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We answer to you.

Coldwater Conservation Plan
For
Big Creek Watershed
Blythe, Ryan, and Schuylkill Townships
Schuylkill County, Pennsylvania
October 2012
RETTEW Project No. 042342001

Prepared for:

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TABLE OF CONTENTS

TABLES

APPENDICES

1.0 INTRODUCTION

Big Creek is a rural stream that demonstrates the mining legacy that is prevalent throughout the anthracite coal region. The Big Creek Watershed is located within a historically mined area, and evidence of these past activities is readily visible throughout the watershed. The Big Creek Watershed is a valuable resource to the community as it provides potable water and outdoor recreation.

With the above in mind, RETTEW Associates, Inc. has developed this Coldwater Conservation Plan for the Schuylkill Headwaters Association, Inc. (SHA) so that the primary issues affecting Big Creek may be identified and remedied in order to restore this coldwater fishery. By incorporating public outreach and biological assessments, this plan may serve as the foundation for conservation initiatives in the watershed.

1.1 Topography and Land Use

The main stem of Big Creek is approximately 4.02 miles long, while total stream length, including tributaries, within the watershed includes 8.46 miles. The Big Creek Watershed drainage area encompasses approximately 3.67 square miles. The watershed is located in Blythe, Ryan, and Schuylkill Townships, Schuylkill County, Pennsylvania and appears on the Delano and Orwigsburg, Pennsylvania United States Geological Survey (USGS) 7.5-minute quadrangles (**Appendix A, Figure 1**). The headwaters of Big Creek originate at an abandoned, flooded stripping pit at approximately 1,380 feet in elevation. Water from the flooded strip mine flows underground then resurfaces as a continuous seep to form the headwaters of Big Creek. An existing water valve can be used to augment water flow from the stripping pit during dry periods. Big Creek then flows east through a wide forested valley. As Big Creek turns south, the valley narrows, then widens again before its confluence with the Schuylkill River at approximately 780 feet in elevation. Topography within the watershed ranges from steep and mountainous to relatively flat floodplains. The Pennsylvania Code, Title 25, Chapter 93, Water Quality Standards assigns Big Creek a water quality designation of Cold Water Fishery, Migratory Fishes (CWF, MF). The Pennsylvania Fish and Boat Commission (PFBC) does not identify this stream reach as a section known to support naturally reproducing trout, and this stream section is not seasonally stocked by the PFBC. Historic land use within the watershed consisted of anthracite coal mining and prior to that, timber harvesting. Although mines are still present within the watershed, most of the land currently is owned by the Blythe Township Municipal Authority; including the Moss Glen Reservoir. Other portions of the watershed are used for hunting and outdoor recreation, since the Moss Glen Rod and Gun Club and other private landowners hold a significant stake in this watershed. Near the confluence of Big Creek and the Schuylkill River, the watershed becomes more populated with residents of the nearby town of Brockton. The vast majority of the land within the watershed is comprised of reforested strip mines.

1.2 Background

The PFBC conducted an aquatic survey at two locations on Big Creek in July of 2003 to determine if wild brook trout (*Salvelinus fontinalis*) were present. At the first station, which was located on the southern channel approximately 310 meters upstream of a utility line crossing, "no fish were captured or observed in 106 meters of stream electrofishing." In addition, "aquatic macroinvertebrate density was fair. Eleven taxa were collected, which included the pollution sensitive stonefly families of Capniidae and Leuctidae." The pH at this location was 4.7. The second station was located approximately 150 meters upstream of the mouth. The pH was recorded at 4.3. Due to the low pH, the fish and macroinvertebrate communities were not sampled; however, stoneflies were observed. The aquatic survey concluded that the presence of pollution sensitive macroinvertebrates indicated that water quality was excellent; however, "Big Creek was too acidic to support a fish community throughout its entire length" (Chikotas and Kaufmann 2004). Both of the PFBC sample stations are shown on the aerial base map in **Appendix A, Figure 2**.

1.3 Pollution Sources

In the environmental and biological fields of study, sources and causes of pollution in a watershed typically are categorized into two broadly defined categories known as point source pollution and non-point source pollution. The terms "point source pollution and non-point source pollution" refer not to a specific polluting substance or practice, but rather describe the means by which a pollutant is introduced.

Point source pollution is most often associated with industries or municipalities that discharge wastewater to natural waters through a pipe or ditch. Point sources of pollution can be measured and treated; therefore, discharges of wastewater in the United States are regulated under the provisions of the Clean Water Act, and sources must obtain permits issued under the National Pollutant Discharge Elimination System (NPDES) in order to discharge wastewater into streams. An NPDES permit requires the discharger to meet certain technology-based effluent limits and perform effluent monitoring. Raw sewage piped to a stream could be referred to as "point source pollution".

Unlike point sources, non-point sources of pollution occur over a wide area and are usually associated with large-scale land activities such as agriculture, livestock grazing, mining, logging, and development of impervious surfaces that result in increased amounts of potentially polluted stormwater runoff. Since there is not one specific point of discharge, non-point source pollution is difficult to measure, regulate, and treat because of the nature of the activities that cause it and the large-scale area from which it is produced. Non-point source pollution can include stormwater runoff that contains harmful substances.

Here, we present a Coldwater Conservation Plan for the Big Creek Watershed to address specific impacts associated with both point and non-point sources. With a clear plan for directing restoration efforts, we may attain the greatest value from investments in the watershed.

1.3.1 Abandoned Mine Drainage Concerns

Abandoned mine drainage (AMD) is a common ill side-effect of coal mining when undertaken without proper site restoration. Coal deposits often underlie pyrite. When mining occurs, whether strip mining or deep mining, the pyrite is exposed to air and water. As the pyrite is weathered, sulfuric acid, ferric sulfate, and ferrous hydroxide can be discharged into aquatic ecosystems. These compounds have the capacity to destroy aquatic life (Smith and Smith 2001).

AMD is the largest contributor of non-point source pollution in Big Creek as well as other Schuylkill River headwaters. Additionally, AMD can be considered point source pollution if the actual source can be identified as a recognizable point (i.e. mine shaft or borehole). For decades, the Upper Schuylkill River tributaries have been draining through abandoned mines, and in doing so have conveyed coal sediment, acidity, and heavy metals into the Schuylkill River. These metals have severely impaired the water quality, destroyed the aquatic community, and placed environmental and economic stigmas on the area to the degree that residents perceive the watershed as incapable of restoring. Big Creek is one such tributary that contributes AMD to the Schuylkill River. In order to improve water quality and restore the stream, the SHA has implemented a streambank stabilization and AMD remediation project near the headwaters of Big Creek. Limestone rock lining and limestone rock filters were installed in two sections of the stream. In addition, a flow-monitoring weir was installed further downstream. While this project was an early restoration attempt, further AMD remediation will be necessary. Additional education and assistance with implementation and maintenance of installed restoration best management practices (BMPs) will be an ongoing necessity.

1.3.2 Land Development Concerns

The primary problem resulting from increased land development is the increase in stormwater runoff from impervious surfaces such as roofs, parking lots, roads, and driveways. The increase in stormwater volumes and velocities can result in accelerated erosion and sedimentation, while thermal and chemical pollution from roads and large parking lots can further degrade water quality. The increased sediment can lead to other problems including alterations in the natural configuration of the channel; loss of stream meanders; decreased occurrences of pool, riffle, and run patterns; and a destruction of the variety and abundance of aquatic habitat.

Increases of impervious surfaces within a watershed can also reduce infiltration and groundwater recharge. Groundwater that supports the base flow of Big Creek and the hydrology to riparian wetlands in the watershed also could be affected with an increase in impervious surfaces.

Fortunately, development within the Big Creek Watershed has remained relatively insignificant. Any new developments in the watershed should undergo regulatory review for stormwater rate, volume, and water quality. BMPs such as rain gardens, rain barrels, and appropriate maintenance of riparian buffers should be encouraged to mitigate the effects of the residential areas in the watershed. Educational programs that target private landowners where potential projects are likely to occur would certainly be a wise course of action.

At the municipal level, subdivision and zoning ordinances that are sensitive to the natural resources of Big Creek should be periodically reviewed for consistency with state regulations so that land development projects will protect the existing groundwater recharge areas and preserve and enhance surface water quality.

2.0 METHODOLOGY

To determine areas of concern within Big Creek Watershed, SHA representatives, Schuylkill Conservation District representatives and RETTEW Associates, Inc. (RETTEW) scientists conducted field investigations of key areas within the watershed on July 3 and July 19, 2012. Photographs, field notes, and coordinates were collected at areas of concern within the watershed. RETTEW utilized a Garmin Oregon 550t to obtain coordinates for the sample points and other features within the watershed. Aerial photography also was reviewed to identify impacted areas in the watershed.

2.1 Sample Point Locations

Nine sample points were strategically positioned within the Big Creek Watershed. Sample Point #1 was located on the mainstem of Big Creek, immediately downstream of the Valley Street Bridge and upstream of the confluence with the Schuylkill River. The second site (Sample Point #2) was located on the easternmost unnamed tributary (UNT) to Big Creek, adjacent to a culvert along State Route (SR) 1011.

Sample Point #3 was located on another UNT to Big Creek adjacent to an existing power line right-of-way. Sample Point #4 was located on the mainstem of Big Creek adjacent to the Moss Glen Reservoir. Sample Point #5 was located along Big Creek in the headwaters area immediately downstream of the stripping pit. Sample Point #6 was located immediately downstream of the previously installed flow-monitoring weir also near the headwaters of Big Creek. Sample Point #7 was located along the outfall of an abandoned stripping pit currently used as a trout pond by the Moss Glen Rod and Gun Club. Although this pond is located within the Big Creek Watershed boundary, it was determined that the outflow drained directly into the Schuylkill River. Sample Point #8 was located upstream of the culvert under SR 1011 along an AMD discharge behind the Moss Glen Rod and Gun Club clubhouse. Lastly, Sample Point #9 was located in a stripping pit east of SR 1011 and north of Sample Point #8. The locations of these sample points are shown on the aerial base map (**Appendix A, Figure 2**). Additional photos of each sample point location as well as other features within the watershed are located in **Appendix B**.

2.2 Water Quality Sampling

At Sample Points #1 – #6, water quality data was obtained with a Hach Model MD-2 Acid Mine Drainage Test Kit on July 3, 2012. The following water quality parameters were identified: acidity, alkalinity, iron, and pH. During a separate field investigation on July 19, 2012, conductivity and pH were measured at Sample Points #7 – #9 with an ExStik EC500 meter.

Acidity is a measure of how much base can be added to the water without causing a large change in pH, or the water's ability to neutralize a strong base. Acidity in AMD impacted streams usually originates from the sulfuric acid produced by the weathering of pyrite. Iron, aluminum, and manganese can also contribute to acidity and all are commonly found in mine drainage (Saint Vincent College Environmental Center 2012).

Alkalinity, or acid neutralizing capacity, measures the water's ability to neutralize a strong acid. Geology plays a contributing factor in a stream's natural alkalinity. Lithic material containing carbonate, bicarbonate, and hydroxide compounds will contribute alkalinity to a stream as they are weathered. For instance, streams that flow through limestone regions or bedrock containing carbonates generally have high alkalinity. These streams would be able to handle acidic influences such as AMD without drastic changes to the pH. Conversely, areas dominated by granite or sandstone may have low alkalinity and therefore poor buffering capacity. Alkalinity is important for fish and other aquatic life because it protects or buffers against rapid pH changes. To maintain a stable, healthy aquatic environment, alkalinity should be at least 20 mg/L (Wilkes University 2012).

Iron is a common metal found in AMD impacted streams. As pH increases, dissolved iron will precipitate to form an orange oxyhydroxide, which will coat the stream's substrate, fill in interstitial spaces, and smother plant and animal life. Rivers and streams typically contain 0.5 -1.0 mg/L of dissolved iron (Lenntech 2011).

Additionally, pH is another measurement of acidity. The amount of available nutrients or elements within a particular environment is restricted by acidity. If a solution has a pH greater than seven, the solution is alkaline. Conversely, if a solution has a pH less than seven, the solution is acidic. Most streams have a pH ranging from 6.5 to 8.5 (Smith and Smith 2011).

Conductivity measures the ability of a solution to conduct electricity. Generally, conductivity increases with increased concentrations of inorganic dissolved solids, including magnesium, iron, and aluminum.

The geology of the watershed primarily affects conductivity. Streams that flow through areas with granite bedrock tend to have lower conductivity because granite is composed of materials that do not readily dissolve. In contrast, streams that flow through areas with clay soils tend to have higher conductivity due to the presence of more readily soluble materials. Conductivity in streams that support good, mixed fisheries ranges between 150 and 500 µS/cm (USEPA 2012).

2.3 Macroinvertebrate Sampling

Benthic macroinvertebrates were collected during the July 3, 2012 aquatic investigation in accordance with the Pennsylvania Department of Environmental Protection's (PADEP) *Instream Comprehensive Evaluation Surveys* protocol (2009). Macroinvertebrates were collected at three sample points (#1, #2, and #4). The collection method of the benthic macroinvertebrates followed the semi-quantitative method. Collected organisms were identified in the lab using a dissecting scope. The following reference keys were utilized: *Aquatic Insects of North America* (Merrit, Cummins, and Berg 2008) and *Freshwater Macroinvertebrates of Northeastern North America* (Peckarsky et al. 1995).

Six biological indices/metrics were utilized for each of the sampling points. The indices then were entered into a weighted function for comparison with other freestone streams. The Index of Biological Integrity (IBI Value) is the summation of this weighted function that includes a single number to attempt to summarize all of the other indices (PADEP 2006). The indices included:

Modified Becks Index

This metric is a weighted measure of the most pollution sensitive macroinvertebrates. A higher score typically indicates a stream that has less human impacts.

EPT Taxa Richness

The EPT taxa richness is the summation of all identified mayfly (***E***phemeroptera), stonefly (***P***lecoptera) and caddisfly (***T***richoptera) taxa. These insect orders are used in this particular index because of their general intolerance for pollution.

Total Taxa Richness

This metric is simply the number of taxa in a particular community. In this study, taxa were identified to various levels as identified in the DEP protocol (2006). At each site, taxa richness refers to the number of different types of discovered macroinvertebrates. Greater diversity is typically associated with a more natural and less impaired stream.

Shannon Diversity Index

This index measures the evenness of individuals in various taxa. As pollution tolerant taxa become dominant and pollution sensitive taxa are lost, this metric typically decreases.

Hilsenhoff Biological Index (HBI)

This index involves assigning pollution tolerance values (ranging from zero to ten with a zero value assigned to taxa with the least amount of pollution tolerance and a ten value assigned to the most pollution tolerant organisms) to the various collected taxa. All collected organisms within the sample are identified, counted, and matched with the appropriate tolerance values. A final value for the entire macroinvertebrate sample then is computed allowing comparison and referencing of HBI scores with other sampled sites and streams. The macroinvertebrate community is typically suspected of being impaired if the HBI score is higher than 4.80.

Percent Intolerant Individuals

The percent of individuals in the sample that have a tolerance value of five or less comprises this index. As pollution tolerant taxa become dominant and pollution sensitive taxa are lost, this metric typically decreases.

The original total number of macroinvertebrate individuals under each genus was multiplied by five due to insufficient quantities collected at each sample point. This revised quantity represents the total number of macroinvertebrates that should be present within a sample with a quantity within the correct range (20% of 200 individuals).

2.4 Fish Sampling

To determine the fish community diversity of Big Creek, electro-fishing was conducted along 100 to 300-foot stream sections on July 3, 2012. Fish sampling was conducted at Sample Points #1 – #4.

3.0 RESULTS & DISCUSSION

3.1 Water Quality Data

Table 1 below shows a summary of the water quality data obtained at each sample point. All parameters, with the exception of pH, appear to be within acceptable ranges for aquatic life. Since aquatic life functions best at a pH range of 6.5 to 8.5, the only sample point with the appropriate pH was Sample Point #7. This is to be expected, as Sample Point #7 was located on the outfall of a stocked trout pond that is regularly limed by the Moss Glen Rod and Gun Club. All other sample points had a pH that is unsuitable for healthy aquatic life.

Table 1. Summary of Water Quality Data

Sample Point	Acidity (mg/L)	Alkalinity (mg/L)	Iron (mg/L)	pH	Conductivity (µS/cm)
1	17.1	20.0	0.0	5.0 – 5.5	-
2	17.1	20.0	0.0	5.0	-
3	17.1	20.0	0.8	5.0	-
4	17.1	20.0	1.0	5.5	-
5	34.2	20.0	0.0	5.0	-
6	-	-	-	5.5 – 6.0	-
7	-	-	-	6.80	157.5
8	-	-	-	4.89	365.0
9	-	-	-	3.0	212.0

3.2 Macroinvertebrate Data

Macroinvertebrates that were sampled within the Big Creek Watershed comprised at least seven taxonomic families (**Appendix C**). Data collected by RETTEW is summarized in the table below (Table 2). Macroinvertebrate impairment is based upon the *Index of Biological Integrity (IBI) for Wadeable, Freestone Streams in Pennsylvania* (PADEP 2006). As noted above, the actual quantities of macroinvertebrates collected at each sample point were so low that the quantities had to be adjusted in order to accurately calculate the IBI value. The IBI threshold for non-impaired streams is 60-63. Interestingly, individuals of the pollution sensitive stonefly family Capniidae were observed at all sample points; however, the benthic macroinvertebrate community was still determined to be impaired at all sample points.

Table 2. Summary of Macroinvertebrate Data

Sample Point	Modified Becks Index	EPT Taxa Richness	Total Taxa Richness	Shannon Diversity Index	HBI Index	Percent Intolerant Individuals (TV 5 or less)	IBI Value
1	0	2	3	0.672	17.50	15.00	**10.14**
2	1	4	6	1.426	35.56	72.22	**29.53**
4	1	2	5	1.076	23.89	38.89	**18.66**

3.3 Electrofishing Data

Electro-fishing data revealed the lack of diversity of fish species found within the Big Creek Watershed. Only one small brook trout was observed at Sample Point #1. No other fish species were observed at any other sample site. Crayfish (*Cambarus* sp.) were observed at Sample Points #1, #3, and #4. In addition, a few frogs and a salamander (species unknown) were observed at Sample Point #3. Based on the near complete lack of fish present within the entire Big Creek Watershed, it is apparent that the fish community is impaired. Although the PFBC's earlier aquatic survey determined that the limiting factor to Big Creek's fish community was the low pH (Chikotas and Kaufmann 2004), the current lack of a healthy fish population is likely due to the acidic water *and* the lack of a reliable food source as evidenced by the poor macroinvertebrate populations.

3.4 Watershed Problems and Solutions

At first glance, the Big Creek Watershed looks pristine. The water is cool and clear. There is very little development within the watershed, and the watershed is predominantly forested. In many cases, these are the marks of a healthy, robust watershed. However, in reality the Big Creek Watershed is severely impaired from AMD. This section focuses on key areas that were identified as causes of impairment within the Big Creek Watershed and the potential restoration work that could be implemented.

3.4.1 Priority Projects

Big Creek Headwaters Area:
As previously mentioned, Big Creek originates at an abandoned stripping pit. The pH in this section of the stream was 5.0. In an attempt to improve pH levels, the SHA previously lined this section of the stream with limestone; however, much of the limestone has been washed away in recent flooding (Photo 1).

Photos 1 and **2**. View of Big Creek where limestone was previously installed (left). View of uncoated and coated limestone rocks in the Big Creek headwaters area (right).

Solution: In order to increase the pH, a source of alkalinity must be introduced into the stream. The calcium carbonate in limestone would provide an adequate source of alkalinity. In fact, what was left of the previously installed limestone was causing an improvement to the water quality in this stream section. As seen in Photo 2 above, much of the limestone is coated with a metal hydroxide, which results from the interaction of the acidic discharge water with the limestone. As a result, a more stable and self-sustaining treatment system that includes a stormwater bypass should be installed in order to improve pH levels.

AMD discharge behind Moss Glen Rod and Gun Club: Water in this stream section was extremely acidic, and much of the stream bottom was coated in orange iron hydroxide sludge.

Photo 3. View of an existing wetland located within the AMD discharge behind the Moss Glen Rod and Gun Club.

Solution: An AMD treatment system should be constructed in order to improve water quality. The nearby shooting range could be an appropriate site for a treatment system. Furthermore, a wetland complex was observed along this discharge (Photo 3). Wetlands can be useful in treating AMD by aerating the water and promoting the oxidation and settling of metals. Therefore, water quality could be improved by utilizing and expanding this wetland complex.

AMD discharges along SR 1011: Two abandoned stripping pits exist north of the Moss Glen Rod and Gun Club and east of SR 1011. As seen in Photo 4, these stripping pits can overflow and contribute AMD to Big Creek. In addition, Sample Point #9 was located in the northern stripping pit. This water had the lowest pH (3.0) observed within the watershed.

Photo 4. View of the overflow channel from the southern abandoned stripping pit.

Solution: Overflow from these stripping pits could be diverted into a limestone channel to increase aeration and then into a passive AMD treatment system in an effort to neutralize the water and remove harmful metals before it flows into the nearby UNT to Big Creek. Additionally, these stripping pits potentially could be filled in with lime-containing fly ash to reduce the flow of AMD into Big Creek.

4.0 RESTORATION SOLUTION DETAILS

As discussed in the previous section of this report, there are many opportunities for improvement. This chapter discusses specific concerns and conditions related to those improvement activities.

4.1 Passive AMD Treatment Systems

Passive AMD treatment systems can be used to improve waters affected by AMD discharges. Passive treatment systems take advantage of the biological, chemical, and physical processes that naturally occur in many streams and wetlands. Metals will react with oxygen in aerated water to form oxide and hydroxide precipitates. Specifically, dissolved iron precipitates as an orange oxyhydroxide, dissolved manganese precipitates as a black oxide, and dissolved aluminum will precipitate as a white hydroxide. In addition, the low pH that is common in most AMD can be raised by contact with carbonate rocks. In a passive treatment system, these natural processes would occur within the constructed wetland system rather than in the receiving waters. Although passive treatment systems generally require more space and longer retention times than conventional treatment systems, they use less costly reagents and require less operational maintenance, so they may ultimately be the better option (Davis).

There are four treatment options as identified by *A Handbook of Constructed Wetlands, Volume 4: Coal Mine Drainage* (Davis):

- "Aerobic wetlands, which promote oxidation reactions to precipitate metals as oxides and hydroxides. These wetlands typically contain cattails growing in soil or spoil substrate. Aerobic wetlands are surface flow wetlands.
- Organic substrate wetlands, which are often called compost wetlands. In these wetlands, the water flows through a thick layer of organic material. The anaerobic conditions in the organic

layer promote chemical and microbial processes that generate alkalinity and neutralize acidity. Organic material includes spent mushroom compost, peat, hay bales, and manure.

- Anoxic limestone drains (ALD), which are buried beds of limestone. The limestone adds alkalinity to the water, which then is fed to a settling pond and wetland where the metals are precipitated. The ALD is sealed to exclude oxygen so that limestone dissolution can occur without armoring (the deposition of metal oxyhydroxides on the limestone) which blocks further dissolution. ALDs are not wetlands, but a pretreatment to prepare acidic water for wetland treatment.
- Successive alkalinity-producing systems (SAPS), which place an organic substrate wetland over a layer of limestone. Water is introduced at the top, flows down through the layers, and is discharged from the bottom. As the mine water moves down through the layers, microbial activity removes dissolved oxygen and reduces Fe^{3+} to Fe^{2+}. Alkalinity then is produced by bacterial sulfate reduction in the limestone layer. The strongly reducing environment of the organic layer prevents the armoring of the limestone. The water discharges to a settling pond where the metals are precipitated. Mine water can be recycled through a SAPS or passes through several SAPSs as often as necessary to remove the acidity."

Each AMD discharge is slightly different in its chemical and physical characteristics. Therefore, it is important to fully evaluate the quality of the water before designing and implementing a passive treatment system. Also, it is likely that an appropriate treatment system would consist of a combination of the above-mentioned treatment options.

5.0 OBTAINING SUPPORT AND MONITORING PROGRESS

Education and cooperation of landowners within the watershed to implement stream restoration solutions is the key to improving and preserving the natural resources and water quality in the Big Creek Watershed. Educating landowners as to why proposed improvements and changes should occur on their property is extremely important and takes tact, courtesy, respect, and sometimes, persistence. Oftentimes if landowners are clearly shown the potential benefits and helped to visualize the project's goals through actual examples (photographs) of completed projects, they are more likely to want to be a partner in a project. The SHA's presence in the community should facilitate landowner partnerships.

5.1 Public Outreach

On January 10, 2013, a public meeting was held at the Mary D Fire Company in order to inform the local public of the results of the sampling conducted within the Big Creek Watershed and to promote awareness of the challenges faced by the Big Creek Watershed. Attendance totaled approximately 25 to 30 people and included representatives from Blythe Township Water Authority, Moss Glen Rod and Gun Club, the Schuylkill Conservation District, Trout Unlimited, SHA, RETTEW Associates, Inc., and citizens of Brockton. The discussion focused on the sampling methodology; results of the water quality, macroinvertebrate, and fish sampling; and key areas for improvement, specifically the headwaters area and the discharge located on the Moss Glen Rod and Gun Club property. Overall, the local community was very interested in learning about the current conditions found throughout the Big Creek Watershed and supportive of implementing solutions to restore the watershed.

6.0 LITERATURE CITED

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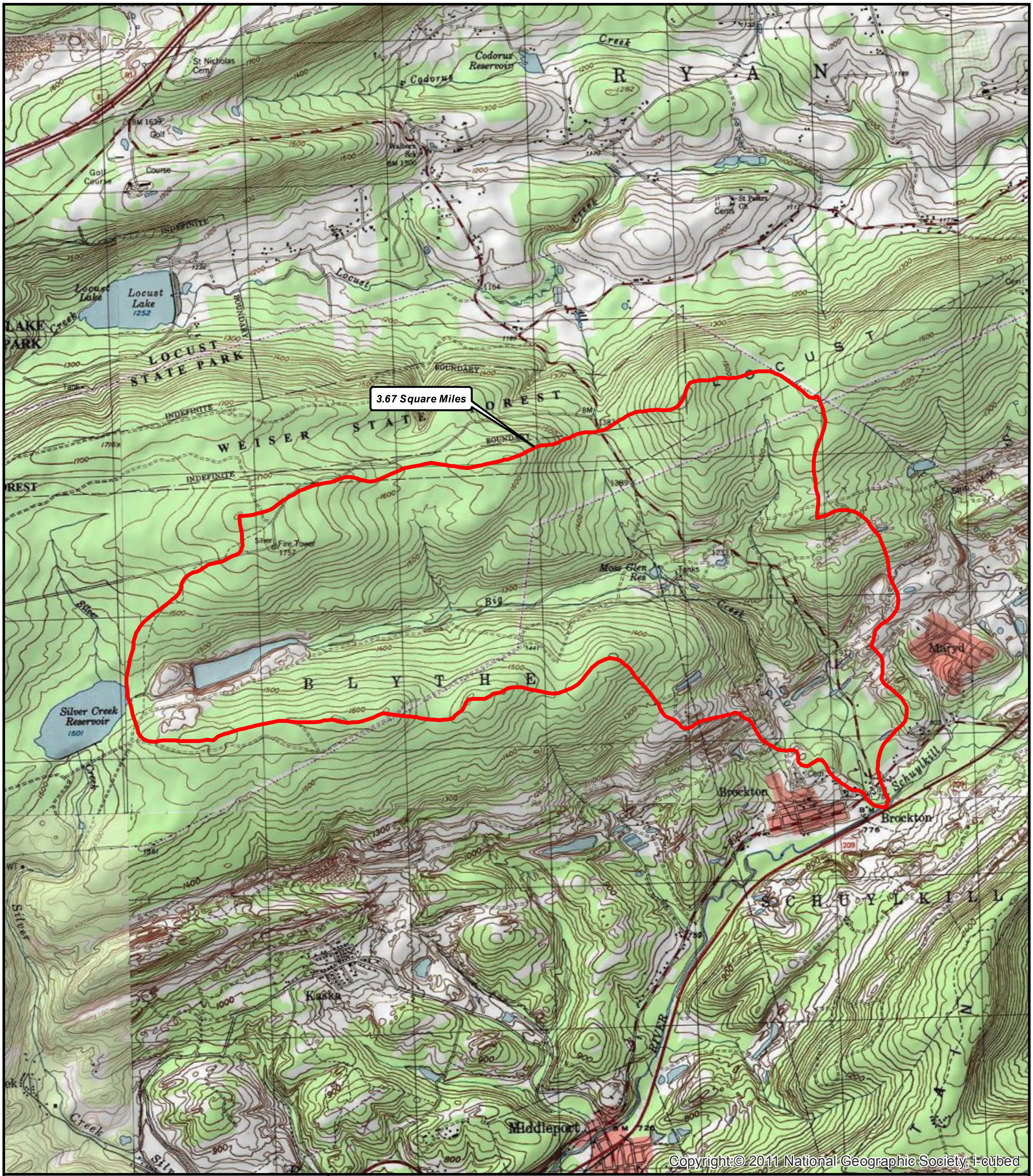
APPENDIX A

PROJECT MAPPING



Big Creek Watershed

River Conservation Plan

Big Creek Watershed

Figure 1 - Topographic Base Map

Project Number: 042342001

N
W E
S

Feet
0 1,500 3,000
1 inch = 3,000 feet

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Ryan, Blythe, & Schuylkill Townships, Schuylkill County, PA
Delano & Orwigsburg 7.5' USGS Topographic Quadrangles

11/13/2012

River Conservation Plan

Big Creek Watershed

Figure 2 - Aerial Base Map

Project Number: 042342001

Ryan, Blythe, & Schuylkill Townships, Schuylkill County, PA

11/13/2012

N W E S

0 600 1,200 Feet

1 inch = 600 feet

PFBC Sample Station (Approximate Location)

Sample Point (pH >6.5)

Sample Point (pH <5.0)

Sample Point (pH 5.0 – 6.5)

Contour (20' Interval)

Road

Stream

NWI Wetland

Big Creek Watershed

Municipal Boundary

RETTEW SM

N:\Projects\04234\042342001\GIS\Basemaps\042342001_Big_Creek_Watershed_Aerial_Basemap_22x34.mxd

APPENDIX B

ADDITIONAL PHOTOGRAPHS

RETTEW Associates, Inc.
Photo Documentation

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 3, 2012

COMMENTS:
PHOTO 5
Looking downstream from the Valley Street Bridge at the mainstem of Big Creek and Sample Point #1.

DATE:
July 3, 2012

COMMENTS:
PHOTO 6
View of UNT to Big Creek at Sample Point #2. This sample point was located adjacent to State Route 1011.

RETTEW Associates, Inc.
Photo Documentation

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 3, 2012

COMMENTS:
PHOTO 7
View of the UNT to Big Creek at Sample Point #3. This sample point was located adjacent to a power line right-of-way.

DATE:
July 3, 2012

COMMENTS:
PHOTO 8
View of Big Creek at Sample Point #4, adjacent to the Moss Glen Reservoir.

RETTEW Associates, Inc.
Photo Documentation

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 3, 2012

COMMENTS:
PHOTO 9
View of the Moss Glen Reservoir, which serves as a local drinking water source after chemical treatment and filtering.

DATE:
July 3, 2012

COMMENTS:
PHOTO 10
View of the abandoned stripping pit that serves as the source point for Big Creek.

RETTEW Associates, Inc.
Photo Documentation

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 3, 2012

COMMENTS:
PHOTO 11
View of the headwaters of Big Creek at Sample Point #5. This portion of the stream was previously lined with limestone; however, high flows during the recent flooding washed away much of the limestone.

DATE:
July 3, 2012

COMMENTS:
PHOTO 12
View of Big Creek at Sample Point #6. This sample point was located downstream of a previously installed flow monitoring weir and limestone rock filters.

RETTEW Associates, Inc.
Photo Documentation

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 19, 2012

COMMENTS:
PHOTO 13
View of an abandoned stripping pit used as a fishing pond by the Moss Glen Rod and Gun Club. This pond is regularly limed and stocked with trout.

DATE:
July 19, 2012

COMMENTS:
PHOTO 14
View of the outfall from the above mentioned pond. Sample Point #7 was located along this stream.

CLIENT:	Schuylkill Headwaters Association, Inc.	**SITE LOCATION:**	Blythe, Ryan, and Schuylkill Townships, Schuylkill County, PA
SITE NAME:	Big Creek Conservation Plan	**PROJECT NUMBER:**	042342001

DATE:
July 19, 2012

COMMENTS:
PHOTO 15
View of the abandoned mine drainage (AMD) discharge at Sample Point #8, located behind the Moss Glen Rod and Gun Club clubhouse.

DATE:
July 19, 2012

COMMENTS:
PHOTO 16
View of the abandoned stripping pit at Sample Point #9.

APPENDIX C

MACROINVERTEBRATE TAXA LIST

Big Creek Macroinvertebrate Taxa

Site	Class/Order/Suborder	Family	Genus	Quantity
1	Plecoptera	Capniidae		29
	Plecoptera	Nemouridae	*Amphinemura*	1
	Trichoptera	Hydropsychidae	*Hydropsyche*	10
			n=	40

2	Diptera	Simuliidae	*Simulium*	3
	Megaloptera	Corydalidae	*Nigronia*	1
	Plecoptera	Capniidae		9
	Plecoptera	Nemouridae	*Amphinemura*	3
	Plecoptera	Perlidae	*Perlesta*	1
	Trichoptera	Philopotamidae	*Chimerra*	1
			n=	18

4	Diptera	Simuliidae	*Simulium*	21
	Megaloptera	Corydalidae	*Nigronia*	1
	Plecoptera	Capniidae		10
	Plecoptera	Nemouridae	*Amphinemura*	3
	Trichoptera	Hydropsychidae	*Hydropsyche*	1
			n=	36

APPENDIX D

PROFESSIONAL QUALIFICATIONS

Mark A. Metzler, Senior Environmental Scientist– Mr. Metzler has an associate's degree in wildlife technology from the Pennsylvania State University. Mr. Metzler has ten years of experience working in the environmental regulatory community (Lancaster County Conservation District) and ten years of private consulting experience. He received training in both the 1987 Corps of Engineers Wetland Delineation Manual and the 1989 Federal Manual from both the PA Dept. of Environmental Protection and the U.S. Army Corps of Engineers. In addition, he received soil mechanics training from the U.S. Dept. of Agriculture – Natural Resources Conservation Service. As an environmental regulator, Mr. Metzler reviewed, permitted, and inspected over 2,000 various plans and project sites many of which involved impacts to Waters of the Commonwealth (wetlands, rivers, lakes). Mr. Metzler has prepared four TMDL implementation plans for the Commonwealth of Pennsylvania and U.S. EPA, as well as numerous watershed assessment and river restoration plans. He is also experienced in dam removal design, the issue of legacy sediment and has overseen dam removal and fish migration projects within Pennsylvania, Maryland, and Virginia.

Julia L. Moore – Ms. Moore has a bachelor's degree in biology with an emphasis in ecology and environmental studies from Lock Haven University. She also specialized in marine biology, which she studied at the Marine Science Consortium on Wallops Island, Virginia. She is familiar with the 1987 *Corps of Engineers Wetlands Delineation Manual* and has widely used the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region* and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* while conducting wetland delineations throughout Pennsylvania. She routinely performs threatened and endangered species coordination for a variety of public and private projects. She has also coordinated various state and federal water obstruction and encroachment permits for stream restoration, abandoned mine drainage remediation, land development, utility line, and transportation projects. In addition, Ms. Moore has assisted in conducting several watershed assessments.