invasive Japanese hops (*Humulus japonicus*), reed canary grass (*Phalaris arundinacea*), and multiflora rose (*Rosa multiflora*).

### Solution:

Streambank stabilization is required to restore the integrity of the channel, especially in the area eroding the base of Pemberton Road. Removal of invasive species and planting native trees and shrubs will help to restore the riparian buffer.

### Impacted Stream Segment #14-17:

Throughout this stream section, the floodplain contains substantial amounts of legacy sediment and the streambanks are approximately 4' high and actively eroding through about 50% of the reach.

### Solution:

Work within this stream section should focus on the creation of an active floodplain, stabilization of streambanks by grading them to a stable slope, installing natural stream design structures to create fish habitat and protect the streambanks, creating floodplain wetlands, planting native species, and controlling invasives. Completing the design, permitting, and construction of this project in conjunction with the restoration of Impacted Stream Segment #15-16 would minimize costs for both projects.

## Impacted Stream Segment #21-22:

Within this stream segment, erosion has impacted both banks of the stream. From point 21 to point 22, approximately 50% of the reach has actively eroded legacy sediment on the 3 to 6 feet high streambanks. In addition to the problem of erosion, invasive species including Japanese hops (*Humulus japonicus*), reed canary grass (*Phalaris arundinacea*), and tree of heaven (*Ailanthus altissima*) dominate the riparian zone.

### Solution:

The restoration of this stream segment should include the grading of eroded streambanks to a more stable slope to reconnect an active floodplain. Enhancement of the riparian buffer including the removal of the invasive species is required to restore balance to the ecosystem and encourage the growth of native species.

## Impacted Stream Segment #34-35:

The riparian buffer along this segment of the stream is forested with many dead ash (*Fraxinus* sp.) trees. Ash trees throughout Pennsylvania have been killed in mass by the invasive emerald ash borer (*Agrilus planipennis*). The area is currently dominated by invasive Japanese hops (*Humulus japonicus*) and multiflora rose (*Rosa multiflora*). In the upstream portion of this segment, the streambanks are eroded 3 to 4 feet high. In the downstream portion, the streambanks are eroded 4 to 8 feet high in some areas.

### Solution:

Conservation practices in this area should focus on streambank stabilization and removal of invasive species. Floodplain reconnection would improve water quality and native habitat along the stream. Native trees and shrubs should be planted to aid in the replacement of some of the dying ash trees. Downstream of this segment, the riparian buffer is forested, and the streambanks are stable.

## Impacted Stream Segment #46-47:

Within this stream segment, the streambanks are actively eroding and are approximately 4 feet high. The stream segment is disconnected from the floodplain. The combination of streambank erosion and floodplain disconnection is likely to have negatively impacted the water quality of the stream.

### Solution:

Restoration of this area should include streambank stabilization by pulling the streambanks back to a stable slope, installing instream rock and log structures with natural stream design techniques, and planting native vegetation. While the presence of existing mature trees limits the amount of grading that should be completed in this area, the installation of floodplain benches and wetland creation should be considered where possible. Floodplain reconnection and invasive species removal will aid in the long-term resiliency of the restored stream segment.

## Impacted Stream Segment #66-67:

Within this stream segment, the stream channel is incised with 2 to 4 feet high, actively eroding streambanks. The riparian buffer is mowed and of minimal width throughout the section. Invasive species including Japanese hops (*Humulus japonicus*) are present within the buffer areas that do exist.

### Solution:

The topography and hydrology of this stream segment lend themselves to the creation of wetlands to filter pollutants, absorb flood waters, and create wildlife habitat within the riparian zone. Minor streambank grading would allow for native plantings to stabilize the steam channel. After the stream channel is restored and wetlands are created, the riparian zone could be planted with native trees and shrubs to aid in improving water quality and habitat creation. Invasive species should be targeted for removal as the restoration project becomes established.

## Impacted Stream Segment #80:

Throughout this section of the stream, the streambanks are 4 feet high and actively eroding legacy sediment. The riparian buffer is 5 to 30 feet wide.

### Solution:

Floodplain restoration and streambank stabilization would benefit this stream segment. Extending the forested riparian buffer width would improve water quality and benefit the wildlife that lives within the riparian zone.

## Impacted Stream Segment #81-83:

The streambanks along this stream section are between 3 and 4 feet high and are undergoing active erosion. The stream channel is incised and disconnected from an active floodplain. A portion of the stream segment is mowed to the top of the streambanks. In the un-mowed areas, the riparian zone is dominated by invasive Japanese hops (*Humulus japonicus*).

### Solution:

Reconnection of the floodplain by installing floodplain benches and stabilizing the streambanks with grading to a stable slope and planting native vegetation is critical to the restoration of this stream segment. The riparian buffer should be enhanced with native tree and shrub plantings. Any work within this section should include a focused effort on minimizing the invasive species that dominate the riparian zone.

## 5.0 RESTORATION IMPLEMENTATION

Restoration of the Lower West Branch Red Clay Creek Watershed will require a combination of best management practices (BMPs) that are specially tailored to improve the aquatic conditions of streams flowing through agricultural and residential communities. Appendix D provides information related to the implementation of each of the proposed restoration BMPs. The format is such that each of the individual BMP sheets may be selected as needed for a particular property/project and provided to the individual landowner. In addition to the handouts, the following sections describe the implementation of priority restoration initiatives in the Lower West Branch Red Clay Creek Watershed.

### 5.1 Land Preservation

With over 30% of the land in Chester County protected from development, land preservation is one of the best methods of protecting water quality. Undeveloped lands naturally infiltrate stormwater at a higher rate than developed lands with higher levels of impervious cover. Avoided capital costs for stormwater infrastructure due to preserving land is estimated at $263 million according to the Return on Environment Report prepared by Chester County Planning Commission (2019). Additionally, an estimated 36,000 gallons of runoff is avoided each year for every acre of protected land, which helps improve water quality by preventing pollutants from entering the streams (Chester County Planning Commission 2019).

Though land preservation can include land acquisition, a more common and cost-effective method is through conservation easements where the landowner maintains ownership of the land while agreeing to restrictions limiting future development, limiting the removal of riparian forested areas, etc. Easements are held by a third party responsible for enforcing the restrictions in perpetuity. Even owners of smaller parcels with no threat of future development can protect the natural features of their property with a conservation easement. Similarly, agricultural easements can prevent future development on farms while allowing the continuation of agricultural operations. Landowners interested in learning more about these tools may contact the Land Preservation staff at BRC.

Despite the many benefits of preserved lands, they sometimes lack rich biodiversity and habitat for native species. As native biodiversity is beneficial for both water quality and wildlife habitat, enriching the native plant diversity of preserved lands is often an important aspect of restoration. As such, native plantings are incorporated into riparian buffer enhancement projects. Landowners may be able to remove invasive plants and incorporate forested riparian buffers and/or native plant meadows on their properties to benefit water quality. Agricultural lands requiring conservation plans under the PA Clean Streams Law develop plans to address concerns such as erosion and sedimentation control in fields, manure management, barnyard stormwater runoff, riparian buffer fencing, and livestock stream crossings for improved water quality. BRC and its conservation partners may be able to provide technical assistance and assist with applications for grant funding to implement these practices.

## 5.2 Green Stormwater Infrastructure and Detention Basins

The Lower West Branch Red Clay Creek Watershed Assessment Map identifies over 38 existing stormwater basins marked in pink hash marks (Clauser and Clauser 2023). Many of these basins are over 20 years old and could be retrofitted to better infiltrate water and improve water quality leaving the basin. While not all detention basins in the watershed were inspected as part of the watershed assessment, most appeared to be functioning as designed. Municipalities should work with HOAs and landowners to regularly inspect and monitor these basins to ensure they are working as designed and address any issues as they arise. Preventative maintenance can save significant funds and protect waterways.

Addressing stormwater flow before it enters the stream channel is the best way to address water quality and stormwater volume that can impair the stream. All municipalities within Chester County fall under the Commonwealth's Act 167 stormwater ordinance requirements. Ordinances adopted under Act 167 require new developments and renovations to meet current stormwater best practices. The ordinances encourage the use of green stormwater infrastructure that is designed to infiltrate stormwater wherever possible to reduce peak stormwater flow to streams and build groundwater reserves. BRC along with Brandywine Conservancy produced a "Green Stormwater Guide", featuring over 16 practices such as permeable paving, rain gardens, bio-swales, and many more that can help protect stream channels. Incorporating these practices in new developments, renovations, and existing infrastructure should be a priority. In some cases, technical assistance and grant funding may be available to help landowners and municipalities implement these best practices.

## 5.3 Riparian Forested Buffers, Meadows, and Floodplains

The riparian zone is the area along the banks of streams. Healthy streams typically have forested riparian buffers that are a minimum of 35 feet (100 feet or more is even better) in width that provide shade for streams, filter pollutants from stormwater runoff, provide organic material such as leaves and wood that serves as a foundation for the aquatic food chain, and stabilize stream banks. Mowing lawns to the top of stream banks provides none of these benefits and can accelerate stream bank erosion. A primary recommendation of this report is to improve riparian buffers throughout the watershed. Examples of this range from planting a few trees in a backyard and enhancing an existing buffer lacking full forest canopy to a substantial new riparian buffer planting along a stretch of impaired stream. In locations where a forested buffer is not appropriate, mowed lawns can be converted to native grass and wildflower meadows that only require mowing once a year.

Field observations noted that adequate, healthy riparian buffers are missing in large portions of the watershed. In many cases, the riparian buffers overwhelmingly consist of invasive plants including multiflora rose (*Rosa multiflora*), poison hemlock (*Conium maculatum*), Japanese hops (*Humulus japonicus*), Japanese stilt grass (*Microstegium vimineum*), Japanese knotweed (*Reynoutria japonica*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*) and tree of heaven (*Ailanthus altissima*). In other areas, lawns are mowed to the top of the streambanks. It was also

noted that many buffers have a large percentage of dead and dying ash (*Fraxinus* sp.) trees infected by the emerald ash borer (*Agrilus planipennis*). In some areas, the stream channel is very close to the road, and evidence of the stream undercutting the roadway exists. Mature trees play an irreplaceable role in stabilizing narrow buffers between streams and roadways, so the loss of many ash trees places infrastructure at risk. In other areas, beavers are damaging buffer trees in places where unnaturally high whitetail deer populations limit the ability of the trees to be replaced without human management. These factors will make establishing and enhancing buffers a challenge. A comprehensive riparian buffer planting and lawn-to-meadow conversion plan is recommended for the areas lacking sufficient riparian buffers in the Lower West Branch Red Clay Creek Watershed (Appendix F). Significant grant funding will be necessary, including funding for bi-annual buffer maintenance for the first four to five years to protect trees from invasive plant pressure and deer, beaver, and meadow vole predation.

## 5.4 Stream Restoration and Bank Stabilization

Sediment pollution is a major cause of aquatic life impairment in the West Branch Red Clay Creek (DEP, 2022). The primary source of sediment within the watershed is legacy sediment that was originally eroded from hillsides when they were denuded of forests and left bare before the implementation of conservation farming. The eroded sediment is deposited in valleys, behind the numerous mill dams, and on floodplains. The deposited soils are highly erodible and continue to erode into the streams, filling the interstitial spaces in the gravel and cobble stream bottoms. This reduces space for aquatic invertebrates to live thereby reducing the biodiversity throughout the ecosystem. Field observations documented eroding streambanks as high as eight feet above the streambed and poorly vegetated riparian zones with active stream bank erosion contributing new sediments to the stream channel (Appendix B). Streambank stabilization and restoration employs several practices including grading stream banks back to a 4:1 or flatter slope and placing in-stream rock and log structures that minimize friction along the streambank to reduce future erosion. Floodplains and wetlands along streams also play an important role in reducing stream bank erosion and relieving downstream flooding by absorbing flooding flows and allowing excess sediment to have a place to settle out naturally. Often, the floodplains are disconnected from the adjacent stream due to high streambank erosion and channelization through several feet of legacy sediment. Streambank restoration can regrade these streambanks, reconnecting these floodplains.

BRC has completed over 25 stream restoration projects on over 6 miles of streams over the past 12 years within the Brandywine Creek and Red Clay Creek Watersheds. These projects continue to reduce stream erosion, increase riparian buffers, and support aquatic and wildlife habitats. Several 8- to 10-year-old projects have withstood numerous high water and flooding events. BRC works closely with landowners, municipalities, funders, and conservation partners to create comprehensive plans for future projects to strategically prioritize these projects with the goal of aggregating multiple projects in targeted watersheds for greater impact.

To learn more about stream restoration, see the Restoration BMP Handouts in Appendix D and visit http://www.brandywineredclay.org/watershed-conservation/ to learn more. A booklet *Stream Restoration for Improved Water Quality,* and related *Stream*

*Restoration: A Holistic Watershed Approach for Improved Water Quality* video are worthwhile related resources that are available from BRC's Watershed Conservation Department.

## 6.0 COST ESTIMATES

As the restoration of the Lower West Branch Red Clay Creek Watershed moves from the assessment and planning stages into the funding and implementation stages, it is imperative that an understanding of both the benefits and costs of completing each project is held by the partnering agencies and landowners. In the previous sections, the benefits of stream restoration are described. In this section, the design and implementation costs for each high and medium priority restoration project are estimated.

Clauser Environmental, LLC prepared a preliminary construction cost opinion based on its experience in the field and costs for various best management practices to serve as a general guideline for the approximate project costs. For each project, a maximum and minimum estimated cost is presented.

Costs associated with stream restoration are quite variable depending upon the overall restoration goals, landowner objectives, project funding requirements, availability of building materials and rock, site conditions, volunteer hours, level of detail required for survey and design, and permitting costs.

The total estimated cost to implement all of the high and medium priority projects within the watershed is $5,783,000 to $10,272,000. These costs include design, permitting, construction, and professional services.

To set each project in motion, the project partners will need to seek out interested landowners and funding opportunities. As the identified projects are located on a mix of privately and publicly owned parcels, landowner support and objectives will need to be at the forefront of every decision during the design, permitting, and construction stages of the projects. After reviewing the project on the ground with the landowner, a more refined cost opinion should be developed and utilized as a guide to seek funding for the project. Important considerations should include access to the project site, locations of resources of special concern (wetlands, endangered and threatened species, etc.), funding limitations, volunteer matches available, and permitting requirements.

After the project is funded and design and permitting are complete, a set of bid documents is typically required for use in selecting a qualified contractor. The bidding process must be conducted following accepted practices and at least three bids should be sought. The selection of a contractor should be based on experience with the type of project being conducted, a check of references, capacity to complete the project within the desired timeline, and cost.

## 7.0 OBTAINING SUPPORT AND MONITORING PROGRESS

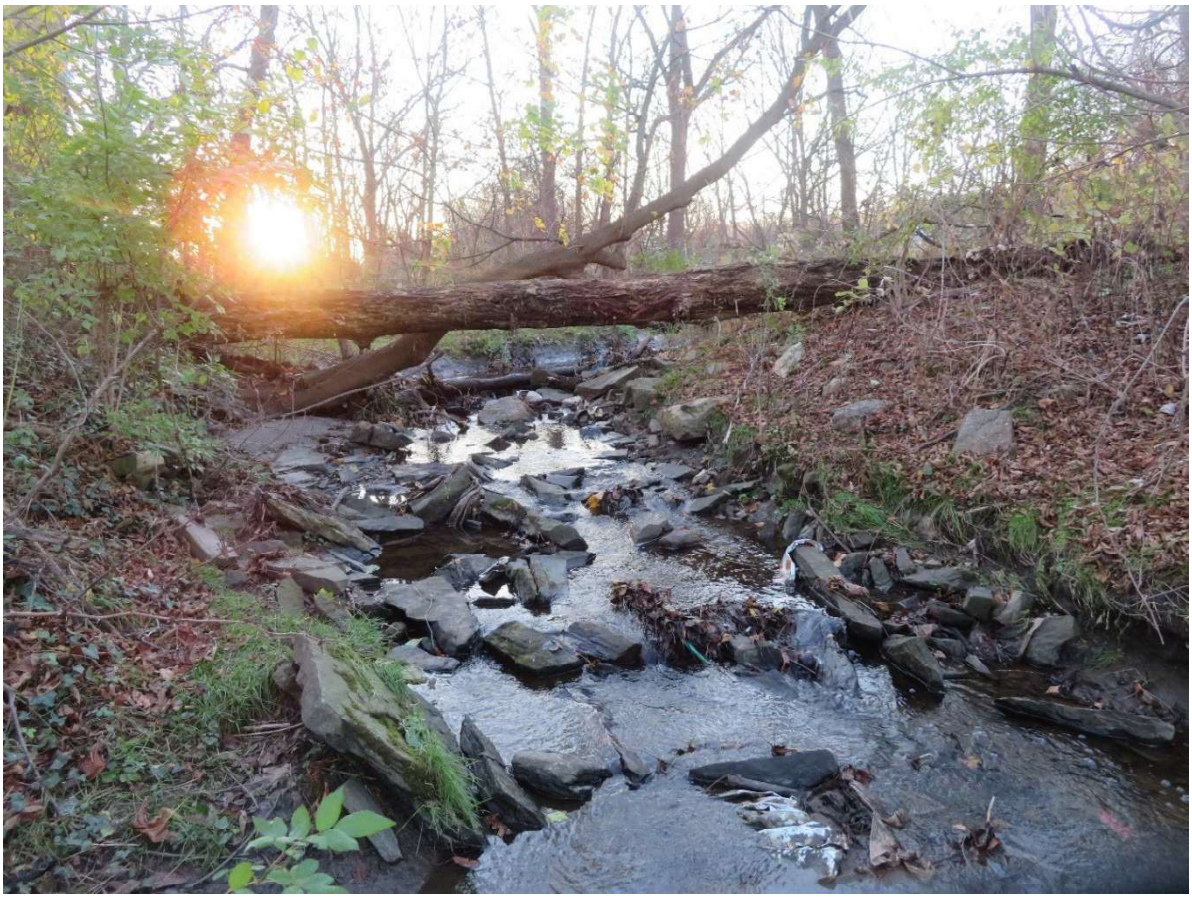
Community outreach and attaining landowner support are often the most challenging steps in restoring a watershed. Developing a positive relationship with landowners is particularly critical. BRC has already taken the first steps in this direction by spending the time up-front to visit many of the landowners whose properties adjoin the stream. Many of the landowners found the stream assessment phase of the project to be particularly of interest and have indicated that they would be interested in learning the results of the study. An important next step is to provide a forum to disseminate information to the community. Possible outreach activities include an open forum-type presentation or a watershed science fair festival where families may attend and not only hear about the results from the study but become engaged through activities and exhibits targeting the watershed.

Within the Lower West Branch Red Clay Creek Watershed, many of the landowners have existing relationships with conservation organizations. It is essential for BRC to nurture and support these relationships as collaborative partners. On-the-ground projects have been completed by Chester County Conservation District, Stroud Water Research Center, Brandywine Conservancy, and others. Some of the key teaming partners for the watershed include:

- New Garden Township, Kennett Township, The Borough of Kennett Square, and Chester County Planning Commission (Project implementation and regulation)
- Stroud Water Research Center (Project development, research, and monitoring)
- Brandywine Conservancy (Project leadership, land preservation, and implementation)
- Natural Lands (Land preservation and conservation)
- Chester County Solid Waste Authority (Funding assistance)
- Chester County Water Resources Authority (Leadership and management)
- University of Delaware (Research and monitoring)
- The Nature Conservancy (Preservation and conservation)
- Chester County Agricultural Preservation Board (Farmland preservation)
- Chester County Conservation District (Agricultural BMP design, soil conservation, nutrient management, and watershed consultation)
- Chester County Water Resources Authority (Leadership and management)
- Chester County Solid Waste Authority (Funding assistance)
- Chester County Emergency Services (Flooding assistance and emergency planning)
- Natural Resources Conservation Service (Conservation plans for individual farms and agricultural best management practices)
- Kennett Township Land Conservation Advisory Committee
- Pennsylvania Department of Environmental Protection (Water quality grant opportunities)
- Pennsylvania Department of Conservation & Natural Resources (Land preservation, resource management, and grant opportunities)

- Pennsylvania Fish & Boat Commission (Fisheries protection, resource management, and aquatic habitat improvement)
- Pennsylvania Game Commission (Wildlife protection and habitat improvement)
- National Fish and Wildlife Foundation (Grant funding)
- United States Geological Survey (Research and monitoring)
- William Penn Foundation (Grant funding and leadership)
- Ducks Unlimited (Volunteers and funding assistance)
- Trout Unlimited (Volunteers and funding assistance)
- Local Scout and Civic Groups (Riparian buffer planting and litter cleanup volunteers)

The effectiveness of installed restoration projects should be monitored within the watershed. The background data collected during the assessment phase of this project provides a baseline by which to compare data collected with the same standard methodologies. Monitoring will aid in not only understanding what best management practices are having the greatest impact and guiding future projects but will provide crucial supporting data to demonstrate success and leverage funding of future projects. With continued progress in the watershed, the water quality of Red Clay Creek will one day be restored.



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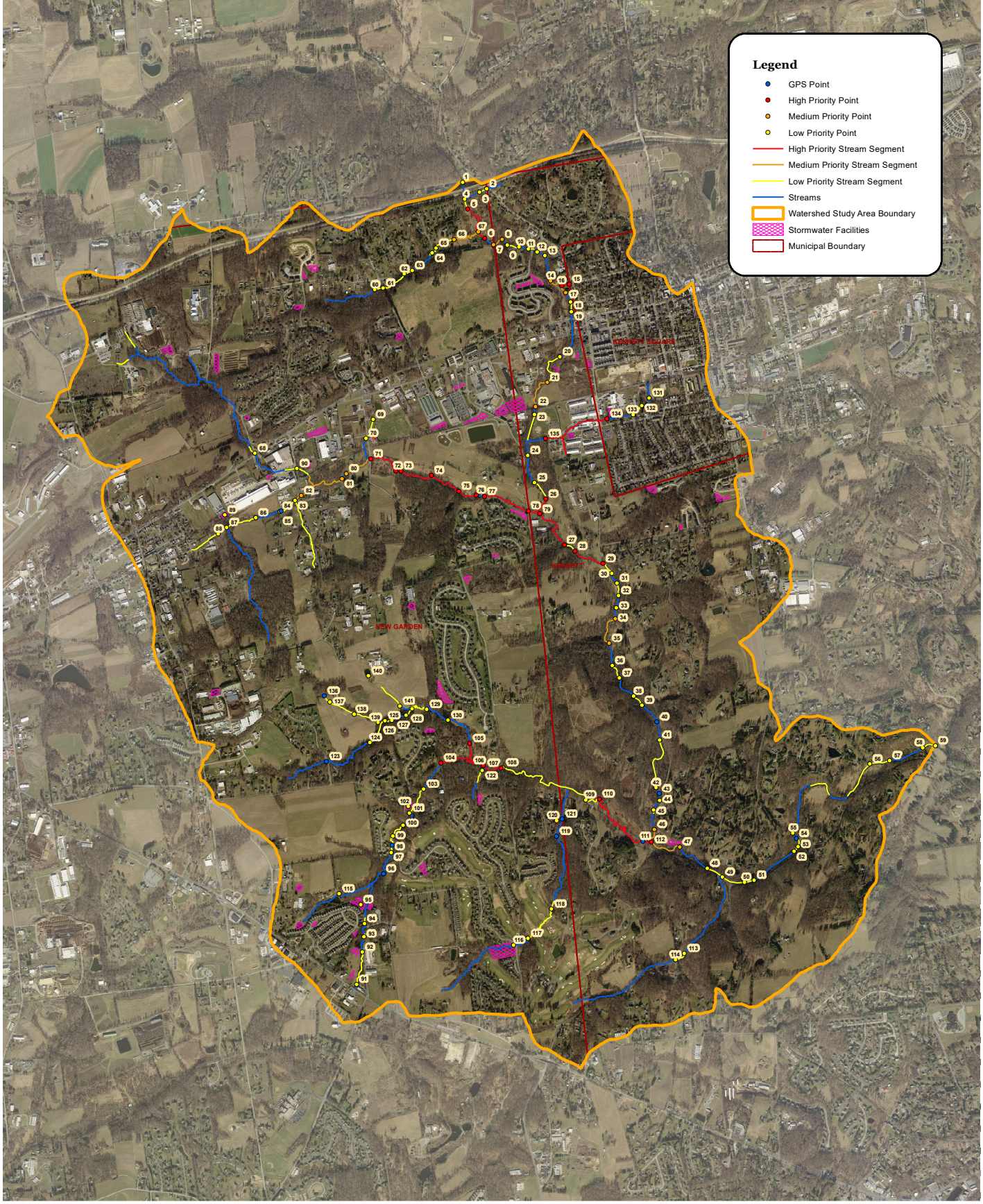
# APPENDIX A
# FIELD INVESTIGATION MAP




# Lower West Branch Red Clay Creek Watershed Restoration Plan Map Chester County, Pennsylvania

N
W E
S

Data Sources:
Chester County GIS Department
Clauser Environmental, LLC
PEMA 2018 Imagery
www.pasda.psu.edu

0 1,000 2,000 4,000 Feet

RED Streams BLUE

Brandywine Red Clay Alliance

CLAUSER environmental llc

# APPENDIX B
# GPS POINT DESCRIPTIONS AND ACTION ITEMS

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 1 | This point is the upstream boundary of the watershed study area. This section of the stream channel is stable, but it is impacted by invasive Japanese hops (*Humulus japonicus* ). | Invasive species removal, Native plantings | Landowners, Conservation District, BRC, Municipalities | Low | |
| 2 | This culvert discharge from under South Mill Street is eroded with a 2' deep scour hole. The area is mowed to the top of the bank on the south streambank downstream of this point. | Restore fish passage, Riparian buffer enhancement, Maintain scour protection | PennDOT, Landowners, BRC, New Garden Township, Kennett Township | Low | |
| 3 | Stormwater discharges from Route 1 at this point and is causing an erosion gully. Upstream of this point, the streambanks are eroded and are 2-3' high and are mowed to the edge on the southern streambank. Downstream of this point, the riparian zone is forested. | Maintain energy dissipation at stormwater discharge, Streambank stabilization, Riparian buffer plantings | Landowners, Conservation District, BRC, PennDOT | Low | |
| 4 | Downstream of this point, the west bank is mowed within 15 feet of the stream where lawn approaches the stream. Invasive species dominate the unmowed areas. | Riparian buffer enhancement, invasive species removal | Landowners, Conservation District, BRC | Low | |
| 5 | Upstream of this point, the streambanks are stable. Downstream, the banks are undercut and 3-4' high. | Floodplain restoration, Invasive species removal, Streambank stabilization, Riparian buffer enhancement, Wetland creation | Landowners, Conservation District, BRC, New Garden Township | High | |
| 6 | Upstream, the banks are eroded approximately 4' high over about 60% of the reach to Point 5. Portions of the area are mowed to the top of the streambanks. Downstream of this point, the banks are stable. | Floodplain restoration, Invasive species removal, Streambank stabilization, Riparian buffer enhancement, Wetland creation | Landowners, Conservation District, BRC, New Garden Township | High | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 7 | Upstream of this point the stream channel and riparian zone are stable. Downstream of this point, the banks are eroded approximately 10' high at the base of Pemberton Road. The riparian zone is dominated by Japanese hops (*Humulus japonicus*), reed canary grass (*Phalaris arundinacea*), and multiflora rose (*Rosa multiflora*). | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, New Garden Township, Kennett Township | Medium | |
| 8 | Upstream of this point, the steambanks are actively eroding and are approximately 4' high. Downstream of this point, the stream is stable. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 9 | Downstream of this point, the bank is eroded 2-3 feet high on the outside of the meander bend. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 10 | Upstream of this point, the bank is eroded 2-3' high on the outside of the meander bend. Downstream of this point is stable. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 11 | Downstream of this point, the stream is eroding the toe of slope for Pemberton St. to the Penn's Manor Rd. stream crossing. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 12 | The streambank is eroded approximately 3-4' high in some outside meander bends downstream of this point. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 13 | The upstream bank is eroded 3-4' high on the western streambank. Streambanks are stable downstream of this point. | Streambank stabilization, Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 14 | Upstream of this point, the stream is stable. Downstream of this point, the western bank is eroded approximately 4' high. | Floodplain reconnection, Streambank stabilization, Invasive species removal, Riparian buffer enhancement, Wetland creation | Kennett Trails Alliance, Landowners, BRC, Conservation District | Medium | Kennett Greenway Trail will be implemented downstream of this area. Work in this area should include coordination of impacts. |
| 15 | Stormwater from the upslope W. Sickle St. roadway drainage discharges to the stream without control. The upslope inlets require maintenance as they are partly eroded. | Maintain upslope stormwater system, Stormwater Retrofits, Regenerative stormwater channel downstream | Landowners, Conservation District, BRC, Borough of Kennett Square Borough, Kennett Township | High | |
| 16 | The upstream stormwater channel is actively eroding and is eroded approximately 3-4' deep to point #15. | Regenerative stormwater channel design | Landowners, Conservation District, BRC, Kennett Township | High | |
| 17 | Upstream of this point, the streambanks are eroded approximately 4' high for about 50% of the reach. | Floodplain reconnection, Streambank stabilization, Invasive species removal, Riparian buffer enhancement, Wetland creation | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 18 | Upstream of this point is stable. Downstream of this point, the channel is incised 4-6' high, but it is mostly stable. On the eastern side of the stream, lawn extends to the top of the streambank. | Riparian zone enhancement, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 19 | Upstream of this point, the channel is approximately 4' high and has some erosion of the streambank. The eastern bank is mowed to the top of the streambanks. | Riparian zone enhancement, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 20 | Upstream of this point, streambanks are stable. There is some litter in the riparian zone. Downstream of this point, the western streambanks are eroded approximately 3' high. | Litter cleanup upstream, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 21 | Upstream of this point, streambanks are eroded up to 4' high over 20% of the reach. Downstream, the banks are up to 6' high and actively eroding approximately 50% of the reach. The downstream riparian zone is dominated by tree of heaven (*Ailanthus altissima)* and Japanese hops (*Humulus japonicus* ). | Invasive species removal, Riparian zone enhancement, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 22 | The surrounding area has been mowed for hay on both sides of the stream. The riparian buffer upstream of this point is dominated by Japanese hops (*Humulus japonicus* ), reed canary grass (*Phalaris arundinacea* ), and tree of heaven (*Ailanthus altissima)* . Approximately 50% of the reach has streambanks which are eroded 3' high and are actively eroding. | Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 23 | The streambanks downstream of this point are mostly stable with some small areas of erosion. The riparian zone is forested. Trash is exposed from dumped waste on the eastern bank of the stream. | Litter cleanup | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 24 | This section of stream has adequate riparian buffers with minor bank erosion. Invasive species including multiflora rose (*Rosa multiflora* ) and privet *(Ligustrum vulgare)* are common throughout this section of stream. | Invasive species removal | Landowners, Conservation District, BRC | Low | Kennett Greenway Trail plans to improve drainage and pave the trail near the creek. Work in this area should include coordination to minimize impacts on stream and protect the trail from erosion & flooding. |
| 25 | An outfall pipe from the nearby sewer plant discharges to the stream in this location. Downstream of this point, the west side of the creek is mowed to within 15' of the stream. | Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | See trail notes above |
| 26 | Upstream of this point, there is minimal streambank erosion, and the stream is mostly stable. There is potential to expand the riparian buffer into the adjacent fields. Downstream of this point, streambanks are 4' high and actively eroding with minimal riparian buffer. Invasive species dominate the area. | Wetland creation, Floodplain restoration, Invasive species removal, Streambank stabilization, Riparian buffer enhancement | Landowners (Kennett Borough), Kennett Township, Kennett Trails Alliance, BRC | Low - Upstream; High - Downstream | The stream restoration, recreation trail access, and native habitat restoration should be included in a Park Master Plan, coordinated with partners |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 27 | Upstream of this point, the stream channel has 4' high eroding streambanks. Downstream of this point, there is an existing riparian buffer planting area. Japanese hops (*Humulus japonicus* ) dominates the riparian zone both upstream and downstream of this point. | Wetland creation, Floodplain restoration, Invasive species removal, Streambank stabilization, Riparian buffer enhancement | Landowners (Kennett Borough), Kennett Township, Kennett Trails Alliance, BRC | High - Upstream; Low - Downstream | The proposed multi-use trail will pass through this and nearby project areas. Project design should include coordination between projects. |
| 28 | This point is the Hillendale Rd. crossing. The riparian zone is mowed both upstream and downstream of this point. Downstream of this point, the streambanks are 4' high and mowed to the top of the streambank in several places. | Floodplain reconnection, Invasive species removal, Riparian buffer enhancement, Streambank stabilization, Wetland creation | Landowners (Kennett Borough), Kennett Township, Kennett Trails Alliance, BRC | Low - Upstream; High - Downstream | |
| 29 | Streambanks upstream of this point are 4-5' high and actively eroding. Most of the stream segment is actively eroding and mowed to the top of the streambanks. | Floodplain reconnection, Invasive species removal, Riparian buffer enhancement, Streambank stabilization, Wetland creation | Landowners (Kennett Borough), Kennett Township, Kennett Trails Alliance, BRC | High - Upstream; Low - Downstream | |
| 30 | Upstream of this point to point 29, the western streambank is 2-3' high with minor areas of erosion. With landowner approval, an adjacent field could be planted to widen the riparian buffer. | Riparian buffer enhancement | Landowners (Kennett Borough), Kennett Township, Kennett Trails Alliance, BRC | Low | |
| 31 | The downstream segment of stream is mowed to the top of the western streambank and incised approximately 3'. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 32 | Areas upstream of this point are mowed to the top of the streambank. Banks are incised approximately 3-4'. Downstream of this point, the channel is forested with incised streambanks. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | There are many dead ash trees in this area and throughout the watershed. Tree plantings may be required to replace the lost forest. |
| 33 | At this point, a 50' section of the eastern streambank is eroded approximately 5' high. A log jam likely caused the erosion, but does not currently exist in the stream. Upstream and downstream of the eroded area, the streambanks are stable and there is a forested riparian zone. | Monitor to determine if future streambank stabilization work is warranted | Landowner, BRC | Low | This area will likely stabilize itself. Work to stabilize the bank would likely create more impact than it would resolve. |
| 34 | Downstream of this point, the banks are 4-8' high and actively eroding. | Floodplain reconnection, streambank stabilization, invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 35 | Upstream of this point, streambanks are 4-8' high and actively eroding. The reach is forested with many dead ash (*Fraxinus* sp.) trees. The area is dominated by invasive Japanese hops (*Humulus japonicus*) and multiflora rose (*Rosa multiflora*). The area downstream of this point is forested and the streambanks are stable. | Floodplain reconnection, streambank stabilization, invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Medium | |
| 36 | There is a stream sampling station at this point. Downstream, the banks are 4' high and incised. The riparian buffer is forested. | Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 37 | Upstream of this point, approximately 30% of the reach has areas of active erosion approximately 4' high. The area is forested with many dead ash trees. There is significant multiflora rose (*Rosa multiflora* ), and privet (*Ligustrum vulgare* ) in the watershed. | Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 38 | Upstream of this point, streambanks are mostly stable and there is a forested buffer. Downstream of this point, streambanks are 3' high and moderately eroded in some sections. | Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 39 | Upstream of this point, the streambanks are moderately eroded in some areas. Downstream of this point, the streambanks are stable and there is a forested buffer. | Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 40 | This point marks a private bridge crossing. This stream section is forested and stable. Downstream of this point, Chandler Mill Rd. is close to the edge of the stream. | | | | |
| 41 | The western streambank is approximately 3' high and actively eroding downstream of this point. | Invasive species removal, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 42 | Upstream of this point, approximately 25% of the reach has streambanks eroded up to 3' high. | Invasive species removal, Streambank stabilization | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 43 | Chandler Mill Dam Breast remains are located at this point. | | | | |
| 44 | An eroded streambank in this area is proposed for stabilization during implementation of the proposed multi-use trail project. | Monitor stabilization implementation | BRC, Kennett Trails Alliance, Kennett Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 45 | The western streambank is approximately 4' high and actively eroding for approximately 75' downstream of this point. | Streambank stabilization, Invasive species removal | BRC, Kennett Township | Low | |
| 46 | Upstream of this point, the streambanks are mostly stable and the riparian zone is forested. Downstream, the eastern bank is 4' high and actively eroding for approximately 30% of the reach. | Streambank stabilization, Invasive species removal, Floodplain reconnection | BRC, Kennett Township | Medium | |
| 47 | Upstream of this point, the streambanks are 4' high and actively eroding. Downstream of this point, the streambanks are stable and the buffer is forested. | Streambank stabilization, Invasive species removal, Floodplain reconnection | BRC, Kennett Township | Medium | |
| 48 | Upstream of this point, the streambanks are stable. The northern bank is undercut and actively eroding. The banks are eroded approximately 4' high. Ash trees in this area are dying, which has created a risk of the banks becoming unstable. | Widen the riparian buffer, Streambank stabilization, Cage trees that are critical to protecting the streambanks to limit beaver damage. | Landowners, Conservation District, Kennett Township, BRC | Low | Beaver are chewing the bases of many trees in this area. The trees should be caged at the base as they will be difficult to replace. |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 49 | Upstream of this point, the northern bank is undercut and actively eroding with minimal riparian buffer. Downstream of this point, the northern streambank has an adequate riparian buffer. The southern bank is incised 4' high and has some areas of erosion. | Widen the riparian buffer, Streambank stabilization, Cage trees that are critical to protecting the streambanks to limit beaver damage. | Landowners, Conservation District, Kennett Township, BRC | Low | The stream channel is very close to Chandler Mill Road in these sections, monitoring/ replacing riparian trees in this thin strip is recommended to protect the roadway from erosion. |
| 50 | Upstream of this point, the banks are 4' high on the southern side with some areas of erosion. Downstream of this point, the channel is incised approximately 5' high. | Streambank stabilization | Landowners, Conservation District, Kennett Township, BRC | Low | |
| 51 | Remnants of a dam are present at this point. Upstream of this point, the stream banks are incised, which is likely caused by legacy sediments. Downstream of this point, streambanks are stable. Erosion of the southern streambank along the road has been stabilized with rip rap. | Streambank stabilization | Landowners, Conservation District, Kennett Township, BRC | Low | |
| 52 | Upstream of this point, the streambanks are stable. Downstream of this point, the southern bank is actively eroding and is currently eroded 8' high. A culvert which discharges stormwater under the road is creating an erosion gully. | Streambank stabilization, stabilize culvert outlet with an energy dissipator | Landowners, Conservation District, Kennett Township, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 53 | Downstream of this point, the southern bank is stabilized with rip rap and mowed to the top of the streambank. The northern bank is stable with a good buffer. | Riparian buffer enhancement | Landowners, Conservation District, Kennett Township, BRC | Low | |
| 54 | The streambanks are stable downstream of this point. | | | | |
| 55 | The northern streambank downstream of this point has an approximately 200' long section that is eroded 4' high and an area that is mowed to the top of the bank. The streambanks are stable downstream of this point. | Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | Did not access South Ridge Meadows HOA due to landowner denying access. |
| 56 | This point marks South Ridge Drive. Upstream of this point, the streambanks are mostly stable. Some areas of a field are mowed near the stream channel. Downstream of this point, streambanks are stable. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | The Low Priority stream segment upstream of this point includes riparian buffer plantings based on a review of the aerial photography as property access for the stream walk was denied in that area. |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 57 | Upstream of this point, the riparian zone is mowed near the channel. A few trees have been planted and are being maintained within the riparian zone. Additional trees could be planted in this area to improve the riparian buffer. A short area of 5' high eroded streambank is present from a cleared log jam and appears to be stabilizing. | Riparian buffer planting, Monitor eroded area from former log jam | Landowners, Conservation District, BRC | Low | |
| 58 | Upstream of this point, the streambanks are stable. Downstream of this point, the southern bank is mowed. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 59 | This point marks the confluence with the East Branch Red Clay Creek. Upstream of this point, the southern bank is mowed and the channel is stable. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | Riparian buffer plantings should be considered for the mainstem of Red Clay Creek immediately downstream of the confluence. |
| 60 | Unnamed tributary: Upstream of this point, the banks are stable. Downstream, the streambanks are mowed to the top of the bank. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 61 | This point marks the Cedar Springs Road culvert crossing. Upstream of this point, the banks are mowed to the top of the bank. The downstream area is forested with litter in the woods. | Riparian buffer enhancement, Litter cleanup | Landowners, Conservation District, BRC | Low | |
| 62 | Downstream of this point, the banks are 3-4' high and actively eroding. The area is mowed to the top of the streambank. | Riparian buffer enhancement, Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 63 | Upstream of this point, the banks are actively eroding and the riparian zone is mowed. The area downstream of this point is forested and stable with some 2-3' high undercut banks in a few places that are providing good habitat. | Riparian buffer enhancement, Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 64 | This point marks the double culvert at the Columbine Road crossing. Branches and debris are partly blocking the culvert. Approximately 100' upstream, the northern streambank is mowed to the top of the bank. The area downstream of this point is mowed to the top of the bank. | Maintain culvert, Riparian buffer enhancement | New Garden Township, Landowners, Conservation District, BRC | Low | |
| 65 | A masonry wall in the floodplain diverts flows out of the floodplain and towards the channel | Create greater floodplain capacity by removing obstructions, Riparian buffer enhancement | New Garden Township, Landowners, Conservation District, BRC | Low | |
| 66 | Upstream of this point, the channel is stable but lacks a riparian buffer. Downstream of this point, the channel is partly eroded and incised approximately 2-4' deep. The majority of the stream segment is mowed to the edge of the stream. | Riparian buffer enhancement, Wetland creation, Invasive Species Removal | Landowners, Conservation District, BRC, New Garden Township | Low - Upstream; Medium - Downstream | |
| 67 | Upstream of this point, the channel is incised 2-4' with some areas of eroding streambanks. Invasive Japanese hops (*Humulus japonicus*) is a dominant plant in the un-mowed areas. The area is well suited for installation of created wetlands and a riparian buffer. | Riparian buffer enhancement, Wetland creation, Invasive Species Removal | Landowners, Conservation District, BRC, New Garden Township | Medium | Upstream area could be improved significantly with just tree plantings. |
| 68 | Unnamed tributary: Upstream of this point, the banks are stable throughout most of this unnamed tributary. Three areas were identified as lacking adequate riparian buffers upstream of this point'. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 69 | The area upstream of this point has Japanese hops (*Humulus japonicus*) dominating the riparian zone. Downstream, a small unnamed tributary is mowed to the top of the bank. | Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC | Low | |
| 70 | The area upstream of this point is mowed to the top of the streambank. Japanese hops (*Humulus japonicus*), Asiatic bittersweet (*Celastrus orbiculatus*), and common reed (*Phragmites australis)* dominate the upstream riparian zone. | Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 71 | This point marks the Thompson Street crossing of an unnamed tributary. Downstream of this point, the streambanks are eroded 4-5' high and actively eroding. The channel lacks floodplain connection. | Floodplain restoration, Streambank stabilization, Riparian buffer enhancement, Wetland creation, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | High | |
| 72 | Upstream of this point, the streambanks are 4-5' high and actively eroding. The channel is incised and is not connected to the active floodplain. A breached dam is exacerbating erosion at this point. | Floodplain restoration, Streambank stabilization, Riparian buffer enhancement, Removal of breached dam currently obstructing the channel, Wetland creation, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | High | |
| 73 | A collapsed stream crossing is blocking the channel at this location. | Remove collapsed stream crossing | Landowners, Conservation District, BRC, New Garden Township | High | |
| 74 | The stream channel upstream of this area has 3-4' high eroding banks. The upstream floodplain is dominated by Japanese hops (*Humulus japonicus*) and reed canary grass (*Phalaris arundinacea*). Downstream, the streambanks are 4' high and actively eroding. | Floodplain restoration, Streambank stabilization, Riparian buffer enhancement, Wetland creation, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | High | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 75 | Downstream of this point, a riparian buffer planting has been completed and is in need of maintenance. Additional buffer plantings could potentially be added in the area owned by the homeowners' association. The streambanks are 4' and actively eroding. | Floodplain restoration, Streambank stabilization, Riparian buffer enhancement, Wetland creation, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | High | |
| 76 | Upstream of this point, the streambanks are 5' high and actively eroding. Downstream, the banks are stable. | Floodplain restoration, Streambank stabilization, Riparian buffer enhancement, Wetland creation, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | High | |
| 77 | Upstream of this point, the streambanks are stable. Downstream, the southern bank is mowed lawn to the top of the streambank. A sparse riparian buffer has been planted downstream. Streambanks are 3-4' high and actively eroding. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement | Landowners, Sub-division HOA, Conservation District, BRC, New Garden Township | High | |
| 78 | Upstream of this point, the banks are 3-4' high and actively eroding. Though trees have been planted in this area, many have been knocked down by invasive Japanese hops (*Humulus japonicus* ) or choked out by reed canary grass (*Phalaris arundinacea* ). | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, New Garden Township | High | A maintenance contract should be included with all future buffer plantings. |
| 79 | Upstream of this point, there is a thriving riparian buffer planting on the northern bank. The streambanks at this point are 3-4' and actively eroding. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | High | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 80 | Downstream of this point, the streambanks are 4' high and actively eroding. The stream buffer is 5-30' wide. Upstream, the riparian zone is forested. The upstream channel is incised 3-4' but has little active erosion. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, New Garden Township | Medium | |
| 81 | The southern bank upstream of this point is covered in Japanese hops (*Humulus japonicus* ). The upstream banks are 4' high and actively eroding. | Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, New Garden Township | Medium | |
| 82 | The banks upstream of this point are 3' high and actively eroding. The area is mowed to the top of the streambank. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement | Landowners, Conservation District, BRC, New Garden Township | Medium | |
| 83 | A small unnamed tributary that is mowed on both sides of the stream throughout the majority of its length discharges to the stream from the south in this location. Upstream of this point, the main channel has a forested buffer on both sides of the stream and the streambanks are 2' high. | Streambank stabilization, Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | Low | A riparian buffer should be installed along the unnamed tributary. |
| 84 | This point marks a point source discharge from the North. | | | | |
| 85 | Downstream of this point, the stream channel is 2' high and actively eroding. Japanese hops (*Humulus japonicus* ) dominate the riparian zone. Upstream of this point, the channel is stable. | Streambank stabilization, Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 86 | This section of stream has a discontinuous buffer that is dominated by multiflora rose (*Rosa multiflora* ) and Japanese hops (*Humulus japonicus* ). The banks are 2' high and actively eroding. An abandoned road crossing is falling into the stream. | Streambank stabilization, Riparian buffer enhancement, Invasive species removal, Remove abandoned crossing | Landowners, Conservation District, BRC, New Garden Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 87 | Downstream of this point, litter is prevalent and the streambanks are 2' high and actively eroding. | Litter cleanup, Streambank stabilization, Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | Low | There are plans for Toughkenamon street and stormwater improvements. This may present an opportunity to enhance buffers, address litter, and improve stormwater inputs. |
| 88 | Litter is prevalent both upstream and downstream of this point. Upstream of this point, the channel is impacted from fill, debris, and mushroom soil within 50' of the stream. | Store mushroom soil away from the creek, Riparian buffer plantings, Litter cleanup | Landowners, Conservation District, BRC | Low | |
| 89 | This point marks a stormwater basin with a grass lawn bottom. | Stormwater retrofit to include planting the basin floor with native species | Landowners, BRC, New Garden Township | Low | |
| 90 | Upstream of this point, the stream discharges from a stream enclosure under a commercial area and then flows through a mowed lawn area. Downstream, the streambanks are 3' high and incised. The riparian buffer is mowed within 15' of the top of bank. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 91 | Downstream of this point, the banks are mowed to the edge of the stream channel on the western streambank. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 92 | The downstream buffer is forested. Upstream of this point, the riparian area is mowed on the western bank. Debris and litter have been dumped into the creek corridor. | Riparian buffer enhancement, Litter cleanup | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 93 | The area downstream of this point is mowed to the eastern streambank. The streambanks are eroded approximately 5' high on the eastern bank for 75' downstream. | Riparian buffer enhancement, Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 94 | This section of stream is mowed to the western stream edge. The banks are eroded 3-4' high for 130' downstream. Downstream, there are some additional 4' high small areas of erosion. | Riparian buffer enhancement, Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 95 | At this point, there is a large stormwater basin and wetland area that is filled with common reed (*Phragmites australis*). | Invasive species removal | Landowners, BRC | Low | |
| 96 | Upstream of this point, there are some small areas of eroding banks in a mature forest. The stream runs over bedrock, and is stable. | | | | |
| 97 | Downstream of this point, the area is mowed to the western bank. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 98 | There is a double box culvert road crossing at this point. | | | | |
| 99 | The upstream area is mowed to the top of the western bank. There are some areas of 3' high bank erosion. | Riparian buffer enhancement, Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 100 | Upstream of this point, the stream channel has 3' high banks. The riparian zone of this stretch of stream is dominated by Japanese hops (*Humulus japonicus*), common reed *(Phragmites australis)*, and reed canary grass (*Phalaris arundinacea*) as understory within the forested areas. Downstream of this point, the stream is stable. | Riparian buffer enhancement, Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 101 | The mature forest downstream of this point has eroded streambanks that are 2-5' high. | Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | Any work within this area should account for minimizing compaction around the roots of the mature trees. |
| 102 | A stormwater basin at this location has large trees on the basin berm and is mowed on the basin interior. | Plant native species on the basin interior, Remove trees from the basin berm | Landowners, BRC | Low | |
| 103 | Upstream, the mature forest area has 2-5' high eroded streambanks. Downstream, the streambanks are stable. | Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 104 | This point marks the upstream end of White Feather Farm. The streams within this area are actively eroding and are 3-4' high. Mowed lawn is near the stream in one section of the downstream area. | Streambank stabilization, Riparian buffer enhancement, Invasive Species Removal | Landowners, BRC, New Garden Township | High | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 105 | This point is on the unnamed tributary that drains into White Feather Farm. The unnamed tributary is actively eroding and is mowed to the stream edge in some areas. | Streambank stabilization, Riparian buffer enhancement, Invasive Species Removal | Landowners, BRC, New Garden Township | High | The design and permitting of the restoration of this area has been completed. Some of the construction funding has been secured. A grant for completion of the balance of the project has been applied for. |
| 106 | This is the downstream point for White Feather Farm where the streambanks are actively eroding and are 3-4' high. Downstream of this point, there is room for additional buffer plantings within the riparian zone. The downstream streambanks are 3-4' high and actively eroding in some areas. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement, Invasive species removal, Wetland creation | Landowners, BRC, New Garden Township | High | |
| 107 | The segment upstream of this point is mowed to the top of the bank with some areas left as buffer. The 3-4' high streambanks are eroding in 50% of the reach. There are opportunities for floodplain reconnection on this site. The streambank is actively eroding in the direction of sewer manholes just upstream of the Sharp Road stream crossing. | Floodplain reconnection, Streambank stabilization, Riparian buffer enhancement, Invasive species removal, Wetland creation | Landowners, BRC, New Garden Township | High | |
| 108 | At this point, a box culvert is degraded and undercut. Scour at the downstream end of the culvert is eroding the downstream bank. | Stabilize culvert outlet | New Garden Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 109 | Upstream of this point, about 15% of the channel has eroded banks up to 3' high. The forest is mature with supplemental tree plantings. There are some areas of invasive multiflora rose (*Rosa multiflora* ) and Japanese hops (*Humulus japonicus* ). Downstream, rip rap stabilization is dumped along the Bucktoe Road slope for 75'. Along the west bank of this section of stream sits Bucktoe Cemetery, a Civil War era cemetery with historical significance. The streambanks bordering the cemetery should be actively monitored for encroachment which would warrant an immediate increase of priority to medium or high priority. | Streambank stabilization, Riparian buffer enhancement, Invasive species removal | Landowners, Conservation District, BRC, New Garden Township, Kennett Township | Low | Buffer trees were planted over the last 20+ years in this area. The historic Bucktoe Cemetery sits on the west bank of the creek in this section, streambank erosion should be monitored to protect this historic site. |
| 110 | Upstream of this point, the channel is incised with 4' high banks. The stream crosses a gas pipeline corridor that is dominated by Japanese knotweed (*Reynoutria japonica* ) and reed canary grass (*Phalaris arundinacea* ). The downstream stretch is forested with 3-4' high actively eroding banks. | Streambank stabilization, Invasive species removal, Wetland creation, Floodplain reconnection | Landowners, Conservation District, BRC, Kennett Township | Low upstream, High downstream | |
| 111 | This point marks a stream monitoring station on Bucktoe Creek. | | | | |
| 112 | This point marks the confluence of Bucktoe Creek. Upstream areas have 3-4' high actively eroding banks. There is opportunity for floodplain reconnection and wetland creation in this stretch of stream. | Streambank stabilization, Invasive species removal, Wetland creation, Floodplain reconnection | Landowners, Conservation District, BRC, Kennett Township | High | |
| 113 | This point is on a tributary along Kaolin Road. The area downstream of this point is mostly forested with some minor areas of streambank erosion. Upstream, the area is mowed to the channel edge. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 114 | Downstream, the area is mowed to the channel edge. Upstream, the area is dominated by invasive multiflora rose (*Rosa multiflora* ) and Japanese stilt grass (*Microstegium vimineum* ). There are some areas with up to 3' high eroded banks. | Riparian buffer enhancement, Streambank stabilization, Invasive species removal | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 115 | This unnamed tributary has a substantial common reed *(Phragmites australis)* population within the riparian zone and adjoining wetlands both upstream and downstream of this point. At this point, the outfall from an on-line dam is actively eroding. | Invasive species removal and buffer enhancements, Maintenance of pond outfall | Landowners, Conservation District, BRC | Low | |
| 116 | The outlet structure at this point serves to provide flood control by detaining water upstream throughout the width of the valley. C*ommon reed (Phragmites australis)* dominates the upstream wetlands. | Invasive species removal | Landowners, Conservation District, BRC | Low | |
| 117 | The reach upstream of this point is forested and stable. Downstream, the stream crosses through a buffered meadow area that has some areas dominated by common reed *(Phragmites australis)* and Japanese hops (*Humulus japonicus* ). | Invasive species removal | Landowners, Conservation District, BRC | Low | |
| 118 | The area upstream of this point is dominated by invasives in a meadow buffer area that crosses the golf course. Downstream, a culvert outfall has a large scour hole at the outlet. | Invasive species removal, Placement of an energy dissipator at the outfall, Riparian buffer enhancements | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 119 | Upstream, there is a mature forest with 2' high eroding pool streambanks. The stream is situated on the bedrock and is primarily stable. Downstream, several homes backup to the stream. Mature trees exist on both sides of the channel. | | | | |
| 120 | A stormwater basin in this location has some erosion around the outfall structure and common reed *(Phragmites australis* ) dominating the basin. | Maintain the basin outfall, Invasive species removal | Landowners, BRC, New Garden Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 121 | A small online dam feeds an adjacent pond in this location. The downstream channel is entrenched but has been stabilized. | | | | |
| 122 | The unnamed tributary at this point flows through a periodically mowed area for approximately the last 300' before entering a culvert under Bucktoe Road. The township is concerned about periodic flooding and sediment deposition at the culvert. The downstream side of the culvert has a scour hole at the outfall. | Riparian buffer enhancement, Engineering evaluation of culvert sizing, Maintain outfall energy dissipator | Landowners, New Garden Township, BRC | Low | The culvert may be undersized and should be evaluated by an engineer |
| 123 | The area upstream of this point is forested with a stable channel on this unnamed tributary. The downstream channel is within a forested riparian zone and has approximately 2' high eroded banks. | | | | |
| 124 | The upstream segment has a riparian zone forested with streambanks that are up to 2' high. Downstream, there is a cornfield within 5' of the stream. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 125 | Downstream of this point, the area is forested with streambanks up to 5' high. | Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 126 | There is a breached dam breast at this point. Downstream, the channel has 2' high banks within a forested channel. | Streambank stabilization | Landowners, Conservation District, BRC, New Garden Township | Low | |
| 127 | Downstream of this point, the area on the northern side of the channel is within agricultural use to the top of the streambank. The area upstream of this point is forested and stable. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 128 | There is a concrete hog slat agricultural crossing at this point. The crossing is partly collapsed on the downstream side due to being undercut. | Replace crossing and install downstream grade control | Landowners, Conservation District, BRC | Low | |
| 129 | The upstream area is covered in hay to the top of the streambanks. The majority of the area has 2' high banks with some 3' high eroding banks. Downstream is forested with stable banks. | Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 130 | The downstream area is mostly stable with a riparian zone dominated by multiflora rose (Rosa multiflora), poison hemlock (*Conium maculatum* ), Japanese hops (*Humulus japonicus* ), reed canary grass (*Phalaris arundinacea* ) and tree of heaven (*Ailanthus altissima* ). | Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC | Low | |
| 131 | The area upslope of this point has little stormwater control, the existing field and parking area are often wet from stormwater. | Stormwater retention, Wetland creation | Landowners, Conservation District, BRC, Kennett Square Borough | Low | |
| 132 | The section downstream of this point is mowed to the top of the stream. | Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Square Borough | Low | Improvements to the nearby parking area could improve water quality. |
| 133 | The section upstream of this point is mowed to the top of the bank. | Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Square Borough | Low | |
| 134 | The section downstream of this point is mowed to the top of the streambank and is heavily impacted by a mushroom farm. Substantial stormwater discharges from the rooftops and paved areas. Several potentially undersized stream crossings restrict the flow of water within the channel and likely contribute to the flooding of the mushroom farm facilities during large storm events. A swale that is dominated by invasive species discharges stormwater to the stream from the south. | Replace existing stream crossings with adequately sized and maintained crossings, Floodplain restoration, Stormwater Retrofits, Riparian buffer enhancement, Regenerative stormwater conveyance installation | Landowners, Conservation District, BRC, Kennett Township, Kennett Square Borough | High | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 135 | The section upstream of this point is mowed to the top of the bank. Upstream, stormwater discharges to the stream without control from a large mushroom farm. The upstream channel has eroding banks and is incised. Downstream, the channel flows through a wooded area. | Replace existing stream crossings with adequately sized and maintained crossings, Floodplain restoration, Stormwater Retrofits, Riparian buffer enhancement, Regenerative stormwater conveyance installation | Landowners, Conservation District, BRC, Kennett Township, Kennett Square Borough | High | Kennett Trails Alliance has plans for a sidewalk/trail connection here that includes riparian buffer plantings along the stream. |
| 136 | Upstream of this point, the stream runs through a wooded area with mature trees and an undergrowth of spicebush. The streambanks are stable. | | | | |
| 137 | The section upstream of this point runs through an open area with a poorly defined channel. The stream runs through a wetland area that is dominated by the invasive common reed (*Phragmites australis* ) and some mowed areas. | Invasive species removal, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 138 | The section upstream of this point has a riparian zone dominated by invasive species including Japanese stilt grass (*Microstegium vimineum)* and multiflora rose (*Rosa multiflora* ). Though only the east bank is wooded, both sides of the stream are dominated by the invasive species. | Invasive species removal, Wetland creation, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 139 | Upstream of this point, crop fields are adjacent to the stream. The streambanks are incised 3-4' high. | Streambank stabilization, Floodplain restoration, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |
| 140 | This point marks a spring fed pond lacking a direct stream outlet. There is fenced animal pasture, as well as a barn and animal lot above the pond. Manure appears to flow from the barn area directly to the pond. | Manure management, Implementation of barn gutter system, | Landowners, Conservation District, BRC, Kennett Township | Low | |

| Point # | Description | Action Item | Key Partners | Priority | Comments |
|---|---|---|---|---|---|
| 141 | Upstream of this point, field run-off from farming operations enters wetland areas that feed a small tributary to Agnew Run. Sediment run-off from farm fields is carried into the tributary by way of a gully on the western bank. The section is routinely mowed, lacking a strong buffer area. | Agricultural management BMPs, Riparian buffer enhancement | Landowners, Conservation District, BRC, Kennett Township | Low | |

# APPENDIX C
# POINT LOCATION DATA

# Lower West Branch Red Clay Creek
## Point Location Data

| Point # | Latitude (°N) | Longitude (°W) |
|---|---|---|
| 1 | 39.85423 | 75.73021 |
| 2 | 39.85376 | 75.72824 |
| 3 | 39.85356 | 75.72884 |
| 4 | 39.85316 | 75.73007 |
| 5 | 39.85252 | 75.72984 |
| 6 | 39.85062 | 75.72847 |
| 7 | 39.85022 | 75.72777 |
| 8 | 39.85054 | 75.72707 |
| 9 | 39.85017 | 75.72667 |
| 10 | 39.85005 | 75.72570 |
| 11 | 39.84990 | 75.72493 |
| 12 | 39.84969 | 75.72421 |
| 13 | 39.84945 | 75.72358 |
| 14 | 39.84784 | 75.72317 |
| 15 | 39.84760 | 75.72164 |
| 16 | 39.84753 | 75.72225 |
| 17 | 39.84706 | 75.72194 |
| 18 | 39.84647 | 75.72156 |
| 19 | 39.84583 | 75.72151 |
| 20 | 39.84301 | 75.72253 |
| 21 | 39.84141 | 75.72361 |
| 22 | 39.83987 | 75.72463 |
| 23 | 39.83937 | 75.72473 |
| 24 | 39.83679 | 75.72536 |
| 25 | 39.83505 | 75.72486 |
| 26 | 39.83402 | 75.72394 |
| 27 | 39.83107 | 75.72249 |
| 28 | 39.83066 | 75.72165 |
| 29 | 39.82983 | 75.71936 |
| 30 | 39.82919 | 75.71867 |
| 31 | 39.82856 | 75.71826 |
| 32 | 39.82779 | 75.71818 |
| 33 | 39.82701 | 75.71836 |
| 34 | 39.82632 | 75.71850 |
| 35 | 39.82479 | 75.71903 |
| 36 | 39.82333 | 75.71881 |
| 37 | 39.82256 | 75.71826 |
| 38 | 39.82137 | 75.71713 |
| 39 | 39.82079 | 75.71644 |
| 40 | 39.81976 | 75.71528 |
| 41 | 39.81854 | 75.71504 |
| 42 | 39.81555 | 75.71545 |
| 43 | 39.81518 | 75.71520 |
| 44 | 39.81473 | 75.71518 |
| 45 | 39.81413 | 75.71568 |
| 46 | 39.81289 | 75.71566 |
| 47 | 39.81175 | 75.71362 |
| 48 | 39.81034 | 75.71139 |
| 49 | 39.80977 | 75.71014 |
| 50 | 39.80941 | 75.70836 |
| 51 | 39.80952 | 75.70757 |
| 52 | 39.81132 | 75.70421 |
| 53 | 39.81159 | 75.70387 |
| 54 | 39.81212 | 75.70398 |
| 55 | 39.81245 | 75.70428 |
| 56 | 39.81671 | 75.69780 |
| 57 | 39.81690 | 75.69617 |
| 58 | 39.81767 | 75.69341 |
| 59 | 39.81779 | 75.69241 |
| 60 | 39.84754 | 75.73764 |
| 61 | 39.84764 | 75.73695 |
| 62 | 39.84851 | 75.73520 |
| 63 | 39.84869 | 75.73453 |
| 64 | 39.84980 | 75.73284 |
| 65 | 39.85008 | 75.73251 |
| 66 | 39.85060 | 75.73103 |
| 67 | 39.85106 | 75.72901 |
| 68 | 39.83732 | 75.74779 |
| 69 | 39.83929 | 75.73801 |
| 70 | 39.83814 | 75.73866 |

# Lower West Branch Red Clay Creek
## Point Location Data

| Point # | Latitude (°N) | Longitude (°W) |
|---|---|---|
| 71 | 39.83683 | 75.73833 |
| 72 | 39.83602 | 75.73623 |
| 73 | 39.83601 | 75.73583 |
| 74 | 39.83574 | 75.73332 |
| 75 | 39.83467 | 75.73112 |
| 76 | 39.83436 | 75.72970 |
| 77 | 39.83427 | 75.72901 |
| 78 | 39.83329 | 75.72545 |
| 79 | 39.83310 | 75.72452 |
| 80 | 39.83592 | 75.74036 |
| 81 | 39.83560 | 75.74072 |
| 82 | 39.83459 | 75.74409 |
| 83 | 39.83429 | 75.74464 |
| 84 | 39.83366 | 75.74575 |
| 85 | 39.83361 | 75.74592 |
| 86 | 39.83324 | 75.74786 |
| 87 | 39.83268 | 75.75030 |
| 88 | 39.83225 | 75.75096 |
| 89 | 39.83348 | 75.75040 |
| 90 | 39.83631 | 75.74441 |
| 91 | 39.80352 | 75.74043 |
| 92 | 39.80555 | 75.73989 |
| 93 | 39.80649 | 75.73972 |
| 94 | 39.80734 | 75.73968 |
| 95 | 39.80856 | 75.73966 |
| 96 | 39.81052 | 75.73804 |
| 97 | 39.81180 | 75.73734 |
| 98 | 39.81231 | 75.73728 |
| 99 | 39.81287 | 75.73716 |
| 100 | 39.81353 | 75.73632 |
| 101 | 39.81430 | 75.73578 |
| 102 | 39.81471 | 75.73585 |
| 103 | 39.81580 | 75.73455 |
| 104 | 39.81743 | 75.73310 |
| 105 | 39.81863 | 75.73068 |

| Point # | Latitude (°N) | Longitude (°W) |
|---|---|---|
| 106 | 39.81721 | 75.72959 |
| 107 | 39.81702 | 75.72812 |
| 108 | 39.81705 | 75.72799 |
| 109 | 39.81486 | 75.72125 |
| 110 | 39.81489 | 75.72013 |
| 111 | 39.81216 | 75.71662 |
| 112 | 39.81213 | 75.71591 |
| 113 | 39.80498 | 75.71342 |
| 114 | 35.80459 | 75.71419 |
| 115 | 39.80927 | 75.74170 |
| 116 | 39.80579 | 75.72747 |
| 117 | 39.80618 | 75.72625 |
| 118 | 39.80799 | 75.72425 |
| 119 | 39.81266 | 75.72374 |
| 120 | 39.81360 | 75.72368 |
| 121 | 39.81372 | 75.72325 |
| 122 | 39.81687 | 75.72971 |
| 123 | 39.81767 | 75.74250 |
| 124 | 39.81881 | 75.73890 |
| 125 | 39.82018 | 75.73762 |
| 126 | 39.82021 | 75.73706 |
| 127 | 39.82048 | 75.73588 |
| 128 | 39.82091 | 75.73536 |
| 129 | 39.82083 | 75.73415 |
| 130 | 39.82014 | 75.73243 |
| 131 | 39.84030 | 75.71527 |
| 132 | 39.83977 | 75.71591 |
| 133 | 39.83925 | 75.71664 |
| 134 | 39.83901 | 75.71880 |
| 135 | 39.83782 | 75.72388 |
| 136 | 39.82188 | 75.74258 |
| 137 | 39.82145 | 75.74211 |
| 138 | 39.82064 | 75.74014 |
| 139 | 39.82008 | 75.73819 |
| 140 | 39.82304 | 75.73888 |
| 141 | 39.82109 | 75.73637 |

# APPENDIX D
# RESTORATION BMP HANDOUTS

# Riparian Buffer Enhancement

Mowing and grazing stream corridors to the stream edge impacts water quality and the community of creatures that live within the stream. Streams lacking a healthy riparian buffer are exposed to high levels of sunlight and lack a filter to minimize sediment and nutrients from discharging into the stream. As sunlight warms the water, it cannot hold as much dissolved oxygen, which is essential for a healthy stream community.

Riparian buffers provide shade, helping moderate daily stream temperature changes during both winter and summer months. Pollutants can be successfully filtered and trapped by the physical structure of the vegetation itself and be taken up through the root systems and stored in the tree and shrub's wood. In addition, healthy riparian buffers provide a home for a diversity of wildlife and function as a corridor to allow wildlife to move from one pocket of habitat to another.


For more information please contact:
**Brandywine Red Clay Association**
**1760 Unionville-Wawaset Road**
**West Chester, PA 19382**
**Phone: (610) 793-1090**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# Streambank Stabilization

Within the Lower West Branch Red Clay Creek Watershed, some stream segments are impaired by erosion and sedimentation within the stream itself. When streambanks erode, sediment that is discharged to the stream channel smothers the small nooks and crannies between the rocks on the streambed that provide micro-habitat areas for the instream community. Sediment discharges are often partnered with the release of soil-bound nutrients. Within these areas, stream restoration and stabilization are often effective tools to improve in-stream habitat and water quality. Stream restoration within the watershed should focus on the long-term stability of the stream by looking at the stream's pattern, profile, and dimension. Where streambanks are actively eroding, stabilization that focuses on establishing native vegetation is often the best long-term option. As the vegetation becomes established, a combination of rip-rap and instream structures are often implemented to provide stabilization. The use of well-positioned in-stream deflectors, cross-vanes, j-hooks, and straight vanes can help to hold the streambanks in place as the vegetation becomes established. These structures, when utilized effectively, minimize streambank erosion by reducing the force of water that is scouring the bank surface and provide habitat for many types of aquatic life.


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# Floodplain Restoration

In many areas of the Lower West Branch Red Clay Creek Watershed, past human activities have placed fill in or caused extensive sedimentation within the riparian zone. The excess material along the edge of the stream channel has disconnected the stream from the floodplain. Floodplain restoration projects are designed to remove excess soil from the floodplain so that the stream is reconnected to an active floodplain. Active floodplains are important to not only reduce the volume and velocity of floodwaters but also to filter nutrients and pollutants from floodwaters and to provide habitat for a diverse riparian community. The restored streambanks and floodplain area can be planted with native wildflowers, grasses, shrubs, and trees to help stabilize the riparian zone and promote the use of the area by a diversity of native wildlife. Floodplain restoration projects can range from establishing a small bankfull bench to help disperse flows to large-scale excavation projects that uncover the historic valley floor.

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# In-stream Restoration Structures

In-stream rock and log deflectors, cross-vanes, j-hooks, and boulder placements are effective tools for creating in-stream fish habitat and aiding in the stabilization of streambanks. The structures are typically constructed based on what materials are available on the site or are locally available. Root wads from clearing operations may be anchored into the streambanks to slow the flow of water in the stream and create habitat for fish and aquatic life. Log sections may be used to create vanes and deflectors to protect banks and create in-stream habitat. Where needed, boulders can be placed either randomly for fish habitat and to disperse flows or aligned to roll the stream flow away from the bank and into the center of the channel. In-stream structures are typically designed to manage low to moderate flow conditions and help shape and maintain a natural stream configuration. During high flow events, the structures are designed to stay in place beneath the floodwaters.

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# Constructed Wetlands

Throughout the Lower West Branch Red Clay Creek Watershed, many areas lack connections to wetlands. The creation of constructed wetlands in the watershed will have multiple positive impacts on the watershed. Foremost, constructed wetlands can serve to remove contaminants and pollutants caused by human activity from the water supply through the same processes as naturally occurring wetlands. These processes help to remove and break down contaminants. Constructed wetlands not only offer the benefit of water quality improvements through a natural and holistic process but also provide a variety of niche habitats for local plants and wildlife. Wetlands are considered to be one of the most productive ecosystems on Earth and provide habitat for birds, mammals, amphibians, and reptiles, as well as diverse plants and fungi in the area. Constructed wetlands can help to reduce the impacts caused by erosion as the complex root systems of wetland species help to anchor soils. Additionally, wetlands can mitigate the impacts of flooding and aid in groundwater recharge. This phenomenon occurs because of the ability of wetlands to hold significant amounts of water, which otherwise might pose a threat to urban areas nearby and downstream.

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# Invasive Species Removal

Throughout the Lower West Branch Red Clay Creek Watershed, invasive species pose a threat to the ecosystem and native species. Of particular concern in the watershed are Japanese hops (*Humulus japonicus*), common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*) and multiflora rose (*Rosa multiflora*). Invasive species wreak havoc on ecosystems by dominating niches belonging to native plants. This results in changes in the populations of all types of creatures, changes in soil and water quality over time, and eventually a reduction in native biodiversity.

Control of most invasive plant species over large areas typically requires selective herbicide application on multiple occasions. It is crucial that soil containing invasive plant roots and seeds is appropriately managed and that tires and tracks from construction equipment are cleaned in such a way as to minimize the risk of the plants spreading to other areas.


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# Litter Cleanup

Throughout the watershed, the impact of human activity is noticeable through the litter laying along the streambanks and streambed. In some parts of the watershed, larger pieces of litter (such as old construction materials and pieces of metal) line the banks of the stream. Litter can change public perception of stream ecosystems, resulting in reduced interest in keeping the stream healthy for both wildlife and human use. This litter not only takes away from the aesthetic value of the stream but can also be detrimental to the stream ecosystem and water quality.

Volunteer litter cleanups may be used to collect litter that is small and easily carried. Large litter will require a more involved effort to remove safely. Community groups such as religious organizations, scout troops, and civic organizations can be great sources of volunteers for litter cleanups.


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# Stormwater Management Retrofits

As the amount of developed land increases within the watershed, the landscape is altered by an increase in impervious cover. Impervious areas shed runoff and increase stormwater discharges to the streams. Increased stormwater flows contribute to flooding, degrade water quality, and accelerate in-stream erosion.

To decrease the impacts of stormwater on the watershed, effective best management practices should be installed with new construction. Where existing stormwater structures exist, they should be evaluated for effectiveness and retrofitted where necessary.

Common stormwater retrofits focus on improving the function of existing structures so that they more closely reflect the natural hydrological cycle. Within existing stormwater basins, native species may be planted or allowed to become established. Minimizing mowing and labor in this way provides for additional wildlife habitat, reduces nutrient discharges to the stream, and allows for the vegetation to return more of the stormwater to the atmosphere through evapotranspiration. Other strategies for stormwater retrofits include installing cisterns to allow for water reuse and infiltration trenches to increase the return of stormwater to the groundwater.


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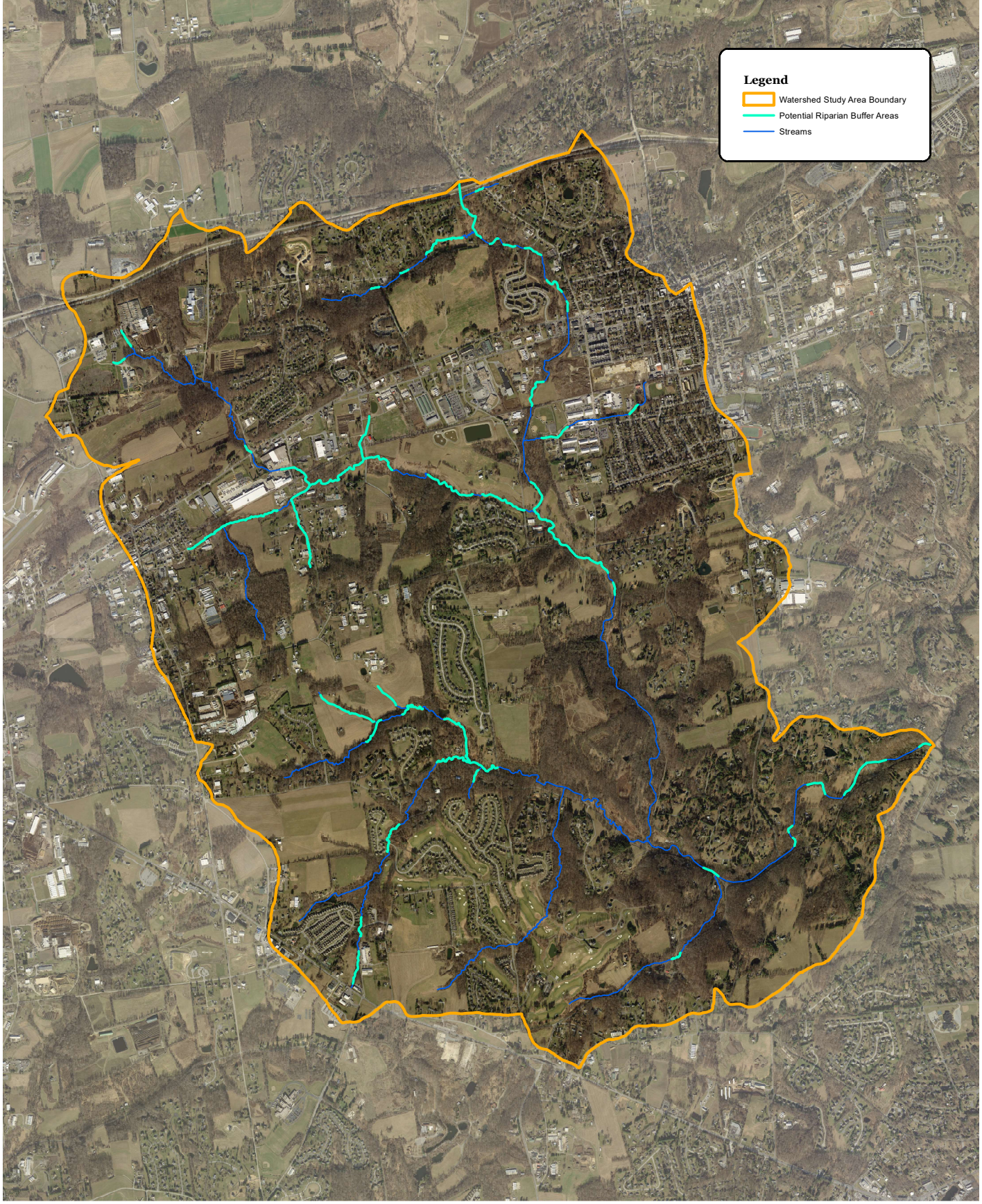
# APPENDIX E
# PRELIMINARY PROBABLE CONSTRUCTION COST OPINION

# Lower West Branch Red Clay Creek Watershed
# Probable Construction Cost Opinion

| Site | Priority | Min Cost | Max Cost |
|---|---|---|---|
| **Buffer Enhancements** | High | **$1,000,000** | **$1,500,000** |
| **5-6** | High | **$250,000** | **$375,000** |
| **7-8** | Medium | **$50,000** | **$75,000** |
| **14-17** | Medium | **$175,000** | **$250,000** |
| **15-16** | High | **$30,000** | **$85,000** |
| **21-22** | Medium | **$150,000** | **$225,000** |
| **26-27** | High | **$350,000** | **$650,000** |
| **28-29** | High | **$225,000** | **$350,000** |
| **34-35** | Medium | **$110,000** | **$250,000** |
| **46-47** | Medium | **$225,000** | **$375,000** |
| **66-67** | Medium | **$200,000** | **$375,000** |
| **71-76** | High | **$750,000** | **$1,900,000** |
| **77-79** | High | **$325,000** | **$650,000** |
| **80** | Medium | **$250,000** | **$375,000** |
| **81-83** | Medium | **$300,000** | **$475,000** |
| **104-106** | High | **$293,000** | **$337,000** |
| **106-107** | High | **$150,000** | **$300,000** |
| **110-112** | High | **$425,000** | **$975,000** |
| **134-135** | High | **$525,000** | **$750,000** |
| | | **$5,783,000** | **$10,272,000** |

Clauser Environmental, LLC is not a construction contractor and therefore probable construction cost opinions are made on the basis of Clauser Environmental, LLC's experience and qualifications as an environmental consultant and represent the consultant's best judgment as experienced and qualified design professionals generally familiar with the industry. This requires a number of assumptions as to actual conditions which will be encountered on the site; the specific decisions of other design professionals engaged; the means and methods of construction the contractor will employ; contractors' techniques in determining prices and market conditions at the time, and other factors over which Clauser Environmental, LLC has no control. Given these assumptions which must be made, Clauser Environmental, LLC states that the above probable construction cost opinion is a fair and reasonable estimate for construction costs but cannot and does not guarantee that actual construction costs will not vary from the Probable Construction Cost Opinion.

APPENDIX F
POTENTIAL RIPARIAN BUFFER ENHANCEMENT AREAS MAP




# Lower West Branch Red Clay Creek
# Potential Riparian Buffer Enhancement Areas
# Chester County, Pennsylvania

N
W E
S

RED Streams BLUE

**Data Sources:**
**Chester County GIS Department**
**Clauser Environmental, LLC**
**PEMA 2018 Imagery**
**www.pasda.psu.edu**

0 1,000 2,000 4,000 Feet

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# APPENDIX G
# PROFESSIONAL QUALIFICATIONS

**Aaron S. Clauser, PhD, CPESC**
At Clauser Environmental, LLC, he serves as Vice President and the technical/production lead on scientific projects. Dr. Clauser has his bachelor's degree in Biology and Environmental Studies from East Stroudsburg University of Pennsylvania and a doctorate in Environmental Science from Lehigh University. Dr. Clauser is a Certified Professional in Erosion and Sediment Control. He has experience as an environmental regulator with the Berks and Schuylkill Conservation Districts where he has served at both the technician and managerial levels. Dr. Clauser began consulting as a Senior Environmental Scientist and Project Manager for RETTEW Associates, Inc. He has given oral presentations at conferences held by the Ecological Society of America, American Society of Limnology and Oceanography, Coldwater Heritage Partnership, Partnership for the Delaware Estuary, Delaware Riverkeeper, Pocono Comparative Lakes Program, and Schuylkill and Berks Conservation Districts and has collaborated on an article published about Pacific Northwest amphibians in a peer-reviewed journal. Dr. Clauser has completed numerous training courses including DEP-sponsored NPDES, Chapter 102 and 105 technical seminars, Applied Fluvial Geomorphology for Engineers (FGE) by Wildland Hydrology, Inc., and Environmentally Sensitive Maintenance of Dirt and Gravel Roads Training. Dr. Clauser served in the PA Air National Guard where he attained the rank of Staff Sergeant. His doctoral dissertation entitled "Zooplankton to Amphibians: Sensitivity to UVR in Temporary Pools" includes quantitative optical and organismal level models that are extended to landscape-level variations in pool optical properties and population-level sensitivity to Ultraviolet Radiation.

**Kora S. Clauser**
Kora works as a biologist with Clauser Environmental, LLC. She has experience with watershed studies, wetland delineation, scientific field investigations, and project delivery. She is currently working towards an M.B.A. degree at Lehigh University. She completed her B.S. in Biological Science with a minor in Psychology at Rowan University.

**Krista S. Clauser**
As the president of Clauser Environmental, LLC, she is responsible for overall client satisfaction, quality assurance, educational outreach programs, and project management. Krista has her bachelor's degree in Special Education and Elementary Education from Kutztown University of Pennsylvania. She has her Master of Education degree from the University of Georgia, with a concentration in Learning, Leadership, and Organization Development. Krista has completed additional graduate-level coursework at Kutztown University of Pennsylvania and Indiana Wesleyan University. Currently, she is a doctoral student, pursuing her EdD at Drexel University in Leadership and Management, concentrating in Creativity and Innovation. She is a certified yoga teacher, breathwork coach, reiki teacher, and qi gong teacher. She has experience as a special education teacher at Schuylkill Intermediate Unit and as a homeschool educator at the elementary, middle, and high school levels. Krista has expertise in integrating environmental/outdoor curricula into a diversity of subjects and educational settings.