Restoration Plan
for
Valley Run Watershed
Chester County, Pennsylvania
December 2008

Prepared for:
Brandywine Valley Association
Robert G. Struble, Jr., Executive Director
1760 Unionville-Wawaset Road
West Chester, PA 19382
(610) 793-1090
(610) 793-2813 fax

RED Streams BLUE
A BVA PROGRAM

Prepared by:
RETTEW Associates, Inc.
Natural Sciences Group
950 East Main Street, Suite 220
Schuylkill Haven, PA 17972
(570) 385-2270
(570) 385-2217 fax
RETTEW Project No. 07-07568-004

Prepared by:
Aaron S. Clauser, PhD, CPESC
Senior Environmental Scientist

Jonathan P. Kasitz
Project Biologist

Reviewed by:
Mark A. Metzler, NICET II
Watershed Specialist

TABLE OF CONTENTS

1.0 INTRODUCTION

"Red Streams Blue" is a program the Brandywine Valley Association has developed to focus on improving the water quality of impaired stream sections throughout the Brandywine Creek Watershed. Valley Run (a tributary to Beaver Creek, tributary to East Branch of Brandywine Creek) is an impaired or "red" stream due primarily to excessive urban stormwater runoff in the watershed. The PA Department of Environmental Protection includes the entire main stem of Valley Run on its 303d list of impaired stream reaches (DEP 2006).

The approximately 4.45 square mile Valley Run Watershed includes a diverse mix of land uses. Cover types range from relatively natural wooded ravines in the southern headwaters to high-density residential developments and commercial shopping centers along the Lincoln Highway corridor. In general, the sub-watersheds that contain more forested cover and less impervious cover along the stream corridor have better water quality.

This restoration plan for Valley Run Watershed addresses specific areas of impairment. With a clear plan for restoration, we may attain the greatest value from the recommended solutions and investments in the watershed.

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

Point source pollution is most often associated with industries or municipalities that discharge wastewater to natural waters through an outfall pipe or ditch. Point sources of pollution are relatively easy to measure and treat. Point source discharges of wastewater in the United States are regulated under the provisions of the Clean Water Act and must obtain discharge permits issued under the National Pollutant Discharge Elimination System (NPDES). An NPDES permit requires the discharger to meet certain technology-based effluent limits and perform effluent monitoring.

Unlike point sources, non-point sources of pollution occur over a wide area and are usually associated with large-scale land use activities such as agriculture, livestock grazing, mining, logging and development of impervious surfaces that result in increased amounts of stormwater runoff. Since there is not one specific point of discharge, non-point source pollution is more difficult to measure, regulate and treat because of the nature of the activities that cause it and the large-scale areas associated with generating the stormwater runoff. Non-point source pollution includes stormwater runoff that contains substances harmful to stream environments. Types of non-point source pollution common to residential and commercialized areas include petro-chemicals, salt, and debris from roads and parking lots, fertilizers and pesticides from mowed lawns, and most importantly, massive amounts of stormwater that flow unimpeded off parking lots, roof tops, roads and other impervious surfaces. The lack or the removal of vital riparian habitat components (such as the destruction of forested riparian buffers and historic filling of wetlands) is also a major cause of streambank erosion, reduced filtration, and water quality impairment.

1.1 Land Use Concerns

The main stem of Valley Run flows in an easterly direction just north of US Route 30, known locally as the Lincoln Highway. This road was one of the very first east-west thoroughfares crossing the Commonwealth, and has played a very important role in the development and growth of the southern portion of Pennsylvania; connecting Philadelphia to Lancaster, York and beyond. Many of the towns and cities that grew along this corridor became major industrial centers of the 19th and 20th centuries.

Prior to industrialization, the watershed has a legacy of agrarian use. These historical land uses, including clearing and grubbing of forests without erosion and sedimentation controls and farming practices that did little to minimize erosion, allowed for heavy sedimentation onto the valley floor after European colonization. Dams that were constructed throughout the watershed trapped and stored sediment in the valley bottoms thus reducing the original floodplain capacity and function. Riparian wetlands within these valley bottoms were also impacted by the accumulated sediments. As the dams failed or were breached, knick points formed and cut through the deposited sediment. The legacy of these activities resulted in a stream that is entrenched in the remaining sediment and largely disconnected from its floodplain (Walter and Merritts 2008).

Valley Run is situated between the industrial centers of Downingtown and Coatesville, which were very important paper mill and steel production centers. Shopping centers, residential development and other service industries and amenities followed the growth of these industrial centers. All of this growth led to high levels of impervious surfaces along the Lincoln Highway corridor, much of which drains directly to the main stem of Valley Run. Stormwater management for much of this early development focused on getting runoff from impervious surfaces such as roofs, parking lots, roadways and driveways directly to the stream channel as quickly as possible. The lack of stormwater volume and rate control devices led to significant alterations in the natural configuration of the channel, loss of stream meanders, decreased diversity of pool, riffle, and run patterns and corresponding destruction of the variety and abundance of aquatic habitat. The large amount of impervious surfaces within the watershed reduced infiltration and groundwater aquifer recharge. These alterations likely reduce stream base flow and influence the hydrology of riparian wetlands in the watershed.

Subsequent commercial and residential development occurring in the 1970's thru 1990's did implement some early stormwater control strategies. Unfortunately, stormwater rate control has not proven very effective for protecting water quality in the Valley Run Watershed. Significant improvements have been made in the science of stormwater management, and most assuredly, this science will continue to be improved over time.

Moving forward, innovative stormwater practices will be required to manage stormwater volume and quality. These practices will need to work within the constraints of the existing infrastructure. Stormwater retrofits for existing residential and commercial areas should be encouraged through educational programs and may be partially funded through grants and loans. Best management practices such as rain gardens, rain barrels, and maintenance (or implementation) of riparian buffers may be most appropriate.

Most of the watershed along the main stem and northern tributaries has been "built out". Redevelopment of "brownfields" should be encouraged. However, future land development in the watershed will likely focus on the more rural areas south of the Lincoln Highway corridor. Development in this area will undergo stringent regulatory review for stormwater discharge rate, volume and water quality. These more stringent regulations, which require the use of more effective stormwater best management practices (BMPs) and limit development of steep slopes, around wetlands and other sensitive areas, will likely be a marked improvement over the development of the remainder of the watershed. Diligence on the part of the local residents and municipal and county reviewers will be required to insure that these practices are implemented, and that development of the remainder of the watershed is done in a way that is sustainable and protects water quality. At the municipal level, subdivision and zoning ordinances that are sensitive to the natural resources of Valley Run should be reviewed periodically. Consistency with state regulations is necessary so that land development projects will protect the existing ground water recharge and surface water quality of the watershed.

2.0 METHODOLOGY

To determine the areas within Valley Run Watershed in need of most attention, Brandywine Valley Association representatives and RETTEW scientists conducted stream walks on June 17^{th}, 18^{th}, and 20^{th}, 2008. These walks included investigations of the main stem and major tributaries in the Valley Run Watershed. Photographs, field notes, and GPS coordinates were collected at areas identified as potential concerns. Where access was not permitted, impacted areas were identified by conducting windshield surveys from roadways and reviewing aerial photography provided by the Chester County GIS Department. Sources of impairment were identified at the parcel level.

RETTEW located the sample points and other features within the watershed using a Trimble Pro XH Global Positioning System (GPS) receiver 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 was downloaded to a personal computer for differential correction using GPS Pathfinder Office software (Version 3.1). Correction files were obtained from a dedicated base station located in West Chester, PA. Mission planning, parameter settings, and post processing typically allow an accuracy of less than (<) 1 meter. The precision of GPS collected data is subject to variation caused by canopy cover, atmospheric interference, time of day, and satellite geometry. GPS collected data should not be used in situations involving high property values, controversial projects, or in situations where legal questions may arise (Hook et al. 1995).

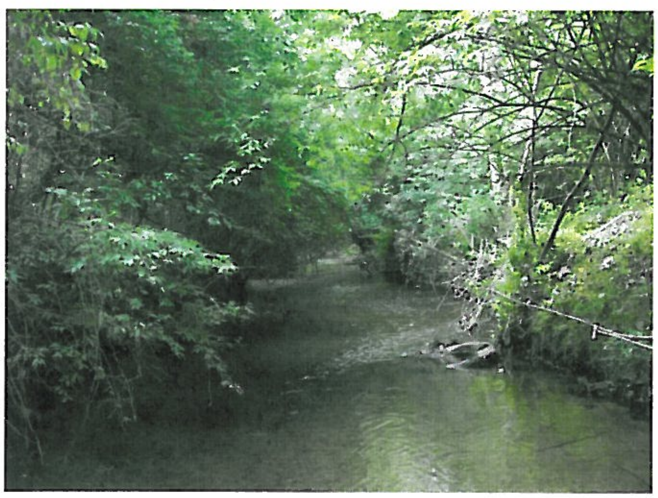
3.0 WATERSHED PROBLEMS AND SOLUTIONS

This section focuses on the sources and causes of impairment within the Valley Run Watershed and potential restoration practices that can be completed to address the noted impacts for high and medium priority areas. Low priority restoration projects are included in Appendix B. The cumulative effect of all of the problems and solutions is substantial in this watershed. Each impacted segment identification number can be cross-referenced with its approximate location on the map in Appendix A.

3.1 High Priority Projects:

Impacted Stream Segment #2-5:

This area of the watershed includes a large pond with Valley Run flowing along its western edge. The pond berm appears to be in need of maintenance as water from the pond is seeping through the berm/streambank along the top of a layer of clay soils, approximately 1-2' above the stream bed. The water is discharging into the stream. During high water conditions, water from the pond also likely overflows the berm and enters Valley Run. At the location of the overflow, an approximately 6' wide gully is down-cutting thru the berm. In the southwestern section of the pond berm, the stream is eroding the berm. The stream in this area appears straightened and has a silt bottom that lacks habitat.



Solution:

The stability of the pond berm should be immediately evaluated by a qualified engineer. The berm likely requires extensive repair to properly fix the leaks. Drawing down the pond will likely be necessary to make these repairs. Long-term solutions for restoring this section of stream should consider fluvial geomorphology practices.

Impacted Stream Segment #21-23, 21-73:

This section of the watershed includes the Caln Township park area. Valley Run and an unnamed tributary flow through the park. The streambanks are mowed and in some places are eroding about 1-2 feet. The stream bottom has a substantial amount of sediment. The unnamed tributary plunges out of a culvert thus eliminating the possibility of fish passage further up into the headwaters of the tributary.

Solution:

A primary focus of any conservation effort in this area should be on riparian buffer restoration. Before the riparian buffer is installed, the restoration of this section of the stream should include some in-stream restoration with a fluvial geomorphological approach to maintain sediment transport through the reach. The use of fish habitat enhancement structures in this section would increase the diversity of the available stream habitat. At Point #73, the culvert carrying the unnamed tributary should be evaluated for methods of restoring fish passage.

Impacted Stream Segment #24-26:
This section of Valley Run has eroded streambanks that are 3-4 feet high. The stream appears to have been straightened and has a sediment laden bottom that lacks adequate fish cover. Large stormwater basins on the north side of G.O. Carlson Blvd. discharge in this area.

Solution:
This stream segment would be an excellent candidate for a full stream channel and floodplain restoration utilizing a fluvial geomorphological approach. While the stream corridor is restricted due to development, a patchwork approach to restoration would likely not provide long-term success in this location. The large stormwater basins that drain to this area should be considered for stormwater volume and water quality retrofits.

Impacted Stream Segment #57:
Japanese Knotweed (*Polygonum cuspidatum*) has established a small population at this location and near Stream Segment #63. Japanese Knotweed is a vigorous invader and is able to extensively alter the plant community after it becomes established.

Solution:
This invasive species should be targeted for immediate removal. Eradication of the two small existing patches is possible at this time and is necessary to help avoid further expansion of the population. As invasive species may be transported into the watershed from other areas in the future, volunteers and municipal work crews should be educated on identifying invasive species and proper eradication methodology.

Impacted Stream Segment #65-68:

This area includes a large mowed area behind a commercial building. Valley Run and an unnamed tributary flow through the mowed area. While a few willows are present along the stream, it is primarily exposed to the sun. Most of the residential areas draining to this point lack stormwater BMP's. A mowed stormwater basin is present on the commercial property.

Solution:

This area would be a great target for construction of a treatment wetland system. The construction of a wetland system in this area could minimize nutrient and contaminant inputs to the stream. The residents of this area, as well as those throughout the watershed, should be targeted with homeowner based stormwater management initiatives. At a minimum, this area would be an excellent location for riparian buffer enhancement through the TreeVitalize program.

3.2 Medium Priority Projects:

Impacted Stream Segment #6:
Confluence of Valley Run and a small tributary (which drains stormwater from a salvage yard). The small pond in this area likely serves as a sediment basin.

Solution:
The discharge should be monitored for potential contaminants. Best Management Practices (BMPs) to consider implementing in this area include vegetated filter strips and a sediment forebay as water quality best management practices.

Impacted Stream Segment #12, 15-16:
This section of Valley Run includes relatively stable streambanks and a vegetated buffer on each side of the stream. The large shopping area to the south of the stream has several stormwater outfalls that discharged to the stream.

Solution:
The stormwater basins in this area could be restructured for the purpose of improving water quality. Surrounding lawn areas could be planted with trees. Potential retrofits include adding infiltration capablilities and native plantings within the basins.

Impacted Stream Segment #18:
A large stormwater basin is situated north of G.O. Carlson Boulevard in this area. The outfall passes thru a small emergent wetland swale before entering Valley Run

Solution:
The basin would be a prime target for stormwater management retrofits that target volume reduction by utilizing naturalization and infiltration techniques. Additionally, riparian buffer enhancements with native shrubs should be considered for this area.

Impacted Stream Segment #32-36:

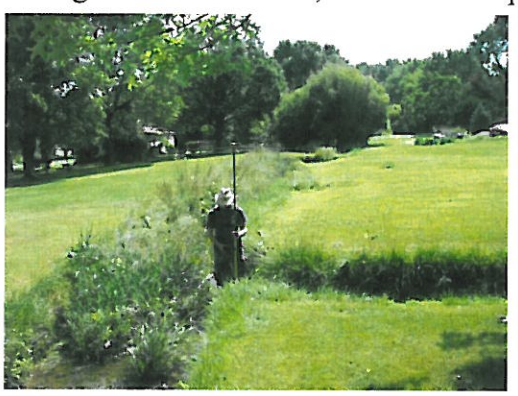
In this section of the stream, stormwater outfalls from the parking lot immediately adjacent the stream and large stormwater basins to the north discharge to the stream. The stream throughout this reach is eroding and heavily laden with sediment.

Solution:

The ideal solution would include restoring the floodplain by removing the encroachments and performing a stream restoration with a fluvial geomorphologic approach. A more feasible and immediate approach to reducing the impacts of this area would include installing urban stormwater retrofits (such as those installed under parking lots for water quality improvement) and naturalizing the stormwater basin. The upstream end of the segment should be evaluated for streambank stabilization and gravel bar removal to maintain the capacity of the bridge structure.

Impacted Stream Segment #49-53:

Throughout this section, the stream appears unnaturally straight with 2-3' banks and a silt bottom. The stream is surrounded by residential properties with mowed lawn to the edge of the stream. The stream in this residential area is dominated by 3' high eroding banks and a silt bottom.



Solution:

Riparian buffer enhancements and streambank stabilization. Restoring the stream with a fluvial geomorphological approach would be ideal, but the limited work area in some sections of this segment would likely limit the scope of the project.

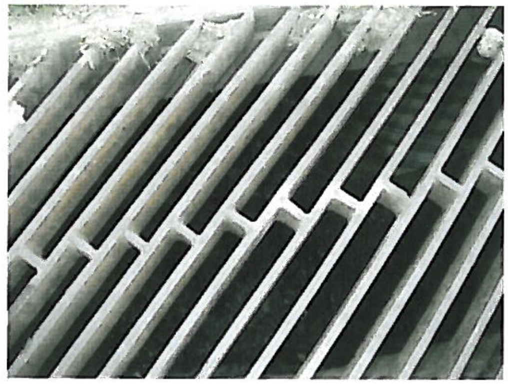
Impacted Stream Segment #62-65:

This stream segment appears to be artificially straightened, with 2-3' eroded banks and a silt/gravel streambed. Litter and debris line the stream channel. Invasive species dominate the thin riparian corridor in areas where the vegetation is not mowed to the streambank. Stormwater discharges to the stream in this area have minimal to no BMP's installed.

Solution:

This segment would benefit from riparian buffer enhancements, urban stormwater retrofits, a community litter cleanup, stream signage, and stream restoration with a fluvial geomorphological approach or fish habitat improvement project.

Impacted Stream Segment #68:
A step in the culvert under Toth Avenue most likely blocks all fish passage to the headwaters above this point.



Solution:
Restore fish passage during culvert replacement.

Impacted Stream Segment #71:
The Coatesville High School is constructed at the very headwaters of Valley Run and contributes to the stormwater impacts within the watershed. Many of the concerns throughout the watershed are due at least in part to the excessive stormwater impacts from residential areas throughout the watershed.

Solution:
The integration of citizen-based stormwater management into the high-school curriculum coupled with a demonstration area on high school property is essential to the long-term recovery of Valley Run.

Impacted Stream Segment #33-93:
This residential community lacks stormwater BMP's. An unnamed tributary flowing through this area attests to this lack of adequate stormwater management.

Solution:

Community outreach in this area should focus on the installation of stormwater BMP's, installing a small riparian buffer, and minimization of nutrient and contaminant discharges to the stream.

Impacted Stream Segment #94:
Several ponds receive stormwater from the golf course in this area. The golf course manages a large proportion of this subwatershed and is a key player in the community. The ponds have varying amounts of wetland buffers around their perimeter.

Solution:
Meet with the Golf Course representatives to discuss minimization of nutrient and pesticide application in areas draining to waterbodies. Review areas that are out of play for wetland enhancement and naturalization.

Impacted Stream Segment #99:
A culvert (5' CMP) crossing to access an industrial plant off of South Bailey Road discharges with a 3-4' drop into a scour pool. This drop effectively blocks the upstream passage for fish.

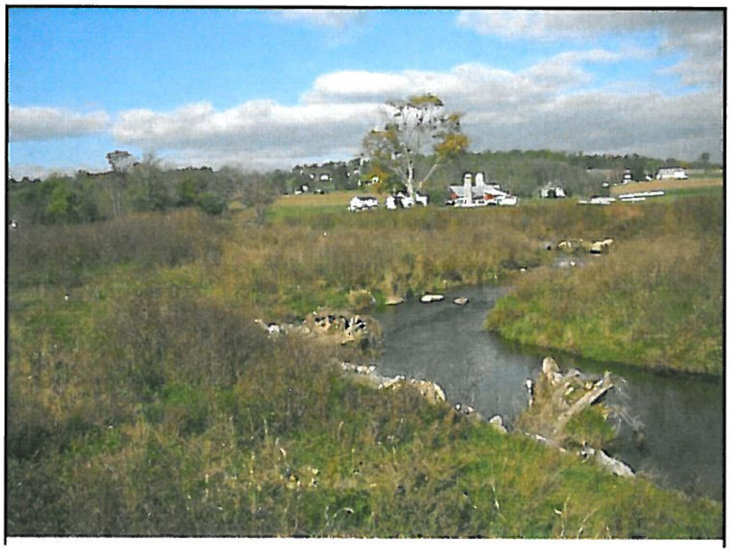
Solution:
Fish passage could be restored in this area by modification of the outfall structure.

4.0 RESTORATION SOLUTION DETAILS

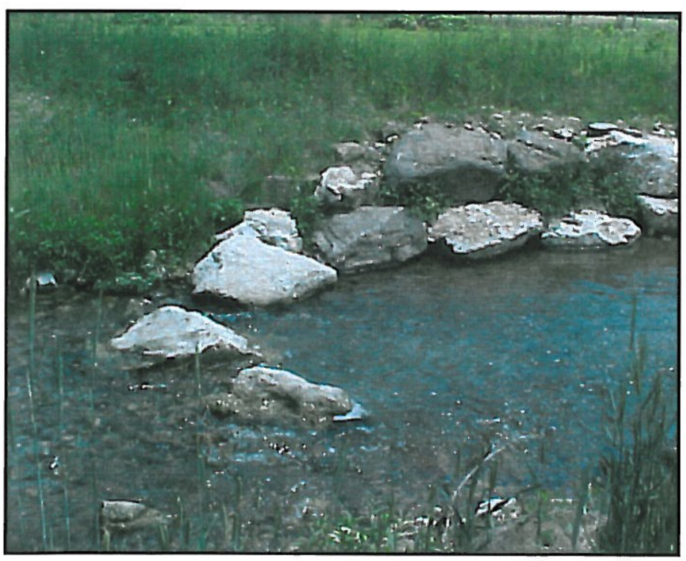
As was discussed in the previous section of this report, there are many opportunities for improvement. This section discusses specific concerns and conditions related to those improvement activities and BMPs.

4.1 Habitat Restoration and Improvement

Streambank Stabilization & Restoration: Streambank 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 urbanized and agricultural areas. Traditional streambank stabilization involves: (1) re-grading localized laterally eroded banks by grading to a more stable slope (3:1 horizontal:vertical); (2) stabilizing the slopes with erosion control matting and vegetation; and, (3) incorporating in-stream structures and/or bioengineering techniques. Traditional in-stream structures may include toe-riprap, rock cribbing, root wads, and log or rock deflectors. Bioengineering methods that may be incorporated in bank stabilization commonly include fascines, branch packing, brush mattresses, live cribwalls, tree revetments and live staking.



Established streambank stabilization project with root wads.



In-stream structures such as this J-hook can be installed to minimize erosion of the newly restored streambank until vegetation becomes established.

If a stream has been channelized or lacks stream bend meanders and adequate space and funds are available, a natural stream channel design (based on fluvial geomorphology) may be appropriate. Natural stream design uses a stable natural channel ("reference reach") as a blueprint for designing the restoration of the impacted reach. The reference reach provides a suitable pattern, dimension and profile for the design of the restored reach. With a design based on bank-full flow, energy should be managed through the reach to minimize erosion while still transporting sediment from upstream areas through the restored area.

Floodplain Restoration:

The Valley Run Watershed has been greatly altered during the period following European colonization. The pre-colonial floodplain has been impacted by a combination of accelerated erosion in the uplands discharging excessive sediment onto the valley floor and constructed dams functioning as sediment traps. As the stream entered each dam, the loss of velocity allowed the stream to drop any sediment it was transporting and cover the pre-dam floodplain. As the dams were breached, the stream quickly cut through the "legacy sediment" and became entrenched. The resultant stream section has a very channelized appearance with steep, eroding banks. Over time, the excess soil in the valley floor was distributed to other areas that were not dammed, as the stream is not yet at a stable state to deal with the excessive sediments that are being flushed through the system. The construction of buildings, roads and other man-made features on top of this new, artificial floodplain has further exacerbated the problem, and made restoration more difficult and expensive.

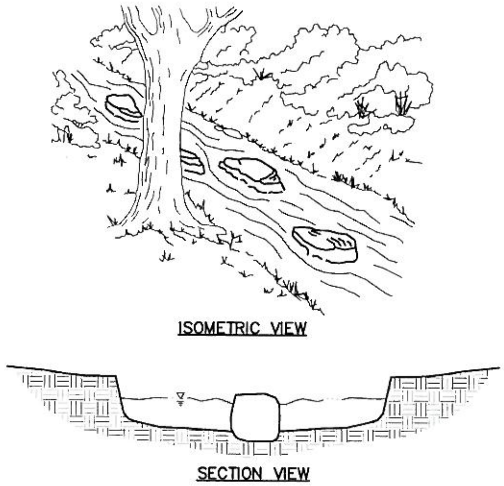
While difficult, removing sediment, fill, buildings and other encroachments from the floodplain is possible, and in some cases is necessary to re-establish a natural floodplain system. This has been done successfully in many stream restoration projects throughout the Commonwealth. Sometimes restoring a floodplain will also allow for the re-establishment of forested riparian buffers and wetlands.

Sample photograph of floodplain restoration – removing previously placed fill and legacy sediments

4.2 In-stream Habitat Improvements for Fishery

Boulder placements:

This type of fish habitat structure is very inexpensive and easy to install. It involves placing larger boulders (3-foot average diameter) with a track hoe or large backhoe. The large rocks provide instant cover for fish.



GENERAL NOTES:

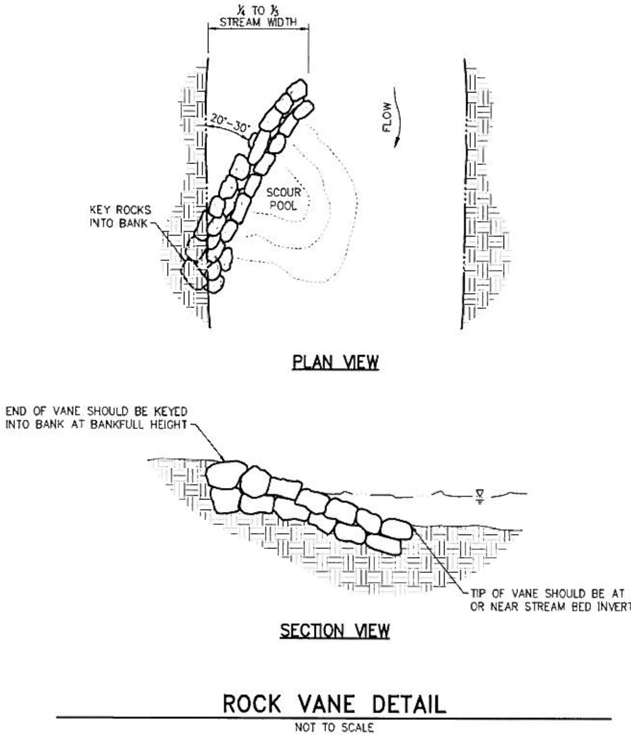
1. BOULDERS SHOULD BE LARGE ENOUGH TO NOT BE DISPLACED DURING HIGH FLOW CONDITIONS.
2. BOULDERS SHOULD BE PLACED IN THE MIDDLE THIRD OF THE STREAM WIDTH TO PREVENT FLOW DEFLECTION INTO STREAMBANKS.

RANDOM BOULDER PLACEMENT DETAIL

NOT TO SCALE

Sample photograph of boulder placements

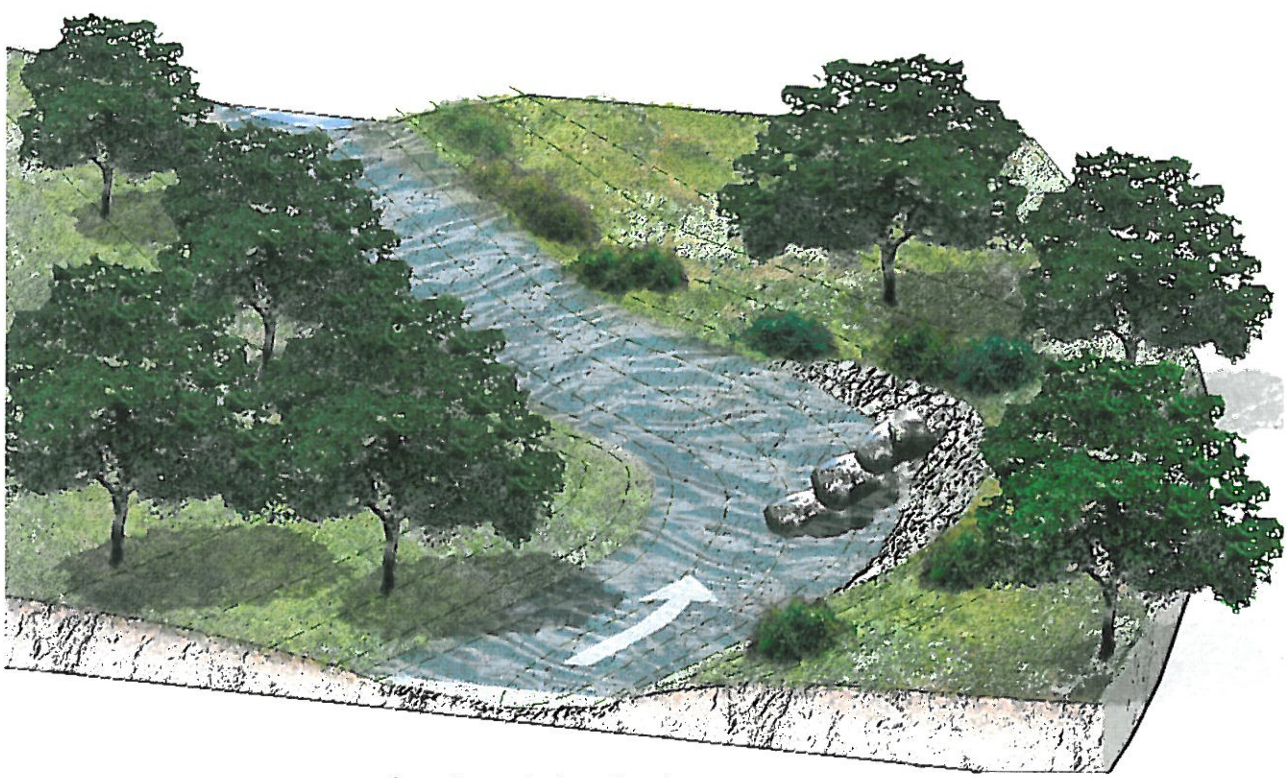
Rock vanes:



Rock vanes are a means of re-directing and centralizing stream flow during high water events in order to minimize bank erosion. However, they do need to be properly designed and installed. Rock vanes should be constructed of large rock or in combination with large, straight logs. Rocks that are preferably rectangular in shape measuring roughly 3-feet wide by 5-feet long by 1.5-feet thick should be utilized for proper construction of the rock vanes.

A large track-hoe will be necessary to install this style of rock vanes.

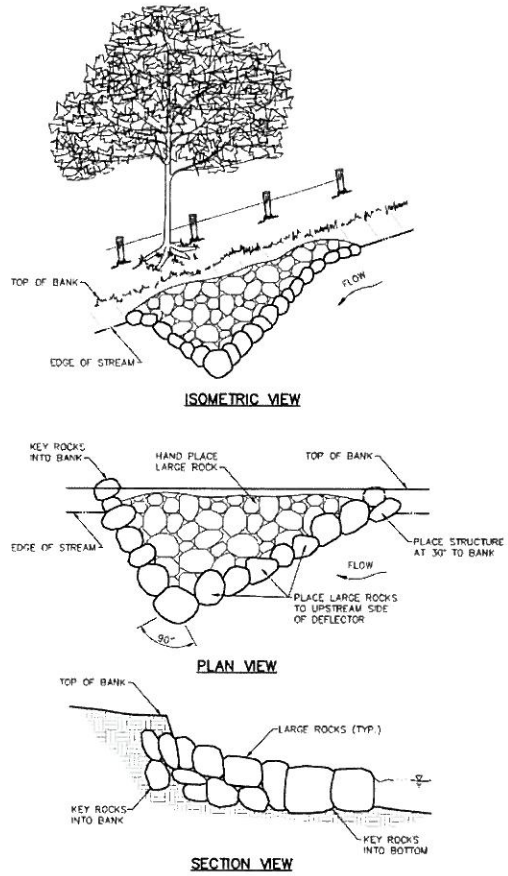
Costs will vary due to the availability of such rock in the general area, and ease of access into the work location.



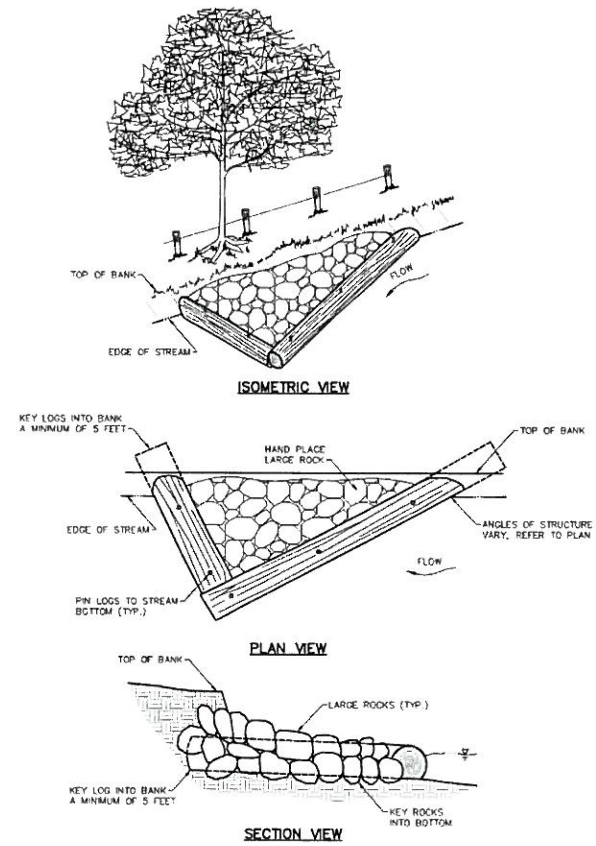
Sample rendering of rock vane

Rock deflectors and log frame deflectors:

Rock and log frame deflectors are used to stabilize eroding streambanks and provide in-stream habitat. Rock deflectors are a bit easier to install because the frame of the structure consists of larger rock whereas the log frame consists of logs that have to be drilled and anchored to the substrate. A backhoe typically is needed for construction.



ROCK DEFLECTOR DETAIL
NOT TO SCALE

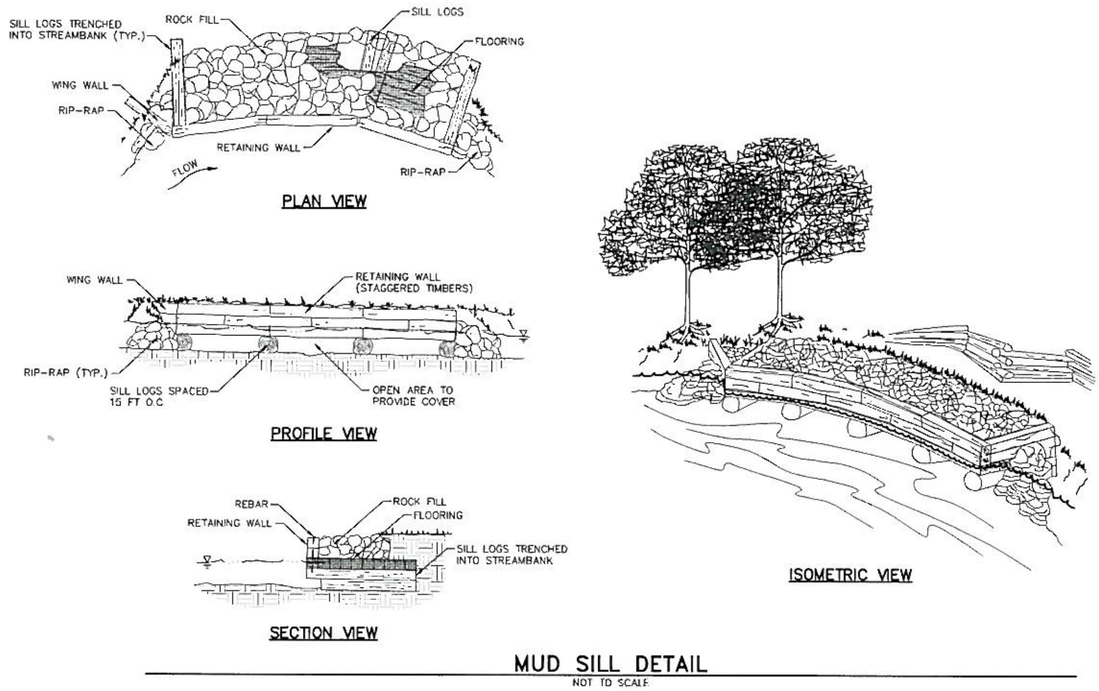


LOG–FRAMED ROCK DEFLECTOR DETAIL
NOT TO SCALE

Sample photograph of a newly installed log frame deflector

Mudsills:

Mudsills are bank stabilization devices that are suited for use on the outside bends of eroding banks and are also fish habitat structures. A backhoe or trackhoe is usually necessary for installation.



Sample photograph of a mudsill indicated by the yellow arrow

4.3 Riparian Buffers and Landscaping

Forested riparian buffers long have been recognized as a vital component of stream health in ecoregions where they should be naturally occurring; Valley Run being no exception. Forested 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 also act as filters of stormwater runoff during storm events. For this reason, forest buffers are especially valuable in 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 and/or, in the case of nitrogen and phosphorus as well as some heavy metals and toxic organics, be taken up through the root systems and stored in the tree and shrub's biomass (wood).

Sample photograph of a three-year-old forest buffer planting

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

Riparian trees and shrubs 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.

An additional benefit of allowing riparian forests to persist and thrive is one that landowners and managers can take directly to the bank. Allowing mowed lawn areas along riparian corridors to revert (with proper planning and maintenance) back to natural riparian thickets and forests can lead to immediate cost savings when one considers the fuel and equipment costs, and man hours required to maintain the traditional and unnatural mowed lawn. There are significant long term cost savings in developing a riparian buffer with native trees and shrubs; maintaining it on a yearly basis for invasive species, when compared with the weekly or bi-weekly mowing for 4-5 months a year that is required to maintain a mowed lawn. 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 through local tree nurseries.

TREE SPECIES	HEIGHT (Feet)	WILDLIFE VALUE	SHADE TOLERANCE	SPACING (Feet)
Red maple (*Acer rubrum*)	75-100	Food source–fruit 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–fruit 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–fruit	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 fruit	Intolerant	10-13
Slippery elm (*Ulmus rubra*)	50-80	Food source–seeds and twigs	Tolerant	10-13
White flowering dogwood	35-50	Food source–fruit	Intermediate	10-13

(*Cornus florida*)				
Redbud (*Cercis Canadensis*)	20-35	Minimal food source–seeds	Tolerant	10-13

SHRUB SPECIES	**HEIGHT (Feet)**	**WILDLIFE VALUE**	**SHADE TOLERANCE**	**SPACING (Feet)**
Sandbar willow (*Salix exigua*)	15-20	Food source–fruit 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–fruit	Intolerant	6-8
Grey dogwood (*Cornus racemosa*)	6-12	Food source–fruit	Tolerant	6-8
Red-osier dogwood (*Cornus sericea*)	6-12	Food source–fruit, 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–fruit	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

Invasive species such as multiflora rose (*Rosa multiflora)*, Tartarian honeysuckle (*Lonicera tatarica*) and garlic mustard (*Alliaria petiolata*) are common within Valley Run Watershed. Species such as these have aggressively invaded riparian corridors throughout sections of Pennsylvania. Others, such as Japanese knotweed (*Polygonum cuspidatum*) and purple loosestrife (*Lythrum salicaria*) are currently found in only a few limited areas, but if allowed to persist, can quickly overtake the floodplains throughout a watershed. They should be identified and removed immediately while the population is still relatively small, before they spread and become impossible to eradicate. In many situations, these plants are pioneer species, meaning they are some of the first plants to establish themselves in areas allowed to fallow.

If left unmanaged, these invasive species 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. Invasive species should be eradicated as the first step in planting a riparian buffer.

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 invasives.

4.4 Stormwater Water Volume and Quality Improvement

Potential water volume and quality improvement projects associated with Valley Run should include a combination of implementing urban stormwater structures in areas developed prior to stormwater management regulations, existing facility retrofits and innovative applications during new construction. The PADEP BMP manual and the Chester County Conservation District should be consulted for design ideas and requirements. Stormwater volume may be controlled by either infiltrating the stormwater into the ground, capturing the stormwater for use, or evapo-transpirating the water back into the atmosphere.

Infiltration trenches and drywells function to return stormwater directly into the ground and ultimately the underground water table. By collecting rooftop water that should contain minimal pollutants, it may be infiltrated with minimal risk of groundwater 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. Infiltration in karst areas poses a concern through the potential formation of sinkholes.

Stormwater capture for use in Valley Run 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.

Evapo-transpiration is another option for stormwater volume management. The use of rain garden bioretention areas to allow for wetland type plants to filter pollutants and minimize runoff should not be overlooked. A good first step would be holding a stormwater basin workshop that all of the property owners and municipal representatives affiliated with basins would be invited to attend. The workshop could include speakers on maintaining outlet structures, legal issues regarding stormwater basins, and contain a healthy dose of ideas for naturalization of stormwater basins. The financial aspect of not mowing and fertilizing vs. maintenance of a naturalized basin should be included.

Sample photograph of an underground detention facility installation

5.0 COST ESTIMATES

Costs associated with stream restoration work and the installation of best management practices will vary from site to site within the watershed. This is due to a variety of reasons including but not limited to: ease of access to the construction site, weather and soil conditions, availability of rock and other building materials, any available volunteer hours, and permitting and design costs.

It is always good practice to get a minimum of three bids for both design and construction work. Time should be taken to prepare a thorough "request for bid" which specifically outlines work to be performed to the greatest detail currently known. Contractors should be given ample opportunity to see the proposed construction site so proper evaluation can be made. Keep in mind, an experienced contractor may have suggestions to the "scope of work" outlined within the "request for bid" which may save time and money.

Some requested services may need to be bid on a "time and materials" fashion. Plan design and permitting can fall into this category because aspects of the project will not be known until the design advances to a certain point.

Preliminary probable construction cost opinions are provided as a general guideline of costs associated with each high and low priority project in Appendix D. As the presented range of costs is preliminary, costs should be re-evaluated for the specific project before seeking project funding. It is important to consider in-kind materials and services such as volunteer effort, stream access, and current regulatory guidelines during the re-evaluation. To get a general idea of construction costs to be expected, the following listing is provided based on PRedICT 2007 and the experience of RETTEW:

Equipment with Operator

Back-hoe	$ 85.00/hour
Track-hoe	$ 135.00/hour
Bulldozer	$ 120.00/hour
Front end loader	$ 100.00/hour
Tri-axle dump truck	$ 95.00/hour
Mobilization/Demobilization	2.5% of construction cost
Bonds and Insurances	2.5% of construction cost

Materials

Rock (rip-rap)	$ 17.00/ton delivered
	$ 30.00/ton installed
	$ 90.00/linear foot installed
Erosion control matting	$ 5.00–10.00/square yard installed
Silt fencing	$ 2.35/foot installed
Super silt fence	$ 10.00/foot installed
Gabion baskets	$ 35.00/square yard installed
Geotextile fabric	$ 2.25/square yard installed
Orange construction fence	$ 2.10/linear foot installed

Excavation

Earthen swales	$ 3.00/linear foot
Basin grading	$ 3.10/cubic yard
Trench work	$ 5.60/cubic yard
Place or strip topsoil	$ 2.35/cubic yard
Backfilling on-site soils	$ 3.00/cubic yard
Clearing and grubbing	$ 5,600.00/acre
Large tree removal	$ 265.00/tree

Streambank Stabilization Measures–In-stream Habitat Improvements

Streambank Stabilization	$ 55.00/foot
Live stakes	$ 2.00–$5.00/stake installed
Fascines	$ 6.50–$23.00/linear foot installed
Natural fiber rolls	$ 68.00/linear foot installed
Live crib walls	$ 13.00–$30.00/square foot of the front face
Root wads	$ 275.00–$1,200.00/root wad installed
Boulder placement	$ 650.00/ten boulders installed
Log vanes	$ 450.00/single wing installed
Rock vanes	$ 450.00/single wing installed
"J" Hook vanes	$ 550.00/vane installed
Rock deflectors	$ 450.00/deflector installed
Log deflectors	$ 500.00/deflector installed
Rock weirs (cross-vanes)	$ 1,450.00/vane installed

Streamside Buffers–Forest Buffers

Bare root seedling stock	$ 0.50–$1.75/seedling–not installed

Semi-transplanted bare root stock	$ 0.75–$2.20/seedling–not installed
Containerized stock (1–2 gallon)	$ 3.50–$7.50/container–not installed
Balled and burlapped stock	$ 30.00–$75.00/tree–not installed
Tree tube protectors	$ 0.75–$1.75/each–not installed
Buffer planted in seedlings	$ 1,050.00/acre
Reinforcement planting after 2 years	$ 70.00/acre
Mowing and general maintenance	$ 30.00/acre
Herbicide application	$ 100.00/acre
Riparian grass buffer seeding	$ 1,050.00/acre

<u>Agricultural Best Management Practices</u>

Conservation Tillage	$ 35.00/acre
Cropland Protection	$ 30.00/acre
Grazing Land Management	$ 400.00/acre
Vegetated Buffer Strip	$11,100.00/mile
Terraces and Diversions	$ 560.00/acre
Nutrient Management	$ 560.00/acre
Ag to Wetland Conversion	$14,500.00/acre
Ag to Forest Conversion	$ 6,750.00/acre
Streambank Fencing (high tensile, 2 wire)	$ 1.75–$2.25/linear foot installed
Stone ford cattle crossing	$ 600.00–$800.00/crossing installed
Stoned watering ramp	$ 350.00/ramp installed

<u>Urban Best Management Practices</u>

Constructed Wetlands	$47,000.00/acre
Bioretention Areas	$ 9,000.00/acre
Detention Basins	$12,000.00/acre

6.0 OBTAINING SUPPORT AND MONITORING PROGRESS

Education and cooperation of landowners within the watershed to implement best management practices and stream restoration solutions is the key to improving and preserving the natural resources and water quality of the Valley Run 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. Often times 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 businesses, then they will be even more interested. Reductions in property maintenance fees by allowing un-developed areas to revert back to natural ecosystems have a positive monetary effect.

The Brandywine Valley Association's presence in the community should facilitate landowner partnerships. Additional partnering will bring additional professional natural resources specialists into BVA projects and helps to further leverage available grant and funding resources. Some of the important teaming opportunities that are available to the Brandywine Valley Association include:

- Caln, East Fallowfield, and West Bradford Townships, and Chester County Planning Commission (Adoption of protective municipal ordinance language to protect critical watershed resources)
- Chester County Conservation District (urban and suburban BMP design, soil conservation and nutrient management, watershed consultation)
- Pennsylvania Department of Environmental Protection (Water quality studies and grant opportunities)
- Pennsylvania Department of Conservation & Natural Resources (Land preservation, resource management and grant opportunities)
- Pennsylvania Fish & Boat Commission (Fisheries management and protection, aquatic habitat improvement)
- Pennsylvania Game Commission (Wildlife protection, habitat improvement and policing)
- Local Scout, Civic Groups and Homeowner Associations (Riparian buffer volunteer planting)

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.

Pollution Reduction Impact Comparison Tool Version 2.0.8 (PRedICT). 2007. Penn State Institutes of the Environment.

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

Walter, R. C. and D. J. Merritts. 2008. Natural Streams and the Legacy of Water-Powered Mills. Science 319(18 January 2008): 299.

APPENDIX A
FIELD INVESTIGATION MAP

APPENDIX B
GPS POINT DESCRIPTIONS AND ACTION ITEMS

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
1	Discharge of large off-line pond to Beaver Creek, downstream of confluence of Valley Run and Beaver Creek. A small spring in the successional woodlot south of the pond feeds into the pond, as well as stormwater from the Wedgewood Community. The pond is valued by residents for its aesthetics, but the berm is known to be in disrepair. (See Points #3-5.)	Reduce potential nutrient input from goose population by discouraging geese inhabiting the area, see Points #3-5	Homeowners' association	Low Priority	
2	Confluence of Valley Run and Beaver Creek. The channel of Valley Run in this location is very straight and includes 2-4' steep banks and a heavily sedimented stream bottom. Extensive successional-floodplain woods exist in the riparian corridor.	N/A	N/A	N/A	
3	Water from the adjacent pond is leaking into the stream, seeping through the berm/stream bank along the top of a layer of clay soils, approximately 1-2' above the stream bed.	Pond berm stabilization, stream restoration with fluvial geomorphology techniques	Homeowners association, Caln Township, Agencies	High Priority	The pond berm from Points #3-5 appears to be failing and should be immediately addressed.
4	A small gully is located at this point, which drains overflow from the adjacent pond, thru the berm into Valley Run. This gully is down-cutting thru the berm which separates these two features, and at this location is 6' wide at the top.	Pond berm stabilization, stream restoration with fluvial geomorphology techniques	Homeowners association, Caln Township, Agencies	High Priority	
5	Stream is eroding towards the adjacent pond. A section approximately 40' long is particularly eroded with 4' high streambanks that encroach within 8-10' of the pond.	Pond berm stabilization, stream restoration with fluvial geomorphology techniques	Homeowners association, Caln Township, Agencies	High Priority	
6	Confluence of Valley Run and a small tributary which drains stormwater off a salvage yard. There is a small dam along this tributary, creating a small pond which may serve as a sediment basin for contaminants draining off the adjacent salvage yard.	Determine potential for contaminants entering tributary from adjacent salvage yard, install water quality filter strips and a sediment forbay	Landowner, Agencies	Medium Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
7	Small stormwater basin overgrown with successional shrubs and trees. This basin has an overflow which drains into the spring-fed wetland leading into the large pond.	N/A	N/A	N/A	
8	Small, stone spring house drains into a small wetland. This wetland drains into the large pond, and appears to be a healthy wetland system.	N/A	N/A	N/A	There is some sign of beaver in this area, this long, narrow wetland includes an old beaver dam.
9	Downstream end of salvage yard property. The salvage yard includes a number of vehicles that are stored within a few feet of the stream.	Monitor water quality for potential contaminants from the salvage yard. Remove encroachments from the floodplain.	Landowner	Low Priority	
10	Upstream end of salvage yard property. A small bridge crossing Valley Run is located approximately 150' downstream of this point. This bridge allows yard personnel to access both sides of the stream.	Riparian buffer enhancement	Landowner	Low Priority	
11	Confluence of Valley Run and first major tributary. This tributary was impacted severely during the construction of the Acme shopping center, and is currently a vegetated swale. The tributary flows thru a stormwater basin adjacent the Acme parking lot.	Entire area could use urban stormwater retrofits to filter contaminants off parking lots and goose droppings, litter cleanup	Landowner	Low Priority	Remainder of tributary upstream of Hazelwood Avenue appears to be relatively stable with significant riparian woods
12	Stormwater outfalls from parking lots behind Acme shopping center drain into Valley Run. Riparian corridor on south side of stream approximately 20' wide. Downstream end of a sanitary sewer easement on the north side of the stream.	Urban stormwater retrofits off parking lot drainage, litter cleanup, naturalize sewer easement on north side	Landowner	Medium Priority	Streambanks from this point upstream are in relatively good shape, 1-2' high, stable, and stream bed consisting of cobble/gravel
13	Downstream end of section of braided stream channel. Approximately 20' forested buffer on south side of stream, with additional mowed lawn area between woods and parking lot.	Urban stormwater retrofits, riparian buffer enhancement (esp. by not mowing lawn area), litter cleanup	Landowner, TreeVitalize	Low Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
14	Small stream crossing behind Acme shopping center. Appears to be used for foot traffic between shopping center and residential area to the north.	Invasive species removal	Landowner	Low Priority	
15	Old, broken 8" metal pipe crosses stream. Still 20-30' riparian buffer on south side of stream, with mowed lawn between woods and parking lot/access roadway	Riparian buffer enhancement by planting of trees in mowed lawn area/ stormwater basin naturalization	Landowner, TreeVitalize	Medium Priority	
16	Stormwater outfall from Commerce Bank/ Acme shopping center	Urban stormwater retrofits	Landowner	Medium Priority	The open, mowed area between the woods and access road would be a good location for a bio-swale, planted with appropriate trees and shrubs
17	Downstream side of bridge conveying Rt 340 over Valley Run. A stormwater outfall is incorporated into the southwest wingwall of the bridge (on the upstream side). From Rt 340 upstream to Municipal Drive, all underbrush (shrubs) on the north side of the stream were recently cleared by Caln Township.	Riparian buffer enhancement by ensuring native shrubs are allowed to dominate the area	Caln Township	Low Priority	The south side of the stream channel has a nice forested riparian buffer in this area
18	Outfall from a large stormwater basin, situated north of G.O. Carlson Boulevard. The outfall passes thru a emergent wetland swale before entering Valley Run	Stormwater management retrofit of basin	Landowner, Caln Township	Medium Priority	
19	Outfall from emergent wetland situated on top of banks on south side of stream	Riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	
20	Center of small bridge accessing firehouse. Some sediment deposition on downstream side of bridge. Small stormwater outfall from north side of stream is located just downstream of bridge. On the township park property upstream, the riparian buffer is mowed to within 10' of the stream on the south side, and to within 15' of the stream on the north side	Riparian buffer enhancement	Caln Township, TreeVitalize	Low Priority	Project is on Township Property
21	Confluence with second major tributary, flowing thru township park. Throughout the park property, this tributary has no riparian buffer	Riparian buffer enhancement	Caln Township, TreeVitalize	High Priority	high visibility restoration project possible

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
22	Footbridge crossing Valley Run, within township park property. Riparian buffer mowed to stream on both sides. 1-2' steep banks with heavy silt/gravel on stream bed.	Riparian buffer enhancement, streambank stabilization with fluvail geomorphology techniques	Caln Township, TreeVitalize	High Priority	Existing stormwater management wetland basin on south side of stream is performing well
23	Stormwater outfall from south side of stream, appears to collect road drainage off Municipal Drive	N/A	N/A	N/A	
24	Downstream edge of Municipal Drive bridge. 3-4' eroding banks on north side of stream (downstream of bridge) should be stabilized	stream restoration with fluvial geomorphology approach	Caln Township, Agencies	High Priority	
25	Outfall from large stormwater basins on the north side of G.O. Carlson Blvd. Stream in this section appears overly straight, with steep, eroding banks, large amounts of sediment and a lack of fish cover	stream restoration with fluvial geomorphology approach, retrofit of large stormwater basins with plantings	Caln Township, Agencies, TreeVitalize	High Priority	
26	Two stormwater outfalls. One from south (off shopping center parking lots) and one from north, from stormwater basin on north side of G.O. Carlson Blvd.	Retrofit large stormwater basin to north with plantings	Landowner	High Priority	
27	Outfall of small stormwater swale from south	Urban stormwater retrofits	Landowner	Low Priority	
28	Stormwater outfall from large stormwater basin north of G.O. Carlson Blvd.	Retrofit large stormwater basin to north with plantings	Landowner	Low Priority	
29	20' of the north bank is eroding badly along the outside of a meander bend, near a walking path.	Streambank stabilization	Landowner, Agencies	Low Priority	
30	Location of a large corrugated metal pipe (CMP) which empties into Valley Run.	N/A	N/A	N/A	
31	Small stormwater swale discharges to the stream. A CMP was found upslope of the swale.	Urban stormwater retrofits	Landowner	Low Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
32	Stormwater outfall from stormwater basin north of G.O. Carlson Blvd. Streambanks throughout this area consist of 3-4' eroded banks. Approx. 20' upstream the riparian buffer is mowed to the southern edge of the stream, and approx. 30' upstream, the southern bank is comprised of gabion baskets to protect the adjacent parking lot.	Riparian buffer enhancement, streambank stabilization, urban stormwater retrofits	Landowner, Agencies	Medium Priority	
33	Confluence of third major tributary from the north. Approx. 30-40' forested buffer on north side of stream, with no buffer to the south. Bottom of stream characterized by a silt/gravel bed, with large cobble firmly entrenched.	Riparian buffer enhancement, urban stormwater management retrofits	Landowner	Medium Priority	
34	Stormwater swale discharges to stream, originating in stormwater basins north of G.O. Carlson Blvd.	N/A	N/A	N/A	
35	Downstream side of North Bailey Road bridge. Stormwater outfalls from the north enter stream at bridge. The entire southern stream bank from Point #32-35 has no riparian buffer. The parking lot adjacent the stream on this southern bank has no stormwater inlets.	Urban stormwater retrofits, riparian buffer implementation, streambank stabilization	Landowner, Agencies, TreeVitalize	Medium Priority	Options to consider in this area include underground stormwater storage and restructuring the parking lot to gain more riparian buffer
36	Upstream side of North Bailey Road bridge. Southern streambanks above bridge are characterized by 5' eroding banks and a large gravel bar is situated just upstream of the bridge.	stream restoration with fluvial geomorphology techniques, fish habitat improvement	Landowner, Agencies	Medium Priority	In-stream fish structure will improve fish habitat while minimizing future maintenance of bridge
37	Outfall swale from small stormwater basin, which has been vegetated with emergent wetland species.	N/A	N/A	N/A	
38	Stormwater swale discharges to stream from south.	N/A	N/A	N/A	
39	Outfall from golf course pond, just upstream of G.O. Carlson Blvd bridge. Large retaining wall on south side of stream extending upstream from the bridge. The north side of the stream from Point #39-44 has very a limited riparian buffer. CMP discharge to south side of stream approx. 25' upstream from Point #39. Additional foundation drains enter stream from south throughout.	Riparian buffer enhancement, urban stormwater retrofits to stormwater basins draining to stream	Landowners	Low Priority	
40	Small golf course pond is situated less than 15' from northern streambank at this location. Riparian buffer to the north is mowed to the streambank.	Riparian buffer enhancement, streambank stabilization	Landowner, Agencies	Low Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
41	Confluence of sizable tributary from the south. Tributary flows on the west side of James Buchanan Road.	N/A	N/A	N/A	
42	Remnant of an old bridge upstream of the tributary confluence. Approx. 20' riparian buffer on both sides, but buffer has significant invasive species. Stream is characterized by 2' eroding banks and a silt/gravel streambed.	Remove old structure, riparian buffer enhancements, remove invasive species	Landowner, Agencies, TreeVitalize	Low Priority	Removing old structure is less important than riparian buffer enhancements
43	Approx. 40' reach with no riparian buffer on north side (golf course). Riparian buffer thick with invasive species.	Invasive species removal, riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	
44	Downstream side of 2nd G.O. Carlson Blvd bridge. Gabion baskets line the north side of the stream, below the Blvd. Large amounts of sediment on streambed and further upstream, the southern bank becomes more steep and eroded.	Streambank stabilization	Landowner, Agencies	Low Priority	
45	Approx. 3' eroded banks on south side of the stream downstream of this point. Sizable riparian buffer, but dominated by invasive species. Approx. 2' vegetated streambanks upstream.	Streambank stabilization, invasive species removal, riparian buffer enhancement with native species	Landowner, Agencies	Low Priority	
46	Vacant bridge crossing Valley Run. No development associated with bridge	N/A	N/A	N/A	
47	Confluence of sizable tributary from the north.	N/A	N/A	N/A	
48	Barley Sheaf Road bridge. Streambanks between Points #47 and 48 are stable, but are dominated by invasive species. Several small stormwater outfalls are also located throughout this reach. Approx. 50' of riparian buffer upstream of the bridge on the north bank of the stream has been mowed.	Invasive species removal, riparian buffer enhancement	Landowners	Low Priority	
49	Outfall of small stormwater swale from north. Downstream of this point the stream appears to be unnaturally straight, with 2-3' banks and a silt bottom. Upstream of this point the stream is surrounded by residential properties with mowed lawn to the edge of the streambanks. The stream in this residential area is dominated by 3' eroding banks and a silt bottom.	Streambank stabilization, riparian buffer enhancement with native species	Landowners, TreeVitalize, Agencies	Medium Priority	
50	Stormwater outfall on northern streambank. The bottom of this CMP is rusted out and experiencing scour. Approx. 5-10' buffer to the south, and mowed lawn to the streambank to the north.	Riparian buffer enhancements and maintenance of stormwater outfall	Landowners, Caln Township	Medium Priority	Area from Point #49-53 has good potential for riparian buffer enhancements

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
51	Center of Loomis Ave. bridge. Upstream of the bridge, the riparian corridor is mowed to the streambanks. The northern bank includes a concrete retaining wall which is being undermined and should be fixed.	Riparian buffer enhancements and streambank restoration	Landowners, Agencies	Medium Priority	
52	Stormwater swale discharges to stream from south.	Riparian buffer enhancements	Landowners, TreeVitalize	Medium Priority	Stormwater swale could be transformed into a bio-swale with appropriate plantings
53	Stormwater swale discharges to stream from south. Forested riparian buffer (15' on north side, 20' on south side) starts at this point.	N/A	N/A	Medium Priority	
54	Riparian corridor is mowed to within 5' of banks, but stream still well shaded.	Riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	
55	Stormwater swale discharges to stream from south. Limited riparian buffers and gravel/silt streambed. Small alley is located within 10' of streambank on south side.	Riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	
56	Center of Seltzer Ave. bridge. Approx. 30' upstream of the bridge the riparian corridor is forested on both sides.	N/A	N/A	N/A	
57	Industrial development within 15' of the top of southern bank. Japanese knotweed starting to take over streambanks.	Invasive species removal, riparian buffer enhancement	Landowner	High Priority	If allowed to gain a foothold in the watershed, knotweed from this location can spread extensively throughout the watershed and beyond
58	Downstream of this point the north bank is mowed to the top of the bank. A stormwater pipe discharges to the north side of the stream approx. 20' downstream. Upstream of the point, the stream has decent buffers on both sides.	Riparian buffer enhancements	Landowner, TreeVitalize	Low Priority	
59	Decent riparian buffers on both sides of stream upstream of this point. Bottom of streambed dominated by fine silts.	N/A	N/A	N/A	
60	Confluence of substantial tributary from the south. Extensive multiflora rose line stream channel. Approx 200 feet upstream of this point is an existing stormwater outfall where the headwalls and pipe need some maintenance.	Invasive species removal, maintain existing stormwater outfall structure	Landowners	Low Priority	Nice riparian buffer in this area, but extensive invasives

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
61	Start of industrial area along stream, encroachments are located within 15' of the southern streambank, with extensive mowed lawn elsewhere.	Riparian buffer enhancements	Landowners, TreeVitalize	Low Priority	Portions of the riparian corridor are maintained as mowed lawn, and could easily be reverted to forest with appropriate planting.
62	Stormwater outfall from the south. The stream appears to be artificially straight, with 2-3' eroded banks and a silt/gravel stream bed. There is significant amounts of litter and debris in the stream channel, as well as invasive species dominating the relatively thin riparian corridor.	Riparian buffer enhancements, urban stormwater retrofits, litter cleanup, stream restoration with fluvial geomorphology techniques, fish habitat improvement	Landowners, Agencies, TreeVitalize, Local Watershed Group	Medium Priority	Good location for riparian buffer plantings and stream cleanup
63	Center of the North Caln Road bridge. Upstream of the bridge is a stream section where it is mowed to the streambanks. Significant areas of impervious cover without stormwater controls. Small area of Jap. Knotweed above bridge.	Urban stormwater retrofits, riparian buffer enhancement, litter cleanup	Landowners, TreeVitalize	Medium Priority	
64	Stormwater outfall from parking lot behind shopping center. A 5-10' riparian buffer starts on the north side of the stream, but the south side is mowed to the streambank	Riparian buffer enhancement, litter cleanup	Landowner, TreeVitalize	Medium Priority	This parking lot appears to be the source of a lot of the litter that plagues this section (and downstream) of the stream
65	Start of mowing to both sides of stream. A few scattered willows provide some shading of the stream, which would easily be complemented with some additional plantings	Riparian buffer enhancements	Landowners, TreeVitalize	High Priority	
66	Stormwater swale enters stream from the residential area to the north	Urban stormwater retrofits	Landowners	High Priority	
67	Small wetland/stormwater basin is located on the south side of the stream, in an open grass area behind the Amelia's store. The streambanks in this area are well vegetated with herbaceous plants.	Naturalization of existing basin and other riparian buffer enhancements	Landowner, TreeVitalize	High Priority	Great visibility for a naturalization project

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
68	Downstream end of large culvert that conveys the stream under Toth Avenue. A step in this culvert is most likely a blockage of fish passage at this point.	Replace culvert to allow for fish passage	Landowner, Caln Township, Agencies	Medium Priority	
69	Upstream end of Toth Avenue culvert. Upstream of this point the riparian corridor consists of small yards which are mowed to within 5-15' of the streambanks. Several nice, large trees dominate these yards. There was no significant evidence of chemical application, though this is common in residential settings.	Riparian buffer enhancements, educate adjacent landowners on water quality issues	Landowner, BVA, TreeVitalize	Low Priority	
70	Three culvert pipes form a bridge crossing stream. A fence appears to mark this location as the property line for the school property. The riparian corridor upstream appears to be substantial. Approx 15' upstream is a small swale that drains a large ponded area into the stream. This ponded area appears to be an old quarry.	N/A	N/A	N/A	
71	Three more culvert pipes constitute another stream crossing. This point is close to the end of the natural area within the school property. The remainder of the watershed at this point is developed for the school facilities.	Riparian buffer enhancements and stormwater retrofits on the school property	School board, TreeVitalize	Medium Priority	Good opportunity to educate students on water quality and watershed stewardship by doing projects on school grounds, with student involvement
72	Start of small dike along top of eastern stream bank, near corner of baseball field (to west) and church parking lot (to east). 3' eroded banks near this point.	Stream restoration with fluvial geomorphology techniques, riparian buffer enhancement	Landowners, Agencies, TreeVitalize	High Priority	
73	Downstream end of culvert conveying stream under Lincoln Highway. Approx 2' drop at end of culvert creates block to fish passage. Riparian corridor below culvert mowed to top of streambanks. Banks are stable, and include gabion baskets in some areas.	Replace bottom of culvert to allow for fish passage, riparian buffer enhancement	Landowners, Agencies, Caln Township, TreeVitalize	High Priority	Entire stretch thru the township park is suitable for riparian and stream enhancements.
74	Small area of daylighted stream between culvert under Amtrak tracks (upstream) and culvert under Lincoln Highway (downstream). Streambanks in this small section consist of 0-7' relatively unstable banks	Streambank stabilization	Landowners, Agencies	Low Priority	
75	Upstream side of Hazelwood Avenue culvert	N/A	N/A	N/A	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
76	Start of small bamboo thicket on east side of stream	Invasive species removal	Landowners	Low Priority	
77	Small spring-house drains into stream from the west. Small amount of erosion off of 1-2' streambanks, but substantial forested riparian buffers	N/A	N/A	N/A	
78	Center of second Embreeville Road culvert crossing.	N/A	N/A	N/A	
79	Center of upstream private driveway crossing, just upstream of a second driveway crossing. Small retaining walls line the stream between the two crossings.	Riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	Plantings in residential yards would help to shade and cool stream
80	Outfall from offline pond. Small tributary from the east drains into the tributary as a forested wetland seep.	N/A	N/A	N/A	
81	Offline pond is located just west of stream. Dredge materials from the pond appear to have been placed in the floodway of the tributary, near the intake pipe.	Stabilize or properly dispose of dredge material	Landowner	Low Priority	
82	Start of forested riparian corridor on both sides of stream.	N/A	N/A	N/A	
83	Several RCP's and pipes drain to the stream from the west, off an adjacent house and outbuilding. A concrete wall lines a portion of the west side of the stream, the rest of which continues to be a 4-5' eroded bank.	Riparian buffer enhancement and streambank stabilization of western bank, stormwater retrofits for property drainage to stream	Landowner, TreeVitalize, Agencies	Low Priority	
84	Confluence of a small tributary from the east. The smaller tributary is intermittent. Below this point the western side of the stream has a 4-5' eroded bank. A 4" outfall pipe enters the stream from the west 10' downstream of the point.	Riparian buffer enhancement and streambank stabilization of western bank	Landowner, TreeVitalize, Agencies	Low Priority	
85	Start of property where the riparian corridor is mowed to the streambanks	Riparian buffer enhancement	Landowners, TreeVitalize	Low Priority	
86	Center of small culvert (36" into a 48" RCP) crossing accessing a private residence east of the stream. There is some minor scour at the endwall.	Streambank stabilization at endwall	Landowner	Low Priority	Most likely a waiverable activity
87	Top of unnamed tributary where two small tributaries converge just east of Embreeville Road. Both tributaries have nice, forested riparian corridors upstream. Some stormwater impacts from residential development in headwaters and road runoff is likely\. 4-5' vertical banks at this point, but downstream the banks become 1-3' and are more stable.	Stormwater retrofits in the headwaters, streambank stabilization	Landowners	Low Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
88	Ingleside Drive crossing of the tributary. Tributary daylights upstream of this crossing, and the riparian corridor in this area consists of mowed lawn to the top of the banks, with scattered large trees.	Riparian buffer enhancements	Landowners, TreeVitalize	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
89	Windsor Lane crossing of the tributary. Tributary culverted thru this portion of the subdivision.	Stream signage	BVA, Caln Township	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
90	Edge Lane crossing of the tributary. Corridor mowed to top of streambanks, which are relatively stable, 1-2' in height at this location.	Riparian buffer enhancements, Urban stormwater retrofits	Landowners, TreeVitalize	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
91	End of cul-de-sac on Norma Drive. Private driveway crosses stream at this location. Corridor mowed to top of banks. Stormwater discharges from roadways to the tributary at this point.	Riparian buffer enhancements, Urban stormwater retrofits	Landowners, TreeVitalize	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
92	Raye Road crossing of the tributary. Upstream of road the lawns are mowed to top of banks. Downstream of the road the stream is more entrenched. Most likely chemicals from the adjacent lawns are washed into the stream in this area.	Riparian buffer enhancement, fertilizer and lawn chemical education for landowners	Landowners, BVA, Caln Township	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
93	Top of tributary at Sylvan Drive. Riparian corridor consists of 0-3' mowed lawn, extending to top of banks. Houses clustered close to stream. Culvert under Sylan Drive has large amounts of sediment deposited at the outlet.	Riparian buffer enhancements, maintain culvert to increase capacity	Landowners, TreeVitalize, Caln Township	Medium Priority	Rainbarrels and raingardens should be installed throughout this neighborhood
94	Stormwater pond overlook from new townhouse community adjacent Township golf course. Several ponds that receive stormwater from the adjacent golf course are visible from this location.	Analyze and improve nutrient management of golf course (fertilizers, geese, chemicals, etc)	Landowner	Medium Priority	
95	Riparian corridor opens up downstream of Gold's Gym parking lot. The corridor is mowed to the top of the banks.	Riparian buffer enhancement, possible location for stormwater retention wetland construction	Landowners, TreeVitalize	Low Priority	Good location for riparian buffer plantings

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
96	Tributary daylights after exiting culvert from under Lincoln Highway. Several driveways and other encroachments are situated along the stream below this point.	Riparian buffer enhancements	Landowner, TreeVitalize	Low Priority	
97	South Bailey Road crossing of the tributary. Riparian corridor downstream of this crossing appears to have been sprayed to kill vegetation. Stream then enters long culvert under Amtrak tracks and Lincoln Highway.	Riparian buffer enhancement	Landowner, TreeVitalize	Low Priority	
98	Small bridge crosses stream, accessing a pallet storage area for the adjacent industrial building. Several stormwater outfalls from the building flow to the stream above and below this crossing. Mowed grass along tributary within the industrial property	Riparian buffer enhancements, stormwater retrofits	Landowner, TreeVitalize	Low Priority	
99	Center of culvert (5' CMP) crossing accessing industrial plant off of South Bailey Road. The downstream end of the culvert has a 3-4' drop into a scour pool, which creates a total block of fish passage.	Replace culvert to allow for better fish passage	Landowner, Agencies	Medium Priority	
100	Center of new culvert crossing tributary, to access new residential development. Stream section below crossing appears to be relatively stable, with significant areas of bedrock along the streambed.	N/A	N/A	N/A	
101	Nice section of forested riparian corridor, along small tributary west of intersection of South Bailey and Stouff Roads. Downstream of South Bailey Road the stream becomes more entrenched and shows some sign of stormwater impairments	Stormwater retrofits along roadways and in headwater areas	Landowners, Caln Township	Low Priority	
102	Small dam breached along headwater tributary, east of Stouff Road.	Streambank stabilization in former impoundment area	Landowner, Agencies	Low Priority	
103	Upstream side of a large successional woods area that continues downslope to the tributary's confluence with the main stem of Valley Run. Minimal erosion was seen along the streambanks through this area.	Invasive species removal throughout woods	Landowners	Low Priority	
104	Downstream side of long culvert below Lincoln Highway. Outlet area has small brick retaining walls on either side to stabilize the banks.	N/A	N/A	N/A	
105	Tributary enters a long culvert that conveys the stream under a large industrial building, the Amtrak tracks and Lincoln Highway.	N/A	N/A	N/A	Options are limited in this area due to existing infrastructure
106	Downstream side of culvert conveying tributary under South Caln Road. The stream enters an area with mowed lawn and active pasture leading up to the top of the streambanks.	Riparian buffer enhancements, streambank fencing	Landowner, Conservation District, TreeVitalize	Low Priority	

GPS Point Descriptions and Action Items

Point #	Description	Action Item	Key Partners	Red-Blue Priority	Comments
107	Downstream end of nice forested section along headwater tributary. However, some signs of stormwater impairments in eroded streambanks.	Riparian buffer enhancement, especially in headwater, residential areas, monitoring of new stormwater features in headwaters	Landowners, East Fallowfield Township	Low Priority	

APPENDIX C
POINT LOCATION DATA

Point Location Data

Point #	Northing	Easting	Approx. Elev.
1	250303.40	2532541.56	262
2	250336.25	2532038.01	278
3	249859.64	2532071.31	272
4	249724.22	2532085.97	280
5	249421.39	2532204.42	276
6	249234.13	2532109.37	278
7	248851.63	2532229.78	272
8	249000.01	2532246.90	290
9	249213.75	2531965.67	269
10	249015.61	2531626.72	275
11	248953.21	2531565.07	273
12	248835.85	2531400.78	271
13	248823.48	2531294.39	278
14	248694.78	2531085.80	277
15	248687.29	2530925.99	279
16	248324.19	2530334.14	282
17	248274.55	2529906.25	290
18	248307.95	2529587.43	276
19	248323.32	2529331.46	286
20	248490.32	2528886.48	290
21	248513.62	2528268.06	286
22	248520.63	2527812.32	293
23	248568.01	2527552.96	290
24	248559.85	2527509.85	291
25	248516.65	2527319.11	293
26	248303.08	2527036.18	295
27	248112.42	2526807.24	296
28	247961.77	2526532.63	297
29	247913.37	2526396.23	294
30	247859.16	2526323.01	296
31	247839.89	2526254.85	298
32	247814.84	2526173.84	293
33	247715.03	2525998.15	293

Point #	Northing	Easting	Approx. Elev.
55	246225.15	2520601.69	333
56	246242.09	2520310.57	336
57	246277.93	2520077.22	334
58	246380.59	2519729.93	351
59	246368.88	2519485.51	339
60	246362.59	2519370.87	341
61	246165.15	2518922.78	341
62	246113.74	2518866.01	357
63	245732.62	2518344.79	353
64	245617.66	2518180.00	352
65	245537.80	2517995.40	353
66	245534.21	2517848.42	347
67	245534.60	2517755.85	351
68	245610.24	2517615.69	360
69	245691.19	2517491.61	368
70	245779.75	2517233.19	344
71	245800.11	2517121.33	361
72	247558.29	2527969.64	298
73	247321.83	2527892.08	318
74	247167.63	2527854.45	321
75	246856.74	2527879.61	334
76	246462.76	2527848.31	336
77	246059.06	2527953.99	358
78	245698.51	2528068.88	359
79	245541.84	2528079.93	373
80	245467.21	2528117.58	357
81	245219.29	2528323.08	377
82	245178.83	2528362.60	379
83	245008.94	2528491.05	391
84	244910.60	2528566.09	386
85	244668.29	2528585.39	414
86	244044.51	2528831.07	465
87	243659.27	2528792.64	457

Data is based on State Plane Coordinate System PA South, NAD83 datum.

APPENDIX D
PRELIMINARY PROBABLE CONSTRUCTION COST OPINION

RETTEW

We answer to you.

Valley Run Watershed Probable Construction Cost Opinion

Site	Min Cost	Max Cost	
2-5	$80,000	$965,000	*
21-23, 21-73	$20,000	$190,000	**
24-26	$18,000	$275,000	**
57	$150	$1,500	
65-68	$5,250	$90,000	**
6	$9,000	$16,500	
12, 15-16	$2,500	$18,000	**
18	$1,000	$9,000	**
32-36	$65,000	$105,000	
49-53	$9,000	$210,000	**
62-65	$9,000	$140,000	**
68	$15,000	$25,000	
71	$5,000	$25,000	
33-93	$8,500	$45,000	
94	$1,000	$11,000	
99	$8,000	$15,000	
	$256,400	$2,141,000	

* Min is stablize pond berm with no stream improvements, Max is to remove dam, construct wetlands, and redesign stream channel

** Min is for naturalization plant material only

*** Low priority projects, while not included here, would have a substantial cumulative impact in this watershed

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 E
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

Joel M. Esh – Mr. Esh has an Associate in Specialized Technology Degree in Computer Aided Drafting and Design from York Technical Institute and 7 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.

Jonathan P. Kasitz – Mr. Kasitz has a bachelor's degree in Biology/Ecology from Millersville University. He has used the 1987 *Corps of Engineers Wetland Delineation Manual* for numerous field delineations in PA, MD and NY. He has completed the U.S. Army Corp of Engineers' Wetland Delineation Course. He has also been trained in several different stream assessment protocols, both in the eastern U. S. as well as in the Rocky Mountain region. Mr. Kasitz participated in internships with the PA Department of Environmental Protection in their Water Quality division and with the PA Department of Military and Veteran Affairs as a Biology Tech at Fort Indiantown Gap. He has worked with various government agencies including the

National Park Service at Yellowstone NP and the US Forest Service in Colorado. He has performed biological surveys for many different threatened and endangered species across the country. He also completed honors research on the effects of ponds on stream nitrate levels in Lancaster County while at Millersville.

Mark A. Metzler – 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 designed several passive wetland treatment systems in conjunction with stream restoration projects in Lancaster County, PA and has performed wetland delineations in central and eastern Pennsylvania.