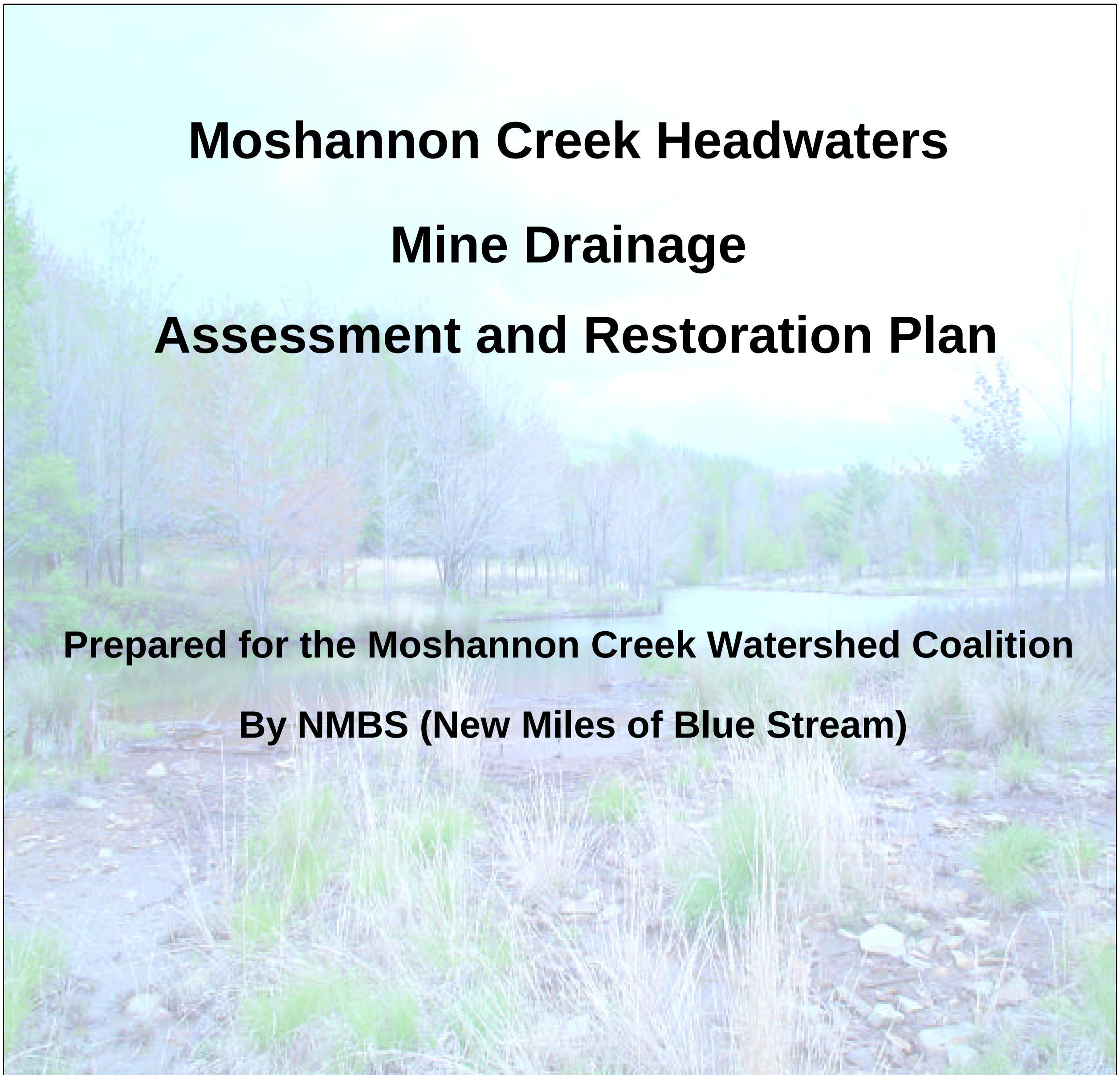

Moshannon Creek Headwaters

Mine Drainage

Assessment and Restoration Plan

Prepared for the Moshannon Creek Watershed Coalition

By NMBS (New Miles of Blue Stream)

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NMBS

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Executive Summary

The Moshannon Creek Headwaters Assessment and Restoration Plan was developed in the effort to address pollution problems affecting the headwaters section of Moshannon Creek downstream to the confluence of Bear Run. The Moshannon Creek Watershed Coalition (MCWC), a local, nonprofit, volunteer organization, in cooperation with numerous partners, has created this plan to provide users with a road map to guide future restoration and implementation activities within the watershed. MCWC contracted with NMBS to perform the field assessment, to develop the monitoring plan, to coordinate monitoring activities with volunteers, and to develop the restoration plan.

The restoration of the Moshannon Creek watershed presents many challenges and project partners should understand that the recommendations identified within are based on the best information on restoration technologies available at the time of its creation. Due to the evolving techniques and technologies used in watershed restoration, changing priorities of government agency programs, and the varying availability of funding for restoration activities, periodic review and editing of this plan is highly recommended.

The headwaters of Moshannon Creek begins at the junction of Blair, Centre and Clearfield Counties in Central Pennsylvania. The watershed area is primarily located on the Houtzdale and Tipton USGS 7.5-minute series topographic maps. Moshannon Creek acts as the border between Centre County to the west and Clearfield County to the east. The headwaters flow through Snyder Township in Blair County, the townships of Gulich and Woodward in Clearfield County, and in Rush Township of Centre County. The assessment was comprised of 9 miles of the main stem of Moshannon Creek with approximately 34 miles of tributaries. The end of the assessment area was at the confluence with Bear Run.

The water quality of the headwaters sections of Moshannon Creek to its confluence with Roup Run is labeled as a High Quality – Cold Water Fishery (HQ-CWF). A Cold Water Heritage grant was awarded to the Clearfield County Conservation District in 2005 to gain a better understanding of the area, and to develop a conservation plan to protect the ecosystem in the headwaters region. After conducting the study, it was found that there were a few impaired areas in the region that were affecting overall aquatic diversity in the stream. Therefore, AMD and AML impairment is beginning in the HQ-CWF section of Moshannon Creek. These impairments may be causing fish kills in high flow events; a landowner has reported that an iron coating is forming on the rocks.

The primary goal of the project partners is to restore the headwaters section of the Moshannon Creek watershed to its confluence with Bear Run. Restoring the headwaters of Moshannon Creek will, in turn, help improve the water quality of the West Branch of the Susquehanna River. Through remediation efforts

of abandoned mine drainage and abandoned mine lands within the headwaters of the Moshannon Creek watershed, a HQ-CWF stream will be improved and a cold water fishery can be restored to the section below Roup Run. Since a large section of the stream below Roup Run is open to the public, a restored fishery would complement the recreational activities that already exist within the watershed.

There were thirty nine notable areas of pollution along the headwaters section of Moshannon Creek; thirty eight are considered significant and require treatment. The impacts in this headwaters section are severe and related to extensive abandoned mine lands throughout this stream reach. Many of the discharges are associated with spoil piles, abandoned high walls, and unreclaimed surface mine areas. Most of the discharges would benefit from reclamation activities that would decrease discharge flow rates and improve water quality. Fewer treatment projects are likely to be required if reclamation efforts take place. Through these reclamation efforts, several areas of abandoned mine lands which pose public safety hazards and negatively impact the aesthetic value of the watershed can be restored.

Most recommended treatment systems for the headwaters of Moshannon Creek are passive systems, but, due to the severity of water quality and the high flow rates, active treatment is recommended at some of the sites. Also, to be as economical as possible, some of the discharges should be combined and treated actively to decrease the number of treatment systems. The preliminary recommendation for the active treatment systems include using lime dosers which require no electricity and limited maintenance. The passive treatment systems will use the most appropriate of the technologies available at the time of design and construction. The systems will consist of a combination of aerobic wetlands, vertical flow wetlands, limestone ponds, upflow ponds, aerating settling ponds, and manganese limestone beds.

If the 38 priority treatment projects are completed, the headwaters of the Moshannon Creek watershed will be greatly improved. Restoration efforts will allow for the aquatic ecosystem that exists in the very top of the headwaters to re-establish and expand their population to newly restored sections of the main stem of Moshannon Creek. Hopefully, below Roup Run, Moshannon Creek will someday house a wide variety of aquatic organisms including native brook trout and a cold water fishery can be established.

Table of Contents:

Introduction

Watershed Vision

It is the vision of the project partners to restore the headwaters of the Moshannon Creek watershed through remediation of abandoned mine drainage and abandoned mine lands. These efforts will support the goal of improving water quality, and restoring a cold water fishery below Roup Run. Another goal is to improve the land quality for human and wildlife use through the reclamation of abandoned highwalls and spoil areas. Restoration efforts will restore impaired sections of the stream expanding recreational opportunities that already exist within the watershed.

The restoration project provided many hands-on learning opportunities related to mine drainage for youth groups and local residents, another goal of MCWC. Education will lead to long-term stewardship in the watershed and the establishment of a relationship with the community that will work towards protecting and cleaning-up local watersheds.

Purpose of Project

The Moshannon Creek Headwaters Assessment and Restoration Plan was developed in the effort to addresses pollution problems affecting the headwaters section of Moshannon Creek downstream to the confluence of Bear Run, along with tributaries in this section. Moshannon Creek Watershed Coalition (MCWC) is a local, nonprofit, volunteer organization, in cooperation with numerous partners, has created this plan to provide users with a road map to guide future restoration and implementation activities within the watershed. MCWC contracted with NMBS to perform the field assessment, develop the monitoring plan, coordinate monitoring activities with volunteers, and develop the restoration plan.

Stream walks began in the spring of 2003 to identify problem areas throughout the headwaters. Water samples were collected at significant discharges in the HQ-CWF section. As discharges were located, the enormity of the problems facing the headwaters section of the watershed was identified and a grant was submitted to conduct a watershed assessment and restoration plan. MCWC secured funding to complete the assessment and develop a restoration plan for the headwaters section downstream to Bear Run.

The primary goal of the project partners is to use the information collected during the assessment and the recommendations in the restoration plan to restore the headwaters section of the Moshannon Creek watershed to its confluence with Bear Run. Restoring the headwaters of Moshannon Creek will, in turn, help improve the water quality of the West Branch of the Susquehanna River. Through remediation efforts of abandoned mine drainage and abandoned mine lands within the headwaters of the Moshannon Creek watershed, a HQ-CWF stream will be improved and a cold water fishery can be restored to the section below Roup Run. A large section of the stream below Roup Run is open to the public, thus, a restored fishery would complement the recreational activities, such as hiking, fishing, hunting, and riding ATVs that already exist within the watershed.

Public Participation

In order to complete the assessment and restoration plan, MCWC reached out into the local community to gain volunteers willing to participate in the stream reconnaissance, weir installation and monthly sampling. Members of local sportsmen's groups, Boy Scouts, Houtzdale Correctional Facility, and citizens stepped forward to help MCWC successfully complete the assessment. MCWC understands the daunting task of restoring Moshannon Creek and considers outreach an important aspect of reaching their goals. They conduct monthly meetings, have annual special meetings to present projects and reports, invite guests to present special topics, maintain a website and publish informational inserts in the Philipsburg Journal to name a few activities to increase membership and encourage public participation.

Watershed Background

Watershed Description

The headwaters section of the Moshannon Creek watershed is primarily located in Centre and Clearfield counties, with small portions also appearing in Blair and Cambria counties. This portion of the watershed is displayed in four USGS 7.5-minute series topographic maps. In descending order of representation these are Houtzdale, Tipton, Ramey, and Blandburg (see map on A-4).

The stream originates in a desolate area near the border between Blair and Centre Counties and flows in a northerly direction acting as the border between Centre County to the west and Clearfield County to the east until its confluence with Bear Run. The Moshannon Creek Watershed covers 288 square miles in 8 townships in Centre and Clearfield Counties. It has a maximum width of 13 miles and a length of about 51 miles from the Blair-Centre County line northeast to the West Branch just south of Karthaus. Nearly all tributaries to Moshannon Creek are acid in nature, and the creek contributes an average unadjusted acid load of 130,000 lbs/day (adjusted 160,000 lbs/day) to the West Branch, completely degrading that stream for many miles below Moshannon Creek's mouth. Moshannon Creek is the 5th largest tributary to the West Branch of the Susquehanna.

Due to the large size of Moshannon Creek and its associated tributaries (288 mi2) and due to the vast impact the watershed has suffered the project partners decided to assess the stream in more manageable phases. Phase I is the headwaters section through the confluence with Bear Run. Additional phases will be assessed and restoration plans developed in the future.

The following table provides approximate lengths for several of the named streams in the assessment area. Note that stream lengths only include the length of the named stream; unnamed tributaries are omitted.

Stream Name	Approx. miles
Bear Run	3.7
Moshannon Creek	10.5
Mountain Branch	5.0
Roup Run	1.9
Sand Spring Run	2.6
Trim Root Run	3. 5
Whiteside Run	3.6
Wilson Run	2.1

The assessment area encompasses approximately 35.5 square miles. The following table provides approximate areas for the same named sub-watersheds in the assessment area. Note that these areas are those represented in a map entitled "sub-watersheds" on page A-5. The areas for these sub-watersheds are for the entire area feeding to the named stream; unlike stream length, this includes unnamed tributaries. The sub-watershed entitled "Moshannon Creek" represents those areas not feeding to one of the named streams.

Stream Name	Approx. square miles
Bear Run	3.0
Moshannon Creek	13.7
Mountain Branch	5.5
Roup Run	1.4
Sand Spring Run	2.6
Trim Root Run	2.8
Whiteside Run	5.1
Wilson Run	1.4

History

Generations of area residents have made their living and enjoyed recreation throughout the Moshannon Creek watershed. Recreation, including fishing, has been a favorite past time in this area, and despite degradation of the stream by AMD and AML, sections of Moshannon Creek and its tributaries still contain a viable wild trout population. Mining occurred within this watershed from the late 1800's to the 1900's affecting both water quality and aesthetics of the surrounding landscape. Deep mining accounted for most of the coal extracted prior to the 1940's, after which surface mining predominated. This mining has left only a few sections within the headwaters of Moshannon Creek unimpaired by AMD and AML.

In 1997 the Fish and Boat Commission investigated the headwaters of Moshannon Creek from Roup Run upstream. According to PFBC biologists this section could be characterized as a small, infertile stream. A site 3 km upstream from Wilson Run was electro-fished. An abundance of naturally reproducing brook trout was found representing several age classes along with slimy sculpins. The study also indicated that the water was lightly buffered with a total alkalinity of 6 mg/L and a pH of 6.6 SU. One recommendation from the study was to manage Moshannon Creek from the source to Roup Run as a Class A wild brook trout fishery with no stocking. The second recommendation was to upgrade the stream to HQ-CWF (PFBC).

Also in 1997 the Fish and Boat Commission sampled Wilson Run. According to PFBC biologists this watershed is classified as a small, infertile coldwater stream. A site about 0.5 km upstream from the mouth was electro-fished. Slimy sculpins and brook trout were the only two species of fish found. Several age classes were found but few adults. The population of the brook trout is probably limited by lack of pools and extensive riffle habitat. The water quality also showed a slightly buffered stream with a total alkalinity of only 2 mg/L and a pH of 6.5 SU. It was also stated in the report that the low alkalinity makes Wilson Run sensitive to acidification. It was recommended that this stream be managed as a Class C wild brook trout fishery with no stocking in order to protect this resource.

Historical data was gathered and reviewed during the watershed assessment. The historical data which was recorded is included on the accompanying CD. For more information on historical data see the accompanying CD or read the additional summary in Appendix B.

Historical Studies

At least five studies have previously been completed which include the affected areas. These include the Scarlift report 1973, Moshannon Creek Water Studies by Dr. Bill Hellier, 1982, 1994, 1996 and a paper by Michelle Merrow titled, " A Comprehensive Hydrological Impacts Assessment of the Headwaters and Upper Reaches of Moshannon Creek, Clearfield and Centre Counties, Pennsylvania.

The Scarlift Reports have flow and water quality data and data from the Federal Water Pollution Control Administration (FWPCA, now known as Environmental Protection Agency, (EPA) from 1966 to 1968. This report determined that most of Moshannon Creek is extremely polluted, estimating an acid load of 130,000 lb/day being discharged into the West Branch of the Susquehanna.

Dr. Hellier investigated the hydrologic impact assessment of Moshannon Creek. His report details where improvements to the water quality could occur using reclamation and up to date mining practices. Pennsylvania Department of Environmental Protection (PA DEP) conducted a water quality assessment in 1994. The PA DEP determined that 36.3 stream miles of the watershed basin and 26.2 stream miles of the main stem display degradation due to AMD.

These historical documents were used in the development of the sampling plan and their data considered in the prioritization of projects within the watershed. Their recommendations were also considered in the development of the restoration plan.

Geology/Topography

The Moshannon Creek Watershed lies within the Appalachian Plateau Physiographic Province just northwest of the Allegheny Front, which separates that area from the Valley and Ridge Province. Topography within the study area is strongly influenced by physiographic setting and by the nature of the Mississippian and Pennsylvania age sedimentary units present, and represents approximately 100 million years of erosion. The headwaters of Moshannon Creek where relief is extreme and stream gradients are steep lie within the Allegheny Mountain section of the province. Gradients and relief are less extreme in the central portions of the watershed, which lie in the Pittsburgh Plateau section of the province. Here the stream lies above the resistant Pottsville sandstone of the Pocono Formation and are downcutting very slowly. Rapid downcutting and extreme relief are again evident near the mouth of Moshannon Creek where the stream has cut through the resistant Pottsville and is rapidly eroding the less resistant sediments beneath it. Total relief in the study area is approximately 1600 feet, but local relief rarely exceeds 700 feet. The highest elevations in the study area are around 2450 feet. Surface elevations decrease toward the north, approaching 900 feet at the mouth of Moshannon Creek. The large topographic relief is due in part to long periods of erosion of the resistant Pocono sandstone in highly fractured zones along portions of the area's anticlines. In addition, the highlands are often capped by one of the many resistant types of sandstone contained within the Coal Measures. The coals themselves outcrop on the valley walls throughout the study area, and the large number of such outcrops above surface drainage in the area is attributable to the stratigraphically high position of the Allegheny Group coals along with heavy fluvial dissection. The drainage networks of the watershed are largely controlled by rock type, folding and faulting. Portions of Moshannon Creek follow the northeast-southwest trending axis of the Houtzdale- Snow Shoe Syncline, and the drainage patterns of many of the study area streams reflect an extensive northwest-southeast trending series of faults.

The stratigraphy of the assessed area is strikingly segmented as can be seen on the geology map found on page A-9. The northwest portion of the assessment area is predominately Pennsylvanian-age rocks while the southeast portion of the area is predominately Mississippian-age rocks. The map illustrates that the far northwest portion is represented as Glenshaw formation rocks, then a large swath of undifferentiated Allegheny group rocks, and finally a strip of undifferentiated Pottsville Group rocks. The southwest portion is Mauch Chunk formation Mississippian age rocks intermingled with large areas of Burgoon Sandstone.

The lithiostratigraphy, excluding coals, of the area consists of heterogeneous succession of flat-lying beds of sandstones, siltstones, claystones, minor limestones, shales and other lithologies representing gradations between these various types.

A variety of coal seams can be found throughout the region. Because of the rich coal reserves that existed in the study area, extensive surface and deep mining activities have occurred. These extensive mining activities have resulted in the widespread pollution of Moshannon Creek and its tributaries. Countless pollutant sources discharge into surface and ground waters of the area. Past coal mining has left behind scarred landscapes, huge amounts of coal refuse, abandoned mine lands (AML) and mine subsidence.

GEOLOGY (Scarlift 1973)

The Moshannon Creek Watershed is situated on the northeast end of the Main Bituminous Coal Field of Appalachia that extends west into Ohio and south as far as Alabama. The study area's stratigraphic sequence consists of 15,000 - 20,000 feet of sedimentary rocks lying above Cambrian age crystalline basement rocks. These sedimentary rocks are all of Paleozoic age except for the Quaternary unconsolidated sands and gravels in the stream valleys. The Mississippian and Pennsylvanian age rocks within this sequence consist of interbedded shales, siltstones, sandstones, clays and bituminous coal seams of varying quality and thickness. The coals are extracted wherever economical to supply the energy needs of the eastern United States and some foreign nations.

The surface formations within the study area range from the upper 300 feet of the Mississippian Pocono Formation to the lower 300 feet of the Pennsylvanian Conemaugh Group - a total stratigraphic thickness of about 1100 feet. The Pennsylvanian age Allegheny Group rocks are the most important to the study areas' coal economy. This sequence of Allegheny Group coals, referred to as the coal measures, ranges vertically from the Clarion-Brookville coal at the base of the group to the Upper Freeport coal. Other coal seams locally present within the study area are the Pottsville's Mercer coals, which are generally of good quality and are mined when present; and the Conemaugh's Mahoning coal, which varies in thickness and lateral continuity.

The mode of formation of the coal measures is responsible in part for the incongruous conditions presently seen within the study area - where certain coal seams are associated with alkaline discharges and other coal seams acid discharges. The coal measures are erratic, cyclic sequences of underclay, coal, claystone, shale and sandstone deposited during a period of mild tectonic activity. The tectonic activity resulted in the erratic submergence and emergence of coastal lands, with mildly fluctuating subsidence rates, and a subsequent variable base level. This created an often repeated open water to swamp to fluvial deltaic depositional sequence. The varying paleoenvironment produced the strong local variations in the physical and chemical nature of the sediments deposited.

Mild tectonic activity continually varied paleoenvironmental conditions and occasionally produced restricted water areas or basins in which biochemical oxygen demand was high. Reducing conditions developed in these basins and were reflected in the character of the materials deposited. The coal and associated overburden deposited in such a reducing environment arc high in pyrite and other sulfuritic compounds, and readily produce acid when exposed to oxygen and water. The Clarion- Brookville coal, the Lower Kittanning, and locally the Middle Kittanning coal were often deposited under such conditions and most of the mine discharges from those seams are acid in nature.

The "A" and "B" coals are shallow in portions of the Houtzdale syncline through the Moshannon Creek basin. Here these coals have been extensively deep and strip mined throughout the syncline. The deep mines have completely altered the natural hydrology of the area. Most of the deep mines were developed to the rise and act as underdrains, passing groundwater through acid producing areas, with no regard for surface watershed boundaries. The acid water discharges from the low points of the deep mines, generally near the synclinal axis, along Moshannon Creek.

Southeast of the Houtzdale-Snow Shoe Syncline, the strata rise toward the Hannah Furnace or Moshannon Anticline. The Allegheny Group rocks have been completely eroded from the anticline, and no extensive coal beds exist beyond a point just southeast of Philipsburg. Lower coals of the Allegheny Group reappear locally in a small basin at the axis of the Black Moshannon Syncline, near Black Moshannon Airport. Surface rocks in the eastern one-third of the Moshannon Creek Watershed are Pottsville and Pocono sandstones, with the coal measures mostly removed by erosion. The absence of mining is reflected by the good water quality of Black Bear Run, Sixmile Run, and most of Black Moshannon Creek which is downstream from the study area, and part of the Phase III assessment area.

Faulting is most extensive in the area from Powell Run to north-central Moshannon Creek. South of Powell Run, major faults are found near Frugality and Dougherty and trend more east-west than those in the northern area. In the northern most area of Moshannon Creek succeeding faults trend more north to south.

The displacements of these faults vary greatly in magnitude, but they are frequently sufficient to make coal extraction across them impractical or impossible; and the limits of the deep mine workings are frequently defined by such faults. Faulting in the Bear Run watershed of Moshannon Creek was of sufficient magnitude to offset coal beds up to forty feet.

Within individual fault blocks, local, strong, minor structures are frequently superimposed on the general anticlinal and synclinal structure. This tends to throw the structural axis off from one fault block to the next, and makes it difficult in highly faulted areas to trace the actual structural axis with a single straight line. Jointing, a characteristic associated with deformation, is also well developed in the study area. Generally, the strata associated with coal measures would provide a fair water supply for nearby communities. The sandstone and coal units within the coal measures provide perched aquifers, contained by impermeable underclays and shales that are used as a domestic water supply. The development of mines along the coal seams, however, tends to open overlying joint spacing as a result of subsequent roof collapse. This decreases the water retention capacities of the overlying rocks, thereby depleting individual home water wells. This is evident in most communities in extensively deep mined areas. These communities are often forced to pipe or haul in water from un-mined areas to combat loss of well water caused by the extraction of the underlying coal.

Soil Descriptions

The 2005 NRCS data shows that there are approximately seventy soil units found along the main stem and tributaries of the headwaters section of Moshannon Creek, with fourteen making up approximately 75% of the watershed. The top five dominant soils along the main stem are Hazelton extremely stony sandy loam, moderately deep (HSD), Hazelton – Dekalb association, very steep (HTF), Hazelton extremely stony stony sandy loam, gently sloping (HSB), Cedarcreek extremely channery loam, moderately steep (95D), Strip mines, acid (Sm). Below are the descriptions for the fourteen major soil units found within the assessment based on area starting with the largest. Information in this section was obtained from data provided by NRCS as well as a review of the Clearfield County Soil Survey. Several discrepancies were noted between the NRCS data and the older Soil Survey; the newer data was presumed to be more accurate for contemporary use. A map of the dominant soils can be seen on A-8.

Hazleton extremely stony sandy loam, 8 to 25 percent slopes (HSD)

This soil unit is moderately steep, deep, well drained, and mainly found on convex sides of mountain ridges. It is found on uplands. Stones of 10 to 30 inch diameters cover approximately 15 to 50 percent of the surface. Permeability is moderately rapid to rapid, and the available water capacity is low to moderate.

Runoff is medium to rapid. The steep slopes and stony surface make this soil unit unsuitable for farming and non-farm uses. It is suitable to tree cultivation. Most of this soil unit is used for woodland. Within the headwaters of Moshannon Creek, this soil unit is found along on the mountainous regions on ridges and mountain tops.

Hazelton – Dekalb association, very steep (HTF)

The Hazleton series consists of deep and very deep, well drained soils formed in residuum of acid gray, brown or red sandstone on uplands. Slope ranges from 0 to 80 percent. Permeability is moderately rapid to rapid. Reaction ranges from strongly acid through extremely acid throughout where the soil remains unlimed. Hazleton soils developed in residuum from acid gray, brown, or red sandstone and are found on summits, shoulders, and the upper third of backslopes. Slopes are usually convex with gradients of 0 to 80 percent. The potential for surface runoff potential is negligible to high. Permeability is moderately rapid to rapid. Most Hazleton soils are in woodland of mixed oaks, maple, cherry and occasional conifers. Some areas have been cleared for pasture and cropland.

The Dekalb series consists of moderately deep, excessively drained soils formed in material weathered from gray and brown acid sandstone in places interbedded with shale and graywacke. Slope ranges from 0 to 80 percent. Permeability is rapid. Reaction ranges from extremely through strongly acid where the soil remains unlimed. Dekalb soils are on nearly level to very steep, uplands and ridges. Slopes are usually convex with gradients of 0 to 80 percent. The regolith weathered from gray and brown acid sandstone in places interbedded with shale and graywacke.   The soils are well drained to somewhat excessively drained. The potential for surface runoff is negligible to high. Permeability is rapid. Most Dekalb soils are in forests of mixed oaks, maple, and some white pine and hemlock. Smaller areas have been cleared for cultivation and pasture.

Hazelton extremely stony sandy loam, gently sloping (HSB)

The Hazleton series consists of deep and very deep, well drained soils formed in residuum of acid gray, brown or red sandstone on uplands. Slope ranges from 0 to 80 percent. Permeability is moderately rapid to rapid. Reaction ranges from strongly acid through extremely acid throughout where the soils remain unlimed. Hazleton soils developed in residuum from acid gray, brown, or red sandstone and are found on summits, shoulders, and the upper third of backslopes. Slopes are usually convex with gradients of 0 to 80 percent. The soils are typically well drained. The potential for surface runoff potential is negligible to high. Permeability is moderately rapid to rapid. Most Hazleton soils are in woodland of mixed oaks, maple, cherry and occasional conifers. Some areas have been cleared for pasture and cropland.

Cedarcreek extremely channery loam, moderately steep (95D)

The Cedarcreek series consists of very deep, well drained soils with moderate or moderately rapid permeability. These soils formed in acid regolith from the surface mining of coal. The regolith is a mixture of partially weathered fine earth and fragments of bedrock. Rock fragments consist mainly of acid sandstone and siltstone with small amounts of shale and coal. Cedarcreek soils are on nearly level to gently sloping benches, gently sloping to strongly sloping hillslopes, and steep to very steep outslopes. These soils formed in regolith from surface coal mine operations. The regolith is a mixture of partially weathered fine earth and fragments of bedrock. The fine earth material is from fragments of bedrock which have been crushed by machinery and weathered. Depth to bedrock is greater than 5 feet. Reaction ranges from strongly acid to extremely acid except for surface layers that have been limed. Fragments of rock range from 15 to 80 percent by volume throughout the profile but average 35 percent or more in the particle-size control section. Rock fragments are sandstone, siltstone, shale, and coal, and the percentage of any one rock type is less than 65 percent of the total rock fragments in the control section. Rock fragments are mostly channers, but stones and a few boulders are included. Clay content in the fine earth fraction of the control section ranges from 18 to 27 percent. Most pedons have red, brown, yellow, or gray lithochromic mottles in some or all horizons.

Strip mines, active, 8 to 40 percent slopes (Sm)

Strip mines is a group of miscellaneous areas disturbed by excavating or stripping of soil and rock overburden to gain access to underlying beds of coal or fire clay. This unit consists of carbonaceous shale, sandstone and shale fragments along with soil material. Many of its characteristics are variable including permeability, the seasonal high water table, and runoff rate. The available water capacity is low to very low, and the erosion hazard is high until plants are established on this disturbed land. Strip mine acreage is mostly woodland or wildlife habitat. Most limitations to this soil unit are caused by the many coarse fragments, extremely acidic material, and extreme variability of its composition. This soil unit borders the Moshannon Creek on the Centre County side of the stream towards the middle to end of the assessed area.

Buchanan extremely stony loam, 0 to 8 percent slopes (BxB)

Soils of the Buchanan series are very deep, somewhat poorly and moderately well drained, and slowly permeable. Depth to bedrock ranges from 5 to 20 feet or more. Depth to the fragipan ranges from 20 to 36 inches. Rock fragments of both subrounded and flat subangular, hard sandstone and shale, channers, gravels, cobbles and stones, range from 0 to 40 percent in individual horizons above the fragipan and from 5 to 60 percent in the fragipan and C horizon. Typically rock fragments make up 10 to 15 percent of the soil by volume with higher amounts in the surface. The soil contains both high and low chroma redox concentrations and depletions above the top of the fragipan and within the upper 10 inches of the argillic horizon. The soil ranges from extremely acid through strongly acid throughout where the soil remains unlimed. The soil is moderately well to somewhat poorly drained. Runoff is medium to high. Permeability is moderate above the fragipan and slow in the fragipan. Woodland is the major use. Some areas are cleared and used for pasture, small grain, and row crops. Wooded areas are mixed hardwoods of oak, maple and ash.

Wharton silt loam, 3 to 8 percent slopes (WhB)

This soil is gently sloping, deep and very deep. They are moderately well drained soils formed in residuum from interbedded clay, shale, siltstone, and fine-grained sandstone. They are found on uplands. Slopes generally are smooth, slightly concave or convex, and 100 to 300 feet long. The areas of this soil are oval, oblong, or irregular in shape and range from about 2 to 40 acres. Permeability is slow or moderately slow in the subsoil and substratum. Available water capacity is high. Runoff is medium. Reaction in un-limed areas is very strongly acid or strongly acid. A seasonal high water table is at a depth of 18 to 36 inches. The hazard of erosion is moderate. Most areas of this soil are in woodland, cultivated, or are in permanent hay.

Philo and Atkins very stony soils (Pk)

The Philo series consists of very deep, moderately well drained soils on flood plains. They formed in recent alluvium derived mainly from sandstone and shale. Permeability is moderate to moderately rapid. Slope ranges from 0 to 6 percent. Depth to hard rock ranges from 60 inches to 12 feet or more. Reaction when the soil remains unlimed range from very strongly acid to moderately acid. The soil is moderately well drained and is subject to stream overflow. The potential for surface runoff is low or very low and permeability is moderate to moderately rapid. A seasonally fluctuating water table rises to within 1-1/2 to 3 feet below the soil surface. Most areas are cleared and cultivated or pastured. Original vegetation was mixed water tolerant hardwoods.

The Atkins series consists of very deep, poorly drained soils formed in acid alluvium washed from upland soils that formed in shale and sandstone. Permeability is slow to moderate. Slope ranges from 0 to 3 percent. The depth to bedrock is greater than 60 inches. Unless limed, this soil is strongly acid or very strongly acid and ranges to moderately acid below a depth of 40 inches. Rock fragments are commonly absent, but may range from 0 to 20 percent by volume in the solum and from 0 to 60 percent by volume in the C horizon. This soil is poorly drained. The water table is a foot or less below the soil surface for appreciable periods. Internal drainage is very slow. Permeability is slow to moderate in the subsoil and ranges to moderately rapid in the substratum. The potential for surface runoff is negligible to low.

Occasional flooding is typical on the Atkins landform. The mechanism of flooding usually involves shallow standing or slowly moving water on the soil surface. Most areas are wooded or pastured. Vegetation is mixed hardwood forest of water tolerant oaks, red maples, black gum, sweet gum, willow, elm, ash, and alder; with aquatic grasses and sedges in places. Many areas originally mapped as Atkins have been filled in, and in subsequent decades developed for urban uses.

Brinkerton silt loam, 3 to 8 percent slopes (BrB)

This soil unit is gently sloping, deep, and poorly drained. It is found on uplands. Permeability is moderate above the firm part of the subsoil and moderately slow to slow in the firm part, and runoff is slow. Reaction in un-limed areas is medium acid to very strongly acid. The seasonal high water table is from the surface to a depth of six inches, and the erosion hazard is moderate. Most areas of this soil type are in woodland. The soil is also suited to some crops that tolerate seasonal wetness, pasture, and trees. Non-farm uses of this soil are limited by the high water table and permeability. Within the headwaters of Moshannon Creek, Brinkerton silt loam is found in small areas along some of the tributaries. This soil is listed as a hydric soil.

Ernest silt loam, 8 to 15 percent slopes (ErC)

Ernest silt loam, 8 to 15 percent slopes, is sloping, deep, and moderately well drained. It has moderately slow to slow permeability and a moderate available water capacity. Runoff is medium, and the erosion hazard of this soil unit is severe. The reaction in un-limed areas is strongly to very strongly acid. The seasonal high water table is 18 to 36 inches. Ernest silt loam, 8 to 15 percent slopes is listed as a Farmland of Statewide Importance. Most areas of this soil are in woodland, but it is also suited to cropland and pasture. Non-farm uses are limited by the high water table and permeability. This soil type is found in the extreme headwater areas of some tributaries.

Wharton silt loam, 8 to 15 percent slopes (WhC)

This soil is sloping, deep, and moderately well drained. They are typically found on uplands. Slopes generally are smooth, slightly concave or convex, and 100 to 300 feet long. The areas of this soil are oval, oblong, or irregular in shape and range from about 4 to 40 acres. Permeability is slow or moderately slow in the subsoil and substratum. Available water capacity is high; runoff is medium. Reaction in un-limed areas is very strongly acid or strongly acid. A seasonal high water table is at a depth of 18 to 36 inches. The hazard of erosion is severe. Most areas of this soil are in woodland, cultivated, or are in permanent hay. Some areas are used for pasture, have remained in native vegetation, and are suited for trees.

Atkins silt loam (At), 0 to 3 percent

This soil is nearly level, deep, poorly drained and found on flood plains, which are frequently flooded. Slopes range from zero to three percent. The permeability is slow to moderate in the subsoil and moderately slow to rapid in the substratum. The available water capacity is high and runoff is very slow. Reaction in un-limed areas is strongly to very strongly acid. The seasonal high water table of this soil unit is between the surface and a depth of 1 foot; a slight hazard of erosion exists. This soil is considered hydric and is also included on the list of Statewide Important Farmland Soils of Clearfield County, Pennsylvania; however, much of the soil surrounding this stream has been disturbed by surface mining. This soil unit belongs to Hydrologic Group D with very brief, frequent flooding from September through July. Frequent flooding and the high water table limit the use of this soil for most non-farm uses. It is especially unsuited to onsite waste disposal. According to the soil survey, Atkins silt loam is fairly well to well suited for wetland plants, openland, woodland, and wetland wildlife.

Leetonia extremely stony loamy sand, 0 to 12 percent slopes (LtB)

The Leetonia series consists of deep, well to excessively drained soils formed in weathered residuum from sandstones, conglomerates and quartzites. They are sloping to very steep soils on narrow ridge crests and long side slopes in hilly to mountainous topography. These soils are gravelly or very gravelly sand, loamy sand or loamy fine sand throughout with sand coarser than very fine sand ranging from 60 to 80 percent and medium and fine sand being dominant. Reaction ranges from extremely acid to very strongly acid in all horizons. The soil is well to excessively well drained. Runoff is medium to slow. Permeability is moderately rapid. The soil mainly consists of a mixed forest of chestnut oak, black oak, white oak, maple, second growth chestnut, dogwood, white pine, pitch pine and Table Mountain pine. A few small areas are used for crops and pasture. Crops found here are corn, wheat, oats, buckwheat, potatoes and mixed hay.

Bethesda very channery silt loam, 8 to 25 percent slopes (92D)

This soil is a very deep, well drained soil formed primarily in Pennsylvanian-age acid regolith from surface mine operations. Bethesda soils are on nearly level to gently sloping interfluves, base slopes, head slopes and benches to very steep nose slopes and side slopes. These soils occur on human-modified hills. The regolith is a mixture of partially weathered fine earth and fragments of bedrock from surface mine operations. Fragments of rock consist mainly of acid shale, siltstone, coal, and medium and fine-grained sandstone. They are moderately deep to a root restrictive, compacted layer. Reaction ranges from strongly acid to extremely acid except for surface layers that have been reclaimed. Rock fragments include shale, sandstone, siltstone, and coal. They range mostly from 2 mm to 25 cm but include stones and boulders. The fine-earth fraction of the control section averages 18 to 35 percent clay. Bethesda soils are well drained.

Permeability is moderate in the upper part and slow or moderately slow in the lower part. The dominant use is wildlife habitat and recreational areas. Most reclaimed areas have been seeded to grasses and some trees. Some of the reclaimed areas are used for hay and pasture.

Wetlands

The headwaters section of Moshannon Creek was reviewed on the National Wetlands Inventory Map (NWI). The maps for the project area are the NWI 7.5 Minute Houtzdale and Tipton Quadrangles. Based on review of this mapping, approximately forty wetland habitats were identified within the drainage basin of the headwaters of Moshannon Creek.

All of the wetland habitats within the headwaters of Moshannon Creek can be placed into one of two systems, Palustrine or Riverine. The Riverine systems can be classified as Upper Perennial with an unconsolidated bottom. Hydrologically, they are permanently flooded. Four classes of Palustrine systems have been identified in this watershed. They are forested, scrub-shrub, emergent, and unconsolidated bottom habitats. The forested and scrub-shrub habitats are characterized as having broad-leaved deciduous, needle-leaved evergreen or dead vegetation. They range from temporarily to seasonally flooded and may result from impoundments. The emergent habitat type found within this watershed is characterized as persistent. Hydrologically, it is temporarily flooded. The unconsolidated bottom habitats range from semi-permanently to permanently flooded and result from impoundments or excavation.

Land Use

The Moshannon Creek watershed is mainly forested and undeveloped. State Game Lands # 60 contain a small portion of the headwaters and is considered critical wildlife habitat. The extreme headwaters section of Moshannon Creek and Mountain Branch is owned by the Houtzdale Municipal Water Authority. They have preserved these sections of land for the use of public water supply. Hunting and fishing are major land uses throughout the entire watershed. Below the extreme headwaters section, extensive mining has occurred since the 1800's , with approximately 25% of the area being affected by mining. Both underground and surface mining have scarred the landscape and degraded the water quality of the stream.

Minimal logging has also occurred at various times within the watershed up until recent times. At this time, much of the watershed is reclaimed surface mines, highwalls, or forested area. Spoil piles cover much of the mining areas; many are adjacent to streams. There are no industrial or other water quality impacts in the watershed. There are many small towns throughout the watershed but their small populations pose little threat to the watershed.

Cultural

The nearest communities in the headwaters section of Moshannon Creek are Ginter, Whiteside, Morann and Hale. These communities are small, rural villages with the majority of households being located along SR 153. Hunting and fishing is a favorite pastime of many of the residents there. The very headwaters of Moshannon Creek to Roup Run support small populations of fish and through remediation efforts it is believed the populations can spread throughout the main stem. Hunting, biking and hiking still occur at this time, and an abundance of wildlife is to be found there. Through restoration efforts in the watershed, the local community will benefit from restoring a significant cultural ingredient to the area.

Mining

Mining History

Because of the rich coal reserves that existed in the study area, extensive surface and deep mining activities have occurred in the watershed from the 1800’s until present. These extensive mining activities have resulted in the widespread pollution of Moshannon Creek and its tributaries. Countless pollutant sources discharge into surface and ground waters of the area. Also, past coal mining has left behind a scarred landscape, huge amounts of coal refuse, abandoned mine lands, and mine subsidence.

Coal mining developed the Moshannon Valley and played a key role in its social and economic development. Railroads, highways, and towns were built in response to mining areas and for the demand of transporting coal to markets. Moshannon Valley experienced a large population growth in the latter 19th century from the high demand for the coal located there. Houtzdale for example, grew by a factor of five between 1872 and 1885.

The earliest mining, 1840s and 1850s, was the deep mines in the A, B, and D coal seams. Deep mines leave behind much refuse material created from the removal of rock to get to the coal. In the 1860s larger scale mining occurred in the Derby Mine west of Philipsburg which led to numerous small mines that were scattered throughout the Moshannon Creek watershed mainly downstream of Wilson Run.

Late in the 19th and early in the 20th centuries was when much of the watershed degradation occurred. This pollution stems from ignorance about poor mining practices or the problems that they were causing. Money from the coal was more important than the environment. Often however, the required clean technology did not exist to protect the environment from the harmful effects of coal mining.

Early in the 20th century the virgin lumber was gone leaving desolate hillsides and coal to be the only remaining industry. In the 1940s the coal industry changed its preferred method of mining from deep mining to surface mining which is used almost exclusively today.

Historical Permits

The following outlines the relevant historical permits categorized by the portion of the assessed area impacted. The impacted area is identified by the stream reach.

Stream Reach: Moshannon Creek from forked tributary to Wilson Run confluence

1. Mining Company: Westport Mining
   Job Name: abandoned strip mines near the Rosemary surface mine
   Permit #: 17673057

2. Mining Company: Westport Mining
   Job Name: Ginter Operation
   Permit #: 1779132
   Coal Seam: A B C
   Notes: This area was initially deep mined and the Eureka #28 deep mine underlies this area; the Viola #1 and Eureka #29 deep mines are interconnected with the B seam surface mine, petition # 17849901

3. Mining Company: Anderson Creek Coal and Clay Co
   Job Name: Karen #1
   Permit #: 4370BSM10; new permit issued , #1779132
   Coal Seam: A
   Time Period: 1940s – 1950s

Stream Reach: Wilson Run to Roup Run

1. Mining Company: Power Operating Co.
   Job Name: Rosemary
   Permit #: 17673057
   Coal Seam: A
   Notes: Eureka #24, Elizabeth #182

2. Mining Company: Yebernetsky Coal Company
   Job Name: Brenda Gayle
   Permit #: 17497, issued 20 Dec 1957
   Coal Seam: A
   Notes: Near Roup Run headwaters
   Time period: 1950's – 1960s

3. Mining Company: Rice Brothers Coal Company
   Job Name: Karen #1
   Permit #: 261M087, issued 16 May 1962

Stream Reach: Between Moshannon Creek and Mt. Branch

1. Mining Company: Hale Coal Co. / W. G. Moore and Sons
   Job Name: Brenda Gayle #1 of the Brookwood deep mine #2
   Permit #: 4770BSM9
   Coal Seam: C through A
   Time Period: 1970s
   Notes: Permit transferred to Al Hamilton Contracting Co in 1969, area day lighted in 1980s; Brenda Gayle #1, permit #4770BSM9

Stream Reach: Hale Run to Mt. Branch, Whiteside Run

1. Mining Company: E. M. Brown Inc.
   Job Name: Eureka #4, #6, #8; Clermont #2 and #3
   Permit #: 17950117 issued 10 Jun 1996
   Coal Seam: A
   Notes: Eureka #5 and #10 mines and the Beulah Shaft underlie tributaries to Whiteside Run

2. Mining Company: Elliot Coal and the Clearfield Sewer and Pipe Co.
   Job Name: Stanley Mine
   Permit #: 267M016
   Coal Seam: D and E seams, deep mines

3. Mining Company: Flango Brothers
   Permit #: 4374SM10

4. Mining Company: Power operating
   Permit #: 437BSM13

5. Mining Company: Minds Coal
   Permit #: 2764SM6

Stream Reach: Mt. Branch to Bear Run

1. Mining Company: Davis mining
   Job Name: Davis Operation, Brenda Gayle #2, as well as deep mines in the area
   Permit #: 14840101
   Coal Seam: Lower Kittanning and Lower Kittanning Rider Coal Seam
   Notes: Davis operation drains to a tributary and to Mt. Branch. Permitted 1984. Owned by Al Hamilton Coal Co. Davis Operation was mined completely from 1940 to 1959 by others.

2. Mining Company: Harchak and Lucas Coal Co.
   Permit #: 18559
   Coal Seam: Lower Kittanning and Clarion coals

3. Job Name: Davis Operation
   Permit #: 4775SM11
   Notes: Conducted by Al Hamilton. Underlain by 3 abandoned deep mines.

4. Mining Company: Unknown
   Coal Seam Name: Clarion Seam Mine

5. Mining Company: Mt. Top Coal Co.

Job Name: #1145
Coal Seam: Clarion Rider Seam

6. Mining Company: John T. Harchal Coal Co.
   Job Name: Ethel #1
   Coal Seam: Lower Kittanning Seam
   Notes: Ethel #1 was intercepted by Davis surface mining

7. Mining Company: Bowman Donley Operation
   Permit #: 4470BSM17
   Coal Seam: Middle and Upper Kittanning
   Time Period: 1980s

8. Mining Company: Power Operating Company
   Job Name: Bear Run
   Permit #: 4775SM15 and SMP14753015
   Coal Seam: A and B
   Notes: 1975, Elliot Coal Co became Power Operating Co. Inc. The Sunnyside, Frelin and Bear Run #2 mines were encountered in the Clarion Coal. Two major deep mine discharges from the A seam pollute an unnamed tributary to Bear Run.

9. Permit #3166BSM17 and #14663005 belonged to the Power Operating Co., Dugan #2. This is related to the above A seam, but not the surface mining on the Clarion and Kittanning seams in the area.

10. Permit #3166BSM16 and #3166BSM17 from the Power Operating Dugan Operation has runoff to the unnamed tributary to Bear Run.

11. Permit #17820114, Power Operating Co, Vought Site, 1980s.

12. Brookwood Shaft Refuse Reclamation Project
    - Deep mining stopped early 1900s
    - Refuse piles covers 15 acres
    - Volume of 1,000,000yd^3
    - Consists of boney, Red Dog and shale, depth range from 1.5 m to 300 m
    - Being removed by Power Operating Co to a burial pit #7 of their Rosemary strip mine
    - Wetlands will be constructed in the place of the refuse pile
    - D seam and is related to the Eureka #8 deep mine

Scarlift Report

An extensive study of the assessment area was completed by Skelly and Loy. The report is located at http://amrclearinghouse.org/Sub/SCARLIFTReports/ClearfieldMoshannon/ClearfieldMoshannon.htm

AML

Page A-7 shows the extent of the remaining catalogued highwalls and spoil areas within the headwaters section of the Moshannon Creek watershed. Several of the AML within the watershed borders the main stem of Moshannon Creek and poses a public safety hazard. Not only are the spoil piles and highwalls ruining the beauty of the landscape, but they are also contributing a source of additional acid runoff to the stream. Most discharges in this headwaters reach are associated with AML. Some of the AML has very steep slopes and poses a safety threat to outdoorsmen who hunt, hike, and ride ATVs in the area. Page A-7 shows the extent of the remaining highwalls and spoil areas in the headwaters section of the Moshannon Creek watershed. The AML areas have been prioritized and will be dealt with in order of importance to the overall health of the watershed.

Twenty three discharges are associated with priority reclamation areas within the headwaters reach of Moshannon Creek. Some of the reclamation areas create more than one discharge and further survey work and investigation is recommended to determine the overall restoration strategy. The AML's are a major source of pollution in the watershed. Most of these priority areas are located within the floodplain of Moshannon Creek and alter the natural path of Moshannon Creek while severely degrading riparian zones, including wetlands. Reclamation of these areas will have a large impact on the overall water quality within the watershed. The Scarlift report has recommendations of eight sites that could be reclaimed. These eight sites produced 188,530 lb of acid per day.

Some of these AML's are spoil piles and potentially contain material that could be used in COGEN plants. The landowner of the Warriors Mark Hunting Club is working with potential buyers at this time to remove piles on his property. As part of the assessment, samples were sent for analysis to determine the BTU values of the piles. This information will be used to determine the best course of action for each reclamation area as efforts move downstream. If the piles are not suitable as a fuel source, they will be regraded and planted in their current location.

Remining Potential

Most of this headwaters reach has been mined extensively and limited coal reserves remain. The property along what is known locally as the Ho Chi Minh Trail was at one time owned by the now bankrupt Power Operating. Junior Coal has since acquired this property. Discussions are taking place to secure landowner agreements for restoration efforts in this area and discussions will include the potential for remining as a way to restore much of the AML land through this section.

Data Collection

Field Reconnaissance

MCWC, Clearfield County Conservation District, and NMBS representatives initially walked the stream in the spring of 2005 in preparation of the assessment. Discharges were located, flagged and inspected for flow devices. Field measurements such as pH, conductivity, and temperature were also collected at each reconnaissance point. Over 100 areas were flagged during field reconnaissance. Thirty nine of these sites were chosen for monthly sampling, while twelve sites were chosen to be monitored on a quarterly basis. The remaining reconnaissance points were considered non-significant, thus, they were not included in the monitoring plan on either a monthly or quarterly sampling schedule. Weirs were built and installed by a partnership with the Houtzdale Correctional Facility. As part of the "work" program, prisoners constructed weirs and aided in their installation. The weirs were installed in the summer of 2006 and sampling began in August 2006. Representatives from the MCWC, The Osceola Mills Boy Scout Troup, and local volunteers collected the monthly samples after being trained by NMBS and experienced volunteers.

Of all of the discharges that were identified and flagged during the various stream walks, 52 monitoring points were established. These points were sampled at various intervals, from one to twelve times over the period of a year, based on how significantly they seemed to be affecting the water quality of Moshannon Creek. These monitoring points, their descriptions, latitude and longitude, and number of times sampled can be found in Table 1.

Historical Data

All of the available historical mining permits were obtained from PADEP and researched for water quality data. The historical water quality data was included in the database and used to evaluate discharges over time. In order to access the historical data, follow the links on the accompanying CD or see page B-1 for more information on how to access this information.

Documentation of Problem Areas

Water Samples: Table 1 represents the sampling locations on Moshannon Creek and its tributaries. The number of times each location was sampled is included in the table. The table contains the monitoring point, sample description and latitude and longitude. Pages A-13 to A-22 display the sample locations.

Table 1: Sampling Plan

Monthly Sampling

Monitoring Point	Description	Latitude	Longitude	Times sampled
MC-FORE	Deep mine discharge in reclaimed field, 1st major impairment of Moshannon Creek	40.75371	-78.37930	11
MC-2	Discharge from poorly reclaimed surface mine	40.76400	-78.36781	11
MC-3	Iron mat bordering stream	40.76789	78.35949	11
MC-7	Discharge entering near the mouth of Roup Run, after this discharge no life in stream	40.78075	-78.34263	11
MC-8	Seepage from manmade channel just below MC-7	40.78166	-78.34242	11
MC-10	Seepage area along RR grade	40.79311	-78.33968	10
MC-11	Seepage that flows through spoil pile near MC-10	40.79491	-78.33915	10
MC-12	Flows from unreclaimed channel and creates dead zone	40.79960	-78.33624	11
MC-13	Deep mine discharge seeping from edge of unreclaimed spoil	40.80037	-78.33372	11
MC-14	Seepage collected from deep mine and surface water in large unreclaimed area	40.80101	-78.33180	11
MC-15	Seeps that flow in large overflow channel	40.80296	-78.32966	10
MC-16	Bore Hole	40.80438	-78.32788	11
MC-20	Seepage from poorly reclaimed area that flows down old railroad grade and enters wetland	40.80859	-78.31556	11
MC-21a	Deep mine discharge creates large channel in highwall area	40.80852	-78.31363	11
MC-21b	Seepage collecting on railroad grade and combining w/ MC-21a near stream	40.80853	-78.31363.	11
MC-22a	Seepage from unreclaimed highwall area (same as MC-21)	40.80876	-78.31074	11
MC-22b	Seepage from unreclaimed highwall area (same as MC-21), collecting in channel beside railroad grade	40.80912	-78.31241	11
MC-23	Seepage from old bore hole, low flow	40.81089	-78.31194	11
MC-24	Seepage at the edge of spoil pile / wetland	40.81341	-78.31189	11
MB-1	Flows from wetland along railroad	40.80590	-78.32092	11
MB 2-6	Large dead area associated with numerous seeps and a deep mine discharge	40.80083	-78.31945	11
MB-7	Seepage from hillside creating kill zone, similar to MB 2-6 sites	40.79897	-78.32046	11
MB-9	Seepage collecting along old railroad bed from unreclaimed area	40.79844	-78.32152	11
MB-10	Small tributary to Mountain Branch w/ seasonal flow	40.79678	-78.32421	11
MB-11	Seepage from wetland area / erosion from road	40.79646	-78.32498	11
BR-2	Flow originates from unreclaimed valley	40.80890	-78.30021	11
BR-3	Small tributary to Bear Run originating in wetland	40.80665	-78.30021	11
BR-5	Tributary to Bear Run coming from a toe of slope discharge	40.80466	-78.28563	11
BBT-1	Deep mine discharge	40.81208	-78.29413	11
BBT-2	Seepage from hillside	40.81291	-78.29010	11
BBT-HW	Headwaters of trib to Bear Run, most likely deep mine	40.81396	-78.28810	11
UT 1-1	Discharge forming from numerous seeps	40.80589	-78.31724	11
UT 1-3	Toe of slope discharge and seeps creating large dead zone	40.80364	-78.31692	11
UT 1-4	Seepage from same dead zone as UT 1-3	40.80346	-78.31658	9
UT 2-1	Large iron mat with wetland seepage	40.81589	-78.30929	11

Monitoring Point	Description	Latitude	Longitude	Times sampled
UT 2-2	Same water flowing from UT 2-1, but in different area	40.81598	-78.31208	11
UT 2-3	Channel in reclaimed field, iron seen in channel	40.81898	-78.32248	1
WR-1	Discharge emanating with large amount of iron flowing to Whiteside Run	40.80637	-78.32793	11
WR-4	Discharge from unreclaimed ponded area that flows through large wetland	40.80232	-78.35147	10
WR-5	Alkaline deep mine discharge	40.80212	-78.35152	10

Quarterly Points

Monitoring Point	Description	Latitude	Longitude	Times sampled
QMC-1	In stream sampling point at headwaters	40.73882	-78.36776	4
QMC-2	In stream sampling point above Roup Run	40.78140	-78.34440	4
QMC-3	In stream sampling point at the Hale Bridge	40.78808	-78.34263	4
QMC-4	In stream sampling point above MC-15	40.80223	-78.32966	4
QMC-5	In stream sampling point below MC-15	40.80329	-78.32957	4
QMC-6	In stream sampling point Above Whiteside Run	40.80520	-78.32721	4
QMC-7	In stream sampling point Above Mountain Branch	40.80616	-78.32152	4
QMC-8	In stream sampling point below Mountain Branch	40.80694	-78.32087	4
QMC-9	In stream sampling point below UT-1	40.80841	-78.31742	4
QMC-10	In stream sampling point below MC-21 / MC-22	40.81142	-78.31216	4
QMC-11	In stream sampling point above Bear Run	40.81739	-78.30727	4
QMC-12	In stream Sampling point below Bear Run	40.82107	-78.30366	4

Permission

Access was granted by various property owners to conduct the water quality sampling. Each landowner was contacted by mail, and permission was obtained for the installation of the weirs and for the monthly sampling. For projects that have been submitted for grants, landowner permission has been granted for additional water sampling and property access for surveying and other project development. Signed agreements will be obtained for all construction projects.

Development of Monitoring Plan

A monitoring plan was developed after the initial reconnaissance and reviewing historical reports and data. The sampling plan focused on the severe mine drainage discharges that were moderate flow or higher and contained significant acid, iron or aluminum loads. Stream sample locations were established throughout the assessment area to determine impacts of combined areas; this helped in determining the priority areas.

See Table 1 for the list of sampling points and the number of times the samples were collected. Other sources of hydrology were not monitored due to them having minimal impacts to overall water quality.

Sampling Methodology

NMBS trained members of the MCWC, Boy Scouts and additional volunteers to conduct the monthly sampling. They were trained to properly conduct field chemistry tests, collect water samples, and measure flow rates in the. Most volunteers had worked on previous assessments conducted by MCWC. Samplers were trained to collect pH, conductivity, and temperature measurements in the field. A representative from NMBS reviewed proper use, care, and maintenance of each of the pieces of equipment required for these measurements. A NMBS representative took volunteer samplers into the field and identified the points that were selected for monitoring and reviewed proper sampling methods with samplers at each of these sites.

The sampling methods used require that samples be taken as close to the source as possible. Samplers were directed to take samples in a section of the stream or discharge where flow is concentrated to provide the best representation of the chemical properties and to avoid sampling in pooled backwater areas or areas that are littered with decaying organic matter. Samplers were also directed to avoid areas that contain heavy concentrations of aquatic vegetation.

Samplers were taught to collect water samples in a manner that would prevent contamination. These steps included the exclusive use of bottles supplied by the lab and the technique of field rinsing equipment. Field rinsing was used to equilibrate the equipment to the sample environment; this was also done to ensure that all cleaning solution residues had been removed before sampling began.

Samplers were taught to rinse and then fill bottles in a manner that minimizes contact with the air. The exposure of the sample to the atmosphere can increase the dissolved oxygen concentration, causing reduced metal ions to oxidize and precipitate as hydroxides. The precipitation of iron and other metal hydroxides can result in lower concentrations of iron and co-precipitating metals in the analyzed sample.

Samplers were instructed to keep bottles cool as soon as possible. Provisions were made as part of the sampling plan to ensure prompt delivery of samples to the lab. Each sampler had a cooler in their vehicle for temporary storage of the samples.

Samplers were taught to use a water resistant field book to record sampling information in the field. The sampling information includes date, sample name, field pH, field conductivity, flow, temperature, and weather conditions. Samplers were also directed to always be aware of and record potential sources of contamination at any field site.

Samplers were instructed to properly label bottles. These labels were the same as those recorded on the chain of custody that was sent with the bottles to the lab. A NMBS representative maintained responsibility for filling out the chain of custody and any additional lab paperwork that was required.

Water Quality Measurements

Water samples were analyzed for mine drainage parameters. The pH, conductivity, and temperature were measured in the field. The pH and conductivity were measured using hand held Testr's by Oakton and temperature was measured with a standard thermometer. The meters were calibrated with buffer solutions prior to each use.

Iron, aluminum, manganese, acidity, alkalinity, lab pH, lab conductivity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and sulfates were measured in the laboratory. Mahaffey Laboratory, Ltd. performed the analyses using standard methods. Samples for metals were preserved in the field by adding five drops of nitric acid. None of the samples were filtered, so they represent total metal concentrations.

Flow Rate:

Several types of flow devices and methods were used to collect flow data during the Moshannon Creek assessment. V-notch or H-notch weirs were installed at most sampling locations. The water flow height over the weir was measured and gallons per minute (gpm) were calculated. Pipes were also installed at numerous locations, and a bucket and stopwatch were used for the "timed volume" method. In-Stream flow measurements were taken by a NMBS representative using a flow meter.

Mapping

Maps were created to show the location of the watershed, the stream quality, the sampling that has been done for this assessment, historical mining activities within the watershed through research in Moshannon District office, the location of wetlands, the location of mining activities and reclamation priorities from online BAMR files, the soils in the watershed, and the geology of the watershed. A description of each of these maps appears on page A-1.

Location maps

The location of the headwaters of the Moshannon Creek watershed can be found on page A-3. This map displays Pennsylvania and the location of the Moshannon Creek watershed within the Commonwealth as well as the surrounding municipalities.

For reference, a map also is provided to illustrate which USGS 7.5 minute topographic quadrants included the area in question. This map can be found on page A-4.

Monitoring Program

Pages A-12 through A-22 represents the sampling plan in the headwaters of Moshannon Creek. Due to the size of the assessment area, the headwaters region was divided into sections which represent areas of prioritization. The specific prioritization areas are displayed on page A-12. The size of the watershed and the number of sample points make it cumbersome to view all samples on one map. So, the following ten pages display each of the five prioritization areas and the samples within each area. Each set of maps first displays the sampling points in their approximate position within the prioritization area and the second displays the same information over the appropriate portion of the relevant USGS 7.5 minute topographic map(s). A-23 displays the location of quarterly that were sampled as part of the watershed assessment.

Stream Quality

Page A-6 displays a color coded version of the headwaters of Moshannon Creek. Taken from the sampling results, the variation in color describes the quality of the stream as it runs from headwaters to Bear Run.

Reclamation Area Overview

Page A-25 identifies sampling points which would most likely benefit from and/or require reclamation.

Scarlift map

A nice map of the entire Moshannon Creek watershed was completed as part of the Scarlift report. This map and the URL to access it on the web are included with the other maps.

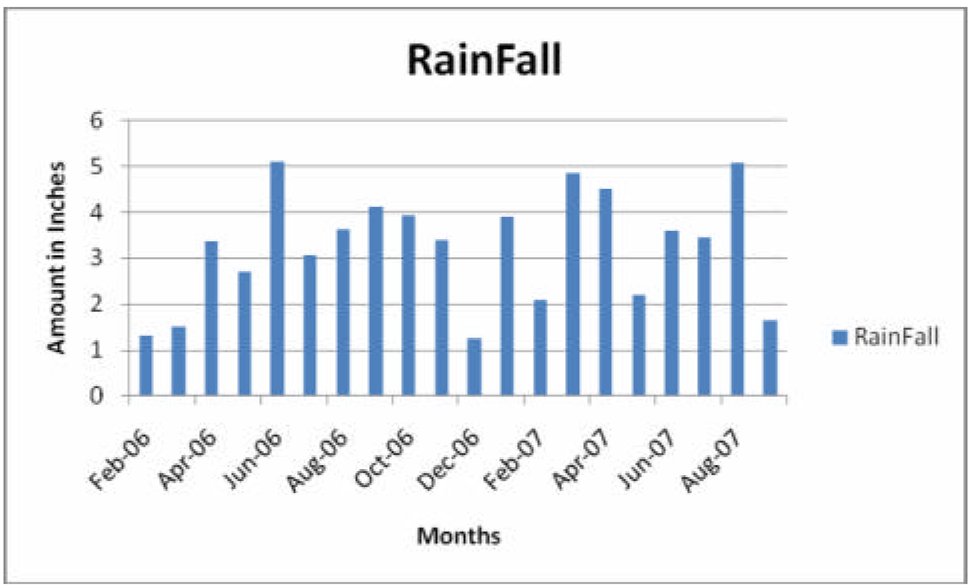
Data Analysis

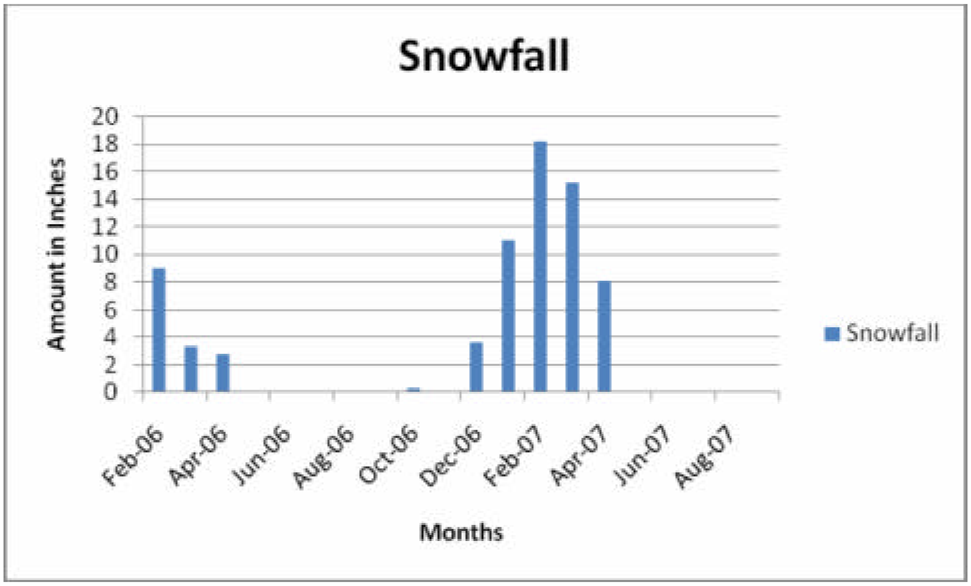
Precipitation during Sampling Period

Precipitation data, both rainfall and snowfall, was obtained from the climate.met.psu.edu website from the "PLBP1-Philipsburg" station. Sampling took place for the assessment from October 2006 through October 2007 through which approximately 40 inches of rain fell that year, with an average of 38 inches typical in Clearfield County. Approximately 56 inches of snow fell in our sample year with a typical average of 49 inches. It can be concluded that our “sample year” was a relative normal year, with a slightly larger snowfall. The year prior to our starting sampling, the area received 41 inches of rain and 46 inches of snow, so it was a also typical year. This should have had the water table at a normal level and allow for the measurement of normal discharge and stream flows throughout the watershed. Total rainfall during the 12-month sampling period is important in the overall evaluation of the remediation efforts. Drought years versus high water years can affect flow rates and may change the overall design of the treatment systems.

The figures below represent rainfall and snowfall from February 2006 through September 2007. By reviewing the precipitation data, it allows us to determine if “normal” conditions exist during the assessment period.

As part of the sampling event, temperature and weather conditions were recorded in the field books. Precipitation events can affect the chemistry of the samples either by dilution or causing flush events. These recorded conditions were considered in the final site evaluations.





Description of Data

The sampling data for each sample location can be found in the following sections. Flow values at each point were collected and samples were analyzed for pH, conductivity, acidity, aluminum, iron, manganese, and sulfate. The loadings for acidity, aluminum, and iron are calculated and included as columns in each table. Each table contains not only the raw water data, but also an average value for each parameter, the maximum value, the minimum value, and the 75% and 90% confidence intervals for each parameter, and the upper bound for 75% and 90% of the standard data as defined by the standard deviation and median values.

There are two values with the text "90" and two with the text "75." The values with the text "CI" appended represent the upper bound for the respective confidence interval for qualifying the data. The values without "CI" represent the highest value for that percentage (e.g., 90% -- this means that 90% of the data is expected to be at or below this value). More accurately, it represents the value on the right tail of the curve which will allow the area under a normal curve to represent that amount of data. For example, the value for "90" represents the z value which is the appropriate number of standard deviations (1.645) to the right of the mean to indicate that 90% of the resulting data will be at or below this value.

Discharge Areas/Water Quality Data

BBT 1

This monitoring point is a deep mine discharge that flows along an old rail road bed and through spoil material. Further investigation is necessary to determine the size of the reclamation area or the potential to remine and daylight the mine. It enters into a tributary of Bear Run below BBT-HW and BBT-2. This discharge may be treated in combination with the upstream discharges using an active system.

Date	**Flow (gpm)**	**pH (SU)**	**Cond**	**Alk**	**Alk load (lbs/day)**	**Acidity (mg/l)**	**Acid load (lbs/day)**	**Iron**	**Iron load (lbs/day)**	**Mn**	**Al**	**Sulfate**
10/08/2006	41.87	2.70	2400.00	0.00	0.00	640.00	321.32	88.80	44.58	19.00	56.30	1128.00
11/11/2006	41.87	2.70	2040.00	0.00	0.00	475.00	238.48	62.50	31.38	13.10	37.60	776.00
12/17/2006	51.10	2.70	2060.00	0.00	0.00	491.00	300.86	62.40	38.23	16.50	45.60	914.00
01/14/2007	82.19	2.80	1520.00	0.00	0.00	333.00	328.18	43.20	42.58	9.62	27.70	553.00
02/11/2007	71.31	2.80	1900.00	0.00	0.00	456.00	389.92	46.60	39.85	13.40	42.00	832.00
03/11/2007	93.58	2.80	1610.00	0.00	0.00	360.00	403.96	46.10	51.73	10.60	31.00	621.00
04/15/2007	28.62	3.00	1310.00	0.00	0.00	247.00	84.77	30.60	10.50	10.30	27.80	473.00
05/13/2007	99.50	2.90	1560.00	0.00	0.00	344.00	410.43	38.20	45.58	12.10	35.70	642.00
06/10/2007	71.31	2.80	1690.00	0.00	0.00	376.00	321.51	49.50	42.33	11.50	34.10	720.00
07/15/2007	46.49	2.70	2240.00	0.00	0.00	622.00	346.74	83.50	46.55	17.80	52.70	1037.00
08/12/2007	71.31	3.20	733.00	0.00	0.00	132.00	112.87	7.36	6.29	10.40	12.70	295.00
Average	63.56	2.83	1733.00	0.00	0.00	406.91	296.28	50.80	36.33	13.12	36.65	726.45
Min	28.62	2.70	733.00	0.00	0.00	132.00	84.77	7.36	6.29	9.62	12.70	295.00
Max	99.50	3.20	2400.00	0.00	0.00	640.00	410.43	88.80	51.73	19.00	56.30	1128.00
90%	101.53	3.08	2504.96	0.00	0.00	655.54	476.45	88.80	60.61	18.47	56.97	1131.14
75%	90.11	3.01	2272.67	0.00	0.00	580.72	422.23	77.37	53.31	16.86	50.85	1009.37
90% CI	75.01	2.90	1965.75	0.00	0.00	481.87	350.60	62.26	43.65	14.73	42.78	848.47
75% CI	71.56	2.88	1895.72	0.00	0.00	459.32	334.25	58.81	41.45	14.25	40.94	811.76
StdDev	23.08	0.16	469.28	0.00	0.00	151.14	109.53	23.10	14.76	3.25	12.35	246.01

BBT 2

This monitoring point is a toe of slope discharge from a reclaimed mine site and "pops" up along the stream. It is related to the BBT-HW stream and would most likely be affected by restoration activities in the headwaters area.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.66	3.20	1040.00	0.00	0.00	262.00	2.07	1.73	0.01	12.30	37.80	427.00
11/11/2006	2.00	3.20	1100.00	0.00	0.00	311.00	7.46	0.63	0.02	10.50	45.70	508.00
12/17/2006	5.00	3.10	1180.00	0.00	0.00	340.00	20.38	0.74	0.04	11.40	51.40	536.00
01/14/2007	6.00	3.20	1030.00	0.00	0.00	288.00	20.72	0.77	0.06	10.40	46.00	435.00
02/11/2007	10.00	3.10	1170.00	0.00	0.00	326.00	39.09	1.00	0.12	12.10	57.10	534.00
03/11/2007	7.50	3.20	1080.00	0.00	0.00	286.00	25.72	0.65	0.06	9.65	43.80	497.00
04/15/2007	20.00	3.20	1160.00	0.00	0.00	311.00	74.58	5.90	1.41	12.00	57.20	545.00
05/13/2007	15.00	3.20	1130.00	0.00	0.00	313.00	56.30	0.83	0.15	10.00	46.20	499.00
06/10/2007	3.33	3.10	1070.00	0.00	0.00	275.00	10.98	0.70	0.03	9.07	39.80	472.00
07/15/2007	0.00											
08/12/2007	0.50	3.10	1040.00	0.00	0.00	264.00	1.58	2.94	0.02	12.30	36.40	406.00
Average	6.36	3.16	1100.00	0.00	0.00	297.60	25.89	1.59	0.19	10.97	46.14	485.90
Min	0.00	3.10	1030.00	0.00	0.00	262.00	1.58	0.63	0.01	9.07	36.40	406.00
Max	20.00	3.20	1180.00	0.00	0.00	340.00	74.58	5.90	1.41	12.30	57.20	545.00
90%	16.93	3.24	1193.70	0.00	0.00	341.24	65.61	4.35	0.90	12.94	58.16	566.74
75%	13.75	3.22	1165.50	0.00	0.00	328.11	53.66	3.52	0.69	12.35	54.54	542.42
90% CI	9.55	3.19	1129.63	0.00	0.00	311.40	38.45	2.46	0.42	11.59	49.94	511.46
75% CI	8.59	3.18	1120.71	0.00	0.00	307.25	34.67	2.20	0.35	11.41	48.80	503.77
StdDev	6.42	0.05	56.96	0.00	0.00	26.53	24.15	1.68	0.43	1.20	7.31	49.14

BBT HW

This monitoring point is for the headwaters of a tributary to Bear Run and originates from a deep mine. This site needs to be investigated to determine how the discharges within this tributary are linked together. This site needs further investigation and is recommended for reclamation.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	**Al**	Sulfate
10/08/2006	5.00	3.40	762.00	0.00	0.00	120.00	7.19	7.20	0.43	11.10	12.20	308.00
11/11/2006	9.10	3.00	717.00	0.00	0.00	130.00	14.19	3.49	0.38	10.90	15.10	316.00
12/17/2006	9.52	3.50	945.00	0.00	0.00	232.00	26.48	5.53	0.63	15.40	35.40	455.00
01/14/2007	139.00	3.60	611.00	0.00	0.00	118.00	196.68	1.57	2.62	9.79	16.40	289.00
02/11/2007	11.90	3.50	1000.00	0.00	0.00	273.00	38.96	2.14	0.31	15.00	46.20	518.00
03/11/2007	34.60	3.70	584.00	0.00	0.00	144.00	59.74	1.26	0.52	10.10	18.20	286.00
04/15/2007	223.24	3.80	504.00	0.00	0.00	103.00	275.72	1.40	3.75	7.92	18.40	257.00
05/13/2007	28.62	3.50	950.00	0.00	0.00	269.00	92.32	2.00	0.69	15.20	4.54	484.00
06/10/2007	16.51	3.50	723.00	0.00	0.00	143.00	28.31	3.05	0.60	10.20	19.40	347.00
07/15/2007	1.50	3.20	1110.00	0.00	0.00	222.00	3.99	19.70	0.35	20.60	31.50	487.00
08/12/2007	0.54	2.60	2390.00	0.00	0.00	633.00	4.10	79.90	0.52	16.60	42.00	1051.00
Average	43.59	3.39	936.00	0.00	0.00	217.00	67.97	11.57	0.98	12.98	23.58	436.18
Min	0.54	2.60	504.00	0.00	0.00	103.00	3.99	1.26	0.31	7.92	4.54	257.00
Max	223.24	3.80	2390.00	0.00	0.00	633.00	275.72	79.90	3.75	20.60	46.20	1051.00
90%	160.94	3.95	1788.95	0.00	0.00	466.33	214.44	49.86	2.83	19.26	45.29	805.88
75%	125.63	3.78	1532.29	0.00	0.00	391.30	170.37	38.34	2.27	17.37	38.76	694.63
90% CI	78.97	3.56	1193.17	0.00	0.00	292.18	112.13	23.11	1.54	14.88	30.12	547.65
75% CI	68.33	3.51	1115.79	0.00	0.00	269.55	98.84	19.64	1.37	14.31	28.15	514.11
StdDev	71.33	0.34	518.51	0.00	0.00	151.57	89.04	23.28	1.12	3.82	13.20	224.74

BR 2

This monitoring point originates in an unreclaimed strip mine area. Area needs further investigation to determine size of reclamation area.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	6.20	3.60	520.00	0.00	0.00	50.00	3.72	1.65	0.12	6.34	5.41	200.00
11/11/2006	9.10	3.60	470.00	0.00	0.00	50.00	5.46	0.44	0.05	5.01	4.62	169.00
12/17/2006	7.50	3.70	462.00	0.00	0.00	51.00	4.59	0.35	0.03	5.19	5.24	186.00
01/14/2007	128.75	3.70	400.00	0.00	0.00	45.00	69.47	0.65	1.00	4.99	4.58	154.00
02/11/2007	0.00											
03/11/2007	14.55	3.80	382.00	0.00	0.00	41.00	7.15	0.23	0.04	4.07	4.13	154.00
04/15/2007	121.95	3.80	334.00	0.00	0.00	29.00	42.41	0.19	0.28	3.27	2.88	130.00
05/13/2007	70.82	3.70	424.00	0.00	0.00	42.00	35.67	0.20	0.17	3.96	4.18	137.00
06/10/2007	14.55	3.60	422.00	0.00	0.00	42.00	7.33	0.44	0.08	3.97	3.98	142.00
07/15/2007	4.00	3.40	503.00	0.00	0.00	60.00	2.88	1.11	0.05	4.21	3.86	183.00
08/12/2007	3.00	3.40	512.00	0.00	0.00	56.00	2.01	1.39	0.05	4.24	3.33	165.00
Average	34.58	3.63	442.90	0.00	0.00	46.60	18.07	0.67	0.19	4.53	4.22	162.00
Min	0.00	3.40	334.00	0.00	0.00	29.00	2.01	0.19	0.03	3.27	2.88	130.00
Max	128.75	3.80	520.00	0.00	0.00	60.00	69.47	1.65	1.00	6.34	5.41	200.00
90%	115.06	3.86	543.46	0.00	0.00	61.07	56.11	1.54	0.68	5.95	5.51	199.58
75%	90.84	3.79	513.20	0.00	0.00	56.72	44.67	1.27	0.53	5.52	5.12	188.27
90% CI	58.85	3.70	474.70	0.00	0.00	51.18	30.10	0.94	0.34	4.98	4.63	173.88
75% CI	51.55	3.68	465.13	0.00	0.00	49.80	26.48	0.86	0.30	4.84	4.51	170.31
StdDev	48.92	0.14	61.13	0.00	0.00	8.80	23.13	0.53	0.30	0.87	0.78	22.84

BR 3

This monitoring point is for a small tributary to Bear Run originating in wetland that is iron stained.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00	4.00	300.00	0.00	0.00	31.00	0.00	0.65	0.00	3.46	3.73	112.00
11/11/2006	6.00	4.10	273.00	1.00	0.07	38.00	2.73	0.22	0.02	2.74	3.54	98.00
12/17/2006	10.00	4.10	280.00	2.00	0.24	40.00	4.80	0.15	0.02	2.76	3.89	113.00
01/14/2007	30.00	4.10	221.00	1.00	0.36	36.00	12.95	0.13	0.05	2.35	3.48	83.00
02/11/2007	10.00	4.20	253.00	2.00	0.24	33.00	3.96	0.12	0.01	2.99	4.79	93.00
03/11/2007	20.00	4.10	213.00	2.00	0.48	33.00	7.91	0.19	0.05	2.40	3.89	82.00
04/15/2007	30.00	4.20	187.00	2.00	0.72	27.00	9.71	0.11	0.04	2.01	3.12	70.00
05/13/2007	15.00	4.20	271.00	2.00	0.36	40.00	7.19	0.19	0.03	2.52	4.34	90.00
06/10/2007	15.00	4.00	278.00	1.00	0.18	39.00	7.01	0.45	0.08	2.89	4.63	103.00
07/15/2007	5.45	3.90	341.00	0.00	0.00	50.00	3.27	0.75	0.05	3.26	4.84	185.00
08/12/2007	1.50	3.80	335.00	0.00	0.00	42.00	0.76	1.27	0.02	4.07	3.66	118.00
Average	13.00	4.06	268.36	1.18	0.24	37.18	5.48	0.38	0.03	2.86	3.99	104.27
Min	0.00	3.80	187.00	0.00	0.00	27.00	0.00	0.11	0.00	2.01	3.12	70.00
Max	30.00	4.20	341.00	2.00	0.72	50.00	12.95	1.27	0.08	4.07	4.84	185.00
90%	29.93	4.28	347.49	2.62	0.62	47.40	11.91	0.99	0.07	3.81	4.94	154.54
75%	24.84	4.21	323.68	2.19	0.50	44.32	9.97	0.81	0.06	3.52	4.65	139.41
90% CI	18.10	4.13	292.22	1.62	0.35	40.26	7.42	0.57	0.04	3.15	4.28	119.43
75% CI	16.57	4.11	285.04	1.48	0.32	39.34	6.84	0.51	0.04	3.06	4.19	114.87
StdDev	10.30	0.13	48.10	0.87	0.23	6.21	3.91	0.37	0.02	0.58	0.58	30.56

BR 5 HW

This monitoring point is for a tributary to Bear Run coming from a toe of slope discharge. Reclamation of this site needs to be investigated. Bear Run up stream of discharge is full of aquatic insects and moss.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00	3.90	211.00	0.00	0.00	26.00	0.00	1.12	0.00	2.12	2.59	60.00
11/11/2006	12.00	3.60	249.00	0.00	0.00	41.00	5.90	0.24	0.03	1.58	3.53	59.00
12/17/2006	10.00	3.70	213.00	0.00	0.00	34.00	4.08	0.27	0.03	0.92	2.59	53.00
01/14/2007	75.00	3.50	304.00	0.00	0.00	55.00	49.46	0.52	0.47	1.00	4.91	87.00
02/11/2007	120.00	3.80	174.00	0.00	0.00	26.00	37.41	0.39	0.56	0.76	2.73	39.00
03/11/2007	30.00	3.60	242.00	0.00	0.00	42.00	15.11	0.48	0.17	0.91	3.88	67.00
04/15/2007	12.00	3.40	401.00	0.00	0.00	56.00	8.06	1.26	0.18	1.27	5.03	117.00
05/13/2007	75.00	3.50	318.00	0.00	0.00	44.00	39.57	0.50	0.45	0.96	3.31	63.00
06/10/2007	60.00	3.50	290.00	0.00	0.00	41.00	29.50	0.49	0.35	1.07	3.46	64.00
07/15/2007	1.32	3.90	341.00	0.00	0.00	50.00	0.79	0.75	0.01	3.26	4.84	145.00
08/12/2007	0.50	3.90	118.00	0.00	0.00	18.00	0.11	1.97	0.01	0.45	0.59	25.00
Average	35.98	3.66	260.09	0.00	0.00	39.36	17.27	0.73	0.21	1.30	3.41	70.82
Min	0.00	3.40	118.00	0.00	0.00	18.00	0.00	0.24	0.00	0.45	0.59	25.00
Max	120.00	3.90	401.00	0.00	0.00	56.00	49.46	1.97	0.56	3.26	5.03	145.00
90%	102.39	3.97	392.98	0.00	0.00	59.58	47.36	1.59	0.56	2.59	5.55	127.10
75%	82.41	3.88	352.99	0.00	0.00	53.50	38.31	1.33	0.45	2.20	4.90	110.16
90% CI	56.01	3.76	300.16	0.00	0.00	45.46	26.34	0.99	0.31	1.69	4.05	87.79
75% CI	49.98	3.73	288.10	0.00	0.00	43.63	23.61	0.91	0.28	1.57	3.86	82.68
StdDev	40.37	0.19	80.78	0.00	0.00	12.29	18.29	0.52	0.21	0.79	1.30	34.21

MB 1

This monitoring point flows out of a wetland area above the railroad grade. Abandoned spoil parallels the stream below these discharges. The seeps that make up MB 1 start in this area.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006	12.00	3.80	422.00	0.00	0.00	33.00	4.75	0.65	0.09	5.53	1.51	153.00
12/17/2006	0.28	3.80	499.00	0.00	0.00	42.00	0.14	2.66	0.01	6.72	3.07	218.00
01/14/2007	8.57	3.90	424.00	0.00	0.00	35.00	3.60	0.59	0.06	5.37	2.01	177.00
02/11/2007	0.00											
03/11/2007	6.67	4.00	429.00	0.00	0.00	38.00	3.04	0.55	0.04	6.98	2.95	191.00
04/14/2007	6.00	4.00	488.00	0.00	0.00	40.00	2.88	3.82	0.27	8.09	4.62	224.00
05/13/2007		3.60	564.00	0.00		53.00		5.15		7.41	3.18	202.00
06/10/2007	1.43	3.50	571.00	0.00	0.00	46.00	0.79	4.70	0.08	7.48	2.47	213.00
07/15/2007	0.00											
08/12/2007	0.50	3.40	516.00	0.00	0.00	54.00	0.32	8.13	0.05	6.01	1.94	192.00
Average	3.55	3.75	489.13	0.00	0.00	42.63	2.22	3.28	0.09	6.70	2.72	196.25
Min	0.00	3.40	422.00	0.00	0.00	33.00	0.14	0.55	0.01	5.37	1.51	153.00
Max	12.00	4.00	571.00	0.00	0.00	54.00	4.75	8.13	0.27	8.09	4.62	224.00
90%	10.79	4.12	588.40	0.00	0.00	55.49	5.17	7.74	0.23	8.31	4.32	234.80
75%	8.61	4.01	558.52	0.00	0.00	51.62	4.28	6.39	0.19	7.83	3.84	223.20
90% CI	5.84	3.88	524.22	0.00	0.00	47.17	3.33	4.86	0.14	7.27	3.29	209.88
75% CI	5.15	3.84	513.66	0.00	0.00	45.80	3.00	4.38	0.13	7.10	3.11	205.78
StdDev	4.41	0.23	60.35	0.00	0.00	7.82	1.80	2.71	0.09	0.98	0.97	23.43

MB 2-6

These monitoring points are located near the mouth of Mountain Branch. The main discharge is a deep mine discharge with the other monitoring points associated with toe of slope discharges and contaminant runoff. MB 2, MB 3, and MB 4 start at an abandoned surface mine that was poorly reclaimed. MB 5 and MB 6 flow directly out of spoil material and have much higher flows. The discharges were combined and collected together due to their proximity and emanating from the same area that needs reclaimed.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	3.90	2.90	1810.00	0.00	0.00	394.00	18.43	11.80	0.55	12.60	46.50	734.00
11/12/2006	2.10	2.90	1490.00	0.00	0.00	296.00	7.45	10.10	0.25	13.60	41.90	571.00
12/17/2006	10.87	2.90	1540.00	0.00	0.00	294.00	38.32	7.89	1.03	12.40	38.30	561.00
01/14/2007	33.45	3.00	1210.00	0.00	0.00	225.00	90.25	5.53	2.22	11.20	27.20	415.00
02/11/2007	0.00											
03/11/2007		2.60	2260.00	0.00		449.00		27.00		8.09	40.00	800.00
04/14/2007	8.00	3.10	1020.00	0.00	0.00	166.00	15.92	3.43	0.33	9.00	19.80	330.00
05/13/2007	11.17	2.60	2260.00	0.00	0.00	388.00	51.97	22.20	2.97	8.65	36.30	658.00
06/10/2007	17.27	3.00	1090.00	0.00	0.00	169.00	35.00	9.26	1.92	9.29	18.40	347.00
07/15/2007	1.42	2.80	1520.00	0.00	0.00	306.00	5.21	13.50	0.23	10.50	32.00	579.00
08/12/2007	2.00	2.90	1670.00	0.00	0.00	373.00	8.95	24.10	0.58	12.20	37.90	691.00
Average	9.02	2.87	1587.00	0.00	0.00	306.00	30.17	13.48	1.12	10.75	33.83	568.60
Min	0.00	2.60	1020.00	0.00	0.00	166.00	5.21	3.43	0.23	8.09	18.40	330.00
Max	33.45	3.10	2260.00	0.00	0.00	449.00	90.25	27.00	2.97	13.60	46.50	800.00
90%	25.80	3.14	2299.67	0.00	0.00	465.47	75.61	26.90	2.77	13.92	49.23	833.67
75%	20.75	3.06	2085.22	0.00	0.00	417.48	61.93	22.86	2.28	12.97	44.59	753.90
90% CI	14.32	2.96	1812.37	0.00	0.00	356.43	45.31	17.73	1.67	11.75	38.70	652.42
75% CI	12.73	2.93	1744.55	0.00	0.00	341.25	40.75	16.45	1.51	11.45	37.23	627.20
StdDev	10.20	0.16	433.23	0.00	0.00	96.94	27.62	8.16	1.00	1.92	9.36	161.13

MB 7

This monitoring point is a toe of slope discharge located just upstream from the MB2-6 discharges. The discharge is coming from the same hillside as MB 2-6 and should be improved by reclamation activities in this area.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.70	3.00	1460.00	0.00	0.00	257.00	2.16	7.41	0.06	11.90	26.20	555.00
11/12/2006	1.30	3.10	1170.00	0.00	0.00	204.00	3.18	4.79	0.07	9.70	30.10	445.00
12/17/2006	0.58	3.20	1080.00	0.00	0.00	192.00	1.34	0.91	0.01	7.73	20.20	452.00
01/14/2007	2.50	3.20	896.00	0.00	0.00	145.00	4.35	1.26	0.04	6.86	17.80	330.00
02/11/2007	0.00											
03/11/2007	0.00											
04/14/2007	2.80	3.20	994.00	0.00	0.00	170.00	5.71	0.89	0.03	8.42	25.60	391.00
05/13/2007	3.03	3.20	1080.00	0.00	0.00	196.00	7.12	1.53	0.06	8.37	30.50	427.00
06/10/2007	0.70	3.00	1140.00	0.00	0.00	180.00	1.51	2.45	0.02	7.13	21.90	432.00
07/15/2007	0.70	3.10	1170.00	0.00	0.00	296.00	2.48	7.21	0.06	9.55	29.90	509.00
08/12/2007	0.50	3.10	1090.00	0.00	0.00	205.00	1.23	5.69	0.03	8.28	22.90	421.00
Average	1.16	3.12	1120.00	0.00	0.00	205.00	3.23	3.57	0.04	8.66	25.01	440.22
Min	0.00	3.00	896.00	0.00	0.00	145.00	1.23	0.89	0.01	6.86	17.80	330.00
Max	3.03	3.20	1460.00	0.00	0.00	296.00	7.12	7.41	0.07	11.90	30.50	555.00
90%	2.97	3.26	1374.28	0.00	0.00	280.13	6.66	8.04	0.08	11.20	32.62	546.27
75%	2.43	3.22	1297.76	0.00	0.00	257.52	5.63	6.69	0.07	10.44	30.33	514.36
90% CI	1.71	3.17	1204.76	0.00	0.00	230.04	4.37	5.06	0.05	9.51	27.55	475.57
75% CI	1.55	3.15	1179.25	0.00	0.00	222.51	4.03	4.61	0.05	9.25	26.78	464.94
StdDev	1.10	0.08	154.58	0.00	0.00	45.67	2.09	2.72	0.02	1.55	4.62	64.47

MB 9

This monitoring point emanates in unreclaimed spoil piles. It forms a discrete channel that creates a wetland area before discharging to Mountain Branch.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	2.14	3.50	1360.00	0.00	0.00	260.00	6.67	1.69	0.04	30.30	10.70	684.00
11/12/2006	35.10	3.70	740.00	0.00	0.00	63.00	26.52	0.59	0.25	15.10	4.47	303.00
12/18/2006	8.12	3.50	1260.00	0.00	0.00	120.00	11.68	0.81	0.08	26.90	9.44	625.00
01/14/2007	35.10	3.60	980.00	0.00	0.00	85.00	35.78	0.77	0.32	20.60	6.57	423.00
02/11/2007	1.00	3.60	1320.00	0.00	0.00	120.00	1.44	0.80	0.01	29.50	12.30	649.00
03/11/2007		3.50	1000.00	0.00		100.00		0.43		18.80	6.62	479.00
04/14/2007	91.21	3.60	1050.00	0.00	0.00	87.00	95.15	0.37	0.40	20.90	6.85	498.00
05/13/2007	44.87	3.50	1410.00	0.00	0.00	127.00	68.33	0.72	0.39	29.50	11.50	694.00
06/10/2007	35.10	3.40	1240.00	0.00	0.00	102.00	42.93	1.22	0.51	31.50	10.10	613.00
07/15/2007	11.90	3.30	1580.00	0.00	0.00	183.00	26.11	2.69	0.38	32.60	10.90	853.00
08/12/2007	11.06	3.30	1570.00	0.00	0.00	164.00	21.75	3.51	0.47	37.30	10.90	790.00
Average	27.56	3.50	1228.18	0.00	0.00	128.27	33.64	1.24	0.29	26.64	9.12	601.00
Min	1.00	3.30	740.00	0.00	0.00	63.00	1.44	0.37	0.01	15.10	4.47	303.00
Max	91.21	3.70	1580.00	0.00	0.00	260.00	95.15	3.51	0.51	37.30	12.30	853.00
90%	72.67	3.71	1658.52	0.00	0.00	219.99	81.35	2.89	0.59	37.87	13.32	868.16
75%	59.10	3.65	1529.03	0.00	0.00	192.39	67.00	2.40	0.50	34.49	12.06	787.77
90% CI	41.83	3.56	1357.93	0.00	0.00	155.93	48.73	1.74	0.38	30.02	10.39	681.55
75% CI	37.53	3.54	1318.89	0.00	0.00	147.61	44.19	1.59	0.35	29.01	10.01	657.31
StdDev	27.42	0.13	261.60	0.00	0.00	55.76	29.01	1.01	0.18	6.83	2.55	162.41

MB 10

This monitoring point is a seep emanating in a forested wetland area approximately 1 acre in size. It collects four seeps through this area. A large dead zone has been created. There is a large variation in flow due to the surface runoff in the area of the flow device.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.00	3.70	859.00	0.00	0.00	76.00	0.91	1.53	0.02	18.50	5.84	373.00
11/12/2006	287.97	3.90	481.00	0.00	0.00	43.00	148.48	0.58	2.00	9.52	3.17	185.00
12/17/2006	12.61	3.90	640.00	0.00	0.00	58.00	8.77	0.88	0.13	13.70	5.47	293.00
01/14/2007	116.80	3.90	493.00	0.00	0.00	43.00	60.22	0.49	0.69	8.73	3.39	218.00
02/11/2007	1.00	4.00	662.00	0.00	0.00	56.00	0.67	0.69	0.01	14.20	6.91	312.00
03/11/2007	116.80	4.00	526.00	0.00	0.00	50.00	70.03	0.42	0.59	10.00	4.48	243.00
04/14/2007	136.19	4.00	543.00	0.00	0.00	50.00	81.65	0.50	0.82	11.30	5.29	253.00
05/13/2007	64.40	3.80	886.00	0.00	0.00	81.00	62.55	1.61	1.24	16.20	6.85	410.00
06/10/2007	35.35	3.60	801.00	0.00	0.00	63.00	26.70	1.24	0.53	13.20	4.90	353.00
07/15/2007	2.50	3.40	1310.00	0.00	0.00	128.00	3.84	4.23	0.13	29.60	8.41	650.00
08/12/2007	12.61	3.40	1220.00	0.00	0.00	109.00	16.48	3.49	0.53	27.30	6.73	535.00
Average	71.57	3.78	765.55	0.00	0.00	68.82	43.66	1.42	0.61	15.66	5.59	347.73
Min	1.00	3.40	481.00	0.00	0.00	43.00	0.67	0.42	0.01	8.73	3.17	185.00
Max	287.97	4.00	1310.00	0.00	0.00	128.00	148.48	4.23	2.00	29.60	8.41	650.00
90%	216.98	4.16	1235.48	0.00	0.00	114.39	119.52	3.54	1.59	27.14	8.19	579.49
75%	173.22	4.04	1094.07	0.00	0.00	100.67	96.69	2.90	1.29	23.68	7.41	509.75
90% CI	115.41	3.89	907.24	0.00	0.00	82.56	66.53	2.06	0.90	19.12	6.37	417.61
75% CI	102.22	3.86	864.60	0.00	0.00	78.42	59.65	1.87	0.81	18.08	6.14	396.58
StdDev	88.40	0.23	285.67	0.00	0.00	27.70	46.11	1.28	0.60	6.98	1.59	140.89

MB 11

This monitoring point is a small flow discharge, but has high aluminum levels. It seeps through a wetland area before entering Mountain Branch.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006	12.00	3.70	464.00	0.00	0.00	63.00	9.07	0.62	0.09	4.07	6.93	168.00
12/17/2006	1.50	3.70	781.00	0.00	0.00	115.00	2.07	0.84	0.02	8.35	17.30	401.00
01/14/2007	10.00	3.70	578.00	0.00	0.00	80.00	9.59	0.74	0.09	5.58	11.10	263.00
02/11/2007	0.00											
03/11/2007		3.70	562.00	0.00		77.00		0.73		6.46	13.20	256.00
04/14/2007	4.00	3.80	605.00	0.00	0.00	79.00	3.79	0.63	0.03	5.98	11.00	281.00
05/13/2007	6.00	3.60	707.00	0.00	0.00	96.00	6.91	2.09	0.15	6.88	13.10	285.00
06/10/2007	6.67	3.60	679.00	0.00	0.00	88.00	7.04	3.57	0.29	5.81	12.50	294.00
07/15/2007	1.00	3.40	862.00	0.00	0.00	118.00	1.41	12.40	0.15	8.65	11.30	363.00
08/12/2007	0.50	3.50	746.00	0.00	0.00	93.00	0.56	5.26	0.03	7.22	10.50	311.00
Average	4.17	3.63	664.89	0.00	0.00	89.89	5.05	2.99	0.10	6.56	11.88	291.33
Min	0.00	3.40	464.00	0.00	0.00	63.00	0.56	0.62	0.02	4.07	6.93	168.00
Max	12.00	3.80	862.00	0.00	0.00	118.00	9.59	12.40	0.29	8.65	17.30	401.00
90%	11.32	3.83	868.83	0.00	0.00	119.41	10.89	9.38	0.25	8.89	16.43	400.09
75%	9.17	3.77	807.46	0.00	0.00	110.53	9.13	7.46	0.21	8.19	15.06	367.36
90% CI	6.43	3.70	732.87	0.00	0.00	99.73	7.12	5.12	0.16	7.34	13.40	327.58
75% CI	5.75	3.68	712.41	0.00	0.00	96.77	6.50	4.48	0.14	7.10	12.94	316.68
StdDev	4.35	0.12	123.98	0.00	0.00	17.95	3.55	3.89	0.09	1.42	2.76	66.11

MC FORE (MC-1)

The MC-FORE discharge is the first source of significant degradation to Moshannon Creek. The discharge did not exist until a deep mine discharge was capped near the Janesville Dam. After the deep mine was capped, the discharge emanated in a reclaimed field. The discharge is piped through a wetland complex before entering Moshannon Creek. In the summer of 2004, high flow events were noticed and the discharge began to coat rocks with an iron precipitate in Moshannon Creek severely impacting the only HQ-CWF section of Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006		6.30	605.00	36.00		-8.00		11.40		7.16	0.26	258.00
12/17/2006	8.57	5.30	1420.00	28.00	2.88	232.00	23.84	156.00	16.03	43.30	0.36	776.00
01/14/2007	10.00	5.30	922.00	22.00	2.64	102.00	12.23	91.60	10.98	29.90	1.19	432.00
02/11/2007	5.00	5.50	1550.00	38.00	2.28	269.00	16.13	149.00	8.93	41.00	0.26	772.00
03/11/2007	8.57	5.30	1430.00	27.00	2.77	246.00	25.28	142.00	14.59	40.20	0.84	833.00
04/14/2007	20.00	5.40	2180.00	43.00	10.31	323.00	77.46	228.00	54.68	59.40	0.31	1168.00
05/13/2007	30.00	5.40	2270.00	44.00	15.83	397.00	142.81	227.00	81.66	59.80	0.40	1243.00
06/09/2007	20.00	5.30	2160.00	40.00	9.59	401.00	96.17	272.00	65.23	72.60	0.35	1461.00
07/14/2007	20.00	5.30	2260.00	36.00	8.63	484.00	116.07	317.00	76.02	85.20	0.45	1444.00
08/11/2007	10.00	5.50	2450.00	33.00	3.96	445.00	53.36	252.00	30.22	68.00	0.37	1459.00
Average	13.21	5.46	1724.70	34.70	6.54	289.10	62.59	184.60	39.82	50.66	0.48	984.60
Min	0.00	5.30	605.00	22.00	2.28	-8.00	12.23	11.40	8.93	7.16	0.26	258.00
Max	30.00	6.30	2450.00	44.00	15.83	484.00	142.81	317.00	81.66	85.20	1.19	1461.00
90%	27.99	5.96	2767.26	46.54	14.39	544.18	141.31	335.71	88.50	88.31	0.97	1701.32
75%	23.54	5.81	2453.54	42.98	12.03	467.42	117.62	290.24	73.85	76.98	0.82	1485.65
90% CI	17.89	5.62	2054.39	38.44	9.16	369.76	88.83	232.38	56.05	62.56	0.64	1211.25
75% CI	16.48	5.57	1955.18	37.32	8.37	345.49	80.94	218.01	51.16	58.98	0.59	1143.05
StdDev	8.98	0.31	633.77	7.20	4.77	155.06	47.85	91.86	29.60	22.89	0.30	435.70

MC 2

This monitoring point contributes runoff from an unreclaimed surface mine area greater than 30 acres in size. The discharge runs through a man-made channel collecting numerous seeps before becoming ponded due to a clogged pipe. The discharge sometimes overtops the existing access road creating erosion problems. The discharge then flows through a forested area and wetland before entering Moshannon Creek. Discoloration of Moshannon Creek occurs where MC-2 enters the main channel.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/11/2000	1.88	3.60	427.00	0.00	0.00	43.00	0.97	5.10	0.11	3.98	2.48	150.00
10/08/2006	0.00											
11/12/2006	12.00	5.10	162.00	6.00	0.86	17.00	2.45	2.42	0.35	1.47	4.36	57.00
12/17/2006	3.53	3.90	406.00	0.00	0.00	41.00	1.74	1.06	0.04	5.25	4.93	166.00
01/14/2007	15.00	4.50	174.00	4.00	0.72	19.00	3.42	0.75	0.13	2.16	1.80	64.00
02/11/2007	1.76	4.10	495.00	2.00	0.04	53.00	1.12	1.58	0.03	5.82	7.81	222.00
03/11/2007	15.00	4.30	235.00	3.00	0.54	27.00	4.86	0.85	0.15	0.85	2.10	90.00
04/14/2007	30.00	3.80	829.00	0.00	0.00	129.00	46.41	0.92	0.33	11.20	21.30	398.00
05/13/2007	15.00	3.50	1100.00	0.00	0.00	194.00	34.89	2.74	0.49	14.80	27.00	584.00
06/09/2007	60.00	3.70	738.00	0.00	0.00	102.00	73.38	1.46	1.05	9.81	16.30	376.00
07/14/2007	0.50	3.20	886.00	0.00	0.00	132.00	0.79	13.90	0.08	11.90	12.40	349.00
Average	14.06	3.97	545.20	1.50	0.22	75.70	17.00	3.08	0.28	6.72	10.05	245.60

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Min	0.00	3.20	162.00	0.00	0.00	17.00	0.79	0.75	0.03	0.85	1.80	57.00
Max	60.00	5.10	1100.00	6.00	0.86	194.00	73.38	13.90	1.05	14.80	27.00	584.00
90%	43.32	4.88	1082.00	5.07	0.79	174.58	59.17	9.70	0.79	14.77	24.67	532.74
75%	34.52	4.60	920.47	4.00	0.62	144.83	46.48	7.71	0.64	12.35	20.27	446.34
90% CI	22.88	4.26	714.95	2.63	0.40	106.97	30.34	5.17	0.44	9.27	14.67	336.40
75% CI	20.23	4.17	663.87	2.29	0.34	97.56	26.32	4.54	0.39	8.50	13.28	309.08
StdDev	17.79	0.55	326.32	2.17	0.35	60.11	25.63	4.02	0.31	4.89	8.89	174.56

MC 3

This monitoring point is an iron mat with an associated discharge that borders Moshannon Creek for approximately 20 yards. Discoloration of Moshannon Creek is occurring where MC-3 enters the main channel. There is also a large spoil/complex upstream from this discharge that needs to be addressed, but does not directly impact that seepage.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	2.50	5.90	1860.00	34.00	1.02	142.00	4.26	119.00	3.57	22.80	0.13	1138.00
11/12/2006	3.00	6.10	1900.00	58.00	2.09	137.00	4.93	121.00	4.35	24.60	4.68	671.00
12/17/2006	7.50	6.00	1930.00	68.00	6.12	135.00	12.14	121.00	10.88	23.90	0.10	1117.00
01/14/2007	6.32	6.00	1850.00	55.00	4.17	129.00	9.78	129.00	9.78	25.80	0.12	1031.00
02/11/2007	1.00	6.10	1920.00	55.00	0.66	126.00	1.51	101.00	1.21	19.80	0.13	981.00
03/11/2007		6.10	1910.00	58.00		129.00		118.00		23.90	0.31	1088.00
04/14/2007	3.75	6.10	2030.00	62.00	2.79	125.00	5.62	115.00	5.17	23.60	0.10	1136.00
05/13/2007	3.33	6.00	1910.00	59.00	2.36	129.00	5.15	121.00	4.83	24.10	0.24	990.00
06/09/2007	4.00	6.00	1790.00	61.00	2.93	111.00	5.32	132.00	6.33	26.70	0.12	1071.00
07/14/2007	2.73	5.80	1820.00	40.00	1.31	137.00	4.48	99.80	3.27	19.20	0.11	1032.00
08/11/2007	2.50	6.20	1960.00	50.00	1.50	132.00	3.96	119.00	3.57	23.80	0.11	1060.00
Average	3.66	6.03	1898.18	54.55	2.49	130.18	5.72	117.80	5.30	23.47	0.56	1028.64
Min	1.00	5.80	1790.00	34.00	0.66	111.00	1.51	99.80	1.21	19.20	0.10	671.00
Max	7.50	6.20	2030.00	68.00	6.12	142.00	12.14	132.00	10.88	26.70	4.68	1138.00
90%	6.82	6.21	2008.00	70.80	5.20	143.70	10.72	134.04	10.21	27.16	2.81	1242.66
75%	5.87	6.15	1974.95	65.91	4.38	139.63	9.21	129.15	8.73	26.05	2.13	1178.26
90% CI	4.66	6.08	1931.29	59.45	3.35	134.26	7.30	122.70	6.85	24.58	1.24	1093.17
75% CI	4.36	6.07	1921.33	57.97	3.09	133.03	6.82	121.22	6.38	24.25	1.03	1073.75
StdDev	1.92	0.11	66.76	9.88	1.64	8.22	3.04	9.87	2.99	2.24	1.37	130.11

MC 7

This monitoring point is considered the "killer" of Moshannon Creek. It discharges near the mouth of Roup Run and is associated with MC-8. The discharge is associated with a deep mine discharge that is ponded before becoming channelized and entering the mouth of Roup Run. Dead zones and iron mats are created due to the high iron levels at this site. The discharge would most likely benefit from site reclamation and soil amendments. An increase in quality and a decrease in flow should be seen. Further site investigation will occur.

MC 7 (cont)

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	20.81	3.00	2030.00	0.00	0.00	209.00	52.15	34.50	8.61	34.20	7.11	849.00
11/12/2006	42.56	3.20	1470.00	0.00	0.00	161.00	82.16	31.20	15.92	24.60	4.68	671.00
12/17/2006	49.23	3.30	1820.00	0.00	0.00	193.00	113.93	44.20	26.09	36.50	9.59	947.00
01/14/2007	46.32	3.20	1590.00	0.00	0.00	167.00	92.76	41.70	23.16	31.40	7.10	732.00
02/11/2007	23.10	3.30	1930.00	0.00	0.00	212.00	58.72	57.50	15.93	41.40	12.40	957.00
03/11/2007	49.23	3.50	1380.00	0.00	0.00	153.00	90.32	41.60	24.56	25.30	6.60	675.00
04/14/2007	64.40	3.30	2160.00	0.00	0.00	248.00	191.51	47.20	36.45	43.40	14.90	1272.00
05/13/2007	49.23	3.10	2380.00	0.00	0.00	286.00	168.83	52.60	31.05	48.80	16.70	1319.00
06/09/2007	35.35	3.20	1780.00	0.00	0.00	197.00	83.50	46.60	19.75	36.70	10.80	976.00
07/14/2007	20.00	2.90	2440.00	0.00	0.00	290.00	69.55	47.70	11.44	45.50	11.70	1185.00
08/11/2007	30.24	2.80	2300.00	0.00	0.00	256.00	92.83	29.60	10.73	37.20	8.06	1032.00
Average	39.13	3.16	1934.55	0.00	0.00	215.64	99.66	43.13	20.34	36.82	9.97	965.00
Min	20.00	2.80	1380.00	0.00	0.00	153.00	52.15	29.60	8.61	24.60	4.68	671.00
Max	64.40	3.50	2440.00	0.00	0.00	290.00	191.51	57.50	36.45	48.80	16.70	1319.00
90%	62.74	3.49	2533.67	0.00	0.00	295.12	171.39	57.38	34.88	49.58	16.09	1336.95
75%	55.64	3.40	2353.38	0.00	0.00	271.20	149.81	53.09	30.50	45.74	14.25	1225.02
90% CI	46.25	3.26	2115.19	0.00	0.00	239.60	121.29	47.43	24.72	40.67	11.81	1077.15
75% CI	44.11	3.23	2060.83	0.00	0.00	232.39	114.78	46.13	23.40	39.51	11.26	1043.40
StdDev	14.35	0.20	364.21	0.00	0.00	48.32	43.60	8.67	8.84	7.76	3.72	226.11

MC 8

This monitoring point is located directly below MC-8. Some runoff contributes to this discharge during high flows, but the main flow is connected with a deep mine entry. The discharge runs through a man-made channel then enters Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.00	2.90	3890.00	0.00	0.00	480.00	5.76	41.10	0.49	89.50	28.80	2485.00
11/12/2006	7.50	3.20	2310.00	0.00	0.00	256.00	23.02	31.90	2.87	49.60	17.60	1310.00
12/17/2006	15.00	3.20	3830.00	0.00	0.00	490.00	88.13	30.30	5.45	91.30	36.20	2492.00
01/14/2007	15.00	3.20	3570.00	0.00	0.00	368.00	66.19	35.40	6.37	87.00	32.80	2101.00
02/11/2007	1.00	3.20	3840.00	0.00	0.00	428.00	5.13	52.60	0.63	108.00	41.60	2283.00
03/11/2007	80.00	3.20	3470.00	0.00	0.00	401.00	384.67	45.10	43.26	96.00	36.50	2259.00
04/14/2007	20.00	3.40	3860.00	0.00	0.00	452.00	108.40	26.50	6.36	119.00	58.60	2642.00
05/13/2007	30.00	3.20	3850.00	0.00	0.00	385.00	138.50	17.80	6.40	97.10	49.40	1638.00
06/09/2007	60.00	3.20	3170.00	0.00	0.00	300.00	215.84	15.10	10.86	64.40	27.40	21.00
07/14/2007	12.00	3.00	4110.00	0.00	0.00	436.00	62.74	14.70	2.12	87.90	34.30	2409.00
08/11/2007	4.62	2.80	4230.00	0.00	0.00	431.00	23.88	23.80	1.32	86.00	20.70	2120.00
Average	22.37	3.14	3648.18	0.00	0.00	402.45	102.02	30.39	7.83	88.71	34.90	1978.18
Min	1.00	2.80	2310.00	0.00	0.00	256.00	5.13	14.70	0.49	49.60	17.60	21.00
Max	80.00	3.40	4230.00	0.00	0.00	490.00	384.67	52.60	43.26	119.00	58.60	2642.00
90%	64.21	3.41	4522.20	0.00	0.00	521.26	288.31	50.86	27.86	119.71	54.50	3225.22
75%	51.62	3.33	4259.19	0.00	0.00	485.51	232.25	44.70	21.83	110.38	48.60	2849.97
90% CI	34.99	3.22	3911.71	0.00	0.00	438.28	158.19	36.56	13.87	98.06	40.81	2354.18
75% CI	31.19	3.19	3832.41	0.00	0.00	427.50	141.29	34.71	12.05	95.24	39.03	2241.04
StdDev	25.43	0.17	531.32	0.00	0.00	72.23	113.24	12.45	12.17	18.85	11.92	758.08

MC 10

This monitoring point is comprised of three different sources of water with similar chemistry. The discharges are all considered toe of slope discharges that become ponded in an old surface mine cut before crossing the railroad grade and entering a large wetland. The three discharges combine before entering Moshannon Creek. Unreclaimed spoil and "cuts" are located throughout this area, so reclamation is a priority. The flow at this site is "flashy" and greatly affected during surface runoff during rain events.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.10	4.30	355.00	3.00	0.04	18.00	0.24	3.92	0.05	1.92	0.36	145.00
12/17/2006	5.20	4.50	361.00	4.00	0.25	14.00	0.87	0.37	0.02	0.81	0.51	147.00
01/14/2007	105.90	4.60	333.00	4.00	5.08	15.00	19.05	0.15	0.19	0.83	0.62	138.00
02/11/2007	1.00	4.30	370.00	3.00	0.04	29.00	0.35	14.60	0.18	0.90	2.66	145.00
03/11/2007	77.82	4.70	314.00	4.00	3.73	16.00	14.93	0.25	0.23	0.75	0.91	133.00
04/14/2007	109.02	4.50	488.00	5.00	6.54	26.00	33.99	0.26	0.34	2.09	1.69	226.00
05/13/2007	22.09	4.40	425.00	4.00	1.06	23.00	6.09	0.30	0.08	2.11	1.43	169.00
06/10/2007	16.51	4.10	448.00	1.00	0.20	24.00	4.75	0.62	0.12	2.98	1.64	184.00
07/15/2007	0.54	3.50	458.00	0.00	0.00	44.00	0.28	8.68	0.06	3.31	0.75	193.00
08/12/2007	1.24	5.10	376.00	6.00	0.09	29.00	0.43	9.06	0.13	1.84	0.22	150.00
Average	34.04	4.40	392.80	3.40	1.70	23.80	8.10	3.82	0.14	1.75	1.08	163.00
Min	0.54	3.50	314.00	0.00	0.00	14.00	0.24	0.15	0.02	0.75	0.22	133.00
Max	109.02	5.10	488.00	6.00	6.54	44.00	33.99	14.60	0.34	3.31	2.66	226.00
90%	108.34	5.08	488.45	6.32	5.76	38.67	26.66	12.33	0.30	3.27	2.33	211.87
75%	85.98	4.88	459.66	5.44	4.54	34.20	21.08	9.77	0.25	2.82	1.96	197.17
90% CI	57.54	4.62	423.05	4.32	2.98	28.50	13.97	6.51	0.19	2.23	1.48	178.45
75% CI	50.47	4.55	413.94	4.05	2.60	27.09	12.20	5.70	0.18	2.09	1.36	173.80
StdDev	45.17	0.42	58.14	1.78	2.47	9.04	11.28	5.17	0.10	0.92	0.76	29.71

MC 11

This monitoring point is located downstream from MC-10. It forms from an unreclaimed channel, then flows through a forested area and spoil pile that borders the railroad grade before entering Moshannon Creek. The discharge from this area is fairly insignificant, but reclamation or removal of the spoil pile is important for restoration efforts in the headwaters reach.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
12/17/2006	1.25	3.50	345.00	0.00	0.00	39.00	0.58	0.51	0.01	1.79	2.46	106.00
01/14/2007	15.00	3.50	323.00	0.00	0.00	38.00	6.83	0.65	0.12	1.56	2.10	89.00
02/11/2007	1.00	3.60	322.00	0.00	0.00	37.00	0.44	0.55	0.01	2.02	3.41	86.00
03/11/2007		3.60	293.00	0.00		33.00		0.79		1.71	2.25	85.00
04/14/2007	4.00	3.50	383.00	0.00	0.00	45.00	2.16	1.09	0.05	1.66	2.76	118.00
05/13/2007	4.00	3.40	432.00	0.00	0.00	48.00	2.30	1.00	0.05	1.77	2.63	93.00
06/11/2007	8.57	3.40	413.00	0.00	0.00	43.00	4.42	2.19	0.23	1.76	2.27	92.00
07/15/2007	1.00	3.20	482.00	0.00	0.00	64.00	0.77	4.92	0.06	2.00	2.06	140.00
08/12/2007	0.50	3.30	427.00	0.00	0.00	57.00	0.34	4.51	0.03	1.71	1.93	110.00
Average	3.92	3.44	380.00	0.00	0.00	44.89	2.23	1.80	0.07	1.78	2.43	102.11
Min	0.00	3.20	293.00	0.00	0.00	33.00	0.34	0.51	0.01	1.56	1.93	85.00
Max	15.00	3.60	482.00	0.00	0.00	64.00	6.83	4.92	0.23	2.02	3.41	140.00
90%	12.06	3.66	483.75	0.00	0.00	61.45	6.04	4.65	0.19	2.02	3.18	132.19
75%	9.61	3.60	452.53	0.00	0.00	56.47	4.90	3.79	0.15	1.95	2.95	123.14
90% CI	6.64	3.52	414.58	0.00	0.00	50.41	3.58	2.75	0.11	1.86	2.68	112.14
75% CI	5.82	3.50	404.18	0.00	0.00	48.75	3.17	2.46	0.10	1.83	2.60	109.12
StdDev	4.95	0.13	63.07	0.00	0.00	10.07	2.32	1.73	0.07	0.15	0.46	18.29

MC 12

This monitoring point flows through an unreclaimed channel. The mouth of the discharge flows through spoil material and creates a large iron mat and dead zone. The flow is very disperse through this area and flow was difficult to obtain.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006	6.67	3.20	683.00	0.00	0.00	115.00	9.20	4.05	0.32	3.47	11.30	221.00
12/17/2006	0.54	3.20	990.00	0.00	0.00	206.00	1.33	8.83	0.06	4.73	19.50	376.00
01/14/2007	10.00	3.20	667.00	0.00	0.00	104.00	12.47	4.25	0.51	3.73	13.30	241.00
02/11/2007	3.75	3.00	1250.00	0.00	0.00	297.00	13.35	15.30	0.69	5.27	31.60	502.00
03/11/2007	12.00	3.20	800.00	0.00	0.00	135.00	19.43	6.43	0.93	3.85	16.20	303.00
04/14/2007	30.00	2.90	1460.00	0.00	0.00	266.00	95.69	15.80	5.68	5.96	34.60	479.00
05/13/2007	30.00	2.80	1610.00	0.00	0.00	284.00	102.16	12.40	4.46	5.03	32.40	506.00
06/09/2007	5.00	2.80	1430.00	0.00	0.00	265.00	15.89	14.80	0.89	5.09	29.90	498.00
07/14/2007	2.07	2.80	1570.00	0.00	0.00	329.00	8.17	16.10	0.40	6.39	37.90	562.00
08/11/2007	7.50	2.80	1370.00	0.00	0.00	255.00	22.93	16.90	1.52	5.57	22.10	430.00
Average	9.78	2.99	1183.00	0.00	0.00	225.60	30.06	11.49	1.55	4.91	24.88	411.80
Min	0.00	2.80	667.00	0.00	0.00	104.00	1.33	4.05	0.06	3.47	11.30	221.00
Max	30.00	3.20	1610.00	0.00	0.00	329.00	102.16	16.90	5.68	6.39	37.90	562.00
90%	27.32	3.30	1786.04	0.00	0.00	358.63	90.62	19.91	4.71	6.51	40.60	609.92
75%	22.04	3.21	1604.58	0.00	0.00	318.60	72.40	17.37	3.76	6.03	35.87	550.30
90% CI	15.06	3.09	1373.70	0.00	0.00	267.67	49.21	14.15	2.55	5.42	29.85	474.45
75% CI	13.47	3.06	1316.31	0.00	0.00	255.01	43.45	13.35	2.24	5.26	28.35	455.60
StdDev	10.66	0.19	366.59	0.00	0.00	80.87	36.82	5.12	1.92	0.97	9.55	120.44

MC 13

This monitoring point is comprised of seeps emanating from the toe of a spoil pile. The discharge may be related to deep mining in the area. There is a large unreclaimed area surrounding the discharge which is located only 25 yards off the creek. There is ponded water and lots of garbage through this area.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	6.00	3.00	1290.00	0.00	0.00	222.00	15.97	11.70	0.84	6.51	21.60	475.00
11/12/2006	8.57	3.20	686.00	0.00	0.00	129.00	13.26	5.73	0.59	1.40	1.06	209.00
12/17/2006	6.67	3.30	1460.00	0.00	0.00	324.00	25.91	172.00	13.76	8.38	3.67	705.00
01/14/2007	10.00	3.50	1020.00	0.00	0.00	226.00	27.10	26.20	3.14	2.27	1.59	438.00
02/11/2007	6.00	3.70	1260.00	0.00	0.00	303.00	21.80	144.00	10.36	7.26	5.34	583.00
03/11/2007		3.40	1030.00	0.00		218.00		132.00		7.10	5.59	465.00
04/14/2007	36.22	3.60	1610.00	0.00	0.00	323.00	140.28	155.00	67.32	7.01	3.16	744.00
05/13/2007	8.57	3.10	1590.00	0.00	0.00	297.00	30.52	170.00	17.47	9.68	5.65	605.00
06/09/2007	0.55	2.90	1410.00	0.00	0.00	264.00	1.74	86.80	0.57	6.66	4.53	559.00
07/14/2007	4.29	2.90	1700.00	0.00	0.00	339.00	17.44	145.00	7.46	9.00	4.56	713.00
08/11/2007	5.00	2.90	1500.00	0.00	0.00	296.00	17.75	107.00	6.42	6.37	4.33	585.00
Average	9.19	3.23	1323.27	0.00	0.00	267.36	31.18	105.04	12.79	6.51	5.55	552.82
Min	0.55	2.90	686.00	0.00	0.00	129.00	1.74	5.73	0.57	1.40	1.06	209.00
Max	36.22	3.70	1700.00	0.00	0.00	339.00	140.28	172.00	67.32	9.68	21.60	744.00
90%	25.41	3.71	1828.14	0.00	0.00	371.10	95.65	209.30	45.72	10.71	14.66	805.12
75%	20.53	3.56	1676.22	0.00	0.00	339.88	76.25	177.92	35.81	9.45	11.92	729.20
90% CI	14.32	3.37	1475.50	0.00	0.00	298.64	51.57	136.47	23.20	7.78	8.30	628.89
75% CI	12.77	3.33	1429.69	0.00	0.00	289.23	45.43	127.01	20.07	7.40	7.47	606.00
StdDev	9.86	0.29	306.91	0.00	0.00	63.06	39.19	63.38	20.01	2.55	5.53	153.37

MC 14

This monitoring point is associated with a deep mine discharge in the same unreclaimed area as MC-13. Multiple seeps contribute to the sample location. ATV's have greatly impacted this area and caused dispersion of the discharge as it flows through the unreclaimed area before entering Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.00	3.00	1610.00	0.00	0.00	373.00	4.47	124.00	1.49	9.70	20.90	746.00
11/12/2006		3.40	656.00	0.00		129.00		39.20		4.08	7.61	233.00
12/18/2006	1.71	3.30	1270.00	0.00	0.00	350.00	7.18	131.00	2.69	8.57	15.40	629.00
01/14/2007	7.50	3.30	667.00	0.00	0.00	130.00	11.69	37.50	3.37	4.35	7.88	285.00
02/11/2007	0.00											
03/11/2007		3.20	830.00	0.00		155.00		45.70		5.59	13.00	267.00
04/14/2007	12.00	3.10	1280.00	0.00	0.00	302.00	43.46	71.50	10.29	6.52	28.20	552.00
05/13/2007	10.00	3.00	1360.00	0.00	0.00	297.00	35.61	56.40	6.76	7.21	30.70	508.00
06/09/2007	2.00	2.90	1370.00	0.00	0.00	287.00	6.88	58.60	1.41	7.71	22.30	571.00
07/14/2007	0.50	3.00	1710.00	0.00	0.00	415.00	2.49	141.00	0.85	10.40	20.90	766.00
08/11/2007	0.90	3.10	1450.00	0.00	0.00	327.00	3.53	115.00	1.24	8.96	16.00	591.00
Average	3.96	3.13	1220.30	0.00	0.00	276.50	14.41	81.99	3.51	7.31	18.29	514.80
Min	0.00	2.90	656.00	0.00	0.00	129.00	2.49	37.50	0.85	4.08	7.61	233.00
Max	12.00	3.40	1710.00	0.00	0.00	415.00	43.46	141.00	10.29	10.40	30.70	766.00
90%	11.50	3.40	1838.07	0.00	0.00	446.05	40.56	149.54	9.00	10.88	31.10	831.51
75%	9.23	3.32	1652.18	0.00	0.00	395.03	32.69	129.22	7.35	9.81	27.25	736.21
90% CI	6.47	3.22	1415.66	0.00	0.00	330.12	23.66	103.35	5.45	8.44	22.34	614.95
75% CI	5.72	3.19	1356.87	0.00	0.00	313.98	20.88	96.92	4.87	8.10	21.12	584.82
StdDev	4.59	0.16	375.54	0.00	0.00	103.07	15.90	41.07	3.34	2.17	7.79	192.53

MC 15

This monitoring point is a stream overflow channel, but the water quality is different than the main channel. It would be unnoticed in high flow events. There are multiple seeps that make up this channel.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006		4.10	243.00	2.00		31.00		8.37		1.27	1.05	82.00
11/12/2006		3.20	519.00	0.00		72.00		22.50		3.32	0.54	151.00
12/18/2006	2.31	3.20	1030.00	0.00	0.00	205.00	5.68	102.00	2.83	6.66	0.40	421.00
01/14/2007	20.00	3.30	614.00	0.00	0.00	116.00	27.82	53.70	12.88	4.36	0.52	269.00
02/11/2007	1.00	3.60	954.00	0.00	0.00	230.00	2.76	102.00	1.22	6.11	0.42	413.00
04/15/2007		4.10	244.00	2.00		27.00		6.55		2.55	1.50	99.00
05/12/2007	20.00	3.30	1010.00	0.00	0.00	203.00	48.68	113.00	27.10	7.71	0.68	373.00
06/10/2007	6.00	3.20	892.00	0.00	0.00	179.00	12.88	118.00	8.49	7.74	0.66	382.00
07/15/2007	0.40	3.00	1080.00	0.00	0.00	208.00	1.00	90.40	0.43	7.10	0.40	431.00
08/12/2007	0.75	3.00	1150.00	0.00	0.00	214.00	1.92	88.60	0.80	7.16	1.43	400.00
Average	7.21	3.40	773.60	0.40	0.00	148.50	14.39	70.51	7.68	5.40	0.76	302.10
Min	0.40	3.00	243.00	0.00	0.00	27.00	1.00	6.55	0.43	1.27	0.40	82.00
Max	20.00	4.10	1150.00	2.00	0.00	230.00	48.68	118.00	27.10	7.74	1.50	431.00
90%	21.91	4.07	1337.09	1.79	0.00	279.46	43.70	142.65	23.71	9.26	1.45	533.23
75%	17.49	3.87	1167.53	1.37	0.00	240.05	34.88	120.94	18.89	8.09	1.24	463.68
90% CI	12.77	3.61	951.79	0.84	0.00	189.91	25.47	93.32	13.74	6.62	0.98	375.19
75% CI	11.09	3.55	898.17	0.71	0.00	177.45	22.14	86.46	11.91	6.25	0.91	353.20
StdDev	8.94	0.41	342.55	0.84	0.00	79.61	17.82	43.85	9.75	2.34	0.42	140.50

MC 16

This monitoring point is a borehole located approximately 30 yards off of Moshannon Creek. It is disperse flow and has created a large iron mat. Treatment will be difficult due to the closeness to the main channel.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	70.82			0.00	0.00	202.00	171.54	83.50	70.91	3.91	10.20	370.00
11/12/2006	46.32	3.30	815.00	0.00	0.00	186.00	103.31	70.20	38.99	3.44	8.16	350.00
12/18/2006	64.40	3.60	849.00	0.00	0.00	207.00	159.85	75.80	58.53	3.57	8.43	377.00
01/14/2007	96.30	3.70	690.00	0.00	0.00	154.00	177.83	52.40	60.51	2.80	5.53	339.00
02/11/2007	64.40	3.40	836.00	0.00	0.00	195.00	150.58	65.40	50.50	3.30	9.16	330.00
03/09/2007	64.40	3.20	830.00	0.00	0.00	184.00	142.09	83.20	64.25	4.08	9.50	354.00
04/15/2007	136.19	3.20	878.00	0.00	0.00	180.00	293.95	76.60	125.09	3.66	9.66	340.00
05/12/2007	116.80	3.10	863.00	0.00	0.00	175.00	245.10	62.80	87.95	3.04	8.28	307.00
06/10/2007	35.35	3.00	838.00	0.00	0.00	182.00	77.15	72.00	30.52	3.52	10.40	338.00
07/15/2007	35.35	3.10	823.00	0.00	0.00	194.00	82.23	74.50	31.58	3.69	9.90	329.00
08/12/2007	2.30	3.40	832.00	0.00	0.00	191.00	5.27	71.90	1.98	3.37	8.30	344.00
Average	66.60	3.30	825.40	0.00	0.00	186.36	146.26	71.66	56.44	3.49	8.87	343.45
Min	2.30	3.00	690.00	0.00	0.00	154.00	5.27	52.40	1.98	2.80	5.53	307.00
Max	136.19	3.70	878.00	0.00	0.00	207.00	293.95	83.50	125.09	4.08	10.40	377.00
90%	129.84	3.67	909.49	0.00	0.00	210.01	277.90	86.50	109.98	4.09	11.12	375.37
75%	110.81	3.56	884.19	0.00	0.00	202.90	238.29	82.04	93.87	3.91	10.44	365.77
90% CI	85.67	3.42	851.99	0.00	0.00	193.49	185.95	76.14	72.58	3.67	9.55	353.08
75% CI	79.93	3.38	843.99	0.00	0.00	191.35	174.01	74.79	67.72	3.62	9.34	350.18
StdDev	38.44	0.23	51.12	0.00	0.00	14.38	80.02	9.02	32.55	0.37	1.37	19.40

MC 20

This discharge starts in a wetland area creating a dead zone of cherry and maple trees. It channelizes before entering Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006		3.40	597.00	0.00		56.00		4.10		9.01	1.71	197.00
11/12/2006	60.00	3.60	343.00	0.00	0.00	50.00	35.97	2.08	1.50	6.11	4.98	99.00
12/18/2006	2.73	3.00	1220.00	0.00	0.00	49.00	1.60	4.45	0.15	7.08	2.31	157.00
01/14/2007	12.00	3.70	395.00	0.00	0.00	62.00	8.92	1.95	0.28	7.17	6.14	165.00
02/11/2007	0.00											
03/09/2007	0.00											
04/15/2007	30.00	3.90	308.00	0.00	0.00	52.00	18.71	1.06	0.38	4.52	6.01	140.00
05/12/2007	0.50	3.60	404.00	0.00	0.00	48.00	0.29	4.73	0.03	6.16	2.85	115.00
06/10/2007	0.00											
07/15/2007	0.00											
08/12/2007	1.25	3.50	488.00	0.00	0.00	59.00	0.88	3.60	0.05	8.38	3.77	173.00
Average	10.65	3.53	536.43	0.00	0.00	53.71	11.06	3.14	0.40	6.92	3.97	149.43
Min	0.00	3.00	308.00	0.00	0.00	48.00	0.29	1.06	0.03	4.52	1.71	99.00
Max	60.00	3.90	1220.00	0.00	0.00	62.00	35.97	4.73	1.50	9.01	6.14	197.00
90%	43.18	3.99	1056.80	0.00	0.00	62.56	34.24	5.49	1.31	9.39	6.90	205.36
75%	33.39	3.85	900.22	0.00	0.00	59.90	27.27	4.78	1.04	8.65	6.02	188.53
90% CI	20.93	3.70	733.11	0.00	0.00	57.06	20.53	4.03	0.77	7.85	5.07	170.57
75% CI	17.84	3.65	673.93	0.00	0.00	56.05	17.68	3.76	0.66	7.57	4.74	164.21
StdDev	19.78	0.28	316.34	0.00	0.00	5.38	14.09	1.43	0.55	1.50	1.78	34.00

MC 21a

This monitoring point is a discharge that comes from 4 acres of abandoned spoil. This site is comprised of runoff from the acidic spoil and seeps from the mined area. There are seeps emanating along the base of the spoil pile and is related to the MC 21b discharge. The "b" discharge starts in a wetland area. Both discharges channelize together before entering Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	9.10			0.00	0.00	384.00	41.90	5.44	0.59	22.10	49.40	825.00
11/12/2006		2.80	1800.00	0.00		324.00		1.19		6.43	7.96	704.00
12/17/2006	3.33	2.90	1710.00	0.00	0.00	349.00	13.94	9.78	0.39	20.00	38.30	740.00
01/14/2007	60.00	2.90	1420.00	0.00	0.00	251.00	180.58	10.90	7.84	12.20	29.30	477.00
02/11/2007	0.00											
03/09/2007		2.70	1890.00	0.00		406.00		42.50		17.00	42.00	791.00
04/15/2007	23.30	2.90	1390.00	0.00	0.00	237.00	66.22	25.50	7.12	8.76	22.80	473.00
05/12/2007	20.00	2.80	1890.00	0.00	0.00	308.00	73.86	15.60	3.74	12.50	30.10	625.00
06/10/2007	12.00	2.70	1840.00	0.00	0.00	315.00	45.33	14.10	2.03	15.30	34.50	660.00
07/15/2007	0.00											
08/12/2007	1.50	2.90	1670.00	0.00	0.00	344.00	6.19	3.72	0.07	18.80	42.90	672.00
Average	14.36	2.83	1701.25	0.00	0.00	324.22	61.14	14.30	3.11	14.79	33.03	663.00
Min	0.00	2.70	1390.00	0.00	0.00	237.00	6.19	1.19	0.07	6.43	7.96	473.00
Max	60.00	2.90	1890.00	0.00	0.00	406.00	180.58	42.50	7.84	22.10	49.40	825.00
90%	45.83	2.97	2028.65	0.00	0.00	415.41	156.88	35.41	8.45	23.41	53.44	866.53
75%	36.36	2.93	1930.13	0.00	0.00	387.97	128.07	29.06	6.84	20.82	47.30	805.29
90% CI	24.85	2.88	1817.00	0.00	0.00	354.62	97.33	21.34	5.13	17.66	39.83	730.84
75% CI	21.69	2.86	1782.17	0.00	0.00	345.47	86.44	19.22	4.52	16.80	37.78	710.43
StdDev	19.13	0.09	199.03	0.00	0.00	55.43	58.20	12.83	3.24	5.24	12.41	123.73

MC 21b

This monitoring point is comprised of drainage from spoil and a poorly reclaimed mine site. The headwaters of the discharge is a wetland area that has formed at the toe of slope of a mine site. The discharge combines with the MC-21A discharge 30 yards before entering Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006		3.30	1140.00	0.00		187.00		4.33		20.60	19.90	501.00
11/12/2006	60.00	3.70	402.00	0.00	0.00	69.00	49.64	15.30	11.01	20.30	40.10	136.00
12/17/2006	6.00	3.40	890.00	0.00	0.00	186.00	13.38	4.66	0.34	14.70	21.70	413.00
01/14/2007	60.00	3.50	559.00	0.00	0.00	110.00	79.14	4.39	3.16	8.84	14.40	253.00
02/11/2007	0.00											
03/09/2007		3.70	648.00	0.00		123.00		2.55		12.90	19.20	330.00
04/15/2007	45.00	3.70	596.00	0.00	0.00	118.00	63.67	3.00	1.62	10.40	18.60	286.00
05/12/2007	6.00	3.40	933.00	0.00	0.00	163.00	11.73	4.34	0.31	15.30	22.30	391.00
06/10/2007	6.00	3.30	816.00	0.00	0.00	119.00	8.56	3.52	0.25	12.30	12.30	305.00
07/15/2007	0.00											
08/12/2007	1.76	3.20	886.00	0.00	0.00	131.00	2.76	3.22	0.07	12.80	10.90	310.00
Average	20.53	3.47	763.33	0.00	0.00	134.00	32.70	5.03	2.39	14.24	19.93	325.00
Min	0.00	3.20	402.00	0.00	0.00	69.00	2.76	2.55	0.07	8.84	10.90	136.00
Max	60.00	3.70	1140.00	0.00	0.00	187.00	79.14	15.30	11.01	20.60	40.10	501.00
90%	63.83	3.79	1139.42	0.00	0.00	197.09	83.38	11.48	8.90	20.87	34.04	495.71
75%	50.80	3.69	1026.25	0.00	0.00	178.10	68.13	9.54	6.94	18.87	29.79	444.34
90% CI	34.96	3.57	888.69	0.00	0.00	155.03	51.85	7.18	4.85	16.45	24.64	381.90
75% CI	30.62	3.54	850.97	0.00	0.00	148.70	46.09	6.54	4.11	15.78	23.22	364.78
StdDev	26.32	0.19	228.62	0.00	0.00	38.35	30.81	3.92	3.96	4.03	8.57	103.77

MC 22a

This discharge consists of two monitoring points which originate from the same hillside as MC-21. MC-22 splits along the RR bed with some of the discharge seeping along the side hill while some flows through a small wetland. The discharges are toe of spoil seeps that create wetlands as they flow towards its confluence with Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006		3.00	1310.00	0.00		218.00		8.44		13.40	26.30	483.00
11/12/2006		3.10	870.00	0.00		132.00		2.61		7.49	12.40	295.00
12/17/2006	15.00	3.00	1220.00	0.00	0.00	226.00	40.65	6.12	1.10	12.10	26.60	504.00
01/14/2007	20.00	3.00	1030.00	0.00	0.00	167.00	40.05	4.11	0.99	9.80	20.70	345.00
02/11/2007	8.57	2.90	1390.00	0.00	0.00	262.00	26.92	7.96	0.82	12.30	35.60	552.00
03/09/2007		3.00	1180.00	0.00		210.00		5.54		8.90	25.60	438.00
04/15/2007	105.94	3.20	961.00	0.00	0.00	151.00	191.82	4.26	5.41	6.91	17.30	328.00
05/12/2007	60.00	3.00	1220.00	0.00	0.00	192.00	138.14	6.58	4.73	7.37	19.10	406.00
06/10/2007	30.00	2.90	1280.00	0.00	0.00	214.00	76.98	8.80	3.17	9.85	23.60	469.00
07/15/2007	12.00	2.90	1480.00	0.00	0.00	248.00	35.69	10.90	1.57	12.00	27.00	548.00
08/12/2007	11.06	2.90	1440.00	0.00	0.00	238.00	31.56	11.30	1.50	11.30	21.80	509.00
Average	32.82	2.99	1216.45	0.00	0.00	205.27	72.73	6.97	2.41	10.13	23.27	443.36
Min	8.57	2.90	870.00	0.00	0.00	132.00	26.92	2.61	0.82	6.91	12.40	295.00
Max	105.94	3.20	1480.00	0.00	0.00	262.00	191.82	11.30	5.41	13.40	35.60	552.00
90%	88.68	3.15	1538.70	0.00	0.00	272.62	172.48	11.56	5.38	13.84	33.30	589.93
75%	71.87	3.10	1441.73	0.00	0.00	252.35	142.46	10.18	4.49	12.72	30.28	545.83
90% CI	52.57	3.04	1313.62	0.00	0.00	225.58	107.99	8.35	3.46	11.25	26.30	487.56
75% CI	46.63	3.02	1284.38	0.00	0.00	219.47	97.38	7.93	3.14	10.91	25.39	474.26
StdDev	33.95	0.09	195.89	0.00	0.00	40.94	60.64	2.80	1.80	2.25	6.10	89.10

MC 22b

This discharge consists of two monitoring points which originate from the same hillside as MC-21. Spoil is found n the area of the discharge and will need to be reclaimed before a system is constructed. The discharges are toe of spoil seeps that create wetlands as they flow towards its confluence with Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00	3.10	1330.00	0.00	0.00	288.00	0.00	17.60	0.00	14.90	40.10	582.00
11/12/2006	12.61	2.80	1560.00	0.00	0.00	315.00	47.63	24.20	3.66	12.20	34.00	570.00
12/17/2006	12.61	2.90	1350.00	0.00	0.00	288.00	43.55	8.04	1.22	11.60	29.60	560.00
01/14/2007	23.10	2.80	1680.00	0.00	0.00	327.00	90.58	21.90	6.07	12.60	28.20	593.00
02/11/2007	0.00											
03/09/2007	23.10	3.00	1400.00	0.00	0.00	271.00	75.06	7.28	2.02	12.90	35.30	555.00
04/15/2007	99.50	3.00	1230.00	0.00	0.00	215.00	256.52	6.60	7.87	8.49	24.60	444.00
05/12/2007	30.24	2.90	1540.00	0.00	0.00	276.00	100.08	6.92	2.51	10.20	30.20	543.00
06/09/2007	12.00	2.90	1610.00	0.00	0.00	299.00	43.02	11.00	1.58	12.90	34.90	613.00
07/15/2007	0.00											
08/12/2007		2.90	1630.00	0.00		336.00		15.20		15.30	35.70	678.00
Average	21.32	2.92	1481.11	0.00	0.00	290.56	82.05	13.19	3.12	12.34	32.51	570.89
Min	0.00	2.80	1230.00	0.00	0.00	215.00	0.00	6.60	0.00	8.49	24.60	444.00
Max	99.50	3.10	1680.00	0.00	0.00	336.00	256.52	24.20	7.87	15.30	40.10	678.00
90%	69.74	3.08	1739.70	0.00	0.00	349.80	209.18	24.37	7.46	15.83	40.28	673.47
75%	55.17	3.03	1661.89	0.00	0.00	331.98	170.93	21.01	6.15	14.78	37.94	642.60
90% CI	36.63	2.98	1567.31	0.00	0.00	310.31	127.00	16.92	4.65	13.51	35.10	605.08
75% CI	32.02	2.96	1541.37	0.00	0.00	304.36	113.48	15.80	4.19	13.16	34.32	594.79
StdDev	29.44	0.10	157.20	0.00	0.00	36.02	77.28	6.80	2.64	2.12	4.72	62.36

MC 23

This discharge flows out of a borehole / sinkhole on the railroad grade and does not enter Moshannon Creek on the surface. The water lies in a pond along the railroad grade creating a large deadzone. The borehole and ground water need to be investigated further.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.20	3.90	1490.00	0.00	0.00	409.00	0.98	187.00	0.45	13.00	0.05	899.00
11/12/2006	0.20	3.90	1500.00	0.00	0.00	391.00	0.94	236.00	0.57	16.60	0.05	846.00
12/17/2006	0.20	3.40	1600.00	0.00	0.00	389.00	0.93	227.00	0.54	16.50	0.05	944.00
01/14/2007	0.20	3.70	1540.00	0.00	0.00	396.00	0.95	234.00	0.56	16.20	0.05	868.00
02/11/2007	1.00	5.10	1600.00	9.00	0.11	389.00	4.66	240.00	2.88	16.80	0.05	823.00
03/09/2007	1.00	4.00	1560.00	0.00	0.00	385.00	4.62	236.00	2.83	16.90	0.05	924.00
04/14/2007	1.00	5.20	1770.00	9.00	0.11	384.00	4.60	230.00	2.76	15.70	0.05	963.00
05/12/2007	0.50	5.10	1780.00	9.00	0.05	406.00	2.43	260.00	1.56	17.80	0.05	838.00
06/10/2007	4.00	3.90	1480.00	0.00	0.00	375.00	17.99	252.00	12.09	18.00	0.05	914.00
07/15/2007	0.00											
08/12/2007	1.00	5.20	1660.00	8.00	0.10	397.00	4.76	237.00	2.84	16.50	0.05	913.00
Average	0.85	4.34	1598.00	3.50	0.04	392.10	4.29	233.90	2.71	16.40	0.05	893.20
Min	0.00	3.40	1480.00	0.00	0.00	375.00	0.93	187.00	0.45	13.00	0.05	823.00
Max	4.00	5.20	1780.00	9.00	0.11	409.00	17.99	260.00	12.09	18.00	0.05	963.00
90%	2.69	5.52	1777.00	10.95	0.12	408.97	12.71	265.53	8.41	18.67	0.05	970.94
75%	2.13	5.16	1723.13	8.71	0.09	403.90	10.18	256.01	6.70	17.98	0.05	947.54
90% CI	1.40	4.71	1654.60	5.86	0.06	397.44	6.95	243.90	4.51	17.12	0.05	917.78
75% CI	1.23	4.60	1637.57	5.15	0.05	395.83	6.15	240.89	3.97	16.90	0.05	910.38
StdDev	1.12	0.72	108.81	4.53	0.05	10.26	5.12	19.23	3.47	1.38	0.00	47.26

MC 24

This monitoring point emanates in a wetland area and is associated with a 1 acre spoil pile, 10 ft high consisting of shale and coal ash. Acidic runoff enters the wetland where it is partially treated before entering Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	2.00	3.80	791.00	0.00	0.00	43.00	1.03	6.24	0.15	7.29	4.26	358.00
11/12/2006	15.00	3.70	605.00	0.00	0.00	42.00	7.55	5.63	1.01	5.74	3.31	239.00
12/17/2006	2.40	3.80	670.00	0.00	0.00	50.00	1.44	1.50	0.04	6.65	6.35	300.00
01/14/2007	20.00	3.70	557.00	0.00	0.00	40.00	9.59	1.38	0.33	5.54	3.34	238.00
02/11/2007	1.00	3.70	648.00	0.00	0.00	46.00	0.55	2.05	0.02	6.66	4.73	268.00
03/09/2007	6.67	3.80	647.00	0.00	0.00	44.00	3.52	1.19	0.10	5.70	4.89	277.00
04/15/2007	30.00	3.90	393.00	0.00	0.00	30.00	10.79	0.74	0.27	3.56	1.75	168.00
05/12/2007	8.57	3.50	625.00	0.00	0.00	48.00	4.93	1.69	0.17	4.38	3.34	241.00
06/09/2007	2.40	3.40	765.00	0.00	0.00	55.00	1.58	2.27	0.07	5.62	2.47	280.00
07/15/2007	0.00											
08/12/2007	1.25	3.40	807.00	0.00	0.00	54.00	0.81	8.07	0.12	6.04	2.58	298.00
Average	8.12	3.67	650.80	0.00	0.00	45.20	4.18	3.08	0.23	5.72	3.70	266.70
Min	0.00	3.40	393.00	0.00	0.00	30.00	0.55	0.74	0.02	3.56	1.75	168.00
Max	30.00	3.90	807.00	0.00	0.00	55.00	10.79	8.07	1.01	7.29	6.35	358.00
90%	24.03	3.96	852.65	0.00	0.00	57.21	10.53	7.30	0.71	7.52	5.95	349.32
75%	19.24	3.87	791.91	0.00	0.00	53.59	8.62	6.03	0.56	6.98	5.27	324.46
90% CI	12.92	3.76	714.63	0.00	0.00	49.00	6.19	4.41	0.38	6.29	4.41	292.83
75% CI	11.47	3.73	695.42	0.00	0.00	47.85	5.58	4.01	0.33	6.12	4.20	284.96
StdDev	9.68	0.18	122.71	0.00	0.00	7.30	3.86	2.57	0.29	1.10	1.37	50.22

UT 1-1

This monitoring point is a discharge that emanates in the same area as UT 1-4 through UT 1-2. There are seeps emanating at the toe of slope creating a large kill zone before the discharge becomes channelized and flows through a wooded area until its confluence with an Unnamed Tributary to Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006	28.80	3.00	1180.00	0.00	0.00	229.00	79.08	10.20	3.52	14.50	27.60	440.00
12/17/2006	5.20	2.90	1800.00	0.00	0.00	402.00	25.07	29.40	1.83	24.10	50.50	881.00
01/14/2007	35.10	3.00	1190.00	0.00	0.00	230.00	96.80	12.50	5.26	13.40	25.00	443.00
02/11/2007	0.00											
03/11/2007		3.10	1150.00	0.00		226.00		13.10		15.20	29.00	470.00
04/14/2007	16.15	3.00	1260.00	0.00	0.00	223.00	43.18	8.99	1.74	11.70	21.60	466.00
05/13/2007	5.20	2.90	1600.00	0.00	0.00	285.00	17.77	9.30	0.58	14.90	27.80	563.00
06/10/2007	0.85	2.70	1770.00	0.00	0.00	275.00	2.80	8.85	0.09	15.20	23.70	572.00
07/15/2007	0.00											
08/12/2007	0.54	3.20	522.00	0.00	0.00	70.00	0.45	7.44	0.05	5.15	7.77	154.00
Average	9.18	2.98	1309.00	0.00	0.00	242.50	37.88	12.47	1.87	14.27	26.62	498.63
Min	0.00	2.70	522.00	0.00	0.00	70.00	0.45	7.44	0.05	5.15	7.77	154.00
Max	35.10	3.20	1800.00	0.00	0.00	402.00	96.80	29.40	5.26	24.10	50.50	881.00
90%	30.66	3.22	1994.66	0.00	0.00	393.59	99.42	24.15	5.05	22.82	45.99	829.34
75%	24.20	3.15	1788.34	0.00	0.00	348.12	80.90	20.64	4.09	20.25	40.16	729.82
90% CI	15.98	3.06	1551.42	0.00	0.00	295.92	61.14	16.60	3.07	17.29	33.47	615.55
75% CI	13.93	3.04	1478.47	0.00	0.00	279.84	54.14	15.36	2.71	16.38	31.41	580.37
StdDev	13.06	0.15	416.81	0.00	0.00	91.85	37.41	7.10	1.93	5.20	11.77	201.04

UT 1-3

This monitoring point is a discharge that emanates in the same area as UT 1-4 through UT 1-1. There are seeps emanating at the toe of slope creating a large kill zone before the discharge becomes channelized and flows through a wooded area until its confluence with an Unnamed Tributary to Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.10	2.80	2050.00	0.00	0.00	445.00	5.87	19.70	0.26	16.30	49.90	870.00
11/12/2006	5.00	2.80	1670.00	0.00	0.00	338.00	20.26	10.00	0.60	12.20	37.40	633.00
12/18/2006	11.06	2.70	2400.00	0.00	0.00	563.00	74.67	18.30	2.43	19.30	68.30	1027.00
01/14/2007	35.10	2.70	2130.00	0.00	0.00	427.00	179.72	16.80	7.07	15.70	52.20	796.00
02/11/2007	1.00	2.70	2340.00	0.00	0.00	522.00	6.26	31.10	0.37	19.30	74.80	961.00
03/11/2007	28.62	2.60	2250.00	0.00	0.00	466.00	159.92	27.10	9.30	17.20	62.20	898.00
04/14/2007	58.92	2.70	2200.00	0.00	0.00	399.00	281.90	21.50	15.19	13.60	43.20	823.00
05/13/2007	35.10	2.70	2190.00	0.00	0.00	411.00	172.98	19.20	8.08	12.20	39.30	715.00
06/10/2007	11.06	2.60	2380.00	0.00	0.00	418.00	55.44	22.60	3.00	14.80	44.50	823.00
07/15/2007	1.50	2.60	2360.00	0.00	0.00	540.00	9.71	30.80	0.55	17.30	56.60	992.00
08/12/2007	2.30	2.70	2240.00	0.00	0.00	515.00	14.20	35.60	0.98	17.30	48.60	917.00
Average	17.34	2.69	2200.91	0.00	0.00	458.55	89.18	22.97	4.35	15.93	52.45	859.55
Min	1.00	2.60	1670.00	0.00	0.00	338.00	5.87	10.00	0.26	12.20	37.40	633.00
Max	58.92	2.80	2400.00	0.00	0.00	563.00	281.90	35.60	15.19	19.30	74.80	1027.00
90%	49.09	2.81	2542.06	0.00	0.00	572.48	244.55	35.27	12.43	20.05	72.14	1053.97
75%	39.54	2.77	2439.40	0.00	0.00	538.20	197.80	31.57	10.00	18.81	66.22	995.47
90% CI	26.92	2.73	2303.77	0.00	0.00	492.90	136.02	26.68	6.78	17.17	58.39	918.17
75% CI	24.03	2.72	2272.82	0.00	0.00	482.56	121.93	25.57	6.05	16.80	56.60	900.53
StdDev	19.30	0.07	207.39	0.00	0.00	69.26	94.45	7.48	4.91	2.51	11.97	118.19

UT 1-4

This monitoring point is a discharge that flows through spoil. The discharge crosses an access road and enters into the same kill zone as UT 1-3. The discharge then picks up some flow from toe of slope seeps and enters into a wooded area before entering the Unnamed Tributary to Moshannon Creek.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.60	3.30	991.00	0.00	0.00	216.00	4.14	5.88	0.11	9.39	29.60	422.00
01/14/2007	28.62	3.10	946.00	0.00	0.00	190.00	65.20	3.34	1.15	7.25	23.30	333.00
02/11/2007	1.00	3.30	825.00	0.00	0.00	171.00	2.05	2.64	0.03	8.40	27.70	328.00
03/11/2007	5.20	3.30	723.00	0.00	0.00	137.00	8.54	1.40	0.09	6.38	18.70	296.00
04/14/2007	8.12	3.30	847.00	0.00	0.00	160.00	15.58	1.97	0.19	7.90	23.50	306.00
05/13/2007	8.12	3.20	906.00	0.00	0.00	175.00	17.04	3.59	0.35	7.60	22.70	319.00
06/10/2007	6.85	3.20	844.00	0.00	0.00	143.00	11.75	4.62	0.38	6.66	16.20	284.00
07/15/2007	2.65	3.20	912.00	0.00	0.00	188.00	5.97	4.53	0.14	8.41	22.70	360.00
08/12/2007	2.30	3.10	979.00	0.00	0.00	212.00	5.85	7.08	0.20	8.41	23.20	365.00
Average	7.16	3.22	885.89	0.00	0.00	176.89	15.13	3.89	0.29	7.82	23.07	334.78
Min	1.00	3.10	723.00	0.00	0.00	137.00	2.05	1.40	0.03	6.38	16.20	284.00
Max	28.62	3.30	991.00	0.00	0.00	216.00	65.20	7.08	1.15	9.39	29.60	422.00
90%	21.16	3.36	1025.86	0.00	0.00	222.39	47.13	6.91	0.85	9.39	29.72	404.49
75%	16.95	3.32	983.74	0.00	0.00	208.70	37.50	6.00	0.68	8.92	27.72	383.51
90% CI	11.83	3.27	932.55	0.00	0.00	192.06	25.79	4.90	0.48	8.35	25.28	358.01
75% CI	10.42	3.25	918.51	0.00	0.00	187.49	22.58	4.60	0.42	8.19	24.62	351.02
StdDev	8.51	0.08	85.09	0.00	0.00	27.66	19.45	1.83	0.34	0.96	4.05	42.38

UT 2-1

This monitoring point starts in the same wetland area as UT 2-2, but forms a discrete channel. UT 2-1 exits the wetland and forms a channel through a reclaimed mine site. Iron staining can be seen in the channel.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	12.70	3.30	722.00	0.00	0.00	59.00	8.98	8.80	1.34	5.37	0.94	264.00
11/12/2006	17.10	3.40	646.00	0.00	0.00	51.00	10.46	9.73	2.00	4.69	0.72	218.00
12/17/2006	8.57	3.40	713.00	0.00	0.00	58.00	5.96	10.00	1.03	5.20	0.88	277.00
01/14/2007	11.90	3.40	699.00	0.00	0.00	59.00	8.42	12.10	1.73	5.68	0.97	276.00
02/11/2007	8.57	3.50	714.00	0.00	0.00	61.00	6.27	15.50	1.59	5.37	1.16	284.00
03/09/2007	1.28	3.40	733.00	0.00	0.00	54.00	0.83	12.60	0.19	5.34	1.07	302.00
04/15/2007	12.00	3.50	801.00	0.00	0.00	68.00	9.78	13.30	1.91	5.72	1.06	301.00
05/12/2007	10.00	3.30	965.00	0.00	0.00	78.00	9.35	15.80	1.89	7.44	1.58	331.00
06/09/2007	8.57	3.20	993.00	0.00	0.00	78.00	8.02	9.71	1.00	7.33	1.41	366.00
07/15/2007	28.62	4.10	706.00	2.00	0.69	87.00	29.86	37.10	12.73	7.43	1.67	348.00
08/12/2007	8.12	3.30	838.00	0.00	0.00	70.00	6.82	13.50	1.31	6.11	1.16	274.00
Average	11.58	3.44	775.45	0.18	0.06	65.73	9.52	14.38	2.43	5.97	1.15	294.64
Min	1.28	3.20	646.00	0.00	0.00	51.00	0.83	8.80	0.19	4.69	0.72	218.00
Max	28.62	4.10	993.00	2.00	0.69	87.00	29.86	37.10	12.73	7.44	1.67	366.00
90%	22.86	3.83	961.26	1.17	0.40	84.51	21.43	27.37	8.12	7.59	1.63	363.19
75%	19.47	3.71	905.35	0.88	0.30	78.86	17.85	23.46	6.41	7.10	1.49	342.56
90% CI	14.99	3.55	831.48	0.48	0.17	71.39	13.11	18.29	4.14	6.46	1.29	315.31
75% CI	13.96	3.52	814.62	0.39	0.13	69.69	12.03	17.11	3.63	6.31	1.25	309.09
StdDev	6.86	0.24	112.95	0.60	0.21	11.42	7.24	7.90	3.46	0.98	0.30	41.67

UT 2-2

This monitoring point starts in the same wetland area as UT 2-1, but forms a discrete channel. UT 2-2 exits the wetland and forms a channel through a reclaimed mine site. Iron staining can be seen in the channel.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	1.09	3.40	555.00	0.00	0.00	35.00	0.46	0.97	0.01	3.02	0.17	167.00
11/12/2006	0.98	3.40	452.00	0.00	0.00	35.00	0.41	2.09	0.02	2.78	0.14	129.00
12/18/2006	0.20	3.40	495.00	0.00	0.00	29.00	0.07	1.94	0.00	3.43	0.19	169.00
01/14/2007	3.00	3.50	461.00	0.00	0.00	34.00	1.22	2.17	0.08	2.90	0.16	148.00
02/11/2007	0.00											
03/09/2007	11.89	3.50	505.00	0.00	0.00	29.00	4.13	3.02	0.43	3.26	0.20	171.00
04/15/2007	2.00	3.50	531.00	0.00	0.00	40.00	0.96	3.90	0.09	3.51	0.20	200.00
05/12/2007	1.33	3.30	749.00	0.00	0.00	48.00	0.77	3.19	0.05	5.23	0.35	235.00
06/09/2007	0.50	3.20	761.00	0.00	0.00	20.00	0.12	0.90	0.01	4.22	0.23	237.00
07/15/2007	1.00	3.20	753.00	0.00	0.00	57.00	0.68	1.41	0.02	5.05	0.32	245.00
08/12/2007	0.50	3.20	681.00	0.00	0.00	51.00	0.31	1.31	0.01	3.93	0.24	203.00
Average	2.04	3.36	594.30	0.00	0.00	37.80	0.91	2.09	0.07	3.73	0.22	190.40
Min	0.00	3.20	452.00	0.00	0.00	20.00	0.07	0.90	0.00	2.78	0.14	129.00
Max	11.89	3.50	761.00	0.00	0.00	57.00	4.13	3.90	0.43	5.23	0.35	245.00
90%	7.59	3.57	803.69	0.00	0.00	56.42	2.87	3.75	0.29	5.16	0.33	256.07
75%	5.92	3.51	740.69	0.00	0.00	50.82	2.28	3.25	0.22	4.73	0.30	236.31
90% CI	3.72	3.43	660.52	0.00	0.00	43.69	1.53	2.61	0.14	4.18	0.26	211.17
75% CI	3.21	3.41	640.59	0.00	0.00	41.92	1.35	2.46	0.12	4.05	0.24	204.92
StdDev	3.37	0.13	127.29	0.00	0.00	11.32	1.19	1.01	0.13	0.86	0.07	39.92

UT 2-3

This discharge is associated with a wetland area on the unnamed tributary. Crayfish were seen in the channel below the discharge and its impact has been deemed to be minimal.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.00											
11/12/2006		6.10	114.00	13.00		7.00		2.53		0.41	0.15	32.00
Average	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
Min	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
Max	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
90%	0.00	16.13	301.53	34.39	21.39	18.52	11.52	6.69	4.16	1.08	0.40	84.64
75%	0.00	13.12	245.10	27.95	14.95	15.05	8.05	5.44	2.91	0.88	0.32	68.80
90% CI	0.00	16.13	301.53	34.39		18.52		6.69		1.08	0.40	84.64
75% CI	0.00	13.12	245.10	27.95		15.05		5.44		0.88	0.32	68.80
StdDev	0.00	6.10	114.00	13.00	13.00	7.00	7.00	2.53	2.53	0.41	0.15	32.00

WR 1

This monitoring point is an iron seep located 10 yards downstream of the headwaters of the tributary. The channel bottom is covered with iron precipitate and algae.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	4.29	7.00	334.00	43.00	2.21	-30.00	-1.54	14.80	0.76	0.93	0.06	115.00
11/12/2006	15.00	6.60	325.00	40.00	7.19	-18.00	-3.24	7.10	1.28	0.85	0.05	103.00
12/18/2006	6.00	6.50	340.00	50.00	3.60	-20.00	-1.44	16.20	1.17	1.23	0.19	112.00
01/14/2007	10.00	6.70	292.00	33.00	3.96	-16.00	-1.92	15.10	1.81	0.83	0.05	94.00
02/11/2007	1.00	6.60	356.00	42.00	0.50	-25.00	-0.30	8.56	0.10	0.81	0.05	109.00
03/09/2007	10.00	6.50	291.00	34.00	4.08	-18.00	-2.16	18.10	2.17	0.95	0.05	101.00
04/15/2007	20.00	6.60	333.00	35.00	8.39	-15.00	-3.60	7.71	1.85	0.89	0.05	116.00
05/12/2007	10.00	6.50	344.00	38.00	4.56	-18.00	-2.16	9.11	1.09	0.84	0.05	99.00
06/09/2007	10.00	6.50	306.00	35.00	4.20	-17.00	-2.04	11.30	1.35	0.88	0.05	104.00
07/15/2007	5.45	6.50	332.00	40.00	2.61	-18.00	-1.18	15.20	0.99	0.92	0.05	115.00
08/12/2007	5.00	6.70	343.00	40.00	2.40	-18.00	-1.08	8.13	0.49	0.79	0.05	107.00
Average	8.79	6.61	326.91	39.09	3.97	-19.36	-1.88	11.94	1.19	0.90	0.06	106.82
Min	1.00	6.50	291.00	33.00	0.50	-30.00	-3.60	7.10	0.10	0.79	0.05	94.00
Max	20.00	7.00	356.00	50.00	8.39	-15.00	-0.30	18.10	2.17	1.23	0.19	116.00
90%	17.57	6.86	362.31	47.20	7.65	-12.18	-0.32	18.53	2.19	1.10	0.13	118.81
75%	14.93	6.78	351.66	44.76	6.54	-14.34	-0.79	16.55	1.89	1.04	0.11	115.20
90% CI	11.44	6.68	337.58	41.54	5.08	-17.20	-1.41	13.92	1.49	0.96	0.08	110.43
75% CI	10.64	6.66	334.37	40.80	4.75	-17.85	-1.55	13.33	1.40	0.94	0.08	109.35
StdDev	5.33	0.15	21.52	4.93	2.23	4.37	0.94	4.01	0.61	0.12	0.04	7.29

WR 4

This monitoring point emanates from a 3 acre mossy wetland. There is clear water and no evidence of staining. The flow is fairly variable and dry most of the year.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	0.33	3.90	321.00	0.00	0.00	19.00	0.08	1.28	0.01	1.09	0.83	109.00
11/12/2006	30.00	3.90	222.00	0.00	0.00	200.94	72.28	0.65	0.23	0.67	59.00	6.20
01/14/2007	20.00	4.40	268.00	4.00	0.96	14.00	3.36	0.29	0.07	0.63	0.80	92.00
02/11/2007	0.00											
03/09/2007	0.00											
04/14/2007	20.00	4.10	248.00	1.00	0.24	24.00	5.76	0.36	0.09	0.61	1.22	89.00
05/13/2007		3.80	292.00	0.00		28.00		0.75		0.62	1.39	79.00
06/09/2007	6.67	3.70	254.00	0.00	0.00	24.00	1.92	0.78	0.06	0.51	0.66	64.00
07/14/2007	0.00											
08/11/2007	1.50	4.00	438.00	0.00	0.00	23.00	0.41	5.91	0.11	0.41	0.05	160.00
Average	8.72	3.97	291.86	0.71	0.20	47.56	13.97	1.43	0.09	0.65	9.14	85.60
Min	0.00	3.70	222.00	0.00	0.00	14.00	0.08	0.29	0.01	0.41	0.05	6.20
Max	30.00	4.40	438.00	4.00	0.96	200.94	72.28	5.91	0.23	1.09	59.00	160.00
90%	27.68	4.35	410.12	3.18	0.83	159.06	61.09	4.72	0.22	1.00	45.31	162.02
75%	21.97	4.23	374.54	2.43	0.64	125.51	46.91	3.73	0.18	0.89	34.43	139.03
90% CI	15.04	4.11	336.56	1.64	0.46	89.70	33.20	2.68	0.15	0.78	22.81	114.49
75% CI	13.14	4.07	323.11	1.36	0.38	77.02	27.42	2.30	0.13	0.74	18.69	105.79
StdDev	11.52	0.23	71.89	1.50	0.38	67.78	28.65	2.00	0.08	0.21	21.99	46.46

WR 5

This monitoring point is an alkaline discharge entering Whiteside Run. The mouth of the channel is cloudy with large amounts of algae present.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
10/08/2006	12.00	7.20	327.00	118.00	16.98	-104.00	-14.96	9.95	1.43	0.46	0.05	23.00
11/12/2006	93.58	6.60	335.00	108.00	121.19	-87.00	-97.62	6.91	7.75	0.44	0.07	25.00
01/14/2007	222.60	6.90	307.00	103.00	274.93	-86.00	-229.55	5.10	13.61	0.34	0.05	26.00
02/11/2007	46.50	6.70	322.00	117.00	65.24	-98.00	-54.64	4.81	2.68	0.35	0.08	23.00
03/09/2007	164.08	6.70	321.00	105.00	206.59	-89.00	-175.11	5.06	9.96	0.36	0.05	27.00
04/14/2007	199.99	6.80	334.00	102.00	244.60	-84.00	-201.44	4.43	10.62	0.37	0.05	31.00
05/13/2007	99.50	6.80	353.00	109.00	130.05	-88.00	-104.99	5.19	6.19	0.42	0.05	28.00
06/09/2007	71.31	6.70	316.00	102.00	87.22	-88.00	-75.25	5.15	4.40	0.39	0.05	29.00
07/14/2007	19.00	6.80	307.00	102.00	23.24	-82.00	-18.68	8.76	2.00	0.38	0.05	28.00
08/11/2007	25.32	6.90	319.00	96.00	29.15	-74.00	-22.47	0.60	0.18	1.06	0.57	26.00
Average	95.39	6.81	324.10	106.20	119.92	-88.00	-99.47	5.60	5.88	0.46	0.11	26.60
Min	12.00	6.60	307.00	96.00	16.98	-104.00	-229.55	0.60	0.18	0.34	0.05	23.00
Max	222.60	7.20	353.00	118.00	274.93	-74.00	-14.96	9.95	13.61	1.06	0.57	31.00
90%	221.06	7.08	347.04	117.64	274.46	-74.46	29.44	9.79	13.29	0.81	0.38	30.79
75%	183.25	7.00	340.14	114.20	227.95	-78.53	-9.35	8.53	11.06	0.70	0.29	29.53
90% CI	135.13	6.90	331.36	109.82	168.79	-83.72	-58.71	6.92	8.22	0.57	0.19	27.93
75% CI	123.17	6.87	329.17	108.73	154.08	-85.01	-70.97	6.52	7.52	0.54	0.17	27.53
StdDev	76.40	0.17	13.95	6.96	93.95	8.23	78.36	2.55	4.50	0.22	0.16	2.55

Q-MC-1

This quarterly monitoring point is located in the headwaters of Moshannon Creek above where the MCFORE discharge enters.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	412.90	6.40	129.00	8.00	39.61	3.00	14.85	0.05	0.25	0.02	0.05	7.00
11/09/2006	577.34	6.40	86.00	8.00	55.38	5.00	34.61	0.05	0.35	0.02	0.05	8.00
04/04/2007	1958.11	6.30	89.00	7.00	164.36	0.00	0.00	0.05	1.17	0.02	0.06	9.00
06/13/2007	955.61	6.60	122.00	9.00	103.13	8.00	91.67	0.05	0.57	0.02	0.05	7.00
Average	975.99	6.43	106.50	8.00	90.62	4.00	35.28	0.05	0.59	0.02	0.05	7.75
Min	412.90	6.30	86.00	7.00	39.61	0.00	0.00	0.05	0.25	0.02	0.05	7.00
Max	1958.11	6.60	129.00	9.00	164.36	8.00	91.67	0.05	1.17	0.02	0.06	9.00
90%	2116.06	6.63	142.95	9.34	182.88	9.54	101.37	0.05	1.27	0.02	0.06	9.32
75%	1773.00	6.57	131.98	8.94	155.12	7.87	81.49	0.05	1.06	0.02	0.06	8.85
90% CI	1546.03	6.53	124.73	8.67	136.75	6.77	68.33	0.05	0.93	0.02	0.06	8.54
75% CI	1374.50	6.50	119.24	8.47	122.87	5.94	58.39	0.05	0.82	0.02	0.06	8.30
StdDev	693.05	0.13	22.16	0.82	56.09	3.37	40.18	0.00	0.42	0.00	0.00	0.96

Q-MC-2

This quarterly monitoring point is located in the main stem of Moshannon Creek above the confluence with Roup Run.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2504.30	6.50	78.00	7.00	210.20	6.00	180.17	0.89	26.73	0.15	0.06	13.00
11/09/2006	3288.25	6.40	67.00	8.00	315.44	5.00	197.15	0.36	14.19	0.11	0.06	15.00
04/03/2007	10767.16	6.00	77.00	6.00	774.65	7.00	903.76	0.33	42.61	0.31	0.23	20.00
06/13/2007	4080.00	6.40	78.00	8.00	391.39	6.00	293.54	0.44	21.53	0.23	0.12	15.00
Average	5159.93	6.33	75.00	7.25	422.92	6.00	393.66	0.51	26.26	0.20	0.12	15.75
Min	2504.30	6.00	67.00	6.00	210.20	5.00	180.17	0.33	14.19	0.11	0.06	13.00
Max	10767.16	6.50	78.00	8.00	774.65	7.00	903.76	0.89	42.61	0.31	0.23	20.00
90%	11399.58	6.69	83.81	8.82	827.55	7.34	959.07	0.93	46.08	0.35	0.25	20.66
75%	9521.99	6.58	81.16	8.35	705.79	6.94	788.93	0.80	40.12	0.30	0.21	19.18
90% CI	8279.75	6.51	79.40	8.04	625.24	6.67	676.36	0.72	36.17	0.27	0.18	18.21
75% CI	7340.96	6.45	78.08	7.80	564.36	6.47	591.29	0.65	33.19	0.25	0.16	17.47
StdDev	3793.10	0.22	5.35	0.96	245.98	0.82	343.72	0.26	12.05	0.09	0.08	2.99

Q-MC-3

This quarterly monitoring point is located on the main stem of Moshannon Creek at Hale Bridge.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2251.85	5.50	119.00	4.00	108.01	9.00	243.02	2.10	56.70	0.92	0.16	35.00
11/07/2006	3558.98	5.80	81.00	6.00	256.05	8.00	341.41	0.80	34.14	0.36	0.12	23.00
04/03/2007	11877.27	4.60	198.00	4.00	569.68	12.00	1709.04	1.84	262.05	2.22	0.77	71.00
06/13/2007	6684.43	4.50	217.00	4.00	320.61	15.00	1202.30	2.61	209.20	2.49	0.49	74.00
Average	6093.13	5.10	153.75	4.50	313.59	11.00	873.94	1.84	140.52	1.50	0.39	50.75
Min	2251.85	4.50	81.00	4.00	108.01	8.00	243.02	0.80	34.14	0.36	0.12	23.00
Max	11877.27	5.80	217.00	6.00	569.68	15.00	1709.04	2.61	262.05	2.49	0.77	74.00
90%	13135.53	6.17	259.76	6.15	630.31	16.20	2032.03	3.09	325.25	3.18	0.89	92.89
75%	11016.39	5.85	227.86	5.65	535.00	14.64	1683.55	2.71	269.66	2.67	0.74	80.21
90% CI	9614.33	5.63	206.75	5.32	471.95	13.60	1452.99	2.46	232.89	2.34	0.64	71.82
75% CI	8554.76	5.47	190.80	5.08	424.30	12.82	1278.74	2.28	205.09	2.09	0.56	65.48
StdDev	4281.09	0.65	64.44	1.00	192.53	3.16	704.01	0.76	112.29	1.02	0.31	25.62

Q-MC-4

This quarterly monitoring point is located on the main stem of Moshannon Creek directly upstream from where the MC-15 discharge enters.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2448.20	3.80	182.00	0.00	0.00	21.00	616.48	4.65	136.51	1.04	0.53	58.00
11/09/2006	4205.70	5.00	109.00	5.00	252.15	15.00	756.46	3.22	162.39	0.65	0.40	32.00
04/04/2007	13924.02	4.20	232.00	2.00	333.93	18.00	3005.33	2.73	455.81	2.21	1.12	81.00
06/13/2007	5890.28	4.10	251.00	1.00	70.63	24.00	1695.13	3.50	247.21	2.53	0.86	83.00
Average	6617.05	4.28	193.50	2.00	164.18	19.50	1518.35	3.53	250.48	1.61	0.73	63.50
Min	2448.20	3.80	109.00	0.00	0.00	15.00	616.48	2.73	136.51	0.65	0.40	32.00
Max	13924.02	5.00	251.00	5.00	333.93	24.00	3005.33	4.65	455.81	2.53	1.12	83.00
90%	14957.16	5.12	297.80	5.55	419.48	25.87	3329.40	4.87	488.71	3.09	1.26	102.76
75%	12447.52	4.86	266.42	4.48	342.66	23.95	2784.43	4.46	417.02	2.65	1.10	90.95
90% CI	10787.10	4.70	245.65	3.78	291.83	22.69	2423.87	4.20	369.59	2.35	1.00	83.13
75% CI	9532.29	4.57	229.96	3.24	253.42	21.73	2151.39	3.99	333.75	2.13	0.91	77.22
StdDev	5069.97	0.51	63.41	2.16	155.20	3.87	1100.94	0.81	144.82	0.90	0.33	23.87

Q-MC-5

This quarterly monitoring point is located on the main stem of Moshannon Creek 100 yards downstream of where the MC-15 discharge enters.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2012.87	3.80	182.00	0.00	0.00	22.00	531.00	5.44	131.30	1.14	0.57	57.00
11/09/2006	4903.59	5.00	111.00	5.00	293.99	16.00	940.78	3.18	186.98	0.59	0.37	33.00
04/04/2007	12359.95	4.20	232.00	2.00	296.42	19.00	2815.96	2.50	370.52	1.91	1.06	82.00
06/13/2007	5561.53	4.10	254.00	1.00	66.69	24.00	1600.52	4.10	273.42	2.91	0.97	83.00
Average	6209.49	4.28	194.75	2.00	164.27	20.25	1472.06	3.81	240.56	1.64	0.74	63.75
Min	2012.87	3.80	111.00	0.00	0.00	16.00	531.00	2.50	131.30	0.59	0.37	33.00
Max	12359.95	5.00	254.00	5.00	296.42	24.00	2815.96	5.44	370.52	2.91	1.06	83.00
90%	13415.32	5.12	299.11	5.55	416.98	26.01	3114.43	5.90	412.50	3.29	1.28	102.85
75%	11247.00	4.86	267.71	4.48	340.94	24.28	2620.22	5.27	360.76	2.79	1.12	91.08
90% CI	9812.40	4.70	246.93	3.78	290.63	23.13	2293.25	4.85	326.53	2.47	1.01	83.30
75% CI	8728.24	4.57	231.23	3.24	252.61	22.26	2046.14	4.54	300.66	2.22	0.93	77.42
StdDev	4380.45	0.51	63.44	2.16	153.62	3.50	998.40	1.27	104.53	1.01	0.33	23.77

Q-MC-6

This quarterly monitoring point is located on the main stem of Moshannon Creek above the confluence with Whiteside Run.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2285.74	3.50	231.00	0.00	0.00	29.00	794.84	7.24	198.44	1.55	0.93	72.00
11/09/2006	5219.99	4.70	125.00	4.00	250.37	20.00	1251.86	4.09	256.00	0.70	0.50	37.00
04/04/2007	14875.90	4.10	244.00	1.00	178.38	22.00	3924.29	3.06	545.83	1.98	1.13	86.00
06/13/2007	7205.93	4.00	270.00	1.00	86.41	28.00	2419.38	4.21	363.77	2.49	0.92	89.00
Average	7396.89	4.08	217.50	1.50	128.79	24.75	2097.59	4.65	341.01	1.68	0.87	71.00
Min	2285.74	3.50	125.00	0.00	0.00	20.00	794.84	3.06	198.44	0.70	0.50	37.00
Max	14875.90	4.70	270.00	4.00	250.37	29.00	3924.29	7.24	545.83	2.49	1.13	89.00
90%	16247.07	4.89	322.39	4.35	308.05	32.03	4395.26	7.61	592.33	2.93	1.31	110.23
75%	13583.95	4.64	290.83	3.49	254.11	29.84	3703.86	6.72	516.71	2.55	1.17	98.42
90% CI	11821.98	4.48	269.94	2.92	218.42	28.39	3246.43	6.13	466.67	2.30	1.09	90.61
75% CI	10490.42	4.36	254.16	2.50	191.45	27.29	2900.73	5.69	428.86	2.12	1.02	84.71
StdDev	5380.05	0.49	63.76	1.73	108.97	4.43	1396.76	1.80	152.78	0.76	0.26	23.85

Q-MC-7

This quarterly monitoring point is located on the main stem of Moshannon Creek above the confluence with Mountain Branch.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	2426.89	3.80	209.00	0.00	0.00	16.00	465.61	2.81	81.77	1.44	0.52	66.00
11/09/2006		5.80	136.00	7.00		10.00		3.08		0.66	0.25	34.00
04/04/2007	23536.19	4.50	229.00	4.00	1128.89	12.00	3386.67	3.07	866.42	1.83	1.00	81.00
06/13/2007	7643.96	4.50	237.00	4.00	366.63	19.00	1741.52	3.62	331.80	2.48	0.84	83.00
Average	11202.35	4.65	202.75	3.75	498.51	14.25	1864.60	3.15	426.67	1.60	0.65	66.00
Min	2426.89	3.80	136.00	0.00	0.00	10.00	465.61	2.81	81.77	0.66	0.25	34.00
Max	23536.19	5.80	237.00	7.00	1128.89	19.00	3386.67	3.62	866.42	2.48	1.00	83.00
90%	29289.66	6.02	278.47	8.47	1445.84	20.88	4273.56	3.71	1086.04	2.85	1.20	103.25
75%	23846.97	5.61	255.69	7.05	1160.77	18.89	3548.67	3.54	887.63	2.48	1.04	92.04
90% CI	21645.06	5.34	240.61	6.11	1045.45	17.57	3255.41	3.43	807.36	2.23	0.93	84.62
75% CI	18502.73	5.13	229.22	5.40	880.87	16.57	2836.90	3.34	692.80	2.04	0.84	79.02
StdDev	10995.33	0.83	46.03	2.87	575.88	4.03	1464.41	0.34	400.83	0.76	0.33	22.64

Q-MC-8

This quarterly monitoring point is located on the main stem of Moshannon Creek below the confluence with Mountain Branch.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	3781.70	4.20	128.00	1.00	45.35	10.00	453.46	1.91	86.61	0.82	0.30	39.00
11/09/2006	10438.64	5.60	86.00	6.00	751.02	11.00	1376.87	1.88	235.32	0.44	0.24	23.00
04/04/2007	38784.85	4.90	108.00	5.00	2325.35	11.00	5115.76	1.51	702.25	0.79	0.46	35.00
06/13/2007	11315.59	4.50	201.00	4.00	542.74	17.00	2306.65	2.95	400.27	1.82	0.68	69.00
Average	16080.20	4.80	130.75	4.00	916.11	12.25	2313.19	2.06	356.11	0.97	0.42	41.50
Min	3781.70	4.20	86.00	1.00	45.35	10.00	453.46	1.51	86.61	0.44	0.24	23.00
Max	38784.85	5.60	201.00	6.00	2325.35	17.00	5115.76	2.95	702.25	1.82	0.68	69.00
90%	41587.12	5.80	212.80	7.55	2536.48	17.52	5629.09	3.08	790.29	1.94	0.74	73.67
75%	33911.78	5.50	188.11	6.48	2048.89	15.93	4631.30	2.77	659.64	1.65	0.65	63.99
90% CI	28833.66	5.30	171.77	5.78	1726.30	14.88	3971.14	2.57	573.20	1.46	0.58	57.58
75% CI	24995.99	5.15	159.43	5.24	1482.50	14.09	3472.24	2.42	507.88	1.31	0.53	52.74
StdDev	15505.73	0.61	49.88	2.16	985.03	3.20	2015.75	0.62	263.94	0.59	0.20	19.55

Q-MC-9

This quarterly monitoring point is located on the main stem of Moshannon Creek below the confluence with Unnamed Tributary #1.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	4093.50	4.20	131.00	1.00	49.09	11.00	539.94	1.23	60.37	0.85	0.25	41.00
11/07/2006	13575.08	5.10	79.00	5.00	813.89	11.00	1790.57	2.48	403.69	0.38	0.38	24.00
04/04/2007	30618.93	4.70	142.00	4.00	1468.61	14.00	5140.12	1.70	624.16	1.01	0.57	48.00
06/13/2007	11997.55	4.40	173.00	3.00	431.59	18.00	2589.53	2.18	314.05	1.52	0.81	56.00
Average	15071.27	4.60	131.25	3.25	690.79	13.50	2515.04	1.90	350.57	0.94	0.50	42.25
Min	4093.50	4.20	79.00	1.00	49.09	11.00	539.94	1.23	60.37	0.38	0.25	24.00
Max	30618.93	5.10	173.00	5.00	1468.61	18.00	5140.12	2.48	624.16	1.52	0.81	56.00
90%	33436.61	5.24	195.59	6.06	1686.49	18.96	5710.81	2.80	734.27	1.71	0.90	64.66
75%	27910.26	5.05	176.23	5.21	1386.88	17.31	4749.17	2.53	618.81	1.48	0.78	57.92
90% CI	24253.94	4.92	163.42	4.65	1188.64	16.23	4112.93	2.35	542.42	1.33	0.70	53.45
75% CI	21490.76	4.83	153.74	4.23	1038.83	15.41	3632.10	2.21	484.69	1.21	0.64	50.08
StdDev	11164.34	0.39	39.11	1.71	605.29	3.32	1942.72	0.55	233.25	0.47	0.24	13.62

Q-MC-10

This quarterly monitoring point is located on the main stem of Moshannon Creek below where discharges MC-21 and MC-22 enter the stream.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	3729.53	3.90	146.00	0.00	0.00	12.00	536.65	1.49	66.63	0.90	0.32	45.00
11/07/2006	12722.36	4.90	86.00	4.00	610.22	14.00	2135.75	2.13	324.94	0.46	0.33	26.00
04/04/2007	33509.20	4.50	155.00	4.00	1607.24	11.00	4419.90	2.15	863.89	1.18	0.83	52.00
06/13/2007	10150.51	4.30	176.00	3.00	365.14	17.00	2069.15	1.92	233.69	1.35	0.61	58.00
Average	15027.90	4.40	140.75	2.75	645.65	13.50	2290.36	1.92	372.29	0.97	0.52	45.25
Min	3729.53	3.90	86.00	0.00	0.00	11.00	536.65	1.49	66.63	0.46	0.32	26.00
Max	33509.20	4.90	176.00	4.00	1607.24	17.00	4419.90	2.15	863.89	1.35	0.83	58.00
90%	36228.97	5.08	204.25	5.86	1777.97	17.85	4922.92	2.43	939.39	1.61	0.93	68.10
75%	29849.31	4.88	185.14	4.93	1437.24	16.54	4130.75	2.28	768.75	1.42	0.80	61.22
90% CI	25628.43	4.74	172.50	4.31	1211.81	15.68	3606.64	2.17	655.84	1.29	0.72	56.67
75% CI	22438.61	4.64	162.95	3.84	1041.45	15.02	3210.56	2.10	570.52	1.20	0.66	53.24
StdDev	12888.19	0.42	38.60	1.89	688.34	2.65	1600.34	0.31	344.74	0.39	0.25	13.89

Q-MC-11

This quarterly monitoring point is located on the main stem of Moshannon Creek above the confluence with Bear Run.

Date	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
08/07/2006	4537.37	4.00	150.00	0.00	0.00	13.00	707.30	1.39	75.63	1.03	0.34	46.00
11/07/2006	11937.18	4.80	92.00	4.00	572.55	15.00	2147.08	1.80	257.65	0.44	0.31	29.00
04/04/2007	32901.98	4.50	158.00	4.00	1578.11	11.00	4339.80	1.77	698.31	1.10	0.79	54.00
06/13/2007	17670.83	4.20	187.00	2.00	423.78	20.00	4237.82	1.79	379.28	1.39	0.66	60.00
Average	16761.84	4.38	146.75	2.50	643.61	14.75	2858.00	1.69	352.72	0.99	0.53	47.25
Min	4537.37	4.00	92.00	0.00	0.00	11.00	707.30	1.39	75.63	0.44	0.31	29.00
Max	32901.98	4.80	187.00	4.00	1578.11	20.00	4339.80	1.80	698.31	1.39	0.79	60.00
90%	36548.52	4.95	212.24	5.65	1743.39	21.10	5743.49	2.01	783.74	1.65	0.92	69.38
75%	30594.47	4.78	192.53	4.70	1412.45	19.19	4875.21	1.92	654.04	1.45	0.80	62.72
90% CI	26655.18	4.66	179.49	4.07	1193.50	17.93	4300.74	1.85	568.23	1.32	0.72	58.31
75% CI	23678.16	4.58	169.64	3.60	1028.03	16.97	3866.61	1.80	503.38	1.22	0.66	54.98
StdDev	12028.37	0.35	39.81	1.91	668.56	3.86	1754.10	0.20	262.02	0.40	0.24	13.45

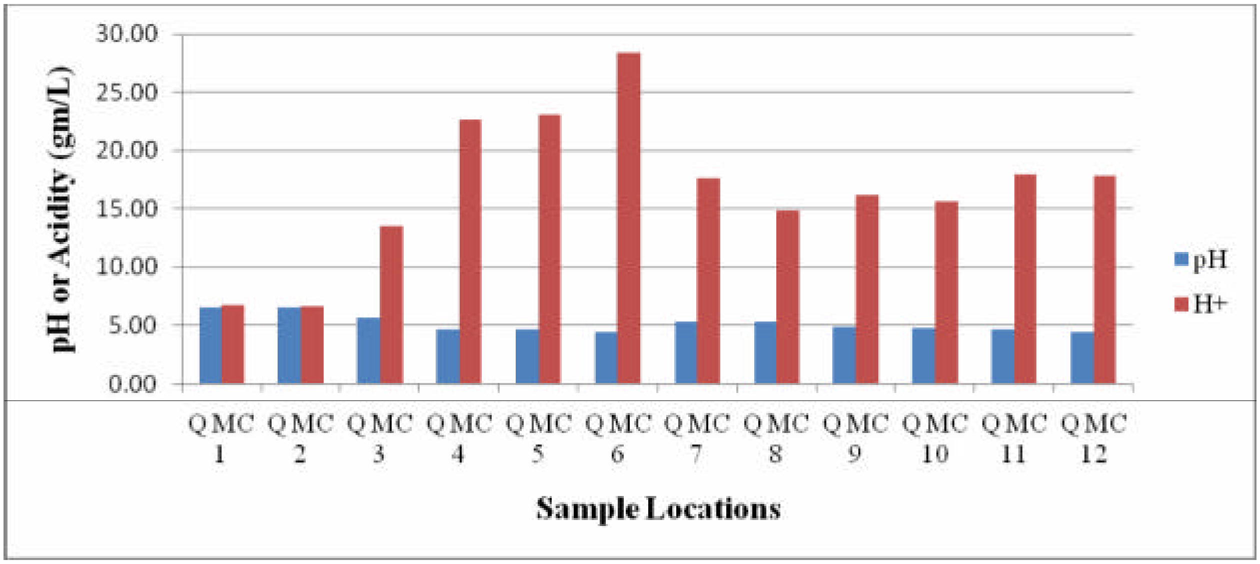
Q-MC-12

This quarterly monitoring point is located on the main stem of Moshannon Creek below the confluence with Bear Run.

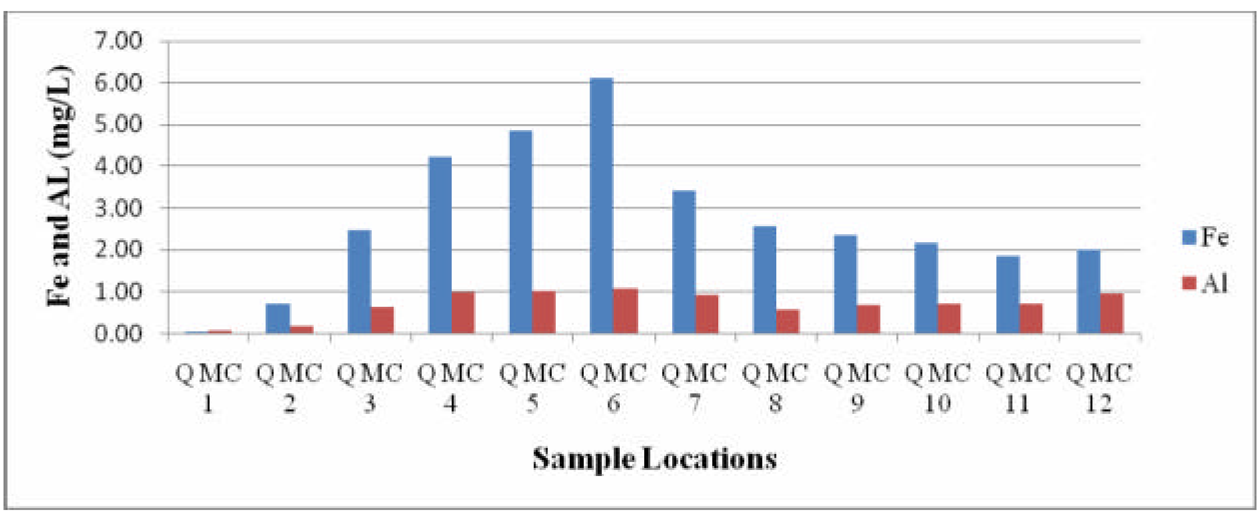
Date	**Flow (gpm)**	**pH (SU)**	**Cond**	**Alk**	**Alk load (lbs/day)**	**Acidity (mg/l)**	**Acid load (lbs/day)**	**Iron**	**Iron load (lbs/day)**	**Mn**	**Al**	**Sulfate**
08/07/2006	3383.80	4.00	153.00	0.00	0.00	12.00	486.90	1.29	52.34	1.00	0.33	48.00
11/07/2006	9593.77	4.60	103.00	4.00	460.16	11.00	1265.43	1.91	219.72	0.56	0.45	30.00
04/04/2007	42909.77	4.30	171.00	3.00	1543.59	15.00	7717.97	1.96	1008.48	1.28	1.08	57.00
06/13/2007	16549.95	4.10	190.00	2.00	396.90	20.00	3969.01	1.84	365.15	1.52	0.80	60.00
Average	18109.32	4.25	154.25	2.25	600.16	14.50	3359.83	1.75	411.42	1.09	0.67	48.75
Min	3383.80	4.00	103.00	0.00	0.00	11.00	486.90	1.29	52.34	0.56	0.33	30.00
Max	42909.77	4.60	190.00	4.00	1543.59	20.00	7717.97	1.96	1008.48	1.52	1.08	60.00
90%	46709.77	4.69	215.70	5.06	1687.68	21.15	8732.77	2.26	1099.12	1.77	1.23	70.96
75%	38103.56	4.55	197.21	4.21	1360.43	19.15	7115.99	2.11	892.19	1.56	1.06	64.28
90% CI	32409.55	4.47	184.98	3.65	1143.92	17.82	6046.30	2.01	755.27	1.43	0.95	59.85
75% CI	28106.44	4.40	175.73	3.23	980.30	16.82	5237.91	1.93	651.80	1.33	0.86	56.51
StdDev	17386.29	0.26	37.36	1.71	661.10	4.04	3266.23	0.31	418.05	0.41	0.34	13.50

Comparison of Upstream (QMC-1) vs. Downstream (QMC-12)

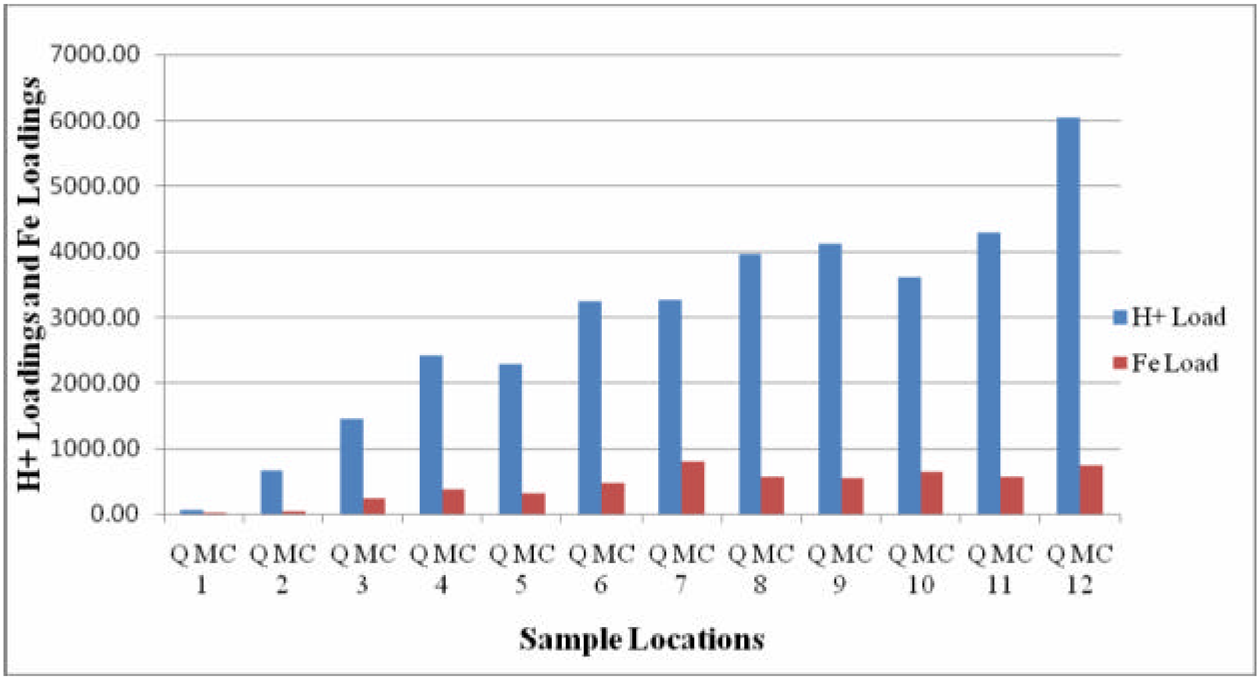
The graph on the next page represents the change in water quality from the headwaters of Moshannon Creek before degradation (top) to a sample collected below Bear Run (bottom). The pH decreases from an average of 6.53 to 4.47 showing degradation from the discharges that enter along the length of the main stem and the tributaries. The headwaters section remains relatively undisturbed and supports a native brook trout population. Below the extreme headwaters section degradation from past mining practices begin impacting the stream quality and below Roup Run, the quality in Moshannon Creek is completely degraded. Acidity concentrations increase from an average of 6 mg/L in the headwaters to 18 mg/L below Bear Run, again showing the degradation of stream quality caused by the mine drainage discharges.



The below graph represents the change in iron and aluminum concentrations from the headwaters of Moshannon Creek (top) to a sample collected below Bear Run (bottom). The average iron concentration increases from 0.05 mg/L to a high of 6.13 mg/L above the confluence with Whiteside Run to 2.01 mg/L below Bear Run. It is unexpected that more of an increase is not seen due to the impacts of the severe iron laden discharges. The average manganese concentration is 0.06 mg/L in the headwaters to a high of 2.47 mg/L above the confluence with Whiteside Run to 1.43 mg/L below Bear Run. The average aluminum concentration is 0.06 mg/L in the headwaters, 1.09 mg/L above the confluence with Whiteside Run and 0.95 mg/L below Bear Run. These levels are not severe in the main stem and are encouraging that Moshannon Creek itself can be restored through treatment of the most significant discharges in the watershed.



The below graph represents the change of acid and iron loadings from the headwaters of Moshannon Creek (top) to a sample collected below Bear Run (bottom). It is not enough to only look at the mg/L of acidity and iron to judge the degradation of a stream. You must review the loadings to truly understand the impacts on the stream. The graph shows a steady increase in acid load as you move downstream. The acid load in the headwaters is 68 lbs/day and below Bear Run it has increased to 6046 lbs/day. The iron load does not show a consistent increase, but does jump dramatically below Roup Run. In the headwaters the iron load is 0.93 lbs/day and reaches a high below Roup Run of 807 lbs/day and decreases slightly to 755 lbs/day below Bear Run. The impact of Roup Run can clearly be seen on the graphs and is a high priority area in the restoration of the headwaters section of Moshannon Creek.



Macroinvertebrate Data

An aquatic investigation of the headwaters of Moshannon Creek and two tributaries was conducted on May 27 and 28, 2008 to determine baseline conditions of the aquatic macro-invertebrate fauna. The following is taken from and summarizes the results in that report. To view the full report, see Appendix E.

The substrate in Moshannon Creek is comprised largely of rubble, gravel and sand with few boulders. Pools and runs generally outnumbered riffles. The ideal habitat condition for a freestone stream is close to a 1:1 ratio of pools to riffles. Most Moshannon Creek riffles are not well defined; few rock edge surfaces are exposed to shallow current, which limits attachment areas for macroinvertebrates. Most stations sampled had riparian vegetation consisting of trees and shrubs except where crossed by gravel roads and fords or where ponds and swamps reached near the stream.

A combined total of 54 taxa were collected. The uppermost station, Moshannon Creek headwaters, had the highest number of taxa at 36 and the tributary Mountain Branch the lowest at 5 taxa. Moshannon Creek headwaters had the highest IBI Score and Mountain Branch the lowest IBI scores.

Although Moshannon Creek is considered impaired downstream of the MCFORE discharge, the in stream water chemistry with relatively low metals concentrations, low acidity, and presence of EPT taxa upstream and downstream of Wilson Run suggests that reclamation and treatment of the major mine discharges has the potential for considerable improvement in macroinvertebrate taxa richness and numbers of organisms. The diverse macroinvertebrate fauna upstream in Moshannon Creek and in Wilson Run would provide a ready source of aquatic organisms to replenish downstream areas after reclamation projects are completed and water quality improves and stabilizes. Restoration of the macroinvertebrate fauna downstream of Hale Road Bridge may be more difficult to achieve because of the presence of iron precipitate; however, even partial removal of the iron and an increase in pH should also result in significant improvements in the macroinvertebrate fauna.

	Modified Becks	**EPT Taxa Richness**	**Total Taxa Richness**	**Shannon Diversity Index**	**Hilsenhoff Biotic Index**	**Percent Intolerant Individuals**	**IBI Score**
Mo Ck Headwaters, 1MC	1	1	1	1	0.894	0.91	**96.8**
Mo Ck upstream McFore, 2MC	0.846	0.91	0.94	0.955	0.856	0.881	**89.9**
Mo Ck downstream McFore, 3MC	0.154	0.217	0.4	0.731	0.534	0.283	**38.7**
Mo Ck upstream Wilson Run, 4MC	0.487	0.478	0.486	0.617	0.976	0.848	**64.9**
Wilson Run near mouth	0.923	0.913	0.914	1	0.866	0.919	**92.3**
Mo Ck downstream Wilson Run, 5MC	0.462	0.391	0.514	0.782	0.854	0.717	**62**
Mo Ck Hale Bridge Rd, 6MC	0.077	0.043	0.2	0.114	0.566	0.254	**20.9**
Mo Ck upstream Mountain Branch, 7MC	0.103	0.043	0.4	0.356	0.641	0.295	**30.6**
Mountain Branch	0.103	0.043	0.143	0.172	0.504	0.05	**16.9**
Shannon's; the lower the # the less diverse the population							

Hilsenhoff Bi Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution
IBI; 0 to 100, high #'s = better integrity		

The above table is a summary statistical analysis used to determine the overall aquatic health of a stream. The Index of Biological Integrity(IBI) is a means to integrate collected information from other biological metrics. The IBI score yields a broad view of the aquatic composition of streams. The values shown are the adjusted standard metric score ranging from 0 to 1.00 then that sum is multiplied by 100 to yield a score range between 0 and 100. The IBI Score of 0 equates to a stream that does not contain aquatic life while a score of 100 equates to a pristine stream, usually a high value stream that contains an abundance of aquatic life. The following is a summary of the IBI results as conducted during the aquatic survey:

- Mo Ck Headwaters 1MC: The IBI score of 96.8 indicates a healthy stream with excellent marcoinvertebrate fauna and pristine conditions. This reach of stream has good in stream habitat while pools outnumber riffles with those riffles being not well defined.

- Mo Ck upstream McFore 2MC: The IBI score of 89.9 indicates a healthy stream with excellent marcoinvertebrate fauna and pristine conditions. This reach of stream has fair in stream habitat while pools outnumber riffles with some of those riffles having an open canopy. The reduced habitat could explain the lower EPT taxa and taxa richness.

- Mo Ck downstream McFore 3MC: The IBI score of 38.7 indicates a severely degraded stream. This stream reach is downstream of the first major mine discharge in the watershed. The stream shows signs of iron staining but not of current iron deposition. Beavers have damned up the creek 50 yards downstream on the sampling point reducing the pool riffle complex while beaver damns and open swampy area is upstream.

- Mo Ck upstream of Wilson Run 4MC: The IBI score of 64.9 is just above the threshold of 63.0 considered to be severely degraded conditions. The stream shows signs of iron staining but not of current iron deposition.

- Wilson Run near mouth 5MC: The IBI score of 62.0 is just below the threshold of 63.0 considered to be severely degraded conditions. The stream shows signs of iron staining but not of current iron deposition. Slimy algae and silt coat the substrate.

- Mo Ck at Hale Bridge Road 6MC: The IBI score of 20.9 poor water quality conditions. The low pH and iron precipitate caused a severe depression of macroinvertebrates. This stream reach bank area has recently been leveled and seeded.

- Mo Ck upstream Mountain Branch 7MC: The IBI score of 30.6 indicates a severely degraded stream. This stream reach has low pH, alkalinity, and iron precipitate coating the substrate. Upstream of this site has few riffles and swampy conditions.

- Mountain Branch: The IBI score of 16.9 indicates a severely degraded stream. This stream reach has heavy iron precipitate coating the substrate. Upstream of this site has few riffles and extensive swampy conditions with slimy algae and thick silt coating the substrate.

AMD Treatment Methods:

Through the years, many treatments have been developed for AMD remediation and currently there are a number of organized efforts in Pennsylvania using both active and passive treatment methods on a watershed scale. Active treatment methods incorporate the use of mechanized procedures for the addition of alkaline materials and require constant monitoring and maintenance. Basic chemicals are used as additives to increase the pH and cause the precipitation of metals, such as Fe, Mn, and Al. The chemicals commonly used are Ca(OH)2 (hydrated lime), NaOH (caustic soda), NH_3 (ammonia), CaO (pebble quicklime) and Na_2CO_3 (soda ash) (Robb and Robinson, 1995). The chemicals used on a particular site depend on mine drainage characteristics and site accessibility. Hydrated lime is commonly used, but is hydrophobic and requires mixing. Pebble quicklime (CaO) is utilized at sites where it is usually dissolved by a water wheel arrangement. Soda ash, in the form of briquettes, is used in remote areas with low flows and low acidity. Caustic soda is also used in remote areas with low flows. Liquid caustic soda is capable of treating high acidity and high Mn because it raises the pH quickly, but it is expensive and dangerous to handle. Another potentially dangerous chemical used less frequently is ammonia. It must be handled carefully and is stored as a liquid. Ammonia can raise the pH above 9.2, but may have direct negative impacts on the biota of the receiving streams (Skousen and Ziemkiewicz, 1995).

Other active treatment methods include dissolved air flotation and ion exchange devices, flocculants, coagulants, and oxidants (Skousen and Ziemkiewicz, 1995). Active methods are successful, but expensive. It is not uncommon for water treatment costs to exceed $200,000 per year at AMD sites using active treatment. Another concern is the large volume of sludge produced from the precipitation of metals. Disposal costs for the sludge add to the cost of chemical treatment. Active methods may also cause environmental damage because potentially harmful chemicals are used. The high cost and possible side effects of active treatment can be avoided by the use of passive treatment systems.

Passive treatment systems, which require only limited maintenance, are the alternative approach to active treatment methods. They require no input of manufactured chemicals and have a lower operation and maintenance cost. A downside is that they do require longer retention times and larger treatment areas (Hedin et al., 1994). Page D-1 shows the evolution of passive treatment technology since the early 1980s.

Passive treatment systems were first designed after it was observed that natural wetland systems in the path of AMD had some positive effects. The first passive systems described were natural *Sphagnum* wetlands that were improving AMD as discharges flowed through them. The first constructed wetlands were small and planted with cattails (*Typha latifolia)*. They were designed to encourage oxidation processes to precipitate unwanted metals and in turn increase the pH (Robb and Robinson, 1995). Constructed wetlands function by precipitating metal hydroxides, forming metal sulfides, and adsorbing small amounts of metals to the plant community (Skousen and Ziemkiewicz, 1995).

Two types of wetlands are constructed, aerobic and anaerobic. Aerobic wetland systems are designed to encourage metal precipitation through oxidation processes and are therefore normally shallow, vegetated, and have surface flow predominating (Robb and Robinson, 1995). Anaerobic wetland systems require that the mine water flow through an organic layer under anaerobic conditions. The organic material most commonly used is spent mushroom compost. This organic material must contain sulfate-reducing bacteria for metal sulfide precipitates to form (Robb and Robinson, 1995).

Both vegetation and bacteria are vital to wetland treatment success. Wetland plant species have many roles in mine drainage treatment. They include substrate consolidation, metal accumulation, stimulation of microbial activity and improve the aesthetics of the site. Constructed wetlands can also provide valuable wildlife habitat, for animals such as reptiles and amphibians. Plants may also serve as a food source. Sulfate reducing bacteria, such as *Desulfovibrio* and *Desulfotomaculum,* play a major role by increasing the pH and encouraging metal precipitation. It has been shown that *Desulfovibrio* are most effective at a pH > 4.5 so an important aspect of anaerobic wetland treatment is maintaining the pH within the organic layer (Nawrot and Klimstra, 1990). Sulfate reducers exist in the absence of oxygen and are only found in the deeper parts of the organic layer where they are able to perform their function of sulfate reduction and alkalinity production. Treatment efficiencies of these microbial dependent wetlands show trends of seasonal variation. The decrease in treatment efficiency may be due to biological functions slowing with decreasing temperatures (Kepler, 1990).

These bacteria utilize the organic substrate as a carbon source and use sulfate as an electron acceptor in the following reactions:

$$SO_4^{2-} + 2\ CH_2CHOHCOO^- + 4\ H^+ \rightarrow H_2S + 2\ CH_3COOH + 2\ H_2CO_3 \quad (1)$$

$$SO_4^{2-} + CH_3OO^- + 3\ H^+ \rightarrow H_2S + 2\ H_2CO_3 \quad (2)$$

$$SO_4^{2-} + 2\ CH_3CHOHCOO^- + 3\ H^+ \rightarrow 3H_2S + 6\ H_2CO_3 \quad (3)$$

Sulfate reducing bacteria cannot break down complex organic substrates so they rely mainly on fermenting bacteria to provide substrates like acetate and lactate from larger organic molecules (Cork and Cusanovich, 1979). Plants aid in maintaining these bacterial communities by providing attachment sites and a continual supply of organic matter (Skousen and Ziemkiewicz, 1995).

Another type of passive treatment technology is an anoxic limestone drain (ALD). The Tennessee Division of Water Pollution Control in 1988 first built prototype ALDs. At the same time, the Tennessee Valley Authority (TVA) personnel found that AMD from a coal refuse dam was being neutralized by calcium carbonate limestone in an old road buried beneath the dam (Brodie et al., 1993). In an ALD, alkalinity is produced when AMD contacts limestone in an anoxic environment producing bicarbonate alkalinity. ALDs consist of a shallow limestone filled trench, sealed from the atmosphere, through which the AMD is channeled. Limestone with greater than 90% $CaCO_3$ is used to produce the greatest amount of alkalinity (Brodie et al., 1993). The limestone layer is often covered with plastic or geotextile fabric. Clay soil is then placed over the plastic or fabric followed by a covering of a heavy soil, then vegetated. The amount of limestone used is determined by the flow and loading of the AMD and desired longevity for the system. Usually, extra limestone is employed to ensure a comfortable safety factor for longevity. The use of an oxidation basin immediately after the ALD allows for precipitation of the metals (Brodie et al., 1993).

Three other criteria are followed when constructing ALDs. The first is to keep out any organic matter that may allow microorganisms to grow and coat the limestone. The second is that larger limestone (1"-6") should be used to maintain flow in case plugging occurs due to metal precipitation. Finally, oxygen should be kept out of the drain to deter metal precipitates from forming (Skousen and Ziemkiewicz, 1995). ALDs have been found to raise pH and introduce as much as 300 mg/l of bicarbonate alkalinity as shown by the following equations:

$$CaCO_3\ (s) + 2\ H^+ \longleftrightarrow Ca^{2+} + H_2CO_3^- \quad (1)$$

$$CaCO_3\ (s) + H_2CO_3^- \longleftrightarrow Ca^{2+} + 2\ HCO_3^- \quad (2)$$

$$CaCO_3\ (s) + H_2O \longleftrightarrow Ca^{2+} + HCO_3^- + OH^- \quad (3)$$

The rate of calcium dissolution is dependent on carbon dioxide partial pressure. Generally, the rate of calcium dissolution will increase as the partial pressure increases (Plummer et al., 1979).

As the water leaves the ALD and is exposed to oxygen, the increased pH promotes metal precipitation and the bicarbonate alkalinity neutralizes the acidity produced by metal hydrolysis (Hedin and Watzlaf, 1994). Dissolved oxygen (DO) concentration is a limiting factor in the utility of ALDs. A DO level of less than 1.0 mg/l is recommended to ensure that Fe^{3+} will not precipitate, coating the limestone or clogging the system

(Kepler and McCleary, 1994). Al^{3+}, however, can precipitate at a pH > 4.5 in the absence of oxygen, therefore clogging the system even in the absence of oxygen (Kepler and McCleary, 1994). ALDs are often used in combination with anaerobic constructed wetlands and vertical flow wetlands, which are also called successive alkalinity producing systems (SAPS) in the literature.

Vertical flow wetlands are being used on mine sites for the treatment of AMD (page D-2 and D-3). It is a newer technology that has shown great success. Vertical flow wetlands combine ALDs and anaerobic wetlands into one integrated system. Vertical flow is promoted through rich organic wetland substrates followed by a limestone bed (Kepler and McCleary, 1994). Most systems are constructed as ponds lined with 65-85 cm of limestone on which approximately 65 cm of spent mushroom compost is spread. To maintain reducing conditions within the organic layer, at least 85 cm of compost is recommended (Demchak, et al. 2001). On top of the compost layer is freestanding water with a depth of 40-255 cm (Skousen and Ziemkiewicz, 1995). Perforated pipes under the limestone layer collect the flow. Various piping patterns are used from a minimal approach where only 2-3 pipes are placed lengthwise through the system, to a maximal approach where piping is placed in a grid-like pattern on 5' or 10' centers. Demchak et al. recommends the use of increased piping to insure preferential flow does not occur.

Vertical flow wetlands add alkalinity both through bacterial sulfate reduction and limestone dissolution. Bacterial-mediated sulfate reduction occurs in the organic layer. Bacteria oxidize organic compounds using sulfate and release hydrogen sulfide and bicarbonate. The sulfate reduction directly affects concentrations of dissolved metals by raising alkalinity and providing the conditions necessary for precipitating them as metal sulfides (Skousen and Ziemkiewicz, 1995). Metals precipitating in the system may decrease the lifespan. Flushing the wetlands may be a solution to increasing the treatment success and may aid in the prevention of clogging. Acidic conditions may also be created from reactions involving H_2S, including $H_2S \rightarrow H^+ + HS^-$ and $Fe^{2+} + HS^- \rightarrow FeS + H^+$. When the mine water enters the organic layer containing dissolved Fe^{3+}, dissolved O_2, or precipitated Fe and Mn oxides, the H_2S is oxidized and mineral acidity is affected (Hedin et al., 1994). As the H_2S levels increase, the acidity decreases raising pH levels. The amount of H_2S produced can be qualitatively detected by both the odor of the gas and the rich black color of the organic layer which can be an indicator of successful treatment within the wetland (Nawrot and Klimstra, 1990).

Another source of bicarbonate in vertical flow wetlands is attributed to dissolution of the limestone, $CaCO_3 + H^+ \rightarrow Ca^{2+} + HCO_3^-$. The dissolution rate and concomitant alkalinity generation are greatly affected by the partial pressure of CO_2. Anaerobic mine water increases CO_2 partial pressures due to decomposing organic matter and precipitation of metal sulfides. The dissolved CO_2 is a weak diprotic acid and continues to react with limestone, producing more Ca^{2+} and HCO_3^-. When highly acidic water contacts limestone, the first reaction is neutralization of proton acidity. The reaction increases pH and decreases metal solubility.

As pH rises above 4.5, bicarbonate accumulates, decreasing the solubility of metals (Hedin et al., 1994a). It has been stated that limestone dissolution requires a 12-hour contact time for maximum alkalinity production (Kepler and McCleary, 1994). In vertical flow wetlands, through a combination of bacterial mediated sulfate reduction and limestone dissolution, alkalinity is produced. The increased pH results in the precipitation of metals when the discharged water is exposed to oxygen.

Passive treatment technology is undergoing rapid development because of the importance of developing remediation methods for AMD at a low cost. Other systems are being studied to determine if they can be successfully used as cost-efficient systems, either alone or in combination with other systems. One such system is a limestone pond. The pond is constructed on an upwelling of an AMD seep or underground discharge point. Limestone is placed on the bottom of the pond and water flows up through it. They are normally constructed with 1-3 m of water, 0.3-1.0 m of limestone, and have a retention time of 1-2 days. The drainage requires a low DO, and should contain minimal Fe^{3+} and Al^{3+}, so clogging does not occur (Skousen and Ziemkiewicz, 1995). If higher concentrations of metals are present, a flushing system can be added.

Another technique involves the use of open limestone channels. They add alkalinity to acidic water in open channels or ditches lined with limestone. The channel should contain a slope greater than 20% to maintain flow velocities that keep precipitates in suspension (Skousen and Ziemkiewicz, 1995). Direct addition of limestone sand to streams is another technique being used. The sand is placed in the headwaters of a stream and during high flows the sand moves downstream and mixes with natural sediments. No harmful effects have been seen. An increase in pH and calcium levels have been observed along with a decrease in toxic aluminum species. A careful selection of particle size, purity and mass of the limestone is important for treatment success (Downey et al., 1994).

Diversion wells have been used in Scandinavia to treat small acidic streams since the late 1970’s (Sverdrup, 1983). The first full-sized wells were implemented in Sweden in 1980 and were first used in Lebanon County, Pennsylvania in 1986. Diversion wells are constructed from a cylinder or vertical tank made of either concrete or metal. They are 1.5-1.8 m in diameter, 2.0-2.5 m deep and filled with limestone. They contain a large pipe that extends vertically down the center of the well. Water is fed from the stream into the pipe that exits near the bottom through a nozzle. Water then flows up through the limestone, fluidizing it. Grinding and dissolution of the limestone occurs creating alkalinity. Due to the high pressure created within the wells, floc is removed at a consistent rate, so limestone coating is not a concern. Diversion wells are not entirely passive in that limestone must be added on a monthly basis and sometimes even daily. They work best where metal concentrations are low since there are no settling ponds employed.

Bioremediation is another passive treatment technique being used. Seeded microbes are used to convert metals to their less harmful species. Metal oxidation and precipitation are promoted through hydroxide formation, as is metal reduction and precipitation through sulfide formation. One example is the use of metal oxidizing beds for the treatment of both Mn and Fe (Skousen and Ziemkiewicz, 1995). Mn is difficult to remove because of the high pH required to precipitate it (> 9.0) and competition with Fe precipitation when Fe is present in high concentration. Researchers in Maryland have established a combination of microbes that have been shown to precipitate Mn to effluent standards. These beds have been in use for approximately 10 years, with the first being constructed in Pennsylvania in 1994.

Treatment, Operation, and Maintenance

Operation and Maintenance

Through discussions with the various project partners, MCWC and the local conservation districts, long term maintenance of the constructed treatment systems will be conducted through a coordinated effort. The partners are willing to do the field work associated with maintenance of the treatment cells. An operation and maintenance plan will be developed for each treatment project as it enters final design.

Wetlands require minimal maintenance. Visual inspections are necessary to insure muskrats and beavers are not impacting inlet/outlet structures or destroying vegetation. Vertical flow wetlands require regular flushing to insure plugging does not occur, but automatic flushing systems using solar power are fairly common. This flushing frequency will vary depending on the size of the system and metal loading entering the system. The primary maintenance issue is with solids removal in the settling ponds. The purpose of the settling pond is to collect precipitated metals. These solids accumulate over time and will eventually need to be removed. Ponds are typically designed to operate for 10 years or more before needing to be cleaned out.

Prioritization of Treatment Areas

The prioritization of treatment areas was based on a variety of criteria including loading rates, location, size available for treatment and cost effectiveness. Treatment areas are located throughout the watershed on property owned by individual landowners. Permission will need to be obtained when submitting grants in order to complete the design/permitting phase, along with construction of the projects. All landowners were contacted before the assessment began for permission to install flow devices on their property and conduct monthly sampling. Most landowners in the watershed are cooperative of the MCWC and its efforts to restore Moshannon Creek.

Thirty eight treatment systems are being recommended for construction to improve water quality in the watershed and allow for repopulation of trout throughout the headwaters of Moshannon Creek. We will, however, address quality of each sample location and give a brief justification for our decision to treat or not treat each location.

Each priority area and its conceptual treatment design are presented below. All are conceptual designs and will most likely change during the design and permitting phase of each individual project as more information is gathered. Cost estimates are also given for each project. The cost estimates were obtained using AMDtreat.

The water quality throughout the watershed is varied and will need varying technologies to treat, ranging from passive to active systems. Due to the size of the assessment area and the varying water quality, the stream has been divided into "AREAS" of treatment, rather than strict prioritization. Much of the watershed is being influenced by abandoned mine lands, so many of the projects will include a reclamation component in conjunction with treatment systems for the discharges themselves.

Appendix C contains tables of "rankings". Due to the size of the watershed and the need for reclamation, prioritization was difficult. It was determined that breaking the watershed into areas and prioritizing from the headwaters of those sections downstream was the most logical and that is what is presented in this restoration plan. The ranking tables in Appendix C, also show priorities based on both acid and iron loads and are ranked strictly from highest to lowest. This is another approach that may be taken in implementing the restoration plan. By starting with the highest acid load, the largest removal of acid on a lb/day basis would be obtained, however direct restoration of stream miles may not be achieved. This approach would be recommended if the goal would be to remove acid loadings from both the overall Moshannon Creek Watershed and subsequently the West Branch of the Susquehanna.

Many of the discharges, twenty three, are associated with abandoned highwalls and/or spoil piles and that is where restoration efforts should begin. Through restoration efforts a decrease in flow rates and increase in water quality should be seen which would decrease the number of treatment systems necessary to restore the watershed. Many sites are also recommended to be treated together after future investigation occurs and the feasibility of combining their flow is determined. Therefore, the 38 treatment system recommendations made below, may be altered upon further investigation at each individual site or area.

The restoration plan makes recommendations of each treatment area based on restoration of stream miles and restoring a fishery to this headwaters area. The conceptual designs presented below can be easily adjusted as deemed necessary to insure successful implementation of this plan an eventual restoration of Moshannon Creek.

Area #1: Upper Reaches of Moshannon Creek (Mainstem)

Priority #1-1: MC-1 (MC-FORE)

Site Description:

The MC-FORE discharge is the first source of significant degradation to Moshannon Creek. The discharge was not existent until a deep mine discharge was capped near the Janesville Dam. After the deep mine was capped, the discharge emanated in a reclaimed field. The discharge is piped through a wetland complex before entering Moshannon Creek. In the summer of 2004, high flow events were noticed and the discharge began to coat rocks with an iron precipitate in Moshannon Creek severely impacting the only HQ-CWF section of Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	13.21	5.46	1724.70	34.70	6.54	289.10	62.59	184.60	39.82	50.66	0.48	984.60
Min	0.00	5.30	605.00	22.00	2.28	-8.00	12.23	11.40	8.93	7.16	0.26	258.00
Max	30.00	6.30	2450.00	44.00	15.83	484.00	142.81	317.00	81.66	85.20	1.19	1461.00
90%	27.99	5.96	2767.26	46.54	14.39	544.18	141.31	335.71	88.50	88.31	0.97	1701.32
75%	23.54	5.81	2453.54	42.98	12.03	467.42	117.62	290.24	73.85	76.98	0.82	1485.65
90% CI	17.89	5.62	2054.39	38.44	9.16	369.76	88.83	232.38	56.05	62.56	0.64	1211.25
StdDev	8.98	0.31	633.77	7.20	4.77	155.06	47.85	91.86	29.60	22.89	0.30	435.70

Recommendations:

The discharge emanates from a pipe and flows through a rock-lined channel before entering a wetland area. The landowner has dug an additional pond to increase settling of the iron precipitate to protect the headwaters section of Moshannon Creek. The design chemistry of this discharge is 25 gpm with a pH of 5.6, acidity of 370 mg/L, alkalinity of 40 mg/L, iron of 235 mg/L, and aluminum of 0.6 mg/L. This alkaline discharge will be treated with an aerobic wetland. The wetland area was sized using the iron removal rate of 5 g/m2/day of Fe to allow for metal precipitation and the increase in pH. Due to the extreme loading rate of iron, 70 lbs/day, a large wetland complex will be built. The wetlands will be constructed with a substrate of a 1:1 ratio of organic matter and limestone to maintain the pH as the iron precipitates. Different sizes and depths of wetlands will be established to increase contact time and allow for greater precipitation of the iron. Overall size of the aerobic wetland should be 750’ by 400’, but this area will be broken into smaller cells.

The Moshannon Creek Watershed Coalition has received funding for the design and permitting phase of this project through the Growing Greener Grant Program, along with supplemental funding through the PA American Water Grant Program. The conceptual site design will be completed by spring 2010 and a construction grant will be submitted.

The approximate cost of constructing the wetland area is $350,000. Miscellaneous costs of $5,000 are added for riparian plantings. The design and permitting phase has already been funded at a cost of $50,000. The overall design and construction cost of MC-1 is $405,000.

Predicted Effect of System on Receiving Stream:

Treatment of the MC-1 discharge is designed to remove 110 lbs/day of acidity, 70 lbs/day of iron and 0.2 lbs/day of aluminum. This will improve water chemistry in the headwaters segment of Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary, but aerobic wetlands may need to be modified or replaced after a 20+ year lifespan. Visual checks of the wetlands will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-2: MC-2

Site Description:

This monitoring point contributes runoff from an unreclaimed surface mine area greater than 30 acres in size. The discharge runs through a man-made channel collecting numerous seeps before becoming ponded due to a clogged pipe. The discharge sometimes overtops the existing access road creating erosion problems. The discharge then flows through a forested area and wetland before entering Moshannon Creek. Discoloration of Moshannon Creek is occurring where MC-2 enters the main channel.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	14.06	3.97	545.20	1.50	0.22	75.70	17.00	3.08	0.28	6.72	10.05	245.60
Min	0.00	3.20	162.00	0.00	0.00	17.00	0.79	0.75	0.03	0.85	1.80	57.00
Max	60.00	5.10	1100.00	6.00	0.86	194.00	73.38	13.90	1.05	14.80	27.00	584.00
90%	43.32	4.88	1082.00	5.07	0.79	174.58	59.17	9.70	0.79	14.77	24.67	532.74
75%	34.52	4.60	920.47	4.00	0.62	144.83	46.48	7.71	0.64	12.35	20.27	446.34
90% CI	22.88	4.26	714.95	2.63	0.40	106.97	30.34	5.17	0.44	9.27	14.67	336.40
StdDev	17.79	0.55	326.32	2.17	0.35	60.11	25.63	4.02	0.31	4.89	8.89	174.56

Recommendations:

Since the discharge emanates from an abandoned mine area, the first phase of this project would be site reclamation. Surveying needs to be completed at this site to determine the extent of reclamation needed. Through reclamation efforts the discharge should decrease in quantity and increase in quality. Samples will be collected of the spoil material to determine if it can be taken to a COGEN plant, and if not it, it will be regraded with lime addition and soil amendments .

A system has been designed based on the characteristics of the discharge now, but will need to be modified after reclamation efforts occur. A design flow rate of 30 gpm was used. The discharge has a pH of 4.2, acidity of 110 mg/L, iron of 6 mg/L, and aluminum of 15 mg/L. An equalization basin will be constructed to allow precipitation of metals to occur before entering a vertical flow wetland containing 1600 tons of limestone. The VFW will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging. The VFW will discharge to a settling basin to allow for metal precipitation before entering Moshannon Creek.

The approximate cost of constructing the VFW is $350,000, if no site reclamation occurs. The approximate cost of site reclamation is $150,000 using an estimated 30 acres of material and $5,000/acre. The design and permitting phase of the project would be at a cost of $75,000 to design both the reclamation and treatment phase of the project. The overall design and construction cost of MC-2 is $575,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-2 discharge is designed to remove 40 lbs/day of acidity, 2 lbs/day of iron and 5.5 lbs/day of aluminum. This will continue the improvement of water chemistry in the headwaters segment of Moshannon Creek.

Other:

A final O&M plan will be developed after reclamation and construction is complete. Limited maintenance should be necessary, due to the use of automatic flushing devices. . Visual checks of the wetlands will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-3: MC-3

Site Description:

This monitoring point is an iron mat with an associated discharge that borders Moshannon Creek for approximately 20 yards. Discoloration of Moshannon Creek is occurring where MC-3 enters the main channel. There is also a large spoil/complex upstream from this discharge that needs to be addressed, but does not directly impact that seepage.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	3.66	6.03	1898.18	54.55	2.49	130.18	5.72	117.80	5.30	23.47	0.56	1028.64
Min	1.00	5.80	1790.00	34.00	0.66	111.00	1.51	99.80	1.21	19.20	0.10	671.00
Max	7.50	6.20	2030.00	68.00	6.12	142.00	12.14	132.00	10.88	26.70	4.68	1138.00
90%	6.82	6.21	2008.00	70.80	5.20	143.70	10.72	134.04	10.21	27.16	2.81	1242.66
75%	5.87	6.15	1974.95	65.91	4.38	139.63	9.21	129.15	8.73	26.05	2.13	1178.26
90% CI	4.66	6.08	1931.29	59.45	3.35	134.26	7.30	122.70	6.85	24.58	1.24	1093.17
StdDev	1.92	0.11	66.76	9.88	1.64	8.22	3.04	9.87	2.99	2.24	1.37	130.11

Recommendations:

Since the discharge emanates from an area where spoil piles are located, the first phase of this project would be site reclamation. Surveying needs to be completed at this site to determine the extent of reclamation needed. Samples will be collected of the spoil material to determine if it can be taken to a COGEN plant, and if not, it will be regraded with lime addition and soil amendments.

A system has been designed based on the characteristics of the discharge, but if the site is hydrologically connected to the spoil pile, it will need to be modified after reclamation efforts occur. A design flow rate of 10 gpm was used. The discharge has a pH of 6.08, acidity of 134 mg/L, iron of 125 mg/L, and aluminum of 1 mg/L. This alkaline discharge will be treated with an aerobic wetland. The wetland area was sized using the iron removal rate of 5 g/m2/day of Fe to allow for metal precipitation and the increase in pH. The size of the wetland will be approximately 300 by 150 feet. The wetland will be constructed with a substrate of a 1:1 ratio of organic matter and limestone to maintain the pH as the iron precipitates. Different sizes and depths of wetlands will be established to increase contact time and allow for greater precipitation of the iron.

The approximate cost of constructing the wetland is $125,000, if no affect is seen from site reclamation. The approximate cost of site reclamation is $200,000 based on a site estimate of 40 acres. The design and permitting phase of the project would be at a cost of $75,000 to design both the reclamation and treatment phase of the project. The overall design and construction cost of MC-3 is $400,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-3 discharge is designed to remove 16 lbs/day of acidity, 15 lbs/day of iron and 0.1 lbs/day of aluminum. This will continue the improvement of water chemistry in the headwaters segment of Moshannon Creek.

Other:

A final O&M plan will be developed after reclamation and construction is complete. Limited maintenance should be necessary on the aerobic wetland. Visual checks of the wetlands will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-4: MC-7

Site Description:

This monitoring point is considered the "killer" of Moshannon Creek. It discharges near the mouth of Roup Run and is associated with MC-8. The discharge is linked to a deep mine discharge that is ponded before becoming channelized and entering the mouth of Roup Run. Dead zones and iron mats are created due to the high iron levels at this site. The discharge would most likely benefit from site reclamation and soil amendments. An increase in quality and a decrease in flow should be seen. Further site investigation will occur.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	39.13	3.16	1934.55	0.00	0.00	215.64	99.66	43.13	20.34	36.82	9.97	965.00
Min	20.00	2.80	1380.00	0.00	0.00	153.00	52.15	29.60	8.61	24.60	4.68	671.00
Max	64.40	3.50	2440.00	0.00	0.00	290.00	191.51	57.50	36.45	48.80	16.70	1319.00
90%	62.74	3.49	2533.67	0.00	0.00	295.12	171.39	57.38	34.88	49.58	16.09	1336.95
75%	55.64	3.40	2353.38	0.00	0.00	271.20	149.81	53.09	30.50	45.74	14.25	1225.02
90% CI	46.25	3.26	2115.19	0.00	0.00	239.60	121.29	47.43	24.72	40.67	11.81	1077.15
StdDev	14.35	0.20	364.21	0.00	0.00	48.32	43.60	8.67	8.84	7.76	3.72	226.11

Recommendations:

Surveying needs to be completed at this site to determine the extent of reclamation needed. Samples will be collected of the waste material to determine lime addition rates and to determine the most effective soil amendment. A system has been designed based on the characteristics of the discharge now and it will need to be modified after reclamation efforts occur. A design flow rate of 50 gpm was used. The discharge has a pH of 3.2, acidity of 240 mg/L, iron of 50 mg/L, and aluminum of 12 mg/L. This discharge is pushing the limits of passive technology, but with reclamation and the improvement of water quality, a passive system will most likely be effective. The treatment would begin with low pH iron oxidation which will allow for initial removal of iron and acidity. This will be followed by a series of VFWs containing a total of 2800 tons of limestone. A combination of two VFWs, each with 1400 tons of limestone, will be followed by settling basins. The VFWs will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the treatment train is $425,000, if no affect is seen from site reclamation. The approximate cost of site reclamation is $150,000 based on a site estimate of 30 acres. The design and permitting phase of the project would be at a cost of $75,000 to design both the reclamation and treatment phase of the project. The overall design and construction cost of MC-3 is $650,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-7 discharge is designed to remove 144 lbs/day of acidity, 30 lbs/day of iron and 7 lbs/day of aluminum. This will continue the improvement of water chemistry in the headwaters segment of Moshannon Creek, by treating the “killer” discharge in this section.

Other:

A final O&M plan will be developed after reclamation and construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-5: MC-8

Site Description:

This monitoring point is located directly below MC-7. Some runoff contributes to this discharge during high flows, but the main flow is connected with a deep mine entry. The discharge runs through a man-made channel then enters Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	22.37	3.14	3648.18	0.00	0.00	402.45	102.02	30.39	7.83	88.71	34.90	1978.18
Min	1.00	2.80	2310.00	0.00	0.00	256.00	5.13	14.70	0.49	49.60	17.60	21.00
Max	80.00	3.40	4230.00	0.00	0.00	490.00	384.67	52.60	43.26	119.00	58.60	2642.00
90%	64.21	3.41	4522.20	0.00	0.00	521.26	288.31	50.86	27.86	119.71	54.50	3225.22
75%	51.62	3.33	4259.19	0.00	0.00	485.51	232.25	44.70	21.83	110.38	48.60	2849.97
90% CI	34.99	3.22	3911.71	0.00	0.00	438.28	158.19	36.56	13.87	98.06	40.81	2354.18
StdDev	25.43	0.17	531.32	0.00	0.00	72.23	113.24	12.45	12.17	18.85	11.92	758.08

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping, to determine if it can be channelized and combined with the MC-7 discharge. The severity of this discharge makes passive treatment difficult and an active treatment system may be necessary. In combination with the MC-7 and the site reclamation, one doser system would be efficient to mitigate this site.

A system has been designed based on the characteristics of only the MC-8 discharge and it will need to be modified if channelization to MC-7 occurs. A design flow rate of 40 gpm was used. The discharge has a pH of 3.2, acidity of 440 mg/L, iron of 36 mg/L, and aluminum of 40 mg/L. The passive system would begin with low pH iron oxidation which will allow for initial removal of iron and acidity. It will be followed by a limestone pre-treatment cell consisting of 750 tons of limestone. It will be followed by a settling basin, a VFW with 1200 tons of limestone and another combination of settling basin and a 1200 ton limestone VFW. The VFW's will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

Active treatment may be the better option at this, especially if combined with the MC-7 discharge. In order to treat the flow of MC-8 only 26 tons/yr of pebble quicklime would be needed or 34 tons/yr of hydrated lime. If the discharges were combined, you would need 80 tons/yr of pebble quicklime or 100 tons/yr of hydrated lime.

The approximate cost of constructing the passive treatment train is $525,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-8 is $570,000. If the discharge was combined and treated actively with MC-7 using pebble quicklime, the yearly chemical cost would be $22,000. If hydrated lime was used, the yearly cost would be $15,000. Upfront costs would include a doser system and associated footprint work or a tank and clarifier. These costs would range from $75,000 to $125,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-8 discharge is designed to remove 211 lbs/day of acidity, 17 lbs/day of iron and 19 lbs/day of aluminum. This will continue the improvement of water chemistry in the headwaters segment of Moshannon Creek, by treating the “killer” discharges in this section.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-6: MC-10

Site Description:

This monitoring point is comprised of three different sources of water with similar chemistry. The discharges are all considered toe of slope discharges that become ponded in an old surface mine cut before crossing the railroad grade and entering a large wetland. The three discharges combine before entering Moshannon Creek. Unreclaimed spoil and “cuts” are located throughout this area, so reclamation is a priority. The flow at this site is “flashy” and greatly affected during surface runoff during rain events.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	34.04	4.40	392.80	3.40	1.70	23.80	8.10	3.82	0.14	1.75	1.08	163.00
Min	0.54	3.50	314.00	0.00	0.00	14.00	0.24	0.15	0.02	0.75	0.22	133.00
Max	109.02	5.10	488.00	6.00	6.54	44.00	33.99	14.60	0.34	3.31	2.66	226.00
90%	108.34	5.08	488.45	6.32	5.76	38.67	26.66	12.33	0.30	3.27	2.33	211.87
75%	85.98	4.88	459.66	5.44	4.54	34.20	21.08	9.77	0.25	2.82	1.96	197.17
90% CI	57.54	4.62	423.05	4.32	2.98	28.50	13.97	6.51	0.19	2.23	1.48	178.45
StdDev	45.17	0.42	58.14	1.78	2.47	9.04	11.28	5.17	0.10	0.92	0.76	29.71

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 50 gpm was used. The discharge has a pH of 4.6, acidity of 30 mg/L, iron of 7 mg/L, and aluminum of 2 mg/L. The treatment train would consist of an equalization basin, followed by a VFW with 1200 tons of limestone, followed by a settling basin. The VFW will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $150,000, with an additional $50,000 for site reclamation. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MC-10 is $245,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-10 discharge is designed to remove 18 lbs/day of acidity, 4 lbs/day of iron and 1 lbs/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-7: MC-11

Site Description:

This monitoring point is located downstream from MC-10. It forms from an unreclaimed channel, then flows through a forested area and spoil pile that borders the railroad grade before entering Moshannon Creek. The discharge from this area is fairly insignificant, but reclamation or removal of the spoil pile is important for restoration efforts in the headwaters reach.

	Flow (gpm)	**pH (SU)**	**Cond**	**Alk**	**Alk load (lbs/day)**	**Acidity (mg/l)**	**Acid load (lbs/day)**	**Iron**	**Iron load (lbs/day)**	**Mn**	**Al**	**Sulfate**
Average	3.92	3.44	380.00	0.00	0.00	44.89	2.23	1.80	0.07	1.78	2.43	102.11
Min	0.00	3.20	293.00	0.00	0.00	33.00	0.34	0.51	0.01	1.56	1.93	85.00
Max	15.00	3.60	482.00	0.00	0.00	64.00	6.83	4.92	0.23	2.02	3.41	140.00
90%	12.06	3.66	483.75	0.00	0.00	61.45	6.04	4.65	0.19	2.02	3.18	132.19
75%	9.61	3.60	452.53	0.00	0.00	56.47	4.90	3.79	0.15	1.95	2.95	123.14
90% CI	6.64	3.52	414.58	0.00	0.00	50.41	3.58	2.75	0.11	1.86	2.68	112.14
StdDev	4.95	0.13	63.07	0.00	0.00	10.07	2.32	1.73	0.07	0.15	0.46	18.29

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the spoil pile. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 10 gpm was used. The discharge has a pH of 3.5, acidity of 50 mg/L, iron of 3 mg/L, and aluminum of 3 mg/L. The treatment train would consist of a small VFW with 600 tons of limestone, followed by a settling basin. The VFW will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $125,000, with an additional $50,000 for site reclamation. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MC-11 is $220,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-11 discharge is designed to remove 6 lbs/day of acidity, 1 lb/day of iron and 1 lb/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek, along with restoring surface area through the reclamation of a spoil pile.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-8: MC-12

Site Description:

This monitoring point flows through an unreclaimed channel. The mouth of the discharge flows through spoil material and creates a large iron mat and dead zone. The flow is very disperse through this area and flow was difficult to obtain.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	9.78	2.99	1183.00	0.00	0.00	225.60	30.06	11.49	1.55	4.91	24.88	411.80
Min	0.00	2.80	667.00	0.00	0.00	104.00	1.33	4.05	0.06	3.47	11.30	221.00
Max	30.00	3.20	1610.00	0.00	0.00	329.00	102.16	16.90	5.68	6.39	37.90	562.00
90%	27.32	3.30	1786.04	0.00	0.00	358.63	90.62	19.91	4.71	6.51	40.60	609.92
75%	22.04	3.21	1604.58	0.00	0.00	318.60	72.40	17.37	3.76	6.03	35.87	550.30
90% CI	15.06	3.09	1373.70	0.00	0.00	267.67	49.21	14.15	2.55	5.42	29.85	474.45
StdDev	10.66	0.19	366.59	0.00	0.00	80.87	36.82	5.12	1.92	0.97	9.55	120.44

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 3.0, acidity of 275 mg/L, iron of 14 mg/L, and aluminum of 30 mg/L. Due to the low flow at this site, the moderate concentrations of iron and aluminum can be treated passively. The treatment train would consist of a pre-treatment cell with 500 tons of limestone followed by a settling basin. The outflow would enter a VFW with 1000 tons of limestone and an additional settling basin. The VFW will consist of 3 feet of limestone and two feet of organic matter. It will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $150,000, with an additional $50,000 for site reclamation. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MC-12 is $245,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-12 discharge is designed to remove 66 lbs/day of acidity, 3 lb/day of iron and 7 lb/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek, along with restoring surface area through the reclamation of a spoil pile.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-9: MC-13

Site Description:

This monitoring point is comprised of seeps emanates from the toe of a spoil pile. The discharge may be related to deep mining in the area. There is a large unreclaimed area surrounding the discharge which is located only 25 yards off of Moshannon Creek. There is ponded water and lots of garbage through this area.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	9.19	3.23	1323.27	0.00	0.00	267.36	31.18	105.04	12.79	6.51	5.55	552.82
Min	0.55	2.90	686.00	0.00	0.00	129.00	1.74	5.73	0.57	1.40	1.06	209.00
Max	36.22	3.70	1700.00	0.00	0.00	339.00	140.28	172.00	67.32	9.68	21.60	744.00
90%	25.41	3.71	1828.14	0.00	0.00	371.10	95.65	209.30	45.72	10.71	14.66	805.12
75%	20.53	3.56	1676.22	0.00	0.00	339.88	76.25	177.92	35.81	9.45	11.92	729.20
90% CI	14.32	3.37	1475.50	0.00	0.00	298.64	51.57	136.47	23.20	7.78	8.30	628.89
StdDev	9.86	0.29	306.91	0.00	0.00	63.06	39.19	63.38	20.01	2.55	5.53	153.37

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 3.4, acidity of 300 mg/L, iron of 136 mg/L, and aluminum of 8 mg/L. Due to the low flow at this site, the high concentration of iron can be treated passively. Also, reclamation efforts should both decrease the flow even further, along with improving the water quality. The treatment train would consist of a pre-treatment low pH iron oxidation system followed by an aerobic wetland, approximately 325 ft by 175 ft based on the removal rate of 5 g/m^2/day of Fe. The wetland will consists of a 1:1 ratio of organic matter and limestone to maintain pH levels throughout the system. A final limestone cell with 750 tons of limestone will be placed to increase the pH and alkalinity before being discharged into Moshannon Creek.

The approximate cost of constructing the passive treatment train is $250,000, with an additional $75,000 for site reclamation. The design and permitting phase of the project would be at a cost of $65,000. The overall design and construction cost of the treatment system for MC-13 is $390,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-13 discharge is designed to remove 72 lbs/day of acidity, 32 lbs/day of iron and 2 lbs/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek, along with restoring surface area through the reclamation of a spoil pile.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the aerobic wetland and limestone cell. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-10: MC-14

Site Description:

This monitoring point is associated with a deep mine discharge in the same unreclaimed area as MC-13. Multiple seeps contribute to the sample location. ATV's have greatly impacted this area and caused dispersion of the discharge as it flows through the unreclaimed area before entering Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	3.96	3.13	1220.30	0.00	0.00	276.50	14.41	81.99	3.51	7.31	18.29	514.80
Min	0.00	2.90	656.00	0.00	0.00	129.00	2.49	37.50	0.85	4.08	7.61	233.00
Max	12.00	3.40	1710.00	0.00	0.00	415.00	43.46	141.00	10.29	10.40	30.70	766.00
90%	11.50	3.40	1838.07	0.00	0.00	446.05	40.56	149.54	9.00	10.88	31.10	831.51
75%	9.23	3.32	1652.18	0.00	0.00	395.03	32.69	129.22	7.35	9.81	27.25	736.21
90% CI	6.47	3.22	1415.66	0.00	0.00	330.12	23.66	103.35	5.45	8.44	22.34	614.95
StdDev	4.59	0.16	375.54	0.00	0.00	103.07	15.90	41.07	3.34	2.17	7.79	192.53

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area as related to MC-13. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 10 gpm was used. The discharge has a pH of 3.2, acidity of 330 mg/L, iron of 103 mg/L, and aluminum of 22 mg/L. Due to the low flow at this site, the high concentrations of iron and aluminum can be treated passively. Also, reclamation efforts should both decrease the flow even further, along with improving the water quality. The treatment train would consist of a pre-treatment low pH iron oxidation system followed by a VFW with 1200 tons of limestone. The VFW will be followed by a settling basin. An alternative would be to do the site reclamation and combine MC-13 and MC-14. This mixed water would then be treated actively with either pebble quicklime (10 tons/year) or hydrated lime (12 tons/year).

The approximate cost of constructing the passive treatment train is $175,000. The cost for reclamation is included in the MC-13 design. If active treatment is ultimately recommended, the yearly chemical cost would be less than $20,000/year with upfront costs of approximately $100,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-14 is $220,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-14 discharge is designed to remove 40 lbs/day of acidity, 12 lbs/day of iron and3 lbs/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek, along with restoring surface area through the reclamation of a spoil pile.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical flow wetland due to the automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-11: MC-15

Site Description:

This monitoring point is a stream overflow channel, but the water quality is different than the main channel. It would be unnoticed in high flow events. There are multiple seeps that make up this channel.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	7.21	3.40	773.60	0.40	0.00	148.50	14.39	70.51	7.68	5.40	0.76	302.10
Min	0.40	3.00	243.00	0.00	0.00	27.00	1.00	6.55	0.43	1.27	0.40	82.00
Max	20.00	4.10	1150.00	2.00	0.00	230.00	48.68	118.00	27.10	7.74	1.50	431.00
90%	21.91	4.07	1337.09	1.79	0.00	279.46	43.70	142.65	23.71	9.26	1.45	533.23
75%	17.49	3.87	1167.53	1.37	0.00	240.05	34.88	120.94	18.89	8.09	1.24	463.68
90% CI	12.77	3.61	951.79	0.84	0.00	189.91	25.47	93.32	13.74	6.62	0.98	375.19
StdDev	8.94	0.41	342.55	0.84	0.00	79.61	17.82	43.85	9.75	2.34	0.42	140.50

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 3.6, acidity of 190 mg/L, iron of 100 mg/L, and aluminum of 1 mg/L. Due to the low flow at this site, the high concentration of iron can be treated passively. The treatment train would consist of a pre-treatment low pH iron oxidation system followed by an aerobic wetland, approximately 280 ft by 150 ft based on the removal rate of 5 g/m^2/day of Fe. The wetland will consists of a 1:1 ratio of organic matter and limestone to maintain pH levels throughout the system. A limestone cell with 500 tons of limestone will follow the wetland to increase the pH and alkalinity before being discharged to Moshannon Creek.

The approximate cost of constructing the passive treatment train is $125,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-15 is $170,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-15 discharge is designed to remove 46 lbs/day of acidity, 12 lbs/day of iron and3 lbs/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the aerobic wetland and limestone cell. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #1-12: MC-16

Site Description:

This monitoring point is a borehole located approximately 30 yards off of Moshannon Creek. It is disperse flow and has created a large iron mat. Treatment will be difficult due to the closeness to the main channel.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	66.60	3.30	825.40	0.00	0.00	186.36	146.26	71.66	56.44	3.49	8.87	343.45
Min	2.30	3.00	690.00	0.00	0.00	154.00	5.27	52.40	1.98	2.80	5.53	307.00
Max	136.19	3.70	878.00	0.00	0.00	207.00	293.95	83.50	125.09	4.08	10.40	377.00
90%	129.84	3.67	909.49	0.00	0.00	210.01	277.90	86.50	109.98	4.09	11.12	375.37
75%	110.81	3.56	884.19	0.00	0.00	202.90	238.29	82.04	93.87	3.91	10.44	365.77
90% CI	85.67	3.42	851.99	0.00	0.00	193.49	185.95	76.14	72.58	3.67	9.55	353.08
StdDev	38.44	0.23	51.12	0.00	0.00	14.38	80.02	9.02	32.55	0.37	1.37	19.40

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 100 gpm was used. The discharge has a pH of 3.4, acidity of 200 mg/L, iron of 75 mg/L, and aluminum of 10 mg/L. The treatment train would consist of low pH iron oxidation to precipitate as much iron as possible up front. This is already occurring as can be seen by the large iron mat. A series of combination VFWs and settling basins will follow. The first VFW will have 1500 tons of limestone, the second will have 1300 tons of limestone and the third will have 1000 tons of limestone. The VFWs will consist of 3 feet of limestone and two feet of organic matter. They will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $450,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MC-16 is $495,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MC-16 discharge is designed to remove 240 lbs/day of acidity, 90 lbs/day of iron and 12 lbs/day of aluminum. This will continue the improvement of water chemistry in the upper reaches of Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFWs will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Area #2: Mountain Branch

Priority #2-1: MB-11

Site Description:

This monitoring point is a small flow discharge, but has high aluminum levels. It seeps through a wetland area before entering Mountain Branch.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	4.17	3.63	664.89	0.00	0.00	89.89	5.05	2.99	0.10	6.56	11.88	291.33
Min	0.00	3.40	464.00	0.00	0.00	63.00	0.56	0.62	0.02	4.07	6.93	168.00
Max	12.00	3.80	862.00	0.00	0.00	118.00	9.59	12.40	0.29	8.65	17.30	401.00
90%	11.32	3.83	868.83	0.00	0.00	119.41	10.89	9.38	0.25	8.89	16.43	400.09
75%	9.17	3.77	807.46	0.00	0.00	110.53	9.13	7.46	0.21	8.19	15.06	367.36
90% CI	6.43	3.70	732.87	0.00	0.00	99.73	7.12	5.12	0.16	7.34	13.40	327.58
StdDev	4.35	0.12	123.98	0.00	0.00	17.95	3.55	3.89	0.09	1.42	2.76	66.11

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 10 gpm was used. The discharge has a pH of 3.7, acidity of 100mg/L, iron of 5 mg/L, and aluminum of 15 mg/L. The treatment train would consist of a small VFW with 750 tons of limestone followed by a settling basin. The VFW will consist of 3 feet of limestone and two feet of organic matter. They will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $125,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MB-11 is $170.000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB-11 discharge is designed to remove 12 lbs/day of acidity, 0.6 lbs/day of iron and 1.8 lbs/day of aluminum. Treating this discharge will begin improving water quality within Mountain Branch.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-2: MB-10

Site Description:

This monitoring point is a seep emanating in a forested wetland area approximately 1 acre in size. It collects four seeps through this area. A large dead zone has been created. There is a large variation in flow due to the surface runoff in the area of the flow device.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	71.57	3.78	765.55	0.00	0.00	68.82	43.66	1.42	0.61	15.66	5.59	347.73
Min	1.00	3.40	481.00	0.00	0.00	43.00	0.67	0.42	0.01	8.73	3.17	185.00
Max	287.97	4.00	1310.00	0.00	0.00	128.00	148.48	4.23	2.00	29.60	8.41	650.00
90%	216.98	4.16	1235.48	0.00	0.00	114.39	119.52	3.54	1.59	27.14	8.19	579.49
75%	173.22	4.04	1094.07	0.00	0.00	100.67	96.69	2.90	1.29	23.68	7.41	509.75
90% CI	115.41	3.89	907.24	0.00	0.00	82.56	66.53	2.06	0.90	19.12	6.37	417.61
StdDev	88.40	0.23	285.67	0.00	0.00	27.70	46.11	1.28	0.60	6.98	1.59	140.89

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 125 gpm was used. The discharge has a pH of 4.0, acidity of 100mg/L, iron of 3 mg/L, and aluminum of 8 mg/L. Due to the varying flow rates from this discharge, parallel VFW will be used. When the flow is high, both sides will be on-line and during low flow events, the water will only flow through one side of the system. The treatment train will begin with an equalization basin which will be used to precipitate any metals and allow for the distribution of flow. Each of the VFWs will have 1500 tons of limestone and each will be followed by a settling basin. The VFWs will consist of 3 feet of limestone and two feet of organic matter. They will have a grid like piping system which will also act to flush the system to limit aluminum plugging.

The approximate cost of constructing the passive treatment train is $450,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MB-11 is $495,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB-11 discharge is designed to remove 150 lbs/day of acidity, 4.5 lbs/day of iron and 12 lbs/day of aluminum. Treating this discharge will continue the improvement of water quality within Mountain Branch.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFWs will have an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-3: MB-9

Site Description:

This monitoring point emanates in unreclaimed spoil piles. It forms a discrete channel that creates a wetland area before discharging to Mountain Branch.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	27.56	3.50	1228.18	0.00	0.00	128.27	33.64	1.24	0.29	26.64	9.12	601.00
Min	1.00	3.30	740.00	0.00	0.00	63.00	1.44	0.37	0.01	15.10	4.47	303.00
Max	91.21	3.70	1580.00	0.00	0.00	260.00	95.15	3.51	0.51	37.30	12.30	853.00
90%	72.67	3.71	1658.52	0.00	0.00	219.99	81.35	2.89	0.59	37.87	13.32	868.16
75%	59.10	3.65	1529.03	0.00	0.00	192.39	67.00	2.40	0.50	34.49	12.06	787.77
90% CI	41.83	3.56	1357.93	0.00	0.00	155.93	48.73	1.74	0.38	30.02	10.39	681.55
StdDev	27.42	0.13	261.60	0.00	0.00	55.76	29.01	1.01	0.18	6.83	2.55	162.41

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 50 gpm was used. The discharge has a pH of 3.5, acidity of 155 mg/L, iron of 2 mg/L, and aluminum of 12 mg/L. Reclamation efforts should both decrease the flow and improve the water quality, therefore, the conceptual design will need to be adjusted after reclamation efforts occur. The treatment train would an equalization basin followed by a VFW with 1200 tons of limestone followed by a settling basin. The discharge will then flow into a limestone cell with 1000 tons of limestone and a final settling basin.

The approximate cost of constructing the passive treatment train is $450,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MB-9 is $495,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB-9 discharge is designed to remove 93 lbs/day of acidity, 1.2 lbs/day of iron and 7.2 lbs/day of aluminum. Treating this discharge will continue the improvement of water quality within Mountain Branch.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW and limestone cell will have automatic flushing systems. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-4: MB-7

Site Description:

This monitoring point is a toe of slope discharge located just upstream from the MB2-6 discharges. The discharge is coming from the same hillside as MB 2-6 and should be improved by reclamation activities in this area.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	1.16	3.12	1120.00	0.00	0.00	205.00	3.23	3.57	0.04	8.66	25.01	440.22
Min	0.00	3.00	896.00	0.00	0.00	145.00	1.23	0.89	0.01	6.86	17.80	330.00
Max	3.03	3.20	1460.00	0.00	0.00	296.00	7.12	7.41	0.07	11.90	30.50	555.00
90%	2.97	3.26	1374.28	0.00	0.00	280.13	6.66	8.04	0.08	11.20	32.62	546.27
75%	2.43	3.22	1297.76	0.00	0.00	257.52	5.63	6.69	0.07	10.44	30.33	514.36
90% CI	1.71	3.17	1204.76	0.00	0.00	230.04	4.37	5.06	0.05	9.51	27.55	475.57
StdDev	1.10	0.08	154.58	0.00	0.00	45.67	2.09	2.72	0.02	1.55	4.62	64.47

Recommendations:

Further investigation needs to occur at this site to determine the connectivity to the MB 2-6 discharges. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 5 gpm was used. The discharge has a pH of 3.2, acidity of 230 mg/L, iron of 5 mg/L, and aluminum of 30 mg/L. Reclamation efforts at MB 2-6 should both decrease the flow and improve the water quality, therefore, the conceptual design will need to be adjusted after reclamation efforts occur. The treatment train includes an equalization basin followed by a VFW with 800 tons of limestone followed by a settling basin.

The approximate cost of constructing the passive treatment train is $125,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MB-7 is $170,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB-7 discharge is designed to remove 14 lbs/day of acidity, 0.3 lbs/day of iron and 1.8 lbs/day of aluminum. Treating this discharge will continue the improvement of water quality within Mountain Branch.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary as the VFW and limestone cell will have automatic flushing systems. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-5: MB 2-6

Site Description:

These monitoring points are located near the mouth of Mountain Branch. The main discharge is a deep mine discharge with the other monitoring points are associated with toe of slope discharges and contaminant runoff. MB 2, MB 3, and MB 4 start at an abandoned surface mine that was poorly reclaimed. MB 5 and MB 6 flow directly out of spoil material and have much higher flows. The discharges were combined and collected together due to their proximity and emanating from the same area that needs reclaimed.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	9.02	2.87	1587.00	0.00	0.00	306.00	30.17	13.48	1.12	10.75	33.83	568.60
Min	0.00	2.60	1020.00	0.00	0.00	166.00	5.21	3.43	0.23	8.09	18.40	330.00
Max	33.45	3.10	2260.00	0.00	0.00	449.00	90.25	27.00	2.97	13.60	46.50	800.00
90%	25.80	3.14	2299.67	0.00	0.00	465.47	75.61	26.90	2.77	13.92	49.23	833.67
75%	20.75	3.06	2085.22	0.00	0.00	417.48	61.93	22.86	2.28	12.97	44.59	753.90
90% CI	14.32	2.96	1812.37	0.00	0.00	356.43	45.31	17.73	1.67	11.75	38.70	652.42
StdDev	10.20	0.16	433.23	0.00	0.00	96.94	27.62	8.16	1.00	1.92	9.36	161.13

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 25 gpm was used. The discharge has a pH of 2.96, acidity of 356 mg/L, iron of 18 mg/L, and aluminum of 40 mg/L. Due to the low flow at this site, the high concentration of aluminum can be treated passively. Also, reclamation efforts should both decrease the flow even further, along with improving the water quality. This abandoned mine area is also related to MB 7 and improvement should be seen at the discharge too. The treatment train would consist of a pre-treatment limestone cell with 500 tons of limestone, followed by a series of VFW and settling basins. The first VFW would have 1200 tons of limestone and the second would have 800 tons of limestone.

The approximate cost of constructing the passive treatment train is $450,000, with an additional $100,000 for site reclamation. The design and permitting phase of the project would be at a cost of $75,000. The overall design and construction cost of the treatment system for MB 2-6 is $625,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB 2-6 discharges is designed to remove 107 lbs/day of acidity, 5.5 lbs/day of iron and 12 lbs/day of aluminum. This will continue the improvement of water chemistry in Mountain Branch, along with restoring surface area through the reclamation of a spoil material.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the VFWs due to the installation of an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-6: MB 1

Site Description:

This monitoring point flows out of a wetland area above the railroad grade. Abandoned spoil parallels the stream below these discharges and the seeps that make up MB 1 start in this area.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	3.55	3.75	489.13	0.00	0.00	42.63	2.22	3.28	0.09	6.70	2.72	196.25
Min	0.00	3.40	422.00	0.00	0.00	33.00	0.14	0.55	0.01	5.37	1.51	153.00
Max	12.00	4.00	571.00	0.00	0.00	54.00	4.75	8.13	0.27	8.09	4.62	224.00
90%	10.79	4.12	588.40	0.00	0.00	55.49	5.17	7.74	0.23	8.31	4.32	234.80
75%	8.61	4.01	558.52	0.00	0.00	51.62	4.28	6.39	0.19	7.83	3.84	223.20
90% CI	5.84	3.88	524.22	0.00	0.00	47.17	3.33	4.86	0.14	7.27	3.29	209.88
StdDev	4.41	0.23	60.35	0.00	0.00	7.82	1.80	2.71	0.09	0.98	0.97	23.43

Recommendations:

Further investigation needs to occur at this site to determine how best to handle the spoil pile. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 10 gpm was used. The discharge has a pH of 3.8, acidity of 50 mg/L, iron of 5 mg/L, and aluminum of 3 mg/L. The treatment train would consist of a small VFW with 500 tons of limestone and a settling basin.

The approximate cost of constructing the passive treatment train is $100,000, with an additional $50,000 for site reclamation. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for MB 1 is $195,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the MB 1 discharge is designed to remove 6 lbs/day of acidity, .6 lbs/day of iron and 0.03 lbs/day of aluminum. This is the final area to be addressed in the Mountain Branch watershed.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the VFW due to the installation of an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-7 UT 1-4

Site Description:

This monitoring point is a discharge that flows through spoil. The discharge crosses an access road and enters into the same kill zone as UT 1-3. The discharge then picks up some flow from toe of slope seeps and enters into a wooded area before entering the Unnamed Tributary to Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	7.16	3.22	885.89	0.00	0.00	176.89	15.13	3.89	0.29	7.82	23.07	334.78
Min	1.00	3.10	723.00	0.00	0.00	137.00	2.05	1.40	0.03	6.38	16.20	284.00
Max	28.62	3.30	991.00	0.00	0.00	216.00	65.20	7.08	1.15	9.39	29.60	422.00
90%	21.16	3.36	1025.86	0.00	0.00	222.39	47.13	6.91	0.85	9.39	29.72	404.49
75%	16.95	3.32	983.74	0.00	0.00	208.70	37.50	6.00	0.68	8.92	27.72	383.51
90% CI	11.83	3.27	932.55	0.00	0.00	192.06	25.79	4.90	0.48	8.35	25.28	358.01
StdDev	8.51	0.08	85.09	0.00	0.00	27.66	19.45	1.83	0.34	0.96	4.05	42.38

Recommendations:

Due to the high volumes of metals in the combination of UT 1-4, UT 1-3 and UT 1-1 discharges, one large active treatment system may be the best option for this unnamed tributary. Before restoration efforts begin on this tributary, further investigation will occur to insure the best treatment is applied. For now, a passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 3.3, acidity of 192 mg/L, iron of 5 mg/L, and aluminum of 25 mg/L. The treatment train would consist of an equalization basin followed by a small vertical flow passive system containing 500 tons of limestone. A settling basin will allow for the precipitation of iron. A 1000 ton limestone cell to remove the aluminum and additional settling basin will follow.

The approximate cost of constructing the passive treatment train is $250,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for UT 1-4 is $295,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the UT 1-4 discharge is designed to remove 1.2 lbs/day of iron, 6 lbs/day aluminum, and 46 lbs/day of acidity. Treating this discharge will begin improving water quality in the unnamed tributary.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the VFW and limestone cell due to the installation of an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-8 UT 1-3

Site Description:

This monitoring point is a discharge that emanates in the same area as UT 1-4 through UT 1-1. There are seeps emanating at the toe of slope creating a large kill zone before the discharge becomes channelized and flows through a wooded area until its confluence with an Unnamed Tributary to Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	17.34	2.69	2200.91	0.00	0.00	458.55	89.18	22.97	4.35	15.93	52.45	859.55
Min	1.00	2.60	1670.00	0.00	0.00	338.00	5.87	10.00	0.26	12.20	37.40	633.00
Max	58.92	2.80	2400.00	0.00	0.00	563.00	281.90	35.60	15.19	19.30	74.80	1027.00
90%	49.09	2.81	2542.06	0.00	0.00	572.48	244.55	35.27	12.43	20.05	72.14	1053.97
75%	39.54	2.77	2439.40	0.00	0.00	538.20	197.80	31.57	10.00	18.81	66.22	995.47
90% CI	26.92	2.73	2303.77	0.00	0.00	492.90	136.02	26.68	6.78	17.17	58.39	918.17
StdDev	19.30	0.07	207.39	0.00	0.00	69.26	94.45	7.48	4.91	2.51	11.97	118.19

Recommendations:

The flow and water chemistry is such at UT 1-3, that passive treatment technology may fail. Due to the high volumes of metals in the UT discharges, one large active treatment system may be the best option. Before restoration efforts begin on this tributary, further investigation will occur to insure the best treatment is applied. For now, a passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 40 gpm was used. The discharge has a pH of 2.7, acidity of 492 mg/L, iron of 28 mg/L, and aluminum of 60 mg/L. The passive treatment train would consist of an equalization basin, followed by a VFW with 1800 tons of limestone, followed by a settling basin. Another VFW with 1800 tons of and an additional settling basin would complete the treatment train. Due to the high levels of aluminum at this site, an active system would most likely be used. The active system would use 22 tons/yr pebble quicklime or 30 tons/yr of hydrated lime. These values would increase if all of the discharges on the unnamed tributary would be treated together.

The approximate cost of constructing the passive treatment train is $650,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for UT 1-3 is $695,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the UT 1-3 discharge is designed to remove 13 lbs/day of iron, 28 lbs/day aluminum, and 236 lbs/day of acidity. Treating this discharge will continue improving water quality within the unnamed tributary.

Other:

A final O&M plan will be developed after construction is complete and will vary greatly depending on treatment with an active or passive system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #2-9 UT 1-1

Site Description:

This monitoring point is a discharge that emanates in the same area as UT 1-4 through UT 1-2. There are seeps emanating at the toe of slope creating a large kill zone before the discharge becomes channelized and flows through a wooded area until its confluence with an Unnamed Tributary to Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	9.18	2.98	1309.00	0.00	0.00	242.50	37.88	12.47	1.87	14.27	26.62	498.63
Min	0.00	2.70	522.00	0.00	0.00	70.00	0.45	7.44	0.05	5.15	7.77	154.00
Max	35.10	3.20	1800.00	0.00	0.00	402.00	96.80	29.40	5.26	24.10	50.50	881.00
90%	30.66	3.22	1994.66	0.00	0.00	393.59	99.42	24.15	5.05	22.82	45.99	829.34
75%	24.20	3.15	1788.34	0.00	0.00	348.12	80.90	20.64	4.09	20.25	40.16	729.82
90% CI	15.98	3.06	1551.42	0.00	0.00	295.92	61.14	16.60	3.07	17.29	33.47	615.55
StdDev	13.06	0.15	416.81	0.00	0.00	91.85	37.41	7.10	1.93	5.20	11.77	201.04

Recommendations:

The flow and water chemistry is such at UT 1-1, that passive treatment technology may fail. Due to the high volumes of metals in the UT discharges one large active treatment system may be the best option. Before restoration efforts begin on this tributary, further investigation will occur to insure the best treatment is applied. For now, a passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 25 gpm was used. The discharge has a pH of 3.0, acidity of 300 mg/L, iron of 16 mg/L, and aluminum of 35 mg/L. The passive treatment train would consist of an equalization basin and a 1500 ton limestone VFW which discharges to a settling basin. An additional VFW with 600 ton limestone and an additional settling basin will follow. Due to the high levels of aluminum at this site, an active system would most likely be used. An active system would use either 10 tons/yr of pebble quicklime or 13 tons/yr of hydrated lime. These values would increase if all of the discharges on the unnamed tributary would be treated together.

The approximate cost of constructing the passive treatment train is $550,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for UT 1-3 is $595,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the UT 1-1 discharge is designed to remove 4.8 lbs/day of iron, 10.5 lbs/day aluminum, and 90 lbs/day of acidity. Treating this discharge will continue improving water quality within the unnamed tributary.

Other:

A final O&M plan will be developed after construction is complete and will vary greatly depending on treatment with an active or passive system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Area #3: Whiteside Run

Priority #3-1: WR 5

Site Description:

This monitoring point is an alkaline discharge entering Whiteside Run. The mouth of the channel is cloudy with large amounts of algae present.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	95.39	6.81	324.10	106.20	119.92	-88.00	-99.47	5.60	5.88	0.46	0.11	26.60
Min	12.00	6.60	307.00	96.00	16.98	-104.00	-229.55	0.60	0.18	0.34	0.05	23.00
Max	222.60	7.20	353.00	118.00	274.93	-74.00	-14.96	9.95	13.61	1.06	0.57	31.00
90%	221.06	7.08	347.04	117.64	274.46	-74.46	29.44	9.79	13.29	0.81	0.38	30.79
75%	183.25	7.00	340.14	114.20	227.95	-78.53	-9.35	8.53	11.06	0.70	0.29	29.53
90% CI	135.13	6.90	331.36	109.82	168.79	-83.72	-58.71	6.92	8.22	0.57	0.19	27.93
StdDev	76.40	0.17	13.95	6.96	93.95	8.23	78.36	2.55	4.50	0.22	0.16	2.55

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 150 gpm was used. The discharge has a pH of 6.9, acidity of -85 mg/L, iron of 7 mg/L, and aluminum of <1 mg/L. The treatment train would consist of an aerobic wetland, approximately 220 ft by 110 ft based on the removal rate of 5 g/m^2/day of Fe. The wetland will consists of a 1:1 ratio of organic matter and limestone to maintain pH levels throughout the system. A limestone cell with 500 tons of limestone will follow the wetland to increase the pH and alkalinity before it impacts Whiteside Run.

The approximate cost of constructing the passive treatment train is $100,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for WR 5 is $170,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the WR 5 discharge is designed to remove 13 lbs/day of iron. Treating this discharge will begin improving water quality within Whiteside Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the aerobic wetland and limestone cell. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #3-2: WR 4

Site Description:

This monitoring point emanates from a 3 acre mossy wetland. There is clear water and no evidence of staining. The flow is fairly variable and dry most of the year.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	8.72	3.97	291.86	0.71	0.20	47.56	13.97	1.43	0.09	0.65	9.14	85.60
Min	0.00	3.70	222.00	0.00	0.00	14.00	0.08	0.29	0.01	0.41	0.05	6.20
Max	30.00	4.40	438.00	4.00	0.96	200.94	72.28	5.91	0.23	1.09	59.00	160.00
90%	27.68	4.35	410.12	3.18	0.83	159.06	61.09	4.72	0.22	1.00	45.31	162.02
75%	21.97	4.23	374.54	2.43	0.64	125.51	46.91	3.73	0.18	0.89	34.43	139.03
90% CI	15.04	4.11	336.56	1.64	0.46	89.70	33.20	2.68	0.15	0.78	22.81	114.49
StdDev	11.52	0.23	71.89	1.50	0.38	67.78	28.65	2.00	0.08	0.21	21.99	46.46

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 4.1, acidity of 25 mg/L, iron of 2 mg/L, and aluminum of 2 mg/L. The treatment train would consist of a small equalization basin, followed by a VFW with 500 tons of limestone. A settling basin would follow the VFW to allow for the precipitation of metals before entering Whiteside Run.

The approximate cost of constructing the passive treatment train is $100,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for WR 4 is $145,000.

Predicted Effect of System on Receiving Stream:

Reclamation and treatment of the WR 4 discharge is designed to remove 6 lbs/day of acidity and 0.5 lbs/day of both iron and aluminum. Treating this discharge will continue improving water quality within Whiteside Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical flow wetland. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #3-3 WR-1

Site Description:

This monitoring point is an iron seep located 10 yards downstream of the headwaters. The channel bottom is covered with Fe precipitant and algae.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	8.79	6.61	326.91	39.09	3.97	-19.36	-1.88	11.94	1.19	0.90	0.06	106.82
Min	1.00	6.50	291.00	33.00	0.50	-30.00	-3.60	7.10	0.10	0.79	0.05	94.00
Max	20.00	7.00	356.00	50.00	8.39	-15.00	-0.30	18.10	2.17	1.23	0.19	116.00
90%	17.57	6.86	362.31	47.20	7.65	-12.18	-0.32	18.53	2.19	1.10	0.13	118.81
75%	14.93	6.78	351.66	44.76	6.54	-14.34	-0.79	16.55	1.89	1.04	0.11	115.20
90% CI	11.44	6.68	337.58	41.54	5.08	-17.20	-1.41	13.92	1.49	0.96	0.08	110.43
StdDev	5.33	0.15	21.52	4.93	2.23	4.37	0.94	4.01	0.61	0.12	0.04	7.29

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 6.7, acidity of -17 mg/L, iron of 15 mg/L, and aluminum of 0.05 mg/L. The treatment train would consist of an aerobic wetland, approximately 150 ft by 100 ft based on the removal rate of 5 g/m^2/day of Fe. The wetland will consists of a 1:1 ratio of organic matter and limestone to maintain pH levels throughout the system. A limestone channel with 500 tons of limestone will follow the wetland to increase the pH and alkalinity before being discharged to Whiteside Run.

The approximate cost of constructing the passive treatment train is $125,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for WR 1 is $170,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the WR 1 discharge is designed to remove 3.5 lbs/day of iron and 42 lbs/day of acidity. Treating this discharge will continue improving water quality within Whiteside Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the wetland and limestone channel. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Area #4 Unnamed Tributary #2 & Lower Main Stem

Priority #4-1 UT 2-3

Site Description:

This monitoring point is for a channel which emanates in a reclaimed field; iron is seen in the channel. There is no discrete channel, rather widespread seepage occurs. This seepage enters the tributary by way of a field. The seepage is a source of iron in the tributary channel. Crayfish have been seen in channel below the discharge.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
Min	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
Max	0.00	6.10	114.00	13.00	0.00	7.00	0.00	2.53	0.00	0.41	0.15	32.00
90%	0.00	16.13	301.53	34.39	21.39	18.52	11.52	6.69	4.16	1.08	0.40	84.64
75%	0.00	13.12	245.10	27.95	14.95	15.05	8.05	5.44	2.91	0.88	0.32	68.80
90% CI	0.00	16.13	301.53	34.39		18.52		6.69		1.08	0.40	84.64
StdDev	0.00	6.10	114.00	13.00	13.00	7.00	7.00	2.53	2.53	0.41	0.15	32.00

Recommendations:

The discharge has a pH of 6.10, acidity of 7 mg/L, iron of 2 mg/L, and aluminum of 0.15 mg/L. These loadings are not significant. Treatment is not recommended.

Priority #4-2 UT 2-2

Site Description:

This monitoring point starts in the same wetland area as UT 2-1, but forms a discrete channel. UT 2-2 exits the wetland and forms a channel through a reclaimed mine site. Iron staining can be seen in the channel.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	2.04	3.36	594.30	0.00	0.00	37.80	0.91	2.09	0.07	3.73	0.22	190.40
Min	0.00	3.20	452.00	0.00	0.00	20.00	0.07	0.90	0.00	2.78	0.14	129.00
Max	11.89	3.50	761.00	0.00	0.00	57.00	4.13	3.90	0.43	5.23	0.35	245.00
90%	7.59	3.57	803.69	0.00	0.00	56.42	2.87	3.75	0.29	5.16	0.33	256.07
75%	5.92	3.51	740.69	0.00	0.00	50.82	2.28	3.25	0.22	4.73	0.30	236.31
90% CI	3.72	3.43	660.52	0.00	0.00	43.69	1.53	2.61	0.14	4.18	0.26	211.17
StdDev	3.37	0.13	127.29	0.00	0.00	11.32	1.19	1.01	0.13	0.86	0.07	39.92

Recommendations:

The recommendation for this site would be a small passive system to treat the combination of UT 2-2 and UT 2-1. The values listed here are for this site, not a combined site. A vertical flow passive system with 500 tons limestone has been designed based on water quality characteristics collected during the assessment. A design flow rate of 10 gpm was used. The discharge has a pH of 3.5, acidity of 45 mg/L, iron of 3 mg/L, and aluminum of 0.5 mg/L. The treatment train would consist of an equalization basin followed by a vertical flow wetland with 500 tons of limestone. A settling basin would follow the VFW to allow for precipitation of metals.

The approximate cost of constructing the passive treatment train is $100,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for UT 2-2 is $145,000.

Predicted Effect on Receiving Stream:

Treatment of the UT 2-2 discharge is designed to remove 1.5 lbs/day of iron, 0.06 lbs/day aluminum, and 5.4 lbs/day of acidity. Treating this discharge will continue improving water quality in the stream.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical flow wetland. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-3 UT 2-1

Site Description:

This monitoring point starts in the same wetland area as UT 2-2, but forms a discrete channel. UT 2-1 exits the wetland and forms a channel through a reclaimed mine site. Iron staining can be seen in the channel.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	11.58	3.44	775.45	0.18	0.06	65.73	9.52	14.38	2.43	5.97	1.15	294.64
Min	1.28	3.20	646.00	0.00	0.00	51.00	0.83	8.80	0.19	4.69	0.72	218.00
Max	28.62	4.10	993.00	2.00	0.69	87.00	29.86	37.10	12.73	7.44	1.67	366.00
90%	22.86	3.83	961.26	1.17	0.40	84.51	21.43	27.37	8.12	7.59	1.63	363.19
75%	19.47	3.71	905.35	0.88	0.30	78.86	17.85	23.46	6.41	7.10	1.49	342.56
90% CI	14.99	3.55	831.48	0.48	0.17	71.39	13.11	18.29	4.14	6.46	1.29	315.31
StdDev	6.86	0.24	112.95	0.60	0.21	11.42	7.24	7.90	3.46	0.98	0.30	41.67

Recommendations:

This would be a small system and combined with UT 2-2. The values listed here are for this site not a combined site. A vertical flow wetland containing 1000 ton limestone has been designed based on water quality characteristics collected during the assessment. A design flow rate of 20 gpm was used. The discharge has a pH of 3.4, acidity of 75 mg/L, iron of 20 mg/L, and aluminum of 1.3 mg/L. The treatment train would consist of an equalization basin, followed by the VFW and a final sediment basin to allow for the precipitation of metals before entering the unnamed tributary.

The approximate cost of constructing the passive treatment train is $150,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for UT 2-1 is $195,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the UT 2-1 discharge is designed to remove 4.8 lbs/day of iron, 0.31 lbs/day aluminum, and 18 lbs/day of acidity. Treating this discharge will continue improving water quality in the unnamed tributary.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the VFW due to the installation of an automatic flushing system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-4 MC 23

Site Description:

This discharge flows out of a borehole / sinkhole on the railroad grade and does not enter Moshannon Creek on the surface. The water lies in pond along the railroad grade creating a large deadzone. The borehole and ground water need to be investigated further.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	0.85	4.34	1598.00	3.50	0.04	392.10	4.29	233.90	2.71	16.40	0.05	893.20
Min	0.00	3.40	1480.00	0.00	0.00	375.00	0.93	187.00	0.45	13.00	0.05	823.00
Max	4.00	5.20	1780.00	9.00	0.11	409.00	17.99	260.00	12.09	18.00	0.05	963.00
90%	2.69	5.52	1777.00	10.95	0.12	408.97	12.71	265.53	8.41	18.67	0.05	970.94
75%	2.13	5.16	1723.13	8.71	0.09	403.90	10.18	256.01	6.70	17.98	0.05	947.54
90% CI	1.40	4.71	1654.60	5.86	0.06	397.44	6.95	243.90	4.51	17.12	0.05	917.78
StdDev	1.12	0.72	108.81	4.53	0.05	10.26	5.12	19.23	3.47	1.38	0.00	47.26

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 5 gpm was used. The discharge has a pH of 4.7, acidity of 400 mg/L, iron of 243 mg/L, and aluminum of 0.05 mg/L. The treatment train would consist of an aerobic wetland, approximately 250 ft by 130 ft based on the removal rate of 5 g/m^2/day of Fe. The wetland will consists of a 1:1 ratio of organic matter and limestone to maintain pH levels throughout the system. A limestone channel with 500 tons of limestone will follow the wetland to increase the pH and alkalinity before being discharged to Moshannon Creek.

The approximate cost of constructing the passive treatment train is $225,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-23 is $270,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the MC-23 discharge is designed to remove 15 lbs/day of iron, and 24 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the wetland system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-5 MC 24

Site Description:

This monitoring point emanates in a wetland area and is associated with a 1 acre spoil pile approximately ten feet high, consisting of shale and coal ash. Acidic runoff enters the wetland where it is partially treated before entering Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	8.12	3.67	650.80	0.00	0.00	45.20	4.18	3.08	0.23	5.72	3.70	266.70
Min	0.00	3.40	393.00	0.00	0.00	30.00	0.55	0.74	0.02	3.56	1.75	168.00
Max	30.00	3.90	807.00	0.00	0.00	55.00	10.79	8.07	1.01	7.29	6.35	358.00
90%	24.03	3.96	852.65	0.00	0.00	57.21	10.53	7.30	0.71	7.52	5.95	349.32
75%	19.24	3.87	791.91	0.00	0.00	53.59	8.62	6.03	0.56	6.98	5.27	324.46
90% CI	12.92	3.76	714.63	0.00	0.00	49.00	6.19	4.41	0.38	6.29	4.41	292.83
StdDev	9.68	0.18	122.71	0.00	0.00	7.30	3.86	2.57	0.29	1.10	1.37	50.22

Recommendations:

This area needs further investigation to determine the best approach for site reclamation. Based on the water quality, a small vertical flow wetland can be used if the discharge quality is the same after reclamation. A design flow rate of 20 gpm was used. The discharge has a pH of 3.8, acidity of 50 mg/L, iron of 5 mg/L, and aluminum of 5 mg/L. The VFW should contain 800 tons of limestone and will be followed by a settling basin to allow for the precipitation of metals.

The approximate cost of constructing the passive treatment train is $225,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-24 is $270,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the MC-24 discharge is designed to remove 1.2 lbs/day of iron, 1.2 lbs/day aluminum, and 12 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical wetland system. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-6 MC 22a

Site Description:

This discharge consists of two monitoring points which originate from the same hillside as MC-21. MC-22 splits along the railroad bed with some of the discharge seeping along the side hill while some flows through a small wetland. The discharges are toe of spoil seeps that create wetlands as they flow towards its confluence with Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	32.82	2.99	1216.45	0.00	0.00	205.27	72.73	6.97	2.41	10.13	23.27	443.36
Min	8.57	2.90	870.00	0.00	0.00	132.00	26.92	2.61	0.82	6.91	12.40	295.00
Max	105.94	3.20	1480.00	0.00	0.00	262.00	191.82	11.30	5.41	13.40	35.60	552.00
90%	88.68	3.15	1538.70	0.00	0.00	272.62	172.48	11.56	5.38	13.84	33.30	589.93
75%	71.87	3.10	1441.73	0.00	0.00	252.35	142.46	10.18	4.49	12.72	30.28	545.83
90% CI	52.57	3.04	1313.62	0.00	0.00	225.58	107.99	8.35	3.46	11.25	26.30	487.56
StdDev	33.95	0.09	195.89	0.00	0.00	40.94	60.64	2.80	1.80	2.25	6.10	89.10

Recommendations:

Water quality is moderate at this site, but passive treatment is recommended. A vertical flow wetland can be used, but will require a pre-treatment cell due to high aluminum levels. A design flow rate of 55 gpm was used. The discharge has a pH of 3.04, acidity of 225 mg/L, iron of 10 mg/L, and aluminum of 28 mg/L. The passive treatment train would consist of a pre-treatment cell with 500 tons of limestone followed by a

VFW with 1400 tons of limestone and a settling basin. Another combination of a VFW with 1100 tons of limestone and a final settling basin will be used to allow for treatment of the discharge.

The approximate cost of constructing the passive treatment train is $525,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-22a is $570,000.

Predicted Effect on Receiving Stream:

Treatment of the MC-22a discharge is designed to remove 6.6 lbs/day of iron, 18.5 lbs/day aluminum, and 148.5 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical wetland system as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-7 MC 22b

Site Description:

This discharge consists of two monitoring points which originate from the same hillside as MC-21. Spoil is found n the area of the discharge and will need to be reclaimed before a system is constructed. The discharges are toe of spoil seeps that create wetlands as they flow towards its confluence with Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	21.32	2.92	1481.11	0.00	0.00	290.56	82.05	13.19	3.12	12.34	32.51	570.89
Min	0.00	2.80	1230.00	0.00	0.00	215.00	0.00	6.60	0.00	8.49	24.60	444.00
Max	99.50	3.10	1680.00	0.00	0.00	336.00	256.52	24.20	7.87	15.30	40.10	678.00
90%	69.74	3.08	1739.70	0.00	0.00	349.80	209.18	24.37	7.46	15.83	40.28	673.47
75%	55.17	3.03	1661.89	0.00	0.00	331.98	170.93	21.01	6.15	14.78	37.94	642.60
90% CI	36.63	2.98	1567.31	0.00	0.00	310.31	127.00	16.92	4.65	13.51	35.10	605.08
StdDev	29.44	0.10	157.20	0.00	0.00	36.02	77.28	6.80	2.64	2.12	4.72	62.36

Recommendations:

The flow and water chemistry is such at MC-22b that passive treatment technology may fail. Due to the high volumes of metals in the discharge an active treatment system may be the best option. Before restoration efforts begin on this discharge, further investigation will occur to insure the best treatment is applied. For now, a passive system has been designed based on water quality characteristics collected during the assessment.

A design flow rate of 40 gpm was used. The discharge has a pH of 2.98, acidity of 310 mg/L, iron of 17 mg/L, and aluminum of 35 mg/L. The passive treatment train would consist of a limestone cell with 600 tons of limestone to be used as a “sacrificial cell” to protect the integrity of the rest of the system. An equalization basin would then be followed by a VFW with1600 tons of limestone and a settling basin. Another VFW with 1000 tons of limestone and a settling basin would complete the treatment train. If an active system would be used, it would need 20 tons/yr of pebble quicklime or 25 tons/yr of hydrated lime.

The approximate cost of constructing the passive treatment train is $650,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-22b is $695,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the MC-22b discharge is designed to remove 68.1 lbs/day of iron, 16.8 lbs/day aluminum, and 148.8 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical wetland systems as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-8 MC 21a

Site Description:

This monitoring point is a discharge that comes from an unreclaimed mine site. This site is comprised of runoff from the acidic spoil and seeps from the mined area. There are seeps emanating along the base of the spoil pile and is related to the MC 21b discharge. The "b" discharge starts in a wetland area. Both discharges channelize together before entering Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	14.36	2.83	1701.25	0.00	0.00	324.22	61.14	14.30	3.11	14.79	33.03	663.00
Min	0.00	2.70	1390.00	0.00	0.00	237.00	6.19	1.19	0.07	6.43	7.96	473.00
Max	60.00	2.90	1890.00	0.00	0.00	406.00	180.58	42.50	7.84	22.10	49.40	825.00
90%	45.83	2.97	2028.65	0.00	0.00	415.41	156.88	35.41	8.45	23.41	53.44	866.53
75%	36.36	2.93	1930.13	0.00	0.00	387.97	128.07	29.06	6.84	20.82	47.30	805.29
90% CI	24.85	2.88	1817.00	0.00	0.00	354.62	97.33	21.34	5.13	17.66	39.83	730.84
StdDev	19.13	0.09	199.03	0.00	0.00	55.43	58.20	12.83	3.24	5.24	12.41	123.73

Recommendations:

The flow and water chemistry is such at MC-21a that passive treatment technology may fail. Due to the high volumes of metals in the discharge an active treatment system may be the best option. Before restoration efforts begin on this discharge, further investigation will occur to insure the best treatment is applied, along with reclaiming the area as needed. For now, a passive system has been designed based on water quality characteristics collected during the assessment.

A design flow rate of 30 gpm was used. The discharge has a pH of 2.88, acidity of 354 mg/L, iron of 21 mg/L, and aluminum of 40 mg/L. The passive treatment train would consist of a pre-treatment cell using700 tons limestone, two VFW's each using 1000 tons limestone and two sediment basins. If an active system is chosen, it would use 16 tons/yr pebble of quicklime or 20 tons/yr of hydrated lime.

The approximate cost of constructing the passive treatment train is $575,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-21a is $620,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the MC-21a discharge is designed to remove 7.5 lbs/day of iron, 14.4 lbs/day aluminum, and 127 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical wetland systems as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #4-9 MC 21b

Site Description:

This monitoring point is comprised of drainage from spoil and a poorly reclaimed mine site. The headwaters of the discharge is a wetland area that has formed at the toe of slope of a mine site. The discharge combines with the MC-21A discharge 30 yards before entering Moshannon Creek.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	20.53	3.47	763.33	0.00	0.00	134.00	32.70	5.03	2.39	14.24	19.93	325.00
Min	0.00	3.20	402.00	0.00	0.00	69.00	2.76	2.55	0.07	8.84	10.90	136.00
Max	60.00	3.70	1140.00	0.00	0.00	187.00	79.14	15.30	11.01	20.60	40.10	501.00
90%	63.83	3.79	1139.42	0.00	0.00	197.09	83.38	11.48	8.90	20.87	34.04	495.71
75%	50.80	3.69	1026.25	0.00	0.00	178.10	68.13	9.54	6.94	18.87	29.79	444.34
90% CI	34.96	3.57	888.69	0.00	0.00	155.03	51.85	7.18	4.85	16.45	24.64	381.90
StdDev	26.32	0.19	228.62	0.00	0.00	38.35	30.81	3.92	3.96	4.03	8.57	103.77

Recommendations:

The flow and water chemistry is such at MC-21b that passive treatment technology may fail. Due to the high volumes of metals in the discharge an active treatment system may be the best option. The discharge may also be combined with MC-21a after reclamation and one treatment system built. For now, a passive system has been designed based on water quality characteristics collected.

A design flow rate of 45 gpm was used. The discharge has a pH of 3.5, acidity of 160 mg/L, iron of 8 mg/L, and aluminum of 25 mg/L. The passive treatment train would consist of a pre-treatment cell using 500 tons limestone, a VFW using 1600 tons limestone and a sediment basin. If an active system is chose it would use 22 tons/yr of pebble quicklime.

The approximate cost of constructing the passive treatment train is $450,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the passive treatment system for MC-21b is $495,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the MC-21b discharge is designed to remove 4.32 lbs/day of iron, 13.5 lbs/day aluminum, and 86.4 lbs/day of acidity. Treating this discharge will continue improving water quality within Moshannon Creek.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical wetland systems as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Area #5 Bear Run

Priority #5-1 BR5 HW

Site Description:

This monitoring point is for a tributary to Bear Run coming from a toe of slope discharge. Reclamation of this site needs to be investigated. Bear Run up stream of discharge is full of aquatic insects and moss.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	35.98	3.66	260.09	0.00	0.00	39.36	17.27	0.73	0.21	1.30	3.41	70.82
Min	0.00	3.40	118.00	0.00	0.00	18.00	0.00	0.24	0.00	0.45	0.59	25.00
Max	120.00	3.90	401.00	0.00	0.00	56.00	49.46	1.97	0.56	3.26	5.03	145.00
90%	102.39	3.97	392.98	0.00	0.00	59.58	47.36	1.59	0.56	2.59	5.55	127.10
75%	82.41	3.88	352.99	0.00	0.00	53.50	38.31	1.33	0.45	2.20	4.90	110.16
90% CI	56.01	3.76	300.16	0.00	0.00	45.46	26.34	0.99	0.31	1.69	4.05	87.79
StdDev	40.37	0.19	80.78	0.00	0.00	12.29	18.29	0.52	0.21	0.79	1.30	34.21

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 75 gpm was used. The discharge has a pH of 3.76, acidity of

50 mg/L, iron of 1.0 mg/L, and aluminum of 4 mg/L. The passive treatment train would consist of a two limestone ponds using a total of 1800 tons limestone, each followed by a settling basin to allow for metal precipitation. Organic matter in the limestone cells is not needed due to the low iron concentrations.

The approximate cost of constructing the passive treatment train is $450,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for BR5-HW is $495,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BR 5 HW discharge is designed to remove 1.0 lbs/day of iron, 3.5 lbs/day aluminum, and 45 lbs/day of acidity. Treating this discharge will begin improving water quality with the Bear Run watershed.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the limestone cells as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #5-2 BR 3

Site Description:

This monitoring point is for a small tributary to Bear Run originating in wetland that is iron stained.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	13.00	4.06	268.36	1.18	0.24	37.18	5.48	0.38	0.03	2.86	3.99	104.27
Min	0.00	3.80	187.00	0.00	0.00	27.00	0.00	0.11	0.00	2.01	3.12	70.00
Max	30.00	4.20	341.00	2.00	0.72	50.00	12.95	1.27	0.08	4.07	4.84	185.00
90%	29.93	4.28	347.49	2.62	0.62	47.40	11.91	0.99	0.07	3.81	4.94	154.54
75%	24.84	4.21	323.68	2.19	0.50	44.32	9.97	0.81	0.06	3.52	4.65	139.41
90% CI	18.10	4.13	292.22	1.62	0.35	40.26	7.42	0.57	0.04	3.15	4.28	119.43
StdDev	10.30	0.13	48.10	0.87	0.23	6.21	3.91	0.37	0.02	0.58	0.58	30.56

Recommendations:

A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 25 gpm was used. The discharge has a pH of 4.1, acidity of 40 mg/L, iron of 0.5 mg/L, and aluminum of 4 mg/L. The passive treatment train would consist of an equalization basin, followed by a limestone cell with 1200 tons of limestone and a settling basin. Organic matter in the limestone cell is not needed due to the low iron concentrations.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BR 3 discharge is designed to remove 0.12 lbs/day of iron, 1.2 lbs/day aluminum, and 12 lbs/day of acidity. Treating this discharge will begin improving water quality within Moshannon Creek.

The approximate cost of constructing the passive treatment train is $235,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for BR-3 is $280,000.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the limestone cells as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #5-3 BR 2

Site Description:

This monitoring point measures flow originates in an unreclaimed strip mine area. Area needs further investigation to determine size of reclamation area.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	34.58	3.63	442.90	0.00	0.00	46.60	18.07	0.67	0.19	4.53	4.22	162.00
Min	0.00	3.40	334.00	0.00	0.00	29.00	2.01	0.19	0.03	3.27	2.88	130.00
Max	128.75	3.80	520.00	0.00	0.00	60.00	69.47	1.65	1.00	6.34	5.41	200.00
90%	115.06	3.86	543.46	0.00	0.00	61.07	56.11	1.54	0.68	5.95	5.51	199.58
75%	90.84	3.79	513.20	0.00	0.00	56.72	44.67	1.27	0.53	5.52	5.12	188.27
90% CI	58.85	3.70	474.70	0.00	0.00	51.18	30.10	0.94	0.34	4.98	4.63	173.88
StdDev	48.92	0.14	61.13	0.00	0.00	8.80	23.13	0.53	0.30	0.87	0.78	22.84

Recommendations:

Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. The discharge has a pH of 3.7, acidity of 50 mg/L, iron of 1 mg/L, and aluminum of 5 mg/L. The passive treatment train would consist of an equalization basin followed by a limestone pond with 1500 tons of limestone and a settling basin. Organic matter in the limestone cells is not needed due to the low iron concentrations.

The approximate cost of constructing the passive treatment train is $275,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for BR-2 is $320,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BR 2 discharge is designed to remove 0.6 lbs/day of iron, 3.0 lbs/day aluminum, and 30 lbs/day of acidity. Treating this discharge will continue improving water quality in Bear Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the limestone cells as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #5-4 BBT HW

Site Description:

This monitoring point is for the headwaters of a tributary to Bear Run and originates from a deep mine. This site needs to be investigated to determine how the discharges within this tributary are linked together. This site needs further investigation and is recommended for reclamation.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	43.59	3.39	936.00	0.00	0.00	217.00	67.97	11.57	0.98	12.98	23.58	436.18
Min	0.54	2.60	504.00	0.00	0.00	103.00	3.99	1.26	0.31	7.92	4.54	257.00
Max	223.24	3.80	2390.00	0.00	0.00	633.00	275.72	79.90	3.75	20.60	46.20	1051.00
90%	160.94	3.95	1788.95	0.00	0.00	466.33	214.44	49.86	2.83	19.26	45.29	805.88
75%	125.63	3.78	1532.29	0.00	0.00	391.30	170.37	38.34	2.27	17.37	38.76	694.63
90% CI	78.97	3.56	1193.17	0.00	0.00	292.18	112.13	23.11	1.54	14.88	30.12	547.65
StdDev	71.33	0.34	518.51	0.00	0.00	151.57	89.04	23.28	1.12	3.82	13.20	224.74

Recommendations:

The flow and water chemistry is such that it will push passive system capabilities. An active system may be the most economical way to treat the entire tributary after reclamation occurs. Further investigation needs to occur at this site, along with topographic mapping to determine the size of the reclamation area. A passive system has been designed based on water quality characteristics collected during the assessment. A design flow rate of 50 gpm was used. The discharge has a pH of 3.5, acidity of 292 mg/L, iron of 23 mg/L, and aluminum of 30 mg/L. The passive treatment train would consist of a pre-treatment pond using 500 tons limestone followed by a small settling basin. A VFW with 2400 tons of limestone would follow and an additional settling basin. Finally, a VFW with 1200 tons of limestone and final settling basin would complete the treatment train.

The approximate cost of constructing the passive treatment train is $650,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for BBT-HW is $695,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BBT HW discharge is designed to remove 14 lbs/day of iron, 18 lbs/day aluminum, and 175 lbs/day of acidity. Treating this discharge will continue improving water quality within Bear Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the vertical flow wetlands as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #5-5 BBT 2

Site Description:

This monitoring point is a toe of slope discharge from a reclaimed mine site and "pops" up along the stream. It is related to the BBT-HW stream and would most likely be affected by restoration activities in the headwaters area.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	6.36	3.16	1100.00	0.00	0.00	297.60	25.89	1.59	0.19	10.97	46.14	485.90
Min	0.00	3.10	1030.00	0.00	0.00	262.00	1.58	0.63	0.01	9.07	36.40	406.00
Max	20.00	3.20	1180.00	0.00	0.00	340.00	74.58	5.90	1.41	12.30	57.20	545.00
90%	16.93	3.24	1193.70	0.00	0.00	341.24	65.61	4.35	0.90	12.94	58.16	566.74
75%	13.75	3.22	1165.50	0.00	0.00	328.11	53.66	3.52	0.69	12.35	54.54	542.42
90% CI	9.55	3.19	1129.63	0.00	0.00	311.40	38.45	2.46	0.42	11.59	49.94	511.46
StdDev	6.42	0.05	56.96	0.00	0.00	26.53	24.15	1.68	0.43	1.20	7.31	49.14

Recommendations:

Even thought the aluminum levels are extremely high at this site, the low flow rates allow for passive treatment to be used. The treatment train will consist of an equalization basin followed by a limestone cell with 600 tons of limestone and a settling basin. Another combination of limestone cell and settling basin will be used to complete the treatment train. Organic matter is not recommended as this site because of the low iron levels. A design flow rate of 10 gpm was used. The discharge has a pH of 3.1, acidity of 310 mg/L, iron of 3 mg/L, and aluminum of 50 mg/L.

The approximate cost of constructing the passive treatment train is $275,000. The design and permitting phase of the project would be at a cost of $45,000. The overall design and construction cost of the treatment system for BBT-2 is $320,000.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BBT 2 discharge is designed to remove 0.5 lbs/day of iron, 6.0 lbs/day aluminum, and 37 lbs/day of acidity. Treating this discharge will continue improving water quality within Bear Run.

Other:

A final O&M plan will be developed after construction is complete. Limited maintenance should be necessary on the limestone cells as automatic flushing systems will be installed. Visual checks of the system will be made monthly to insure that wildlife or other natural processes are not affecting the integrity of the system. A field monitoring plan will be established to determine the overall effects of the project on water quality.

Permits will need to be obtained for the construction of the project. A field meeting with PADEP, PGC, PFBC, Army Corp of Engineers, Conservation District, and NMBS will occur to insure all permitting issues are addressed.

Priority #5-6 BBT 1

Site Description:

This monitoring point is a deep mine discharge that flows along an old rail road bed and through spoil material. Further investigation is necessary to determine the size of the reclamation area or the potential to remine and daylight the mine. It enters into a tributary of Bear Run below BBT-HW and BBT-2. This discharge may be treated in combination with the upstream discharges using an active system.

	Flow (gpm)	pH (SU)	Cond	Alk	Alk load (lbs/day)	Acidity (mg/l)	Acid load (lbs/day)	Iron	Iron load (lbs/day)	Mn	Al	Sulfate
Average	63.56	2.83	1733.00	0.00	0.00	406.91	296.28	50.80	36.33	13.12	36.65	726.45
Min	28.62	2.70	733.00	0.00	0.00	132.00	84.77	7.36	6.29	9.62	12.70	295.00
Max	99.50	3.20	2400.00	0.00	0.00	640.00	410.43	88.80	51.73	19.00	56.30	1128.00
90%	101.53	3.08	2504.96	0.00	0.00	655.54	476.45	88.80	60.61	18.47	56.97	1131.14
75%	90.11	3.01	2272.67	0.00	0.00	580.72	422.23	77.37	53.31	16.86	50.85	1009.37
90% CI	75.01	2.90	1965.75	0.00	0.00	481.87	350.60	62.26	43.65	14.73	42.78	848.47
StdDev	23.08	0.16	469.28	0.00	0.00	151.14	109.53	23.10	14.76	3.25	12.35	246.01

Recommendations:

The severity of this discharge makes passive treatment unlikely. A lime doser is recommended at this site. If the doser is designed to treat only the BBT 1 discharge, then 55 tons/yr of pebble quicklime would be needed. A design flow rate of 75 gpm was used. The discharge has a pH of 2.9, acidity of 482 mg/L, iron of 62 mg/L, and aluminum of 43 mg/L. If a passive system would be used this site would require 7200 tons of limestone to effectively increase the pH and precipitate the metals before being discharged to Moshannon Creek, however, the high metal loadings would quickly overwhelm the system. Further investigation should occur to determine if it is possible to treat the entire BBT tributary. Additional flow rates and water sampling would need to be done.

Predicted Effect on Receiving Stream:

Reclamation and treatment of the BBT 1 discharge is designed to remove 56 lbs/day of iron, 39 lbs/day aluminum, and 434 lbs/day of acidity. Treating this discharge will continue improving water quality within Bear Run.

Appendix A: Maps

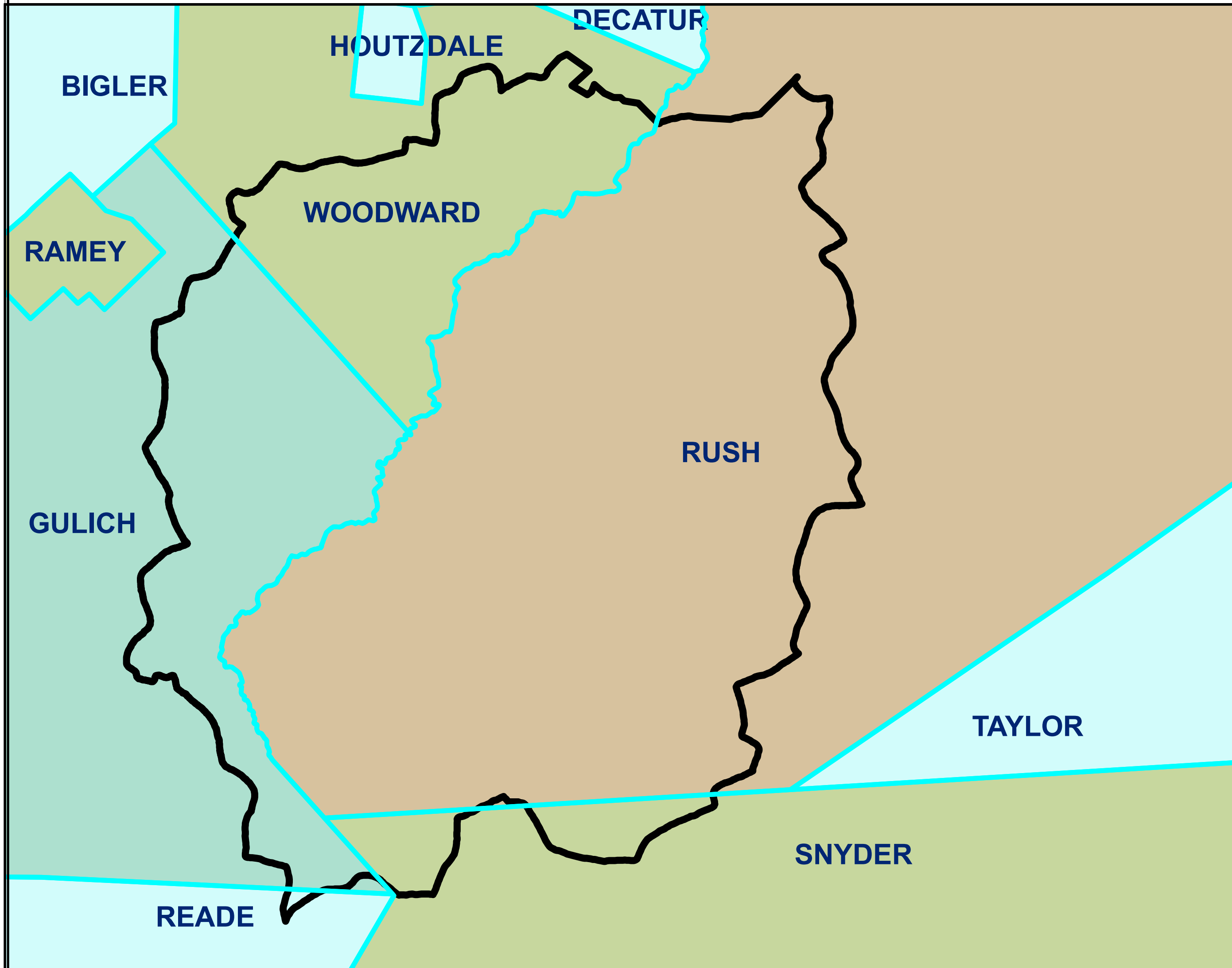
A-3	Watershed in PA	This displays the location of the watershed in Pennsylvania as well as the nearby civil boundaries.
A-4	Topographic Quads containing Assessment Area	This displays the watershed within the USGS 7.5 Minute Series topographic quadrangles. The boundaries of the quadrangles are displayed and quadrangle name is identified.
A-5	Sub Watersheds	This displays an identification of the sub watersheds within the assessment area.
A-6	Stream Quality	This displays a color coded version of the watershed. The variation in color describes the quality of the stream as it runs from headwaters to mouth based upon the sampling performed.
A-7	Impaired Streams	This identifies streams within the specified assessment area and whether the streams are currently considered impaired by DEP.
A-8	AML priorities	This displays AML priorities in and near the watershed as determined and reported by the Bureau of Abandoned Mine Reclamation in 2008.
A-9	Soil survey	This displays the soils of the area as reported by NRCS in 2005. Some differences will appear on this map as compared to the last published soil survey report. The data used to create this map was considered more recent, and thereby more appropriate to report.
A-10	Geology	This displays the regional bedrock within and near the watershed. Data was provided by DCNR (see http://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspx) which digitized data from the 1980 map published by the Bureau of Topographic and Geologic Survey.
A-11	Wetlands/NWI	This displays the NWI wetland areas within the watershed (as identified by US Fish & Wildlife).
A-12	Prioritization Areas	This displays an overview of the areas in which sampling ultimately occurred and in which treatment will need to occur.
A-13	Sampling in Prioritization Area 1	This displays the sampling points within prioritization area 1.

A-14	Sampling in Prioritization Area 1 on Topo	This displays the same data as is seen above, but relevant portions of USGS quad maps are also displayed to provide context and area topography.
A-15	Sampling in Prioritization Area 2	This displays the sampling points within prioritization area 2.
A-16	Sampling in Prioritization Area 2 on Topo	This displays the same data as is seen above, but relevant portions of USGS quad maps are also displayed to provide context and area topography.
A-17	Sampling in Prioritization Area 3	This displays the sampling points within prioritization area 3.
A-18	Sampling in Prioritization Area 3 on Topo	This displays the same data as is seen above, but relevant portions of USGS quad maps are also displayed to provide context and area topography.
A-19	Sampling in Prioritization Area 4	This displays the sampling points within prioritization area 4.
A-20	Sampling in Prioritization Area 4 on Topo	This displays the same data as is seen above, but relevant portions of USGS quad maps are also displayed to provide context and area topography.
A-21	Sampling in Prioritization Area 5	This displays the sampling points within prioritization area 5.
A-22	Sampling in Prioritization Area 5 on Topo	This displays the same data as is seen above, but relevant portions of USGS quad maps are also displayed to provide context and area topography.
A-23	Quarterly Sampling	This displays the points at which quarterly sampling occurred.
A-24	Macroinvertebrate Sampling	This displays the points at which macroinvertebrate sampling occurred.
A-25	Reclamation Area Overview	This displays the sampling point areas which would likely benefit from reclamation efforts.
A-26	Scarlift map	This shows the map accompanying the Scarlift report. The web link to access this graphic and the associated reports accompanies the graphic.

Maps should be used as reference only. Exact precision is neither implied nor guaranteed.

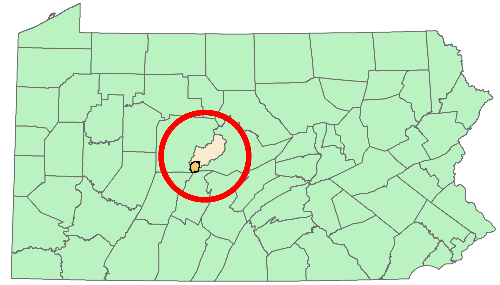
Watershed in PA

N



Assessment area within surrounding civil bounds

1:90,000



Assessment Area within State of Pennsylvania

Civil boundary and watershed boundaries Accessed from PASDA

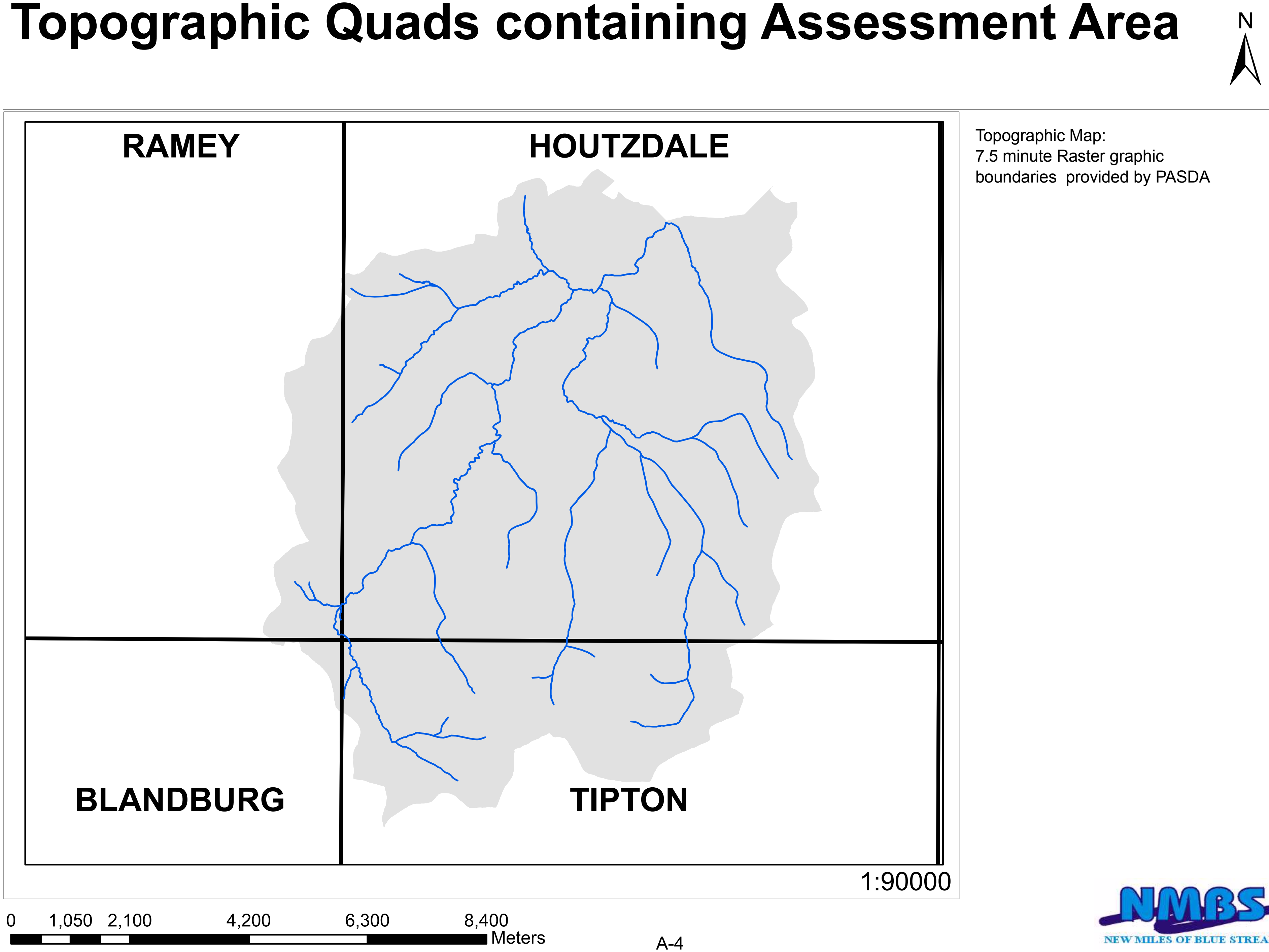
0 1,050 2,100 4,200 6,300 8,400 Meters

A-3

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NMBS NEW MILES OF BLUE STREAM

Topographic Quads containing Assessment Area



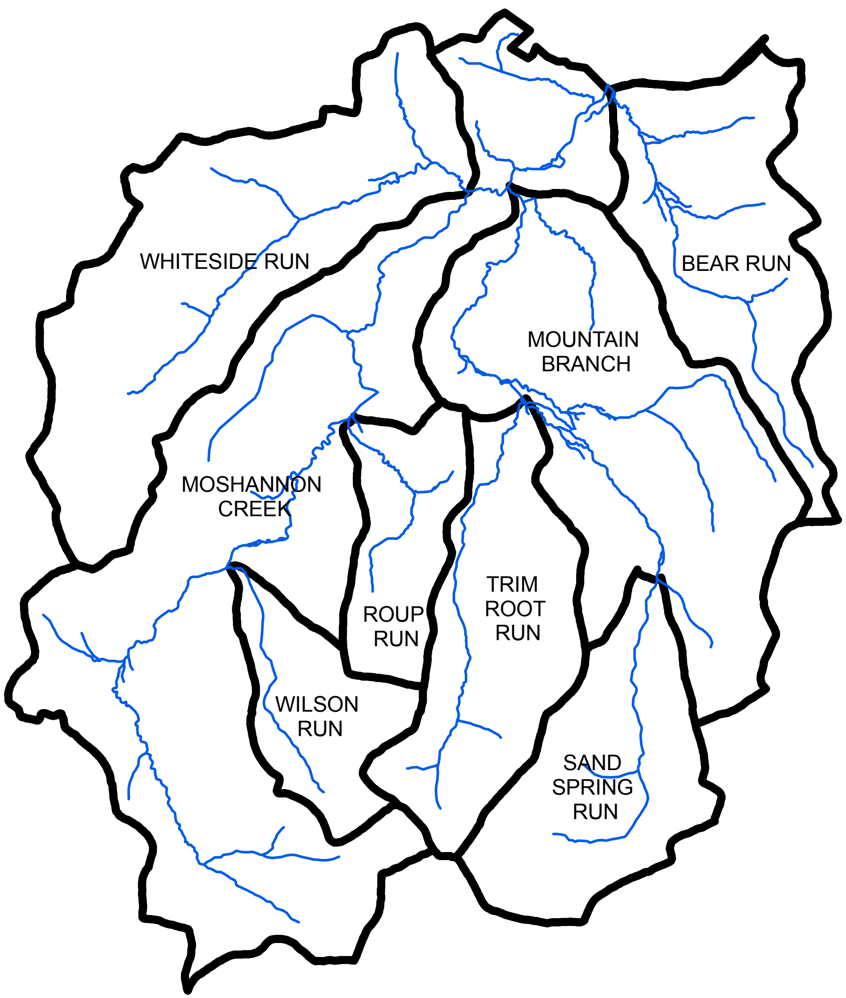
Topographic Map:
7.5 minute Raster graphic
boundaries provided by PASDA

NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Sub watersheds

N



Assessment Area within Moshannon Creek Watershed

Legend

Sub-watershed bounds

Streams

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies.
Impaired stream data provided by PA DEP (2009 data)
Accessed from PASDA

sub-watersheds in assessment area: Moshannon Creek part 1 1:90,000

0 1,050 2,100 4,200 6,300 8,400 Meters

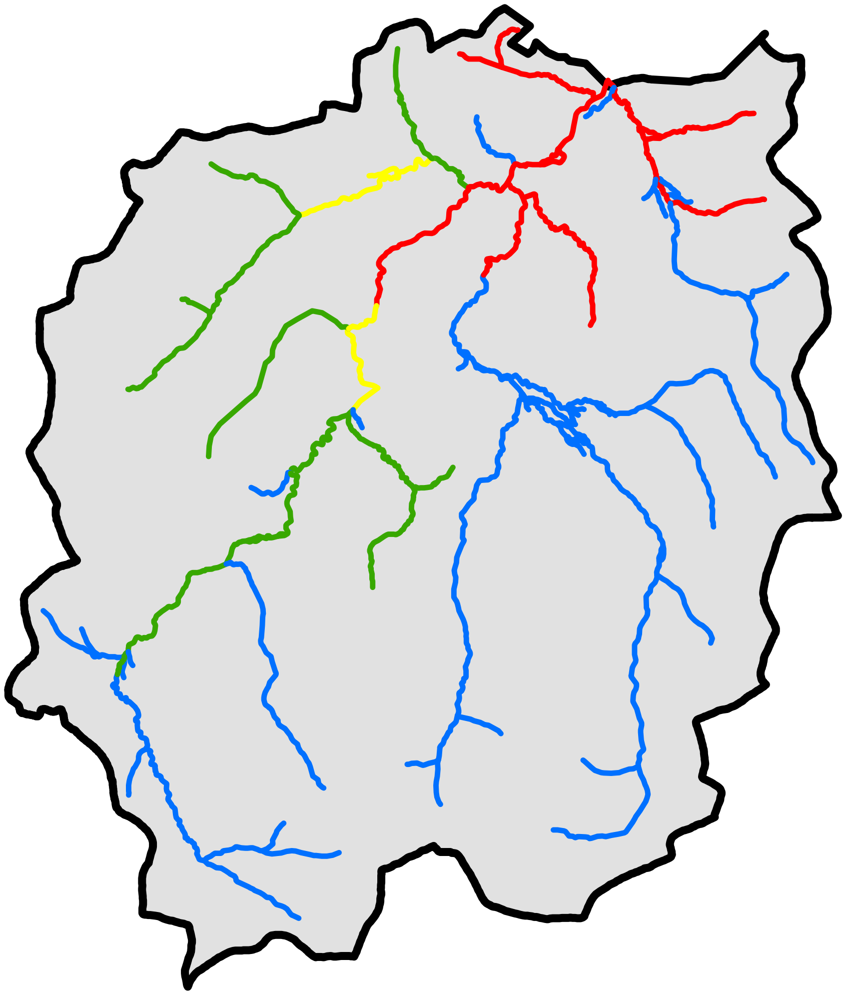
A-5

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Stream Quality

N



Assessment Area within Moshannon Creek Watershed

Legend

Stream Quality

- Highly degraded
- Moderately degraded
- Slightly degraded
- High quality

Civil boundary and watershed boundaries accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

Stream quality based upon assessment results

1:90,000

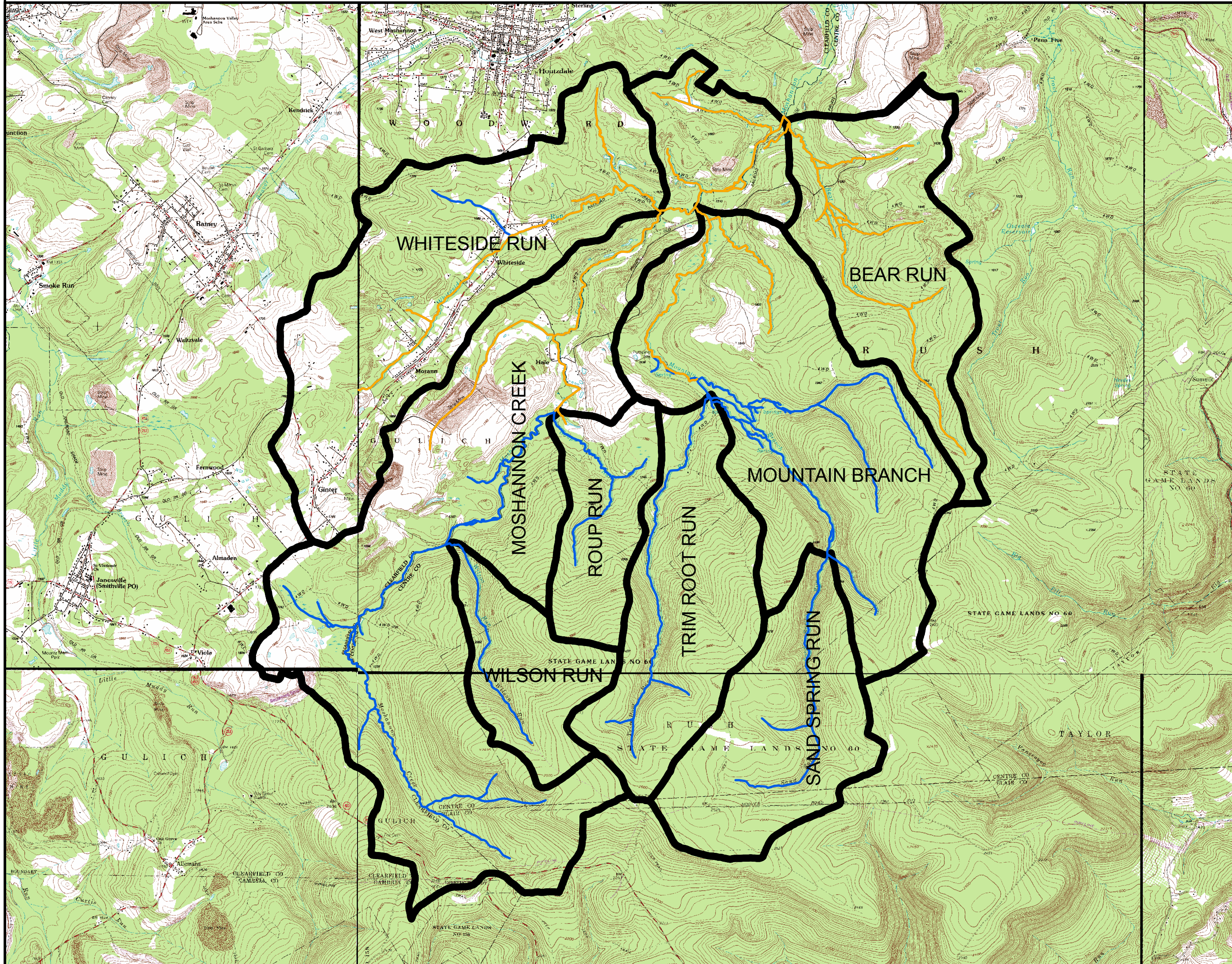
0 1,050 2,100 4,200 6,300 8,400 Meters

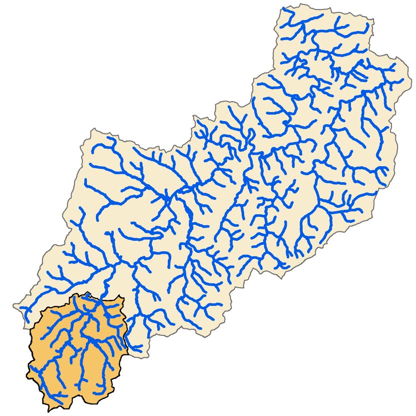
A-6

NMBS
NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Impaired Streams (DEP)





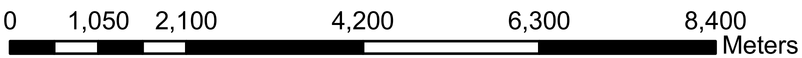
Assessment Area within Moshannon Creek Watershed

Legend

- Impaired Streams
- Sub-watershed bounds
- Streams

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies.
Impaired stream data provided by PA DEP (2009 data)
Accessed from PASDA

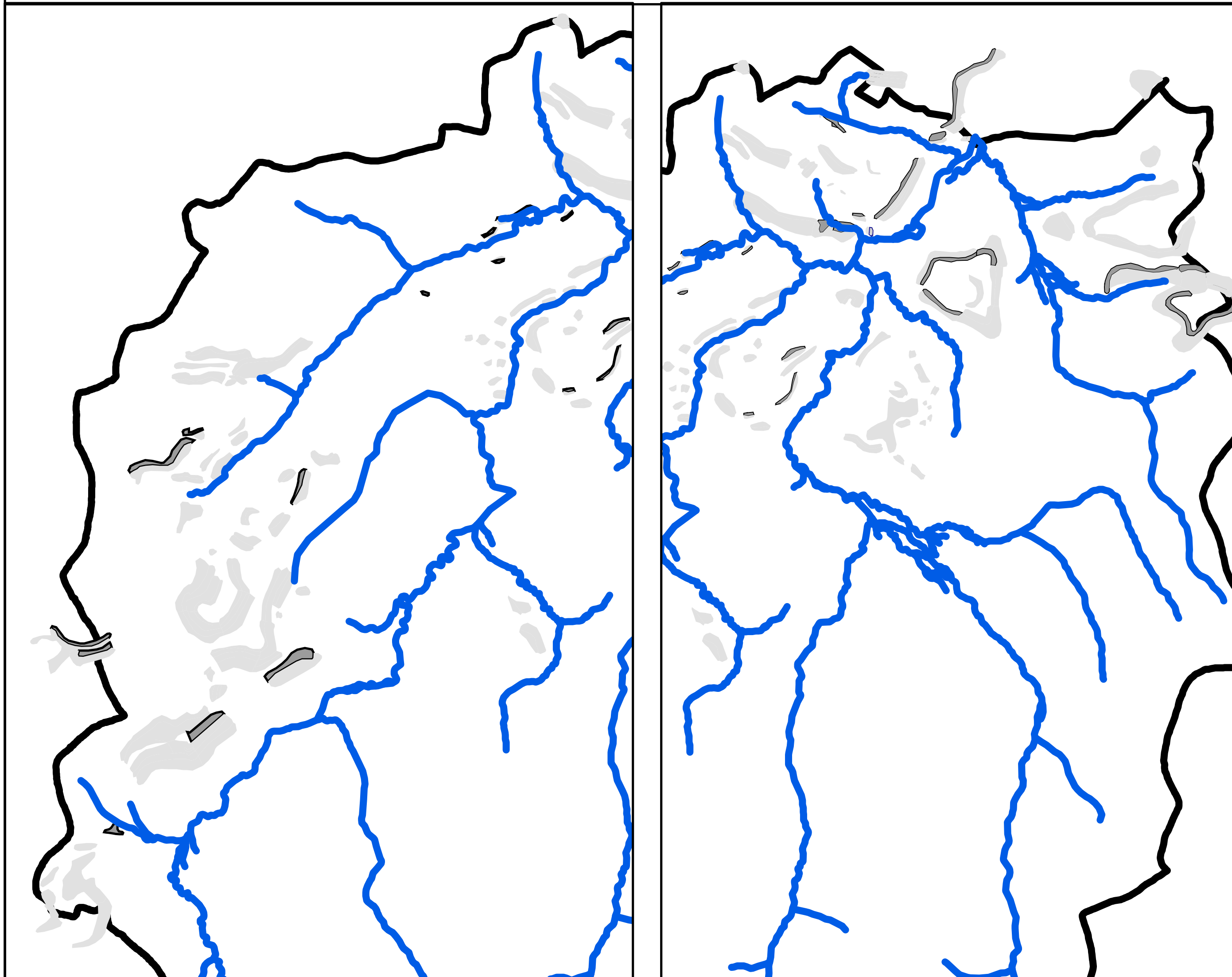
Impaired streams in assessment area: Moshannon Creek part 1 1:90,000



Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

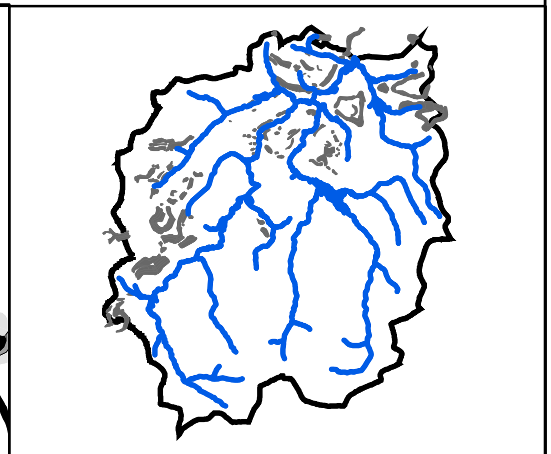
NEW MILES OF BLUE STREAM

Identified AML Areas



AML in assessment area: Moshannon Creek part 1

1:61,818



Overview

Legend

- Streams
- Assessment Area

SF_PRIORIT

- 1
- 2
- 3
- NONE
- UNDET

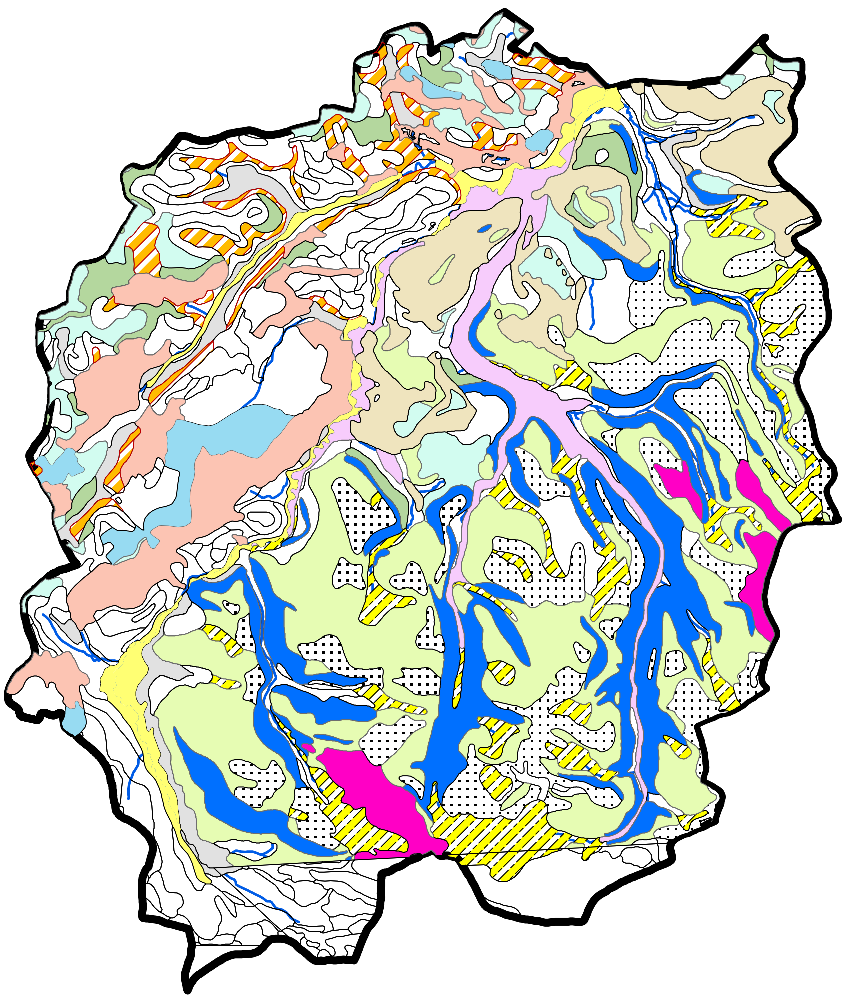
Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies.
AML Data from DEP 2008 list
Accessed from PASDA

0 750 1,500 3,000 4,500 6,000 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Soils

N



Legend

Soil Types

<all other values>

musym

- Hazelton (HSD)
- Hazelton-Dekalb (HTF)
- Hazelton (HSB)
- Cedarcreek (95D)
- Strip Mines (Sm)
- Buchanan (BxB)
- Wharton (WhB)
- Philo and Atkins (Pk)
- Brinkerton (BrB)
- Ernest silt (ErC)
- Wharton (WhC)
- Atkins (At)
- Leetonia (LtB)
- Bethesda (92D)

Soil data provided by NRCS

Predominate soils within assessment area

1:90,000

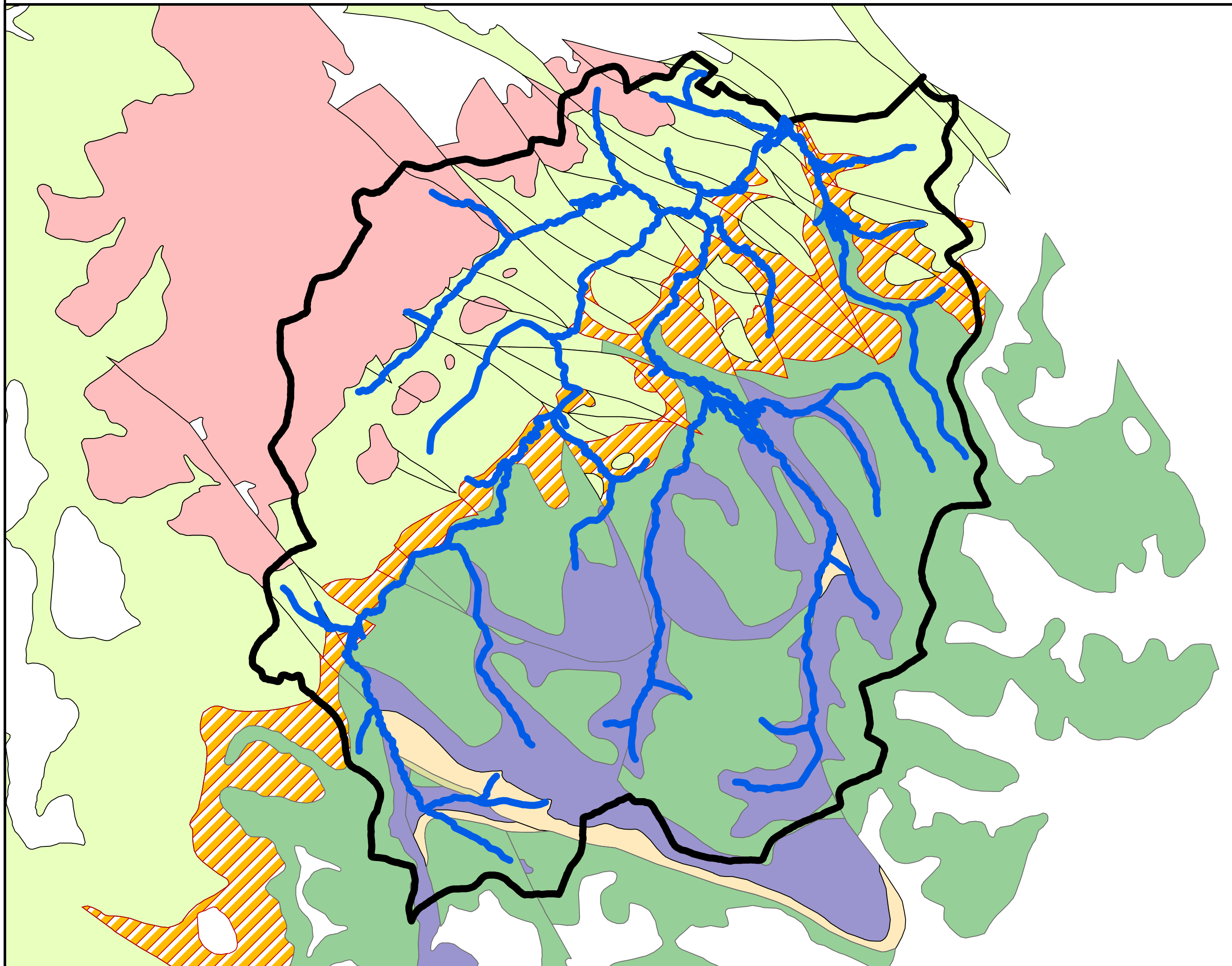
0 1,050 2,100 4,200 6,300 8,400 Meters

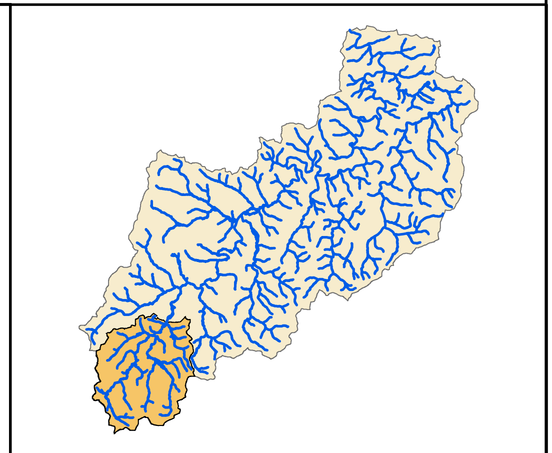
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NMBS NEW MILES OF BLUE STREAM

Bedrock Geology

N





Assessment Area within Moshannon Creek Watershed

Legend

Streams

Sub-watershed bounds

NAME

Allegheny Formation

Burgoon Sandstone

Duncannon Member of Catskill Formation

Glenshaw Formation

Mauch Chunk Formation

Pottsville Formation

Rockwell Formation

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies. Geology data from the Susquehanna River Basin Commission Accessed from PASDA

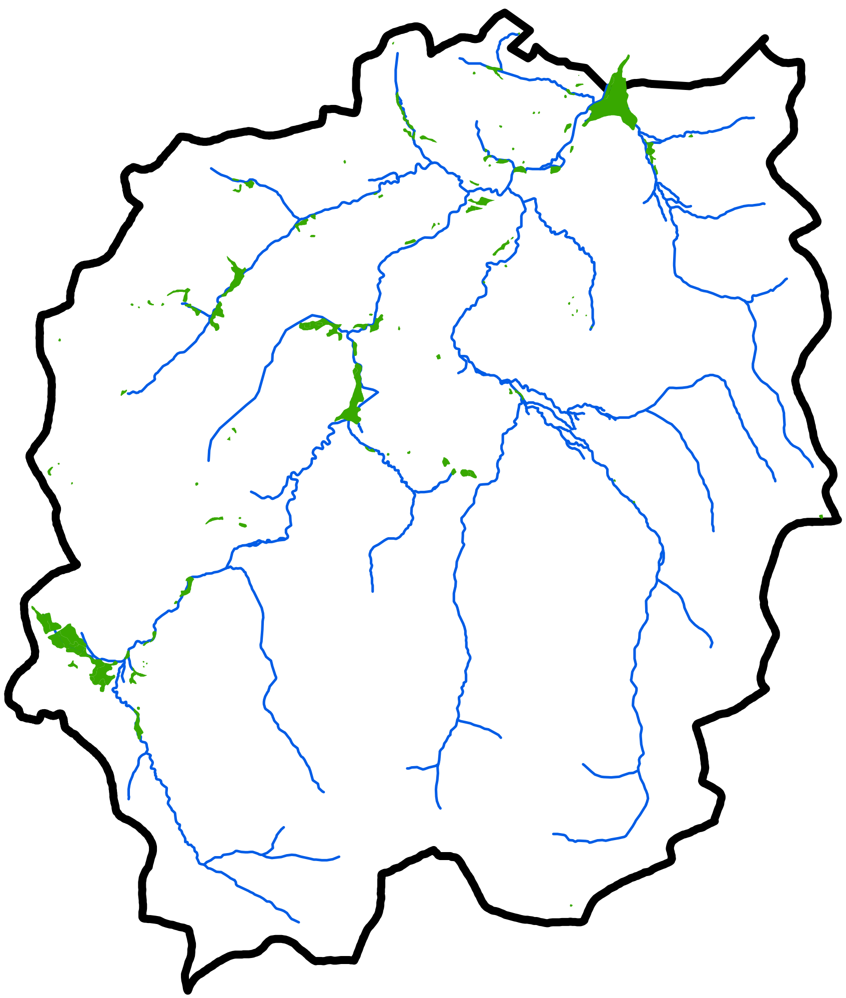
Bedrock geology in assessment area: Moshannon Creek part 1 1:90,000

0 1,050 2,100 4,200 6,300 8,400 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

National Wetland Inventory



Assessment Area within Moshannon Creek Watershed

Legend

- Identified NWI areas
- Streams
- Assessment area

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies.
Geology data from the Susquehanna River Basin Commission
Accessed from PASDA

Possible wetland areas identified by the U.S. Fish & Wildlife Service

Identified wetland areas in assessed area

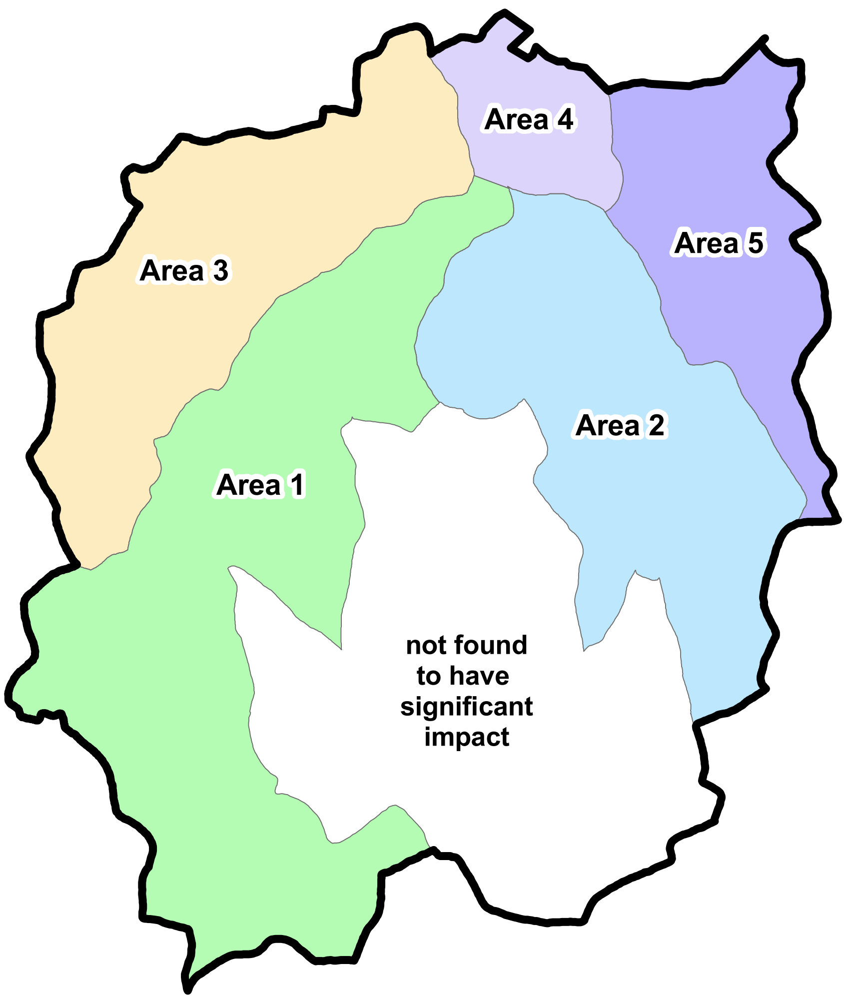
1:90,000

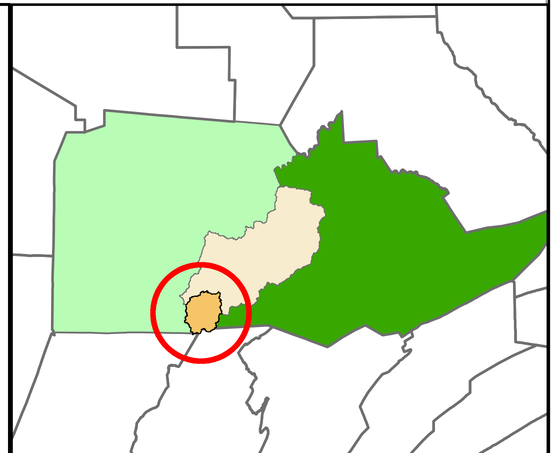
0 1,050 2,100 4,200 6,300 8,400 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Prioritization Areas





Assessment Area within
Centre & Clearfield Counties

Civil boundary and
watershed boundaries
Accessed from PASDA

Prioritizaiton areas for assessment

1:90,000

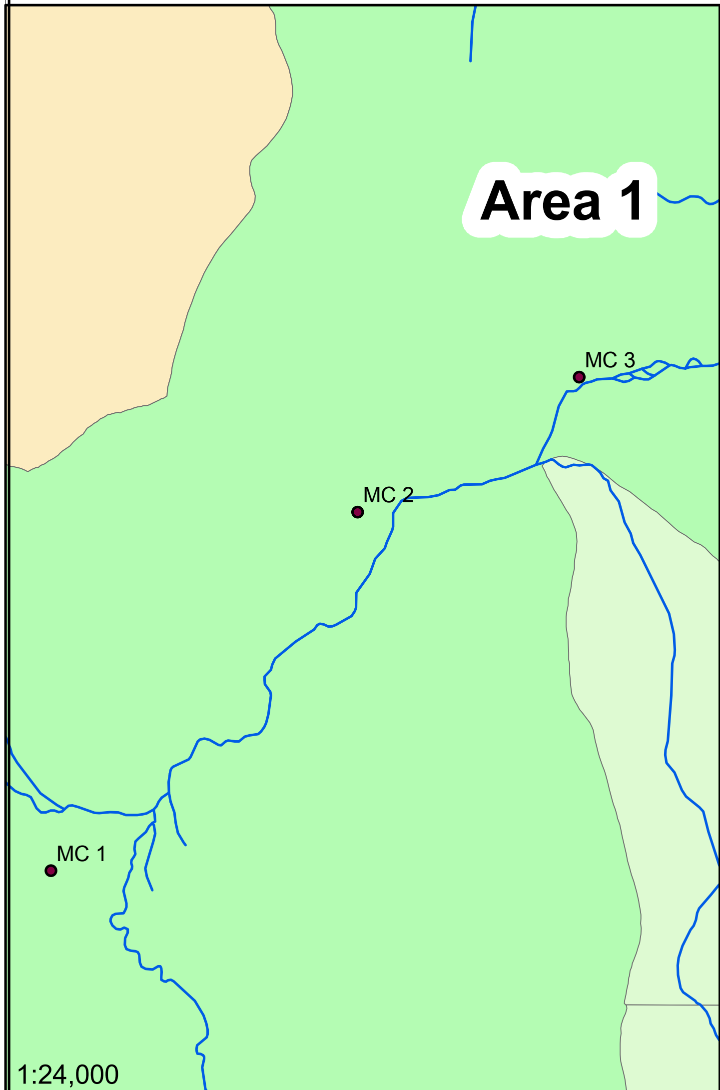
0 1,100 2,200 4,400 6,600 8,800 Meters

A-12

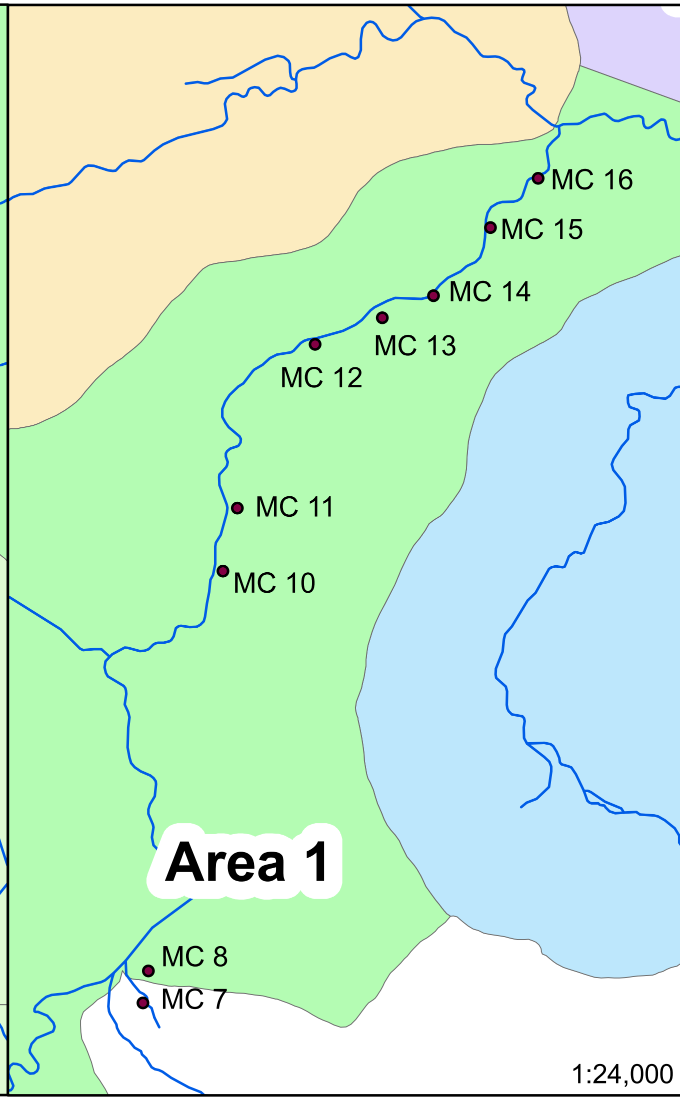
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NMBS NEW MILES OF BLUE STREAM

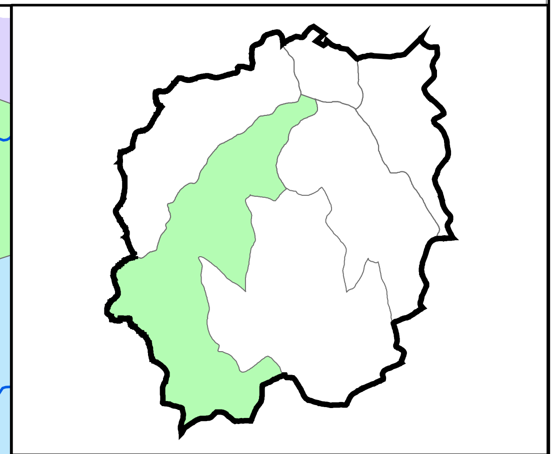
Sampling in Priority Area #1



Monthly sampling points in bottom portion of priority area



Monthly sampling points in top portion of priority area



Priority Area 1 within Assessment Area

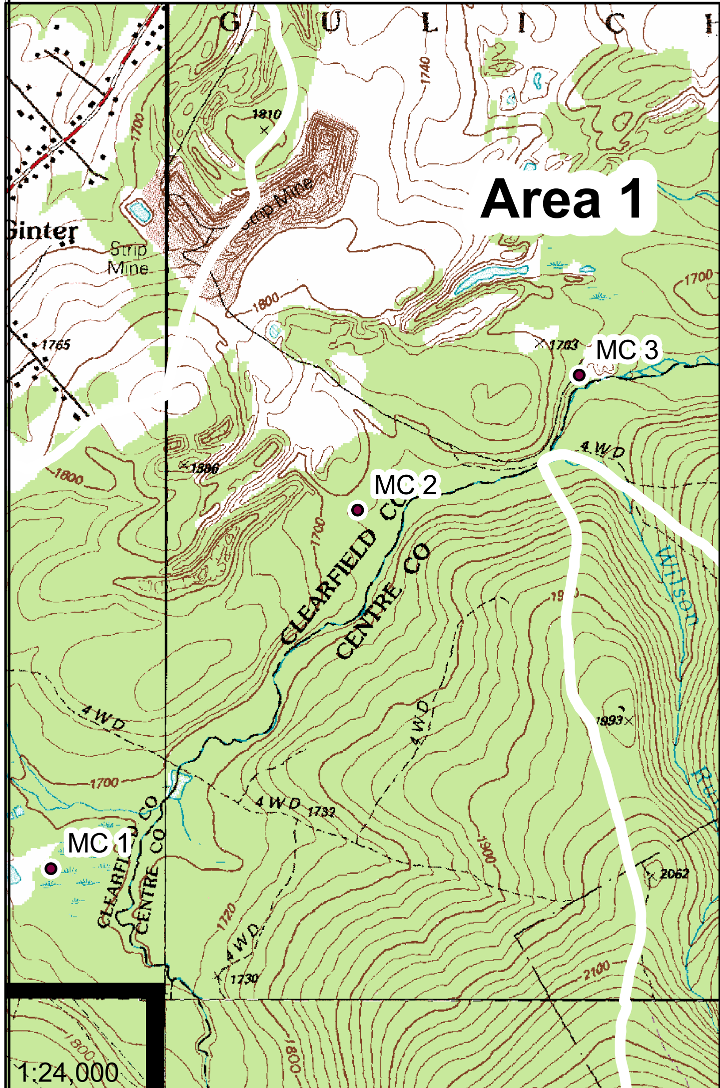
Civil boundary and
watershed boundaries
Accessed from PASDA

Stream data provided by
USGS, EPA, USDA Forest Service
and other agencies
also accessed from PASDA

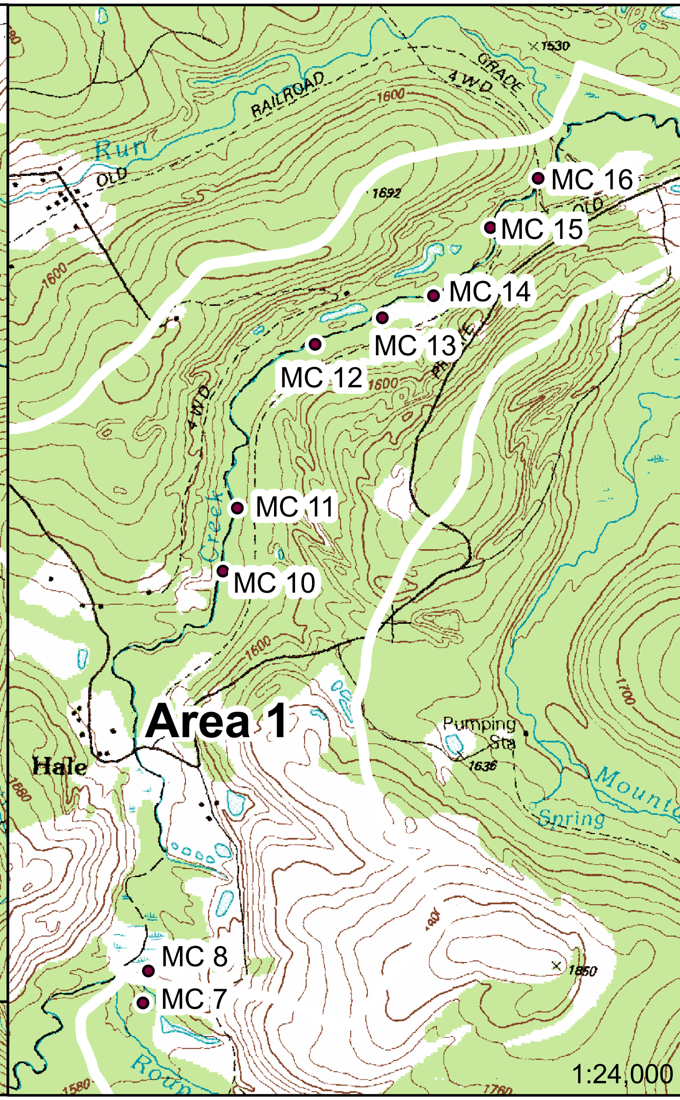
0 262.5 525 1,050 1,575 2,100 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

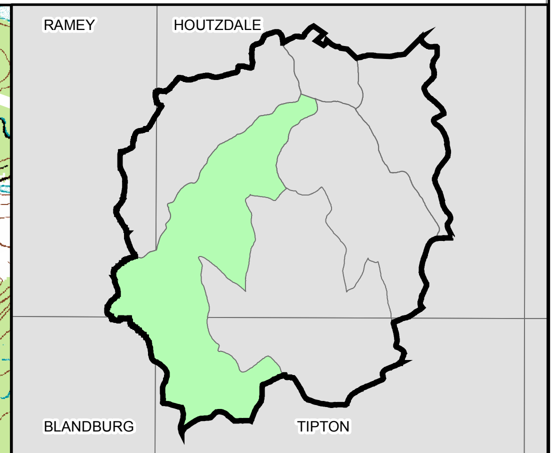
Sampling in Priority Area #1



Monthly sampling points in bottom portion of priority area



Monthly sampling points in top portion of priority area



Priority Area 1 within Assessment Area and USGS Quads

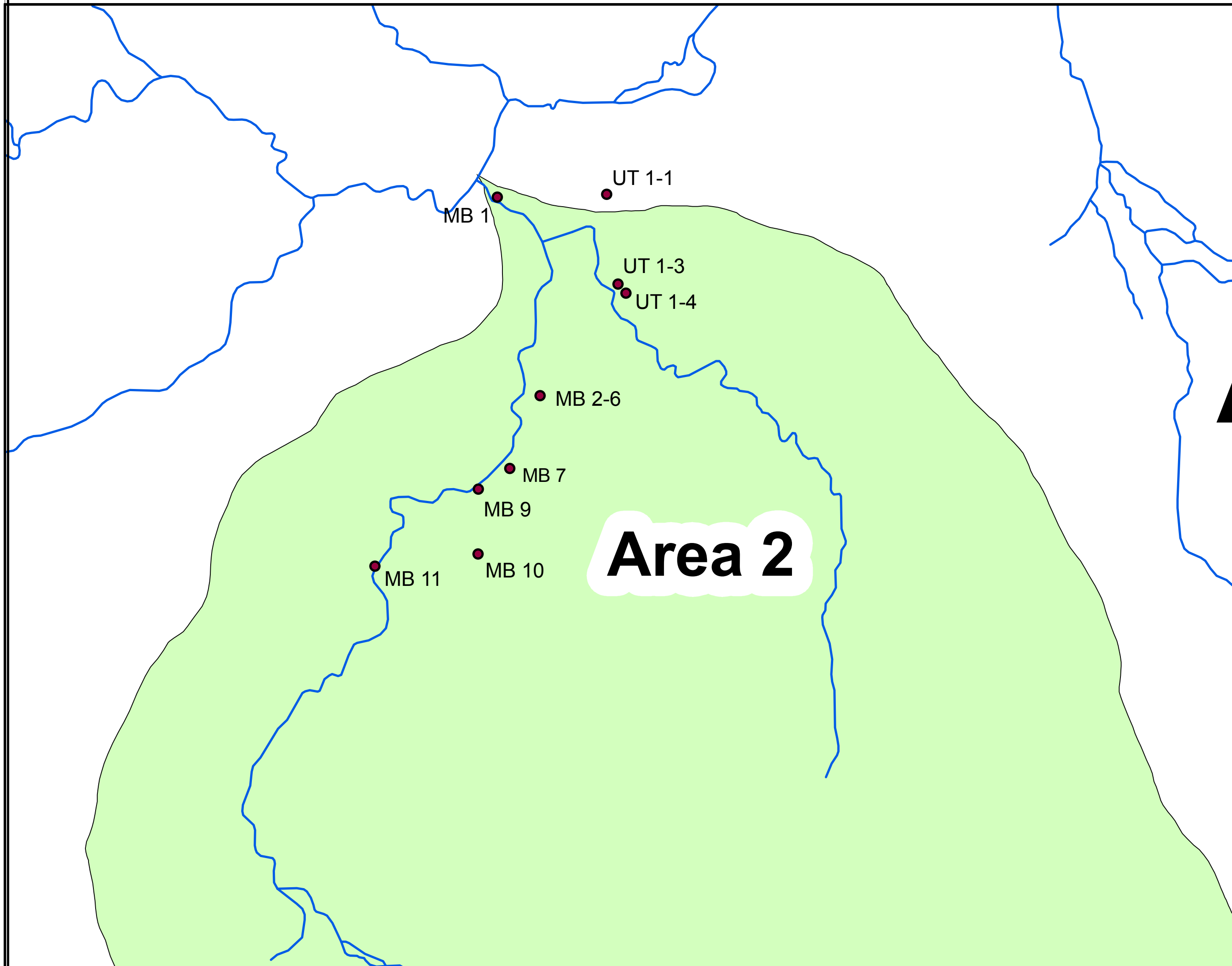
Civil boundary,
watershed boundaries,
and topographic rasterization
Accessed from PASDA

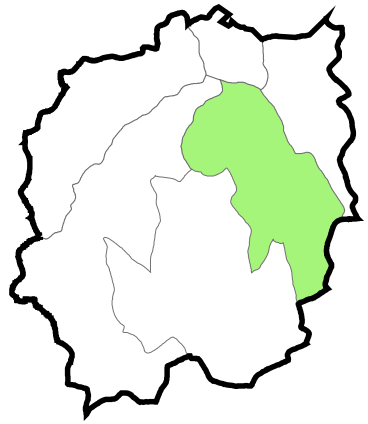
0 262.5 525 1,050 1,575 2,100 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Sampling in Priority Area #2





Priority Area 2 within Assessment Area

Civil boundary and watershed boundaries Accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

Monthly sampling points in priority area

1:18,995

0 240 480 960 1,440 1,920 Meters

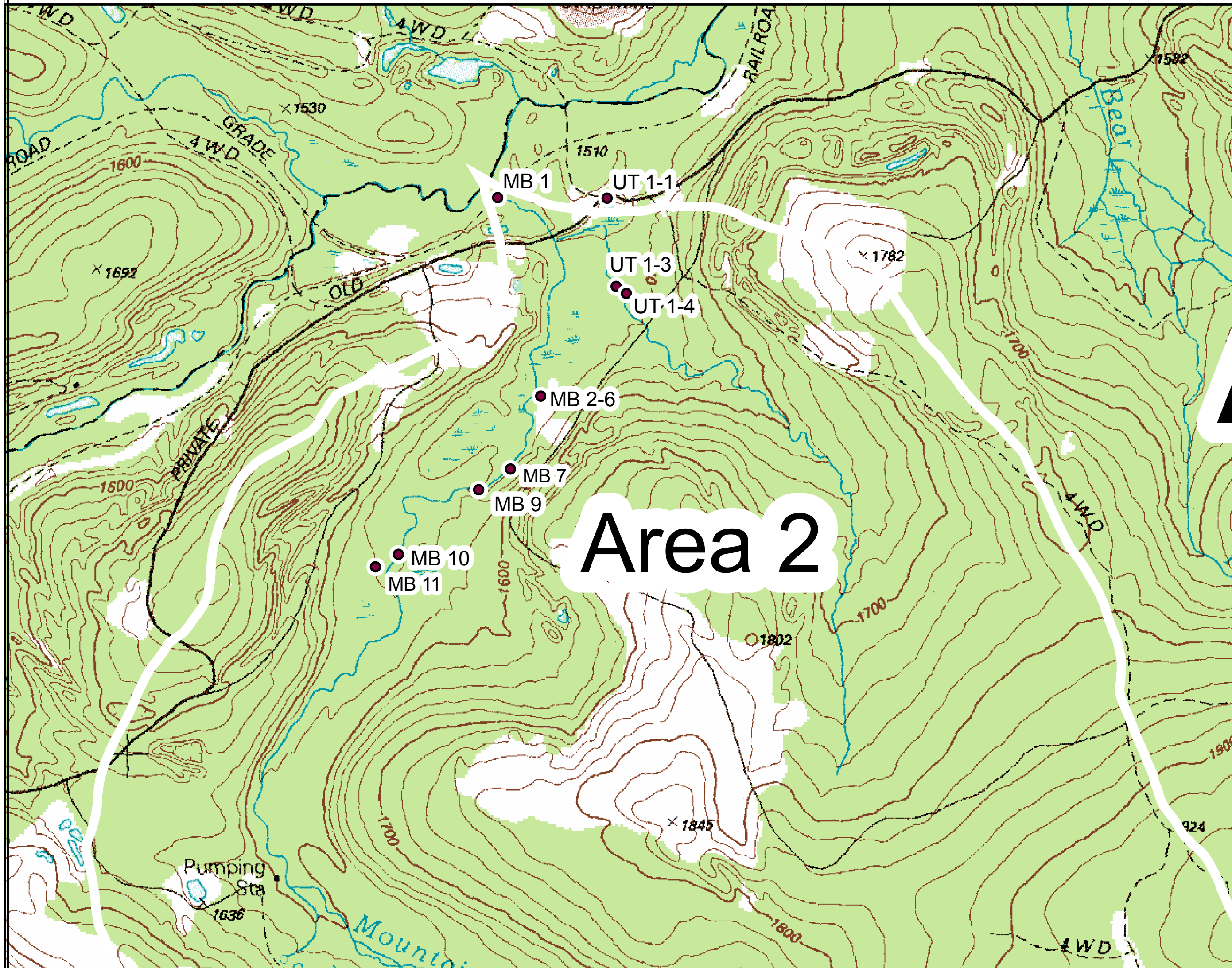
A-15

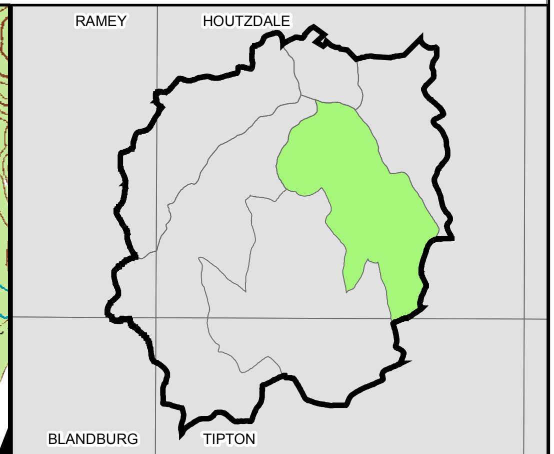
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NMBS NEW MILES OF BLUE STREAM

Sampling in Priority Area #2

N





Priority Area 2 within
Assessment Area
and USGS Quads

Monthly sampling points in priority area

1:18,995

Civil boundary,
watershed boundaries,
and topographic rasterization
Accessed from PASDA

0 240 480 960 1,440 1,920 Meters

A-16

NMBS
NEW MILES OF BLUE STREAM

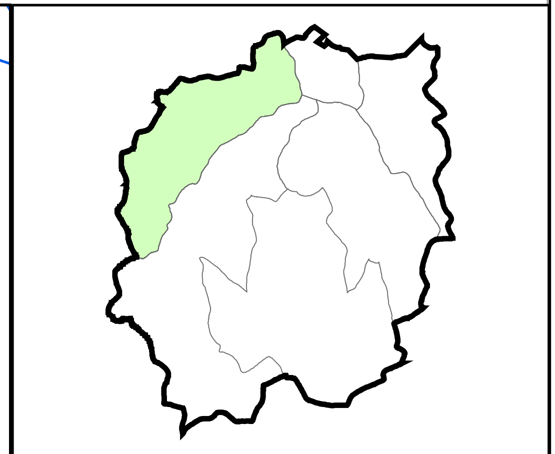
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Sampling in Priority Area #3

N

Monthly sampling points in priority area

1:17,327



Priority Area 3 within Assessment Area

Civil boundary and watershed boundaries Accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

0 215 430 860 1,290 1,720 Meters

A-17

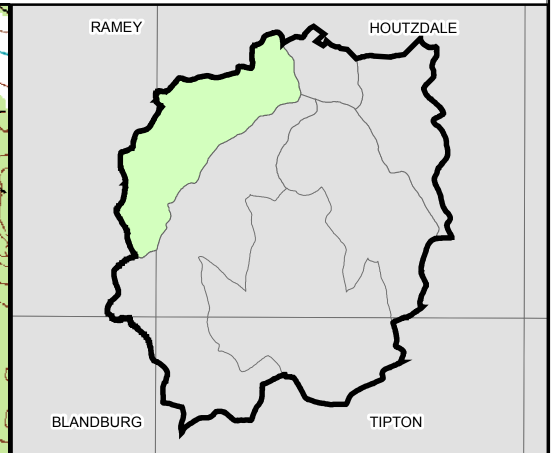
NMBS NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Sampling in Priority Area #3

Monthly sampling points in priority area

1:17,327



Priority Area 3 within Assessment Area and USGS Quads

Civil boundary,
watershed boundaries,
and topographic rasterization
Accessed from PASDA

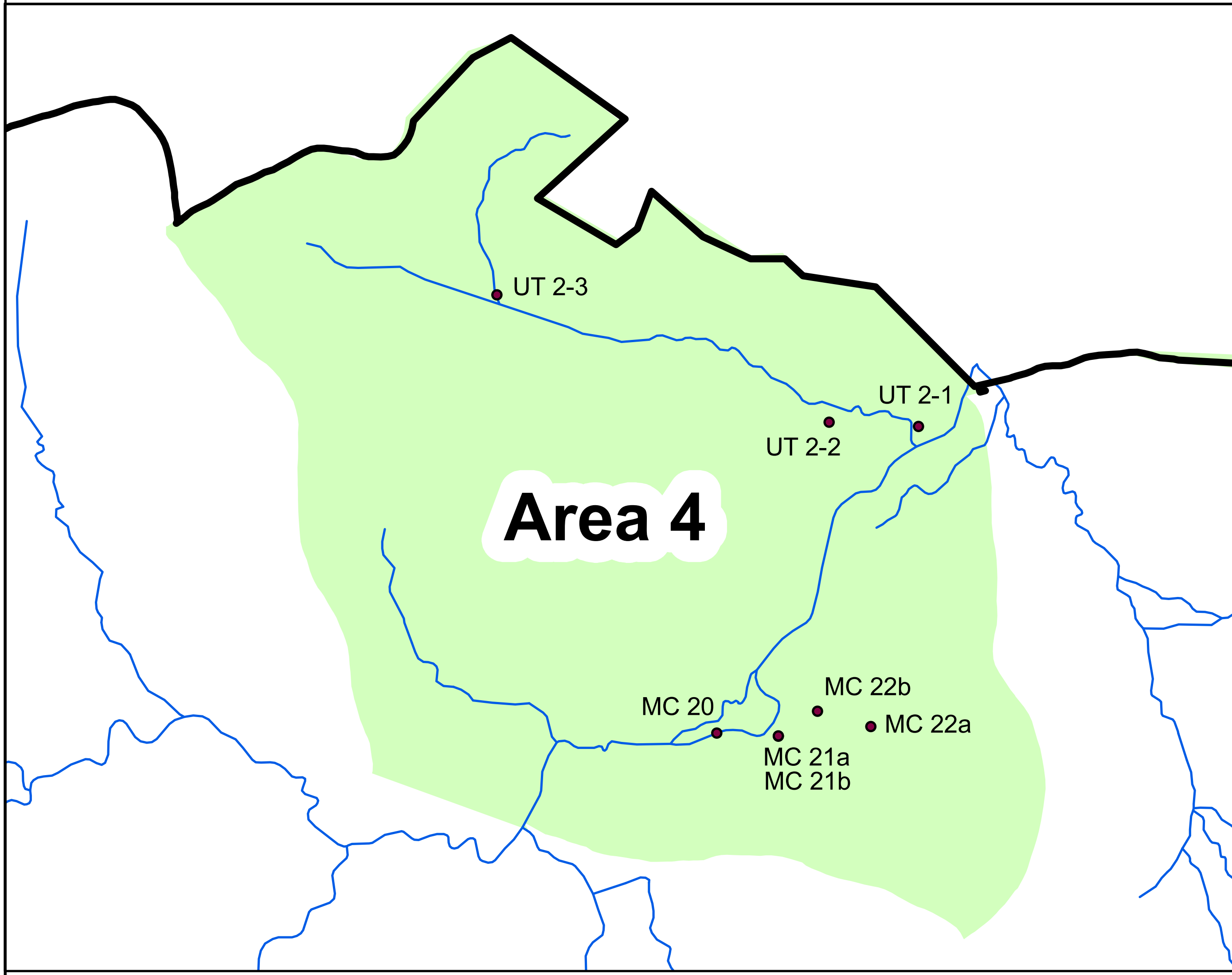
0 212.5 425 850 1,275 1,700 Meters

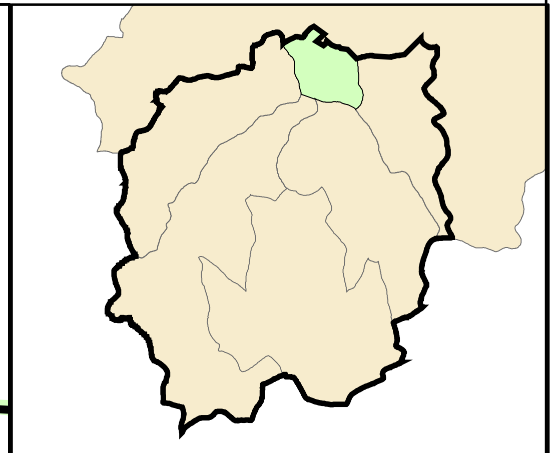
A-18

NMBS
NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Sampling in Priority Area #4





Priority Area 4 within Assessment Area

Civil boundary and watershed boundaries Accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

Monthly sampling points in priority area

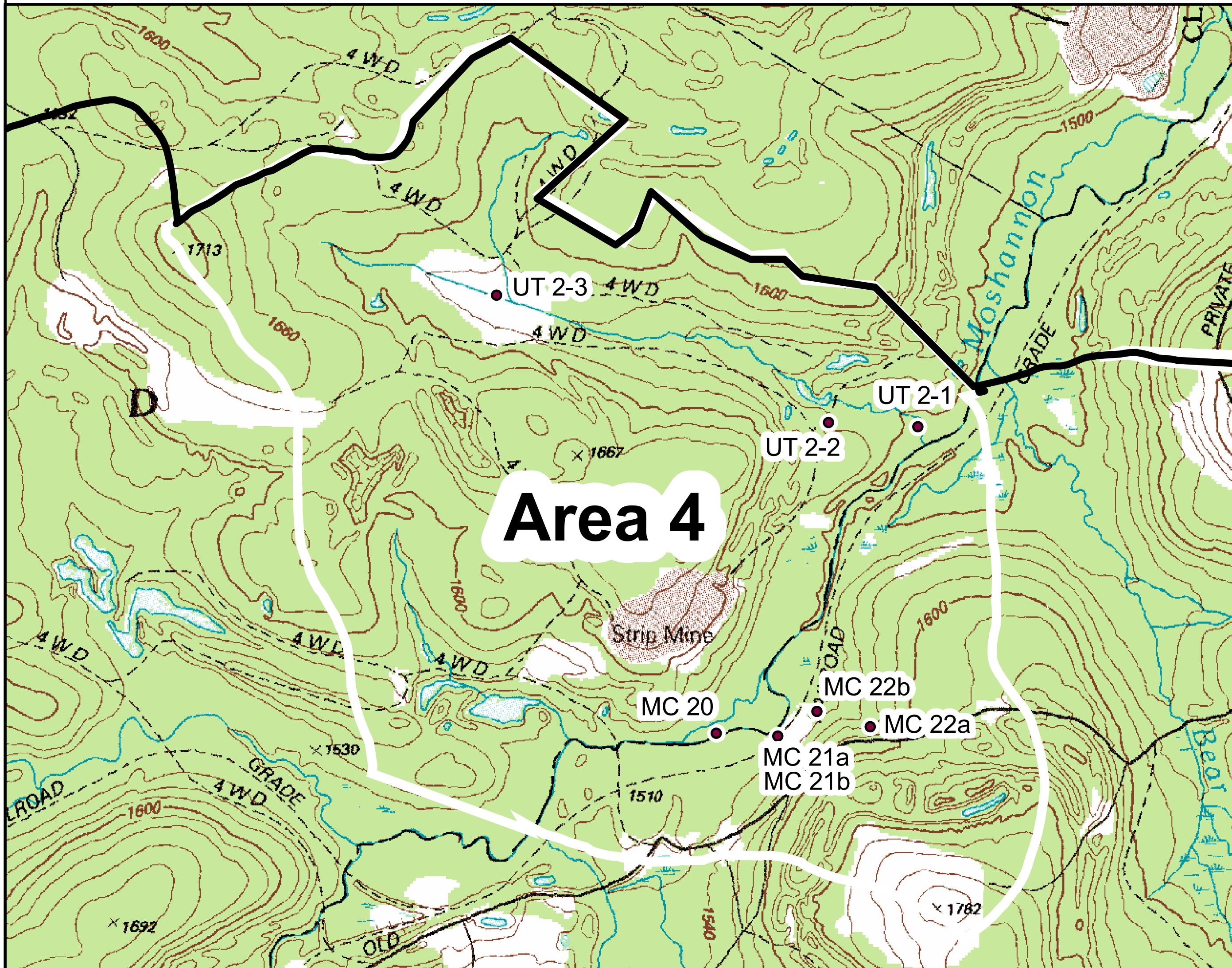
1:17,669

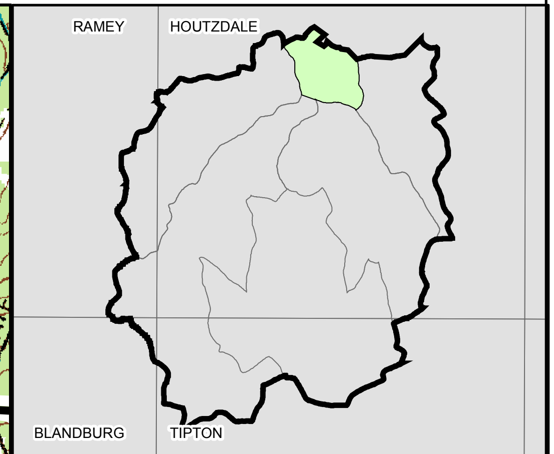
0 220 440 880 1,320 1,760 Meters

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Sampling in Priority Area #4





Priority Area 4 within Assessment Area and USGS Quads

Monthly sampling points in priority area

1:17,669

Civil boundary, watershed boundaries, and topographic rasterization Accessed from PASDA

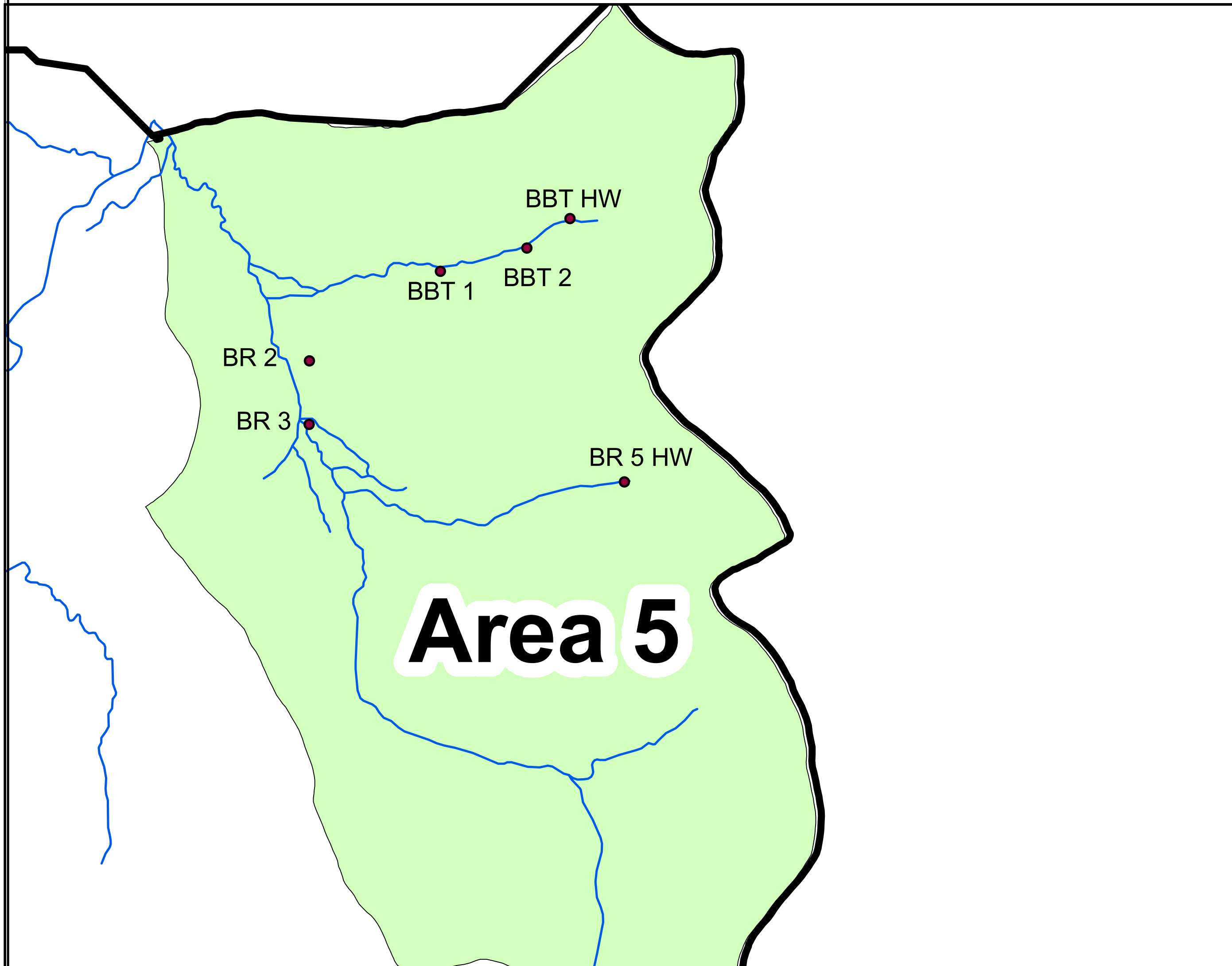
0 220 440 880 1,320 1,760 Meters

A-20

NMBS NEW MILES OF BLUE STREAM

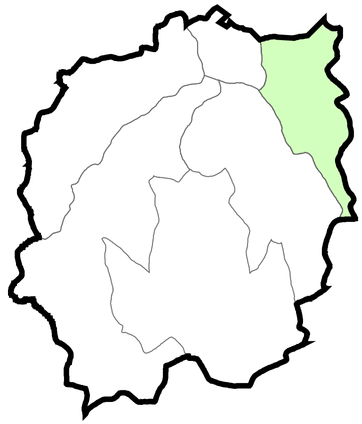
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Sampling in Priority Area #5



Monthly sampling points in priority area

1:26,292



Priority Area 5 within Assessment Area

Civil boundary and watershed boundaries Accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

0 325 650 1,300 1,950 2,600 Meters

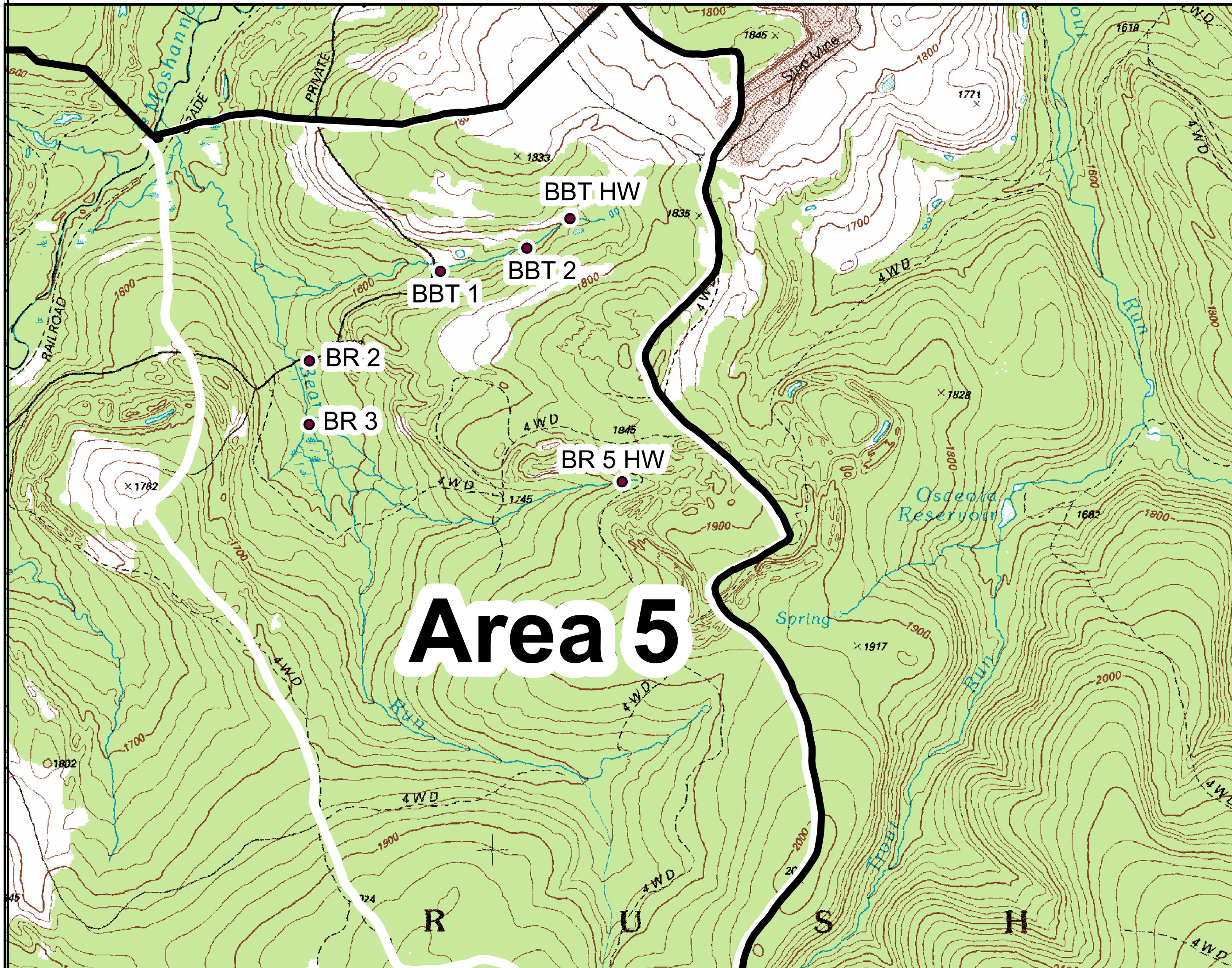
A-21

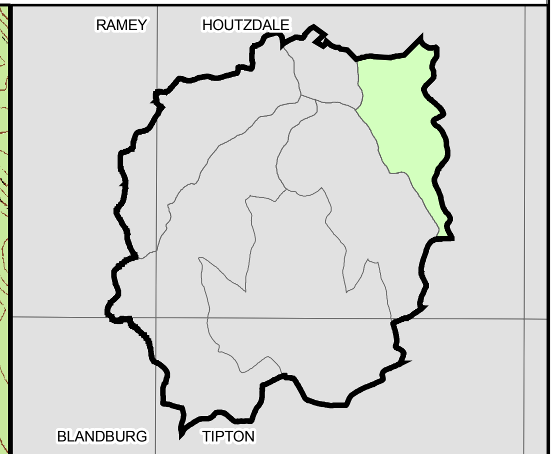
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Sampling in Priority Area #5

N





Priority Area 5 within Assessment Area and USGS Quads

Civil boundary,
watershed boundaries,
and topographic rasterization
Accessed from PASDA

Monthly sampling points in priority area

1:26,292

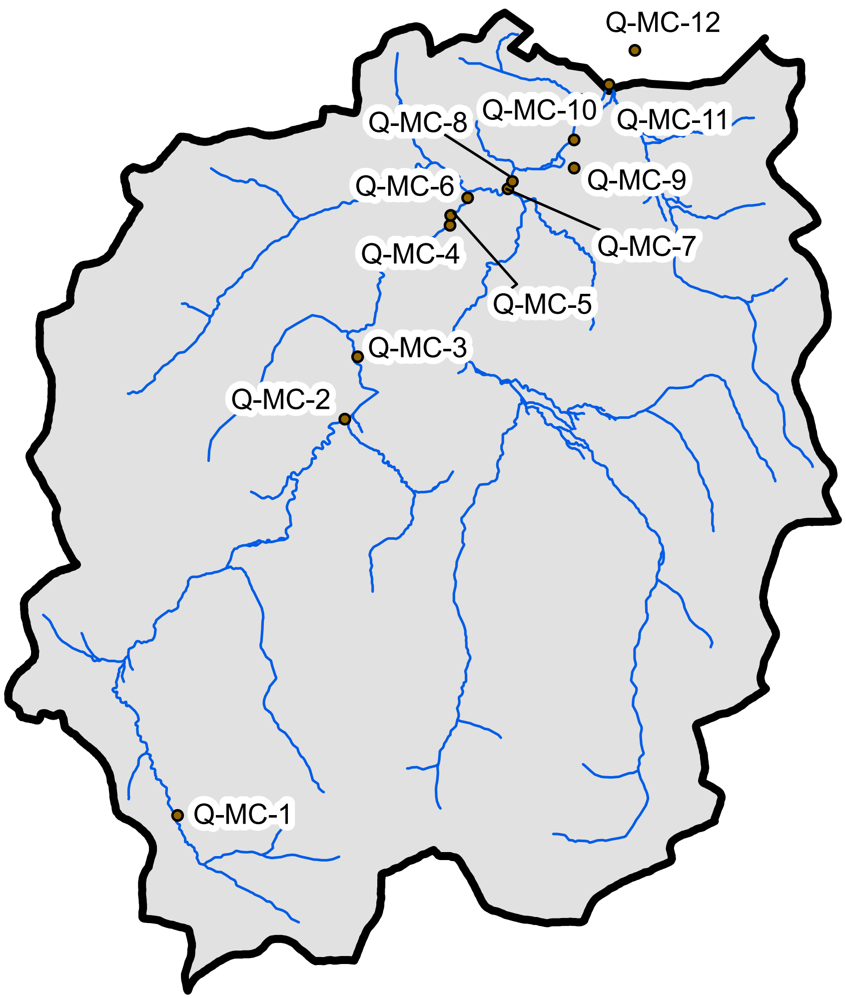
0 325 650 1,300 1,950 2,600 Meters

A-22

NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Quarterly samples



Assessment Area within Moshannon Creek Watershed

Civil boundary and watershed boundaries Accessed from PASDA

Stream data provided by USGS, EPA, USDA Forest Service and other agencies also accessed from PASDA

Location of quarterly samples

1:90,000

0 1,100 2,200 4,400 6,600 8,800 Meters

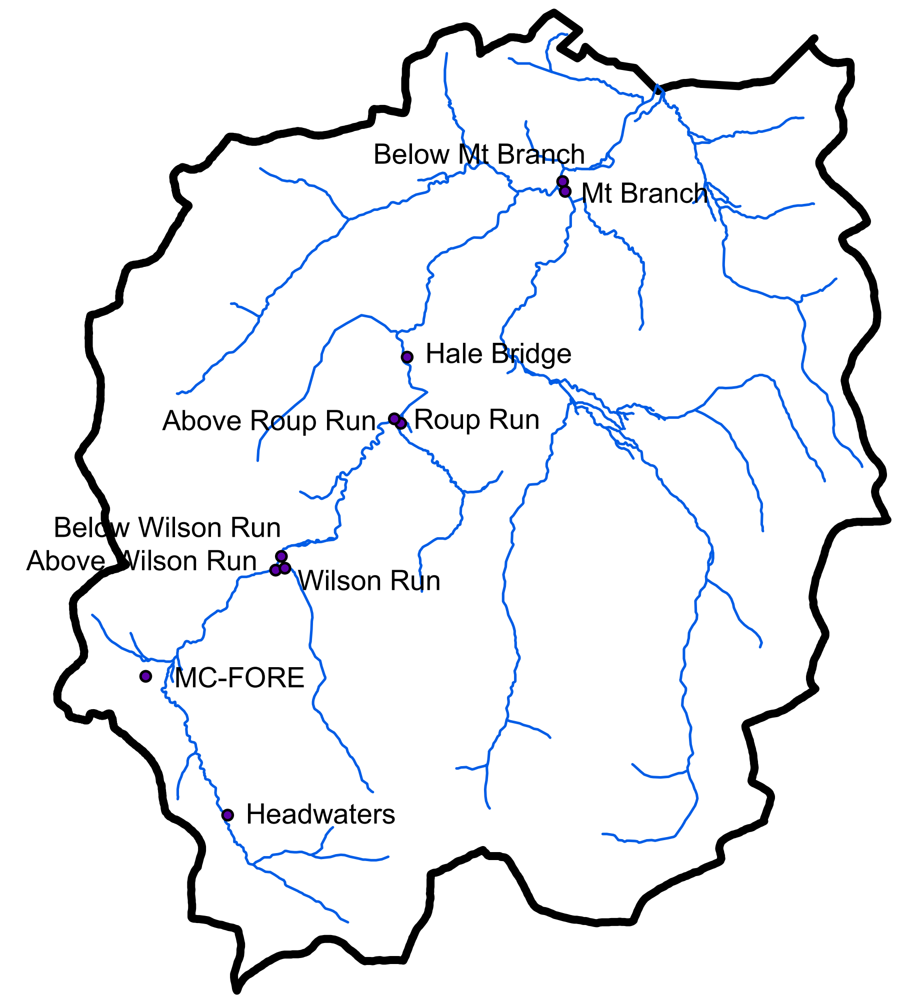
A-23

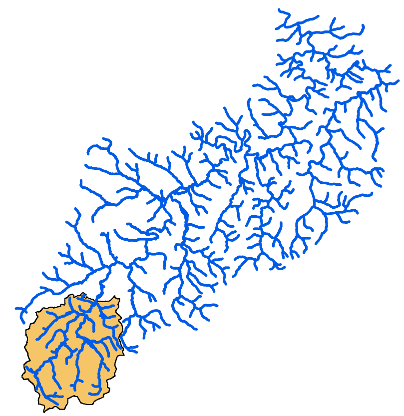
Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

NEW MILES OF BLUE STREAM

Macro invertebrate Sampling

N





Assessment Area within Moshannon Creek Watershed

Legend

- Assessment Area
- Streams
- Sampling sites

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies.
Impaired stream data provided by PA DEP (2009 data)
Accessed from PASDA

macroinvertebrate sampling points in assessment area

1:90,000

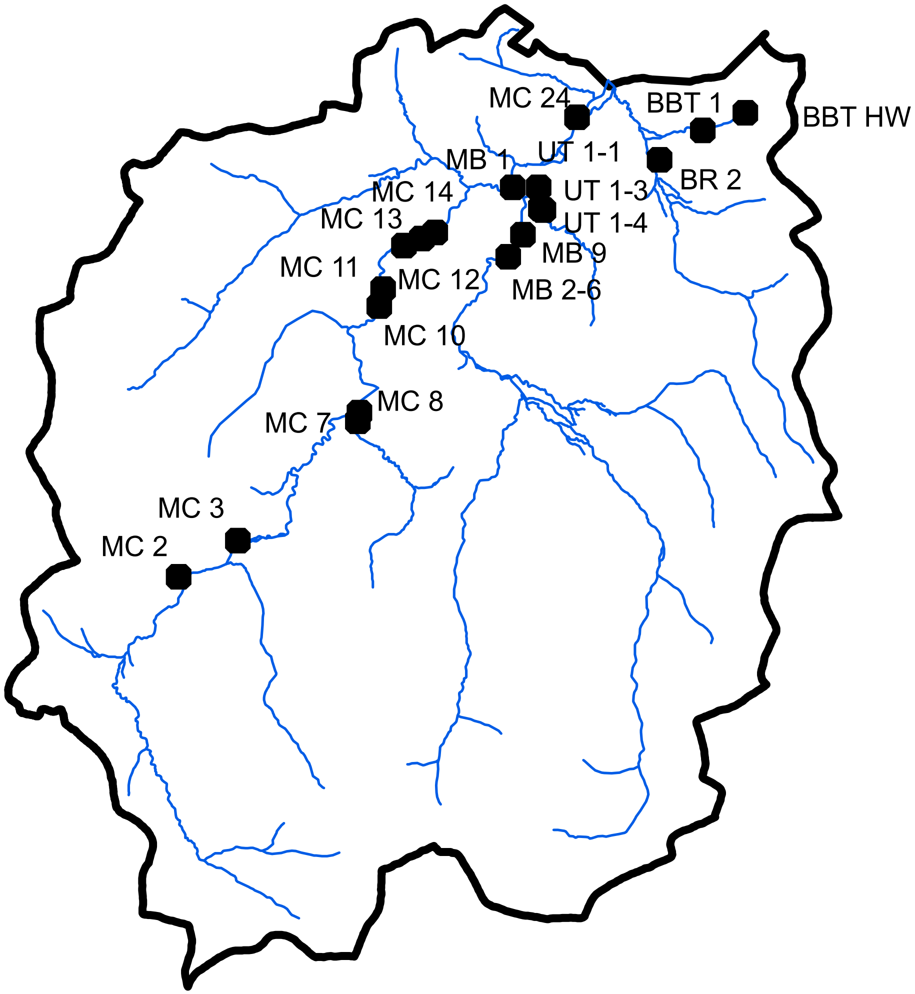
0 1,050 2,100 4,200 6,300 8,400 Meters

NMBS NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Potential Reclamation Areas

N



Assessment Area within Moshannon Creek Watershed

Legend

Streams

Assessment area

Sampling points needing reclamation

Stream outlines provided by USGS, EPA, USDA Forest Service, and other agencies. Geology data from the Susquehanna River Basin Commission
Accessed from PASDA

Sampling points identified as having reclamation needs

1:90,035

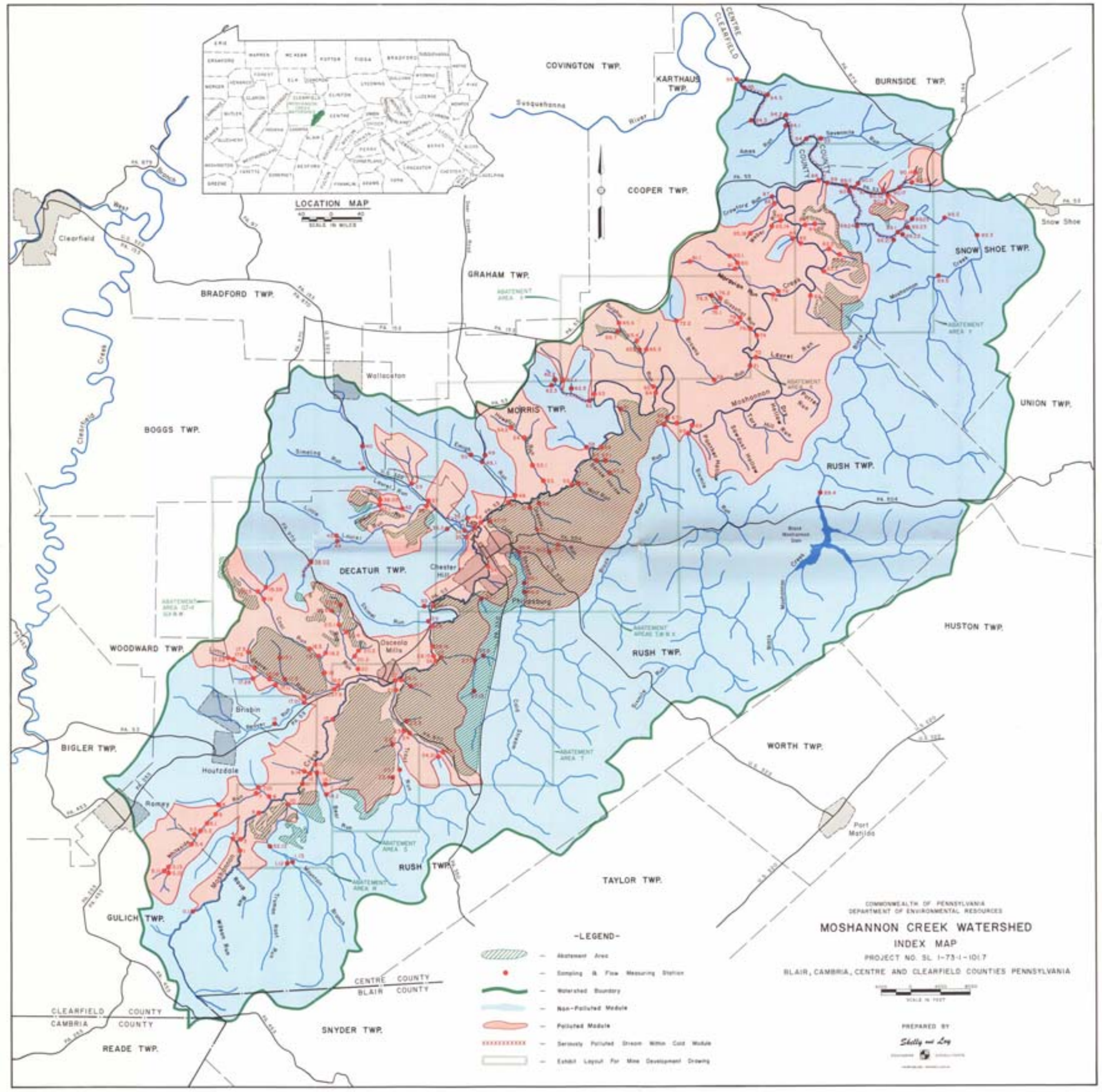
0 1,050 2,100 4,200 6,300 8,400 Meters

A-25

NMBS
NEW MILES OF BLUE STREAM

Map is intended as representational. Size and position of map elements are not guaranteed in size or placement.

Scarlift map



This map was obtained at

http://amrclearinghouse.org/Sub/SCARLIFTReports/ClearfieldMoshannon/MoshannonCreekWatershedIndexMap.pdf.

Appendix B: Associated files

The following table lists the files which were collected during the process of developing this assessment. These files can be found on the accompanying CD. To access associated information on the CD, open the file "index.html." A copy of the CD will be available for some period of time at http://www.newmilesofbluestream/compprojects/assess/mockhw/index.html

Assessment Data

The assessment data is available on the CD. It is in a CSV file format (text). A definition of the data included is also included. The reference for the data files and the definition of the fields are both available under the menu option "Data."

Historical data

The historical data gathered during the assessment is available on the CD. It is in a CSV file format (text). A definition of the data included is also included. The reference for the data files and the definition of the fields are both available under the menu option "Historical Data." A link to this information is also available under the menu titled "Data."

Images

Pictures taken during the assessment are catalogued and made available on the CD. To access pictures, select "View Pictures" from the menu.

Mine Maps

Mine maps for the assessment area were obtained from the OSM Bureau of Mines. These are catalogued by USGS quadrant. A catalogue of the available mine maps is available under the menu option "Mine maps."

Appendix C: Alternate Ranking Orders

Stream miles

The below ranking is based on the restoration of stream miles. Due to the size of the watershed and the number of treatment systems necessary for restoration, the area was broken into smaller segments to focus restoration efforts. By focusing on each area beginning in the headwaters of that area, stream miles can be recovered and a fishery can begin to be restored. This is presented as Option #1 for restoration efforts and is being put forth as the recommendation for priority treatment systems and reclamation areas.

Area	Site	Reclamation Yes or No	Potential Active Yes or No	Estimated Cost	Acid Load lbs/day	Iron Load lbs/day	Aluminum Load lbs/day
#1	MC 1	N	N	405,000	110	70	0.2
#1	MC 2	Y	N	575,000	40	2	5.5
#1	MC 3	Y	N	400,000	16	15	0.1
#1	MC 7	Y	N	650,000	144	30	7
#1	MC 8	Y	Y	575,000	211	17	19
#1	MC 10	Y	N	245,000	18	4	1
#1	MC 11	Y	N	220,000	6	1	1
#1	MC 12	Y	N	245,000	66	30	7
#1	MC 13	Y	Y	390,000	72	32	2
#1	MC 14	Y	Y	220,000	40	12	3
#1	MC 15	N	N	170,000	46	24	0.2
#2	MB 11	N	N	170,000	12	0.6	1.8
#2	MB 10	N	N	495,000	150	4.5	12
#2	MB 9	Y	N	495,000	93	1.2	7.2
#2	MB 7	N	N	170,000	14	0.3	1.8
#2	MB 2-6	Y	N	625,000	107	5.5	12
#2	MB 1	Y	N	195,000	6	0.6	0.03
#2	UT 1-4	Y	N	295,000	46	1.2	6
#2	UT 1-3	Y	Y	695,000	236	13	28
#2	UT 1-1	Y	N	595,000	90	4.8	10.5
#3	WR 5	N	N	170,000	13		
#3	WR 4	N	N	145,000	6	6	0.5
#3	WR 1	N	N	170,000	42	3.5	
#4	UT 2-3	N	N	No treatment			
#4	UT 2-2	N	N	145,000	5.4	1.5	0.06
#4	UT 2-1	N	N	195,000	18	4.8	0.31

#4	MC 23	N	N	270,000	24	15	
#4	MC 24	Y	N	270,000	12	1.2	1.2
#4	MC 22A	N	N	570,000	148.5	6.6	18.5
#4	MC 22B	Y	Y	695,000	149	68	16.8
#4	MC 21A	Y	Y	620,000	127	7.5	14.4
#4	MC 21B	Y	Y	495,000	86.4	4.3	13.5
#5	BR5 HW	Y	N	495,000	45	1	3.5
#5	BR 3	N	N	280,000	12	0.12	1.2
#5	BR 2	Y	N	320,000	30	0.6	3
#5	BBT HW	Y	N	695,000	175	14	18
#5	BBT 2	N	N	320,000	37	0.5	6
#5	BBT 1	Y	Y		434	56	39

Acid Load

The below ranking is based solely on acid load entering Moshannon Creek. This ranking would not necessarily allow for the restoration of stream miles, but would remove acid load from both the Moshannon Creek Watershed and subsequently the West Branch of the Susquehanna. Because most of Moshannon Creek is on the “tipping point” for restoration, by focusing on the largest inputs of acid and metal loadings may allow for a “quicker” restoration to the main stem. This is presented as Option #2 for restoration efforts and should be considered by the project partners.

Area	Site	Reclamation Yes or No	Potential Active Yes or No	Estimated Cost	Acid Load lbs/day	Iron Load lbs/day	Aluminum Load lbs/day
#5	BBT 1	Y	Y		434	56	39
#2	UT 1-3	Y	Y	695,000	236	13	28
#1	MC 8	Y	Y	575,000	211	17	19
#5	BBT HW	Y	N	695,000	175	14	18
#2	MB 10	N	N	495,000	150	4.5	12
#4	MC 22B	Y	Y	695,000	149	68	16.8
#4	MC 22A	N	N	570,000	148.5	6.6	18.5
#1	MC 7	Y	N	650,000	144	30	7
#4	MC 21A	Y	Y	620,000	127	7.5	14.4
#1	MC 1	N	N	405,000	110	70	0.2
#2	MB 2-6	Y	N	625,000	107	5.5	12
#2	MB 9	Y	N	495,000	93	1.2	7.2
#2	UT 1-1	Y	N	595,000	90	4.8	10.5
#4	MC 21B	Y	Y	495,000	86.4	4.3	13.5
#1	MC 13	Y	Y	390,000	72	32	2
#1	MC 12	Y	N	245,000	66	30	7

#1	MC 15	N	N	170,000	46	24	0.2
#2	UT 1-4	Y	N	295,000	46	1.2	6
#5	BR5 HW	Y	N	495,000	45	1	3.5
#3	WR 1	N	N	170,000	42	3.5	
#1	MC 2	Y	N	575,000	40	2	5.5
#1	MC 14	Y	Y	220,000	40	12	3
#5	BBT 2	N	N	320,000	37	0.5	6
#5	BR 2	Y	N	320,000	30	0.6	3
#4	MC 23	N	N	270,000	24	15	
#1	MC 10	Y	N	245,000	18	4	1
#4	UT 2-1	N	N	195,000	18	4.8	0.31
#1	MC 3	Y	N	400,000	16	15	0.1
#2	MB 7	N	N	170,000	14	0.3	1.8
#3	WR 5	N	N	170,000	13		
#2	MB 11	N	N	170,000	12	0.6	1.8
#4	MC 24	Y	N	270,000	12	1.2	1.2
#5	BR 3	N	N	280,000	12	0.12	1.2
#1	MC 11	Y	N	220,000	6	1	1
#2	MB 1	Y	N	195,000	6	0.6	0.03
#3	WR 4	N	N	145,000	6	6	0.5
#4	UT 2-2	N	N	145,000	5.4	1.5	0.06
#4	UT 2-3	N	N	No treatment			

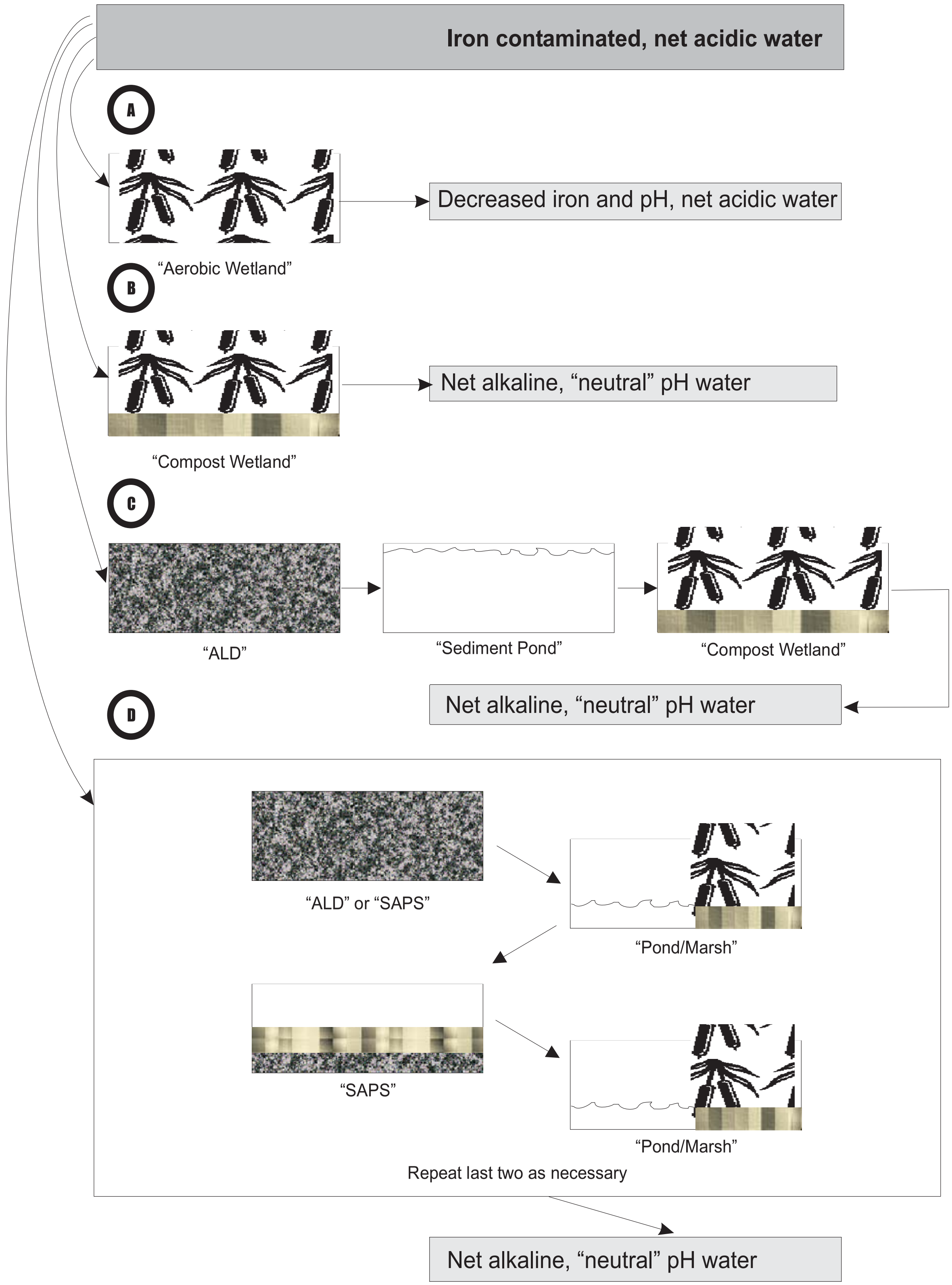
Iron Load

The below ranking is based solely on iron load entering Moshannon Creek. This ranking would not necessarily allow for the restoration of stream miles, but would remove iron load from both the Moshannon Creek Watershed and subsequently the West Branch of the Susquehanna. Because most of Moshannon Creek is on the "tipping point" for restoration, by focusing on the largest inputs of metal loadings may allow for a "quicker" restoration to the main stem. This is presented as Option #3 for restoration efforts and should be considered by the project partners.

Area	Site	Reclamation Yes or No	Potential Active Yes or No	Estimated Cost	Acid Load lbs/day	Iron Load lbs/day	Aluminum Load lbs/day
#1	MC 1	N	N	405,000	110	70	0.2
#4	MC 22B	Y	Y	695,000	149	68	16.8
#5	BBT 1	Y	Y		434	56	39
#1	MC 13	Y	Y	390,000	72	32	2
#1	MC 7	Y	N	650,000	144	30	7

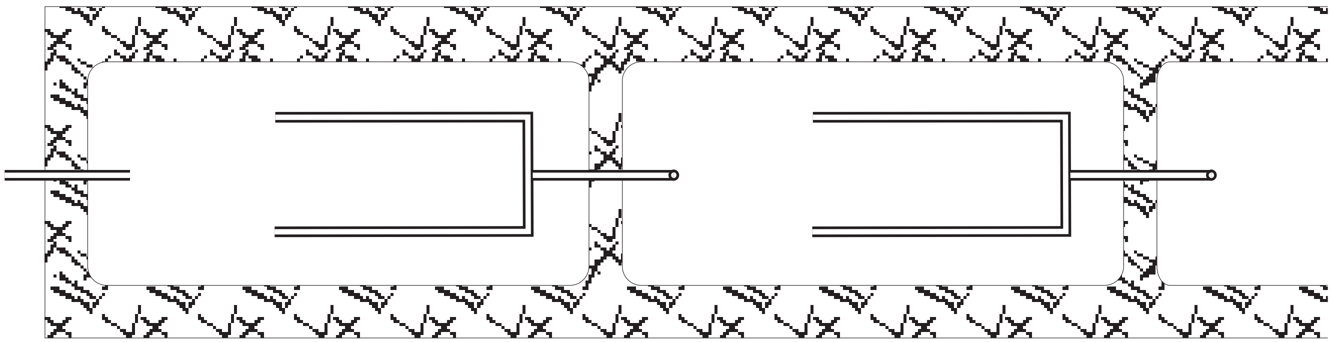
#1	MC 12	Y	N	245,000	66	30	7
#1	MC 15	N	N	170,000	46	24	0.2
#1	MC 8	Y	Y	575,000	211	17	19
#1	MC 3	Y	N	400,000	16	15	0.1
#4	MC 23	N	N	270,000	24	15	
#5	BBT HW	Y	N	695,000	175	14	18
#2	UT 1-3	Y	Y	695,000	236	13	28
#1	MC 14	Y	Y	220,000	40	12	3
#4	MC 21A	Y	Y	620,000	127	7.5	14.4
#4	MC 22A	N	N	570,000	148.5	6.6	18.5
#3	WR 4	N	N	145,000	6	6	0.5
#2	MB 2-6	Y	N	625,000	107	5.5	12
#2	UT 2-1	N	N	195,000	18	4.8	0.31
#2	UT 1-1	Y	N	595,000	90	4.8	10.5
#2	MB 10	N	N	495,000	150	4.5	12
#4	MC 21B	Y	Y	495,000	86.4	4.3	13.5
#1	MC 10	Y	N	245,000	18	4	1
#3	WR 1	N	N	170,000	42	3.5	
#1	MC 2	Y	N	575,000	40	2	5.5
#4	UT 2-2	N	N	145,000	5.4	1.5	0.06
#2	MB 9	Y	N	495,000	93	1.2	7.2
#2	UT 1-4	Y	N	295,000	46	1.2	6
#4	MC 24	Y	N	270,000	12	1.2	1.2
#1	MC 11	Y	N	220,000	6	1	1
#5	BR5 HW	Y	N	495,000	45	1	3.5
#2	MB 11	N	N	170,000	12	0.6	1.8
#2	MB 1	Y	N	195,000	6	0.6	0.03
#5	BR 2	Y	N	320,000	30	0.6	3
#5	BBT 2	N	N	320,000	37	0.5	6
#2	MB 7	N	N	170,000	14	0.3	1.8
#5	BR 3	N	N	280,000	12	0.12	1.2
#3	WR 5	N	N	170,000	13		
#4	UT 2-3	N	N	No treatment			

Evolution of Passive Treatment technology since 1980s

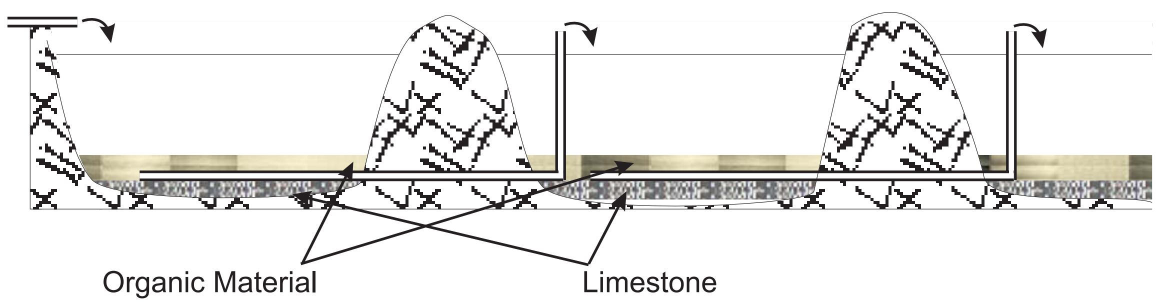


Views of a VFW system

A. Top View

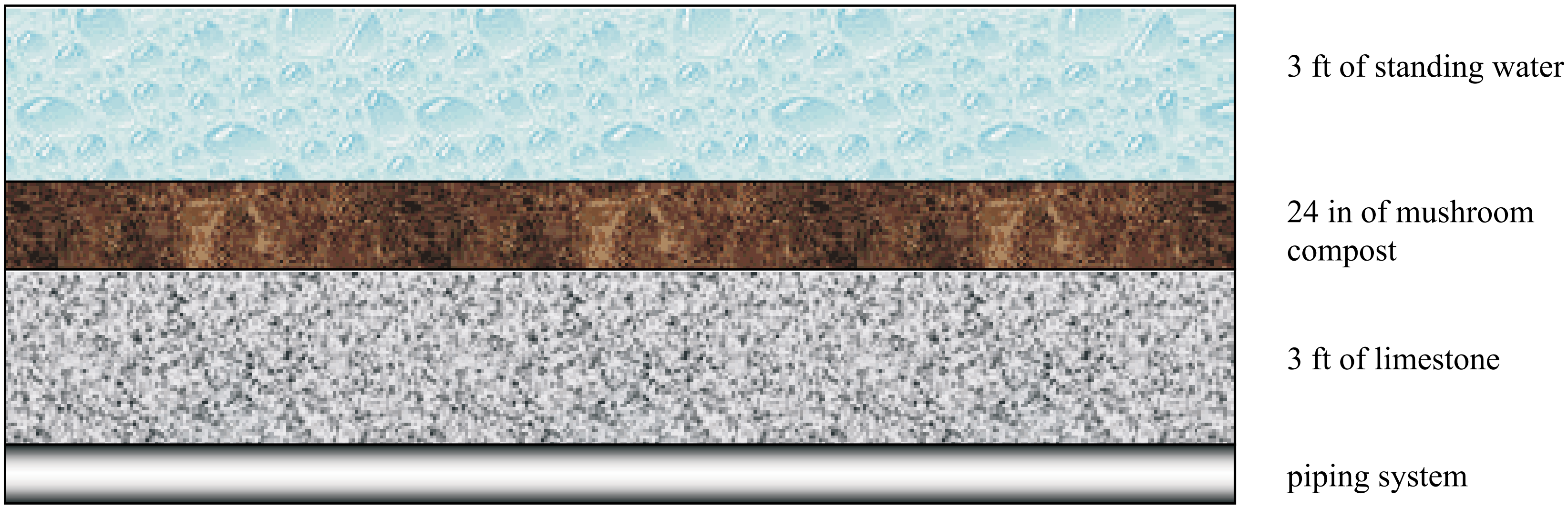


B. Side View

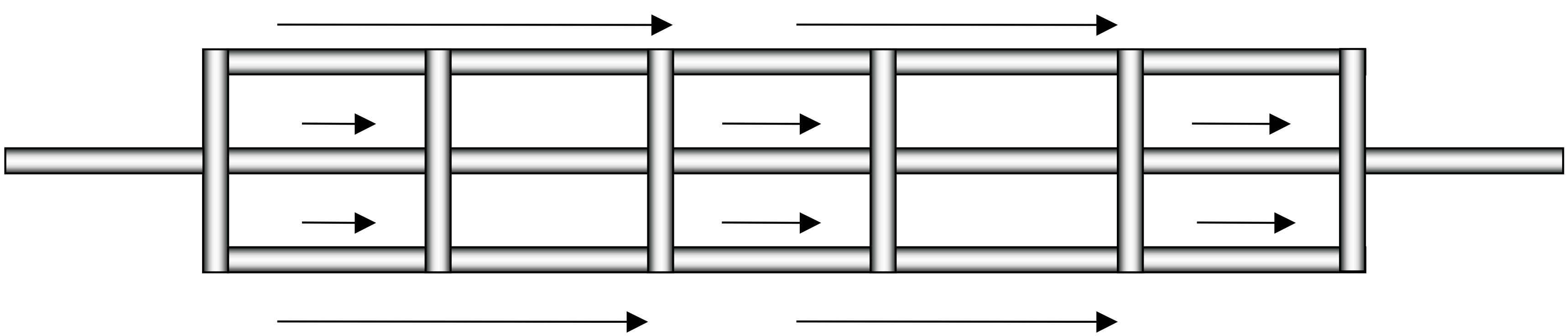


Cross sections of components of a VFW

Cross sections of a VFW



Cross sections of the piping layout in a VFW



Appendix E: Macroinvertebrate Study

Aquatic Investigation of the Headwaters of Moshannon Creek Watershed

Jane Earle

An aquatic investigation of the headwaters of Moshannon Creek and two tributaries was conducted on May 27 and 28, 2008 to determine baseline conditions of the aquatic macroinvertebrate fauna. Jane Earle was lead investigator; assisting were Larry Jackson, Carl Undercofler, Jen Demchak, Rachel Kester, and Sean Bartlett. Locations sampled are listed in Table 1, starting with the most upstream station.

Moshannon Creek watershed is located in Centre and Clearfield Counties in northcentral Pennsylvania. The creek forms the boundary between the two counties. The watershed is largely forested except where highways, secondary, gravel roads, and trails cross, and where reclaimed and unreclaimed surface mines have altered the landscape. Houses, businesses, and other development are located mainly along highways, secondary roads, and in villages. Few public roads traverse the upper watershed. Access to the creek was provided mostly by private gravel roads, trails, and mine access roads. Discharges from abandoned surface and underground coal mines are the major water pollution sources.

Water quality

Water chemistry samples were not collected as part of this investigation but are available in the watershed restoration plan. Data from locations relevant to this report are presented in Table 2 and summarized here. The water quality of Moshannon Creek headwaters and in the area upstream of Roup Run would be considered excellent. The pH ranged from 6.3 to 6.6. Alkalinity concentrations ranging from 7 to 9 mg/l, however, are indicative of infertile, low nutrient conditions.

Water quality worsened at Hale Road Bridge, which had pH ranging from 4.5 to 5.1, slightly lower alkalinity at 4 to 6 mg/l, and acidity slightly higher at 8 to 15 mg/l. Total iron and sulfate concentrations, however, were relatively low for streams receiving coal mine drainage at 0.8 to 2.6 mg/l and 23 to 74 mg/l, respectively. Iron precipitate covered the stream substrate. Water chemistry downstream of Mountain Branch was similar to upstream at Hale Road Bridge, with pH ranging from 4.2 to 5.8, alkalinity from 1 to 6 mg/l, acidity from 10 to 17 mg/l. Iron concentrations ranged from 1.5 to 3.0 mg/l and sulfate concentrations ranged from 23 to 69 mg/l, however, were relatively low for coal mining affected streams. Iron precipitate covered the stream substrate.

Water quality in Mountain Branch was poor. The pH ranged from 3.8 to 5.8, alkalinity from 0 to 7 mg/l, and acidity from 10 to 19 mg/l. Iron ranging from 2.8 to 3.6 mg/l and sulfate ranging from 34 to 83 mg/l were relatively low for streams receiving abandoned mine drainage.

Methods

Sampling followed the protocol developed by the Pennsylvania Department of Environmental Protection (DEP) for determining the index of biological integrity (IBI) for benthic macroinvertebrate communities in wadeable freestone streams in Pennsylvania (Chalfont 2007). The IBI allows direct quantification of important ecological attributes along a gradient of biological conditions and ecosystem stressors and serves as a measure of the extent to which anthropogenic stressors impair the capability of a stream to support a healthy aquatic community. The highest possible IBI value is 100. The closer the stream section IBI is to 100, the better the macroinvertebrate fauna and water quality. An IBI score between 80.0 and 63.0 generally indicates less pristine or declining but still functional water quality conditions. An IBI score below 63.0 generally indicates more severely degraded water quality conditions. IBI scores and their relationship to water quality are further discussed in Appendix G in Chalfont (2007).

Summary of collection and processing methods

Samples were collected with a 500 micron D-frame net. Six one-minute timed kicks were made in riffles within a 100 meter stream section. The substrate was disturbed within an approximately 1 meter area upstream of the net. The contents of the six kicks were combined and preserved in 95% ethanol. In the lab, samples were rinsed in a 500 micron sieve, and placed into a white 18 x 25 inch sorting tray divided into 28 squares with grid lines. The contents of randomly selected grids were removed from the pan into a second pan and subsets were removed until 200 to 240 organisms were removed. Organisms from the sub-sample were identified under a compound microscope using dichotomous keys in established reference publications. More details and the rational for this sampling method can be found in the DEP wadeable streams protocol (Chalfont 2007).

Pollution tolerance values

Each macroinvertebrate taxa has been assigned a pollution tolerance value, based on the Hilsenhoff tolerance values developed for organic pollution and modified for use in Pennsylvania by DEP. The values for Pennsylvania taxa can be found in Appendix E of the DEP wadeable streams protocol (Chalfont 2007). Pollution tolerance values are on a scale of 0 to 10, with 0 indicating the most sensitive or least tolerant to pollution and 10 indicating the most tolerant to pollution.

Metrics

Six metrics are used to develop the Pennsylvania IBI.

Modified Beck's Index

This taxonomic composition metric is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric which reflects the loss of pollution-sensitive taxa is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

Ephemeroptera + Plecoptera + Trichoptera (EPT) Taxa Richness

This community structure metric is a count of the number of taxa belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in a sub-sample. The immature aquatic life stages of these insect orders are generally considered more sensitive to or intolerant of pollution. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution sensitive orders.

Total Taxa Richness

This community structure metric is a count of the total number of taxa in a sub-sample, or total taxa richness. Generally, this metric is expected to decrease with increasing anthropogenic stress to a stream ecosystem, reflecting loss of taxa and increasing dominance of a few pollution tolerant taxa.

Shannon Diversity Index

This taxonomic composition metric measures the taxonomic richness and evenness of individuals across taxa of a sub-sample. This metric is expected to decrease in values with increasing anthropogenic stress to a stream ecosystem, reflecting loss of pollution sensitive taxa and increasing dominance of a few pollution-tolerant taxa.

Hilsenhoff Biotic Index (HBI)

This taxonomic composition metric is calculated as an average pollution tolerance value weighted by the number of individuals of each taxa in the sub-sample. Unlike the other metrics used, the Hilsenhoff Biotic Index generally increases with increasing ecosystem anthropogenic stress.

Percent Intolerant Individuals

This taxonomic composition metric is the percentage of individuals with pollution tolerance values of five or less in a sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

Results

Habitat

The substrate in Moshannon Creek is comprised largely of rubble, gravel and sand with few boulders. Pools and runs generally outnumbered riffles. The ideal habitat condition for a freestone stream is close to a 1:1 ratio of pools to riffles. Most Moshannon Creek riffles are not well defined; few rock edge surfaces are exposed to shallow current, which limits attachment areas for macroinvertebrates. Most stations sampled had riparian vegetation consisting of trees and shrubs except where crossed by gravel roads and fords or where ponds and swamps reached near the stream.

Macroinvertebrates

A combined total of 54 taxa were collected. The uppermost station, Moshannon Creek headwaters, had the highest number of taxa at 36 and the tributary Mountain Branch the lowest at 5 taxa (Table 3). Moshannon Creek headwaters had the highest IBI Score and Mountain Branch the lowest IBI scores (Table 4).

Moshannon Creek Headwaters (Station 1MC)

Station 1MC had good instream habitat, with riffles, undercut banks, and fully shaded canopy. Pools, however, outnumbered riffles and the riffles present were not well defined. A variety of substrate sizes were present, dominated by rubble, sand, and gravel. Station 1MC had high taxa richness, 36, and high EPT taxa richness, 27, indicative of excellent water quality. The IBI score of 96.8 out of possible 100 also indicates an excellent macroinvertebrate fauna and pristine conditions. Four out of the six adjusted standardized metric scores (ASMS) had the highest possible carryover score of 1.000. The lowest ASMS was 0.894 for the Hilsenhoff Biotic Index which was slightly lower than the others due to a variety of mayflies and caddisflies with higher (poorer) tolerance values of 4 and 5. The other ASMS with a value less than 1.0 was the percent tolerant individuals metric, with an observed value of 84.5%, which similarly was influenced by the variety of mayflies and caddisflies with higher tolerance values. The fauna was dominated by *Ephemerella*, *Paraleptophlebia*, and *Plauditus* mayflies, *Amphinemur*a and *Leuctra* stoneflies, the aquatic riffle beetle *Oulimnus*, and Chironomidae (midges).

Moshannon Creek upstream of McFore mine discharge (Station 2MC)

Station 2MC had fewer exposed riffles and more open shade tree canopy compared to upstream at Station 1MC; pools outnumbered riffle areas. 2MC had high taxa richness at 33 and high EPT richness at 21. The IBI score was 89.9, although slightly lower than 1MC, is still indicative of a diverse macroinvertebrate fauna and excellent water quality. The lower ASMS values compared to 1MC, all slightly lower than 1.00, is likely due habitat factors, which may have also contributed to lower number of EPT taxa and total taxa richness. The fauna was dominated by *Ephemerella*, *Paraleptophlebia*, *Plauditus* and *Mccaffertium* mayflies, *Leuctra* stoneflies, the riffle beetle *Promoresia*, midges, Chironomidae, and the cranefly *Antocha*.

Moshannon Creek downstream of McFore Mine Discharge (3MC)

This station was downstream of a large, open swampy area with few trees, several beaver ponds, and a gravel road. Beaver ponds were also present 50 yards downstream of the station, which meant that few riffles were available to sample for macroinvertebrates. The substrate had some iron staining but iron precipitate was not present on most rocks.

This station was downstream of the first major mine discharge in the watershed, which adversely affected the macroinvertebrate fauna. The total taxa richness at 14, total EPT taxa at 5, and total number of individuals at 61 were much lower than upstream. Total numbers of organisms was also low since the entire sample was picked to reach the total of 61 organisms. The IBI score was only 38.7, considerably lower than the upstream average of 93.4. As further evidence of the adverse effect of the mine discharge, all individual metric scores except the Hilsenhoff Biotic Index (HBI) were much lower than upstream. The higher HBI observed metric value compared to upstream is consistent with the macroinvertebrates present having higher pollution tolerance values. Surprisingly, the Shannon Diversity Index was not that much lower than upstream. This is likely due to the relatively uniform but low numbers of individuals of most of the taxa present rather than extreme dominance by one or two particular taxa. The most common taxa were the dipterans Chironomidae and *Simulium*, with tolerance values of 6, which contributed to the low percent intolerant individuals metric score of 26.2.

Moshannon Creek upstream of Wilson Run (Station 4MC)

Like upstream, the substrate was largely composed of rubble and gravel, with few distinct, well defined riffles. No iron precipitate was present on the rocks but iron staining was visible on some rocks and on sand grains. This station showed an improvement in water quality compared to upstream Station 3MC, based on higher total taxa (17), higher EPT taxa (11), and total number of individuals (90). The IBI score of 64.9 is just above the threshold of 63.0 considered to approximate severely degraded conditions. Total numbers of individuals in the sample were very low, however, since the 90 total individuals represent the entire contents of the sample, not a sub-sample. Surprisingly, the total number of EPT taxa (11) was high compared to the overall taxa richness (17) and equal to 65% of the total, indicating the presence low numbers a variety of EPT taxa. The Hilsenhoff Biotic Index (HBI) observed metric value was the lowest (best) of all the stations, which was likely skewed by absence of the higher tolerance valued EPT and other taxa found upstream at stations 1MC and 2MC. The Shannon Diversity Index, however, was lower than the headwater stations, which reflects the dominance of the mine drainage tolerant stonefly, *Leuctra*, which had 48 individuals out of 90 total organisms. The total number of *Leuctra* might have been even higher if sampled earlier in the year, since many of the *Leuctra* had emerged and were seen flying over the stream during sampling. The high numbers of *Leuctra* also contributed to the lower (better) HBI observed metric score, since *Leuctra* has a pollution tolerance value of 0.

Wilson Run near the mouth

The substrate of lower reaches of Wilson Run was comprised of boulders and rubble, with plunge pools and steep gradient. The macroinvertebrate fauna of Wilson Run, with a total taxa richness of 32, EPT taxa richness of 21, and IBI score of 93.0 is indicative of excellent water quality. Total number of organisms was relatively low; the 266 total organisms represent the entire sample count. Some of the mayflies and caddisflies present upstream in Moshannon Creek were missing in Wilson Run. Wilson Run was the only station with the stonefly, *Sweltsa*. The fauna in Wilson Run was dominated by *Ephemerella* and *Paraleptophlebia* mayflies, *Leuctra* and *Amphinemur*a stoneflies, riffle beetle *Oulimnus*, blackflies, *Simulium*, and midges, Chironomidae.

Moshannon Creek downstream of Wilson Run (Station 5MC)

The substrate like elsewhere in Moshannon Creek was comprised of few defined riffles. More gravel was present compared to upstream and slimy algae and silt coated the substrate; iron staining was present on some rocks and sand. The macroinvertebrate fauna was similar to the station upstream of Wilson Run in total number of taxa, EPT taxa, and IBI scores. The IBI score of 62.0 is just below the threshold of 63.0 considered to indicate severe impairment. One difference in the macroinvertebrate fauna noted was the lower numbers of *Leuctra* stoneflies and the higher number of *Amphinemura* stoneflies at station 5MC compared to 4MC, which resulted in a higher (poorer) Hilsenhoff Biotic Index observed metric value. The Shannon Diversity Index was higher at 5MC compared to 4MC, likely due to lack of dominance of *Leuctra* stoneflies and more even numbers among the macroinvertebrate taxa.

Moshannon Creek at Hale Road Bridge (Station 6MC)

This was the first downstream station sampled that had a coating of iron precipitate. Moshannon Creek had a good canopy cover downstream of the bridge, but upstream was open and recently leveled and seeded. An instream pond was present upstream of the bridge. The low pH and iron precipitate caused a severe depression of the macroinvertebrate fauna. The IBI score of 20.9, the low total taxa richness of 7, the low EPT taxa richness of 1, and the low total numbers of individuals at 17 confirms the poor water quality conditions. The macroinvertebrate fauna was dominated by Chironomidae, 10 out of 17 total individuals, which contributed to the high Hilsenhoff Biotic Index observed metric value of 5.35. The only EPT taxa present was the coal mine drainage and acid tolerant net-spinning caddisfly, *Diplectrona*. These caddisflies contributed to a higher than expected percent intolerant individuals metric score of 23.5, since *Diplectrona* has a pollution tolerance value of 0.

Moshannon Creek upstream of Mountain Branch (Station 7MC)

This station had iron precipitate coating the rocks. Few riffles were observed and swampy conditions prevailed upstream of the sampling location. The macroinvertebrate fauna was extremely limited in numbers and taxa richness, with only 4 taxa and 11 individuals, reflecting the poor water quality conditions of low pH, alkalinity, and iron precipitate. The IBI score of 30.6 was also very low and indicative of severe water quality impairment. The only EPT taxa present was the acid and mine drainage tolerant stonefly, *Leuctra*, which had a pollution tolerance value of 0, allowing for a higher than might be expected percent tolerant individuals metric value of 27.3. All other observed metric values also reflected the low taxa richness.

Mountain Branch

Mountain Branch had a thick coating of silt and algae covering the substrate. An extensive swampy area with heavy coating of iron precipitate was present upstream of the mouth. The macroinvertebrate fauna was extremely depressed with a taxa richness of 5 and only one EPT taxa. The IBI score of 16.9 was the lowest of all the stations sampled and indicates severely degraded conditions. The Shannon Diversity Index was a very low 0.50, which reflects the extreme dominance by Chironomidae, 155 out of a total of 175 individuals. The only EPT present was the acid and coal mine drainage tolerant stonefly *Leuctra*. The acid and mine drainage tolerant Megalopterans, fishfly *Nigronia* and alderfly *Sialis*, and the dipteran Ceratopogonidae, *Bezzia*, were also present.

Discussion

The Pennsylvania Department of Environmental Protection's 2008 Integrated Water Quality Monitoring and Assessment Report states that the upper 6.2 miles of main stem Moshannon Creek and the entire length of Wilson Run are unimpaired and support aquatic life (Pennsylvania Department of Environmental Protection 2008) and are classified as high quality cold water fishes (HQ-CWF) in the Department's Regulations (25 Pa. Code Chapter 93). The results of this aquatic investigation indicate that these designations are correct, that an excellent macroinvertebrate fauna is present within the unimpaired area at both headwater stations on Moshannon Creek (1MC and 2MC) and in Wilson Run. Brook trout were observed at both headwater stations of Moshannon Creek and additionally downstream of the McFore discharge.

Although the diverse macroinvertebrate fauna and high IBI scores indicate excellent water quality conditions at the two Moshannon Creek headwater stations and in Wilson Run, the low alkalinity and infertile conditions likely contributed to the relatively low total numbers of organisms. Many Pennsylvania streams with similar excellent IBI scores can reach a 200+ sub-sample count in approximately 6 grid squares of the sorting pan. Stations 1MC and 2MC required 16 to 18 grid squares and Wilson Run required over 25 grid squares to reach the 200+ organisms sub-sample.

Moshannon Creek is listed in DEP's 2008 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as impaired for aquatic life by metals from abandoned mine drainage starting downstream of McFore discharge and continuing to the mouth, a distance of over 51 miles (Pennsylvania Department of Environmental Protection 2008). Also, 3.66 miles of Mountain Branch are listed as impaired for aquatic life by the same causes and sources. Several miles of both streams are also impaired by siltation. The limited taxa richness, low total number of organisms, and low IBI scores at all stations downstream of the McFore discharge and in Mountain Branch confirm the impaired status of these stream segments. Although conditions improved somewhat at the middle reach stations on Moshannon Creek, 3MC and 4MC, located up and downstream of Wilson Run, the IBI scores of 64.9 and 62.0 were still close to the 63.0 threshold indicative of severe impairment. Severely degraded water quality conditions prevailed in the acidic, iron precipitate covered section downstream of Hale Road Bridge and in Mountain Branch, where the macroinvertebrate fauna was extremely reduced in taxa richness and numbers of organisms and IBI scores were very low.

Surprisingly, upper Moshannon Creek and Wilson Run had very few Hydropsychidae caddisflies, which are often one of dominant families present in unimpaired freestone streams. On the main stem Moshannon Creek, this was most likely due to habitat factors, such as the lack of ideal riffles. Also of interest is the presence and in one case, the abundance of *Leuctra* stoneflies in the impaired area of Moshannon Creek upstream and downstream of Wilson Run. This stonefly has a pollution tolerance value of 0 based on its perceived sensitivity to organic enrichment. Other macroinvertebrates with pollution tolerance values of 0, 1, and 2 that were also present in low numbers in Moshannon Creek upstream and downstream of Wilson Run included the mayflies *Attenella*, *Ephemerella*, and *Paraleptophlebia*, stoneflies *Acroneuria* and *Tallaperla*, caddiflies *Diplectrona* and *Lepidostoma*, and the fishfly *Nigronia*. The tolerance of these taxa to diluted mine drainage suggests that pollution tolerance values may not be as relevant for pollution from abandoned coal mine drainage as for pollution sources from other man made activities such as agriculture and urban runoff.

Restoration Potential

The effects of mine drainage on a receiving stream are dependent on the pH, acidity, and concentrations of dissolved metals in the discharge; generally the lower the pH and higher the metals concentrations the more severe the impairment. Iron precipitate in combination with low pH can cause significant reduction in numbers and diversity of macroinvertebrates, as is the case in Moshannon Creek downstream of Hale Bridge. At higher pH, iron precipitate can adversely affect macroinvertebrates by filling in crevices in rocks that provide attachment places and by smothering organisms.

Present instream conditions may help show the potential for restoration success after treatment of mine discharges. The partial recovery of Moshannon Creek from upstream of Wilson Run down to Roup Run indicated by the relatively low metals concentrations, low acidity, and presence of some EPT taxa suggests that treatment of the major mine discharges has the potential for significant improvement in macroinvertebrate taxa richness and numbers of organisms. The diverse macroinvertebrate fauna in the headwaters of Moshannon Creek and in Wilson Run could provide a ready source of aquatic organisms to replenish downstream areas after mine treatment projects are completed and water quality improves and stabilizes. Restoration of the macroinvertebrate fauna downstream of Hale Road Bridge may be more difficult to achieve because of the presence of iron precipitate; however, even partial removal of the iron precipitate and increase in pH to above 6.0 should result in improvements in the macroinvertebrate fauna.

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Table 1. Stations sampled on Moshannon Creek and tributaries on May 27 and 28, 2008.

Station	Station Code	Lat/Long
Moshannon Creek headwaters	1MC	40.7465N 78.3722W
Moshannon Creek upstream of McFore mine discharge	2MC	40.7534N 78.3774W
Moshannon Creek downstream of McFore mine discharge	3MC	40.7558N 78.3752W
Moshannon Creek upstream of Wilson Run	4MC	40.7665N 78.3614W
Wilson Run near mouth	WR	40.7647N 78.3609W
Moshannon Creek downstream of Wilson Run	5MC	40.7665N 78.3606W
Moshannon Creek at Hale Bridge	7MC	40.7880N 78.3430W
Moshannon Creek upstream of Mountain Branch	6MC	40.8086N 78.3183W
Mountain Branch near mouth	MB	40.8064N 78.3213W

Table 2

Table 2 was removed. Chemistry data for the quarterly sampling appears in the text of the assessment document.

Table 3. Macroinvertebrates and pollution tolerance values for stations on upper Moshannon Creek and two tributaries.

Station Code				1MC	2MC	3MC	4MC	WR	5MC	6MC	7MC	MB
TAXA			***Pollution Tolerance Value***									
Oligochaeta			***10***		1	3				1		
Bivalvia	Sphaeridae		***8***				1					
Decapoda	Cambaridae		***6***		1			2				
Ephemeroptera	Ameletidae	Ameletus	***0***	1				2				
	Ephemerellidae	Attenella	***2***	1	1		1	1				
		Ephemerella	***1***	19	11	1		34	1			
	Heptageniidae	Cinygmula	***1***	9	1			6				
		Epeorus	***0***	7				6				
		Heptagenia	***4***		1			2				
		Stenacron	***4***	2			2					
		Mccaffertium	***3***	3	14				2			
	Leptophlebidae	Paraleptophlebia	***1***	27	11		1	23	4			
	Baetidae	Acerpenna	***6***	4	1							
		Baetis	***6***	6	4			6				
		Plauditus	***4***	27	30	1		2				
Odonata	Gomphidae	Lanthus	***5***	4	2			6	1			
Plecoptera	Leuctridae	Leuctra	***0***	22	19	2	48	24	20		1	2
	Nemouridae	Amphinemura	***3***	13	4	1	5	33	13			

	Chloroperlidae	Alloperla	***0***	1								
		Haploperla	***0***		2			1				
		Sweltsa	***0***					2				
	Peltoperlidae	Tallaperla	***0***	7	1		1					
	Perlidae	Acroneuria	***0***				1		1			
	Perlodidae	Isoperla	***2***	5	4			4				
		Malirekus	***2***	1								
		Remenus	***2***	4				4				
	Pteronarcyidae	Pteronarcys	***0***	4	4							
Coleoptera	Elmidae	Optioservus	***4***		8			5				
		Promoresia	***2***	1	51	1		2	2			
		Oulimnus	***5***	23	5	4		28				
	Dytiscidae		***5***			1						
	Ptilodactylidae	Anchytarsus	***5***							1		
Trichoptera	Brachycentridae	Micrasema	***2***		1							
	Glossosomatidae	Agapetus	***0***	2	1							
	Rhyacophilidae	Rhyacophila	***1***	5				4				
	Hydropsychidae	Ceratopsyche	***5***	1		4						
		Diplectrona	***0***	1	3		1	4	2	2		
	Hydroptilidae	Hydroptilla	***6***		4							
	Philopotamidae	Chimarra	***4***				2		1			
		Dolophilodes	***0***	3	1			7				
	Polycentropidae	Polycentropus	***6***	4	1		1	2				
	Lepidostomatidae	Lepidostoma	***1***	6			2	6	2			
	Uenoidae	Neophlyax	***3***	1				1				
Megaloptera	Corydalidae	Nigronia	***2***	1			2		1		2	6
	Sialidae	Sialis	***6***									3

Diptera	Tipulidae	Antocha	***3***		18		1	2				
		Dicranota	***2***	1	4			5				
		Hexatoma	***2***		1		2		2			
		Molophilus	***4***						1	1		
		Pseudolimnophila	***2***			1		1	1			
		Tipula	***4***			1						
	Empididae		***6***		1						1	
	Dolichopodidae		***4***	5				2				
	Ceratopogonidae	Bezzia	***6***	1		8			1	1		9
	Chironomidae		***6***	17	27	13	11	23	11	10	7	155
	Simuliidae	Simulium	***6***	6	5	19	8	16	14	1		
	Tabanidae		***6***			1						
Total Taxa Richness				**36**	**33**	**14**	**17**	**32**	**18**	**7**	**4**	**5**
Total No Individuals				**245**	**243**	**61**	**90**	**266**	**80**	**17**	**11**	**175**
Total EPT Taxa				**27**	**21**	**5**	**11**	**21**	**9**	**1**	**1**	**1**
Total EPT Individuals				**185**	**119**	**9**	**65**	**164**	**46**	**2**	**1**	**2**
Number of Grids needed for 200+ organism sub-set				16	18	All	All	All	All	All	All	All
Water Temperature C				12	12	15	17	12	17	15	17	11

Table 4. Metric Scores and IBI for upper Moshannon Creek stations and two tributaries.

Moshannon Creek Headwaters

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score*
Modified Becks	Ob Val /39	44	1.128	1.000
EPT Taxa Richness	Ob Val /23	27	1.174	1.000
Total Taxa Richness	Ob Val /35	36	1.029	1.000
Shannon Diversity Index	Ob Val /2.90	3.07	1.059	1.000
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	2.65	0.894	0.894
% Intolerant Individuals	Ob Val /92.5	84.5	0.914	0.914
				0.968
IBI Score				**96.8**

Moshannon Creek Upstream of Mc Fore Discharge

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	33	0.846	0.846
EPT Taxa Richness	Ob Val /23	21	0.913	0.913
Total Taxa Richness	Ob Val /35	33	0.943	0.943
Shannon Diversity Index	Ob Val /2.90	2.77	0.955	0.955
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	2.96	0.856	0.856
% Intolerant Individuals	Ob Val /92.5	81.5	0.881	0.881
				0.899
IBI Score				**89.9**

Moshannon Creek downstream of McFore Discharge

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	6	0.154	0.154
EPT Taxa Richness	Ob Val /23	5	0.217	0.217

Total Taxa Richness	Ob Val /35	14	0.400	0.400
Shannon Diversity Index	Ob Val /2.90	2.12	0.731	0.731
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	5.61	0.534	0.534
% Intolerant Individuals	Ob Val /92.5	26.2	0.283	0.283
				0.387
IBI Score				**38.7**

Moshannon Creek up Wilson Run

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	19	0.487	0.487
EPT Taxa Richness	Ob Val /23	11	0.478	0.478
Total Taxa Richness	Ob Val /35	17	0.486	0.486
Shannon Diversity Index	Ob Val /2.90	1.79	0.617	0.617
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	1.98	0.976	0.976
% Intolerant Individuals	Ob Val /92.5	78.4	0.848	0.848
				0.649
IBI Score				**64.9**

Wilson Run

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	36	0.923	0.923
EPT Taxa Richness	Ob Val /23	21	0.913	0.913
Total Taxa Richness	Ob Val /35	32	0.914	0.914
Shannon Diversity Index	Ob Val /2.90	2.91	1.003	1.000
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	2.88	0.866	0.866
% Intolerant Individuals	Ob Val /92.5	85.0	0.919	0.919
				0.923
IBI Score				**92.3**

Moshannon Creek downstream of Wilson Run

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	18	0.462	0.462
EPT Taxa Richness	Ob Val /23	9	0.391	0.391
Total Taxa Richness	Ob Val /35	18	0.514	0.514
Shannon Diversity Index	Ob Val /2.90	2.70	0.931	0.782
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	2.98	0.854	0.854
% Intolerant Individuals	Ob Val /92.5	66.3	0.717	0.717
				0.620
IBI Score				**62.0**

Moshannon Creek at Hale Road Bridge

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	3	0.077	0.077
EPT Taxa Richness	Ob Val /23	1	0.043	0.043
Total Taxa Richness	Ob Val /35	7	0.200	0.200
Shannon Diversity Index	Ob Val /2.90	0.33	0.114	0.114
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	5.35	0.566	0.566
% Intolerant Individuals	Ob Val /92.5	23.5	0.254	0.254
				0.209
IBI Score				**20.9**

Moshannon up Mountain Branch

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score*
Modified Becks	Ob Val /39	4	0.103	0.103
EPT Taxa Richness	Ob Val /23	1	0.043	0.043
Total Taxa Richness	Ob Val /35	14	0.400	0.400
Shannon Diversity Index	Ob Val /2.90	1.03	0.355	0.356
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	4.73	0.641	0.641
% Intolerant Individuals	Ob Val /92.5	27.3	0.295	0.295

				0.306
IBI Score				**30.6**

Mountain Branch

Metric	Std Equ	Obs Metric Value	Std Metric Score	Adj Std Metric Score *
Modified Becks	Ob Val /39	4	0.103	0.103
EPT Taxa Richness	Ob Val /23	1	0.043	0.043
Total Taxa Richness	Ob Val /35	5	0.143	0.143
Shannon Diversity Index	Ob Val /2.90	0.50	0.172	0.172
Hilsenhoff Biotic Index	(10 - Ob Val) /(10 - 1.78)	5.86	0.504	0.504
% Intolerant Individuals	Ob Val /92.5	4.6	0.050	0.050
				0.169
IBI Score				**16.9**

* **Maximum =1.00**

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Glossary

Acidic: a condition where the concentration of positively charged hydrogen ions is high, and the pH is less than 7.0.

Aerobic: a condition existing or process conducted in the presence of oxygen

Alkalinity: a measure of the ability of a solution to absorb positively charged hydrogen ions without a significant change in pH. Also referred to as buffering capacity. Alkaline solutions have a pH greater than 7.0.

Aluminum: a common metal element found in mine drainage that oxidizes as a whitish precipitate at pH levels greater than 4.5.

Anaerobic: a condition existing or process conducted in the absence of oxygen.

Appalachian Clean Streams Initiative: a program sponsored by OSM to coordinate and focus mine drainage cleanup projects in the United States.

BAMR: Bureau of Abandoned Mine Reclamation. Part of the Pennsylvania DEP.

Basic: a condition where the concentration of negatively charged hydroxide ions is high, and the pH is greater than 7.0 (alkaline)

DCNR: (Pennsylvania) Department of Conservation and Natural Resources

DEP: (Pennsylvania) Department of Environmental Protection

Dissolved Oxygen (D.O.): the amount of oxygen that is dissolved in a solution. DO can cause armoring on limestone by oxidizing iron compounds in mine drainage to form iron hydroxide.

Dissolved Solids: compounds in a solution that can be precipitated through chemical processes into solids.

Effluent: the solution that flows out of a basin, pond, tank, wetland, ditch, pipe, or other containment.

Environmental Protection Agency (EPA): the federal agency created by executive order in 1970 to coordinate efforts to protect human health and biological communities form environmental pollutants.

Ferric hydroxide: an iron compound that forms when dissolved iron in mine drainage is oxidized, and appears as a rusty, reddish-orange residue. It is often called yellowboy.

Flow Rate: the rate a solution moves through a ditch, wetland, pond, or stream defined in terms of quantity of mine drainage per unit time (i.e., 150 gallons per minute)

gpm: gallons per minute. See “Flow Rate”

Hydroxide: a compound containing the OH- molecule

Iron: a common metal contained in mine rocks in the form of iron sulfide that oxidizes as a reddish colored hydroxide solid.

Manganese: a metal found in mine drainage that oxidizes as a blackish stain.

Metal: elements that are solids, have few electrons in the outer shell, and lose electrons easily to form cations. Metals of concern in mine drainage are iron, aluminum, manganese, and sometimes lead, mercury, copper and zinc.

Neutral: a condition where the concentration of hydrogen ions equals the concentration of hydroxide ions, resulting in a solution that is neither acidic nor basic and has a pH of 7.0.

Neutralize: to cause a solution to move toward a pH reading of 7.0 through chemical or biological processes.

NMBS: The name of the company that prepared this document. See www.newmilesofbluestream.com for more information.

O & M: Operations and Maintenance

Office of Surface Mining (OSM): the federal agency charged with enforcing SMCRA and dealing with health, safety and resource protection issues related to active mining and abandoned mine problems.

OSM: Office of Surface Mining

Overburden: the layers of rock and soil found above coal bed deposits. Overburden rocks often contain acid forming materials in the form of iron sulfide and other compounds that can form dissolved metals and sulfates.

Oxidation: a reaction in which a substance losses electrons. In the case of mine drainage metals oxidation, the oxidizing agent is gaseous oxygen. Metal oxides are formed in the process.

PADEP: Pennsylvania Department of Environmental Protection

Permeability: a measure of the rate of water movement through soil or other substance.

PFBC: Pennsylvania Fish & Boat Commission

PGC : Pennsylvania Game Commission

pH: a value, expressed as standard units on a scale of 0-14 that uses a logarithmic measure to express concentrations of hydrogen ions. pH readings below 7.0 are said to be acidic, and readings above 7.0 are basic or alkaline.

Porosity: the ration of volume of voids to the total volume of material. Used to describe the ability of a fluid to move through crushed rocks or other material.

Pre Act mining: mining that occurred prior to the passing of SMCRA in 1977.

Pyrite: the iron sulfide mineral, often called “fools gold” that is found in earthen and rock layers near coal seams. Pyrite is the usual source of the sulfur that binds with hydrogen and oxygen in rain water to form the sulfuric acid component of mine drainage.

Reduction: a reaction in which a substance gains electrons. In mine drainage treatment, reduction usually involves stripping away of oxygen atoms from sulfate or metal compounds.

Residence Time: the length of time that mine drainage remains in a treatment pond, wetland, or other structure. Designed residence times depend on incoming flow rate, the rate of treatment process in the structure, the contaminants in the mine drainage to be treated, the size of the structure, and the settling rates of solids in the discharge.

RMEF: Rocky Mountain Elk Foundation

Sedimentation: the process whereby particles settle out of solutions. Sedimentation produces a sludge or other layer of solids at the bottom of a sedimentation or settling pond.

SGL: State Game Lands

Sludge: the layer of solids that settle from a solution, including suspended silt and soil particles and precipitates formed by chemical processes.

Solubility: the amount of material that can dissolve in a given amount of water or other solvent at a given temperature to produce a stable solution. Highly soluble substances dissolve quickly. Soluble products will not settle out of a solution unless they are precipitated.

Substrate: the rich, organic layer of compost or other material found at the bottom of wetlands.

Sulfates: compounds containing sulfur and oxygen. Elevated sulfate levels are common in mine drainage. Sulfates can bond with hydrogen ions to form sulfuric acid or bind to calcium atoms to form a gypsum solid.

Surface Mining Control Act of 1977 (SMCRA): the federal law that requires mining operations to prevent water pollution, reclaim mine lands and protect other sources.

Suspended Solids: solid particles that are suspended in solution. Suspended solids in mine drainage can include oxidized metals, silt or soil and other tiny debris particles.

TDS: Total Dissolved Solids

TMDL : Total Maximum Daily Load

Topographical Map: a map that shows land elevations by use of lines that connect points of equal elevation, water bodies, streams, buildings, mine sites, roads, and other land features.

TSS: Total Suspended Solids

UT: Unnamed Tributary

Vertical Flow Wetland (VFW): specialized mine drainage treatment ponds that make use of chemical and biological processes to treat the acid, metals, and sulfate found in mine drainage.

VFW: See Vertical Flow Wetland

Watershed: an area of land from which water drains toward a single channel.

WPA: Works Progress Administration