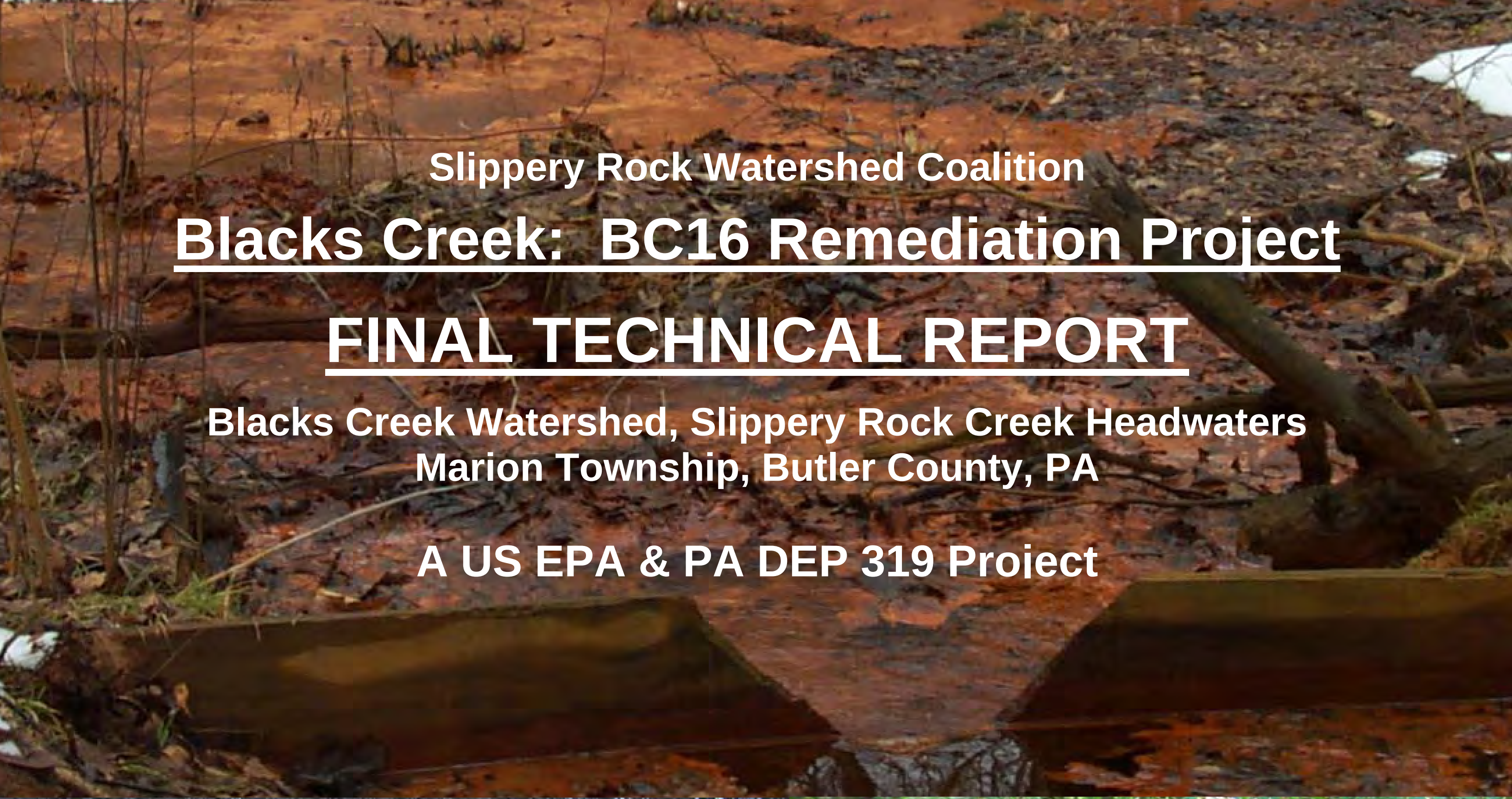
Slippery Rock Watershed Coalition

Blacks Creek: BC16 Remediation Project

FINAL TECHNICAL REPORT

Blacks Creek Watershed, Slippery Rock Creek Headwaters
Marion Township, Butler County, PA

A US EPA & PA DEP 319 Project



Prepared by
BioMost, Inc. and Stream Restoration Incorporated

December 2008

SLIPPERY ROCK WATERSHED COALITION

BLACKS CREEK: BC16 REMEDIATION PROJECT

FINAL TECHNICAL REPORT

Blacks Creek Watershed, Slippery Rock Creek Headwaters
Marion Township, Butler County, PA

"Making It Happen" through a Public-Private Partnership Effort

A US EPA & PA DEP 319 Project

Brief Description of Project Work through Grant and Partnership Contributions

- Conducted water monitoring: BC16 discharge, unnamed trib. (UNT15), Blacks Creek
- Compiled all available recent and historical water quality data
- Completed applications and received permits/approvals; completed E&S Control Plan
- Designed passive treatment system (25-year design life) for the BC16 mine discharge impacting the perennial unnamed ("McIntire") tributary #15 and Blacks Creek; raw water monitoring conducted by PA DEP and other project partners used for design basis (n=18 to 19; avg**/**max): 74**/**175 gpm flow rate, 6.3**/**6.4 pH, 170**/**238 mg/L alkalinity, 2**/**101 mg/L acidity, 55**/**74 mg/L iron, 16**/**26 mg/L manganese, and <1**/**1 mg/L aluminum. (chemical parameters from lab analyses; total values for Fe, Mn, Al)
- Installed Erosion and Sediment Controls
- Installed a passive treatment system consisting of the following components: Settling Pond (~2,500 sq. ft.), Aerobic Wetland (~30,000 sq. ft.), Horizontal Flow Limestone Bed (1400 tons, AASHTO #1, 90% $CaCO_3$, limestone)
- Created O&M site inspection sheet and site schematic for inclusion within the Slippery Rock Watershed Coalition Comprehensive Operation & Maintenance Plan For Watershed Restoration Projects (SRWC, 3/07)
- Created Project Page and uploaded related project information, water quality data, and O&M sheets onto Datashed (www.datashed.org)
- Kept photographic log
- Provided education and outreach activities: Westminster College students conducted site study with evaluation of treatment considerations; Oak Ridge Pointing Dog Club activities coordinated with project implementation; permanent project sign installed; volunteer efforts for upcoming wetland planting
- Submitted electronic updates, quarterly status and final reports; administered contract

DEP Grant Program: US EPA 319 Program

In-Kind/Matching: Dennis Tiche and Linda Furst (Landowners); Foundation for Pennsylvania Watersheds; Quality Aggregates Inc.; Slippery Rock Watershed Coalition; Westminster College student volunteers; Oak Ridge Pointing Dog Club; BioMost, Inc.; Stream Restoration Inc.

Public-Private Partnership

Landowner Providing Construction Area and Access
222 Goff Station Road, Boyers, PA 16020
TICHE, Dennis and FURST, Linda (724) 735-2234

Project Funding, Oversight, & Historic Water Monitoring
PA Dept. of Environmental Protection, Bureau of Watershed Management, Division of Watershed Protection, Nonpoint Source Management Section,
Rachel Carson State Office Building, PO Box 8555, Harrisburg, PA 17105-8555
PRICE, Garry and CARNAHAN, Donna, Central Office Advisors; WAGNER, Russell L., Chief (717) 772-5807

PA Dept. of Environmental Protection, Bureau of District Mining Operations,
PO Box 669, Knox, PA 16232
HEFERLE, Elias, Regional Office Advisor; GILLEN, Timothy, PG; BOWMAN, Roger, Engineer; PLESAKOV, James, MCI; ELICKER, Theresa, MCI; ODENTHAL, Lorraine, Permit Chief; FERRARA, Joseph, Monitoring & Compliance Mgr.; MIRZA, Javed, Dist. Mining Mgr. (814) 797-1191

PA Dept. of Environmental Protection, Bureau of Abandoned Mine Reclamation Division of Acid Mine Drainage Abatement
Rachel Carson State Office Building, PO Box 8476, Harrisburg, PA 17105-8476
SCHUECK, Joseph, (retired) Chief (717) 783-1311

Passive Treatment System Construction
Quality Aggregates Inc., 4955 Steubenville Pike, Suite 245, Pittsburgh, PA 15205
FUCHS, Wayne, Job Foreman; ALOE, Joseph, President; ANKROM, Jeff, Vice President (412) 777-6717

Passive Treatment System Design, Water Monitoring, Operation & Maintenance
BioMost, Inc., 434 Spring Street Ext., Mars, PA 16046
DANEHY, Timothy, QEP; DUNN, Margaret, PG; BUSLER, Shaun, Biologist, GISP; DENHOLM, Clifford, Environmental Scientist; DANEHY, Sylvia, Office Manager; GROTE, Tom, Facilitator (724) 776-0161

Grant Administration, Education and Public Outreach, Volunteer Effort
Stream Restoration Incorporated, 434 Spring Street Ext., Mars, PA 16046
DANEHY, Timothy, QEP; DUNN, Margaret, PG; BUSLER, Shaun, Biologist, GISP; DENHOLM, Clifford, Environmental Scientist; DANEHY, Sylvia, Office Manager; GROTE, Tom, Facilitator (724) 776-0161

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Appendix

Maps *(oversize)*

Blacks Creek Watershed Map, 04/2007, 1”=1000’

Erosion & Sedimentation Control Plan & Details with Passive System Design, 10/2008, 1”=30)

Photos *(7 pages)*

Selected Operation & Maintenance Information Sheets

Datashed Project Page: BC16

Passive Treatment System O&M Inspection Report (BC16) (2 pages)

BC16 Remediation Project (schematic), 12/08, 1”=60’

Student Paper

Leach, Holly Ann and Dave Van Dyne, unpublished 12/14/07, untitled Pilot Study with Lab. Testing, UNT15 Subwatershed, Blacks Creek - Slippery Rock Creek Watershed: *prepared for* Westminster College Environmental Science Capstone Course (Dr. Helen Boylan, Professor) and Slippery Rock Watershed Coalition, 37pp.

News Items

Slippery Rock Watershed Coalition (monthly newsletter)

“Construction of the BC 16 Remediation Project Nears Completion!!!!”, *The Catalyst*, Jan. 2009

“Restoring Blacks Creek”, *The Catalyst*, Apr. 2007

Water Quality Data

906-42 (Blacks Creek above confluence with UNT15)

BC2 (Blacks Creek below confluence with UNT15)

BC4 (UNT15 below BC16 near confluence with Blacks Creek)

BC4.1 (UNT15 above BC16)

BC16 (AMD with passive treatment system)

RS1 (UNT15 below TRX and above RS2)

RS2 (UNT15 below RS1 before entering existing pond SB1)

SB1 (Existing Sediment Pond built within UNT15; above BC4.1)

TB1 (Existing treatment pond forms UNT15 above TRX)

TRX (UNT15 below TB1 and above RS1)

BLACKS CREEK: BC16 REMEDIATION PROJECT

FINAL TECHNICAL REPORT

A BLACKS CREEK MINE DRAINAGE ABATEMENT PROJECT
Slippery Rock Creek Headwaters

submitted to

Pennsylvania Department of Environmental Protection (PA DEP)

Executive Summary

Participants in the Slippery Rock Watershed Coalition received funding from the PA DEP through the US EPA Section 319 (Clean Water Act) Program for installation of a passive system to treat an alkaline, metal-bearing, mine discharge emanating from what is believed to be an abandoned oil well. This project was also made possible by generous financial and in-kind contributions by the Foundation for PA Watersheds and numerous other partners. All activities, including water monitoring, permitting, system design and construction, and development of the final project report with operation and maintenance plan, were completed without incurring increases in original contract costs. This economic and effective approach was facilitated by a public-private partnership effort developed prior to grant submission that included government agencies, landowners, private industry, nonprofits, and volunteers.

After award of the grant but prior to utilizing funds for construction, a watershed restoration plan was required by the EPA to provide an overview of Blacks Creek and its tributaries in relation to the water quality criteria cited in the EPA-approved 1/19/05 Total Maximum Daily Load (TMDL), as well as to locate, characterize, and prioritize for treatment/abatement, all observed historical mine discharges impacting the watershed. Best Management Practices, with preliminary cost estimates, to address the discharges were also provided in the Blacks Creek Restoration Plan (SRWC, Rev. 4/07).

With the second highest metal loading in the Blacks Creek Watershed, out of the 11 priority restoration areas, the BC16 discharge was ranked #2. BC16 is one of two major discharges impacting the "McIntire" trib. (UNT15), a perennial stream which is responsible for >50% of the metal loading in Blacks Creek. Based on laboratory analyses of ~20 samples collected between 1996 to 2007, BC16 ranges (min-max) from 3 to 175 gpm having 6.0 to 6.5 pH, 105 to 238 mg/L alkalinity, -92 to 101 mg/L acidity, 40 to 74 mg/L T. Fe, 10 to 26 mg/L T. Mn, and <1 to 1 mg/L T. Al. The average values are 74 gpm, 6.3 pH, 170 mg/L alkalinity, 2 mg/L acidity, and 55 mg/L, 16 mg/L, and <1 mg/L Total Fe, Mn, and Al, respectively.

The passive treatment system with a projected 25-year design life consists of three major components which operate in series: a Settling Pond (~2,500 SF) that captures the BC16 upwelling, an Aerobic Wetland (~30,000 SF), and a Horizontal Flow Limestone Bed (HFLB) (1,400 tons, AASHTO#1, 90% $CaCO_3$, limestone). In addition to the future planting of the wetland for wildlife habitat by volunteers, both the Settling Pond and the Aerobic Wetland are designed for iron oxidation/hydrolysis, settling, and storage of solids with the Horizontal Flow Limestone Bed designed to generate alkalinity and remove manganese solids. The water is conveyed through the system and to the receiving stream (UNT15) by riprap-lined spillways and a final effluent channel which promote degassing/aeration.

Due to delays prior to and during construction, the passive system has not discharged to date. From monitoring data for discharges with similar raw water characteristics and passive systems of similar design within the Slippery Rock Creek Watershed, ~40 lbs/day of iron and ~7 lbs/day of manganese are projected to be removed by the BC16 passive treatment system. Based on the Blacks Creek Watershed TMDL, this accounts for ~65% of the iron and ~25% of the manganese loading reductions needed at the most heavily-impacted portion of Blacks Creek at BC2. As attaining the desired water quality in Blacks Creek upstream at BC6 is not sufficient to restore the stream at BC2 (PA DEP, 10/20/04), passive treatment of BC16 appears to be both desirable and necessary. To demonstrate the degree of long-term water quality improvement including loading reductions, monitoring data will be accessible to the public through Datashed (www.datashed.org).

Comprehensive Timeline

Abbreviations: BioMost, Inc. (**BMI**); District Mining Office (**DMO**); US Environmental Protection Agency (**EPA**); Horizontal Flow Limestone Bed (**HFLB**); Pennsylvania Department of Environmental Protection (**PA DEP**); QAI (**QAI**); Quality Assurance Project Plan (**QAPP**); Stream Restoration Incorporated (**SRI**)

DATE	DESCRIPTION
02/02/00	Site investigation and water monitoring
01/15/01	Site investigation and water monitoring
02/05/01	Site investigation and water monitoring
02/19/01	Site investigation and water monitoring
09/14/01	Funding Request to Western PA Watershed Protection Program
02/03/02	Proposal for Black's Creek BC16 Remediation Project submitted to DEP Grants Ctr.
08/07/02	Growing Greener Grant application for BC16 approved by PA DEP
09/05/02	PA DEP Knox DMO office to discuss revising Scope of Work to meet available funds
10/18/02	Notice of Intent for PA DEP app. sent Marion Twp. Supervisors & Butler Co. Plan. Comm.
11/30/02	With PA DEP consensus, grant funding returned
01/15/03	BC16 Application for Growing Greener Grant resubmitted to PA DEP
09/26/03	Letter from PA DEP received stating app. for BC16 Growing Greener grant denied
03/05/04	BC16 Growing Greener grant resubmitted to PA DEP
11/16/04	Emails with Elias Heferle, PA DEP, Knox DMO
01/01/05	Email proposal (Work Plan), Scope of Work, Simplified Budget to Garry Price & Steve Lathrop, PA DEP, EPA 319 Program
02/03/05	Correspondence with Jane Earle, PA DEP, EPA 319 Program
02/15/05	BC16 Growing Greener grant (KD040242) PA DEP award notification
03/24/05	Notification to complete Watershed Implementation Plan prior to BC16 Project
03/29/05	Meeting and site tour with Garry Price, PA DEP, EPA 319 Program, to discuss award of Section 319 grant for BC16 Remediation Project on Blacks Creek
04/18/05	Correspondence with Steve Lathrop, PA DEP, EPA 319 Program
09/29/05	Cliff Denholm, SRI, attends EPA 319 Implementation Planning Dialogue meeting
10/04/05	Scope of Work & Simplified Budget for Blacks Creek Restoration Plan sent to PA DEP
10/31/05	Proposed grant agreement for Blacks Creek Restoration Plan sent to SRI by PA DEP
11/02/05	Executed grant agreement for Blacks Creek Restoration Plan submitted to PA DEP
11/18/05	Blacks Creek Restoration Plan QAPP submitted to PA DEP & EPA
11/29/05	Communications with Garry Price, PA DEP, EPA 319 Program
12/08/05	Communications with Stephen Lathrop, PA DEP, EPA 319 Program
12/13/05	EPA comments on QAPP received; Revised QAPP submitted to EPA
12/19/05	Additional EPA comments on QAPP received
12/21/05	Fully-executed contract issued for Blacks Creek Restoration Plan
01/03/06	EPA comments addressed
01/06/06	QAPP plan for Blacks Creek Restoration Plan approved by EPA
01/06/06	Correspondence with Garry Price, PA DEP

01/26/06	Requested info submitted to PA DEP via email
01/30/06	Correspondence with Garry Price, PA DEP, EPA 319 Program
01/31/06	Updated grant proposal and implementation schedule for BC16 emailed to PA DEP
04/05/06	Correspondence with Garry Price, PA DEP
04/07/06	Contract documents for BC16 submitted to PA DEP via email
04/11/06	PA DEP requests 3 executed copies of proposed grant agreement
04/13/06	3 executed copies of BC16 grant agreement submitted to PA DEP
05/05/06	BC16 executed grant agreement (Proj. #2524; DOC #4100034234; 2/1/06 start date; 9/30/07 end date) awarded by PA DEP to SRI
05/16/06	Compliance Review For Grants/Co. Governments Form STD-21 submitted to PA DEP
05/17/06	Stream walks, site investigations, water monitoring, and watershed assessment for Blacks Creek Restoration Plan
05/23/06	Extension Request for Blacks Creek Restoration Plan submitted to PA DEP
05/24/06	Extension Request for Blacks Creek Restoration Plan approved by PA DEP
07/01/06	PA State Programmatic General Permit request to US Army Corps of Engineers
07/05/06	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
09/27/06	Stream walks, site investigations, water monitoring, and watershed assessment for Blacks Creek Restoration Plan
10/03/06	Stream walks, site investigations, water monitoring, and watershed assessment for Blacks Creek Restoration Plan
10/04/06	Stream walks, site investigations, water monitoring, and watershed assessment for Blacks Creek Restoration Plan
10/11/06	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
11/21/06	Extension Request for Blacks Creek Restoration Plan submitted to PA DEP
11/27/06	Extension Request for Blacks Creek Restoration Plan approved by PA DEP
12/15/06	Draft Blacks Creek Restoration Plan submitted to PA DEP
01/15/07	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
02/02/07	Revised Blacks Creek Restoration Plan submitted to PA DEP
02/09/07	Blacks Creek Restoration Plan submitted by PA DEP to EPA
02/12/07	Received initial questions from EPA regarding Blacks Creek Restoration Plan
02/13/07	Email response to EPA initial questions submitted
03/06/07	Received EPA comments on Blacks Creek Restoration Plan
04/---/07	"Restoring Blacks Creek" article in SRWC monthly newsletter *The Catalyst*
04/26/07	Site investigation and water monitoring
04/27/07	Final Blacks Creek Restoration Plan (EPA comments addressed) submitted to PA DEP
04/27/07	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
05/04/07	Final Blacks Creek Restoration Plan submitted by PA DEP to EPA Region 3
05/29/07	PA DEP letter reminder of grant expiration date
06/13/07	Grant Extension Request (DOC 4100034234) submitted to PA DEP
07/26/07	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
08/29/07	Approved Time Extension Request (DOC 4100034234) received from PA DEP
09/24/07	Site investigation and water monitoring

09/24/07	Meeting at site with Westminster College students Holly Ann Leach and Dave Van Dyne
10/23/07	Communications/submissions of monitoring data to Oak Ridge Pointing Dog Club
10/24/07	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
10/30/07	Meeting with Larry Surrena (adjoining property owner) at site
10/31/07	Wetland Determination (1987 COE Manual) by Shaun Busler, BioMost, Inc.
11/03/07	Communications/submissions of monitoring data to Oak Ridge Pointing Dog Club
11/14/07	Site investigation and water monitoring
12/14/07	Cliff Denholm, SRI, attended presentation by students Holly Ann Leach & Dave Van Dyne at Westminster College regarding Capstone course study of BC16 to examine potential effects of aeration, surface area, and water depth on iron precipitation rates
01/14/08	Reimbursement App. (1st) submitted to PA DEP
01/17/08	Quarterly Progress Report submitted to Garry Price & Elias Heferle, PA DEP
02/13/08	PNDI Project Environmental Review Receipt (Search ID 20080213128370)
02/29/08	Request for waiver under Section 105.12(a)(16) submitted to PA DEP
04/08/08	Reimbursement App. (2nd) submitted to PA DEP
04/23/08	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
05/30/08	Waiver of Permit Requirements (WL 10-08-602; EA 10 08 601) approved
06/16/08	Meeting with Oak Ridge Pointing Dog Club representatives
07/18/08	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
08/06/08	PA DEP letter reminder of grant expiration date
08/20/08	Grant Extension Request (DOC 4100034234) submitted to PA DEP
09/02/08	Field construction meeting with BMI and QAI; Elevation reference points set;
09/03/08	Approved Time Extension Request (DOC 4100034234) received from PA DEP
10/17/08	Quarterly Progress Report Submitted to Garry Price & Elias Heferle, PA DEP
10/20/08	Field const. mtg. with BMI, QAI, and landowner Denny Tiche; Landowner to contact logging company; Erosion & Sedimentation Control Plan provided to QAI
10/31/08	Field const. mtg. with BMI & QAI; Site timbered; Clearing & grubbing nearing completion
11/12/08	Construction Inspection; Construction of berm along Porter Road nearing completion; Excavation for wetland construction; boulders piled for wildlife habitat
11/14/08	Reimbursement App. (3rd) & Progress Report submitted to PA DEP
11/18/08	Reimbursement App. (4th) & Progress Report submitted to PA DEP
12/05/08	Construction Inspection; Berm construction for wetland & HFLB
12/09/08	Reimbursement App. (5th) w/Supporting Doc. & Progress Rept. (11/08) sent to PA DEP
12/10/08	Request to revise funding categories submitted to PA DEP
12/15/08	Construction Inspection; Site very muddy due to rain; Stoned access road under const.
12/17/08	Construction Inspection; Access road completed; Limestone for HFLB being delivered; Construction of berm and dirt removal for wetland continues
12/18/08	Construction Inspection; PA Knox DMO on site; ~70% of limestone aggregate for HFLB delivered; Construction of berm and dirt removal for wetland continues
12/29/08	Construction Inspection; HFLB nearing completion; Construction of berm and dirt removal for wetland continues
01/---/09	"Construction of the BC16 Remediation Project Nears Completion" article *The Catalyst*

Introduction

Mining has been conducted in the western Pennsylvania Appalachian Coal Basin for more than 150 years. With coal reserves in Pennsylvania playing a major role in the Industrial Revolution, the United States became a modern developed nation and major world power. This historical utilization of coal to heat our homes and to fuel our industries, however, resulted in a legacy of severe environmental impacts and public safety issues.

According to the Pennsylvania Integrated Water Quality Monitoring and Assessment Report (PA DEP, 2006), these pollutive discharges, commonly referred to as acidic or alkaline or abandoned mine drainage **(AMD)**, are the largest source of stream degradation in the Commonwealth, with over 4,600 miles of streams impacted. In many cases, entire watersheds have been completely decimated by AMD. Furthermore, of the 67 counties in Pennsylvania 45 are impacted with over 250,000 acres of unreclaimed mine lands, 2.6 billion cubic yards of abandoned coal refuse, and about 7,800 abandoned underground mines.

Since 1994, the Slippery Rock Watershed Coalition **(SRWC)** has been actively working to restore the severely degraded headwaters of Slippery Rock Creek. This effort has resulted in the installation of about 18 passive systems for approximately 30 abandoned mine discharges. These passive systems are currently treating over 750 million gallons of mine drainage per year eliminating about 200 tons of iron, 8 tons of aluminum, and 335 tons of acidity annually from Slippery Rock Creek and its tributaries. This reduction in pollution loading has significantly improved over 11 miles of streams with fish being observed in at least 6 miles probably for the first time in about a century.

In 2000, the SRWC began investigating the feasibility of addressing existing coal mine discharges in the Blacks Creek Subwatershed, which adjoins the 27-sq. mi. initial target area for abandoned mine restoration. In 2002, a Growing Greener grant was awarded to Stream Restoration Incorporated **(SRI)** to address AMD discharges BC19 & BC19B just west of and across Blacks Creek from BC16. A passive system consisting of an aerobic wetland was constructed in 2004 to address the net alkaline mine drainage.

Much of the work completed by the SRWC to date has been based upon background data collected by the Pennsylvania Department of Environmental Protection **(PA DEP)** Knox District Mining Office **(Knox DMO)** as published in the 1998 <u>Slippery Rock Creek Watershed Comprehensive Mine Reclamation Strategy Reclamation/Remediation Plan</u> **(CMRS)** for a 27-square mile area which included the Seaton Creek Subwatershed and the watershed for the main stem of Slippery Rock Creek in the uppermost headwaters. Blacks Creek, however, a major tributary in the headwaters of Slippery Rock Creek, was not included in the CMRS. The Blacks Creek Watershed Total Maximum Daily Load **(TMDL)** was prepared by the Knox DMO (PA DEP, 10/20/04) and approved by the US Environmental Protection Agency **(US EPA)** on 01/19/05.

In 2005, SRI was awarded a US EPA 319 grant to address the BC16 abandoned mine discharge located along an unnamed tributary (UNT15 or "McIntire" trib.) to Blacks Creek. Prior to construction, however, a watershed restoration plan was required by the US EPA to provide an overview of Blacks Creek and tributaries thereto in relation to the applicable water quality criteria cited in the TMDL as well as to identify other AMD discharge locations. The AMD discharges were then characterized and prioritized based on pollutant loading and impact to the overall watershed. Best Management Practices **(BMP)**, such as land reclamation and passive treatment systems with preliminary cost estimates, were also described. This information is available in the Blacks Creek Restoration Plan (SRWC, 1/07, rev. 4/07).

In addition to identifying and prioritizing all observed historical mine discharges, this final report describes the BC16 Remediation Project and the expected improvement in water quality in tributary #15 ("McIntire") as well as Blacks Creek. Funding was provided by the PA Department of Environmental Protection through Section 319 of the Federal Clean Water Act administered by the US Environmental Protection Agency.

(See attached Project Location Map.)

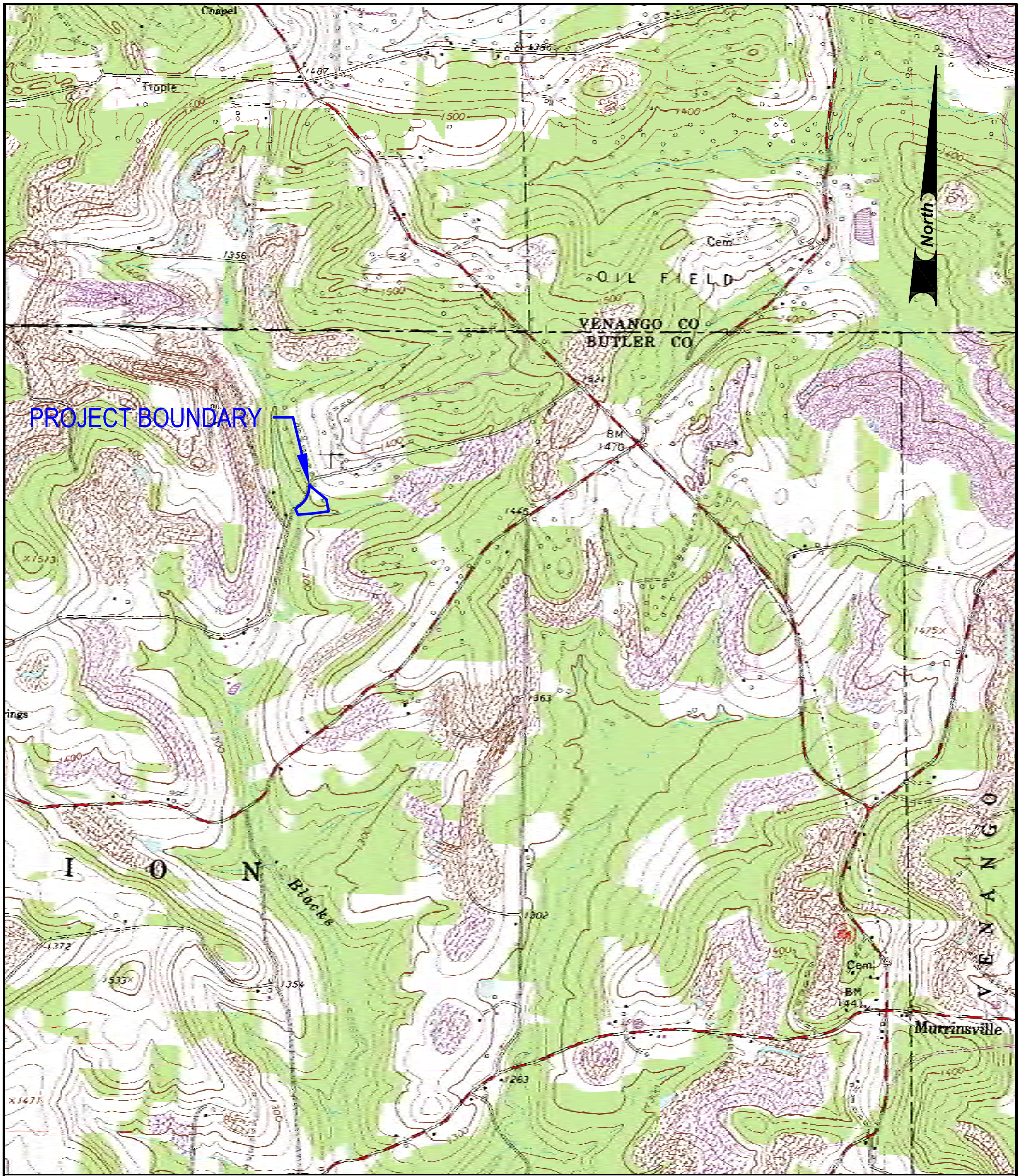
Blacks Creek Watershed: Geography & Geologic Resources

General Geographic Setting

Blacks Creek (DEP Stream Code 34731, Basin 20-C) is a major headwaters tributary and subwatershed of Slippery Rock Creek in the Ohio River Basin in western Pennsylvania. The Blacks Creek Watershed is primarily located in Marion and Venango Townships in northern Butler County with a small portion located in Irwin and Clinton Townships in southern Venango County. The watershed encompasses approximately 9 square miles (5,600 acres) with approximately 110,000 feet (20.8 miles) of 1st, 2nd, 3rd, and 4th order streams that flow in a generally southerly direction. The Blacks Creek headwaters are characterized by spring/wetland- and abandoned mine discharge-fed tributaries. Surface elevations within the watershed range from about 1200 to 1600 feet and contain rural and forested lands with gently rolling hills of low relief. A stream gradient analysis of the major tributaries completed for the Blacks Creek Restoration Plan (SRWC, 1/07, rev. 4/07) indicates that over 70% of Blacks Creek and a major tributary are considered low or very low gradient streams. Blacks Creek enters Slippery Rock Creek about a mile west of Boyers, PA.

Coal, Limestone, and Oil Resources

Coal has been extensively mined throughout the Blacks Creek Watershed by both surface and underground methods primarily within the Pennsylvanian Allegheny Group including the Middle Kittanning, Lower Kittanning, (Kittanning Fm.) and Brookville (Clarion Fm.). Numerous abandoned mine features such as spoil piles, coal refuse piles, water-filled surface mine pits, dangerous highwalls, subsidence, and abandoned mine drainage can be seen throughout the watershed as well as successfully-reclaimed



PROJECT LOCATION - USGS 7.5' BARKEYVILLE, PA (PR1980)

BLACKS CREEK: BC16 REMEDIATION AREA

Stream Restoration Incorporated
Marion Township, Butler County, PA
December 2008, Scale 1" = 2000'

Approximate Center of Project (deg-min-sec)
41-09-52 latitude 79-55-03 longitude

2000 1000 0 2000

BioMost, Inc., Mining and Reclamation Services
Mars, PA: 903 schematic.dwg/topo

surface mines. While there are currently two active quarries on the Vanport limestone (Clarion Fm.; Allegheny Gp.) that may be removing incidental coal encountered during limestone extraction, there are no known coal mines currently in operation within the watershed.

In addition to mining, the northern part of the watershed is part of the Bullion-Clintonville Oil Field with "pay zones" at an average depth of about 1050 feet in the Second and Third Sandstones of the Upper Devonian Venango Group. Petroleum exploration was reported to have begun around 1876. Numerous historic, as well as more recent, oil wells, pumping facilities, storage tanks, and associated piping are commonly observed in this portion of the watershed. Probably in response to the down-hole well casing being compromised, some of these old abandoned oil wells now appear to be conduits for mine drainage to reach to the surface.

(See attached Blacks Creek Watershed Map.)

BC16: Description & Environmental Impact

Geographic Location

The BC16 Remediation Project is located along and south of Porter Road (T-434) in Marion Township, Butler County on property owned by Dennis Tiche and Linda Furst. Currently, there are no inhabited buildings on the property. The site is located on the 7½' USGS Barkeyville (PR1980) topographic map at latitude 41° 09' 51" and longitude 79°55' 06". BC16 lies within the McIntire Restoration Area as shown on Inset 2 of the attached Blacks Creek Watershed Map.

General Description of Upwelling

At sampling point BC16, the discharge appears to be an upwelling from one of the abandoned oil wells. In the construction of oil wells, steel casing is used to line the borehole, not only to assure the integrity of the well but also to prevent surface, shallow subsurface, and groundwater from entering the well. This casing, however, may break due to stress or corrode over time. If the casing is compromised to allow flow into the well from a water-bearing zone(s), the water may be conveyed to lower or higher stratigraphic units (or even to the surface) depending upon if the well is located in a recharge or discharge zone. As a hydrogeologic investigation has not been performed and as the watershed has been extensively mined by both surface and underground methods, the coal mining activity(ies) responsible for the degradation observed at BC16 is uncertain. Neither BC16 nor several other upwellings (BC14, BC15, BC19, and BC19B), which appear to be associated with historical oil production in the general vicinity, were identified in the 1970 Operation Scarlift Report Slippery Rock Creek Mine Drainage Pollution Abatement Project (SL-110). (See list of Selected References.)

Raw Water Characteristics

The BC16 discharge, which was identified in the Blacks Creek Restoration Plan as having the second highest metal loading in the Blacks Creek Watershed and assigned a restoration priority ranking of #2, can be characterized as an alkaline, iron- and manganese-bearing, discharge. Average, median, minimum, and maximum values from pre-construction monitoring of the BC16 discharge are provided in Table 1.

Table 1: Pre-Construction BC16 Discharge Characteristics

Statistical Parameter	**Flow**	**pH**		**Alkalinity**		**Acidity**	**Iron**		**Manganese**		**Aluminum**		**SO_4**
		field	lab	field	lab	lab	total	diss.	total	diss.	total	diss.	lab
n (1996-2007)	*18*	*6*	*19*	*5*	*19*	*19*	*18*	*5*	*18*	*5*	*18*	*5*	*18*
Mean	74	6.1	6.3	168	170	2	55.3	47.7	15.6	11.5	0.3	0.2	593
Median	78	6.1	6.3	163	167	0	55.0	45.2	15.5	11.5	0.3	0.1	550
Minimum	3	5.8	6.0	145	105	-92	40.4	44.2	9.5	9.4	<0.1	<0.1	388
Maximum	175	6.4	6.5	189	238	101	73.9	53.4	26.0	13.5	0.6	0.4	867

Flow in gallons per minute (gpm); pH not averaged from hydrogen ion concentrations; concentrations in mg/L; Metals and pH rounded to nearest tenth; Alkalinity, acidity, and sulfates rounded to nearest whole number; 3/30/00 analyses alkalinity of 66 mg/L and total iron, manganese, and aluminum of 6.8 mg/L, 4.2 mg/L, and 1.2 mg/L, respectively, considered spurious. (See attached monitoring data.)

As shown in the above table, the median and mean are similar for both physical and chemical parameters. Reviewing the range (comparing maximum and minimum), however, identifies variability in the BC16 flow rate. As the three lowest values (See attached water monitoring in the Appendix.) for the 18 monitoring events were measured on 9/28/01 (8 gpm), 11/7/01 (3 gpm), and 11/14/07 (20 gpm), a direct correlation to seasonal precipitation is suggested. Note, however, that the highest flow rate of 175 gpm was also measured in the characteristically “dry season” on 8/28/96. Comparison of flow rates with precipitation data, supplemented with additional monitoring at a frequency to further identify seasonal and yearly variations, is needed to determine a correlation. A wide variation in flow rate has been documented for other mine discharges within the area.

Another parameter which appears to vary widely is acidity. The statistical parameters may, however, be misleading as, prior to ca. 2004, negative acidity measurements were routinely reported by laboratories as “0”. Nonetheless, this does not explain the wide variation in values. For an in-house preliminary comparison, acidities were also calculated from the measured values of iron, manganese, and aluminum. [At a pH of 6^+, proton acidity was not considered a significant contributor of acidity.] As only total metal values, which include both solid and dissolved fractions, were reported for the majority of monitoring events, the calculated acidities were considered conservative (maximum). Even though disparities were noted, both the measured and calculated acidities indicated that BC16 was at times net alkaline and at times net acid.

Impact to Receiving Stream (a.k.a., Trib. 15, UNT15, "McIntire" trib.)

BC16 is one of two major abandoned mine discharges significantly impacting tributary #15 also known as the "McIntire" trib. The result is that UNT15 is the most degraded tributary in the Blacks Creek Watershed and is responsible for the majority (~50%) of the metal loading to Blacks Creek. The BC16 discharge on average has a pollutant loading of 50 lbs/day of iron and 14 lbs/day of manganese. (See Table 2.) This loading equates to ~18,000 lbs/year (~9 tons/year) of iron and ~5,000 lbs/year (~2.5 tons/year) of manganese that enters tributary #15 and Blacks Creek.

Table 2: Raw BC16 Metal Loadings

Iron lbs/day	**Manganese** lbs/day	**Aluminum** lbs/day
50	14	<1

average values from total concentrations

Headwaters AMD and BC16 Impacts to UNT15 and Blacks creek

AMD at UNT15 Headwaters

To aid in the evaluation of the impact of BC16 on UNT15 and on Blacks Creek, the characteristics of UNT15 upstream of the confluence with BC16 are briefly described. The headwaters of UNT15 are formed by drainage from the H & D Coal Company, MDP 3078BC12 (issued 10/15/78), surface mine on the Lower and Middle Kittanning coalbeds, which is locally called, the McIntire Minesite. The headwaters of UNT15 were mined in late 1979 to 1981 (permit area 1199-5) (Gillen, unpublished 1994). Abandoned underground mine workings with somewhat degraded water (5/31/79: 4.9 pH, 2 mg/L alkalinity and 26 mg/L acidity and 3 mg/L, 1 mg/L, 3 mg/L total iron, manganese, and aluminum, respectively) were intercepted during surface mining. Based on our understanding, coal refuse was placed in the backfill of the surface mine. Mine discharges MC1, MC2, and MC3, with severely degraded water (See Table 3 with combined flow at TB1.), were treated initially with soda ash briquettes and later liquid caustic until 1/1994. The remaining old chemical treatment pond **(TB1)** continues to collect the AMD. The TB1 primary spillway has become plugged with iron minerals precipitating at a low pH to the point that the effluent now discharges over the emergency spillway forming the headwaters of UNT15. The TB1 effluent is conveyed by the UNT15 stream channel (portions reconstructed) ~2500' to an old sediment pond (S-1 aka **SB1**) constructed within the channel. About 1500' below the SB1 effluent, the BC16 discharge enters UNT15.

(See Inset 2 on the attached Blacks Creek Watershed Map.)

UNT15 Quality Above and Below BC16

Table 3 illustrates the water quality of UNT15 from the TB1 effluent, which forms the headwaters, to the confluence with Blacks Creek. (Samples are arranged from upstream to downstream.) TRX, RS1, and RS2 are intermediate points on UNT15 between TB1 and SB1. These points illustrate the natural improvement in water quality both from dilution with base flow and other sources of water as well as from the precipitation of iron minerals at a low pH. The water continues to improve downstream, but at point BC4.1 immediately above the confluence with BC16, the stream remains heavily impacted. BC4 is on UNT15 ~100' below the confluence with BC16 just prior to entering Blacks Creek. The impact of BC16 to UNT15 is quite remarkable. Based on the sample analyses, pH and alkalinity increase while acidity decreases. The iron content in UNT15 significantly increases while the aluminum content decreases. The alkaline BC16 discharge with an average flow rate of 74 gpm decreases the aluminum content in UNT15 both by dilution and by increasing the pH. As aluminum solubility is controlled primarily by pH, once the pH reaches ~4.0 aluminum solids begin to form and by pH of ~5 only ~1 mg/L dissolved aluminum is typically in solution. Manganese concentrations within the tributary typically remain about the same or increase slightly. (See Table 3.)

UNT15 Impact to Blacks Creek

The impact of the "McIntire" trib. (UNT15) to Blacks Creek is devastating as illustrated by comparing upstream (906-42) and downstream (BC2) points on Blacks Creek, with iron, manganese, and aluminum content doubling and in some cases more than quadrupling.

Table 3: UNT15 & Selected Blacks Creek Water Quality Data

Location		Sample Point	pH field	Alkalinity		Acidity	Iron		Manganese		Aluminum		SO_4
				field	lab		total	diss.	total	diss.	total	diss.	
← Downstream	Tributary #15	TB1	3.0	-	0	853	262.7	236.5	73.5	66.6	35.0	35.4	2028
		TRX	2.8	-	0	630	109.3	111.4	54.8	52.8	46.5	48.3	1504
		RS1	2.9	-	0	499	80.5	77.4	54.2	51.3	15.8	14.7	1357
		RS2	2.8	-	0	462	79.2	70.4	36.2	37.7	15.8	19.4	1333
		SB1	3.0	-	0	374	33.0	31.9	47.6	42.5	22.5	20.0	1099
		BC4.1	4.1	0	0	98	6.2	3.7	15.8	14.2	9.7	6.7	387
		BC16 AMD	6.1	168	164	2	55.3	47.7	15.6	11.5	0.3	0.2	593
		BC4	6.0	58	34	42	20.8	17.2	16.8	14.3	5.1	1.8	551
Blacks Creek		906-42 above UNT15	7.3	86	73	-36	3.0	1.3	1.7	1.7	0.3	0.1	220
		BC2 below UNT15	6.8	79	69	-29	7.4	6.1	4.6	5.0	1.0	0.1	287

Average values; Alkalinity, acidity, total & dissolved metals, and sulfates in mg/L; Metals and pH rounded to nearest tenth; Alkalinity acidity, and sulfates rounded to nearest whole number; pH not averaged from hydrogen ion concentration; Number of sample sets (n) varies. (See attached monitoring data.)

Relationship to Previous Restoration Efforts

The BC16 project is not the first mine reclamation project to be completed within the watershed. In 2002, Stream Restoration Inc. received a PA DEP Growing Greener grant to install a passive treatment system to address the BC19 & BC19B discharges. These discharges which formerly flowed directly into Blacks Creek are currently being treated by a ~½-acre aerobic wetland that was constructed in 2004. On average, ~12 lbs/day (~4,300 lbs/yr) of iron is being removed. (Additional monitoring is needed to confirm the apparent removal of 1 lb/day of manganese.)

In 2002, a terrain conductivity study was completed by the PA DEP to identify “hot spots” at the McIntire surface mine and coal refuse disposal site. This information was used to determine placement of alkaline material. In 2006, local limestone quarry operator and active Slippery Rock Watershed Coalition participant, Quality Aggregates Inc., placed approximately 10,000 tons of waste lime to create a low-permeability barrier and to provide alkalinity to the subsurface flow. Long-term improvement will be demonstrated by monitoring site drainage. Based on experience with similar efforts, loadings are expected to decrease, but degradation is expected to remain. A passive system, therefore, that has the capability of handling variable site drainage characteristics has been proposed; however, at the time of writing this report, funding has not yet been received. Successful installation of a passive treatment system at both the BC16 and the McIntire Minesite is expected to eliminate 50% of the metal loading to and significantly improve tributary #15 and Blacks Creek.

BC16 Passive Treatment System Installation

Permitting and Site Preparation

A written E&S Plan, conformable with PA Title 25, Chapter 102, was completed and maintained at the site. (Approval by the Butler County Conservation District was not required as the earth disturbance was <5 acres.) Erosion and Sediment Pollution Controls were installed based upon the written plan and included a diversion ditch upgradient and silt fence downgradient of the earth disturbance activities. Requirements for a water obstruction and encroachment permit were waived under PA Title 25, Chapter 105.12(a)(15). Quality Aggregates, Inc. addressed the road bond requirements. Passive system design plans were completed by BioMost, Inc. PA One Call (#2915393) relating to underground utility locations was contacted during design and prior to earth disturbance. After completion of the final system design and compliance with pre-construction regulatory requirements, the construction site was cleared and grubbed. A small temporary berm was installed around the BC16 upwelling. This served two purposes. The first purpose was to determine the feasibility of raising the water level in order to decrease excavation costs. The second was to try to “dry up” the proposed construction area. Even though the decision was made to maintain the pre-construction water level at BC16, the berm was maintained during earth disturbance to collect and to divert the water away from the construction site.

Passive Treatment System Construction

The passive treatment system installed at BC16 consists of the following three components in series **(See plans and photo section.)**:

1. Settling Pond (~2,500 sq. ft.)
2. Aerobic Wetland (~30,000 sq. ft.; volunteer planting effort; species diversity)
3. Horizontal Flow Limestone Bed (~1,400 tons, AASHTO#1, 90% $CaCO_3$)

Settling Pond **(SP)**: The Settling Pond embankments were constructed around the upwelling of the discharge. The ~2500-square foot SP provides initial oxidation, hydrolysis, and settling of solids (primarily iron). A riprap spillway on the eastern side of the Settling Pond assists not only in providing aeration and conveying the discharge to the Aerobic Wetland but also in degassing CO_2. Degassing of CO_2 is important as the resulting increase in pH increases the iron oxidation rate (Fe^{+2} oxidized to Fe^{+3}). The ferric iron then rapidly hydrolyzes to form amorphous iron solids.

Aerobic Wetland **(WL)**: The primary purpose of the ~30,000-square foot Aerobic Wetland (WL) is to provide a location for additional oxidation and settling of metal solids, primarily iron. Internal directional earthen berms are installed to direct flow and maximize retention (decrease "short-circuiting") within the wetland. Two cells are divided by a riprap-lined spillway which again serves to degas CO_2, provide aeration, and serve as a level spreader to distribute flow. (CO_2 is generated and O_2 is consumed as dissolved iron forms solids.) In addition, the wetland and upland areas are to be planted with a variety of species to provide wildlife habitat with food source.

Horizontal Flow Limestone Bed **(HFLB)**: Water is conveyed from the wetland to the Horizontal Flow Limestone Bed via a riprap spillway where the water is encouraged to flow horizontally through a 5-foot thick bed of ~1400 tons of AASHTO #1, 90% $CaCO_3$, Vanport limestone. The limestone aggregate helps assure that the BC16 discharge, which is at times net acid, is consistently net alkaline and that additional alkalinity loading is provided to UNT15 and Blacks Creek. Another function of the HFLB, which has received national interest (Roberts et al, 2008; Denholm et al, 2008; McDevitt, 2008), is the ability of the HFLB to remove manganese. Within the HFLB, a high pH (required for manganese removal with active treatment) is not needed, probably due to several factors including low concentrations of dissolved ferrous iron, availability of dissolved oxygen, activity of bacteria and/or fungi, establishment of autocatalytic manganese oxide substrate, etc. The HFLB effluent is conveyed by a rock-lined spillway directly to UNT15 which provides further degassing/aeration.

(See BC16 system design on attached E & S Control Plan & Details.)

BC16 Passive System Effectiveness & Environmental Improvement

Due to the timing of the EPA-required Blacks Creek Restoration Plan after the grant award for the BC16 system and construction delays associated with the weather, etc., the BC16 passive treatment system has just recently been completed. At this time, there is no final effluent. As this is the winter season, planting by volunteers of the Aerobic Wetland and the upland areas with the permanent species are planned for the spring/summer months. Measurable results based on actual water sample analyses, therefore, can not be provided to demonstrate improvement to the discharge, UNT15, and Blacks Creek. As soon as a final effluent is observed, even before wetland planting, the following points are to be sampled:

Table 4: BC16 Passive System, UNT15, Blacks Creek Monitoring Points

ID #	Latitude / Longitude	Description	Location
BC16	41° 09' 51.3" / 79° 55' 03.4"	Raw AMD	upwelling in SP; point marked in field
903 SP	41° 09' 51.6" / 79° 55' 02.7"	Settling Pond effluent	riprap-lined spillway to WL
903 WL	41° 09' 51.9" / 79° 55' 04.9"	Aerobic Wetland effluent	riprap-lined spillway to HFLB
903 HFLB	41° 09' 51.0" / 79° 55' 05.2"	Horizontal Flow Limestone Bed effluent	weir in riprap-lined spillway from HFLB
BC4.1	41° 09' 51.3" / 79° 55' 02.8"	UNT15 above HFLB effluent	point marked in field
SB1	41° 09' 55.0" / 79° 55' 45.9"	Old Sed. Pond effluent; UNT15 flow rate	outlet pipe
BC4	41° 09' 51.0" / 79° 55' 05.3"	UNT15 below HFLB effluent	point marked in field
906-42	41° 09' 51.2" / 79° 55' 06.4"	Blacks Creek above UNT15 confluence	at stream crossing for Porter Road
BC2	41° 09' 48.9" / 79° 55' 06.0"	Blacks Creek below UNT15 confluence	point marked in field

The monitoring points are depicted on the following BC16 Remediation Project (schematic) which is also provided in the attached O&M Plan and online at Datashed (www.datashed.org). The flow rate of the BC16 discharge is to be measured at the weir installed for the HFLB effluent (903 HFLB) with the upstream flow rate for UNT15 measured at the old Sediment Pond outlet pipe (SB1) ~1500' above the confluence with the BC16 passive system effluent. (Based on cursory field observations, there are small contributions to the stream flow of UNT15 that will not be included; however, flow measurement at SB1 is anticipated to provide a reasonable representation.) The downstream flow rate of UNT15 is to be estimated by adding the flow measurement at 903 HFLB with that at SB1.

In addition to flow measurements of the final system effluent (903 HFLB) and UNT15 at the old Sediment Pond outlet, the following parameters are proposed to be measured bi-annually: field & lab pH; lab specific conductivity (µmho/cm); field temperature (^{o}C); field & lab alkalinity (mg $CaCO_3$/L); lab acidity (mg $CaCO_3$/L); lab total (dissolved if funding available, etc.) iron, manganese, aluminum (mg/L); lab sulfates (mg/L); field dissolved oxygen (mg/L); field ORP (mV). (Funding currently limits SB1 monitoring to field tests.)

As with other passive systems completed through Slippery Rock Watershed Coalition partnership efforts, field data and laboratory sample analyses are to be available online at Datashed (www.datashed.org). Automatically calculated loading reductions will also be provided online.

For the purpose of this final report, estimates of treatment effectiveness and the potential impact to the receiving streams have been provided. Due to the complex nature of the various biogeochemical and mechanical processes involved in passively treating mine water, accurately predicting final effluent water quality may be tenuous. Even though a 100% removal rate is possible, a conservative estimate of 80% and 50% removal of iron and manganese loadings, respectively, was utilized, based on the experience of the project participants with other passive systems having Horizontal Flow Limestone Beds within the Slippery Rock Creek Watershed, including, in particular De Sale 1, De Sale 2, De Sale 3, and Erico Bridge. (Note that the HFLB may require several months of operation prior to effective removal of manganese.) Based upon available data for the BC16 discharge, the passive system is estimated to remove, on average, ~40 lbs/day of iron and ~7 lbs/day of manganese. With the available information provided in the EPA approved Total Maximum Daily Loads (TMDL) for the Blacks Creek Watershed (See Table 5.) prepared by the PA DEP Knox District Mining Office, this reduction in pollutant loading would account for ~65% of the iron and ~25% of the manganese loading reduction needed at sampling point BC2 which is located on Blacks Creek about 200 feet downstream of the confluence with tributary #15 (a.k.a., UNT15 or "McIntire" trib.). If 100% of the iron and manganese loading associated with the BC16 discharge is removed by the passive system roughly 80% of the iron and 60% of the manganese loading reduction required at BC2 would be accomplished.

Table 5: Necessary Reductions at Sample Point BC2 (TMDL, Table D4, p. 4)

	Al (#/day)	**Fe** (#/day)	**Mn** (#/day)	**Acidity** (#/day)
Existing Loads at BC2	4.0	60.2	26.6	0.0
Total Load Reduction (BC6)	2.6	0.0	2.8	8.6
Remaining Load (Existing Loads at BC2-TLR Sum)	1.4	60.2	23.8	NA
Allowable Loads at BC2	1.0	1.2	1.1	0.0
Additional Removal Required at BC2	0.4	59.0	22.8	0.0

Total Fe, Mn, Al; BC2 - Blacks Creek ~200' below UNT15 confluence; BC6 - Blacks Creek in headwaters ~3500'above UNT15 confluence; Percent Reduction eliminated for clarity; See attached Blacks Creek Watershed Map.; Source: Blacks Creek Watershed TMDL (EPA Approved 1/19/05)

The above table is taken directly from the Blacks Creek Watershed TMDL. The following table was developed to illustrate the projected contribution towards attaining the targeted “Allowable Loads at BC2” through the passive treatment of the BC16 AMD.

Table 6: Projected Loading Reductions at BC2 from BC16 Passive Treatment

	Al (#/day)	**Fe** (#/day)	**Mn** (#/day)	**Acidity** (#/day)
Existing Loads at BC2	4.0	60.2	26.6	0.0
Total Load Reduction (BC16 AMD Source)	0	40	7	0
Remaining Load (Existing Loads at BC2-TLR Sum)	4.0	20.2	19.6	NA
Allowable Loads at BC2	1.0	1.2	1.1	0.0
Additional Removal Required at BC2	3.0	19.0	18.5	0.0

Total Fe, Mn, Al; BC2 - Blacks Creek ~200’ below UNT15 confluence; BC16 - AMD source entering UNT15; See attached Blacks Creek Watershed Map.

Note that passive treatment of the BC16 AMD is projected not only to improve the water quality in Blacks Creek at BC2 but also to substantially reduce iron and manganese loadings which is needed to comply with the “Allowable Loads at BC2” identified in the TMDL. As shown in the TMDL Table D4, (See Table 5 in this report.), 100% attainment upstream at BC6 of the allowable loading for total aluminum, iron, and manganese is not sufficient to meet the allowable loads identified for BC2. The treatment of BC16, therefore, is deemed instrumental in the restoration of Blacks Creek at BC2.

Future Efforts

With the installation of the BC16 passive system, significant progress is being made in the restoration of the Blacks Creek Watershed. Nevertheless, substantial work remains. A PA DEP Growing Greener/EPA 319 grant application for the discharges at the McIntire Minesite has been submitted by Stream Restoration Incorporated on behalf of the Slippery Rock Watershed Coalition. This application proposes to address the “worst” (Priority #1) discharge in the Blacks Creek Watershed. Approval or denial of the proposal has not yet been announced. Based on available data, completion of the “McIntire” and BC16 passive treatment systems are expected to eliminate roughly 50% of the total metal loadings, including 60% of the iron and 45% of the manganese to Blacks Creek. Approvals from landowners are required for treatment of the BC14 & BC15 discharges, ranked as priority #3 for restoration. Landowners for the 906-7, -8, and-9 discharges (4^{th} ranked project) have already expressed an interest in allowing a passive system to be constructed. Additional water monitoring of the discharges, passive systems, and streams will be conducted. Passive system operation and maintenance is addressed below.

Operation & Maintenance

Operation and maintenance of passive systems are critical in sustainability of long-term treatment. A comprehensive O&M Plan for all restoration projects within the Slippery Rock Watershed has been previously completed (SRWC, 3/07). The O&M Plan, which is available for viewing and downloading at www.datashed.org, was created to be easily updated and expanded as additional projects are implemented. The O&M Plan has been updated for the BC16 project including a site inspection form and a site schematic. In addition, a project page has been created on Datashed, which provides access to these documents as well as to water monitoring data, electronic inspection reports, customizable directions to the site from any starting point in the USA, and more. Pre-construction water monitoring data has been uploaded. Future water monitoring for the BC16 discharge, individual passive treatment components, and UNT15 and Blacks Creek (upstream and downstream of the BC16 system), are to be added to the database in order to evaluate system performance and water quality improvement. (See selected O&M sheets in Appendix.)

Education & Outreach

Education and outreach have always been important to the Slippery Rock Watershed Coalition. Efforts relating to the BC16 project have included providing updates at Slippery Rock Watershed Coalition monthly public meetings and articles in the monthly newsletter, *The Catalyst*. (See articles in Appendix.). A project site sign also identifies the effort. (See photos in Appendix.) As a project page has been created on Datashed and pertinent information uploaded to the site including water quality data, anyone with internet access can view information about the project. In the future, additional articles will be placed in *The Catalyst* and the site will be included in field tours.

The BC16 discharge was also utilized by Holly Ann Leach and Dave Van Dyne of Westminster College as part of their Environmental Science Capstone Course (Dr. Helen Boylan, Professor). The students conducted research and presented a paper on 12/14/07 (See attached paper in Appendix.) to peers, professors, and the interested public. Information and conclusions from the study were used in discussions of not only the BC16 project, but other passive system designs as well.

Planting of the Aerobic Wetland is planned to be completed by volunteers during the 2009 growing season. This is not only a generous in-kind contribution but also an important educational opportunity as wetland scientists describe the habitat and environmental value of the native hydrophytic species selected for the Aerobic Wetland to all participants.

Selected References

Denholm, Cliff, Tim Danehy, Tom Grote, Shaun Busler, Margaret Dunn, 2008, "Mine Drainage Sludge: Helping the Environment?": *in* Reclamation Matters, American Society of Mining and Reclamation, 2008 2nd Issue, p. 24-27.

Gillen, Timothy, unpublished 4/6/94, Hydrologic Investigation, H & D Coal company, MDP #3078BC12, Irwin & Marion Townships, Venango & Butler Counties: PA Dept. of Environmental Resources (now PA DEP), Knox District Mining Office, 3 pp. with map.

Leach, Holly Ann and Dave Van Dyne, unpublished 12/14/07, untitled Pilot Study with Lab. Testing, UNT15 Subwatershed, Blacks Creek - Slippery Rock Creek Watershed: *prepared for* Westminster College Environmental Science Capstone Course (Dr. Helen Boylan, Professor) and Slippery Rock Watershed Coalition, 37pp.

McDevitt, Bette, March/April 2008, "Glazed With What Oozed": *in* Sierra, The Magazine of the Sierra Club, p. 8.

Pennsylvania Department of Environmental Protection, 10/20/04 (EPA-Approved 1/19/05), Final Blacks Creek Watershed TMDL, Butler County, For Acid Mine Drainage Affected Segments: 47pp.

PA Department of Environmental Protection, Knox District Mining Office, 1998, Slippery Rock Creek Watershed Comprehensive Mine Reclamation Strategy, Reclamation/Remediation Plan, 192pp.

Roberts, Scott, Margaret Dunn, and Cliff Denholm, July 2008, "Passive Systems Treat AMD While Allowing Recovery of Metal Oxides": *in* US Environmental Protection Agency Technology News and Trends, Issue 37, p. 1-2.

Slippery Rock Watershed Coalition, 06/05, BC19 &BC19B Remediation Project Final Report, Public-Private Partnership Effort, Marion Twp., Butler Co.: *prepared by* BioMost, Inc. & Stream Restoration Inc.; *submitted to* PA Department of Environmental Protection.

Slippery Rock Watershed Coalition, 01/07 (Rev. 04/07), Blacks Creek Restoration Plan: *prepared by* BioMost, Inc. & Stream Restoration Inc.; *submitted to* PA Department of Environmental Protection.

Slippery Rock Watershed Coalition, 03/07, Comprehensive Operation and Maintenance Plan for Watershed Restoration Projects: *prepared by* BioMost, Inc. & Stream Restoration Inc.; *submitted to* PA Department of Environmental Protection. *[last update 01/09 for BC16 passive treatment system]*

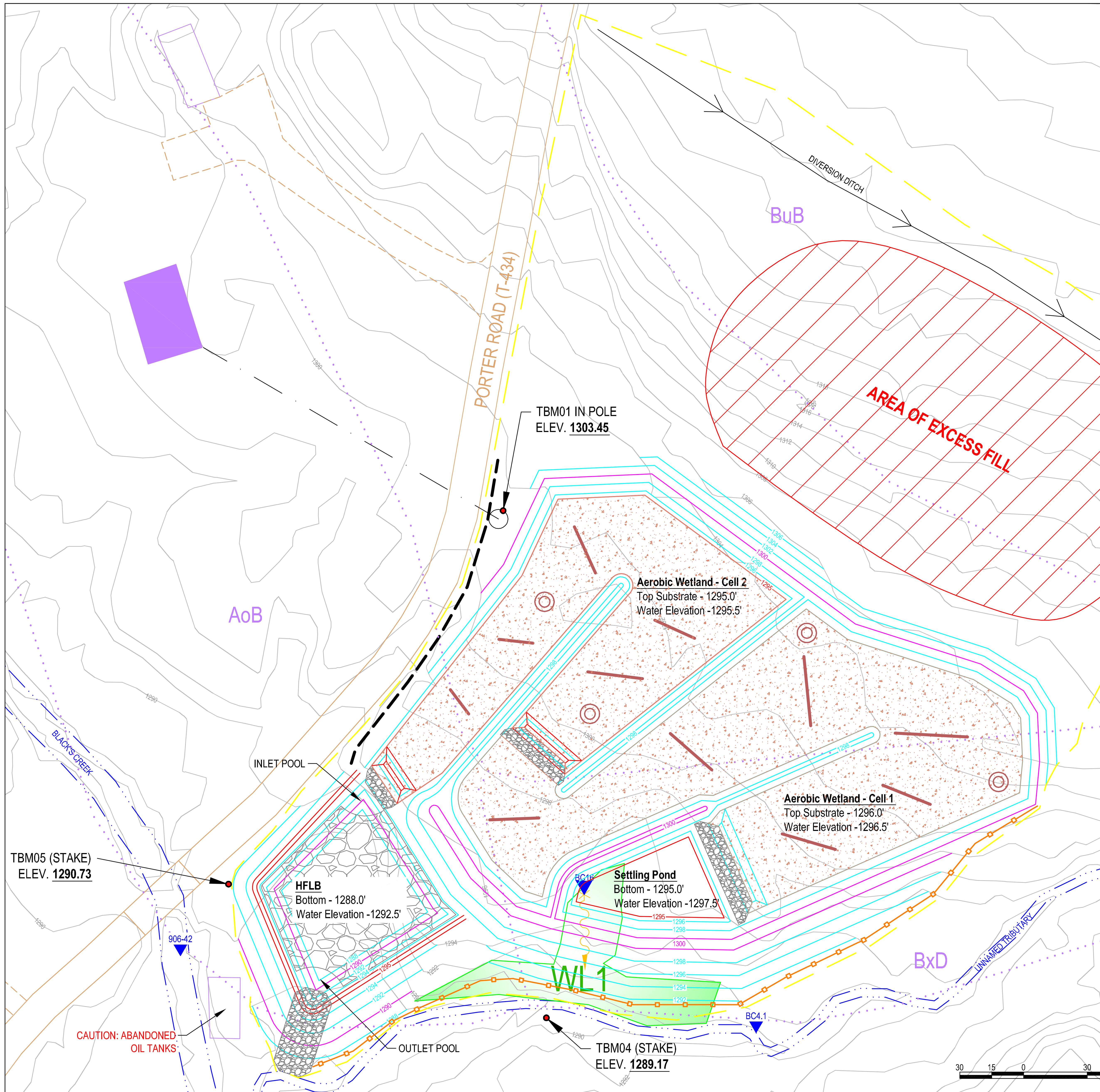
Passive Treatment System Priority List

Priority Rank	Name
1	TB1 ("McIntire" Site)
2	BC16
3	BC14 & BC15
4	906-7, -8, -9
5	906-4, -5
6	906-17
7	906-36
8	906-22, -23
9	906-21
10	906-14
11	906-24

See Table XIII. of Narrative for more information.

BLACKS CREEK WATERSHED MAP

BLACKS CREEK RESTORATION PLAN
SLIPPERY ROCK CREEK WATERSHED
STREAM RESTORATION INCORPORATED
Marion, Clinton, Irwin, & Venango Townships
Butler & Venango Counties, Pennsylvania
Scale: 1" = 1000' April 2007
BioMost, Inc., Cranberry Township, PA
Mining and Reclamation Services



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PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE--STOP CALL

PA1 SYSTEM, INC. 1-800-242-1776

POCS SERIAL NUMBER 2915393

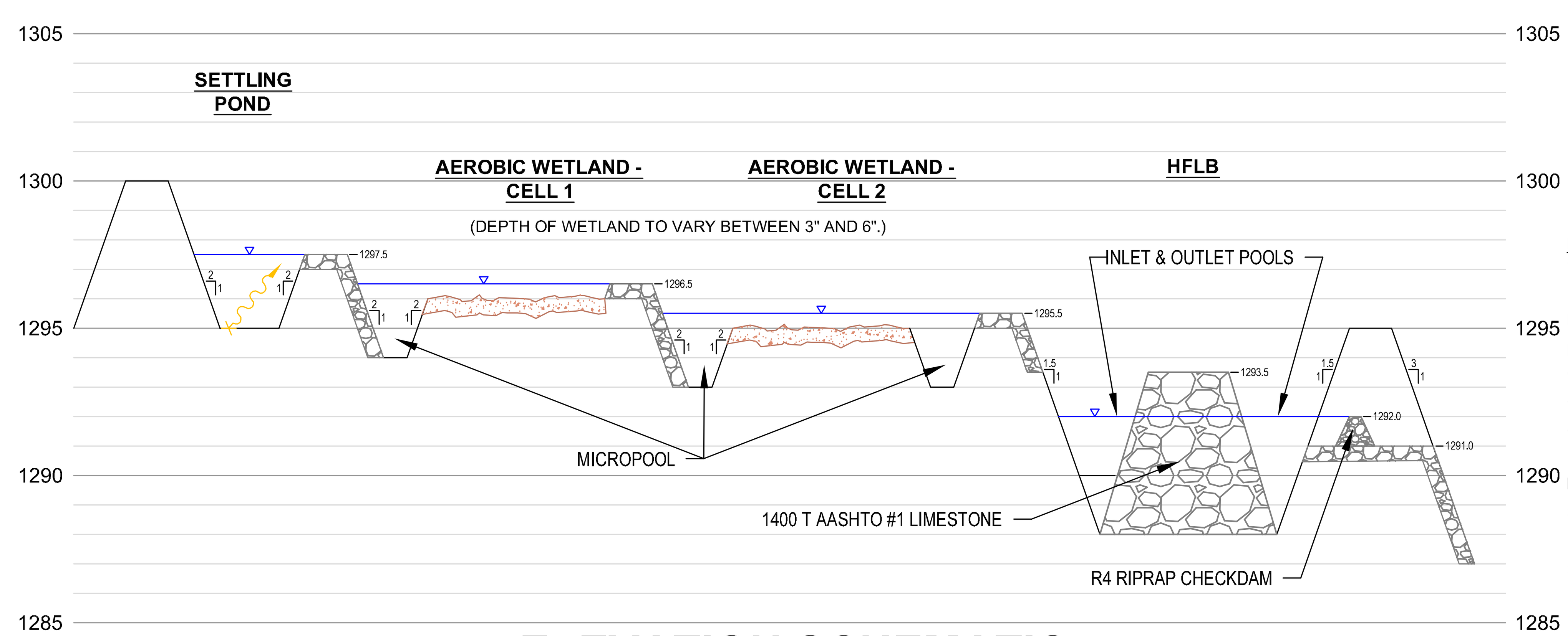
TEMPORARY AND PERMANENT SEEDING SPECIFICATIONS

Temporary
SPECIES: Annual Ryegrass (Penn DOT Formula E)
% PURE LIVE SEED: 88%
APPLICATION RATE: 48 LB./ACRE
FERTILIZER TYPE: None
FERTILIZER APPL. RATE: 0 LB./ACRE
LIMING RATE: 0 T./ACRE
MULCH TYPE: Hay or Straw
MULCHING RATE: 3.0 T./ACRE

***Permanent [Including Steep Slopes (>3:1)]**
ERNST NATIVE UPLAND WILDLIFE FORAGE & COVER MEADOW MIX (ERNMX-123)
SEEDING RATE: 15 lb per acre or 1/3 - 1/2 lb per 1,000 SF
(20%*Virginia Wild Rye*; 20%*Little Bluestem, PA Ecotype*;10%*'Shelter' Switchgrass*; 10%*Indiangrass, PA Ecotype*; 10%*Eastern Gamma Grass*; 5%*Plains Coreopsis*; 5%*'Atlantic' Coastal Panic Grass*; 5%*Fowl Bluegrass*; 4%*' WI Ecotype' Big Bluestem*; 4%*Partridge Pea*; 3%*Black Eyed Susan*; 2%*Showy Tick Trefoil*; 2%*Ox Eye Sunflower*)
WINTER WHEAT FOR FALL PLANTING OR SPRING OATS AT 34 LB./ACRE IN SPRING PLANTING. WINTER RYE OR ANNUAL RYE GRASS AT 25 LB./ACRE MAY ALSO BE USED.
% MIN. PURITY FOR ABOVE SPECIES: 90%
% MIN. GERMINATION FOR ABOVE SPECIES: 80%
FERTILIZER TYPE: 10-20-20
FERTILIZER APPL. RATE: 1,000 LB./ACRE [To be revised based on Soil Test(s)]
LIMING RATE: 6 T./ACRE [To be revised based on Soil Test(s)]
MULCH TYPE: Hay or Straw
MULCHING RATE: 3.0 T./ACRE
ANCHOR MATERIAL: N/A (See note.)
ANCHORING METHOD: N/A (See note.)
RATE OF ANCHOR MATERIAL APPL.: N/A (See note.)
PREFERRED SEEDING SEASON DATES: 3/15 to 6/1; 8/1 to 10/15
*Seeding specifications above do not include planting within the wetland - see details.

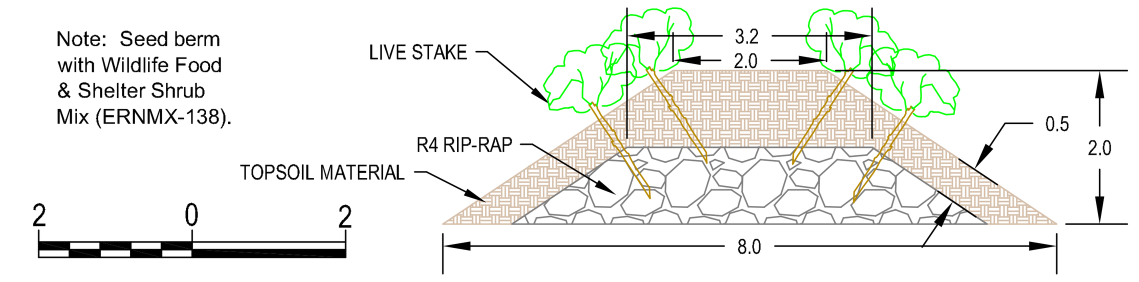
CONSTRUCTION SCHEDULE & BMP INSTALLATION SEQUENCE

1. THE GENERAL APPROACH TO CONSTRUCTION AND BMP INSTALLATION INTENDS THAT: E&S CONTROL FACILITIES BE INSTALLED PRIOR TO EARTH DISTURBANCE ACTIVITIES; EACH STEP SHOULD BE COMPLETED BEFORE BEGINNING THE NEXT; AND THE SITE BE STABILIZED AS SOON AS POSSIBLE UPON COMPLETION OF THE WORK. IF THE WORK IS DIVIDED INTO SMALLER SUBAREAS, THE E&S CONTROLS ARE TO BE INSTALLED PRIOR TO BEGINNING WORK IN THAT AREA. THIS INCLUDES INSTALLING CONTROLS FOR ALL DOWNSTREAM AREAS FROM THE DISTURBANCE ACTIVITY. IF THE EARTH DISTURBANCE ACTIVITIES MUST BE SUSPENDED FOR A PERIOD OF MORE THAN 20 DAYS, THE DISTURBED AREAS ARE TO BE TEMPORARILY STABILIZED WITH SEEDING AND MULCHING OR OTHER SUITABLE MEANS TO PREVENT EROSION.
2. INSTALL UPLAND DIVERSION DITCH & STRAW BALE BARRIER AS SHOWN
   INSTALLATION OF FENCE MUST BE COMPLETED PRIOR TO CONDUCTING UPGRADIENT EARTH DISTURBANCE ACTIVITIES
3. INSTALL PASSIVE TREATMENT SYSTEM
   AREAS WHERE PASSIVE TREATMENT SYSTEM COMPONENTS ARE TO BE CONSTRUCTED WILL BE AFFECTED AS FOLLOWS:
   a) INSTALL BARRIER BELOW AREA TO BE AFFECTED
   b) CLEAR AND GRUBB AREA OF PASSIVE TREATMENT SYSTEM COMPONENT
   c) BEGIN COMPONENT CONSTRUCTION BY DIGGING SUMP
   d) CONSTRUCTION OF COMPONENT THROUGH EXPANDING SUMP/BUILDING BREASTWORK
   e) MAINTAIN POSITIVE DRAINAGE TOWARDS THE COMPONENT SUMP
   f) ALLOW WATER COLLECTED IN SUMP TO SETTLE UNTIL SUITABLE FOR DISCHARGE
   g) WATER DISCHARGED FROM COMPONENT SUMP WILL BE PUMPED TO A STABLE EXISTING WATER COURSE OR OTHER SUITABLE DISCHARGE AREA USING A PUMPED WATER FILTER BAG IF NEEDED
4. USE STONE DELIVERED FOR HFLB AS TEMPORARY ROCK CONSTRUCTION ENTRANCE DURING MATERIAL DELIVERY
5. STABILIZE ALL AFFECTED AREAS AS SOON AS POSSIBLE DURING OR WITHIN 1 WEEK AFTER CONSTRUCTION
6. REMOVE ALL TEMPORARY BMPS UPON PERMANENT UNIFORM 70% PERENNIAL VEGETATIVE COVER ESTABLISHMENT

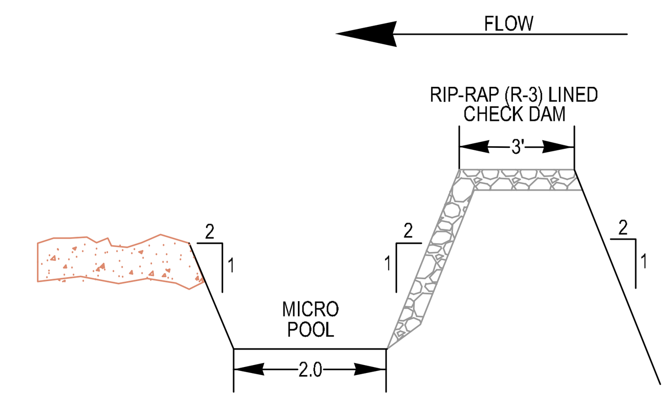


ELEVATION SCHEMATIC

NOT TO SCALE



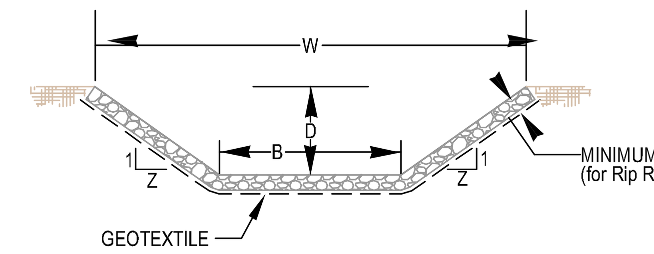
1 INTERNAL WETLAND BERM DETAIL
SCALE: 1" = 2'



RIP-RAP DATA CHART

NCSA No.	AVG. STONE SIZE (d50)	MIN. DEPTH A
R-2	1 1/2"	3"
R-3	3"	6"
R-4	6"	12"
R-5	9"	18"
R-6	12"	24"
R-7	18"	36"
R-8	24"	48"

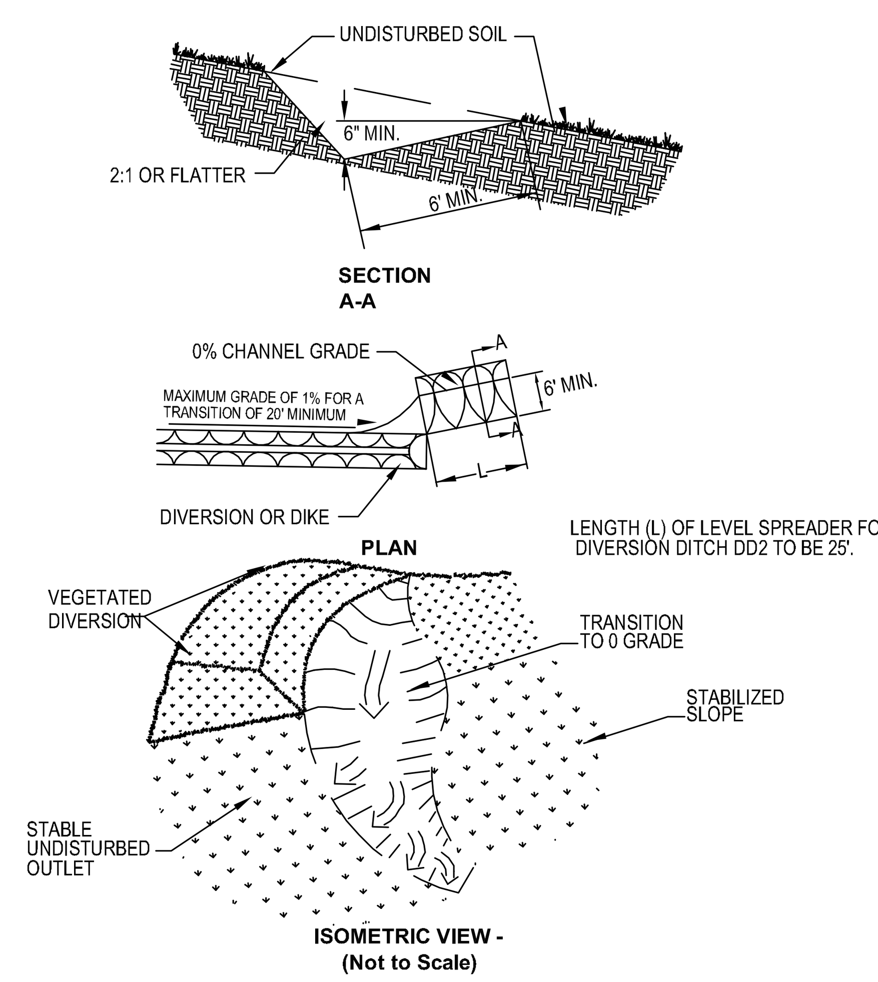
2 CHECK DAM DETAIL
NOT TO SCALE



RIP-RAPPED CHANNELS

CHANNEL TYPE	W	B	D	Z	LINING
HFLB SPILLWAY	18	10	2	2	R-4
DIVERSION DITCH	8	0	2	2	GRASS

3 CHANNEL DETAIL
NOT TO SCALE



4 LEVEL SPREADER
NOT TO SCALE

AS-BUILT NOTES (Changes not shown on plan/details)

Area of Excess Fill expanded to accept material from lowered wetland elevations & diversion ditch moved upgradient.

Elevations adjusted due to field conditions
- Aerobic Wetland - Cell 1: Top Substrate - 1294.0; Water Elevation - 1294.5
- Aerobic Wetland - Cell 2: Top Substrate - 1293.0; Water Elevation - 1293.5
- Aerobic Wetland - Cells 1 & 2: Internal Berm Top Elevations - 1296.0

Notes:

Topographic contours were derived from a bare-earth digital surface model constructed from LiDAR (Spring 2006) from the PAMAP program.

Abandoned oil pipelines exist on the project site. Take caution when working with the pipelines to prevent any remaining oil from entering Blacks Creek.

Existing wetland delineated and located by sub-meter GPS unit by BioMost, Inc. A restoration waiver (EA10 08 601) was received on May 30, 2008 for construction activities.

Passive treatment system to be built on property of Dennis Tiche and Linda A. Furst (210-2F122- 14-0000).

Wetland to be constructed with a high degree of microrelief to create a diversity of hydrologic regimes within the wetland. Average depth to range between 3" to 6".

Wildlife structures, including snags, brush piles, woody debris, and rock piles, will be placed within and surrounding the wetland.

Woody debris salvaged during clearing and excavation activities will be placed throughout wetland following soil placement. The majority of woody debris placed within the wetland is to consist of root wads, stumps, logs, and branches > 4 inches in diameter.

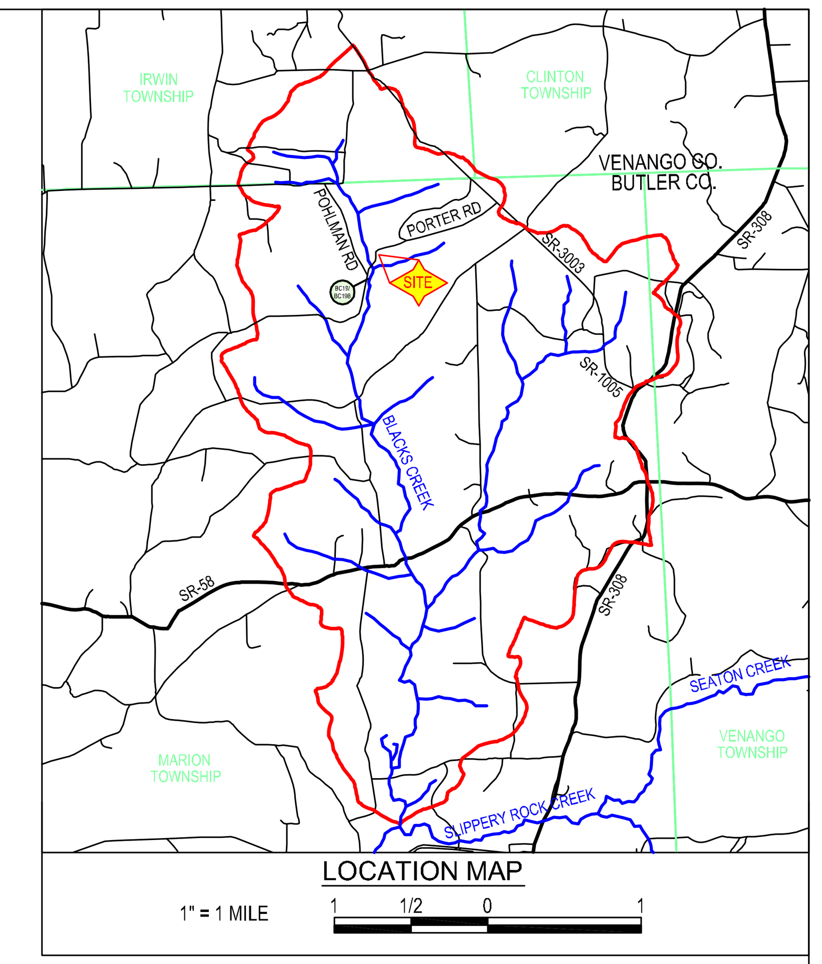
Internal wetland berms and slopes within 5 feet of wetland to be seeded with Wildlife Food & Shelter Shrub Mix sold by Ernst Seed, Meadville, PA (ERNMX-138).

Stockpile existing topsoil for use as wetland substrate. Do not compact.

All dimensions, layout, elevations, etc. may be revised based on field conditions or other factors.

Soils information from 2004 USDA, NRCS SSURGO database for Butler County, PA.

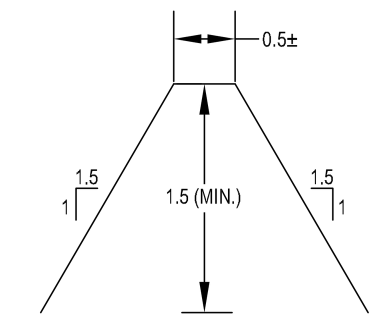
HORIZONTAL LOCATIONS OF TEMPORARY BENCH MARKS ARE VERY APPROXIMATE - USE ONLY FOR ELEVATIONS - **DO NOT USE FOR X-Y LAYOUT OUT**



LOCATION MAP

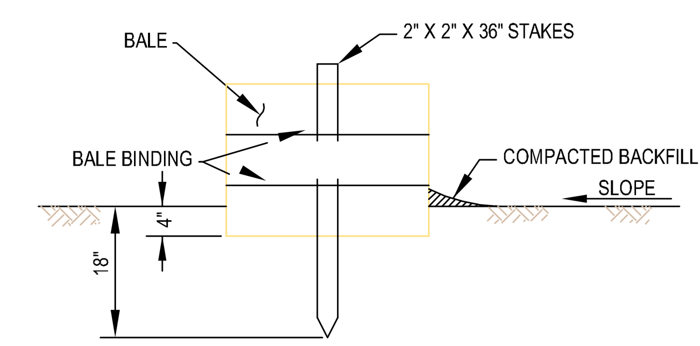
LEGEND

- CONTOUR - INDEX (EXISTING)
- CONTOUR - INTERMEDIATE (EXISTING)
- CONTOUR - INDEX (PROPOSED)
- CONTOUR - INTERMEDIATE (PROPOSED)
- PASSIVE TREATMENT SYSTEM COMPONENT
- WATER
- LIMITS OF DISTURBANCE
- PAVED/IMPROVED ROAD
- STRAW BALE BARRIER
- SAFETY BERM
- EXISTING WETLAND
- WETLAND SUBSTRATE
- SNAG
- WOODY DEBRIS
- UTILITY POLE
- OVERHEAD UTILITY LINE
- ABANDONED MINE DISCHARGE
- WATER SAMPLE POINT
- BUILDING (SHADED IF DWELLING)
- SOIL UNIT BOUNDARY



Safety berms to be installed when project excavations over 6" extend to within less than 10' of the edge of any existing or relocated road. Safety berms to extend along edge of road for a distance of at least 15' in either direction from the maximum extent of the excavation.

5 SAFETY BERM SECTION TYPICAL
NOT TO SCALE



Straw Bale Barriers should not be used for more than 3 months.

Straw Bale Barriers shall be placed at existing level grade. Both ends of the barrier shall be extended at least 8 feet up slope at 45 degrees to the main barrier alignment.

Sediment Shall be removed when accumulations reach 1/3 the above ground height of the barrier.

Any section of Straw Bale Barrier which has been undermined or topped shall be immediately replaced with a Rock Filter Outlet.

6 STRAW BALE BARRIER DETAIL
NOT TO SCALE

REV.	DATE	DESCRIPTION
2	12/31/08	As-built Notes
1	10/20/08	TBMs; Drafting (arrows)

Erosion & Sedimentation Control Plan & Details

PASSIVE TREATMENT SYSTEM
BC16 REMEDIATION PROJECT
in cooperation with
STREAM RESTORATION INCORPORATED

Marion Township, Butler County, Pennsylvania
Scale: 1" = 30' October 2008

BioMost, Inc., Mining and Reclamation Services
Mars, PA

903/DESIGN-FR






The northern portion of the 9-sq. mi. Blacks Creek watershed is part of the Bullion-Clintonville Oil Field with “pay zones” at a depth of ~1050 feet in the Venango Second and Third Sandstones. Petroleum exploration was reported to have begun around 1876. Numerous historic, as well as more recent, oil wells, pumping facilities, storage tanks, and piping systems are commonly observed. If casings are compromised, the old oil wells can provide a conduit for mine drainage to reach the surface.

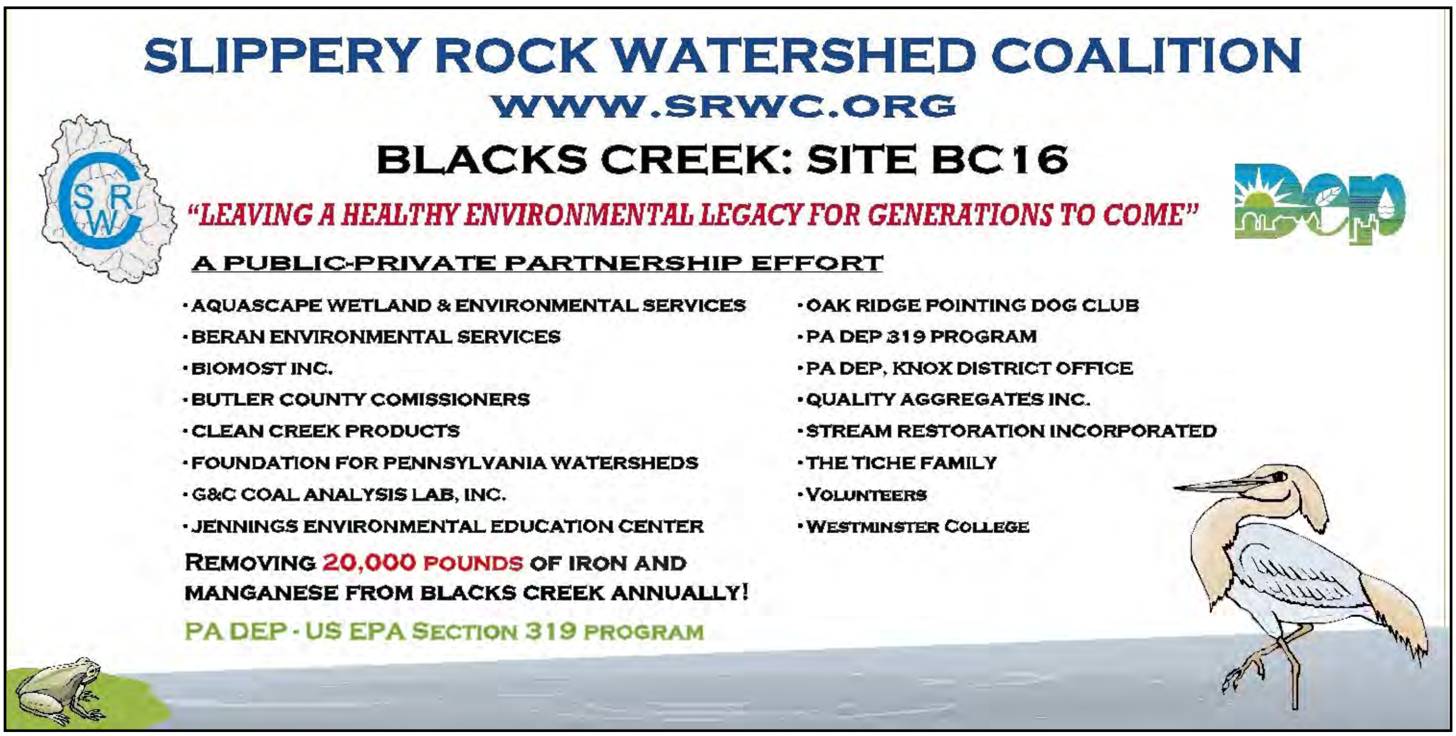
The BC16 abandoned mine discharge (Above) issues (Top Left) from what is believed to be an old oil well. BC16 is generally characterized as an alkaline, iron- and manganese-bearing, discharge. In the Blacks Creek Watershed Restoration Plan, the BC16 discharge was 2nd highest in terms of metal loadings and, therefore, identified as the #2 priority site for restoration. The BC16 discharge flows directly into tributary #15 (Bottom Left and Right) which was identified as the most polluted tributary within the watershed and representing nearly 50% of the pollutant loading to Blacks Creek.

Above the BC16 discharge, tributary #15 at point BC4.1 (Top Left) is typically very acidic with all metals characteristically in the dissolved state. Below BC16, tributary #15 at point BC4 (Top Right) (just prior to the confluence with Blacks Creek) is less acidic but contains high concentrations of iron, manganese, and aluminum. The impact of tributary #15 to Blacks Creek is significant and visually noticeable by comparing upstream and downstream points 906-42 (Center Left) and BC2 (Center Right), respectively. Blacks Creek is still quite impaired downstream at BC2B (Bottom Left) and at BC1 (Bottom Right) although water quality does continue to improve as sources of better quality water enter the creek.

Investigations to abate the BC16 and “McIntire” discharges impacting Blacks Creek by Slippery Rock Watershed Coalition participants began in 2000 (Top). A rapid assessment snapshot (Center) was conducted in partnership with the PA DEP in 2001. Prior to installation of the BC16 passive system, Stream Restoration Inc. completed a Blacks Creek Restoration Plan, as required by the US EPA, which necessitated conducting an assessment (Bottom) of the 9-sq. mi. Blacks Creek Watershed including monitoring of streams and mine discharges.

Once the passive system design and associated permitting were completed, the construction area was cleared and grubbed (Top Left and Right). Next, earth material was excavated using a dozer and excavator to the design elevation of the system. Suitable material from the excavation was used to construct the embankments for the passive system. Large boulders encountered during construction were placed to provide wildlife habitat (Bottom Right).

Construction of the passive system was conducted by Quality Aggregates, Inc. (Top). A temporary berm was built around the discharge (Center) to determine the feasibility of raising the discharge elevation to limit the extent of excavation. To maintain the pre-construction flow rate, the design elevations were maintained. As the decreased flow rate, however, provided for a drier construction area, the berm was left in place during construction. An access road (Bottom Left) was installed for limestone placement within the HFLB (Bottom Right).



The Slippery Rock Watershed Coalition has always tried to incorporate education and outreach activities within every watershed restoration project. Westminster College Students Holly Ann Leach and Dave Van Dyne utilized Blacks Creek and the BC16 discharge (Center Left) to complete a research project for their Environmental Science Capstone Course (Dr. Helen Boylan, Professor). The project consisted of conducting a series of laboratory experiments (Center Right) relating to the effects of aeration, pH, and water level depths within passive components used for treating alkaline mine discharge. A site sign (Bottom) was created to identify partners and environmental benefits of the BC16 passive system.

BC16

Site Type:	Passive Treatment System
Latitude:	41 09 51
Longitude:	-79 55 06
Determined by GPS:	No
Elevation:	1300
Quad:	Barkeyville
Stream:	tributary 15, Blacks Creek
Watershed:	Slippery Rock Creek
Municipality:	Marion Township
County:	Butler
Year Constructed:	2008
Primary Funding Partners:	DEP Section 319 Other
Treatment Technologies:	Aerobic Wetland Manganese Removal Bed Settling Ponds
Contact:	Stream Restoration Inc.
Responsible Organization:	Stream Restoration Inc.
Source of AMD:	
Links:	**http://www.srwc.org/** **http://www.streamrestorationinc.org/**

Loadings

Water Treated	0 (gal/yr)
Total Iron	0 (lb/yr)
Total Manganese	0 (lb/yr)
Total Aluminum	0 (lb/yr)
Acidity	0 (lb/yr)
Alkalinity	0 (lb/yr)

Sample Point	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Dissolved Aluminum (mg/L) - Lab	Dissolved Iron (mg/L) - Lab	Dissolved Manganese (mg/L) - Lab	Dissolved Oxygen (mg/L) - Lab	Field Temperature (C) - Field	Flow (gal/min) - Field	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Aluminum (mg/L) - Lab	Total Iron (mg/L) - Lab	Total Manganese (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
BC16	2.44	167.32	167.32	0.2	47.75	11.53	0.28	10.5	76.17	87.25	6.18	6.18	1391.2	604.52	0.26	55.26	15.48	21.96

PASSIVE TREATMENT SYSTEM O&M INSPECTION REPORT

01/2009

Inspection Date:	______________	Project Name:	BC16 Remediation Project
Inspected by:	______________	Municipality:	Marion Township
Organization:	______________	County:	Butler State: PA
Time Start: ________ End: ________		Project Coordinates:	41° 09' 51'' Lat 79° 55' 06'' Long
Receiving Stream:	Tributary #15 ("McIntire" trib.)	Subwatershed:	Blacks Creek Watershed: Slippery Rock Creek

Weather (circle one): Snow Heavy Rain Rain Light Rain Overcast Fair/Sunny Temp(°F): ≤32 33-40 41-50 51-60 60+

Is maintenance required? Yes/No If yes, provide explanation:

INSPECTION SUMMARY

A. Site Vegetation (Uplands and Associated Slopes)

Overall condition of vegetation on site: 0 1 2 3 4 5 (0=poor, 5=excellent, circle one) (See instructions.)

Is any reseeding required? Yes/No If yes, describe area size and identify location on Site Schematic:

B. Site Access and Parking

Is the access road passable for operation and monitoring? Yes/No?
Does the access road need maintenance? Yes/No?
Describe maintenance performed and remaining (Identify location on Site Schematic.): ______________________________

____

____

C. Vandalism and "Housekeeping"

Is there litter around or in the passive system? ? Yes/No? If Yes, was the litter picked up? Yes/No?
Is there litter that may be considered hazardous or dangerous that requires special disposal? ? Yes/No?
Has the project sign been damaged? ? Yes/No?
Is there evidence of vandalism to the passive system? Yes/No?
Additional comments: ______________________________

D. Ditches, Channels, Spillways

Channel Identification	Erosion Rills (Y/N)	Debris Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Performed and Remaining (Indicate ditch by number i.e. 2a = SP)
1. Diversion Ditch				
2. Rock-Lined Spillways				
a. Settling Pond				
b. Wetland				
c. HFLB				

E. Passive Treatment System Components

Component	Erosion Rills (Y/N)	Berms Stable (Y/N)	Vegetation Successful (Y/N)	Siltation Significant (Y/N)	Water Level Change (Y/N)	Maintenance Performed and Remaining Indicate which component i.e. SP1
Settling Pond						
Wetland						
HFLB						

Additional Comments: ______________________________

____

____

____

____

F. Wildlife Utilization

Animals sighted or tracks observed ____________________

Invasive plants observed ____________________

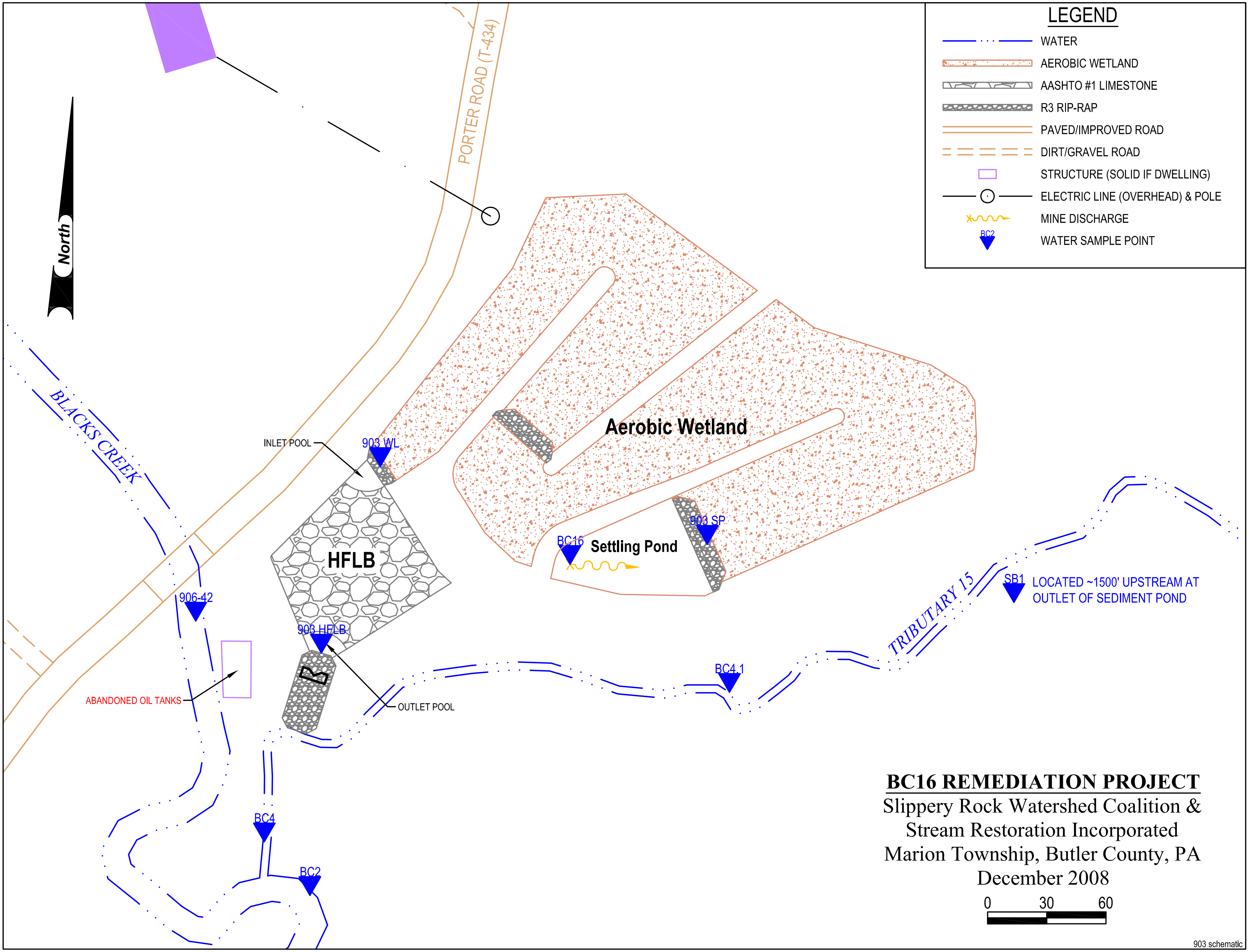
Describe any damage caused to treatment system by wildlife (especially muskrats) and required maintenance:

G. Field Water Monitoring and Sample Collection -

☐ - Not monitored

Sampling Point	Flow		pH	Temp (°C)	ORP (mV)	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
BC16												
903 SP												
903 WL												
903 HFLB												
SB1												
BC4.1												
BC4												
906-42												
BC2												

HFLB weier measurement in feet _________ = _________ gpm



BC16 REMEDIATION PROJECT

Slippery Rock Watershed Coalition &
Stream Restoration Incorporated
Marion Township, Butler County, PA
December 2008

903 schematic

Student Paper

Leach, Holly Ann and Dave Van Dyne, unpublished 12/14/07, untitled Pilot Study with Lab. Testing, UNT15 Subwatershed, Blacks Creek - Slippery Rock Creek Watershed: *prepared for* Westminster College Environmental Science Capstone Course (Dr. Helen Boylan, Professor) and Slippery Rock Watershed Coalition, 37pp.

INTRODUCTION

Strip coal mining has had an adverse impact on the environment. This situation has lead to massive amounts of acid mine (AMD) drainage throughout Pennsylvania, West Virginia and Maryland. It has shown to of taken a large toll ecologically, not only destroying fish communities and drastically changing the flora along small streams and major rivers (National Research Council 2005), but also preventing vegetation from naturally existing. These changes have occurred due to a deficiency in soil nutrients and organic matter. A lack in vegetative growth creates an increase in the rate of bank erosion. Metals and metalloids can begin to bioaccumulate in certain plant species. Fortunately many plants have built in strategies to deal with heavy metal concentrations (Lottermoser 2003). However, this is not the case for all vegetative growth along streams that are affected by AMD. Based on such effects it is important for studies to be performed to understand the full range of effects AMD has on the environment. Before one can study its effects he/she much understand basic background history about the coal industry.

The first coal production in Pennsylvania began in 1761 at Coal Hill. At this time coal was became the primary fuel source for iron furnaces and glass work in the United States. The production of coal in Pennsylvania fueled the American Revolution, the Industrial Revolution, and the two World Wars, making the United States the industrial capital of the world. Throughout history, Americans have shown a high dependency on coal; and Pennsylvania has become the third largest producer. During 200 years of mining, Pennsylvania has produced nearly one quarter of the coal extracted in the United States. In 1918, Pennsylvania produced over 276 million tons of coal, more than any other state. Coal remains the primary fuel for the iron industry and for the production of chemicals, paper, cement and even food (Taylor *et al.* 2003).

There are two types of coal present in Pennsylvania, anthracite and bituminous. Anthracite is a hard coal whereas bituminous is a softer coal and is located primarily in the southwest portion of Pennsylvania (Coal Mining in Pennsylvania 2004). Bituminous has extremely high sulfur content and therefore produces a large amount of acid into the environment (EnviroSci Inquiry 2005).

Approximately 2,400 miles of streams in PA are polluted by AMD (Coal Mining in Pennsylvania 2004). AMD is the single largest source of water pollution in the state (Coal Mining in Pennsylvania 2004). Since 1967, Pennsylvania and the federal government have invested almost 500 million dollars to implement solutions to correct AMD. Currently 20.7 million dollars have been invested to construct thirteen treatment plants throughout the state to treat drainage sites (Coal Mining in Pennsylvania 2004). The Pennsylvania Department of Environmental Protection has estimated that it will cost between $5 billion to $15 billion to clean up AMD-impacted watersheds in the state (EnviroSci Inquiry 2005).

Acid mine drainage, as defined by the EPA, is

> “. . . [water contaminated by pyrite,] an iron sulfide [that] is exposed and [then] reacts with air and water to form sulfuric acid and dissolved iron. Some or all of this iron can precipitate to form the red, orange, or yellow sediments in the bottom of streams containing mine drainage. The acid runoff further dissolves heavy metals such as copper, lead, mercury into ground or surface water. The rate and degree by which acid mine drainage proceeds can be

increased by the action of certain bacteria" (Abandoned Mines' Role in Nonpoint Source Pollution 2007).

A detailed look at the chemistry of acid mine drainage occurs when a sulfidic material is exposed to an oxidizing environment; the materials become chemically unstable (Lottermoser 2003). Specifically, when iron pyrite (FeS_2) is exposed to oxygen and/or water it will go through an oxidizing reaction creating byproducts of sulphate, ferrous irons, and hydrogen ions, as shown in the reaction below (Costello 2003).

$$2FeS_2(s) + 2H_2O(l) + 7\ O_2(g) \rightarrow 4H^+(aq) + 4\ SO_4^{2-}(aq) + Fe^{2+}(aq) + \text{energy}$$

Through release of sulphate and ferrous iron, the waters surrounding the mines become extremely acidic, typically creating a pH level. With further exposure to oxygen, the ferrous iron oxidizes into ferric ion as shown in the following reaction.

$$2Fe^{2+}(aq) + \frac{1}{2}\ O_2(g) + 2H^+(aq) \rightarrow 2Fe^{3+}(aq) + H_2O(l) + \text{energy}$$

If the water sustains a pH less than 3, ferric iron, the oxidized form of iron, can remain in the solution. If the pH rises above 3 the oxidized form will be removed (Lottermoser 2003). However, ferric iron generated in the above reaction can either precipitate as $Fe(OH)_3$ or react directly with iron pyrite to yield more ferrous iron (Costello 2003). The two different reactions are as follows:

$$Fe^{3+}(aq) + H_2O(l) \leftarrow\rightarrow Fe(OH)_3(s) + 3H^+(aq)$$

Or

$$FeS_2(s) + 14Fe^{3+}(aq) + 8\ H_2O(l) \rightarrow 15\ Fe^{2+}(aq) + 2SO_4^{2-}(aq) + 16\ H^+(aq) + \text{energy}$$

The second reaction involving ferric iron with pyrite creates even more acidity in the water due to the creation of hydrogen ions. From this, the cycle continually repeats creating more ferric and ferrous iron (Costello 2003). The reaction rate at which the total byproducts are produced is relative slow. However, an increase in surface area allows oxygen exposure to iron pyrite, therefore increasing the amount that becomes oxidized. As a result, excess amounts of acid are produced at a rate were water is unable to naturally buffer it out (Costello 2003). Typically in AMD waters, the rate of Fe^{2+} to Fe^{3+} is controlled by pH, the amount of dissolved oxygen, and the presence of iron oxidizing bacteria. Other factors such as solar radiation and photolytic degradation influence the rate of iron oxidation (Lottermoser 2003).

The precipitates formed by these reactions are iron hydroxides, oxyhydroxides or oxyhydroxysulfates. Other names used for the precipitates include, “ochres,” “boulder coats,” and “yellow boy.” These iron solids coat the beds and banks of water channels with a bright reddish-yellow to yellowish-brown color (Lottermoser 2003).

As AMD makes contact with rock and soil, the dissolution of other metals such as aluminum, manganese, magnesium and sodium may occur due to surface discharge (National Research Council 2005). Aluminum specifically develops from the weathering of clay or the dissolution of secondary minerals. It is least soluble when exposed to a pH between 5.7 and 6.2. However, when the pH is above or below this range it can be solubilized (Lottermoser 2003). Between a pH of 5 and 8 aluminum can be completely removed from the system thru precipitation (Costello 2003).

When aluminum is dissolved, it is present only in the 3^{+} oxidation state. This state can combine with organic and inorganic ions, allowing it to be present in a variety of forms in AMD waters (Lottermoser 2003). If the pH alters to a neutral state aluminum hydroxide will precipitate out as shown in the reaction below.

$$Al^{3+}(aq) + 3H_2O(l) \leftrightarrow Al(OH)_3(s) + 3H^{+}(aq)$$

When dealing with manganese as apart of AMD, the element is found in its aqueous state Mn^{2+}. As Mn^{2+} oxidizes it will convert into one of many forms of solid manganese. These forms include Mn_3O_4 (Hausmannite), Mn_2O_3(manganite or Feitknechtite) and MnO_2 (Manganese Dioxide) (Lovett 2007). However, it must be kept in mind that iron requires oxygen to precipitate out of solution; therefore, if iron uses all of the available oxygen, manganese oxidation will not occur. In this case, pH must increase to approximately 10 in order to remove manganese as a hydroxide, but there is the chance that aluminum will begin to resolubilize within the solution (Lovett 2007).

The accumulation of these metal precipitates, especially iron causes a thick yellow-orange color coating on the bottom of the stream. This can destroy many of the organisms that inhabit the water. The microorganisms living at the bottom of the stream that decompose the organic material are the start of the food chain in a stream environment. With the suffocation of these organisms, the food chain is destroyed. The acidic water also affects reproduction and respiratory functions. In addition the slug that is formed from AMD can affect dissolve oxygen content and clog the gills of many aquatic organisms (Taylor et al. 2003).

To solve the environmental problems associated with acid mine drainage active or passive treatment systems can be implemented. Active chemical treatment was mainly used when AMD treatment first started. The process relies on an alkali material to increase the pH which will then precipitate metal out of solution. These types of systems are effective however they are expensive and require a lot of manpower and time to keep the system operating (Project construction 2004). Primary passive treatments include the construction of wetlands, anoxic limestone drains, open limestone channels (Skousen) and flow ponds. Modifications must be made to these systems to meet the specific treatment goals of the area affect by AMD (Zipper 2001). Wetlands can be designed either aerobically or anaerobically.

Aerobic wetlands aerate the mine water as it flows through vegetation allowing for oxidation and precipitation of ferrous iron creating a byproduct of FeOOH. Affected AMD areas having mildly acidic or net-alkaline waters with elevated iron concentrations will implement an aerobic wetland.

When the area for a passive treatment system is limiting for large wetland construction, anoxic limestone drains can be used. This type of treatment requires trenches to be filled with limestone that have the ability to quickly produce biocarbonate alkalinity through limestone dissolution. To capture AMD subterraneously the anoxic limestone drains must be installed at the point of discharge in which it is capped with clay or compacted soil in order for oxygen to not come into contact with the AMD water. As the water flows through the trench, limestone is dissolved and bicarbonate alkalinity is released (Zipper 2001).

For open limestone channels to be used there must be a sufficient distance for the water to travel before or during treatment to allow for iron to be removed and small amounts of alkalinity to be generated. This type of treatment is most effective when constructed on a slope that is greater than 20%. The speed of water flow will aid in dislodging armored iron along the channel. This treatment however is not heavily relied on for stand-alone AMD treatment (Zipper 2001).

To offset limitations present in anaerobic wetlands and anoxic limestone drains, flow pond systems combine mechanisms of each of these treatments. Major elements including a drainage system, a limestone layer, and an organic layer are used in this type of passive treatment system. Dissolved oxygen is removed by aerobic bacteria utilizing biodegradable organic compounds as energy sources and sulfate-reducing bacteria in the anaerobic zone of the organic layer. Generating alkalinity are the two functions occurring as water flows through the organic layer (Zipper 2001). In order for the sulfate-reduction to occur, low dissolved oxygen concentrations, biodegradable carbon, and the presence of dissolved sulfate are necessary. To prevent the armoring of limestone by iron precipitate, the organic layer must be able to remove dissolved oxygen below 1mg/L. Acidic anoxic water dissolves $CaCO_3$ in the limestone layer which in turns produces alkalinity. Finally, water is discharged into a settling pond where acid neutralization and metal precipitation occur before final discharge (Zipper 2001).

This research investigated AMD at the McIntire Restoration Area located within Marion Township of Butler County, Pennsylvania. (Below are pictures taken throughout different tested area).

Site TB1

BC16 runoff into unnamed tributary

A pilot study provided us with information regarding iron, aluminum, manganese, dissolved oxygen(DO), ORP(oxidation-reduction potential) and pH at various sites in the affected area.

These results allowed us to narrow our study to focus on point source BC16. BC16 is number two on the Slippery Rock Watershed Coalition's (SRWC's) passive treatment system priority list. Due to the severity of the point source, we decided to mimic passive treatment systems in the laboratory using sample water from the BC16 site. Primary parameters included precipitation of iron out of solution in relation to pH levels and oxidation. Analyses of aluminum, manganese and dissolved oxygen were also reviewed to determine if any of these parameters were affected during testing. Testing using the BC16 site included an aeration study to determine the time it would take aerated AMD water to reach a pH at which iron would oxidize and precipitate out of solution. Another study was performed to mimic the effects of settling ponds. Surface area, depth, and amount of surface aeration were taken into account to compare the time it would take iron to fall out of solution for various set-ups. It is our hope that these studies will provide the SRWC with useful information in designing a passive treatment system for this site.

Materials and Methods

Pilot Study:

A pilot study was performed at six different locations along an unnamed tributary impacted by AMD that runs into Blacks Creek. Appendix 1 shows a map of the area of interest with the sampling locations indicated. The Hach DR/890 Portable Colorimeter was used to test the water for aluminum, iron, manganese, and dissolved oxygen content. All reagents for these tests were purchased from Hach. Temperature, pH and ORP were also tested while on site using a pH/ORP combo tester waterproof meter manufactured by Hanna instruments.

Aluminum was tested using Method 8012 of the Hach procedures manual (Dr/890 Colorimeter Procedures Manual 2007). The aluminum indicator combines with aluminum in the sample water to produce a red-orange color. The concentration of aluminum in the sample is directly proportion to the intensity of the color that is produced. Ascorbic acid is also added to the solution to ensure the removal of iron so that it does not interfere with the aluminum reading.

Method 8008 in the procedures manual explains the procedure for total iron testing (Dr/890 Colorimeter Procedures Manual 2007). The FerroVer Iron reagent reacts with all solution and/or insoluble forms of iron in the sample water to produce a soluble form of ferrous iron. 1,10-phenanthroline then reacts with the solution to form an orange color which is proportional to the concentration of iron within the sample.

Manganese was tested in the high range (1-20.0mg/L) using Method 8034(Dr/890 Colorimeter Procedures Manual 2007). When sodium periodate is added to solution, it oxidizes the manganese within the sample to form a purple permanganate state after it has been buffered with citrate. The concentration of manganese within the sample is directly proportional to the intensity of the purple color that is produced.

A high range dissolved oxygen 12-mL sealed AccuVac Ampul containing reagent is used to test for dissolved oxygen. Once sample water enters the ampul a yellow color will form, which then turns purple as oxygen within the water reacts with the reagent. The intensity of the color is directly proportional to the dissolved oxygen concentration. This procedure is based on Method 8166 of the Hach procedure manual (Dr/890 Colorimeter Procedures Manual 2007)..

Lab Testing:

Subsequent lab tests were performed on water collected from AMD point source, sample location BC16. Sampling containers were completely submerged into the water to eliminate headspace in the container. This was done to minimize additional dissolved oxygen getting into the water upon transportation. Initial lab measurements of aluminum, manganese and dissolved oxygen, using the Hach DR/890 portable colorimeter, were taken to provide baseline values. Laboratory pH measurements were taken using an Accumet pH meter 915 by Fisher Scientific. Standards in a range of 0.05ppm to 10ppm were used to create a calibration curve.

Lab measurements of ferrous iron were performed based on a standard method (Franson 2005). Iron standards were made by dilution of a 1000ppm Fe stock standard manufactured by Quality Assurance System. A hydroxylamine solution was added to each standard to ensure the iron stayed in the ferrous state. Ammonium acetate was added to buffer the solution. The buffered Fe solution reacts with the phenanthroline to produce an orange complex. Absorbance of the solution was measured at a wavelength of 510nm using a Hewlett Packard 8452A Diode array Spectrophotometer and Spectronic 20 Genesys.

pH Study:

A pH study was set up in the traditional titration form. 500mL of BC16 sample water was placed into a beaker and placed under a 100mL pipet containing sodium hydroxide solution. The Accumet pH meter 915 by Fisher Scientific was placed into the water to allow for a continuous reading of the pH. As sodium hydroxide was added to the water a stir bar was continuously running to allow for complete mixing of the two solutions.

During the first trial, the iron concentration was tested each time the pH increased approximately 0.10 through the addition of sodium hydroxide. Initially 2mL of sample were removed to test for the concentration. However, once the acidity of the solution began to decrease, a larger volume of sample was required to have detectable iron levels. Results were adjusted to reflect the change in volume.

The same procedure was used for additional trials; however, the iron concentration was tested more frequently between pH readings to determine the exact pH at which the concentration of iron began to level off. Initially 2mL of sample was removed to test for iron. As the pH reached 7.15-7.18, 4-5mL of sample was removed and used for testing. At the conclusion of the titration, the concentrations of aluminum, manganese, iron, and dissolved oxygen were determined.

Aeration Study:

An aeration study was performed to oxidize 2000mL of sample water and to determine how long it would take for iron to precipitate out of solution and maintain a steady pH reading. A bucket allowing for a water surface area of 633.15cm^2 was filled with 2000mL of water from site BC16. The Accumet pH meter 915 by Fisher Scientific was positioned within the water to allow for a continuous pH recording. An Aquaculture air pump delivered air at a rate of 26.73 cm^3/sec through an air stone that was placed at the bottom middle of the bucket. Air was continuously pumped into the water throughout the duration of the experiment. A magnetic bar was used as well to ensure continuous distribution of the air. Initial iron, aluminum, manganese, pH, and dissolved oxygen measurements were taken in replicate using the procedures mentioned above.

During the first trial the pH was recorded every five minutes and the concentration of iron was tested every ten minutes. The amount of water sampled was adjusted when needed to ensure that absorbance readings were within the calibration range. Concentration results were adjusted to reflect the change in volumes. After the pH reached an approximate average of 7.20, final iron, aluminum, manganese, and dissolved oxygen concentration readings were recorded.

Trials two and three followed the same setup and procedure as trial one with the exception that only initial and final measurements were taken.

Settling Pond Study:

A settling pond study was performed to model how long it would take for iron to precipitate out of solution within settling ponds of varying surface area and depths. Preliminary studies were performed using varied depth and surface area. A pan with a surface area of 1663.2cm^2 and a depth of 1.9cm contained 2000mL, and two buckets with a surface area of 633.15cm^2 with one having 2000mL and a depth of 4.1 cm and the second having 4000mL and a depth of 8.2cm, were allowed to sit for 48 hours. All of these containers were filled with BC16 water. Initial measurements of iron, aluminum, manganese, pH and dissolved oxygen were taken before all of the containers were filled. Iron concentrations for each were periodically taken until all of the iron had precipitated out of solution. Final concentrations of aluminum, manganese, pH and dissolved oxygen were taken. The same 2000mL pan and bucket set-ups were used for replicate analyses in a 24-hour study. BC16 water was added to three buckets and three pans. Initial measurements of iron, aluminum, manganese, pH and dissolved oxygen were taken before both the buckets and pans were filled. The iron concentrations for each bucket and pan where tested after one hour, four hours, six hours, and twenty-four hours. Final concentrations of aluminum, manganese, pH and dissolved oxygen were taken at the conclusion of the twenty-four hour period.

Results and Discussion

Pilot Test

The pilot test gave provided for six different locations within the McIntire Restoration Area. The results of aluminum concentration are shown in Figure 1. The red bars are the two point sources that were tested, while the blue bars are areas downstream from the point sources. The white bar indicates a section of Blacks Creek that was not affected by acid mine drainage. The location indicating the highest aluminum concentration was water just downstream from point source BC16. Site 906-15 had a higher aluminum concentration the TB1, this is possible because aluminum becomes more soluble in acidic or basic solutions. Whereas, this site has a neutral pH in which aluminum does not take on a soluble toxicity level (United States 1988).

Figure 1.

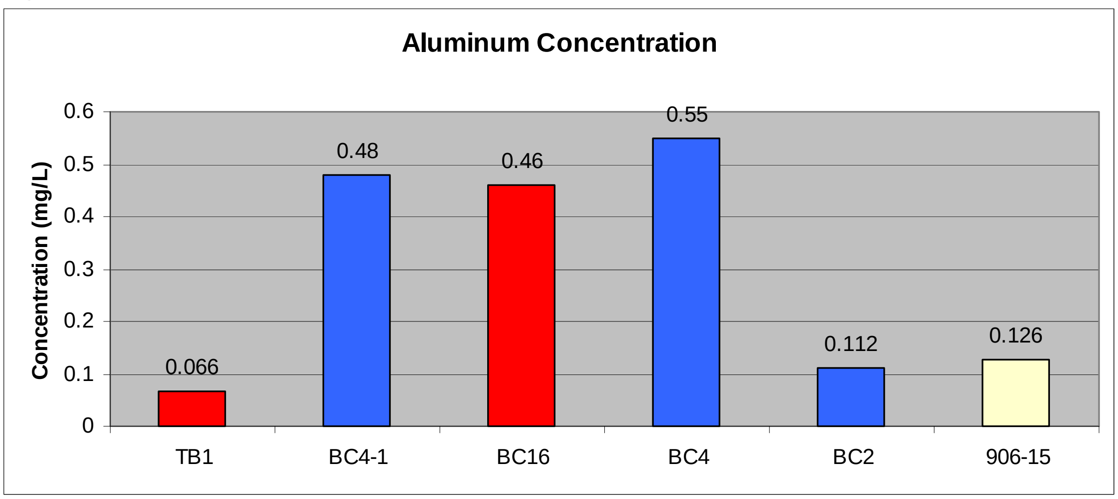


Figure 1 displays the concentration of aluminum for each site tested during the pilot study. Red bars indicate point sources and the white indicates an area unaffected by AMD.

Iron and manganese tests were also performed on these same site locations. The results for these two tests are shown in Figures 2 and 3. TB1 had the highest iron concentration with BC16 having the second highest concentration. These two locations would have the highest total ferrous iron concentration because they are two major point sources of interest for the Slippery

Rock Watershed Coalition. Site 906-15 had an extremely low concentration value which would be expected since the site is not affected by AMD. According to the EPA, 1ppm is considered a safe value of iron within freshwater systems (United States 2006). In contrast, TB1 was the only site with a substantial concentration of manganese, with a value of 71.5mg/L.

Figure 2.

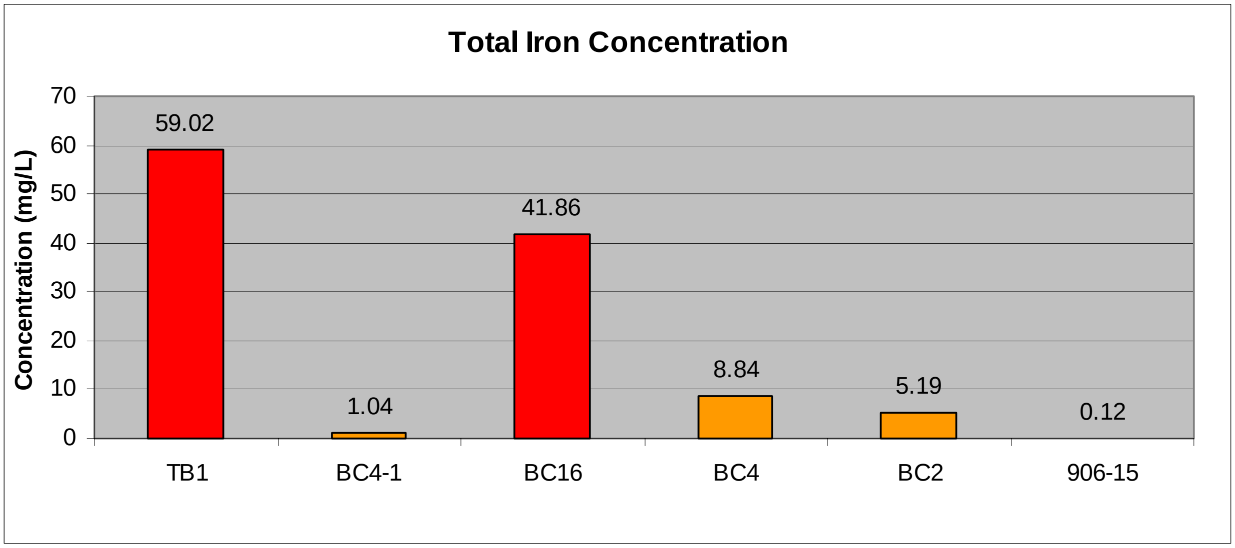


Figure 2 displays the concentration of total iron for each site tested during the pilot study. Red bars indicate AMD point sources.

Figure 3.

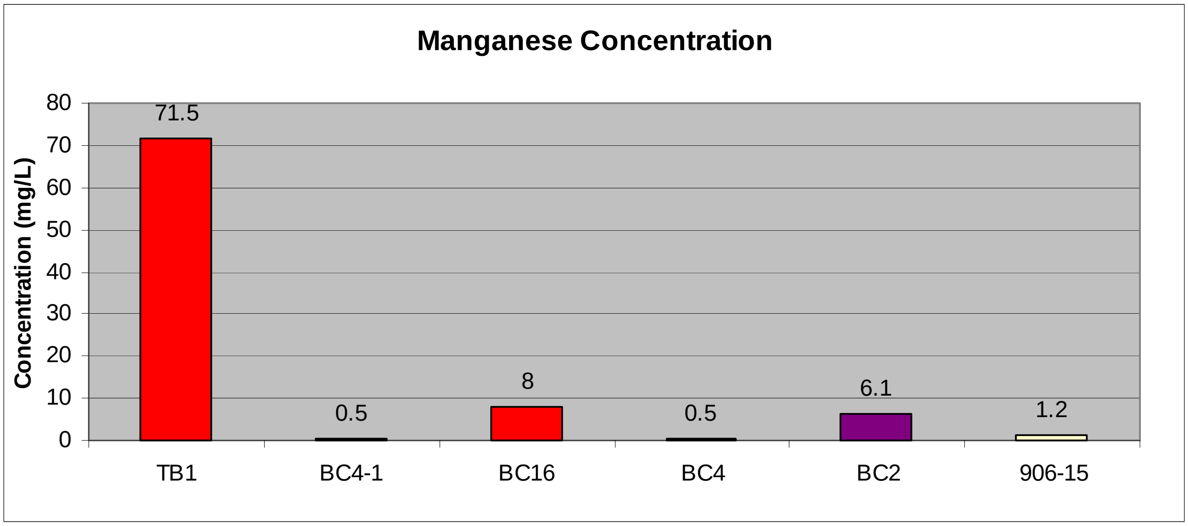


Figure 3 displays the concentration of manganese for each site tested during the pilot study. Red bars indicate AMD point sources.

The final two tests, pH and dissolved oxygen, were performed on all six sites. The results for these two tests are shown in Figures 4 and 5. The pH levels for the first two sites are extremely low; however, the last four sites have relatively neutral readings. BC16 and BC4 are still considered acidic, but they are much higher then the TB1 reading of 3.96. The results for dissolved oxygen are quite different. BC16 had the lowest dissolved oxygen concentration compared to all of the other site locations with a concentration of 6.3 units. This particular result led to further questions regarding iron precipitation at the BC16 location. Therefore, following the pilot test, subsequent experimental designs were put into place to mimic passive treatment methods using sample water from site BC16.

Figure 4.

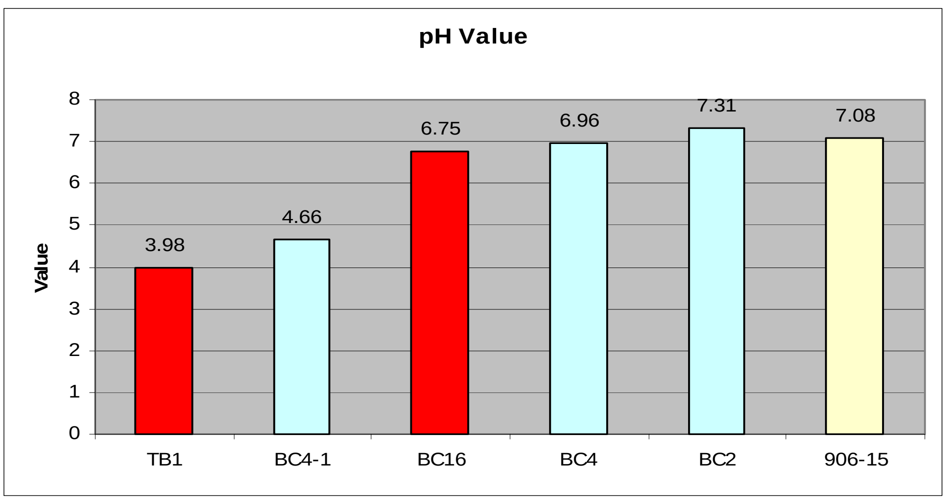


Figure 4 displays the pH values for each site tested during the pilot study. Red bars indicated AMD point sources.

Figure 5.

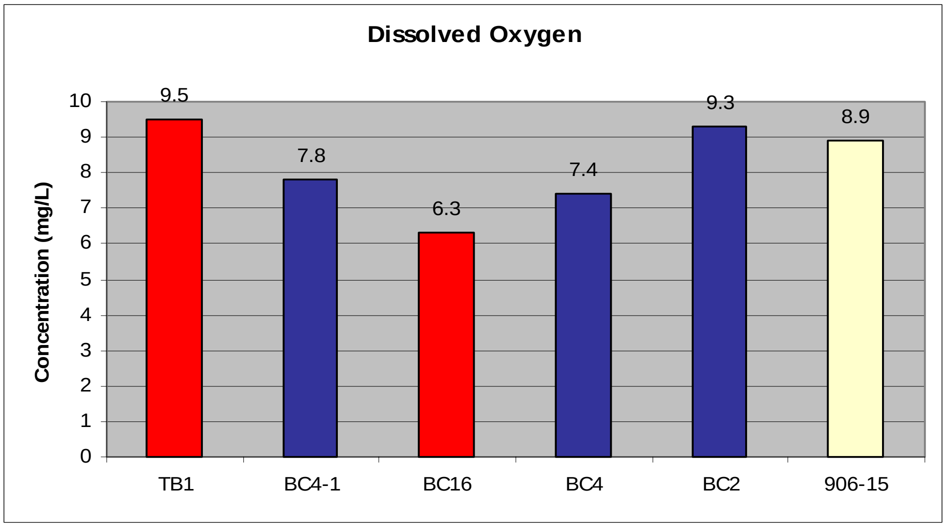


Figure 5 displays the concentration values for dissolved oxygen for each site tested during the pilot study. The red bars indicate AMD point sources.

pH Study

Initially a pH study was performed using the BC16 site. However, before tests could be run to determine the concentration of iron a standard curve had to be constructed as shown in Figure 6.

Figure 6.

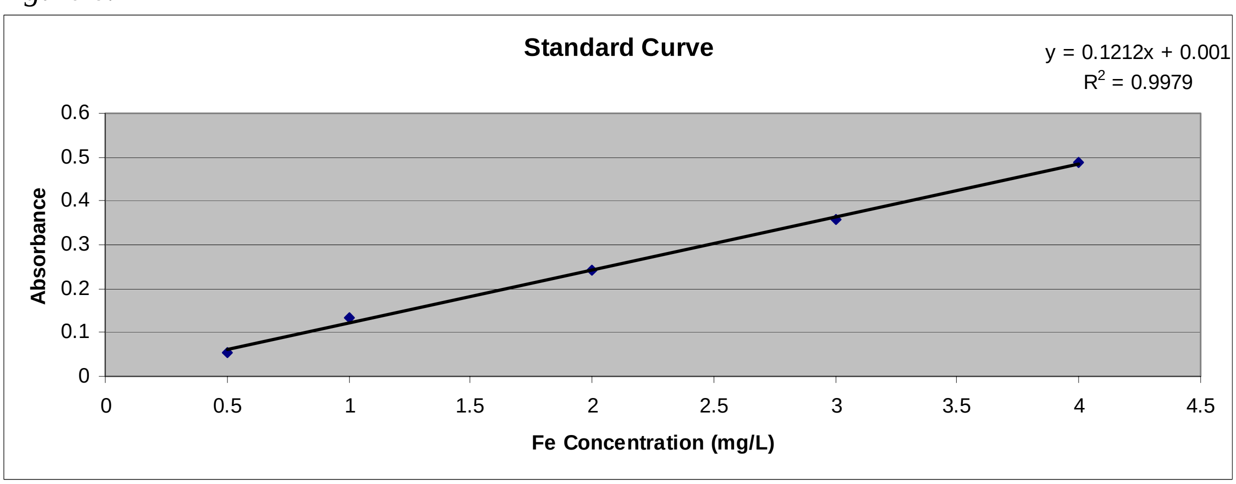


Figure 6 is the standard curve constructed for the pH, aeration and settling pond studies.

This study allowed us to determine at what pH level ferrous iron began to precipitate out of solution. We were also able to determine at what pH level ferrous iron was completely out of the solution. Two trials were performed using the titration method. The results of these trials followed the same trend as seen in Figure 2b. When the pH value reached approximately 7.3, most of the ferrous iron had completely precipitated out of solution.

Figure 7.

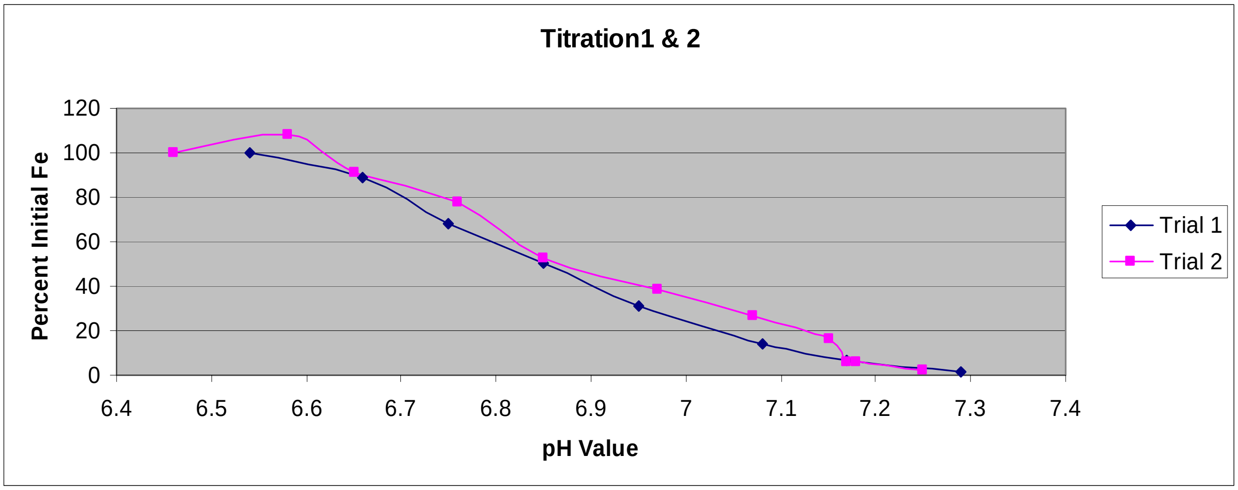


Figure 7 displays the percentage of iron left in sample as compared to the initial concentration in relation to increasing pH.

At the beginning of and end of each trial, aluminum, manganese, and dissolved oxygen concentrations were taken to determine if their values had been affected by the increase of pH through the method of titration. These results are shown in Figure 8. It is important to know that aluminum must be multiplied by 100 to have an accurate concentration value. This was done to allow aluminum to be visible on the graph. Since the aluminum value is extremely small. From the graph, it appears there was a large difference between the initial and final concentration values for aluminum. In actuality the difference in aluminum concentration is not significant enough to become a cause of concern.

When looking at manganese there is not much of a difference, which is not unreasonable because for manganese to fall out of solution, the pH needs to be between 8.5 and 9. In this study the highest the pH obtained was 7.3. It was also expected that the dissolved oxygen concentration would go down slightly due to iron precipitation. As ferrous iron oxidizes it begins to use up the oxygen within the solution to form ferric hydroxide.

Figure 8.

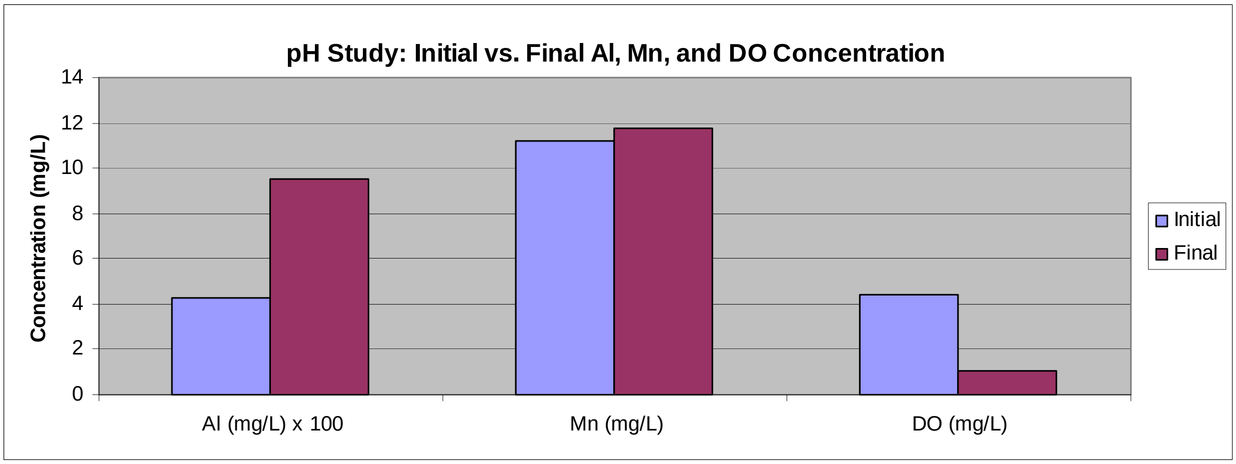


Figure 8 displays the initial and final concentration values for aluminum, manganese, and dissolved oxygen.

Aeration Study

The purpose of the aeration study was to determine if introduced oxygen to the BC16 sample water would increase the rate of iron precipitation through increased pH and CO_2 degassing. The results are shown on Figure 9. All three trials showed very good reproducibility. Time is shown in hours and indicates that all three trials reached a pH between 7.2 and 7.4 within a time of 1.33-1.50 hours. However, it can be seen that there was a drastic increase in pH initially and then it began to steadily decrease and finally increase once more toward the end when all of the ferrous iron was precipitated out. The pH increase is likely the result of CO_2 degassing due to the removal of carbonic acid. Gradual decrease in pH might be a result of the consumption of alkalinity as iron precipitates out. The increase at the end of the graph is likely due to a generation of CO_2.

Figure 9.

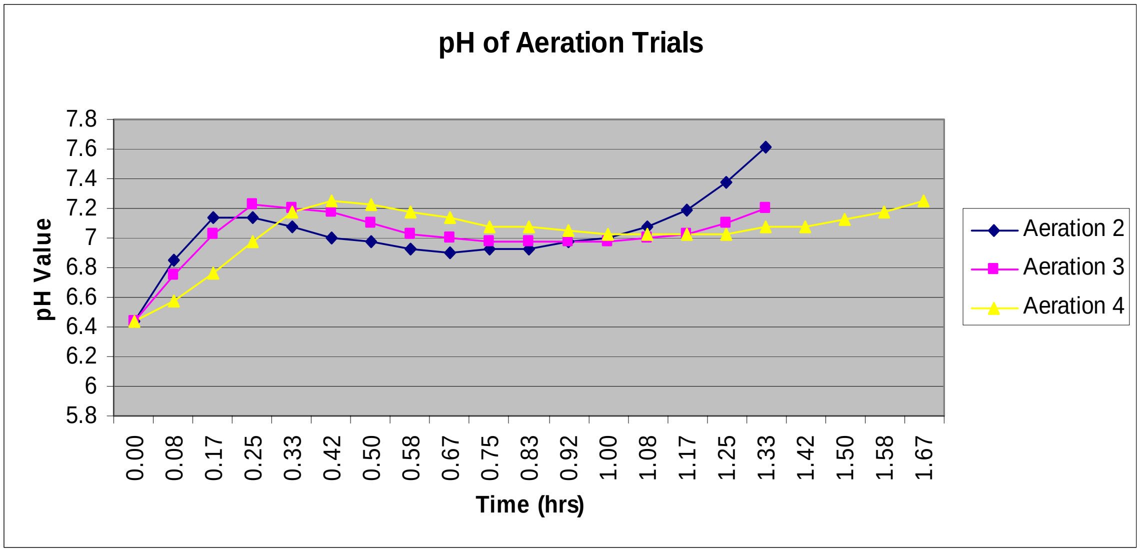


Figure 9 displays the pH value for each trial in relation to the time during aeration.

Another element to this study was looking at the concentration of ferrous iron throughout the aeration process. Figure 10 shows the percentage of iron remaining in the sample over time. It is apparent that ferrous iron steadily precipitated out of solution throughout the duration of the trial even though there was some variance in the pH values toward the beginning. These results suggest that precipitation of iron through aeration in a 2000mL sample is complete within two hours.

Figure 10.

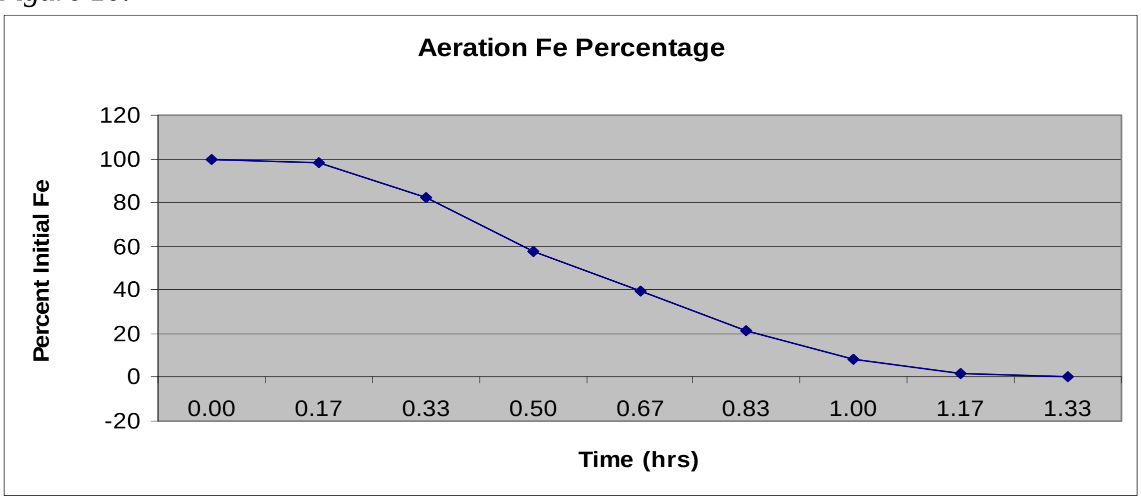


Figure 10 indicates the percent of ferrous iron present as it correlates to the amount of time for it to precipitate out of solution through aeration.

Finally, the initial and final concentration of aluminum, manganese and dissolved oxygen were taken just as in the pH study. The95% confidence interval was used for n=3 to construct the error bars for each in shown in Figure 11. Aluminum and manganese both show that there was not a significant difference between the initial and final concentrations. Dissolved oxygen did have a drastic increase for its final concentration. This is not unexpected because within the study, air containing oxygen was consistently being pumped into the BC16 water.

Figure 11.

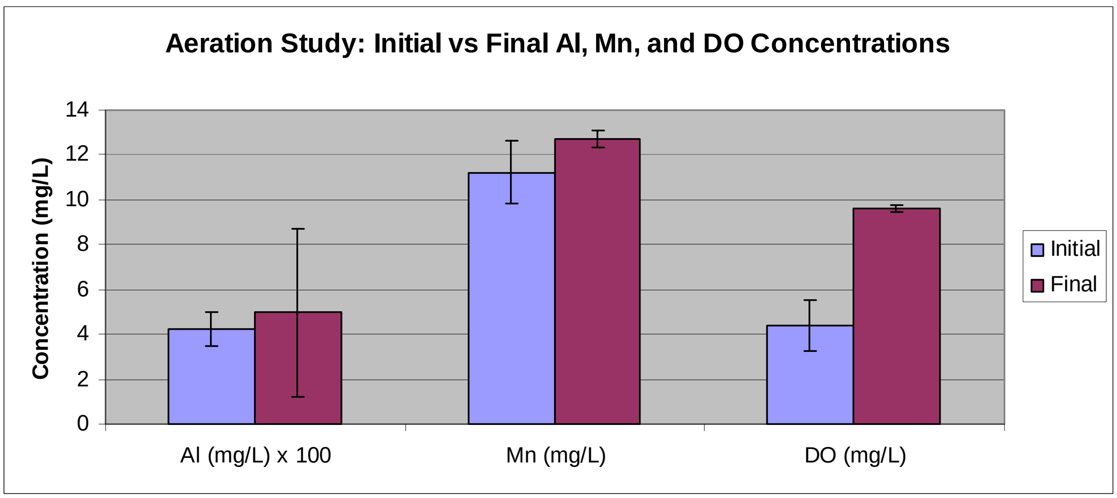


Figure 11 uses a 95% confidence interval for the comparison of initial and final values of aluminum, manganese, and dissolved oxygen with n=3 to determine error bars for each.

Settling Pond Study

The final study tried to mimic the effects a settling pond would have on the AMD water. Depth, surface area and volume of water were taken into account. Initially, the study was set up with a 2000mL pan, a 2000mL bucket and a 4000mL bucket. As Figure 12 shows, the 4000mL bucket required the greatest amount of time to allow all of the iron to precipitate out. Toward the being of the study the 2000mL and 4000mL bucket were similar in concentration. This is not unexpected toward the beginning of the study because both buckets had the same surface area. The pan however had a surface area just under approximately 1700cm^2 allowing for oxidation to occur more rapidly, and subsequently precipitating out more quickly. In addition both 2000mL containers only required 24-hours or less to precipitate out all of the iron, while the 4000mL was not finished until approximately 48-hours.

Figure 12.

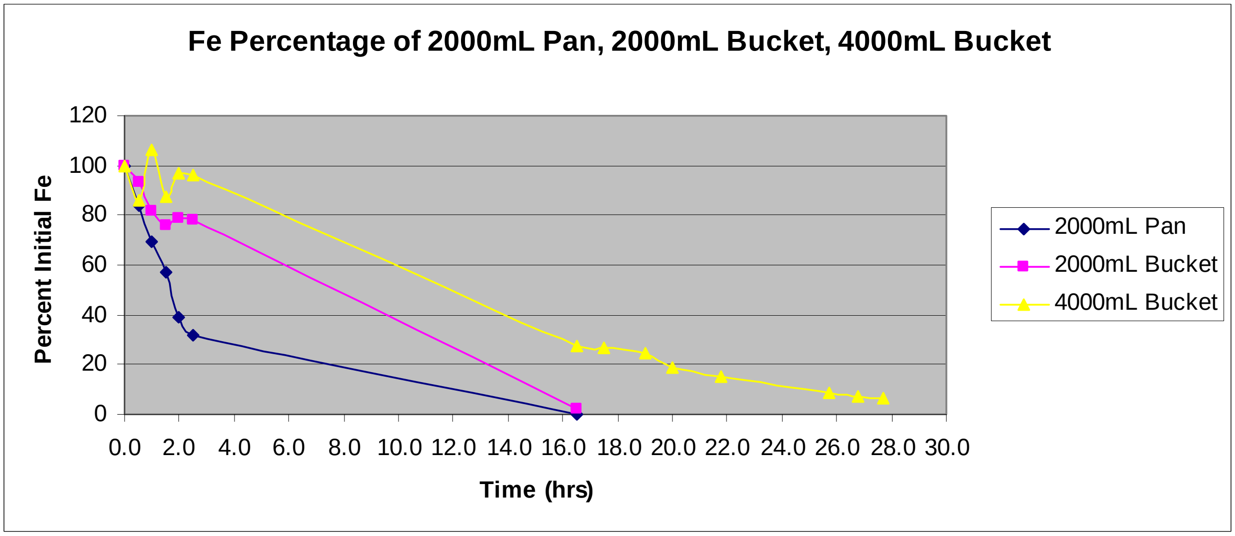


Figure 12 depicts time in correlation to the percentage of iron remaining in solution for each volume of BC16 sample.

Based on the results from the initial trial it was determined subsequent trials should be performed using only 2000mL between the pan and bucket to determine the time difference for iron to precipitate out in relation to surface area and depth. Figure 13 shows the results of three pans that were allowed to sit for twenty-four hours, and Figure 14 shows the results of three buckets that were allowed to sit for the same amount of time. When comparing the two, it can be seen that the pan had a drastic initial decrease in the amount of iron present as compared to the buckets. It can be assumed that surface area and depth are a huge factor when trying to precipitate out ferrous iron using a settling pond within a passive treatment system. The shallower the water with an increase surface area will prove to yield quicker precipitation.

Figure 13.

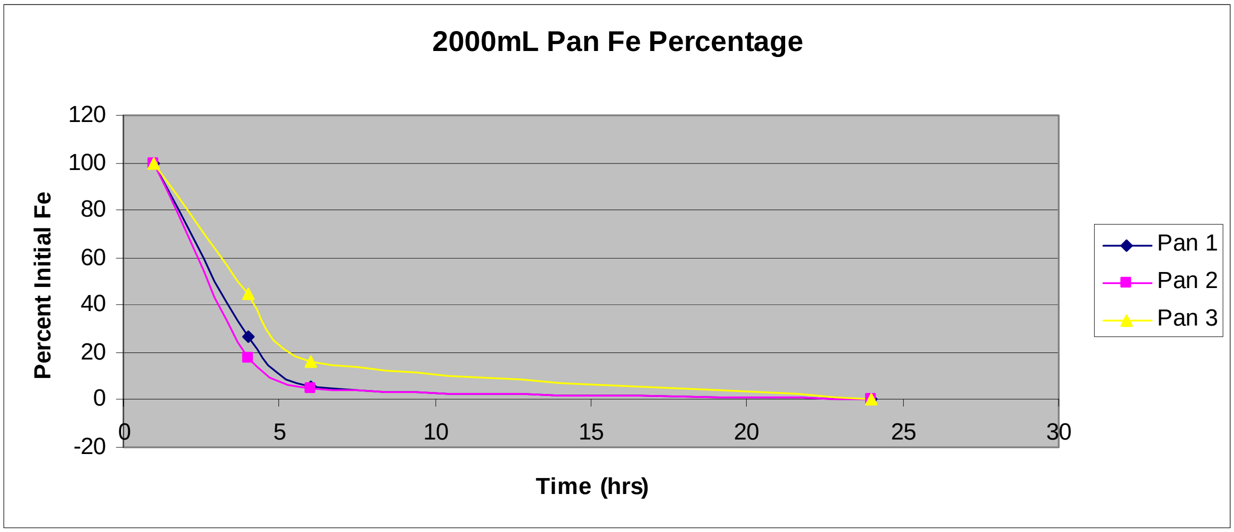


Figure 13 indicates the percentage of iron remaining in solution over time for each trial using a pan with a 2000mL sample volume.

Figure 14.

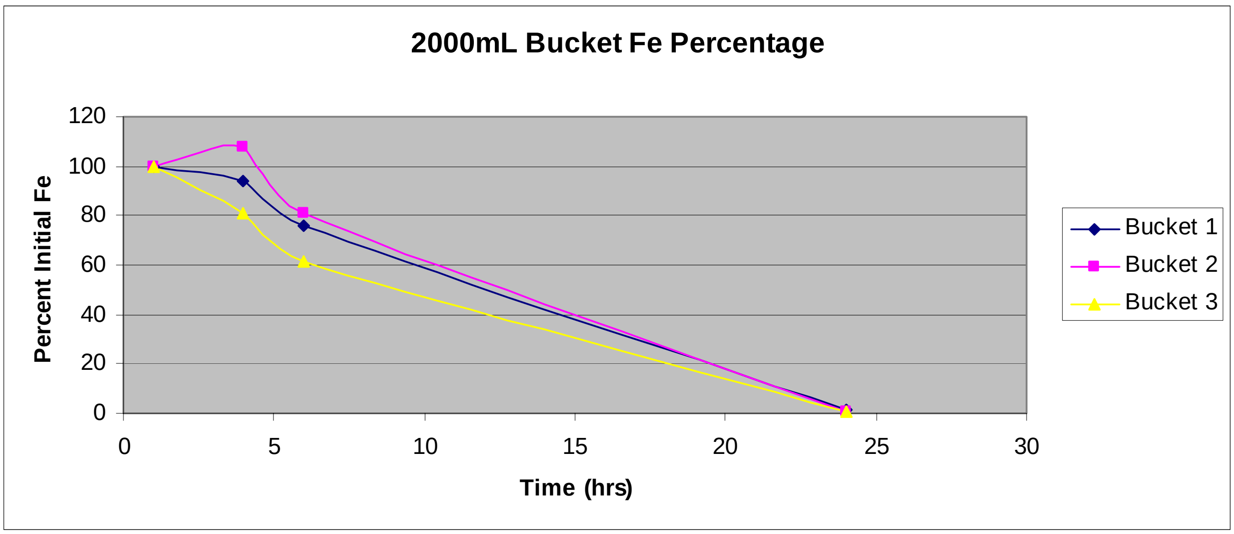


Figure 14 displays the percentage of iron remaining in solution over time for each bucket trial with a 2000mL sample volume.

Finally, initial and final concentrations were compared for aluminum, manganese, dissolved oxygen, and pH values as shown in Figure 15. When analyzing aluminum, the concentration value must be multiplied by 100 to receive the correct value. This was done to allow for visualization on the graph in relation to the other factors tested. Aluminum appears to have decreased in all tests; however, the value of difference is large enough to have aid in its removal from solution. In addition, manganese did not change much from its initial reading. Manganese is extremely hard to remove from solution because of the pH value required to allow for removal. Dissolved oxygen did not alter much either compared to the initial concentration. This is not unsurprising because oxygen would enter the system through aeration on the surface but would then be lost as iron precipitated out. The pH values were also expected because as time progressed through the study more and more ferrous iron began to precipitate out of solution allowing for the pH to increase.

Figure 15.

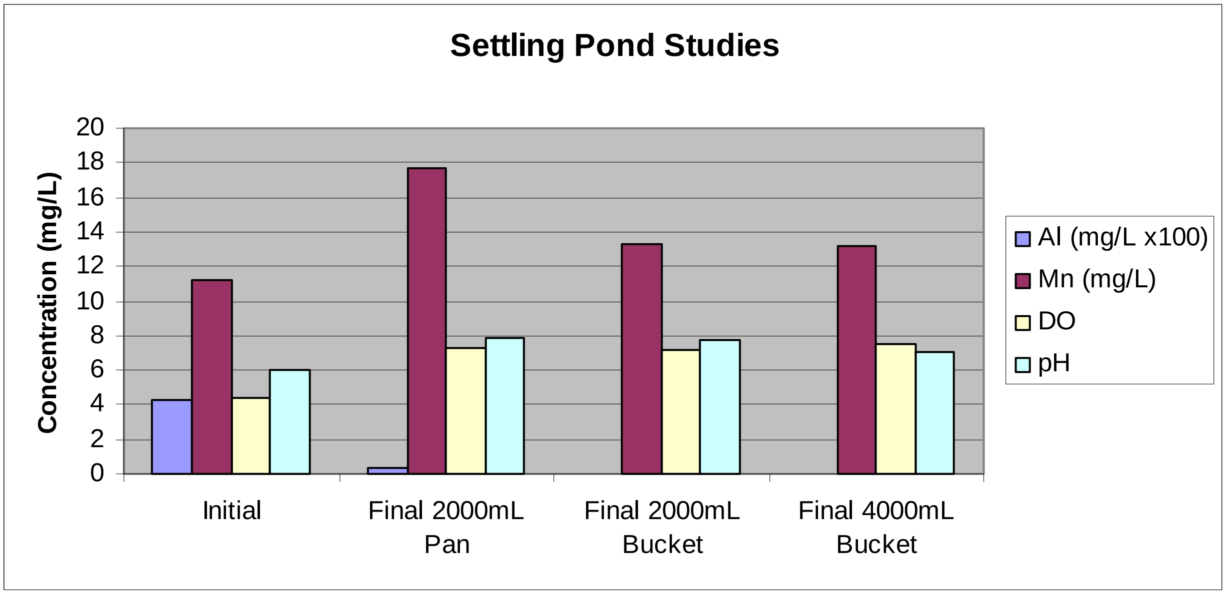


Figure 15 displays the initial and final concentration values for aluminum, manganese, dissolved oxygen, and pH for settling pond studies. The aluminum value is increased by a factor of 100 to allow for visualization on the graph.

A 95% confidence interval based on n=3 was performed for each pan and bucket with a volume of 2000mL as shown in Table 1. The table demonstrates the average ferrous iron concentration in relation to the length of the study.

Table 1

Time (hrs)	2000mL Pan	2000mL Bucket
0	42.3 ± 5.11	42.3 ± 5.11
1	42.0 ± 3.09	39.3 ± 14.2
4	12.4 ± 14.7	36.5 ± 0.530
6	3.74 ± 6.88	28.3 ± 2.30
24	0.000 ± .0500	0.390 ± 0.290

Table 1 displays the 95% confident interval based on n=3 for ferrous iron concentration

Comparison Analysis

Upon completion of each study's analysis, a comparison of final pH values and final ferrous iron concentration was constructed to determine if there was any relationship dependency between the two. The results of this comparison are shown in Figure16. It has been determined that as the pH value increases, the concentration of ferrous iron decreases. The R^2 value for these relationships was 0.8965. It appears that this relation is not mechanism dependent and relates through each study that was performed.

Figure 16

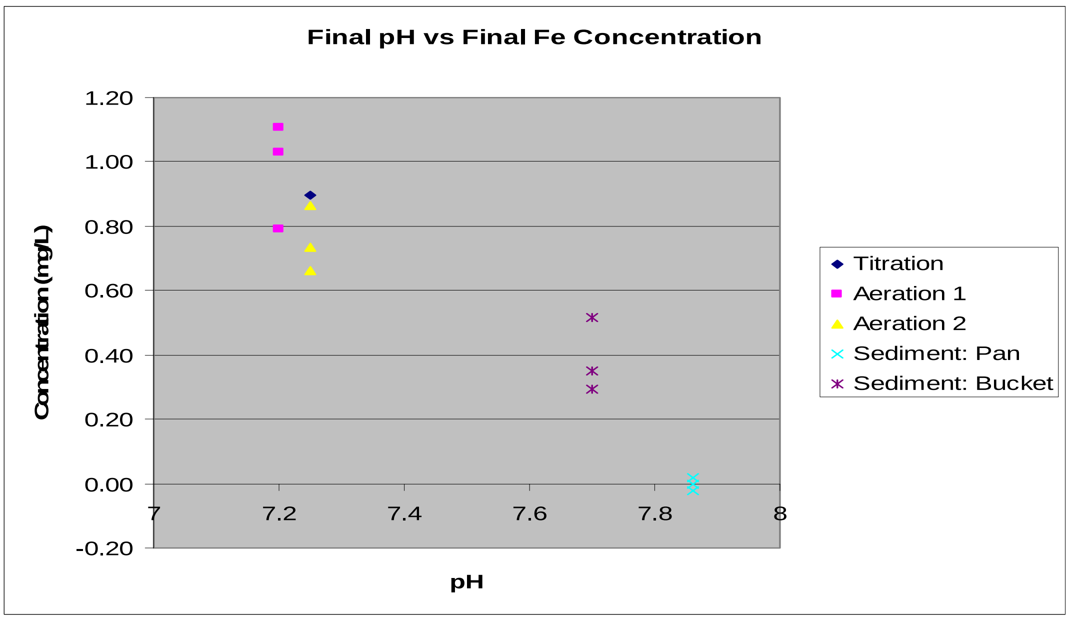


Figure 16 displays the relation between final pH values and final ferrous iron concentrations for each study performed.

In addition, the average initial and final ferrous iron concentrations using a 95% confidence interval based on n=3 were determined for all of the tests performed. These results are shown in Table 2. These results do not show any trends except that there was a significant difference between ferrous iron concentrations in each study for the initial verse final values and all mechanisms efficient for iron removal.

Table 2

	Initial Fe (mg/L)	Final Fe (mg/L)
Titration	42.3 ± 5.11	0.900
Aeration	42.3 ± 5.11	.870 ± .180
2000mL Pan	42.3 ± 5.11	0 ± .0500
2000mL Bucket	42.3 ± 5.11	.390 + .290

Table 2 displays the average initial verse final ferrous iron concentrations for each study using a 95% confidence interval based on n=3

Work Cited

"Abandon Mines' Role in Nonpoint Source Pollution." Environmental Protection Agency. 5 Oct. 2007. 4 Dec. 2007 <http://www.epa.gov/reg3wapd/nps/mining/mines.htm>.

Costello, Christine. Acid Mine Drainage: Innovative Treatment Technologies. National Network of Environmental Management Studies Fellow. Washington, DC: U.S. Environmental Protection Agency, 2003. 3 Dec. 2007 <http://clu-in.org/download/studentpapers/costello_amd.pdf>.

"Dr/890 Colorimeter Procedures Manual." Hach. 2007. Hach Company. 4 Dec. 2007 <http://www.hach.com/fmmimghach?/CODE%3A4847022_8ED14119%7C1>.

"EnviroSci Inquiry." Coal Mining in Pennyslvania. 2004. Lehigh University. 4 Dec. 2007 <http://www.leo.lehigh.edu/envirosci/enviroissue/amd/links/history.html>.

Franson, Maryann H., ed. "Iron." Standard Methods, for the Examination of Water and Wastewater. New York: American Public Health Association, 2005. 3-76-3-79.

Lottermoser, Bernd G. Mine Wates Characterization, Treatment and Environmental Impacts. Berlin: Springer, 2003. 30-111.

Lovett, Raymond J. Removal of Manganese From Acid Mine Drainage. West Virginia University. 2007. 5 Dec. 2007 <http://wvmdtaskforce.com/proceedings/92/92LOV/92LOV.HTM>.

National Research Council. Regional Cooperation for Water Quality Improvement in Southwestern Pennsylvania. Washington, DC: The National Academies P, 2005.

"Project Construction." Ecosystem Restoration. 1 Sept. 2004. Montana State University. 12 Dec. 2007 <http://ecorestoration.montana.edu/mineland/guide/construction/water/surface/active/default.htm>.

Skousen, Jeff. Overview of Passive Systems for Treating Acid Mine Drainage. West Virginia University. West Virginia University Extension Service, 2007. 6 Dec. 2007 <http://www.wvu.edu/~Agexten/landrec/passtrt/passtrt.htm>.

Taylor, Wil, Margaret Dunn, and Busler Shaun. Accepting the Challenge. 3rd ed. Cranberry, Pennsylvania: Slippery Rock Watershed Coalition, 2003.

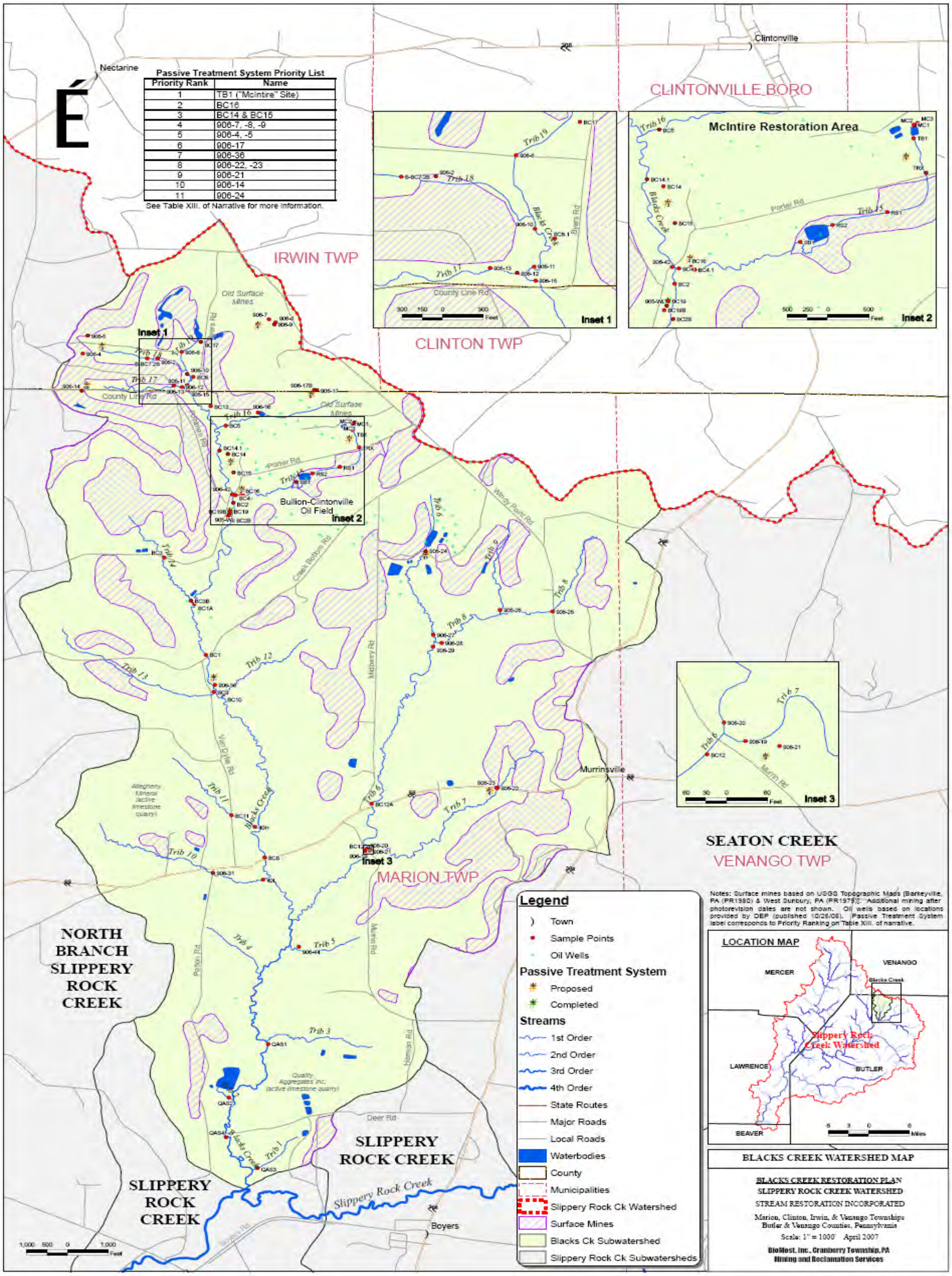
United States. Office of Water. Environmental Protection Agency. National Recommended Water Quality Criteria. 2006. 13 Dec. 2007 <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

United States. Office of Water Regulations and Standards. Environmental Protection Agency. Ambient Water Quality Critera for Aluminum - 1988. 1988. 11 Dec. 2007 <http://www.epa.gov/npdes/pubs/owm587.pdf>.

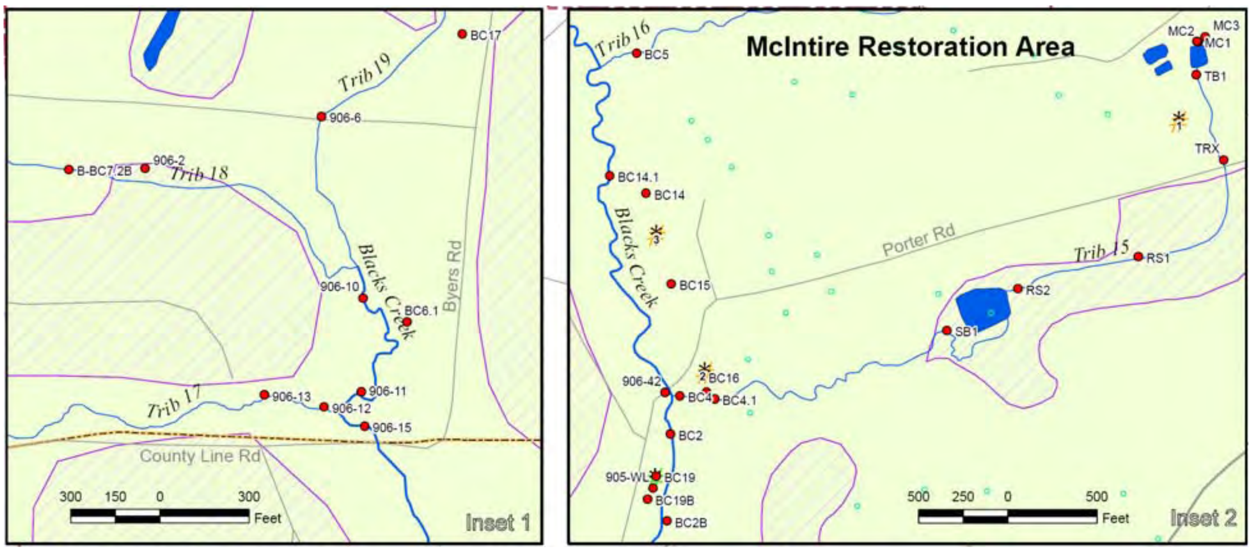
United States. U.S. Geological Survey. U.S. Department of the Interior. Manganese Remediation. 19 Mar. 2007. 6 Dec. 2007 <http://energy.er.usgs.gov/health_environment/acid_mine_drainage/remediation.html>.

Zipper, C, and C Jage. Passive Treatment of Acid-Mine Drainage with Vertical-Flow Systems. Virginia State University. Virginia Cooperative Extension, 2001. 6 Dec. 2007 <http://www.ext.vt.edu/pubs/mines/460-133/460-133.html#L4>.

Appendix 1



Map of the Slippery Rock Watershed Coalition.



This is an enlarged area of the larger map; the block on the right shows the unnamed tributary and the BC16 point source.

Appendix 2

Surface Area Calculations:

Pan:

Length-59.4cm	Area = Length X Width
Width- 28.0cm	Area = 59.4cm X 28.0cm
Depth- 1.9cm	Area = 1660cm^2

Bucket:

Diameter- 28.4cm	Area = ∏ r^2
Radius- 14.2cm	Area = ∏ 14.8cm^2
	Area = 633cm^2

pH, Aeration, Settling Pond Study:

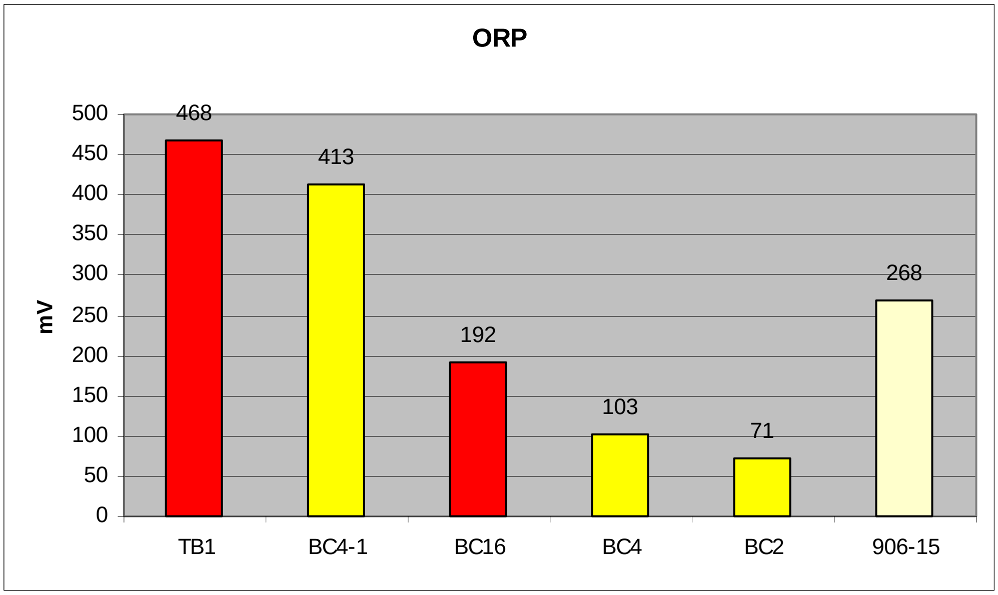
Standard Curve Formula: y=0.1212x + 0.001
X = Concentration
X = (Absorbency – 0.001) / 0.1212
X = (0.461 - 0.001) / 0.1212
X = 3.79mg/L

Adjusted Concentration = (Concentration) (diluted sample volume) / sample size
Adjusted Concentration = (3.79mg/L) (10mL) / 1mL
Adjusted Concentration = 37.9mg/L

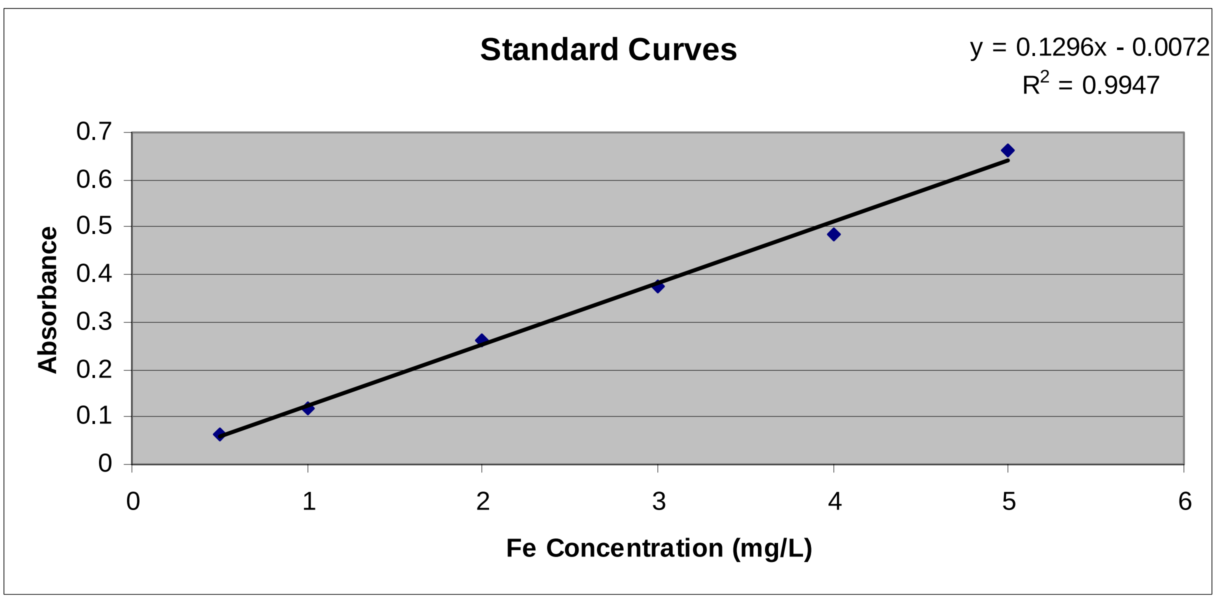
mg Fe = (Adjusted Concentration)(total volume remaining of sample)
mg Fe = (37.9mg/L)(496mL)
mg Fe = 18800mg

% Fe = (mg Fe / initial mg Fe) (100)
% Fe = (18800mg / 18800mg) (100)
% Fe = 100%

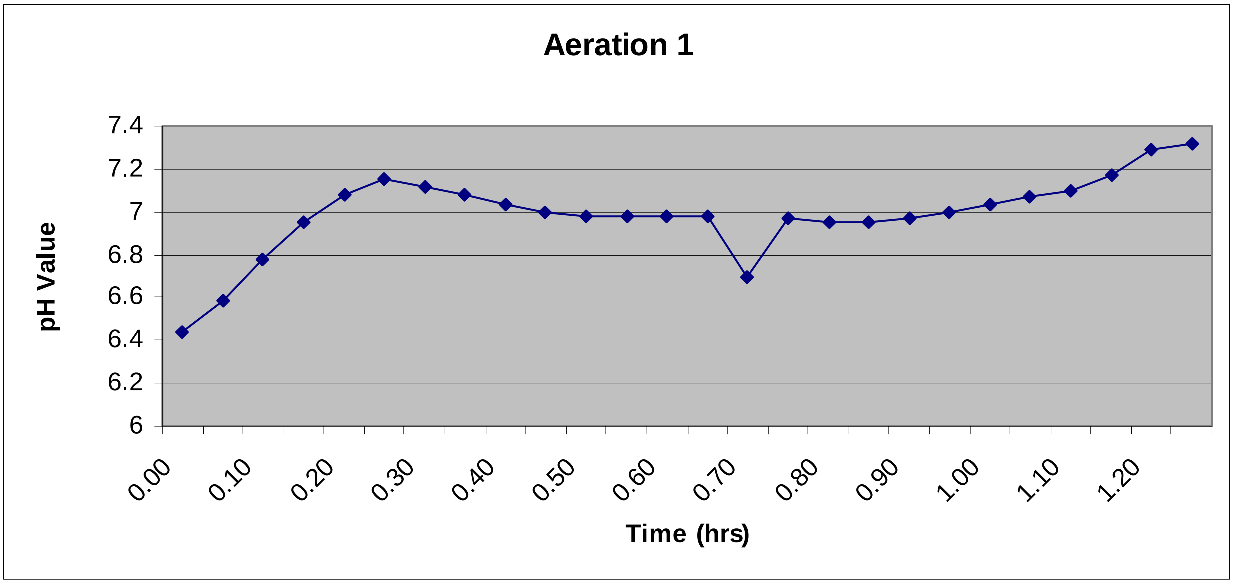
Appendix 3



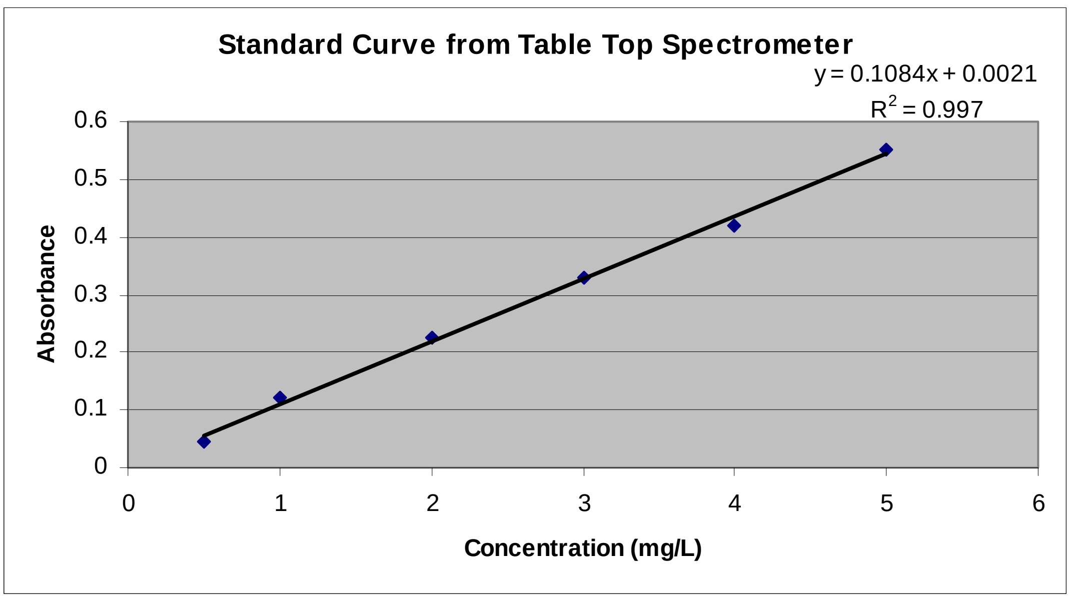
This graph displays the ORP values for all of the sites tested during the run of the pilot study.



This is the second standard curve constructed during the titration study.



This is the initial trial run for the aeration study in which 500mL of BC16 water was used.



This is the standard curve constructed when having to use the Table Top Spectrophotometer (Spectronic 20 Genesys).

Appendix 4

Pilot Study

Site	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	DO (mg/L)	ORP (mV)
TB1	0.066	59.02	71.5	3.98	9.5	468
BC4-1	0.48	1.04	0.5	4.66	7.8	413
BC16	0.46	41.86	8	6.75	6.3	192
BC4	0.55	8.84	0.5	6.96	7.4	103
BC2	0.112	5.19	6.1	7.31	9.3	71
906-15	0.126	0.12	1.2	7.08	8.9	268

pH Study

Trail 1 pH	Initial Fe Percentage
6.54	100
6.66	89.05
6.75	68.36
6.85	50.63
6.95	31.05
7.08	13.76
7.17	6.62
7.29	1.74

Trail 2	
pH	Initial Fe Percentage
6.46	100
6.58	107.84
6.65	91.12
6.76	77.77
6.85	52.66
6.97	38.16
7.07	26.73
7.15	16.32
7.17	5.91
7.18	5.56
7.25	2.22

pH Study: Initial and Final concentrations

	Al (mg/L) x 100	Mn (mg/L)	DO (mg/L)
Initial	4.27 ± 0.76	11.2 ± 1.41	4.40 ± 1.14
Final	9.50 ± 7.23	11.7 ± 0.290	1.07 ± 1.00

Aeration Trials: pH

	Aeration 1	Aeration 2	Aeration 3
time (hrs)	pH	pH	pH
0.00	6.44	6.44	6.44
0.08	6.85	6.75	6.58
0.17	7.14	7.03	6.76
0.25	7.14	7.22	6.97
0.33	7.07	7.20	7.17
0.42	7.00	7.17	7.25
0.50	6.97	7.10	7.22
0.58	6.93	7.03	7.17
0.67	6.90	7.00	7.14
0.75	6.92	6.97	7.08
0.83	6.92	6.97	7.07
0.92	6.97	6.97	7.05
1.00	7.00	6.98	7.03
1.08	7.07	7.00	7.02
1.17	7.19	7.03	7.02
1.25	7.37	7.10	7.03
1.33	7.61	7.20	7.07
1.42			7.08
1.50			7.12
1.58			7.17
1.67			7.25

Aeration Study: Percentage of Initial Fe

Time (hrs)	percentage
0.00	100.00
0.17	97.89
0.33	82.41
0.50	57.55
0.67	39.89
0.83	21.35
1.00	8.48
1.17	1.48
1.33	-0.05

Aeration Study: Initial and Final Concentrations

	Al (mg/L) x 100	Mn (mg/L)	DO (mg/L)
Initial	4.27 + 0.76	11.23 + 1.41	4.40 + 1.14
Final	4.97 ± 3.74	12.73 ± 0.38	9.63 ± 0.14

Settling Pond Study: Percentage of Initial Fe

time (hrs)	2000mL Pan	2000mL Bucket	4000mL Bucket
0.00	100.00	100.00	100.00
0.50	83.66	93.03	86.17
1.00	69.48	81.64	106.25
1.50	57.39	75.93	87.57
2.00	38.94	78.98	97.19
2.50	31.85	78.02	95.95
16.50	0.19	2.28	27.11
17.50			26.55
19.00			24.27
20.00			19.01
21.75			15.29
25.75			8.33
26.75			7.25
27.67			6.45

Settling Pond Study: 2000mL Pan: Percentage of Initial Fe

Time (hrs)	Pan 1	Pan 2	Pan 3
1	100.00	100.00	100.00
4	26.40	17.38	44.68
6	5.30	4.85	16.39
24	0.00	-0.05	0.04

Settling Pond Study: 2000mL Bucket: Percentage of Initial Fe

Time (hrs)	Bucket 1	Bucket 2	Bucket 3
1	100.00	100.00	100.00
4	93.92	107.77	80.77
6	75.92	81.08	61.58
24	1.33	1.02	0.64

Settling Pond Study: Initial and Final Concentration

	Initial	Final 2000mL Pan	Final 2000mL Bucket	Final 4000mL Bucket
Al (mg/L x100)	4.27	0.35	0	0
Mn (mg/L)	11.23	17.73	13.27	13.2
DO (mV)	4.4	7.27	7.2	7.5
pH	6.06	7.86	7.7	7.01

January 2009

THE CATALYST

SLIPPERY ROCK WATERSHED COALITION MONTHLY ACTIVITIES UPDATE

THIS MONTH'S MEETING: Thursday 1/8/09 at 7 pm at Jennings Environmental Education Center, pizza and pop provided. 12/11/08 meeting attendance: C. Cooper, C. Denholm, M. Dunn, D. Johnson, V. Kefeli

Student Symposium — Energizing to the SRWC!!!

The Slippery Rock Watershed Coalition Student Symposium was never better!!! Held on December 4, 2008 at the Andrew J. McKelvey Campus Center at Westminster College, the event began at 5:30 PM with a poster and networking session where people could meet, eat, and talk to poster presenters. Lots of yummy food was graciously provided by Westminster College. In addition to posters from organizations like the **Sierra Student Coalition** at Westminster College, **Wallace and Pancher**, the **Lawrence County Conservation District**, and **Stream Restoration Incorporated**, there were several academic research posters. The research posters were:

> "The Effectiveness of a Passive Treatment System for a Western Pennsylvania Stream Affected by Acid Mine Drainage" by **Amber Okert, Westminster College**
>
> "The Productivity of Passive Treatment Systems on Acid Mine Drainage of Slippery Rock Creek" by **Vanessa Kriley, Westminster College**
>
> "Teratogenic Effects of Ethylene Glycol and 5-methyl-1H-benzotriazole on Zebrafish Central Nervous System Development" by **Michael Romeo, Westminster College**
>
> "Research related to Fabricated Soils and Landscape Rehabilitation" by **Joshua McGinnis**, **Shari Mastalski**, and **Beth Rihn**, Slippery Rock University

Following the poster session, chemistry professor **Dr. Helen Boylan** provided a welcome and introduction to the event. **Dr. David Swerdlow**, an English professor, provided some interesting stories and readings related to the environment while student **Lynn Elliot read her original poem entitled "Minnows",** which was inspired by a recent fish kill that occurred in a stream running through the campus of Westminster College. Just prior to the student presentations, SRWC participant **Cliff Denholm** provided a short reflection on the importance of student involvement in research and field study. Six student presentations from three schools were given:

> "Leaves of Poplar and Willow Under Composting in Fabricated Soil" by **Joshua McGinnis, Slippery Rock Univ.**
>
> "Current Performance of a Passive Wetland Treating Acid Mine Drainage from Underground Mine Seals at Moraine State Park, Butler County, Pennsylvania" by **Jay Winter, California University of Pennsylvania**
>
> "Production of Fast Growing Woody Plant Material for Mining Soil Regeneration, Bio-regenerative Architecture, and Energy Production" by **Shari Mastalski, Slippery Rock University**
>
> "Investigating a Local Fish Kill" by **Fred Romeo, Westminster College**
>
> "Chestnut Plants on Salicaceae Plantation with Fabricated Soil" by **Beth Rihn, Slippery Rock University**
>
> "Sanitary Sewer Overflows" by **Steve Yamnitsky, Slippery Rock University**

We would thank to all of the students (and their professors) for their hard work and dedication as well as the audience members who took the time out of their busy schedules to support the students. We look forward to another great symposium next year!!!!!!

PHOTO OF THE MONTH

Students from **Westmister College's Advanced Chemistry** course pose with their **professor Dr. Helen Boylan** (center front) for a picture after their presentations at the November 2008 SRWC meeting.

PHOTO OF THE MONTH

Construction of the BC 16 Remediation Project Nears Completion!!!!

The Blacks Creek Watershed has been impacted by oil and coal production for over a century. The Bullion-Clintonville Oil Field, located in the northern portion of the watershed, once contained hundreds, if not thousands, of oils wells. In addition, mine discharges severely degrade the stream with high levels of iron, aluminum, manganese, and acidity.

The BC16 discharge emanates as an upwelling from an old, compromised, oil well that is now providing a conduit for contaminated ground water to reach the surface. The most likely source is from an old upgradient surface mine and coal refuse disposal site. BC16 is characterized as an alkaline iron and manganese discharge and was identified in the **Blacks Creek Restoration Plan** as having the **second highest metal loading** in the Blacks Creek watershed and given a restoration priority ranking of #2.

The BC 16 passive treatment system is being constructed by **Quality Aggregates Inc.** and consists of a naturally-functioning aerobic wetland and a horizontal flow limestone bed. Construction began 11/2008 and will finish in the next few weeks. A father/son team of **Drew Fuchs** and **Wayne Fuchs**, along with **Mason Frederick** and **Tom "Buck" Ealy**, have braved the cold and rain and snow to construct the passive system. Thank you for your dedication!!!!!!!!!

Thanks to all of the partners for making this project a reality!!!

- **PA DEP, Bureau of Watershed Management (US EPA 319 program)**
- **PA DEP, Knox DMO**
- **Dennis Tiche (landowner)**
- **BioMost, Inc.**
- **Quality Aggregates Inc.**
- **Stream Restoration Incorporated**

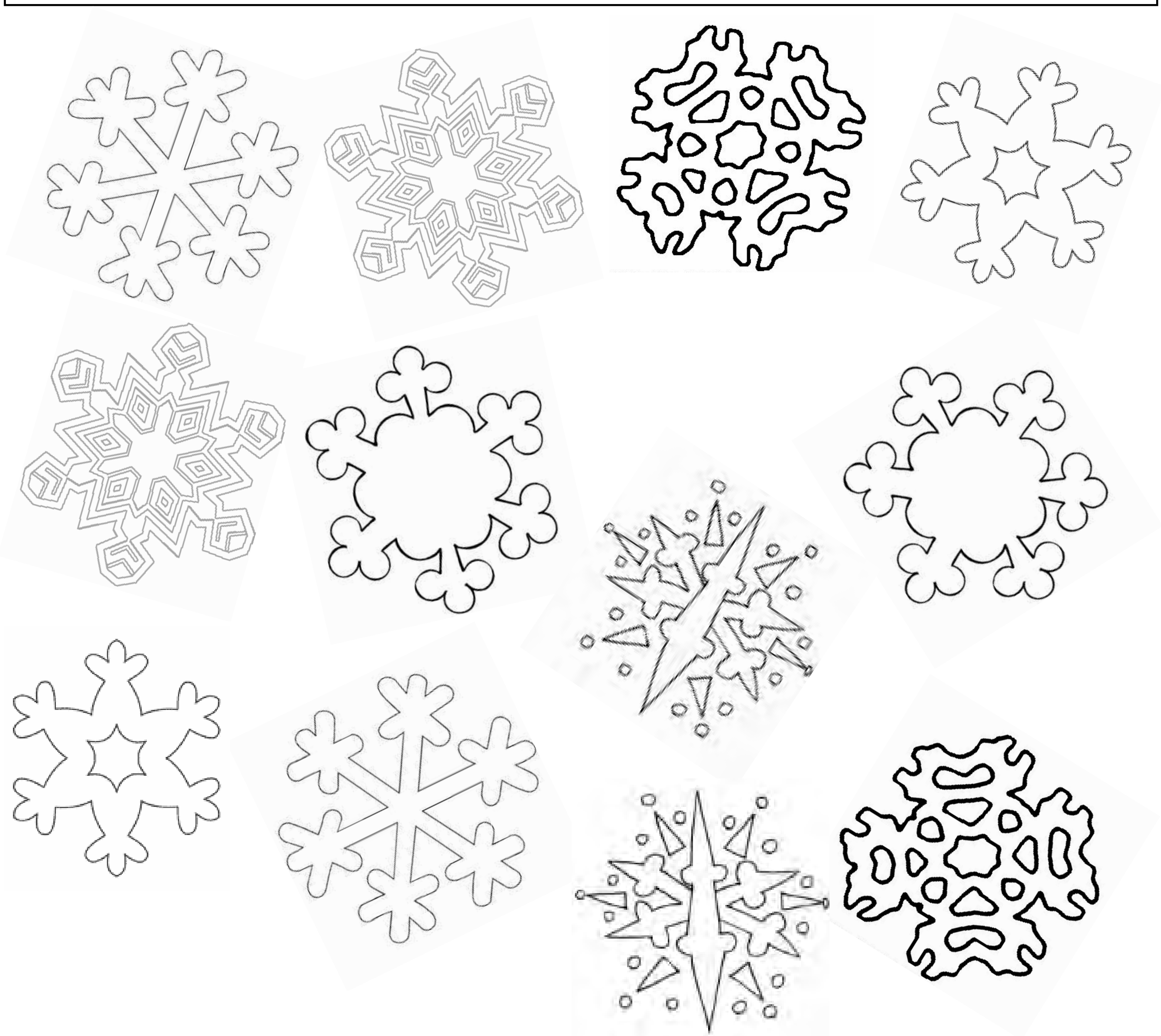
Once operational, the passive system is expected to prevent **17,500 lbs/year (~9 tons/year) of iron** and **5,100 lbs/year (~2.5 tons/year) of manganese** from entering Blacks Creek!

The KIDS Catalyst

SLIPPERY ROCK WATERSHED COALITION FUN ACTIVITY

Snowflake Match-Up

No 2 snowflakes are alike—except for in this Kids Catalyst page! Snowflakes develop differently depending on the temperature and how wet the air is. A typical snowflake begins by forming around a speck of dust. Then it grows into a tiny hexagonal prism. The initial symmetry of the snowflake results from the molecular structure of ice. As the crystal grows, it's often blown about in the sky. The air and temperature around the crystal are constantly changing. Snowflakes are extremely sensitive; even a small change in these conditions can lead to different growth patterns. The final shape of the crystal reflects these growth conditions. The longer the snowflake is blown about in the sky, the more complex the resulting snow crystal. No two crystals have the same history so they don't grow in the same way. No two have ever been the same, or ever will be. Below there are 6 pairs of snowflakes; try to find the matches, and then color each matching pair a different color. If you send us your completed paper, we will mail you a free gift certificate!



Name ________________________ Age _____ Address ____

Slippery Rock Watershed Coalition c/o Stream Restoration Incorporated
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Thanks to The William & Frances Aloe Charitable Foundation, Environmentally Innovative Solutions, LLC, Dominion Peoples, Amerikohl Mining, Inc., Quality Aggregates Inc., Drs. Ron & Kathy Falk Family, BioMost, Inc., Allegheny Mineral Corporation and PA DEP for their support. For more information contact: Slippery Rock Watershed Coalition, c/o Stream Restoration Incorporated (PA non-profit), 434 Spring Street Ext., Mars, PA 16046 (724)776-0161, fax (724)776-0166, sri@streamrestorationinc.org, www.srwc.org. Jan. distribution: 1221 copies

Watershed Plan Recognition — Very Rewarding!!!!!

It was a pleasant surprise to discover one of **Texas A&M University's** examples of an EPA Watershed Plan is none other than the **Blacks Creek Restoration Plan** which was designed by **Cliff Denholm** and **Shaun Busler** of Stream Restoration Inc. and the SRWC! Congratulations to Cliff and Shaun for a job well done! The university's link to Cliff and Shaun's plan can be found at **http://watershedplanning.tamu.edu/resources.php**

In addition, the **US EPA, Office of Solid Waste and Emergency Response** recently added a "profile" of the SRWC's work remediating AMD in the Slippery Rock Creek Watershed to its Green Remediation website. This profile can be viewed at: **http://www.cluin.org/greenremediation/tab_d.cfm** The project, the **DeSale Restoration Area**, is also **highlighted as an example of Green Remediation best management practices for land and ecosystems!!!** It can be accessed at: **http://www.cluin.org/greenremediation/subtab_b1_land.cfm.** The Green Remediation strategy employed by the SRWC at the DeSale project site was to utilize a series of natural gradient-driven settling ponds, vertical-flow ponds, and constructed wetlands to passively treat AMD. Check out the websites mentioned above for project site details and the positive results which have made a difference in the health and improvement of the watershed!!!

Student Symposium Photo

Beth Rihn, Shari Mastalski, and Joshua McGinnis (left to right) stand in front of their poster at the SRWC Student Symposium. In addition to being students at Slippery Rock University's Sustainable System program, Josh and Shari have assisted Stream Restoration Inc. in wetland and upland plantings at the Fox Run Restoration Area - Phase II, located in a nearby watershed.

April 2007

THE CATALYST

SLIPPERY ROCK WATERSHED COALITION MONTHLY ACTIVITIES UPDATE

<u>THIS MONTH'S MEETING:</u> Thursday 4/12/07 at 7 pm at Jennings Environmental Education Center, pizza and pop provided. 3/8/07 Meeting Attendance: J. Belgredan, S. Busler, C. Cooper, T. Danehy, C. Denholm, R. Donlan, M. Dunn, T. Grote, D. Johnson, V. Kefeli, B. Lubold, S. Smith, W. Taylor, S. VanDerWal

"Black Glaze" - Green Technology

Vessels to Sustain Watershed Restoration

Fifteen passive treatment systems have been constructed within the Slippery Rock Creek Watershed to combat the effects of approximately 30 abandoned mine discharges that degrade our streams. These passive treatment systems remove dissolved metals from the water using natural materials such as limestone and compost. The metals form solids that are collected in the passive treatment systems. The sooty black mineral formed within the limestone beds of some passive treatments systems in the Slippery Rock Creek Watershed is called todorokite, which contains about 50% manganese. Participants in the Slippery Rock Watershed Coalition are in the process of developing methods to recover this manganese ore.

Manganese, in the form of the material collected from the mine drainage, is commonly used as a colorant in different glazes for pottery. When local potter **Robert Isenberg of The Pottery Dome (Mercer, PA)** was approached by Slippery Rock Watershed Coalition participant **Kyle Durrett** with the concept of using some of the manganese in his pottery glazes, he was immediately interested. Robert Isenberg feels that making good use of the recovered manganese is a worthwhile endeavor. The largest request for this new glaze has come from the **North Country Brewing Company** located in downtown **Slippery Rock, PA**.

The **North Country Brewing Co.** has a yearly "Mug Club" where patrons can purchase one of **300 (!!!)** handmade mugs that they can use as their own personal mug that resides at the brewery. Each mug holds slightly more than one pint and is unlike any other mug in size, shape, and glaze. North Country Brewing supports many local grassroots organizations and is graciously **donating 5% (!!!!!) of the profits from sales of the new mugs to the Slippery Rock Watershed Coalition** to benefit long-term maintenance on the passive treatment systems in the watershed. These highly-anticipated new mugs will be available soon. They are sure to go fast so don't wait till they are gone!

The Slippery Rock Watershed Coalition would like to thank **North Country Brewing** for their generous support. To learn more about the **North Country Brewing Company**, check out their website at **www.northcountrybrewing.com** or stop in and enjoy a light snack or some "sturdy traditional food" at **141 South Main Street, Slippery Rock, PA**. The Coalition would also like to thank **The Pottery Dome** and **Robert Isenberg** for helping to promote this truly GREEN technology! To learn more about the award-winning art and the artist **Bob Isenberg**, visit **The Pottery Dome (www.potterydome.com) on the Leesburg–Grove City Road (State Route 208)** just 2 miles west of the Grove City Outlet Shops.

Above Left: Local businessman and North Country Brewing Co. host Bob McCafferty shows off a few of the new "Mug Club" mugs that incorporate manganese in the glaze recovered from passive treatment systems located in the Slippery Rock Creek Watershed. **Above Right:** Local artist and potter Robert Isenberg shows how he created 300 unique hand-thrown mugs at The Pottery Dome in Mercer, PA.

PHOTO OF THE MONTH

PHOTO OF THE MONTH

Shaun Busler, SRWC participant, is shown doing field work for the Blacks Creek assessment and implementation plan. Shaun checks rocks during a macroinvertebrate inventory (Left) and shows the location of an abandoned underground mine (Right), indicated by subsidence. *See article on back page.*

New Spring Research at Grove City College

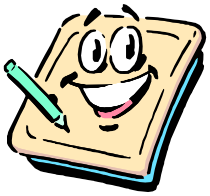
Richard Cattley, a junior at **Grove City College** who is majoring in Biology, will be assessing the water quality of Wolf Creek around the Grove City campus as part of an independent research program. Supervising Richard's work is **Dr. Fred Brenner**, a professor of Biology and participant of the **Slippery Rock Watershed Coalition**. Richard will be sampling for chemical parameters as well as biodiversity in order to determine the quality of the stream locally. The newly-collected data will then be compared to data from the late 1970s and early 1980s in order to compare how the stream is doing today in relation to the past. Some of the sampling locations will include above and below the water treatment plant located near the college. Other sampling points will be further upstream and north of I-80. We look forward to learning about Richard's findings and plan to share them in a future Catalyst issue!

PA Environmental Digest Showcases Westminster Students' Research Presentations

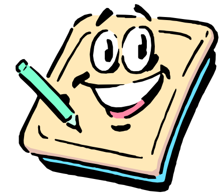
An article highlighting 19 Westminster College students' research of AMD treatment sites was featured in the PA Environment Digest on March 9, 2007! The chemistry and biochemistry students presented their research findings at a monthly meeting of the Slippery Rock Watershed Coalition. The article can be viewed via the PA Environment Digest at **www.paenvironmentdigest.com.** Thank you, PA Environment Digest for recognizing the importance of student involvement in the environmental research process and showing their hard work and accomplishments! (The PA Environment Digest is a weekly online update featuring written articles and short videos highlighting environmental issues in Pennsylvania.)

Women in Science at SRU and Kyle Durrett

"Women are valued and respected as educators and scientists at SRU." This comment from **Tamra Schiappa**, geology professor at **Slippery Rock University**, is backed up statistically by the fact that SRU employs high percentages of women faculty—twice the national average in some departments! **Kyle Durrett**, participant of the **SRWC**, can attest to it—he is a student at SRU who has studied under the tutelage of several female professors. In the Winter 2007 edition of **"The Rock"** magazine, Kyle is pictured working in a female educator's class in the article "Women Faculty Serve Critical Mentoring Role for Students."



The KIDS Catalyst

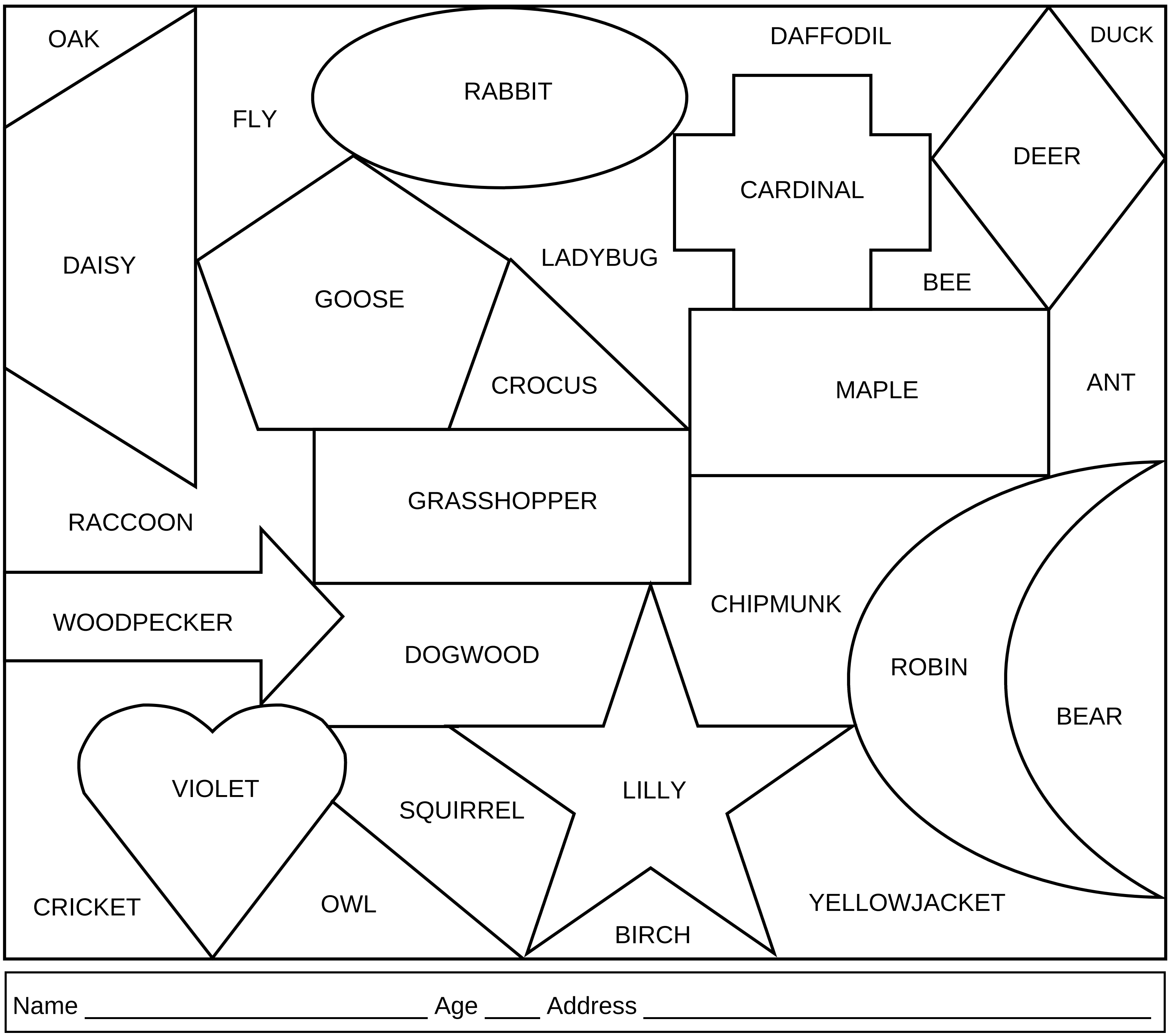


SLIPPERY ROCK WATERSHED COALITION FUN ACTIVITY

<u>Spring is "Shaping" Up</u>

Nature "springs" back to life this time of the year—it's spring! Hibernating animals wake from their restful winter slumbers, migrating birds return from their warmer winter "vacation" spots, flowers bloom with beautiful colors and wonderful scents, insects creep, hop, and fly all around us, the trees are green again… Pennsylvania is blessed with an amazing variety of life in nature! The large square below contains many shapes each with the name of a bird, tree, mammal, flower, or insect we can usually see in the spring. You need to put each name into a category to color each shape according to the key below. You can even try to find all of these things in your backyard, neighborhood, park, etc.! If you mail us your completed paper, we will send you a free gift certificate!

Bird = yellow   Tree = green   Mammal = blue   Flower = purple   Insect = red



Name ___________________________ Age ____ Address ____

Slippery Rock Watershed Coalition c/o Stream Restoration Incorporated
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Thanks to The William & Frances Aloe Charitable Foundation, Environmentally Innovative Solutions, LLC, Dominion Peoples, Amerikohl Mining, Inc., Quality Aggregates Inc., Drs. Ron & Kathy Falk Family, BioMost, Inc., Allegheny Mineral Corporation and PA DEP for their support. For more information contact: Slippery Rock Watershed Coalition, c/o Stream Restoration Incorporated (PA non-profit), 3016 Unionville Road, Cranberry Twp., PA 16066, (724)776-0161, fax (724)776-0166, sri@streamrestorationinc.org, www.srwc.org. April distribution: 1332

Restoring Blacks Creek

The SRWC is pleased and very excited to report that the assessment and implementation plan for the 9-sq. mi. Blacks Creek Watershed is nearing completion! This plan builds upon the more extensive **2006 Slippery Rock Creek Watershed Assessment and Restoration Plan** spear-headed by **Beran Environmental Services, Inc.** (Boyers, PA) with support from **Confluence Ecological, PA DEP Growing Greener Program, and the Butler County Commissioners**. In addition, abandoned mine restoration projects have been recently completed in the Blacks Creek Watershed by the **PA DEP Bureau of Abandoned Mine Reclamation and the Knox District Office; Aquascape; Quality Aggregates, Inc.; SRWC;** and others. A major tributary to Slippery Rock Creek, Blacks Creek is primarily in Butler County with a small portion extending into Venango County and is located just downstream of the 27-sq. mi. area, which has been the focus of the SRWC's restoration efforts for more than a decade.

Cliff Denholm takes a water sample from one of many water-filled pits

Shaun Busler and **Cliff Denholm** of Stream Restoration Inc. greatly appreciated the opportunity to inventory the abandoned mine discharges throughout the watershed and to develop a restoration plan. Many abandoned mine features were observed throughout the watershed: spoil piles, coal refuse piles, highwalls, subsidence, and water-filled surface mine pits. The impairment of Blacks Creek from AMD is evident and the main goal of this plan is to improve the stream quality and the aquatic ecosystem. The support of the **US EPA** and the **PA DEP Bureau of Watershed Management** in the efforts to restore Blacks Creek is greatly appreciated!

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
906-42	2/2/2000			7.3		707			81	0			3.6	1.9	2.4	2.3	0.7	0.1	316	9
906-42	1/15/2001		7.1	7.2		625	2		79	0			9.5	2.6	1.9	1.8	0.2	0.2	256	5
906-42	2/5/2001		7.1	6.9		533	2		49	0			2.9	2.8	1.8	1.7	0.2	0.1	218	8
906-42	10/3/2006		7.4	7.1	92.0	541	15	67	64	-49			1.3	0.6	1.3	1.3	0.1	0.0	171	7
906-42	4/26/2007		7.2	6.9	143.0	604	14		56	-48			0.8	0.4	1.2	1.1	0.4	0.1	199	2
906-42	9/24/2007	80	7.5	7.8	116.0	768	15	113	108	-99			1.5	0.0	2.1	2.1	0.2	0.1	225	3
906-42	11/14/2007	115	7.2	6.3	128.0	521	9	79	75	-58			1.5	0.7	1.6	1.5	0.4	0.3	156	7
Min		80	7.1	6.3	92.0	521	2	67	49	-99			0.8	0.0	1.2	1.1	0.1	0.0	156	2
Max		115	7.5	7.8	143.0	768	15	113	108	0			9.5	2.8	2.4	2.3	0.7	0.3	316	9
Avg		98	7.3	7.1	119.8	614	9	86	73	-36			3.0	1.3	1.7	1.7	0.3	0.1	220	6
Range		35	0.4	1.4	1.4	247	13	46	59	99			8.7	2.8	1.2	1.1	0.6	0.3	160	7

Description: Blacks Creek; Sampled at T-434 (Porter Rd.) crossing located upstream of confluence with unnamed "McIntire" tributary #15 and below BC14 and BC15 discharges ; BMI sampling point; Formerly BMI sampling point MID

Latitude: 41.164225850 **Longitude:** 79.918454603

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
BC2	8/23/1996			6.8					86	0			4.0		2.9		0.3		230	12
BC2	11/7/1996			6.4					80	0			9.3		6.5		1.0		189	0
BC2	3/11/1997			6.7					70	0			5.5		4.1		1.8		211	14
BC2	2/2/2000		6.8	6.7		1015	4		58	0			17.3	13.0	12.7	10.5	2.5	0.0	457	30
BC2	3/30/2000			6.3					182	0			49.0		15.0		0.3		842	70
BC2	6/28/2000			6.4					68	0			10.1		5.8		1.4		281	8
BC2	1/15/2001		5.8	6.6		775	3		47	0			10.3	6.4	8.5	5.9	2.3	0.4	401	20
BC2	2/5/2001		6.6	6.5		799	4		37	0			10.9	10.6	7.3	6.8	2.3	0.2	406	18
BC2	5/15/2003		7.0	6.8		476	12		46				2.1		1.9		0.1		300	
BC2	6/17/2003		7.0	7.1		560	18	94	60				2.1		1.8		0.1		190	
BC2	7/16/2003		6.5	7.4		255	18	88	80	-40			4.8		4.1		0.0	0.0	290	
BC2	9/13/2003		6.5	7.4		202	17	104	83	-27			2.4		2.9		0.9		235	
BC2	10/18/2003		7.0	7.4		482	9	64	51				2.1		2.9		1.4	0.1	185	
BC2	12/16/2003			7.7		205			58	-36			1.7		2.2		0.8	0.1	205	
BC2	1/18/2004			7.4		606			68	-48			2.3		3.1		0.4	0.2	270	
BC2	2/14/2004			7.5		385			62	-48			2.3		3.0		0.8	0.4	300	
BC2	3/11/2004			7.4		331			65	-53			1.5		2.2		1.0	0.2	275	
BC2	4/16/2004			7.2		446			63	-23			1.5		2.1		0.1	0.0	225	
BC2	5/6/2004		7.0	6.9		778	15	69	55	-42			6.9	5.1	3.8	3.6	1.4	0.1	381	7
BC2	5/12/2004			7.8		357			67	-56			1.9		2.8		0.0	0.1	225	
BC2	10/18/2004			6.7					69	-19			11.6		7.7		2.5		294	24
BC2	10/18/2004			6.7					69	-19			11.6		7.7		2.5		294	24
BC2	10/21/2004		6.6	6.8		823	11	62	55	-35			9.7	7.4	5.5	5.3	1.5	0.2	397	14
BC2	1/12/2005		6.1	6.0		383	6	15	9	4			2.5	1.5	2.7	2.7	1.8	0.2	185	8
BC2	2/1/2005	927		7.0					76	-26			7.9		4.9		2.0		253	24
BC2	2/1/2005	927		7.0					76	-26			7.9		4.9		2.0		253	24
BC2	4/6/2005		7.1	7.0		558	13		50	-40			4.1	3.1	2.8	2.8	0.7	0.0	275	4
BC2	5/9/2005	931		6.9					75	-31			5.8		3.5		0.7		247	16
BC2	5/9/2005	931		6.9					75	-31			5.8		3.5		0.7		247	16
BC2	8/2/2005	197		7.0					103	-57			12.7		6.1		0.3		271	24

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
BC2	11/9/2005	240		6.8					71	-18										
BC2	2/8/2006	820		6.6					56	5			6.6		3.9		0.7		233	6
BC2	5/9/2006	465		6.9					83	-42			7.7		3.2		0.3		259	20
BC2	8/3/2006	692		6.8					80	-63			4.0		2.9		0.3		215	4
BC2	8/13/2006		7.0	7.6		231		106	83	-55			2.3		2.5		0.6	0.1	275	
BC2	10/3/2006		7.1	6.7	89.0	656	15	64	54	-38			5.6	4.6	3.4	3.3	0.9	0.1	237	1
BC2	4/26/2007		7.0	6.5	148.0	543	14	41	38	-29			3.4	2.5	2.9	2.9	1.3	0.1	305	6
BC2	9/24/2007	120	7.3	7.3	45.0	947	14	116	96	-83			12.6	10.2	5.4	5.4	0.2	0.2	318	12
BC2	11/14/2007	175	6.8	6.0	140.0	705	8	92	48	-28			5.3	3.1	6.0	5.8	1.8	0.3	270	6
BC2	9/26/2008		7.2	7.3		737	13	113	90	-66			13.9		3.8		0.3		287	4
Min		120	5.8	6.0	45.0	202	3	15	9	-83			1.5	1.5	1.8	2.7	0.0	0.0	185	0
Max		931	7.3	7.8	148.0	1015	18	116	182	5			49.0	13.0	15.0	10.5	2.5	0.4	842	70
Avg		584	6.8	6.9	105.5	552	11	79	69	-29			7.4	6.1	4.6	5.0	1.0	0.1	287	15
Range		811	1.5	1.8	1.8	813	15	101	173	88			47.5	11.5	13.2	7.8	2.5	0.4	657	70

Description: Blacks Creek; Downstream of 906-42 and the confluence with unnamed "McIntire" tributary #15; Upstream of BC19 &19B passive treatment system effluent discharge and BC2B; PA DEP sampling point; Same as BMI point 905 UP and Beran Environmental BC6;

Latitude: 41.163585908 **Longitude:** 79.918323647

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
BC4	8/23/1996	175		5.9					42	48			30.0		19.5		2.6		620	60
BC4	11/7/1996	145		3.4					0	154			3.6		22.2		9.6		403	0
BC4	6/28/2000	130		6.1					72	32			31.5		19.4		6.1		652	20
BC4	1/15/2001		5.2	4.7		1181	5		2	81			19.1	13.5	21.9	19.8	9.4	6.1	784	33
BC4	2/5/2001	47	6.0	6.3		1021	6		36	27			18.1	16.3	13.7	12.9	3.9	0.4	497	18
BC4	10/3/2006		6.4	6.4	113.0	1068	13	48	40	9			20.3	18.4	12.1	11.4	3.8	0.1	454	22
BC4	4/26/2007	205	6.6	6.3	167.0	989	13	43	31	-5			13.6	10.8	10.3	10.1	4.7	0.2	467	29
BC4	9/24/2007	50	7.0	6.8	17.0	1259	12	129	78	-53			33.2	30.2	11.1	10.8	0.2	0.2	495	41
BC4	11/14/2007	60	5.1	4.8	250.0	1235	10	10	2	86			17.4	14.0	21.5	21.1	6.0	3.6	585	24
	Min	47	5.1	3.4	17.0	989	5	10	0	-53			3.6	10.8	10.3	10.1	0.2	0.1	403	0
	Max	205	7.0	6.8	250.0	1259	13	129	78	154			33.2	30.2	22.2	21.1	9.6	6.1	784	60
	Avg	116	6.0	5.6	136.8	1126	10	58	34	42			20.8	17.2	16.9	14.3	5.1	1.8	551	27
	Range	158	1.9	3.4	3.4	270	8	119	78	207			29.7	19.3	11.9	11.0	9.4	6.0	381	60

Description: Unnamed "McIntire" tributary #15 to Blacks Creek; Sampled at mouth prior to confluence with Blacks Creek; Downstream of BC16 discharge; PA DEP sampling point; Same as BMI sampling point 906-41, formerly BMI point DS

Latitude: 41.164177066 **Longitude:** 79.918147726

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
BC4.1	6/28/2000	120		3.3					0	162			7.5		20.9		12.4		468	14
BC4.1	10/4/2006	78	3.5	3.5	612.0	930	12		0	93			3.5	3.4	14.2	13.7	9.9	6.6	348	1
BC4.1	4/26/2007	115	5.0	4.5	252.0	793	13		0	34			8.6	0.8	10.6	10.2	7.3	4.3	376	14
BC4.1	9/24/2007	10	4.6	4.6	413.0	650	15	0	1	22			0.9	0.5	6.3	6.3	2.4	2.1	226	2
BC4.1	11/14/2007	40	3.3	3.3	578.0	1335	10	0	0	176			10.4	10.1	27.0	26.8	16.5	13.7	515	8
Min		10	3.3	3.3	252.0	650	10	0	0	22			0.9	0.5	6.3	6.3	2.4	2.1	226	1
Max		120	5.0	4.6	612.0	1335	15	0	1	176			10.4	10.1	27.0	26.8	16.5	13.7	515	14
Avg		73	4.1	3.8	463.8	927	13	0	0	98			6.2	3.7	15.8	14.2	9.7	6.7	387	8
Range		110	1.8	1.4	1.4	685	6	0	1	154			9.5	9.6	20.6	20.5	14.1	11.6	289	13

Description: Unnamed tributary #15 to Blacks Creek; "McIntire" tributary; Sampled upstream of BC16 discharge; PA DEP sampling point; Same as BMI sampling point 906-43

Latitude: 41.164245786 **Longitude:** 79.917445037

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
BC16	8/28/1996	175		6.3					190	96			73.9		26.0		0.1		754	72
BC16	11/7/1996	100		6.3					228	16			62.2		18.6		0.1		388	0
BC16	3/11/1997			6.4					228	32			44.7		19.3		0.2		488	28
BC16	3/30/2000	60		6.5						0									391	8
BC16	6/28/2000	91		6.3					238	0			55.1		17.1		0.3		688	18
BC16	2/5/2001	33	5.9	6.4		1473	10		166	0			51.3		14.0		0.1		865	15
BC16	2/19/2001	70	5.8	6.4		1436	10	145	169	0			49.3	44.8	16.0	13.5	0.5	0.3	628	11
BC16	4/19/2001	106		6.4					206	0			59.1		18.6		0.3		536	14
BC16	5/8/2001	90		6.2					174	0			65.7		20.4		0.3		867	24
BC16	9/28/2001	8		6.3					156	101			71.7		21.3		0.3			22
BC16	11/7/2001	3		6.3					128	74			61.0		15.1		0.6		736	42
BC16	2/7/2002	45		6.3					168	26			55.3		16.0		0.3		641	
BC16	2/8/2006	90		6.3					167	-22			56.7		13.9		0.3		644	8
BC16	5/9/2006	72		6.4					185	-33			43.6		10.5		0.3		559	10
BC16	8/3/2006	84		6.3					120	-72			40.4		10.2		0.3		540	2
BC16	10/4/2006	89	6.4	6.2	92.0	1356	11	188	141	-13			52.0	45.2	10.6	10.4	0.0	0.0	423	14
BC16	4/26/2007	143	6.0	6.4	133.0	1330	11	189	159	-92			44.2	44.2	9.5	9.4	0.2	0.1	491	24
BC16	9/24/2007	45	6.2	6.5	60.0	1361	11	163	105	-55			53.6	51.2	11.7	11.5	0.2	0.1	513	15
BC16	11/14/2007	20	6.1	6.0	64.0		10	156	128	-27			54.9	53.4	13.0	12.9	0.4	0.4	515	20
	Min	3	5.8	6.0	60.0	1330	10	145	105	-92			40.4	44.2	9.5	9.4	0.0	0.0	388	0
	Max	175	6.4	6.5	133.0	1473	11	189	238	101			73.9	53.4	26.0	13.5	0.6	0.4	867	72
	Avg	74	6.1	6.3	87.3	1391	11	168	170	2			55.3	47.7	15.6	11.5	0.3	0.2	593	19
	Range	172	0.6	0.5	0.5	143	1	44	134	193			33.5	9.2	16.5	4.0	0.6	0.4	479	72

Description: AMD; oil well upwelling south of Porter Road (T-434); flow to UNT15 (McIntire) to Blacks Ck.(BC4.1 downstr. ; BC4 upstr.); PA DEP & BMI mon. pt.; 3/30/00 Alk 60 mg/L, Fe 6.8mg/L, Mn 4.2 mg/L, Al 1.2 mg/L spurious?

Latitude: 41.164244086 **Longitude:** 79.917603365

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
RS1	1/15/2001		2.9	2.9		2215	0		0	574			92.8	88.8	62.5	59.0	16.2	15.6	1622	7
RS1	2/5/2001	26	2.9	3.0		1841	1		0	424			68.3	66.0	46.0	43.6	15.3	13.9	1091	6
Min		26	2.9	2.9		1841	0		0	424			68.3	66.0	46.0	43.6	15.3	13.9	1091	6
Max		26	2.9	3.0		2215	1		0	574			92.8	88.8	62.5	59.0	16.2	15.6	1622	7
Avg		26	2.9	3.0		2028	1		0	499			80.5	77.4	54.3	51.3	15.8	14.7	1357	7
Range		0	0.0	0.1	0.1	374	1		0	150			24.5	22.8	16.5	15.5	0.9	1.8	531	1

Description: Unnamed "McIntire" tributary #15 to Blacks Creek; Sample point located half way between TRX and RS2; BMI sampling point

Latitude: 41.166493586 **Longitude:** 79.908885176

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
RS2	1/15/2001		2.8	2.8		2270	0		0	518			95.0	93.5	63.8	61.5	17.1	15.6	1801	6
RS2	2/5/2001		2.9	3.0		1814	1		0	411			63.5	61.0	8.7	8.6	14.6	13.6	1144	6
RS2	5/28/2004		2.8						0	456	1.5			56.6		43.0		29.1	1053	
Min			2.8	2.8		1814	0		0	411	1.5		63.5	56.6	8.7	8.6	14.6	13.6	1053	6
Max			2.9	3.0		2270	1		0	518	1.5		95.0	93.5	63.8	61.5	17.1	29.1	1801	6
Avg			2.8	2.9		2042	1		0	462	1.5		79.3	70.4	36.2	37.7	15.8	19.4	1333	6
Range			0.1	0.2	0.2	456	1		0	106	0.0		31.5	36.9	55.0	52.9	2.5	15.6	748	0

Description: Unnamed "McIntire" tributary #15 to Blacks Creek; Sample point located below RS1 prior to flowing into existing pond (SB1); BMI sampling point

Latitude: 41.165952287 **Longitude:** 79.911320708

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
SB1	11/15/1996	45		3.1					0	292			24.2		33.5		14.8		694	0
SB1	1/27/1997	76		3.0		1770				312			43.7		46.5		22.6		990	0
SB1	2/2/2000	13	3.3	3.0		1825	6		0	354			32.3	31.7	41.4	40.8	15.1	14.9	808	6
SB1	1/15/2001	13	2.8	2.9		2073	7		0	419			23.6	22.9	56.8	48.5	28.8	27.3	1563	4
SB1	2/5/2001	14	2.9	3.0		1860	6		0	392			32.0	30.9	48.8	45.0	20.2	18.4	1001	7
SB1	2/19/2001	31	3.0	3.0		1662	6		0	357			40.1	37.1	43.0	41.6	15.7	14.4	741	5
SB1	9/28/2001	12	2.9	2.7		2488	15		0	503			35.5		63.5		40.2		2089	4
SB1	5/28/2004		2.9						0	361	5.0			37.0		36.8		25.1	909	
Min		12	2.8	2.7		1662	6		0	292	5.0		23.6	22.9	33.5	36.8	14.8	14.4	694	0
Max		76	3.3	3.1		2488	15		0	503	5.0		43.7	37.1	63.5	48.5	40.2	27.3	2089	7
Avg		29	3.0	3.0		1946	8		0	374	5.0		33.0	31.9	47.6	42.5	22.5	20.0	1099	4
Range		64	0.5	0.4	0.4	826	9		0	211	0.0		20.2	14.3	30.0	11.7	25.4	12.9	1395	7

Description: Existing Sediment Pond built within the unnamed "McIntire" tributary #15 to Blacks Creek; Sampled at white pipe and spillway; Located below RS2 and upstream of BC4.1; PA DEP & BMI sampling point

Latitude: 41.165283646 **Longitude:** 79.912747689

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
TB1	11/15/1996	47		3.3					0	898			244.0		71.2		28.5		1732	0
TB1	1/27/1997			3.3		2990				879	292.0		330.0	290.0	91.7		35.9		2100	0
TB1	2/2/2000	13	3.3	3.2		2670	3		0	775			288.5	284.0	89.0	86.5	23.3	21.2	2250	34
TB1	1/15/2001	10	2.9	3.0		2902	2		0	796			273.8	246.3	95.5	81.3	20.4	19.6	2517	5
TB1	2/5/2001	12	3.0	3.1		2572	3		0	671			257.5	218.3	71.3	69.5	20.6	16.9	1972	6
TB1	7/22/2002	22	2.9			3800			0	1151	185.2		250.3	252.2	28.2	28.9	57.6	58.5	2207	
TB1	4/2/2004		2.9						0	840	119.0		195.0	182.0	67.6	63.4	58.7	54.5	1938	
TB1	5/28/2004		2.9						0	817	135.0			183.0		70.1		41.6	1506	
	Min	10	2.9	3.0		2572	2		0	671	119.0		195.0	182.0	28.2	28.9	20.4	16.9	1506	0
	Max	47	3.3	3.3		3800	3		0	1151	292.0		330.0	290.0	95.5	86.5	58.7	58.5	2517	34
	Avg	21	3.0	3.2		2987	3		0	853	182.8		262.7	236.5	73.5	66.6	35.0	35.4	2028	9
	Range	37	0.5	0.3	0.3	1228	1		0	480	173.0		135.0	108.0	67.3	57.6	38.4	41.6	1011	34

Description: Existing treatment pond at the H&D "McIntire" minesite; Generally sampled at spillway as effluent pipe has become plugged; Receives the MC1, MC2, and MC3 abandoned mine discharges; Located upstream of sampling point TRX; BMI sampling point

Latitude: 41.169316141 **Longitude:** 79.907798212

Blacks Creek Water Quality Database

Sample Point	Date	Flow (gpm)	Field pH	Lab pH	ORP (mv)	Spec. cond. (umhos/cm)	Field T (C)	Alk (Field) (mg/L)	Alk (Lab) (mg/L)	Acid. (mg/L)	Fe+2 (mg/L)	Fe+3 (mg/L)	Fe (mg/L)	D. Fe (mg/L)	Mn (mg/L)	D. Mn (mg/L)	Al (mg/L)	D. Al (mg/L)	Sulfate (mg/L)	TSS (mg/L)
TRX	11/15/1996			3.0					0	552			68.7		55.5		24.1		1128	0
TRX	2/2/2000		2.9	2.9		2521	1		0	670			150.3	148.3	86.5	83.0	23.5	23.3	1927	11
TRX	1/15/2001		2.9	2.9		2260	1		0	570			111.8	106.3	60.8	53.0	17.5	17.1	1593	14
TRX	2/5/2001		3.0	3.1		1925	1		0	479			88.3	80.3	48.5	47.8	16.3	14.6	1355	5
TRX	2/19/2001	38	2.9	3.1		1921	3		0	426			94.8	94.8	56.0	52.3	20.5	19.3	1103	19
TRX	7/22/2002	22	2.6			3310			0	1123	4.2		152.2	154.8	28.7	29.2	179.9	184.1	2161	
TRX	4/2/2004		2.9						0	546	14.0		99.3	92.4	47.6	44.4	43.8	39.6	1386	
TRX	5/28/2004		2.8						0	671	1.5			103.0		60.2		40.0	1377	
	Min	22	2.6	2.9		1921	1		0	426	1.5		68.7	80.3	28.7	29.2	16.3	14.6	1103	0
	Max	38	3.0	3.1		3310	3		0	1123	14.0		152.2	154.8	86.5	83.0	179.9	184.1	2161	19
	Avg	30	2.8	3.0		2387	2		0	630	6.6		109.3	111.4	54.8	52.8	46.5	48.3	1504	10
	Range	16	0.4	0.2	0.2	1389	2		0	697	12.5		83.5	74.6	57.8	53.9	163.6	169.6	1058	19

Description: Unnamed "McIntryre" tributary #15 to Blacks Creek; Sampled at the Porter Road (T434) crossing, on the south side of the bridge; Located downstream of existing treatment pond (TB1) and upstream of RS1; PA DEP & BMI sampling point

Latitude: 41.168013602 **Longitude:** 79.907195925