RETTEW

We answer to you.

Beaver Creek Watershed
Coldwater Conservation Plan
Schuylkill County, Pennsylvania
November 2009

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1.0 INTRODUCTION

Beaver Creek in Schuylkill County, Pennsylvania is a rural stream that demonstrates the disparity between forest and agricultural land use on aquatic ecosystems. Although a difference in trout populations throughout the watershed has been known for some time, a clear plan for conservation is needed to guide stream improvement and protection efforts. Schuylkill Conservation District, Schuylkill County Trout Unlimited, and the Coldwater Heritage Partnership have partnered to oversee and fund the development of a Coldwater Conservation Plan for Beaver Creek so that the primary issues that put Beaver Creek at risk may be identified. By incorporating public outreach and stream assessments, this plan may serve as the foundation and guide for conservation initiatives in the Beaver Creek Watershed.

1.1 Topography and Land Use

The Beaver Creek Watershed is located in Walker and Schuylkill Townships, Schuylkill County, Pennsylvania. The watershed contains approximately 8.3 stream miles within an approximately 5.6 square mile drainage basin. The main stem of Beaver Creek is approximately 3.1 miles long. The headwaters of Beaver Creek originate in a valley between Sharp Mountain and Second Mountain at approximately 1,020 ft. in elevation. The Pennsylvania Code, Title 25, Chapter 93, Water Quality Standards assigns Beaver Creek a water quality designation of High Quality Cold Water Fishery (HQ-CWF) from the headwaters to Church Lane and a designation of Cold Water Fishery (CWF) from Church Lane to the mouth. These water quality designations are reflected by the wild Brook trout populations within these two sections. The headwaters of Beaver Creek contain a Class A wild Brook trout population. Land use in this area is a combination of agriculture and single family rural residences on the valley floor with a forested riparian floodplain to the east of Valley Road. The steeper slopes of Second Mountain and Sharp Mountain are forested. Two major unnamed tributaries enter Beaver Creek from the west. Both tributaries flow through agricultural areas and are adjoined by both crop and pasture lands. Impacts from the agricultural areas likely contribute to the decreased density of wild Brook trout downstream of the confluence of the upper tributary and Beaver Creek (Appendix A: Point 18). The drainage basins of these tributaries are almost entirely agricultural and large sections of these streams lack a riparian buffer. As Beaver Creek flows into Cold Run, agricultural and development influences on Beaver Creek likely impact Cold Run. Beaver Creek is the largest and only named tributary to Cold Run, but there are several unnamed tributaries and farm ponds in the basin. Cold Run drains into the Little Schuylkill River.

1.2 Background

Wnuk and Kaufmann completed sampling in July of 1996 to quantify the wild trout population throughout the Cold Run Watershed and to measure any changes in stream conditions in the stocked trout portion that may have occurred since a 1978 Pennsylvania Fish and Boat Commission (PFBC) survey (1997). This survey determined the presence of a Class A wild Brook trout population. Based on this determination, the Pennsylvania Department of Environmental Protection upgraded the Chapter 93 water quality of the headwaters of Beaver Creek to High Quality Cold Water Fishery.

The wild Brook trout population in the lower section of Beaver Creek (downstream of the confluence with the northernmost unnamed tributary) is sparse; primarily limited by seasonally warm water temperatures and agricultural impacts of the two unnamed tributaries. The degradation of the tributaries has affected Beaver Creek at least since 1978, as physical and chemical values, aquatic macroinvertebrate communities, and fish communities were very similar in both survey years (Wnuk and Kaufmann 1997).

In the environmental and biological fields of study, sources and causes of pollution in a watershed (leading to impairment) are typically categorized into two broadly defined categories known as "point source pollution" or "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 relatively easily 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 resulting 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. Types of non-point source pollution common to agricultural areas such as those present in the Beaver Creek Watershed include increased sedimentation and nutrient runoff from barnyard wastes and livestock loafing in waterways. The lack or the removal of vital habitat components (such as the destruction of forested riparian corridors) is also a cause of impairment.

Here, we present a coldwater conservation plan for the Beaver Creek Watershed to address specific areas of impairment from point and non-point source pollutants. With a clear plan for conservation, we may attain the greatest value from investments in the watershed.

1.3 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 results in accelerated erosion and sedimentation, while thermal and chemical pollution from roads and large parking lots 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 habitats.

The increase in impervious surfaces within the watershed would also reduce infiltration and groundwater recharge. Ground water that supports the base flow of Beaver Creek and the hydrology to riparian wetlands in the watershed also could be affected with an increase in impervious surfaces.

New developments in the watershed will undergo regulatory review for stormwater rate, volume and water quality. Most of the existing residences pre-date existing stormwater volume and rate control regulations. Best Management Practices (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 Beaver Creek should be periodically reviewed for consistency with state regulations so that land development projects will protect the existing ground water recharge and preserve and enhance surface water quality.

1.4 Agricultural Concerns

Agricultural nutrients such as phosphorus and nitrogen, in the form of commercial fertilizers, manure, and sludge can create nutrient related pollution. If these nutrients are applied to enhance production in excess of plant needs, they can wash into aquatic ecosystems causing excessive bacterial, plant and/or algal growth. The resulting crashes in the excessive populations may depress dissolved oxygen levels and kill other aquatic life, decrease recreational opportunities, and potentially contaminate drinking water. Farmers can implement nutrient management plans, which help maintain high yields and save money on the use of fertilizers while reducing non-point source pollution. Overgrazing and unrestricted cattle access to streams exposes soils, increases soil erosion and sedimentation, encourages invasion by undesirable plants and destroys fish habitat. The farming community in the Beaver Creek Watershed implements many of the desired conservation BMPs, but additional education and assistance with implementation are an ongoing necessity.

2.0 METHODOLOGY

2.1 Stream Walk

Schuylkill Conservation District representatives and RETTEW environmental scientists conducted a stream walk on May 18, 2009 to determine areas of concern within the main stem and forested reaches of Beaver Creek Watershed. Photographs, field notes, and GPS locations were collected at identified areas of concern or of interest. Within the headwaters and tributaries, impacted areas were identified by conducting windshield surveys from roadways and reviewing aerial photography. Sources of impairment were identified at the landowner level.

RETTEW located sample points and other features within the watershed using Trimble Pro XH and Trimble GeoXT, Global Positioning System (GPS) receivers during the site visits. The instrument settings used were: a) Elevation Mask of 15 degrees to limit lowest angle of satellite acceptance to 15 degrees, b) Signal Noise Ratio Mask 6 to minimize weak signal strength, c) PDOP Mask 6 to control the geometry of satellite constellations, and d) Mode Setting Overdetermined 3D which requires a minimum of five satellites for acceptable readings. Logging interval was set at 1 second with typically a minimum of 60 readings collected at each point (Trimble Navigation 1994). Data collected in the field were downloaded to a personal computer for differential correction using GPS Pathfinder Office software (Version 4.1). Correction files were obtained from a dedicated base station located in Schuylkill Haven, PA. Mission planning, parameter settings, and post processing typically allow an accuracy of less than (<) 1 meter (3.3 feet). The precision of GPS collected data is subject to variation caused by canopy cover, atmospheric interference, time of day, and satellite geometry.

2.2 Stakeholder Survey

A survey was mailed to 48 households and two businesses with property adjoining Beaver Creek. Ten surveys were completed and returned (Appendix C).

2.3 Macroinvertebrate Sampling

Benthic macroinvertebrates were collected during the May 18, 2009 aquatic investigation in accordance with the PA Department of Environmental Protection *Draft Instream Comprehensive Evaluation* protocol (PA DEP 2007). There were two sample sites. The first was approximately 330 feet upstream of the confluence of Beaver Creek and Cold Run. The second site was on the main stem of Beaver Creek 330 feet upstream of the confluence with the northern most unnamed tributaries on Valley Road. The location of these sample sites is shown on the Beaver Creek Watershed – Conservation Plan Map in Appendix A.

As the sampling occurred during the period of November to May, the 6 D-frame method of sample collection was utilized in accordance with the PA DEP Standardized Biological Field Collection and Laboratory Methods (PA DEP “Methods”, Section V.C.). Collected organisms were identified in the lab using a dissecting scope and reference keys (Merrit and Cummins 1996, Peckarsky et al. 1995).

Six biological indices/metrics were utilized for each of the sampling sites. The indices were then 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 (PA DEP 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 impacted 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 (0) to ten (10) with a 0 value assigned to taxa with the least amount of pollution tolerance and a 10 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 is then 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 (5) or less comprises this index. As pollution tolerant taxa become dominant and pollution sensitive taxa are lost, this metric typically decreases.

2.4 Habitat Analysis

Habitat analyses were in accordance with the PA Department of Environmental Protection *Draft Instream Comprehensive Evaluation Survey* protocol (PA DEP 2007) and the PA DEP "Methods". The habitat analyses included assigning a score of 1 to 20 for each of 12 parameters that indicate the quality of the habitat. Habitat parameters including instream cover (fish), epifaunal substrate, embeddedness, velocity/depth regimes, channel alteration, sediment deposition, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, grazing or other disruptive pressure, and riparian vegetative zone width were assessed. A cumulative score of 240-192 is considered "optimal"; "suboptimal" 180-132; "marginal" 120-72; and, "poor" 60 or less. The gaps between these categories are left to the discretion of the field investigator (PA DEP 2007).

2.5 Chemical and Temperature Analysis

Chemical analysis and temperature readings were conducted in accordance with the PA Department of Environmental Protection *Draft Instream Comprehensive Evaluation Survey* protocol (PA DEP 2007). The various used sampling meters were calibrated in the field with manufacturer's recommendations being followed. Sampling of all sites occurred on one day. A YSI-60 Portable pH Meter with a two point slope calibration (4.00 and 7.00 buffer solutions) was utilized to measure the pH and temperature of each site. A YSI-85 Portable Conductivity Meter was utilized to measure conductivity at each site. The conductivity was recorded at the water temperature of the site. The specific conductance was also recorded where the meter normalized the conductivity for a water temperature of 25°C. A YSI-85 Portable Dissolved Oxygen Meter was utilized to measure dissolved oxygen. The meter was calibrated hourly at ambient temperature during the sampling day.

3.0 RESULTS

3.1 Stakeholder Survey Data

The stakeholder survey revealed that watershed residents are most concerned about littering, sediment and soil loss from agriculture, chemical/manure runoff from agriculture, high levels of nutrients from agriculture, stream bank erosion, and storm water control as problems facing Beaver Creek. Half of the respondents consider the water quality in Beaver Creek to be "healthy", while the other half are not sure of the water quality. Half of the respondents said their family spends time enjoying Beaver Creek on a daily or weekly basis. Nine of ten respondents consider themselves conservationists while only three of ten fish Beaver Creek (Appendix C).

3.2 Macroinvertebrate Sampling Results

Macroinvertebrates that were sampled within the Beaver Creek Watershed comprised at least 18 taxonomic Families (Appendix D). Data collected by RETTEW indicates that the benthic macroinvertebrate population was impaired at Sample Site #1 (Table 1, Table 2).

Table 1

Impairment Determination Values

Site	Macroinvertebrates	Habitat
1	40.51	199
2	71.97	183

Macroinvertebrate impairment is based upon the Index of Biological Integrity (IBI) for Wadeable, Freestone Streams in Pennsylvania. The IBI threshold for non-impaired streams is 60-63 (Robert Ryder, *pers. comm.)*.

Potential Habitat Impairment is based upon DEP ICE protocol (March 2007 *Draft*).

3.3 *Habitat Analysis Results*

The habitat analysis data for Beaver Creek indicated that all of the sample stations were unimpaired for habitat. Both sample sites have habitat that is considered optimal (Table 1). Specific impairment information is provided on the field data sheets (Appendix E).

Table 2

Benthic Macroinvertebrate Data

Site	Modified Becks Index	EPT Taxa Richness	Total Taxa Richness	Shannon Diversity Index	HBI Index	% Intolerant Individuals (TV 5 or less)	IBI Value
Sample Site 1	9	8	19	1.722	6.63	28.25	40.51
Sample Site 2	17	13	25	2.539	2.90	79.90	71.97

3.4 *Chemical and Temperature Analysis Results*

The water temperature, dissolved oxygen, pH, and conductivity were measured at the sample sites as part of the physical and chemical analysis (Table 3). The cold water temperatures, high dissolved oxygen and near neutral pH at both sites would be conducive to supporting trout populations on the day the sampling was conducted. The Flowing Water Body Field Data Forms for each site can be found in Appendix F.

Table 3

Sampling Date: 5/18/2009

Water Sampling Data

Site	Temp (^{0}C)	DO (mg/L)	pH	Cond. (µmhos)
Sample Site 1	13.1	9.27	7.08	92.1
Sample Site 2	11.5	8.60	6.55	59.0

3.5 Watershed Problems and Solutions

This section focuses on the sources and causes of impairment within the Beaver Creek Watershed and the potential restoration work and best management practices that could be implemented to address the impacts for high and medium priority areas. Each impacted segment identification number can be cross-referenced with its approximate location on the map of Appendix A. Low priority restoration projects are included in Appendix B and are mapped in Appendix A.

3.5.1 High Priority Projects

Impacted Stream Segment #12-14:
This stream segment includes a residential property, off-line pond, and a dirt lane that crosses a bridge over Beaver Creek. The dirt lane likely contributes sediment to Beaver Creek as stormwater flowing down it would directly enter the stream. This section of stream had excessive sedimentation present in the pools. Throughout this stream reach, the vegetation is mowed to the stream bank. An approximately 50 foot section of the stream bank is eroding.

Solution:

Conservation work in this area should include addressing stormwater discharges from the dirt lane, stabilization of the approximately 50 foot section of stream bank and riparian buffer tree/shrub plantings. The stormwater flowing down the dirt lane from the north could potentially be diverted into a bioretention area via a waterbar or conveyor belt diversion located just north of the bridge crossing. Work to stablize the 50 foot section of stream bank could include installation of a small floodplain bench and a stable slope of no greater than 3:1. The use of toe rip-rap and/or restoration BMPs such as cross vanes or deflectors could be incorporated to add additional stability and fish structure to the reach. In order to filter runoff and aid in shading the reach, the riparian zone could be planted with trees and shrubs. While tree species are typically recommended, shrub species should be considered in this area to ensure the property owner retains the view of the pond located to the east of the stream.

Impacted Stream Segment #33-34:

Cattle have unrestricted access to this portion of the unnamed tributary of Beaver Creek, which likely contribute to nutrient and sediment loading of the stream system.

Solution:

The first priority for this area is to install stream bank fencing in combination with stable stream crossings. This would promote herd health and minimize impacts to the stream. A native stream buffer should be planted to filter runoff from the upslope crop fields and pasture areas. Stabilized watering areas should be incorporated into the design so that the benefit of clean, fresh water for the livestock is balanced with minimizing nutrient and sediment inputs to the stream.

Impacted Stream Segment #39-40:
Cattle in this reach graze within the riparian zone and have free access to the stream. While rotational grazing appeared to be in use during the assessment, the pastures that were observed allow the cattle unrestricted access to the stream. In the downstream pasture, an off-line pond is also present within the pasture.

Solution:
Stream bank fencing with stable stream crossings and watering areas should be installed to promote herd health and minimize impacts to the stream. Native tree and shrub species could be incorporated into a naturalized stream buffer to filter runoff from the upslope agricultural areas.

Impacted Stream Segment #47-48:
Cattle have unrestricted access to this unnamed tributary of Beaver Creek. The cattle are currently adding nutrients and sediments to the stream that may harm the downstream health of the stream.

Solution:
Stream bank fencing, stable watering areas, and stable stream crosssings should be a priority in this section of the stream. The stream banks are not eroded in this portion of the stream, but native tree species should be planted to create a riparian buffer. This would minimize nutrient inputs to the stream and aid in mitigating seasonal warming of the water in the tributary and the downstream portion of Beaver Creek.

Impacted Stream Segment #49-50:
Cattle have unrestricted access to this unnamed tributary of Beaver Creek. There is approximately 100 feet of 1-2 foot high eroded stream bank in this portion of the stream.

Solution:
Stream bank fencing, stable stream crossings, and stable watering areas should be installed to minimize the impacts of the cattle grazing in this pasture. The stream bank should be stabilized to minimize additional sedimentation and nutrient inputs into the stream from bank erosion. A native riparian buffer should be planted throughout this section of stream to prevent erosion in the future.

3.5.2 Medium Priority Projects:

Impacted Stream Segment #1-2:
This stream segment is situated within a horse pasture where horses have unrestricted access to the stream channel which likely results in increased nutrient and sediment loading.

Solution:
Stream bank fencing, stable watering areas, and stable stream crossings should be considered to minimize sedimentation and nutrient inputs to the stream. A native stream buffer should be planted.

Impacted Stream Segment #7-8:
There is a five foot buffer on the northern stream bank. The buffer ends and an active agricultural field begins.

Solution:
While the existing buffer is much better than no buffer at all, additional stream buffer width in this and other agricultural areas would aid in filtering sediment and nutrients.

Impacted Stream Point #24:
The grass is mowed to the top of the stream bank. The west bank has four foot high eroded banks. This section of stream has experienced stream bank erosion during high flow events. The eroded banks extend approximately 100 feet. There is a forested buffer upstream of this segment.

Solution:
The stream bank should be stabilized by constructing a floodplain bench and incorporating toe rip-rap and instream structures to minimize future erosion of the field edge. The mowed lawn could be planted with native tree species to extend the riparian buffer. A forested stream buffer would aid in reducing erosion and nutrient inputs to the stream.

Impacted Stream Segment #43-44:
Cattle in this area have access to the stream and both stream banks for grazing. There is an active agricultural field adjacent to the stream.

Solution: Stream bank fencing, stabilized watering areas, and stabilized stream crossings are the priority for this segment. The riparian buffer could be extended to reduce nutrient and sediment loading from the agricultural field.

4.0 RESTORATION SOLUTION DETAILS

An understanding of the specific concerns and conditions related to stream improvement activities and best management practices (BMPs) is key to effectively improving water quality. Here, we discuss the stream improvement techniques that would likely be most effective in Beaver Creek.

4.1 Habitat Restoration and Improvement

Stream Bank Stabilization & Restoration: Stream bank stabilization is the most basic step in restoring a degraded stream. Eroded vertical walls or undercut banks are often present where erosion has gone unchecked over time in agricultural areas. Traditional stream bank stabilization involves re-grading localized laterally eroded stream banks by grading the banks back to a more stable slope (3:1 horizontal to vertical), stabilizing the slopes with erosion control matting and vegetation and possibly adding in-stream structures or bioengineering techniques on the banks. Traditional in-stream structures may include the use of toe rip-rap and log or rock deflectors. Bioengineering methods that may be incorporated in bank stabilization could include the use of fascines, branch packing, brush mattresses, live cribwalls, and tree revetments and live staking.

If a stream has been channelized or lacks stream bend meanders, and space and funds are available, a natural stream channel design (Fluvial Geomorphology) may be appropriate for stream restoration. Natural stream design uses a stable natural channel ("reference reach") as a template for the design on the impacted reach. The reference reach provides the pattern, dimension and profile for the design of the restored stream to transport flows and sediment as it dissipates energy through its particular geometry and in-stream structures. Natural stream design and restoration involves stabilization of an entrenched stream channel in place using in-stream structures and bioengineering. Typical in-stream structures for bank stability include rock cross vanes, J-hook vanes, half rock vanes, single and double wing deflectors, and root wads that divert the main force of the stream from the stream bank and/or absorb water energy. Bioengineering techniques and erosion control matting are often combined and recommended in the implementation of stream restoration designs.

4.2 Riparian Buffers and Landscaping

Forested riparian buffers have long been recognized as a vital component of stream health in eco-regions where they should be naturally occurring. Forest buffers provide shade, helping moderate diurnal stream temperatures during both winter and summer months. Water temperature can increase during summer and decrease in winter by removal of shade trees in riparian areas.

Forest buffers act as filters of stormwater runoff during storm events. For this reason, forest buffers are especially valuable in agricultural or urban watersheds when stormwater can be discharged into a buffer rather than discharged directly into a stream. A wide variety of pollutants such as suspended solids (sediment), nutrients (nitrogen and phosphorus), heavy metals, toxic organic pollutants, and petroleum compounds can be successfully filtered and trapped by the physical structure of the vegetation itself. Nitrogen and phosphorus, as well as some heavy metals and toxic organics, can be taken up through the root systems and stored in tree and shrub biomass (wood).

Forested riparian buffers serve to stabilize stream banks via the root systems of trees and shrubs which provide deep penetrating structural integrity to the soil. Buffers also reduce the erosive force of stormwater runoff and flood events because the above-ground, physical structure of trees and shrubs slow water velocity via friction. Long-term loss of riparian vegetation can result in accelerated stream bank erosion and channel widening, increasing the width/depth ratio.

Riparian trees and shrubs also provide terrestrial wildlife habitat. Riparian buffer strips often act as travel corridors for wildlife traveling from one area to another. Additionally, riparian forests serve to provide food, shelter, and nesting areas. Riparian forests provide a vital function in aquatic ecosystems. Leaf detritus is the main force supporting many lotic (flowing water) aquatic food webs. Large woody debris plays an important role, providing fish and insect cover and spawning locations. Establishing a successful forested riparian buffer takes careful planning, planting, and maintenance.

The following tree and shrub species are recommended for forested riparian buffer plantings. All species are native and readily available at native tree nurseries.

TREE SPECIES	**HEIGHT (Feet)**	**WILDLIFE VALUE**	**SHADE TOLERANCE**	**SPACING (Feet)**
Red maple (*Acer rubrum*)	75-100	Food source – fruits and young shoots	Tolerant	12-15
Silver maple (*Acer saccharinum*)	75-100	Food source – seeds and young twigs. Good cavity tree.	Intermediate	12-15
Shagbark hickory (*Carya ovata*)	75-100	Food source – twigs and nuts	Intermediate	12-15
Persimmon (*Diospyros virginiana*)	50-75	Food source – fruit	Intolerant	10-13
Hackberry (*Celtis occidentalis*)	75-100	Food source – fruits and twigs	Intermediate	12-15
White ash (*Fraxinus americana*)	75-100	Food source – fruit	Tolerant	12-15
Red ash (*Fraxinus pennsylvanica*)	50-75	Food source – fruit	Intolerant	10-13
Eastern white pine (*Pinus strobus*)	75-100	High value food source – needles and seeds. Good cover and nesting tree.	Intermediate	12-15
Sycamore (*Platanus occidentalis*)	75-100	Moderate value for cover and food source – fruits	Intermediate	12-15
White oak (*Quercus alba*)	75-100	Food source – acorns and twigs	Intermediate	12-15
Red oak (*Quercus rubra*)	75-100	Medium value for nesting. Food source.	Intermediate	12-15
Pin oak (*Quercus palustris*)	75-100	Food source – acorns and twigs	Intolerant	12-15
Black willow (*Salix nigra*)	35-50	Food source – buds, fruit and twigs	Very intolerant	10-13
Sassafras (*Sassafras albidum*)	35-50	Food source – twigs and fruits	Intolerant	10-13
Slippery elm (*Ulmus rubra*)	50-80	Food source – seeds and twigs	Tolerant	10-13

SHRUB SPECIES	HEIGHT (Feet)	WILDLIFE VALUE	SHADE TOLERANCE	SPACING (Feet)
White flowering dogwood (*Cornus florida*)	35-50	Food source – fruit	Intermediate	10-13
Redbud (*Cercis canadensis*)	20-35	Minimal food source – seeds	Tolerant	10-13
Sandbar willow (*Salix exigua*)	15-20	Food source – fruits and twigs	Very tolerant	8-10
Smooth alder (*Alnus serrulata*)	12-20	Food source – fruit	Very intolerant	8-10
Serviceberry (*Amelanchier Canadensis*)	5-25	Food source – fruit, twigs and leaves	Very tolerant	8-10
Buttonbush (*Cephalanthus occidentalis*)	6-12	Food source – fruit	Very intolerant	8-10
Silky dogwood (*Cornus amomum*)	6-12	Food source – fruits	Intolerant	6-8
Grey dogwood (*Cornus racemosa*)	6-12	Food source – fruits	Tolerant	6-8
Red-osier dogwood (*Cornus sericea*)	6-12	Food source – fruits, buds and twigs	Very intolerant	6-8
Winterberry (*Ilex verticillata*)	6-12	Intermediate wildlife value	Intermediate	6-8
Staghorn sumac (*Rhus typhina*)	35-50	Food source – fruits	Very tolerant	8-10
Highbush blueberry (*Vaccinium corymbosum*)	6-12	Food source – fruit	Tolerant	6-8
Northern arrowwood (*Viburnum regonitum*)	6-12	Food source – fruit	Tolerant	6-8

Fortunately, the Beaver Creek Watershed has been less affected by invasive plant species than many of the other watersheds in Schuylkill County. Multiflora rose is one of the more noxious invasive species that is present. Any new colonies of this or other invasive species should be removed. If left unmanaged, invasive species tend to out-compete desired native species for space and nutrients. The correct natural progression and succession of the desired native plant community can be stalled for years and, in turn, negatively impact the rest of the food web.

It is very important to maintain newly planted forest buffers by removing unwanted, invasive species. Mowing, string trimming, and physically pulling out invasive species can be effective ways of dealing with these unwanted "weeds", but many times enough root mass remains and the plant returns. Also, mowing and such other physical removal means are labor intensive and many times not cost effective. Herbicide, when properly applied, can be a safe, efficient means of dealing with invasive species.

4.3 Agricultural Improvements

Stream Bank Fencing: Stream bank fencing protects stream banks, promotes re-vegetation, enables forest buffer plantings, protects in-stream habitat and eliminates cattle from entering and loafing in the stream channel. The installation of a two-wire, high-tensile electric fence (powered by AC chargers or solar/battery chargers) is preferred. For construction, eight-foot long locust or pressure treated wooden fence posts should be pounded into the ground on 50-foot centers. Corners should be braced and constructed of 8-foot posts. Temporary poly wire electric fencing can be erected around planted riparian buffers until permanent fencing can be installed.

Cattle Crossing: To direct cattle from barn to pasture or from one pasture to another, cattle crossings can be incorporated as needed into the stream bank fence design to allow cattle to cross the stream at selected locations without damaging the integrity of the stream. Cattle crossings should be installed perpendicular across the stream and equipped with electric fence and droppers to deter cattle from entering the stream and wandering upstream or downstream of the crossing. Crossings can be constructed of rock (R-4 rock base covered with 2B stone) or through the use of concrete hog slats set at an 8:1 horizontal to vertical slope cut into stream banks. The center of the crossing should be set at the stream bottom's invert elevation.

Crop Residue Management – (Conservation Tillage): This BMP involves leaving crop residue (plant materials from past harvests) on the soil surface to reduce runoff and soil erosion, conserve soil moisture, keep nutrients and pesticides on the field, and improve soil, water, and air quality.

Cover Crop: Cover crops can either be crops grown between cash crop cycles, or intercropped with the cash crops to cover the bare ground, such as in orchards, groves, and other long-term sites. Used appropriately, cover crops can improve soil structure and fertility, decrease soil erosion, provide foliage and animal feed, and suppress crop pests such as weeds, insects, nematodes, and plant pathogens including fungi. Residues from cover crops can be incorporated for use as green manure to supply nutrients and improve fertility for the next crop. Using cover crops can increase on-farm crop diversity, may enhance some beneficial organisms, and possibly even contribute to carbon sequestration.

Grazing Land Management: The management of lands for livestock grazing includes the manipulation of the soil-plant-animal complex of the grazing land in pursuit of a desired result. This BMP develops a sound plan that minimizes the water quality impacts of grazing and browsing activities on pastured lands along streams and involves rotational grazing. To reduce the impacts of grazing on water quality, farmers and ranchers can adjust grazing intensity, keep livestock out of sensitive areas, provide alternative sources of water and shade, and allow pastures to recover between grazings.

Nutrient Management: Nutrient management is a plan for managing the amount, source, placement, form and timing of the application of animal manure, chemical fertilizer, biosolids (sewage sludge) or other plant nutrients used in the production of agricultural products to prevent pollution, maintain soil productivity and achieve realistic yield goals. Nutrient management minimizes agricultural non-point source pollution of surface and ground water resources. Manure management facilities provide the opportunity to apply manure when soil conditions are suitable and crop nutrient needs are high. Manure storage facilities eliminate the need to haul and apply manure daily. Properly designed storage facilities are based on herd size, the area draining to the storage, wastewater and the nutrient management plan for the farm.

Strip Cropping/Contour Farming: This BMP is used to control both wind and water erosion. Contour strip cropping involves a planned layout in which the crops follow a definite rotational sequence, and tillage is held closely to the exact contour of the field. If the strips are planted along the contour, damage from water runoff can be minimized.

Terraces and Diversions: Diversions and terraces are designed to intercept water flowing down a slope and direct it across the slope to a stable outlet such as a grassed waterway or underground outlet. Vegetative barriers established above the diversion and terrace channels increase their longevity by promoting sediment deposition above the diversions and channels. Barriers established on top of terraces may provide additional stability; however, barrier vegetation should not be allowed to become established within the terrace channel area.

Watering Trough: A watering trough or tank to provide drinking water for livestock is a great alternative for keeping horses and cows out of the stream. This practice allows for the desired protection from stream banks and riparian vegetation while still providing livestock with water at strategic locations in pastureland.

4.4 Stormwater Water Volume and Quality Improvement

Potential storm water volume and quality improvement projects associated with Beaver Creek should include a combination of existing facility retrofits and innovative applications during new construction. The PADEP BMP manual should be consulted for design ideas and requirements. Stormwater volume may be controlled by either infiltrating the stormwater into the groundwater, capturing the stormwater for use, or evapotranspirating the water back into the atmosphere.

Infiltration trenches and drywells function to return stormwater directly to the groundwater. By collecting rooftop water that should contain minimal pollutants, it may be infiltrated to the groundwater with minimal risk of contamination. During construction of infiltration devices, the main consideration is minimizing compaction of the soil surface that underlies the stone bed. By utilizing an excavator and scooping the soil back and then placing the stone from above, compaction may be minimized. If built in combination with underground detention facilities, the bulk of the water from a new development can sometimes be infiltrated with minimal impact to the buildable area of a site.

Stormwater capture for use in Beaver Creek should be encouraged through educational programs. With the environmentally conscious populace of today, the use of rain barrels and cisterns could become commonplace with proper promotion.

Evapotranspiration is another option for stormwater volume management and is best combined with water quality improvements. The use of rain garden bioretention areas to allow for wetland type plants to filter pollutants and minimize runoff should not be overlooked.

5.0 DISCUSSION

This study analyzed Beaver Creek through the use of a stream walk, windshield surveys, and PA DEP ICE protocol to analyze the habitat and biological impairments present throughout the Beaver Creek Watershed. The sample sites were located in the same general location of sites used by the PFBC to analyze the trout population in previous studies. The major benefit on dividing the watershed into two segments and analyzing the habitat and biology at the downstream end of the segment was effectively analyzing the two habitats present in the watershed. The segment upstream of Sample Site 1 was primarily a forested riparian corridor on the main stem. There are two unnamed tributaries that converge with the main stem in this segment. The land surrounding these tributaries is primarily agricultural fields and active pastures. The segment upstream of Sample Site 2 was a forested riparian corridor with some agricultural fields, pastures, and meadows interspersed. There are no large tributaries in this segment of the Beaver Creek. By utilizing PA DEP protocols and analyzing these two stream segments for habitat and biological impairments, target projects for the conservation of Beaver Creek Watershed were identified.

The macroinvertebrate community (biology) and habitat at Sample Site 2 was identified as not impaired. The Pennsylvania Code, Title 25, Chapter 93, Water Quality Standards assigns Beaver Creek a water quality designation of High Quality Cold Water Fishery (HQ-CWF) from the headwaters to Church Lane. Sample Site 2 was located in this segment just above Church Lane. The results from this study support this designation. The headwaters of Beaver Creek contain a Class A wild Brook trout population (Wnuk and Kaufmann 1997).

The macroinvertebrate community was identified as impaired at Sample Site 1 with an IBI value of 40.51, below the threshold of 60-63. The habitat at Sample Site 1 was identified as not impaired. Sample Site 1 was located just upstream of the mouth. The segment of stream upstream of this sample site loses the high quality designation and is given a designation of CWF from Church Lane to the mouth. The stream supports a sparse wild Brook trout population in this segment. Wnuk and Kaufmann (1997) suggested that this could be due to seasonally warm water temperatures and nutrient enrichment from agricultural lands that are drained by the two unnamed tributaries that converge with Beaver Creek in this segment. The agricultural lands in the watersheds of the tributaries are currently primarily in active pasture or meadow.

It is likely that nutrient enrichment is also occurring in the unnamed tributaries that is subsequently affecting the main stem of Beaver Creek. There are two sources of the nutrient enrichment in these streams. The first is from runoff of agricultural fields. Chemical fertilizers or manure can be applied to fields in excess of the plants needs. The excess can run off the field into the stream. The other source of likely nutrient enrichment is manure from livestock. There are many locations within this watershed where cattle have unrestricted access to the stream. In addition to the nutrient enrichment, it is likely that the present erosion of agricultural fields contributes sediment to the stream.

Projects that target maintenance of existing forested buffers and implementation of new forested buffers in agricultural lands are critical. Water quality should improve as stream bank fencing is implemented. Through the education and cooperation of the landowners within the watershed, these restoration projects and BMPs can be implemented. Subsequently, the natural resources and water quality of the Beaver Creek Watershed will be restored.

6.0 OBTAINING SUPPORT AND MONITORING PROGRESS

Education and cooperation of landowners within the watershed to implement BMPs and stream restoration solutions is the key to improving and preserving the natural resources and water quality of the Beaver 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 they are clearly shown what is in it for them 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. Furthermore, if you are able to communicate what the benefits of sound land management practices could mean to help improve the bottom line of partner farms and businesses, then they will be even more interested. Increases in crop production through preservation of topsoil and a decrease in veterinary bills for treating water borne and transmitted diseases such as mastitis (a painful udder infection that occurs in dairy cows) have a positive monetary effect. The Schuylkill Conservation District’s presence in the community should facilitate landowner partnerships.

7.0 LITERATURE CITED

Hook, D.D., B. Davis, J. Scott, and J. Strubble. 1995. *Locating Delineated Wetland Boundaries in Coastal South Carolina Using Global Positioning Systems*. Wetlands 15(1):31-36.

Merrit R.W. and K.W. Cummins. 1996. *Aquatic Insects of North America*. 3rd Ed. Kendall/Hunt Publishing Company. Dubuque, Iowa. 862 pp.

Peckarsky B. L., P. R. Fraissinet, M. A. Penton, and D. J. Conklin, Jr. 1995.*Freshwater Macroinvertebrates of Northeastern North America*. Cornell University Press. Ithaca, NY. 442 pp.

Pennylvania Department of Environmental Protection (PA DEP). 2006. *Index of Biological Integrity for Wadeable Freestone Streams in Pennsylvania*.

Pennsylvania Department of Environmental Protection (PA DEP). 2007. ICE PROTOCOL

Trimble Navigation Limited. 1994. *GPS Pathfinder Professional System Operation Manuals.* Surveying and Mapping Division, PO Box 3642, Sunnyvale, California.

USGS Pennsylvania StreamStats. http://streamstats.usgs.gov. Viewed on July 7, 2009.

Wnuk, R., and M. Kaufmann. 1997. *Beaver Creek (603a) fisheries management report.* PFBC files, Bellefonte, PA.

APPENDIX A

CONSERVATION PLAN MAP

Beaver Creek Watershed

Field Investigation

Schuylkill County Trout Unlimited

Schuylkill County Conservation District

Legend

- Watershed
- Adjacent Watersheds
- Parcel
- Municipal Boundary
- Sampling Sites
- Stream
- High Priority Stream Segment
- Medium Priority Stream Segment
- Low Priority Stream Segment
- GPS Survey Point
- High Priority Survey Point
- Medium Priority Survey Point
- Low Priority Survey Point

N

1 inch = 750 feet

0 375 750 1,500 2,250 Feet

RETTEW

Projection: SPCS PA South NAD83 (Feet)
Data Sources: Environmental Resource Research Institute, PA DCNR, PA DEP, PA MAP, Schuylkill County, & USGS
N:\08\08-03883-001\GIS\08-03883-001-GPS.mxd

APPENDIX B

GPS POINT DESCRIPTIONS AND ACTION ITEMS

Point #	Description	Action Item	Key Partners	Conservation Priority	Comments
1	A Belgian horse pasture begins at this point. No stream bank fencing is present.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	Medium Priority	
2	The pasture ends at this point (end of project).	Stream bank fencing	Landowner	Medium Priority	
3	Looking downstream, a mowed lawn area begins on the north side of the stream at this point.	Riparian Buffer Enhancement	Landowner	Low Priority	
4	A forested buffer on both sides of the stream begins at this point and continues downstream. A dirt and gravel driveway in this area potentially discharges stormwater to the stream.	Divert runoff from driveway into a stable filter.	Landowner, Conservation District	Low Priority	
5	A roadway stormwater culvert discharges into the stream from the north side.	N/A	N/A	N/A	
6	A stable private bridge crossing with two concrete pipes to a cabin is present at this point. There is a spring house on the north bank 10 ft. downstream. A roadway stormwater culvert discharges into the stream from the north side.	N/A	N/A	N/A	
7	A five foot wide buffer strip filters runoff from an active agricultural field on the north side of the stream. There is filamentous algae present in the stream.	Riparian buffer enhancement	Landowner	Medium Priority	
8	The active agricultural field ends at this point. A forested buffer zone on both sides of the stream begins at this point. There is an Ash tree planted riparian buffer downstream. There is a logging area on the south side of the stream approximately 50 yards downstream.	N/A	N/A	N/A	
9	A roadway stormwater culvert discharges into the stream from the north side.	N/A	N/A	N/A	
10	A roadway stormwater culvert discharges into the stream from the north side. There are substantial fringe wetlands on the south side of the stream. This area provides excellent riparian habitat.	N/A	N/A	N/A	

Point #	Description	Action Item	Key Partners	Conservation Priority	Comments
11	A springhouse is present at this point to the north side of the stream.	N/A	N/A	N/A	
12	There is an intake for an offline pond that lies on the south side of the stream at this point. A stormwater outfall discharges into the stream from the north. A mowed lawn is adjacent to eroded banks on both sides of the stream.	Riparian buffer enhancement, bank stabilization	Landowner, Conservation District E&S staff	High Priority	
13	A private crossing is present at this point. The dirt road likely contributes to the sandy bottom of the stream in this area due to stormwater from the north side of the crossing.	Divert roadway stormwater into a stable filter area, 50 ft. of stream bank stabilization, riparian buffer enhancement on both sides of creek.	Landowner, Conservation District E&S staff	High Priority	
14	A pond outfall is present at this point. This would also be the end of the project that begins at point # 11. A forested buffer begins on both sides of the stream.	N/A	N/A	N/A	
15	Spring seep on the south side of the stream. Riparian buffer exists on both sides of the strema in this area.	N/A	N/A	N/A	
16	Two spring seeps drain from the north in this location.	N/A	N/A	N/A	
17	There is a roadway stormwater drainage outfall on the north side of the stream. A breached dam breast exists approximately 10 yards upstream from this point.	N/A	N/A	N/A	
18	On the south side of the stream there is a hay field. On the north side of the stream, fringe wetland is present. The forested buffer ends at this point.	Native tree plantings	Landowner	Low Priority	Additional trees would aid in keeping the stream water cool.
19	Confluence of an unnamed tributary and Beaver Creek. The tree plantings could extend to the bridge at point 40 on the unnamed tributary.	Native tree plantings	Landowner	Low Priority	Additional trees would aid in keeping the stream water cool.
20	Center line of a bridge stream crossing on a private road.	Native tree plantings	Landowner	Low Priority	Additional trees would aid in keeping the stream water cool.

Point #	Description	Action Item	Key Partners	Conservation Priority	Comments
21	There is a spring house present at this point to the north side of the stream. The area is currently a wet meadow.	Potential area for tree plantings	Landowner	Low Priority	Additional trees would aid in keeping the stream water cool.
22	Confluence of an unnamed tributary from the north of Beaver Creek. A private farm bridge crossing is 20 ft. downstream of this point.	N/A	N/A	N/A	
23	This is the center line of a bridge on Valley Road over an unnamed tributary to the north of the main stem.	N/A	N/A	N/A	
24	The forested buffer ends at this point. The grass on the western stream bank is mowed to the top of the stream bank. The west bank has 4 feet of eroded banks extending 100ft	Stream bank stabilization, riparian buffer enhancement (west side)	Landowner, Conservation District	Medium Priority	
25	Center line of a bridge labeled State Game Propagation Area. Downstream of this point is an offline pond. The eastern streambank is mowed grass, while the west bank is the pond berm.	Riparian Buffer Enhancement to the east of the stream.	Landowner	Low Priority	
26	Roadway stormwater drains from the west side of the steam. A forested buffer begins on both sides of the stream.	Riparian Buffer Enhancement to the east of the stream.	Landowner	Low Priority	
27	An unnamed tributary discharges from the east.	N/A	N/A	N/A	
28	There is a spring seep from the east. A stable logging road also begins on the east bank with evidence of past logging of the uplands.	N/A	N/A	N/A	
29	A forested buffer begins on both sides of the stream.	N/A	N/A	N/A	
30	Confluence of an unnamed tributary from the east and Beaver Creek. A logging operation is active on the eastern side of the stream in the uplands	N/A	N/A	N/A	There is no evidence of pollution to the stream due to the logging operation.
31	An unnamed tributary discharges from east of Beaver Creek	N/A	N/A	N/A	
32	Confluence of Beaver Creek and Cold Run	N/A	N/A	N/A	

Point #	Description	Action Item	Key Partners	Conservation Priority	Comments
33	A pasture with cattle grazing begins at this point. The cattle have direct access to the stream.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation	High Priority	
34	The pasture ends at this point (End of Project).	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation	High Priority	
35	A wet meadow begins at this point. (Fringe Wetlands)	N/A	N/A	N/A	
36	The wet meadow ends at this point.	N/A	N/A	N/A	
37	A hay field begins at this point on the south side of the unnamed tributary.	Riparian buffer enhancement	Landowner	Low Priority	
38	Hay field ends at this point (End of Project).	Riparian Buffer Enhancement	Landowner	Low Priority	
39	A pasture on both sides of the stream begins at this point.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	High Priority	
40	Center line of a bridge on Bridge Lane on an unnamed tributary of Beaver Creek (from North). There are cattle in the stream. Downstream of the bridge the grass is mowed to within 15 ft. of the stream.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	High Priority	
41	A 10 ft. forested buffer on both sides of the stream begins at this point.	Riparian buffer enhancement	Landowner	Low Priority	
42	The 10 ft. narrow forested buffer transitions to a larger forested buffer on both sides of the stream.	End of riparian buffer enhancement	N/A	N/A	
43	A pasture with cattle having direct access to the stream is located downstream of this point. Activie agricultural fields surround the stream.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	Medium Priority	
44	The pasture ends at this point (End of Project).	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	Medium Priority	

Point #	Description	Action Item	Key Partners	Conservation Priority	Comments
45	A narrow forested buffer begins at this point to the south of the unnamed tributary.	Buffer enhancement	Landowner, NRCS, Conservation District	Low Priority	
46	The narrow buffer transitions to a larger forested buffer on both sides of the stream (End of Project).	Riparian buffer enhancement	Landowner, NRCS, Conservation District	Low Priority	
47	A pasture begins on both sides of the stream at this point. Cattle have unrestricted access to the stream.	Stream bank fencing, riparian buffer enhancement	Landowner, NRCS, Conservation District	High Priority	
48	The pasture ends at this point (End of Project).	Stream bank fencing, riparian buffer enhancement	Landowner	High Priority	
49	A pasture begins on both sides of the stream at this point. Cattle have unrestricted access to the stream. There is approximately 100 ft. of 1 to 2 ft. of eroded bank downstream of this point.	Stream bank fencing, stream bank stabilization, riparian buffer enhancement	Landowner, NRCS, Conservation District	High Priority	
50	The pasture ends at this point (End of Project).	Stream bank fencing, stream bank stabilization, riparian buffer enhancement	Landowner, NRCS, Conservation District	High Priority	

APPENDIX C

STAKEHOLDER SURVEYS

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 64 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

I DON'T GO FISHING

What kind of fish do you think live in Beaver Creek? *(Please List)*

DON'T KNOW

Any specific problems we should know about?

NO

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish | Litter clean-up | Streambank stabilization | Tree planting

Ag land preservation | Conservation plans | Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Judith Lawrence Moyer
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Tamaqua, PA 18252

Phone (570) 668-3289
E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed?	Yes No
Do you consider the water quality in Beaver Creek to be "healthy"?	Not Sure Yes No
How long have you lived in the watershed?	73 years
Do you consider yourself a conservationist?	Yes No
Do you fish in Beaver Creek?	Yes No
How often does your family spend time enjoying Beaver Creek?	Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

What kind of fish do you think live in Beaver Creek? *(Please List)*

Trout

Any specific problems we should know about?

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish	Litter clean-up	Streambank stabilization	Tree planting
Ag land preservation	Conservation plans	Streambank fencing/CREP	

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Bernard Bremer
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Tamaqua, Pa 18252

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E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 31 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

All yes

What kind of fish do you think live in Beaver Creek? *(Please List)*

Native Trout - Darters

Any specific problems we should know about?

The Headwater above me have some junked cars - or trucks near the strem - Creek Run near the Road - Bottles + Glass - etc

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish | Litter clean-up | Streambank stabilization | Tree planting

Ag land preservation | Conservation plans | Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Robert LeMasters

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TAMAQUA, PA 18252

Phone ( ) 668-1160

E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

COLDWATER HERITAGE PARTNERSHIP

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 57 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

What kind of fish do you think live in Beaver Creek? *(Please List)*

Any specific problems we should know about?

Stream Bank erosion

As a landowner, I would be interested in learning more about ~~help with the following~~ improvements:

In-stream habitat for fish Litter clean-up Streambank stabilization Tree planting

Ag land preservation Conservation plans Streambank ~~fencing~~/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Dave Koch

Address

Phone ( )668-3849

E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 15 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

RELAXING BY STREAM SITTING IN STREAM
WALKS PICNICS
CAMPING FEED FISH
PICTURES

What kind of fish do you think live in Beaver Creek? *(Please List)*

TROUT VARIOUS
NATIVES

Any specific problems we should know about?

DONNAN FARM LAYS MANURE VERY THICK ON SNOW. IN SPRING, WITH RAINS & SNOW MELT, MANURE RUNS INTO STREAM @ CATAWISSA RD & SHADY LANE

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish | Litter clean-up | Streambank stabilization | Tree planting

Ag land preservation | Conservation plans | Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name DAVID B[illegible]
Address 660 CATTAWISSA RD
TAMAQUA PA 18252

Phone (570) 668-0501
E-mail FBOB@PTD.NET

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? Don't know if we do 14? years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

What kind of fish do you think live in Beaver Creek? *(Please List)*

Any specific problems we should know about? No

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish Litter clean-up Streambank stabilization Tree planting

Ag land preservation Conservation plans Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3 ?	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

____

____

Name Kenneth Mast

Address 1051 Catawissa Road

Tamaqua PA 18252

Phone ( )____________

E-mail ____________________

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 50 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

What kind of fish do you think live in Beaver Creek? *(Please List)* Trout Bass

Any specific problems we should know about?

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish | Litter clean-up | Streambank stabilization | Tree planting

Ag land preservation | Conservation plans | Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Bruce Schock

Address 692 Valley
Tamaqua PA 18252

Phone (570) 640 4458 cell

E-mail None

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 75 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

refreshing

What kind of fish do you think live in Beaver Creek? *(Please List)*

trout, chubs, minnies,

Any specific problems we should know about?

no

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish   Litter clean-up   Streambank stabilization   Tree planting

Ag land preservation   Conservation plans   Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name Oscar Troxell
Address 645 Valley Road
Hamoqua PA 18252

Phone (570) 668-2398
E-mail R TROXELL@PTD.NET **_THANK YOU!!!_**

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? 38 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

NA

What kind of fish do you think live in Beaver Creek? *(Please List)*

TROUT

Any specific problems we should know about?

NO

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish Litter clean-up Streambank stabilization Tree planting

Ag land preservation Conservation plans Streambank fencing/CREP

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name D. Hartz
Address 576 VALLEY RD.
TAMAQUA, PA

Phone ( ) N/A
E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

Beaver Creek

BEAVER CREEK CONSERVATION PLAN

COLDWATER HERITAGE PARTNERSHIP

STAKEHOLDER SURVEY

Were you previously aware that you live in the Beaver Creek Watershed? Yes No

Do you consider the water quality in Beaver Creek to be "healthy"? Not Sure Yes No

How long have you lived in the watershed? MARK 78 BRENDA 40 years

Do you consider yourself a conservationist? Yes No

Do you fish in Beaver Creek? Yes No

How often does your family spend time enjoying Beaver Creek? Daily Weekly Monthly Rarely

How do you enjoy Beaver Creek (just hearing the water, relaxing by the stream, etc.)?

FISHING
HEARING THE WATER

What kind of fish do you think live in Beaver Creek? *(Please List)*

NATIVE BROOK TROUT
CHUBS
SUCKERS

Any specific problems we should know about? NO

As a landowner, I would be interested in learning more about help with the following improvements:

In-stream habitat for fish | Litter clean-up | Streambank stabilization | Tree planting

Ag land preservation | Conservation plans | Streambank fencing/CREP

RECEIVED
JUN 09 2009
SCD

OVER

Please rate the following concerns as related to stream health and water quality in Beaver Creek.

PROBLEM	VERY SERIOUS PROBLEM	SERIOUS PROBLEM	MODERATE PROBLEM	MINOR PROBLEM	NOT A PROBLEM
Littering, roadside dumping	5	4	3	2	1
Sediment, soil loss from Ag operations	5	4	3	2	1
Dirt & gravel roads causing sediment	5	4	3	2	1
Chemical runoff from Ag operations	5	4	3	2	1
Too much manure, nutrients from Ag	5	4	3	2	1
Failing septic systems	5	4	3	2	1
Lack of groundwater recharge	5	4	3	2	1
Flooding	5	4	3	2	1
Stormwater control	5	4	3	2	1
Streambank erosion	5	4	3	2	1
Livestock access to stream	5	4	3	2	1
Land clearing, lack of forest buffers	5	4	3	2	1
Lack of in-stream habitat for fish	5	4	3	2	1
Too much recreational use destroying habitat	5	4	3	2	1
Quadrunners, 4 wheelers, motorcycles	5	4	3	2	1
Graffiti	5	4	3	2	1
Urban sprawl	5	4	3	2	1
Roadway runoff	5	4	3	2	1

Additional comments?

Name MARK + BRENDA HEISLER
Address 619 VALLEY ROAD
TAMAQUA, PA 18252

Phone ( )
E-mail

THANK YOU!!!

PLEASE RETURN IN PROVIDED ENVELOPE

APPENDIX D

MACROINVERTEBRATE TAXA LISTS

Beaver Creek Assessment Sites Macroinvertebrate Taxa

Site	Class/Order/Suborder	Family	Genus	Quantity
	Diptera	Chironomidae		42
	Diptera	Empididae	*Hemedromia* sp.	1
	Diptera	Simulidae	*Simulium* sp.	1
	Turbellaria	Planariidae		1
	Oligochaeta			78
	Nematoda			3
	Decapoda			1
	Anisoptera	Gomphidae	*Arigomphus* sp.	1
	Coleoptera	Elmidae	*Optioservus* sp.	6
1	Coleoptera	Elmidae	*Stenelmis sp.*	3
	Coleoptera	Psephenidae	*Ectopria* sp.	1
	Plecoptera	Perlidae	*Acroneuria* sp.	2
	Plecoptera	Leuctridae	Early instar	4
	Tricoptera	Philopotamidae	*Chimarra* sp.	1
	Tricoptera	Hydropsychidae	*Hydropsyche* sp.	1
	Ephemeroptera	Ephemerliidae	*Ephemerella sp.*	27
	Ephemeroptera	Ephemerliidae	*Euryllophella sp.*	2
	Ephemeroptera	Heptageniidae	*Stenonema* sp.	1
	Ephemeroptera	Baetidae	*Acentrella* sp.	1
			n=	177
	Diptera	Chironomidae		27
	Diptera	Simulidae	*Simulium* sp.	2
	Diptera	Empididae	*Hemedromia* sp.	1
	Diptera	Tipulidae	*Antocha* sp.	1
	Diptera	Tipulidae	*Dicranota* sp.	2
	Diptera	Tipulidae	*Tipulida* sp.	1
	Decapoda			1
	Oligochaeta			6
	Nematoda			2
	Coleoptera	Elmidae	*Optioservus* sp.	21
	Coleoptera	Psephenidae	*Ectopria* sp.	1
	Anisoptera	Gomphidae	*Arigomphus* sp.	1
2	Plecoptera	Nemouridae	*Amphinemura sp.*	10
	Plecoptera	Nemouridae		4
	Plecoptera	Leuctridae	Early instar	30
	Plecoptera	Leuctridae	*Despaxia* sp.	5
	Tricoptera	Ryacophilidae	*Rhyacophila* sp.	1
	Tricoptera	Hydropsychidae	*Hydropsyche* sp.	2
	Tricoptera	Philopotamidae	*Chimarra* sp.	2
	Tricoptera	Philopotamidae	*Wormaldia* sp.	29
	Ephemeroptera	Ephemerliidae	*Ephemerella* sp.	14
	Ephemeroptera	Ephemerliidae	*Euryllophella sp.*	6
	Ephemeroptera	Ephemerliidae		2
	Ephemeroptera	Heptageniidae	*Epeorus* sp.	1
	Ephemeroptera	Heptageniidae	*Stenonema* sp.	32
			n=	204

APPENDIX E

WATER QUALITY NETWORK HABITAT ASSESSMENT FORMS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

WATER QUALITY NETWORK
HABITAT ASSESSMENT

WATERBODY NAME Beaver Creek STR CODE/RMI 2227

STATION NUMBER 1 LOCATION Upstream of confluence with Cold Run on Hollister

DATE 20090518 TIME 1420

AQUATIC ECOREGION ______ COUNTY Schuylkill

INVESTIGATORS ASC

FORM COMPLETED BY ASC

RIFFLE/RUN PREVALENCE

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover (Fish)	Greater than 50% mix of boulder, cobble, submerged logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
SCORE 17	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Well developed riffle and run, riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than two times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 12	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Velocity/Depth Regimes	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score lower than if missing other regimes).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE 18	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored gabion or cement; over 80% of the stream reach channelized and disrupted.
SCORE 17	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition SCORE 10	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20 19 18 17 16	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools. 15 14 13 12 11	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent. 10 9 8 7 6	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. 5 4 3 2 1
7. Frequency of Riffles SCORE 19	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat. 20 19 18 17 16	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15. 15 14 13 12 11	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. 10 9 8 7 6	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is between ratio >25. 5 4 3 2 1
8. Channel Flow Status SCORE 19	Water reaches base of both lower banks and minimal amount of channel substrate is exposed. 20 19 18 17 16	Water fills > 75% of the available channel; or <25% of channel substrate is exposed. 15 14 13 12 11	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed. 10 9 8 7 6	Very little water in channel and mostly present as standing pools. 5 4 3 2 1
9. Condition of Banks SCORE 14	Banks stable; no evidence of erosion or bank failure. 20 19 18 17 16	Moderately stable; infrequent, small areas of erosion mostly healed over. 15 14 13 12 11	Moderately unstable; up to 60% of banks in reach have areas of erosion. 10 9 8 7 6	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars. 5 4 3 2 1
10. Bank Vegetative Protection SCORE 19	More than 90% of the streambank surface covered by vegetation. 20 19 18 17 16	70-90% of the streambank surface covered by vegetation. 15 14 13 12 11	50-70% of the streambank surfaces covered by vegetation. 10 9 8 7 6	Less than 50% of the streambank surface covered by vegetation. 5 4 3 2 1
11. Grazing or Other Disruptive Pressure SCORE 20	Vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally. 20 19 18 17 16	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. 15 14 13 12 11	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. 10 9 8 7 6	Disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height. 5 4 3 2 1
12. Riparian Vegetative Zone Width SCORE 18	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. 20 19 18 17 16	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. 15 14 13 12 11	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. 10 9 8 7 6	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities. 5 4 3 2 1

Total = 199

3800-FM-WSFR0402 9/2005

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

WATER QUALITY NETWORK
HABITAT ASSESSMENT

WATERBODY NAME Beaver Creek STR CODE/RMI 2227

STATION NUMBER 2 LOCATION Mainstem upstream of UNTs at Valley Rd.

DATE 20090518 TIME 1515

AQUATIC ECOREGION ______ COUNTY Schuylkill

INVESTIGATORS ASC

FORM COMPLETED BY ASC

RIFFLE/RUN PREVALENCE

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover (Fish)	Greater than 50% mix of boulder, cobble, submerged logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Well developed riffle and run, riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than two times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Velocity/Depth Regimes	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score lower than if missing other regimes).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE 19	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored gabion or cement; over 80% of the stream reach channelized and disrupted.
SCORE 17	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition SCORE 9	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20 19 18 17 16	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools. 15 14 13 12 11	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent. 10 9 8 7 6	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. 5 4 3 2 1
7. Frequency of Riffles SCORE 18	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat. 20 19 18 17 16	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15. 15 14 13 12 11	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. 10 9 8 7 6	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is between ratio >25. 5 4 3 2 1
8. Channel Flow Status SCORE 18	Water reaches base of both lower banks and minimal amount of channel substrate is exposed. 20 19 18 17 16	Water fills > 75% of the available channel; or <25% of channel substrate is exposed. 15 14 13 12 11	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed. 10 9 8 7 6	Very little water in channel and mostly present as standing pools. 5 4 3 2 1
9. Condition of Banks SCORE 13	Banks stable; no evidence of erosion or bank failure. 20 19 18 17 16	Moderately stable; infrequent, small areas of erosion mostly healed over. 15 14 13 12 11	Moderately unstable; up to 60% of banks in reach have areas of erosion. 10 9 8 7 6	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars. 5 4 3 2 1
10. Bank Vegetative Protection SCORE 18	More than 90% of the streambank surface covered by vegetation. 20 19 18 17 16	70-90% of the stream-bank surface covered by vegetation. 15 14 13 12 11	50-70% of the stream-bank surfaces covered by vegetation. 10 9 8 7 6	Less than 50% of the streambank surface covered by vegetation. 5 4 3 2 1
11. Grazing or Other Disruptive Pressure SCORE 14	Vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally. 20 19 18 17 16	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. 15 14 13 12 11	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. 10 9 8 7 6	Disruption of stream-bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height. 5 4 3 2 1
12. Riparian Vegetative Zone Width SCORE 12	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. 20 19 18 17 16	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. 15 14 13 12 11	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. 10 9 8 7 6	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities. 5 4 3 2 1

Total = 183

APPENDIX F

FLOWING WATER BODY FIELD DATA FORMS

3800-FM-WSFR0086 9/2005

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

FLOWING WATERBODY FIELD DATA FORM

(Information and comments for fields boxed in double lines are required database entries. Other fields are optional for personal use.)

Date-Time-Initials* Example 20040212-0312-XYZ	20090518-1420 - ASC (Date Time Initials)	State Water Plan	Stream Code	Ch. 93 Use
		03A	2227	CWF
Secondary Station ID		Surveyed by: ASC		

*Date as YYYYMMDD, time as military time, and your initials uniquely identify the stream reach.

Survey Type

(1) Basin Survey, (2) Cause / Effect, (3) Fish Tissue, (4) Intensive Surface Waters Assessment (UW) Follow-up, (5) Point-of-First-Use, (6) SERA, (7) Antidegradation (Special Protection), (8) Toxics, (10) Use Attainability, (11) WQN

Location

County: Schuylkill Municipality: Walker Township

Location Description: Just upstream of confluence with Cold Run on Mainstem

Land Use

Residential:	0.04 %	Commercial:	%	Industrial:	%	Cropland:	30 %	Pasture:	14 %
Abd. Mining:	%	Old Fields:	%	Forest:	56 %	Other:	%		

Land Use Comments:

Canopy cover: ☐ open ☐ partly shaded ☒ mostly shaded ☐ fully shaded

Water Quality

Habitat evaluated? ☒ Yes (score 199) ☐ No Stream type: ☒ freestone (cold/warm) ☐ limestone ☐ limestone-influenced

Flow measurement taken: ☐ Yes ☐ No

	Collector-sequence #	Temp (°C)	DO (mg/L)	pH	Cond. (umhos)	Bottles used/notes (N-normal, MNF-metals non-filtered, MF-metals filtered, B-bac't, Others: indicate)
1.		13.1	9.27	7.08	92.1	
2.					119.3	
3.					0.1	

(Field Meter Readings: Temp, DO, pH, Cond.)

Findings

Not Impaired:	☐	Impaired biology?	☒	Impaired habitat?	☐	Is impact localized?	☐	Reevaluate designated use?	☐

Decision comments. Describe the rationale for your "Not Impaired" or "Impaired" decision; reach locations for use designation reevaluations; special condition comments; etc.:

Common descriptors: Water Odors - none, normal, sewage, petroleum, chemical, other; **Water Surface Oils** - none, slick, sheen, globs, flecks; **Turbidity** - clear, slight, turbid, opaque; **NPS Pollution** - no evidence, some potential, obvious; **Sediment Odors** - none, normal, sewage, petroleum, chemical, anaerobic; **Sediment Oils** - absent, slight, moderate, profuse; **Deposits** – none, sludge, sawdust, paper fiber, sand, relict shells, other. **Are the undersides of stones deeply embedded black?**

l

AQUATIC BIOTA (general)

Periphyton*: ☐ Filamentous Algae*: ☐ Macrophytes*: ☐ Slimes*: ☐ Macroinvertebrates**: ☐ Fishes**: ☐

* Relative Abundance (RA) (0 = absent, R = rare, P = present, C = common, A = abundant, VA = very abundant)
** For more detailed macroinvertebrate surveys, use Unassessed Waters form (pg. 2) for RA data; for fish, use the section below)

Preserved Macroinvertebrate Sample ? ☒ Yes ☐ No **Label ID, if yes:** 1

Sampling method: Std. kick screen: ☐ D-frame: ☒ Surber: ☐ Other: ☐ method?: ______

FISHERIES DATA

Sampling Duration (min): ____ **Distance (m):** ____ **Widths (m):** ____, ____, ____ = (avg.) ____ **Area (m^2):** ____

Habitat Complexity/Quality: ☒ excellent ☐ good ☐ fair ☐ poor ☐ very poor

Flow: ☐ flood ☐ bank full ☒ moderate ☐ flow

Crew: ______ **Gear Used:** ______ **Current** (AC/DC): ______

Gear/Crew Performance/Comments: ______

Preserved Fish Sample ? ☐ Yes ☐ No **Label ID, if yes:** ______

Genus/Species	Adults	Juveniles	Anomalies

Comments/Abundance Notes:

Comments: ______

3800-FM-WSFR0086 9/2005

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

FLOWING WATERBODY FIELD DATA FORM

(Information and comments for fields boxed in double lines are required database entries. Other fields are optional for personal use.)

Date-Time-Initials* Example 20040212-0312-XYZ	20090518 - 1515 - ASC (Date / Time / Initials)	State Water Plan	Stream Code	Ch. 93 Use
		03A	2227	CWF
Secondary Station ID	2	Surveyed by: ASC		

*Date as YYYYMMDD, time as military time, and your initials uniquely identify the stream reach.

Survey Type

(1) Basin Survey, (2) Cause / Effect, (3) Fish Tissue, (4) Intensive Surface Waters Assessment (UW) Follow-up, (5) Point-of-First-Use, (6) SERA, (7) Antidegradation (Special Protection), (8) Toxics, (10) Use Attainability, (11) WQN

Location

County: Schuylkill

Municipality: Walker Township

Location Description: Mainstem upstream of UNTs at Valley Rd.

Land Use

Residential:	%	Commercial:	%	Industrial:	%	Cropland:	8.4%	Pasture:	16 %
Abd. Mining:	%	Old Fields:	%	Forest:	75.6%	Other:	%		

Land Use Comments:

Canopy cover: ☐ open ☐ partly shaded ☒ mostly shaded ☐ fully shaded

Water Quality

Habitat evaluated? ☒ Yes (score 183) ☐ No

Stream type: ☒ freestone (cold/warm) ☐ limestone ☐ limestone-influenced

Flow measurement taken: ☐ Yes ☒ No

	Collector-sequence #	Field Meter Readings: Temp (°C)	DO (mg/L)	pH	Cond. (umhos)	Bottles used/notes (N-normal, MNF-metals non-filtered, MF-metals filtered, B-bac't, Others: indicate)
1.		11.5	8.60	6.55	59.0	
2.					79.6	
3.					0.0	

Findings

Not Impaired:	☒	Impaired biology?	☐	Impaired habitat?	☐	Is impact localized?	☐	Reevaluate designated use?	☐

Decision comments. Describe the rationale for your "Not Impaired" or "Impaired" decision; reach locations for use designation reevaluations; special condition comments; etc.:

Common descriptors; Water Odors - none, normal, sewage, petroleum, chemical, other; Water Surface Oils - none, slick, sheen, globs, flecks; Turbidity - clear, slight, turbid, opaque; NPS Pollution - no evidence, some potential, obvious; Sediment Odors - none, normal, sewage, petroleum, chemical, anaerobic; Sediment Oils - absent, slight, moderate, profuse; Deposits - none, sludge, sawdust, paper fiber, sand, relict shells, other. Are the undersides of stones deeply embedded black?

2

AQUATIC BIOTA (general)

Periphyton*: [P] Filamentous Algae*: [0] Macrophytes*: [P] Slimes*: [0] Macroinvertebrates**: [C] Fishes**: [P]

* Relative Abundance (RA) (0 = absent, R = rare, P = present, C = common, A = abundant, VA = very abundant)
** For more detailed macroinvertebrate surveys, use Unassessed Waters form (pg 2) for RA data, for fish, use the section below)

Preserved MacroInvertebrate Sample ? [X] Yes [ ] No Label ID, if yes: 2

Sampling method: Std. kick screen: [ ] D-frame: [X] Surber: [ ] Other: [ ] method?: _____

FISHERIES DATA

Sampling Duration (min): ____ Distance (m): ____ Widths (m): ___, ___, ___ = (avg.) ____ Area (m^2): ____

Habitat Complexity/Quality: [X] excellent [ ] good [ ] fair [ ] poor [ ] very poor

Flow: [ ] flood [ ] bank full [X] moderate [ ] flow

Crew: _____ Gear Used: _____ Current (AC/DC): _____

Gear/Crew Performance/Comments: _____

Preserved Fish Sample ? [ ] Yes [X] No Label ID, if yes: _____

Genus/Species	Adults	Juveniles	Anomalies

Comments/Abundance Notes:

Comments: _____

APPENDIX G

PROBABLE CONSTRUCTION COST OPINION

RETTEW
We answer to you.

Beaver Creek Watershed Probable Construction Cost Opinion

Site	Min Cost	Max Cost
1-2	$15,000	$30,000
7-8	$3,500	$7,000
12-14	$15,000	$30,000
24	$15,000	$25,000
33-34	$15,000	$30,000
39-40	$35,000	$55,000
43-44	$12,000	$25,000
47-48	$20,000	$35,000
49-50	$25,000	$40,000
	$155,500	$277,000

RETTEW Associates, Inc. is not a construction contractor and therefore probable construction cost opinions are made on the basis of RETTEW's experience and qualifications as an engineer and represent RETTEW's best judgment as an experienced and qualified design professional generally familiar with the industry. This requires RETTEW to make 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 RETTEW has no control. Given these assumptions which must be made, RETTEW 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 cost will not vary from the Probable Construction Cost Opinion prepared by RETTEW.

APPENDIX H

PROFESSIONAL QUALIFICATIONS

Aaron S. Clauser, Ph.D., CPESC - 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 has given oral presentations at conferences held by the Ecological Society of America, American Society of Limnology and Oceanography, 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. He is familiar with the 1987 *Corps of Engineers Wetland Delineation Manual*. Dr. Clauser has both conducted and been accepted as an expert witness regarding wetland delineations. 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 UVR.

Mark A. Metzler, NICET II – Mr. Metzler has an associate's degree in Wildlife Technology from the Pennsylvania State University and is certified by the National Institute for Certification in Engineering Technologies in Land Management and Water Control/Erosion and Sediment Control. Mr. Metzler has ten years experience working in the environmental regulatory community (Lancaster County Conservation District) and seven 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 US Corps of Engineers. In addition, he received soil mechanics training from the US 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 three TMDL implementation plans for the Commonwealth of Pennsylvania and US 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.

Bryan J. Kondikoff – Mr. Kondikoff has a bachelor's degree in Biology/Ecology from Millersville University. During his employment and course work, he has been trained to conduct wetland delineations in PA and is familiar with the 1987 *Corps of Engineers Wetland Delineation Manual* and 1989 Federal Interagency Manuel. While attending Millersville, he has also been trained in various stream bioassessment protocols in the eastern U.S. region by completing research in Lancaster County, PA on the long-term effects of stream remediation on both the aquatic macroinvertebrate and fish communities. Mr. Kondikoff has also participated in several internships with The Stroud Water Research Center in Avondale, PA as an Aquatic Biologist and for the PA Department of Environmental Protection in their Water Quality/Vector Management division. He was also employed by The Stroud Water Research Center and

Millersville University, both as a Research Assistant, to conduct numerous water quality assessments in PA, NY, DE, MD, and NJ.

Joel M. Esh – Mr. Esh has an Associate in Specialized Technology Degree in Computer Aided Drafting and Design from York Technical Institute and 6 years of experience at RETTEW. He is responsible for the technical workload of the Natural Sciences department, including computer-aided drafting and design (CADD), global positioning systems (GPS), and geographic information systems (GIS). He has created and been involved with the design of stream restoration plans, dam removal plans, pond restoration plans, wetland mitigation plans, and wetland delineation plans. Additional training has included Introduction to Stream Processes and Ecology by Canaan Valley Institute and West Virginia University. When working in the field, he has assisted with data collection and surveying for stream design and wetland delineations in PA, NY, and DE using the 1987 *Corps of Engineers Wetland Delineation Manual*. Utilizing GIS information, he has obtained and analyzed information for watershed assessments and created maps for grant applications and other uses. He has also been involved with cultural resources by performing site visits for documentation of buildings and bridges and creating plans for historic survey forms. In his first four years at RETTEW, he worked in the Transportation Engineering department, where he has directed data collection, prepared traffic engineering analysis, and completed PENNDOT plans involving right-of-way, traffic signals and highway occupancy permits utilizing PENNDOT resources.

Derek R. Faust - Mr. Faust is a senior pursuing a bachelor’s degree in Environmental Science and a minor in Chemistry from Elizabethtown College. He also spent a semester studying abroad at the School for Field Studies Center for Marine Resource Studies in the Turks & Caicos Islands. He has previous work experience in a laboratory setting with World Resources Company.

Julia L. Moore - Ms. Moore obtained her bachelor’s degree in Biology with an emphasis in ecology/environmental studies from Lock Haven University. Her degree also specialized in marine biology, which she studied at the Marine Science Consortium on Wallops Island, VA.