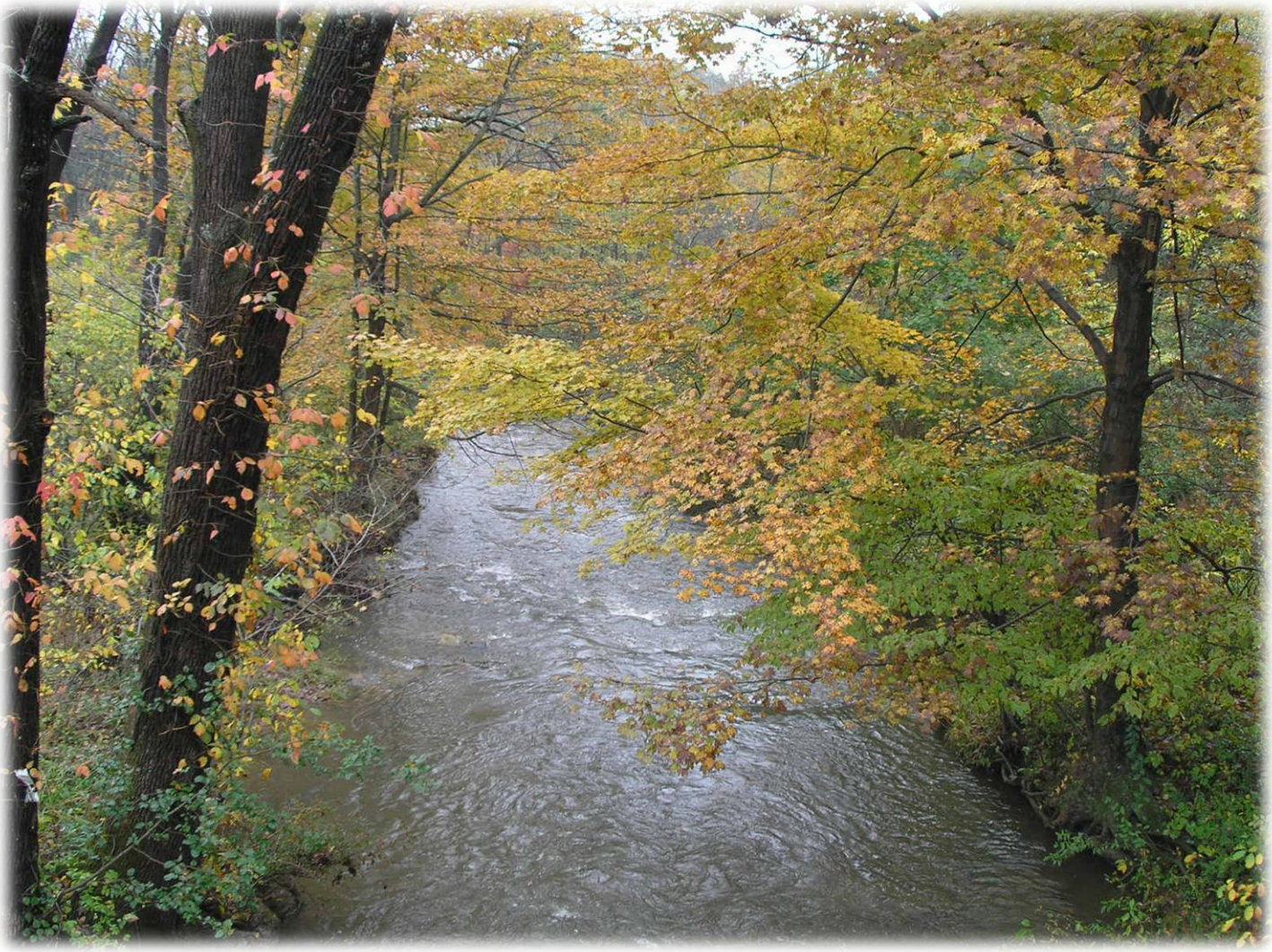
TROUT CREEK WATERSHED ASSESSMENT



This project was prepared by the Lehigh County Conservation District and funded by the Coldwater Heritage Partnership.

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TROUT CREEK WATERSHED ASSESSMENT

Need for Study

While all the other assessments carried out by the Lehigh County Conservation District over the past decade have been aimed at determining the causes for impairment, the assessment of the Trout Creek provided the opportunity to assess a stream which still meets the standards for its designated uses. With less intensive development and lighter industrial use, studying the Trout Creek provided the chance to locate exceptional stream quality where it still exists in Lehigh County, and also determined what threats may face the Trout Creek in the coming future years. Indeed, the Trout Creek has not been comprehensively studied for its eligibility for an upgrade to a designated use of High Quality (HQ) Cold Water Fishes (CWF), or even Exceptional Value (EV). Several tributaries to the Maiden Creek headwaters, located in the directly adjoining watershed, recently qualified for an existing use upgrade to EV; there is reason to believe that the headwaters of the Trout Creek, located along the pristine Blue Mountain, may be similarly eligible for an upgrade.

Scope of Work

This assessment consisted of a number of separate components:

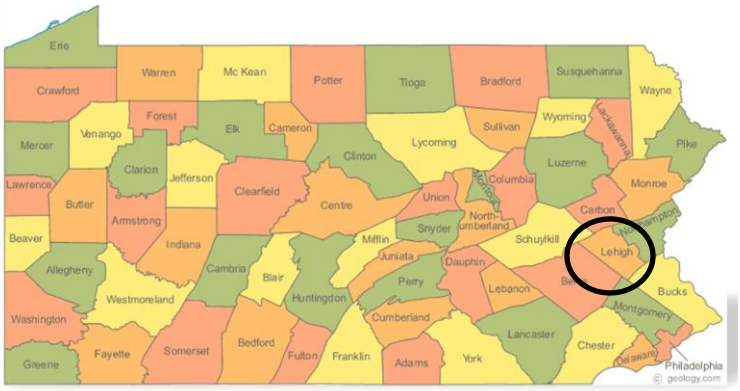
- Full stream visual assessment – Using a modified protocol from the USDA (United States Department of Agriculture) (the same one used for the Little Lehigh and Saucon Creek Assessments), the main stem of the Trout Creek and its major tributaries were traversed and assessed. The majority of the work was primarily done by the Lehigh County Conservation District and volunteers from municipalities.
- Complete watershed National Pollutant Discharge Elimination System (NPDES) permit analysis with Global Positioning System (GPS) coordinates - The existing and historic NPDES files were searched to determine open NPDES (discharge) permits in the watershed. Each site was visited to analyze the potential of these discharges to impact water quality. The sites were mapped, and described.
- Public and municipal meetings – An initial meeting was held for municipalities located in the Trout Creek watershed to discuss their concerns and where they saw opportunities. A second meeting was scheduled to gather historical and contemporary watershed information. One of the topics for this meeting was to ask long-time watershed residents for their recollections and photographs of historic conditions which have changed over time. Individual interviews were carried out by District personnel, municipal staff (particularly long-time public works staff), and local anglers. A representative of the Conservation District also visited municipalities to gather historical information to add to this report. A third meeting will be held to educate the public and municipal officials on the findings.
- Historical aerial photographs and land use analysis – Aerial photographs and land use maps from the 1930's, the 1970's and early 2000's were created, detailing the changes in land uses from the 1930's to present. Land use types include agriculture, forest, highway, industrial, suburban, and urban.
- Effort to create a Trout Creek Watershed Association - At the third meeting, the concept of creating a watershed association will be presented, and interest galvanized in creating a watershed association for the Trout Creek will be gauged. Working with new watershed groups is part of the mission of the Watershed Specialist program; if there is sufficient public interest, a new group will be formed.

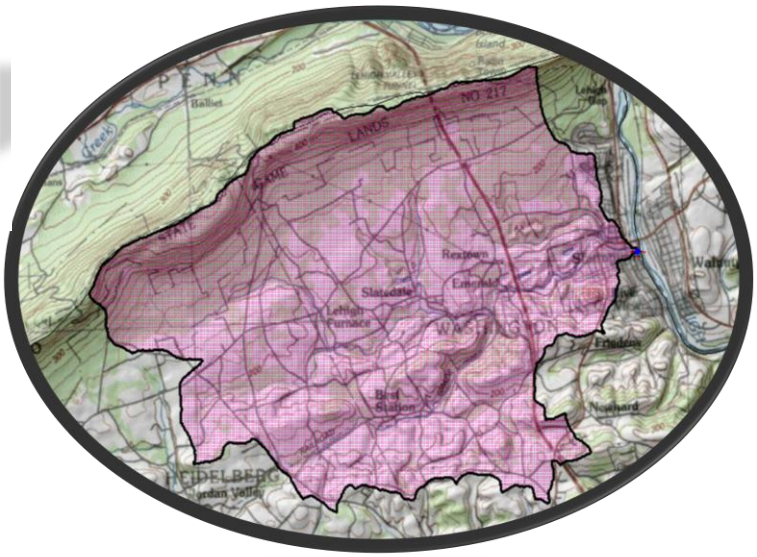
- Watershed assessment report - Based upon the recently-completed model of the Saucon Creek Watershed Conservation Management Plan and the Coplay Creek Watershed Assessment, this final report has been created. This report contains maps, analysis of the visual assessment data, historical information, and next steps for developing recommendations to improve the water quality. This report is vital to municipal governments and other decision-making stakeholders as they make land use decisions and efforts to effectively protect the natural resources.

STUDY AREA & BACKGROUND INFORMATION

Location and Background Information

The Trout Creek watershed is located in Heidelberg and Washington Townships, and the Borough of Slatington, Lehigh County, Pennsylvania. The total watershed area is twenty-two square miles, with over thirty-four stream miles of the mainstem and tributary streams. The designated use for the entire watershed is Cold Water Fishes. At the present time, no portion of the Trout Creek, or its named tributaries, is listed as "impaired." That makes the Trout Creek unique in Lehigh County, where all the other major streams are impaired at least in part. The designation for the Trout Creek has not been revised in some time, and there is reason to believe that some portions of the Trout Creek, particularly those along the Blue Mountain, may qualify for upgrade to High Quality Cold Water Fishes. This study would carry out the work to make this determination.





Public Access

The Slate Heritage Trail runs along the mainstem of the Trout Creek for over three miles, providing ample public access and educational opportunities. Additionally, there are three public parks situated along the Trout Creek.

Fishery

The Trout Creek was most recently surveyed for fish in June of 2010. There is a naturally reproducing population of brown trout, and the stream is stocked with both rainbow and brown trout. The stream does not reach the level of qualifying as a Class A Trout Stream, but with improvements in water quality, has the potential to reach that qualification.

Geology

The shape of the landscape, the characteristics of the water, and the form that streams take are all influenced by the geology of the region. The Trout Creek watershed is mainly comprised of the Pen Argyl Member and Ramseyburg Member. The Pen Argyl Member is comprised of slate with minor phyllite and shale beds. The Ramseyburg Member is composed on alternating turbide sandstone units with interbeds of shale and siltstone. Both the Pen Argyl Member and Ramseyburg Member are defined members of the Martinsburg formation. The Martinsburg formation consists of gray to dark gray, and infrequently tan and purple shale and slate. It lies between Blue Mountain and the areas underlain by limestone. Limestone rocks, generally speaking, tend to be softer, and usually form valley-bottoms; whereas siltstone, sandstone, and shale silicon-based rocks tend to be more resistant to weathering and form ridges. Limestone rocks are often also prone to forming sinkholes (and caves). Map: Geology shows the division between each member.

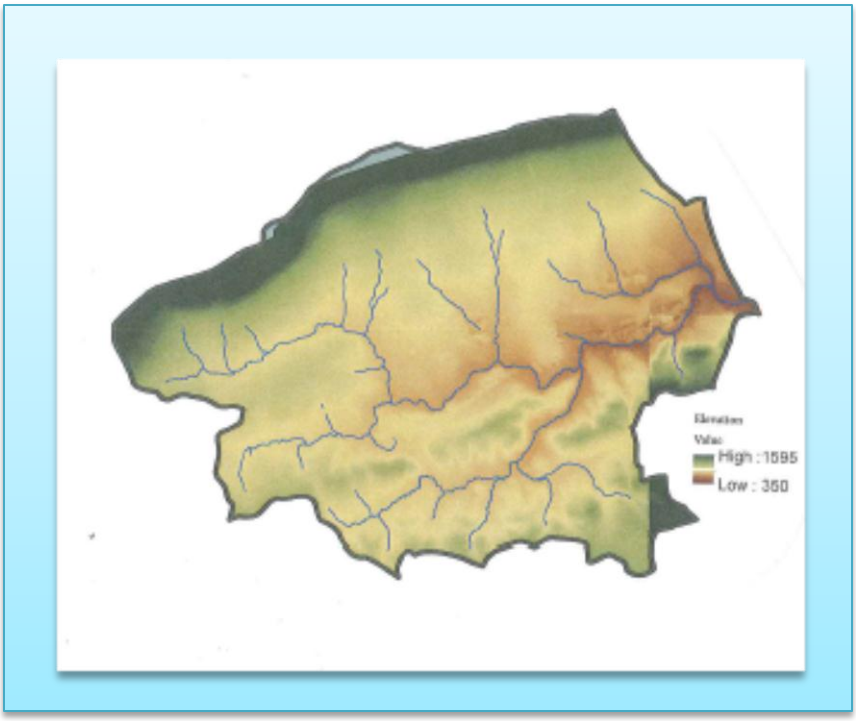
Soils

The specific soil characteristics of a watershed are extremely important in determining the land use and runoff patterns in a watershed. Soils have widely varying characteristics in factors such as nutrient levels and drainage rates. These soil characteristics determine what types of land uses are suitable in different locations (i.e., crops, pasture, recreational trails or fields and development). The rate at which water infiltrates, or soaks, into soils also has a significant impact on watershed runoff patterns. Soils with high infiltration rates, such as sandy soils, produce less overland runoff; soils high in clay are typically less permeable, and will produce more runoff. See Map: Soils to view the soils types of the Trout Creek watershed.

The upper portion of the watershed is primarily composed of Laidig soils, which are deep, well-drained soils that commonly have many stones and boulders on the surface. In forested areas, these soils have a thin, black layer of organic matter on the surface, and a light yellowish-brown, mineral surface layer. Their subsoil is strong brown or red. The lower portion of the watershed is primarily composed of Berks-Weikert; soils that are well drained. Holly and Comly silt loams, which have moderately slow drainage, are the major soils along the stream channels. The slower drainage rate in the floodplain allows for the retention of floodwaters and the growth of hydrophilic (water-loving) vegetation.

Topography

Elevations in the Trout Creek watershed range from 1595 feet above sea level to 350 feet above sea level.



HISTORY & LAND USE

Trout Creek Watershed History

This section is summarized from information contained in Images of America – Slatington, Walnutport, and Washington Township, The Multi-Municipal Comprehensive Plan for The Northern Region of Lehigh County, and Historical Markers, Slatington, Walnutport, and Washington Township, publications provided by the Borough of Slatington, Heidelberg Township, and Washington Township.

Slate was king in the appropriately named Borough of Slatington and the surrounding areas. The first slate quarry was opened and began operating in 1848. The slate industry expanded rapidly, and the villages were fully equipped with business to fulfill the residents' needs. Slate was used for blackboards, shingles, countertops, and many other items, which gave way to a thriving industry and towns such as Slatedale, located in Washington Township. More than one hundred quarries were located in Slatington, Walnutport, and Washington Township.

The Lehigh River and the construction of the Lehigh Canal assisted the slate industry by providing a means of transporting products to market. These waterways were also important for the transportation of coal from Mauch Chunch (present-day Jim Thorpe) to Philadelphia, bringing people through the area and facilitating trade. Many tall walnut trees flourished along the Lehigh Canal, as that is how Walnutport got its name. Walnutport's economy was driven by the area's zinc, coal, and slate industries. Traffic on the Lehigh Canal gave way to the railroads, which also played an important role in this hotbed of small industry. Not only did freight trains travel through the area carrying goods, but a trolley service also transported people across the region.

Historical Aerial Photography Study and Land Use

The land use in a watershed plays a significant role in the health of the stream system. It is both the amount, and the location of each kind of land use (agriculture, suburban, urban, etc.), in relation to the stream and its tributaries that influences the amount of runoff entering the stream, as well as the overall water quality. For example, a farm field located directly adjacent to a stream will contribute a higher sediment load than would a forest patch, while a farm field separated from the stream by a large swath of forest will have much less impact. A paved parking lot located next to a stream will provide a great deal of stormwater runoff containing road salts and oil from poorly maintained vehicles. So, it is not simply the type of land use that impacts water quality, but the distribution of that land use in relation to the stream channels.

Method

Land use has changed dramatically throughout the Lehigh Valley region over the past century. The extent and rate of the changes in land use are important factors in assessing the current health of the Trout Creek. It is possible to analyze the changes in land uses over time using historical aerial photography. These photographs are available for the area starting back in the late 1930's. This report includes Maps of the historical aerial photographs for 1938 and 1971, and aerial photograph for 2009 and their corresponding land uses.

Findings

Substantial changes have taken place in land use in the Trout Creek watershed since 1938. A decline in agriculture came largely at the expense of urban and suburban growth.

Land Use Impacts on Streams

Impervious cover

One critical aspect of the effects of differing land uses on water quality is the amount of the land use that is covered with impervious surfaces, such as roofs and roads that do not absorb any rainfall. A forest absorbs, infiltrates, or uses most of the precipitation that falls on it; a paved industrial complex will absorb almost none.

Determining the amount of a watershed that is currently impervious is an important tool in watershed management. Sources vary as to the exact number, but there is general agreement that, when a stream's watershed reaches certain threshold of impervious surface, the quality of the stream declines rapidly. Using the aerial photos and land use maps, you can see the agricultural land uses changes to suburban and forest.

NPDES Permit Analysis

The NPDES (National Pollutant Discharge Elimination System) program is a nation-wide system of permits required for any site or industry which has a point-source that discharges wastewater or stormwater. NPDES permits are a requirement of the Clean Water Act of 1972. As part of this study, an analysis was done of existing permitted discharges in the watershed. The analysis concluded that the majority of the permits are sewage, non-publicly owned (non-muni). Map: NPDES Sites shows permitted discharges.

Conversion from Agriculture to Suburban Land

Since 1938, agricultural lands in the Trout Creek watershed have been overtaken by suburban development, and by newly re-grown forests. People generally assume that this change – from agriculture to suburban development – means that water quality declines. But that is not necessarily so. Suburban development contributes different pollutants to the streams than agriculture: contaminants to groundwater from septic systems, runoff from roads such as motor oil and road salts, and household chemicals washed down the drain. The sheer volume of runoff from all the additional impervious surfaces in a suburban development is substantial, as well, and can have well-documented negative impacts on streams.

But agricultural lands, while not as impervious as roads and rooftops, are often not particularly effective at infiltrating water. And there are other factors. In 1938, agricultural lands were farmed primarily with conventional practices, utilizing fertilizers, pesticides, and herbicides with little in the way of soil conservation practices. As can easily be seen on the aerial photos of the time, tilling often went right to the edge of the stream. Further, farmers often dredged streams, moved them, and drove equipment across them. Livestock often had unrestricted access to streams. Uncontrolled agricultural runoff would have contributed chemicals and sediment in large quantities to the streams. So historically, agriculture severely impacted stream health as well.

Thus, the shift from agricultural lands to suburban development does not, by itself, necessarily create obvious conditions for water quality degradation. Separating out the influence of the conversion from agriculture to suburban development can be difficult.

Quarries

Industrial land uses –primarily quarrying – have been substantial in the Trout Creek watershed since the mid-19th century. Quarrying has had, and continues to have, a significant impact on the water resources of the region. First of all, blasting and pumping associated with the quarry places fine sediments directly into the Trout Creek. Pumping also decreases the volume of the stream's base flow, or year-round flow from groundwater sources. This happens because the quarry holes intersect with the groundwater aquifers, capturing water that would normally provide base flow in the stream. In order to keep quarry holes dry, quarry operators pump this water out. The pumped groundwater is discharged directly to the stream. When pumping is not done continually, it can create significant variations in stream flow, with impacts similar to stormwater discharges. When the quarry ceases operations, pumping of the holes stop and there is a temporary decrease in base flow until the caverns fill up. In extreme cases with very large operations, this has caused streams to dry up for several years before the base flow could return; however, the size of the active quarries in the Trout Creek watershed would have a minor impact.

Further, as can easily be seen on the 2009 aerial photos, the abandoned quarry holes are filled with water. There is some discussion as to whether the water in these holes is still diverting base flow from the streams. But, generally speaking, the water quality in these quarry holes is excellent, with very cold temperatures and little in the way of pollutants. These pits, if managed correctly, may become valuable wildlife habitats for wetland and water creatures. Sometimes, they are even used as recreation areas. Quarry reclamation can include turning quarries into recreational spots such as parks and fishing holes. It is known that scuba diving has even evolved due to management and reclamation of abandoned quarries. Since quarrying is only a temporary land use, it is essential to look at the positive environmental impacts on your community once the quarrying operation becomes abandoned.

Conclusions

In 1938, land use in the Trout Creek watershed was primarily agriculture. By 2009, this had shifted to a mixture of suburban and forest land. Each of these different land uses is associated with different types of pollutants and stormwater runoff. While the land use changes undoubtedly had significant impacts on the water quality of the Trout Creek and its tributaries, it is difficult to say whether the overall impacts would have been positive or negative. It would be possible through a watershed hydrological analysis to project some of the expected impacts. Development of specific recommendations to improve water quality would require further understanding of the contributions of each type of land use to the stream's impairment. To accomplish this, more in-depth water quality testing and biological analysis would be required.

Recommendation: Conduct a watershed hydrological analysis with additional water quality testing and biological analysis to assess the impacts of each land use on stream health.

VISUAL ASSESSMENT

Background and Method

As part of this study, a full visual assessment was carried out on the main stem of the Trout Creek. To accomplish this, the stream was broken down into reaches, using aerial photos to determine reach breaks where they would be visible on the ground. Reaches varied in length. Map: Visual Assessment Reaches shows the breakdown of the reaches.

The visual assessment protocol used was generally based upon the United States Department of Agriculture (USDA)/Natural Resources Conservation Services (NRCS) Stream Visual Assessment Protocol, with modifications to the method so that it was easier to use. Additions were made to the standard protocol to collect data on the material on the stream bed, and in the stream banks, which will assist with future stream and floodplain restoration projects. The visual assessment protocol used excellent/good/fair/poor rating scale for certain parameters, and requested a narrative explanation of others. Hard copies of the visual assessment data sheets and the accompanying photographs have been created. An example of the visual assessment data sheet is included as Figure: Visual Assessment Data Sheet.

The parameters scored on a rating scale were:

- Hydrologic Alteration
- Riparian Zone
- Floodplain Access/Channel Incision
- Canopy Cover
- Nutrient Enrichment
- Barriers to Fish Movement
- In-Stream Fish Cover/Invertebrate Habitat

Also noted were:

- Riffles
- Material along the stream bottom
- Degree of sedimentation
- Invasive plant species
- Severe problems

FIGURE: VISUAL ASSESSMENT DATA SHEET

TROUT CREEK STREAM VISUAL ASSESSMENT PROTOCOL SHEET

Evaluator(s):

Organization:

Date:

Current weather conditions:

Approximate width of the stream:

Owners Name:

Reach ID:

Hydrologic Alteration (man-made changes to the stream)

□	Excellent	Natural Channel, currently no structures: bridges, retaining walls, dams, weirs, dikes or riprap.
□	Good	Single bridge at upstream end of reach, one structure present, riprap along less than 25% of the reach.
□	Fair	Altered channel; 25% - 50% of the reach with riprap and/or channelization, two structures present.
□	Poor	Greater than 50% of the reach with riprap and/or channelization, three + structures present.

Riparian Zone

□	Excellent	Natural vegetation (vs. manicured lawn) extends at least two stream widths on each side.
□	Good	Natural vegetation extends at least one stream width on each side.
□	Fair	Natural vegetation extends less than half of the stream width on each side.
□	Poor	Streambank edge is mowed grass, pavement, or concrete; filtering function is severely compromised.

Note: Small disturbances are acceptable if they do not reduce the filtering capacity (i.e. a path to access the stream.)

Floodplain Access/Channel Incision

□	Excellent	Channel is not incised. Both banks are low, allowing the channel to easily access its floodplain, or there is minimal erosion or incision (less than one foot) on an outside bend.
□	Good	Limited channel incision (one to two feet on outside bends) with adequate access to floodplain.
□	Fair	Floodplain access is moderately restricted by actively eroding, unvegetated banks (two to three feet.)
□	Poor	Channel is deeply incised (three + feet) and unvegetated. Floodplain is inaccessible. Some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent.)

Canopy Cover

□	Excellent	> 75% of water surface throughout the reach is shaded.
□	Good	> 50% shaded in the reach.
□	Fair	20 to 50% of the reach is shaded.
□	Poor	< 20% of the water surface in the reach is shaded.

Nutrient Enrichment

□	Excellent	Little algal growth on stream substrates.
□	Good	Moderate algal growth on stream substrates.
□	Fair	Overabundance of algal growth on stream substrates.
□	Poor	Severe algal blooms create thick algal mats in stream.

(Remember to take photographs of the reach facing upstream. Photograph any unique features, discharge pipes, and/or areas of concern.)

Barriers to Fish Movement

- ☐ There is NO barrier blocking the movement of fish.
- ☐ There is a barrier.

  Approximately how high is the barrier? _____

  Is the barrier natural or man-made? _____

In-stream Fish Cover/Invertebrate Habitat

Circle which habitat types are present in significant amounts (one stick does not = a significant amount!):

Riffles	Logs/woody debris	Deep pools (two times deeper than the prevailing water depth.)
Thick root mats	Overhanging vegetation	Boulders/Cobble
Leaf packs	Isolated/backwater pools	Undercut banks
	Dense macrophyte beds	Habitat improvement structures

- ☐ Excellent — 8 to 10 habitat types present in the reach.
- ☐ Good — 5 to 7 habitat types.
- ☐ Fair — 3 to 4 habitat types.
- ☐ Poor — 1 to 2 habitat types present in the reach.

Describe the structure of the reach. How many riffles are there? Where are the riffles located (i.e. on a bend or a straight section?) Approximately how long is each riffle? How deep is the deepest pool?

Describe the material along the stream bottom in riffles, runs, glides, and unvegetated bars (i.e. boulder, cobble, gravel, sand, silt, mud.)

Describe the degree of sedimentation. Are there riffles completely buried by the sediment, or are the gravel/cobble particles relatively uncovered? Is there mud over the entire bottom?

Are there stands of invasive plant species (i.e. purple loosestrife, Japanese knotweed, tree of heaven?) If so, how extensive is the problem?

In your opinion, are there any severe problems or unusual areas? What might be the cause?

Are there any recommendations that you can think of to improve the conditions of this reach?

Other notes (Are there good fishing pools? Nice stretches for kayaking? Birding opportunities?)

Hydrologic Alteration

This describes the degree to which the stream has been visibly altered or confined by human activity. Bridge crossings, retaining walls, dams, dykes, or rip-rap banks (lined with large rocks) are all considered alterations. These structures are of concern because they constrain the natural functioning of the stream channel, reduce habitat, and reduce natural conditions for aquatic wildlife. There is generally little that can be done about most of the stream alterations, as existing bridges and stabilized stream banks cannot be removed. The presence of in-line dams and rock dams was also noted; these structures, especially rock dams, can be removed to restore the streams and natural patterns.

Recommendation: Where feasible, when bridges are replaced, ensure that they are adequately sized to prevent acting as obstacles to the free movement of stormwater.

Recommendation: Remove all existing in-line dams and rock dams in the Trout Creek.

Riparian Zone

Ideally, all streams should be protected by a forested or meadow riparian buffer of full-height (i.e., not mowed) trees or meadow grasses. This buffer protects the stream from overland runoff, removes pollutants such as nutrients and silt, and stabilizes the bank with deep, thick root systems. Where ratings were other than "excellent", opportunities exist for improving the riparian buffer condition.

According to recent regulations put in place by the PADEP (Pennsylvania Department of Environmental Protection), all streams are best protected by a riparian buffer of at least 150'.

Recommendation: Where riparian buffers are less than "excellent", contact landowners with information about the benefits of riparian buffers and resources available to encourage their installation.

Floodplain Access/Channel Incision

A channel in a natural condition has low banks, less than a foot or so high, allowing the channel to easily access its floodplain during storm flows. When channels are deeply incised, there is enormous erosion pressure on the banks during flood flows, as fast-moving stormwater cannot reach the floodplain, spread out, and slow down.

Recommendation: Re-grade the streambanks where possible, creating shallow, vegetated areas.

Canopy Cover

The extent to which the stream is shaded by overhanging trees. This shading keeps the water cool, which is important for trout and other cold-water species of fish.

Recommendation: Plant trees along the streambanks in areas with minimal shade. This would be a good project for a volunteer organization.

Nutrient Enrichment

The amount of aquatic vegetation on the streambed and on the rocks on the stream bottom. The amount of aquatic vegetation generally reflects the amount of nutrients in the stream, specifically nitrogen and phosphorous. The excessive amount of vegetation becomes a concern when the algae begin to decompose and consume dissolved oxygen in the water column; fish are unable to survive when the dissolved oxygen in a stream falls below 6.0 mg/L. Sources of nutrients include lawn and farm fertilizers, poorly functioning septic systems, manure on fields, and sewage treatment plant discharges.

Recommendation: Follow-up with landowners whose property has significant nutrient enrichment with suggestions for improving the riparian buffer, and decreasing the amount of nutrients reaching the stream.

Recommendation: Take dissolved oxygen measurements in areas with severe nutrient enrichments.

In-stream Fish Cover/Invertebrate Habitat

This includes riffles, thick root mats, leaf packs, logs, and other woody debris, overhanging vegetation, pools, boulders, undercut banks, and any habitat improvement structures built as part of a stream improvement project. This parameter measures how much habitat there is for both fish, and the aquatic insects that the fish eat, such as mayfly larvae. Where desired, habitat improvements can be made through simple projects which can be carried out by community groups.

Recommendation: Install fish and macroinvertebrate habitat improvement projects where recommended. Improvement projects could include root wad revetments, log veins, or strategic placement of large boulders.

Degree of Sedimentation

In addition, the assessment examined the degree of stream bottom sedimentation. A stream in a natural condition will have a bottom comprised of large gravel and small boulders. When the stream bottom is largely covered with fine sediment (silt and mud), habitat for fish and aquatic macroinvertebrates is degraded. There are several causes for this sedimentation including excessive stormwater runoff with inadequate stormwater controls, erosion of steep stream banks, and fine sediment being discharged from activities.

Recommendation: Investigate a watershed-wide stormwater retrofit plan, which would examine all the areas where presently uncontrolled runoff could be treated and infiltrated back into the ground, or taken up by plants.

Recommendation: Develop plans for streambank stabilization projects and the planting of native riparian buffers on all the stream segments that rate as “fair” or “poor”, to control stream bottom sedimentation.

Invasive Plant Species

The visual assessment made note of where invasive plants were a significant issue along the Trout Creek. ***Invasive*** plants are typically exotic species that were either intentionally or inadvertently introduced.

An ***exotic*** species is one that is not native, but has been introduced and has become established. In 1998, there were some 1,300 species of exotic plants in Pennsylvania (PA DCNR, 1998), and more introduced plants are identified every year.

A ***native*** plant is defined as one that occurred within the state before settlement by Europeans. Over 27% of the vascular plants species now growing within the borders of Pennsylvania are not native.

An invasive plant not only becomes established, but spreads aggressively into other areas and environments. Most invasive plants are introduced from other continents, leaving behind in their native homeland population controls like pests, diseases and predators, which serve to keep these species in check. Due to this absence of natural controls, invasive plants reproduce rapidly and can form stands that exclude nearly all other plants. In the process, they damage natural areas, altering ecosystem processes and displacing desirable native plant species. Invasive species found along the Trout Creek such as multiflora rose, purple loosestrife, knotweed, bamboo, autumn olive, and Japanese barberry, may pose a serious threat to the abundance and diversity of vegetation in the Trout Creek watershed.

Invasive species usually establish themselves first in disturbed areas and then quickly spread across the surrounding landscape. They threaten the ecology of naturally vegetated areas, as they do not provide appropriate food or habitat for native wildlife. For example, multiflora rose grows aggressively and produces large numbers of fruits that are eaten and dispersed by a variety of birds. Dense thickets of multiflora rose exclude most native shrubs and herbs from establishing and may be detrimental to nesting of native birds. Without taking steps to remove it, it is guaranteed to quickly spread.

The primary means of control for most invasive species is manually or mechanically removing them from the landscape. After removing invasive plants, care should be given to adequately treat and replant the disturbed soil with native seeds or native plant stock so that the invasive plants do not reseed the treated area. It is recommended that areas overrun with knotweed be mowed regularly and sprayed annually with an herbicide.

Recommendation: Carry out a stream-wide multiflora rose control program, contacting affected landowners with information on controlling the plant and strategies for removal and replanting.

WATER QUALITY

Water Quality Designations

All of the mapped streams in the Trout Creek watershed have been given water quality designations by the PA DEP in Title 25 PA Code Chapter 93. These designations are based upon the PA DEP evaluation of historic and present stream quality, and they set the standard for which the stream will be managed. The designation for the Trout Creek is Cold Water Fishes, Migratory Fishes.

Determining Water Quality

The PA DEP determines stream quality through sampling of the stream macroinvertebrates: the aquatic insects that live in the stream and on the rocks, fallen woody debris, and leaf packs in the stream. Fly fisherman are familiar with these insects because the "flies" they use imitate them, hoping to fool the fish into biting what looks like familiar food.

Aquatic macroinvertebrates have very different tolerances for habitat and water quality; some, like leeches and black fly larvae, are very tolerant of polluted and poor quality conditions. Others, like mayfly larvae, are more sensitive and require clean water and good habitat to survive. Therefore, the PA DEP determines water quality by sampling the aquatic insects and identifying which ones are living in a particular stretch of stream. Since these organisms live in the water for long periods, this is a more accurate way to measure stream health than taking water samples, which only reveal the water quality at the moment the sample is taken.

Impaired Streams

Every water body in Pennsylvania has a "designated use," assigned by the PA DEP. The designated use specifies the water quality standards that a stream, river, or lake is expected to meet. At the very least, water must be "fishable and swimmable." To achieve the "fishable" standard, water must not be too polluted for the fish that live in the water to be edible. The water must also have low enough bacteria levels to be safe for immersion (swimming). However, most of the streams in Pennsylvania have other, more strict standards associated with them, such as being clean and cold enough to support Cold Water Fishes (CWF), or being able to support an Exceptional Value (EV) ecological community. Each different designation has different water quality standards associated with it. These standards are located in the Pa Code Title 25, Chapter 93.

A water body is considered "impaired" when it does not meet the water quality standards associated with its designated use. None of the sections of the Trout Creek are designated as "impaired" by the PA DEP. When a stream is listed as impaired, it is required to develop a plan to return the stream to the higher water quality standard associated with its designated use. This plan is called a TMDL – Total Maximum Daily Load, and the development of a TMDL is mandated by the Federal Environmental Protection Agency (EPA) in accordance with the Clean Water Act. A TMDL plan locates the sources of the impairments, and calculates what pollutant load reductions are required to return the stream to its designated use. For example, if a watery body is designated as Cold Water Fishes, a sewage treatment plant can still discharge its treated water into that stream. However, the discharge cannot warm that stream to the point that it no longer meets the Cold Water Fishes standards. In the development of a TMDL, all the different pollutants entering a stream are analyzed, and measures taken to ensure that pollutant levels do not prevent the stream from meeting water quality standards.

Water Quality Data

Stream water quality is most effectively evaluated by looking at the biological community living in the stream, rather than by taking water samples and sending them off to a laboratory for testing. No matter how many water samples one takes, it is impossible to measure water quality continuously. By their nature, stream surface water testing is done at a particular moment in time – whenever the sample is taken. This means that only that small bit of water flowing by at that moment is tested. Those results say nothing about water quality during storms, or throughout the whole year. Further, laboratory sampling can only be done for some set number of parameters, such as nitrates, phosphates, maybe hydrocarbons, or bacteria. It would be impossible to test for all substances that could possibly be in the water.

Macroinvertebrate Sampling

The PADEP, the agency charged with the responsibility for water quality standards in Pennsylvania, uses benthic macroinvertebrate sampling to determine the condition of its streams and rivers. *Benthic* means "occurring at the bottom of a body of water," and macroinvertebrates are the animals other than fish living in the streams and rivers ('macro' means visible to the naked eye; 'invertebrate' indicates an animal without a backbone). Examples of stream benthic macroinvertebrates include mayfly larvae, crayfish, fly larvae, water pennies, and hellgrammites. Different types of macroinvertebrates have differing abilities to deal with pollution. Some, such as mayfly and caddisfly larvae, require clean water, a stream bottom largely free of fine sediment, and cool water temperatures. Others, such as black fly larvae, leeches, and planarian worms, can survive in all but the most polluted conditions. A healthy stream will have a large and diverse assemblage of these creatures, whereas an impaired stream will have very few species, and those present will be types that are very tolerant of pollution.

Water quality sampling in Pennsylvania is done by taking samples of benthic macroinvertebrates found on the stream bottoms. Those samples are identified, and the results determine if a stream is in excellent, good, fair, or poor condition.

EDUCATION & OUTREACH

In order to effectively address issues concerning natural resources, the appropriate knowledge base must exist within all aspects of the watershed community. Residents, government elected officials and staff, business owners, and schools all play essential parts in protecting and conserving the natural resources. It is not enough for a few natural resource professionals to understand the problems and the potential solutions; those solutions must be conveyed to and adopted by the people able to implement the solutions. So, it is public works staff that is able to keep salt-laden snow from being dumped into stream by storing plowed snow in fields. It is individual homeowners who must keep their septic systems working properly. It is government elected officials who must enact and enforce ordinances that effectively protect natural resources. And, for any of these actions to take place, the appropriate individuals or groups must understand the problem or issues, accept solutions, and then act upon them. This section highlights areas where efforts at outreach, education, and behavior changes may be needed.

Watershed Association

One of the most important and most pressing recommendations from this report is to create a community-based watershed association. Community-based watershed associations have taken a leading role in protecting the water and land resources within their boundaries across the state of Pennsylvania for many years. These local organizations are generally made up of citizen volunteers who take an interest in the health of the streams and rivers in their area. Watershed Associations use community participation, local leadership, and on-the-ground project development and construction to restore degraded waters and protect the health of pristine waters.

Government Elected and Appointed Officials

This group includes township supervisors, council members, planning commission and zoning hearing board members, and Environmental Advisory Council (EAC) members. These decision-makers must be well-informed in order to put in place sound regulations, and then implement those regulations to appropriately protect the resource. A strong zoning ordinance may do little good if exceptions are routinely granted.

Recommendation: Future education and outreach efforts to reach this group should include:

- Presentations at supervisors' and council meetings, and planning commission and zoning hearing board meetings to present the results of this report, and to determine where additional educational resources might be needed. Topics that may need to be addressed would include conservation easements, benefits of wetlands and wetland protection, and stream health.
- Once a Trout Creek Watershed Association exists, establish a watershed-wide EAC network to work on establishing common goals and working together on natural resource management throughout the watershed. Working on the recommendations from this document could provide a jumping-off point.
    - There is currently an EAC established in Heidelberg Township. An EAC should be created in both the Borough of Slatington and Washington Township.
- Establish a watershed-wide elected official network, bringing together Township Council members and supervisors and Borough Council members to discuss issues concerning zoning, regulation, and development. Regulatory consistency across municipal boundaries could be a goal of this network.
- Work with Zoning Hearing Boards and Planning Commissions to further their education and knowledge of natural resources and environmental protection, focusing particularly on the regulatory power these Boards have to influence how regulations are implemented.
- Once a Trout Creek Watershed Association is established, ensure a strong relationship between the Watershed Association and each of the governing boards of the municipalities.
- Update municipal officials regarding topics and projects that are affecting the Trout Creek watershed.

Municipal Public Works, Roads, and Utility Staff

Municipal staff has responsibility for a number of activities that can have a profound effect on water and natural resources. Among these activities are: mowing of municipally owned properties and roadsides, spraying of herbicides and pesticides, snow removal and road salting, maintenance and upgrade of infrastructure such as sewers and water lines, sewage treatment plants, and heavy equipment operation.

Recommendation: A general educational outreach program should be developed for municipal staff to keep them informed about the best management practices (BMPs) that affect the activities they carry out.

Municipal Attorney

Generally, the municipal governing board will have an attorney and the zoning hearing board may have another. These attorneys often have a significant voice in municipal decision-making. In many cases, these attorneys may take a conservative approach to environmental decision, encouraging bodies to routinely grant exceptions to environmental regulations, with the goal of keeping the municipality from being sued.

Recommendation: A comprehensive municipal attorney outreach and education program should be developed to keep this group informed about current case law, and about the importance of a long term strategy for protecting the municipal resource. The goal of this outreach would be to bring the attorneys on board in natural resource protection at the municipal level.

Municipal Engineers

Municipal engineers are involved with all aspects of development projects, and are often involved with the writing of zoning ordinances and SALDOs (Subdivision and Land Development Ordinances). Yet, their continuing education obligations often do not adequately keep municipal engineers up to date on the latest developments in natural resource conservation. Often, engineers take a "conservative" approach, mandating conventional practices, including non-native species in landscaping, mandatory soil compaction on construction sites, and wide curbed roads containing unnecessary impervious surfaces.

Recommendation: Outreach to municipal engineers should provide attractive opportunities to keep up to date on trends and technology related to development and municipal planning.

Landowners and Residents

Landowners falls into a number of categories: residential, commercial, and industrial. (Landowners also include developers and investment buyers, who own land as an investment; they are discussed in the next section.) It is the practices that landowners carry out on their land that has the greatest influence on water quality in the Trout Creek and its tributaries. For that reason, it is essential that effective outreach and education target this group, ensuring that they have the appropriate information to properly manage their land, and put in place conservation and best management practices that will protect the resource.

Recommendation: Specific efforts should be made to reach landowners in the following areas:

- Reach out to all streamside landowners informing them of the appropriate ways to care for streamside property and giving them opportunities to seek technical advice should they need it.
- Educate landowners about a wide variety of best management practices that affect residential and commercial property, including, but not limited to: care of septic systems, proper use of lawn and garden chemicals, dealing with stormwater, understanding the infiltration systems, such as rain gardens and swales, that may be on their property, how to dispose of household hazardous waste, washing vehicles on lawn areas, not on driveways, and the benefits of native vegetation. Other topics could include: use of detergents on sidewalks, dealing with lawn and garden waste and autumn leaves, landscaping with native plants, and pet waste.
- Watershed municipalities and the watershed association should carry out informational workshops for their residents to promote a sense that everyone has a stake in the health of the watershed, and that individuals can make a difference. Workshops should emphasize local examples.
- Ensure that all residents are aware of and have opportunities to connect with the Trout Creek Watershed Association. Incorporate watershed association materials into the municipal newsletters.

Developers

Reaching out to developers and investment property owners is challenging in any community. Developers often may not be residents, and may not have any ongoing connection to the communities in which they are developing, and thus may not be well-informed about local natural resource concerns. Because gaining zoning and development approvals can be complex and expensive, developers often come into the process already having invested considerable amounts in the planning, leaving them less interested in working around natural resource issues. Additionally, because each community in Pennsylvania regulates differently, developers may be dealing with many different ordinances, and may not have an interest in creative options. So, effective outreach to developers has to be proactive, making sure that information is easy to obtain, that the development process is as accessible and transparent as possible, and that creative options exist.

Recommendations: Specific suggestions for education and outreach to developers include:

- Carry out periodic workshops for developers and investment property owners on regulations in the watershed. Ideally, several municipalities could partner on workshops, even if their regulations differ, so that developers can achieve more "one stop shopping" for information.
- Carry out workshops on innovative techniques and environmental best management practices: rain gardens, green roofs, low impact development, etc. Inform this group about best methods to protect trees during construction. Make sure they understand the environmental harm caused by soil compaction, and are encouraged to use native plants in their landscaping designs.
- Work with developers to develop ways to inform future residents about the on-site stormwater facilities that may be on individual lots: swales, etc., so that these facilities are properly cared for.
- Have municipal EAC's contact new owners when larger parcels of land are purchased to carry out initial outreach about natural resource protection. Site visits can also be a valuable educational opportunity.

School Students and Staff

Schools can become involved with water and stream monitoring, and can carry out pertinent environmental projects. Advocacy for natural resources in schools can be an extremely effective strategy for reaching out to the community overall, since energized students frequently take home ideas to their parents. Parent-teacher organizations are also key for an even broader dissemination of stewardship practices.

Recommendation: To encourage greater participation from the school districts in protecting the natural resources in the watershed, the following should be executed:

- Prepare presentations for school children of various ages as well as the school boards and PTOs.
- Contact science teachers and discuss field trips, environmental lesson plans, and research-based projects.

Community Groups

There are numerous groups within the watershed carrying out a range of missions related to the community. These groups include church groups, girl and Boy Scout troops, historical societies, etc. With education, these entities have the chance to assist with natural resource protection projects while meeting their own objectives. Community groups serve as a major vehicle in spreading the word to a diverse assemblage of residents.

Recommendation: The following recommendations should be implemented to involve these groups:

- Invite group leaders to Watershed Association and EAC meetings.
- Notify groups of volunteer projects.
- Carry out presentations at monthly or regular organizational meetings.

Other Groups

The groups listed above certainly do not represent an exhaustive list of stakeholders. Outreach and education about natural resources is important for a variety of others. Among these are: planners, county elected officials, landscaping and nursery owners, and universities and colleges. Workshops and educational opportunities are recommended for any of these groups, or others not identified in this report, as the need exists.

NEXT STEPS & OVERALL RECOMMENDATIONS

Trout Creek Watershed Association: A Trout Creek Watershed Association should be formed to carry out education and outreach on issues of concern to water quality and stream health within the Trout Creek watershed. Example projects include:

- Carrying out outreach to all streamside landowners informing them of the appropriate ways to care for streamside property and giving them opportunities to seek technical advice should they need it.
- Educating landowners about a wide variety of best management practices that affect residential and commercial property, including, but not limited to: care of septic systems, proper use of lawn and garden chemicals, dealing with stormwater, understanding the infiltration systems, such as rain gardens and swales, that may be on their property, how to dispose of household hazardous waste, washing vehicles on lawn areas, not on driveways, and the benefits of native vegetation. Other topics could include: use of detergents on sidewalks, dealing with lawn and garden waste and autumn leaves, landscaping with native plants, and pet waste.
- Watershed municipalities and the watershed association should carry out informational workshops for their residents to promote a sense that everyone has a stake in the health of the watershed, and that individuals can make a difference. Workshops should emphasize local examples.
- Ensure that all residents are aware of and have opportunities to connect with the Trout Creek Watershed Association. Incorporate Watershed Association materials into the municipal newsletters.

Trout Creek EAC Network: Once a Trout Creek Watershed Association exists, establish a watershed-wide EAC network to work on establishing common goals and working together on natural resource management throughout the watershed. Working on the recommendations from this document could provide a jumping-off point.

    - There is currently an EAC established in Heidelberg Township. An EAC should be created in Washington Township and the Borough of Slatington.

Streambank Stabilization: Develop plans for streambank stabilization projects and the planting of native riparian buffers on all the stream segments that rate as "fair" or "poor," to control stream bottom sedimentation. Re-grading the banks where possible to create shallow, vegetated banks will also allow for additional floodplain storage.

Riparian Buffers: Where riparian buffers are less than "excellent," contact landowners with information about the benefits of riparian buffers and resources available to encourage their installation.

Flooding: Where feasible, when bridges are replaced, ensure that they are adequately sized to prevent acting as obstacles to the free movement of stormwater.

Flooding: Remove all existing in-line dams and rock dams in the Trout Creek.

Additional Water Quality Testing: Conduct a watershed hydrological analysis with additional water quality testing and biological analysis to assess the impacts of each land use on stream health.

Additional Water Quality Testing: Take dissolved oxygen measurements in areas with severe nutrient enrichments.

TMDL Development: This is a model which calculates how pollution loading needs to be decreased so that the stream can meet the water quality standards appropriate to its designated use. Municipalities, watershed landowners and businesses, and the community should participate in the development of the Trout Creek TMDL to ensure a watershed-wide buy in with the project.

Landowner Water Quality Improvement: Follow up with landowners whose property has significant nutrient enrichment with suggestions for improving the riparian buffer, and decreasing the amount of nutrients enriching the stream.

Stormwater Quality Improvement: Retrofits include measures such as wetland plantings and other measures designed to remove pollutants, and using grassy meadows to create sheet flow and infiltration. Retrofit existing stormwater basins to decrease the amount of water entering the stream during storm condition. Investigate a watershed-wide stormwater retrofit plan, which would examine all the areas where presently uncontrolled runoff could be treated and infiltrated back into the ground, or taken up by plants.

Invasive Plant Management: Carry out a stream-wide multiflora rose control program, contacting landowners with information on controlling the invasive plant and strategies for removal and replanting.

Fish and Macroinvertebrate Habitat: Develop and put in place fish and macroinvertebrate habitat improvement projects. Improvement projects could include root wad revetments, log veins, or strategic placement of large boulders.

Fish and Macroinvertebrate Habitat: Plant trees along the stream banks in areas without enough shade. This would be a good project for a volunteer organization.