



STREAM RESTORATION INCORPORATED

A PA Non-Profit Organization 501(c)(3)

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Date: July 28, 2009

To: Roger Bowman, Project Advisor
PA DEP, Bureau of District Mining Operations
White Memorial Building, PO Box 669, Knox, PA 16232

Re: **Fox Run Restoration Area – Phase 2 Final Report**

Jackson & Lake Townships, Mercer County, PA

Project #KD040173: Doc #4100028773

Job# 871102/GGII CEI Final Report/transmittal

Enclosed are three copies of the final report for the above noted project. For future reference, an electronic copy in PDF format will be uploaded to Datashed (www.datashed.org). While all water monitoring of the passive system completed to date has been conducted prior to the establishment of vegetation within the wetland, the passive system is still removing 10-20 pounds per day of iron which otherwise would be entering Fox Run. System performance is expected to improve as density of vegetation increases within the wetland. At least two additional water monitoring events will be conducted over the next year as part of WPCAMR's FACTS program. This data will be publicly available via Datashed.

Thank you for the assistance and commitment to the successful implementation of this worthwhile project. If you have any questions, comments, or concerns please do not hesitate to contact our office.

From: Stream Restoration Incorporated

Clifford Denholm, Env. Sci.

Shaun Busler, GISP

Tom Grote, Facilitator

Sylvia E. Danehy, Exec. Mgr.

Tim Danehy, QEP

Margaret H. Dunn, PG

Sent: Express Mail



**Project # KDO60132CEI
Document # 4100041161
Fox Run, Yellow Creek Watershed
Jackson & Lake Townships
Mercer County, PA**

Final Report Fox Run Restoration Area Phase II Stream Restoration Incorporated

June 2009

*(report with monitoring & maintenance updates available at:
www.Datashed.org)*

FOX RUN Restoration Area - PHASE II: FINAL REPORT **Jackson Township, Mercer County, PA**

“Making it Happen” through a Public-Private Partnership Effort

A Pennsylvania Growing Greener Watershed Restoration Project

Brief Description of Project Work through Grant and Partnership Contributions

- Completed and submitted to the appropriate agencies, applications and notifications including Environmental Assessment, Waiver of Chapter 105 Permit Requirements, PA Natural Diversity Inventory request, and PA One Call request; received permits/approvals;
- Completed design and installation of E & S Controls;
- Designed a passive treatment system for an alkaline, metal-laden, abandoned mine discharge (87-2) to enhance metal precipitation and settling of particulates prior to entering Fox Run; design based on raw water monitoring of discharge #87-2 conducted by MCCD and BioMost, Inc. with the following “worst case” characteristics: 1300 gpm (max.), 200 mg/L (min.) alkalinity, and 10 mg/L (max.) Total Fe;
- Construction consisted of the creation of a multi-component (in series) passive treatment system including an intake manifold collection system, a passive aerator, a 5,000-square foot Settling Pond and a 17,000-square foot aerobic wetland;
- Planted variety of trees in riparian and upland areas with volunteers as contributions in-kind;
- Developed Project Page on Datashed (www.datashed.org) for use by MCCD and others;
- Conducted education and outreach programs including wetland planting by volunteers;
- Kept photographic log; submitted quarterly status reports and final report; administered contract.

Grant Program and Funding: Environmental Stewardship and Watershed Protection Growing Greener II County Environmental Initiative Grant - \$31,579

In-Kind/Matching: Mercer County Conservation District; Brenner’s Ecological Services; Grove City College; Urban Wetland Institute; Quality Aggregates Inc.; BioMost, Inc.; Stream Restoration Inc.

(report with monitoring & maintenance updates available at www.datashed.org)

PUBLIC-PRIVATE PARTNERSHIP EFFORT

Landowner Support

KISH, Richard F. & Barbara A., Jackson Twp., Mercer Co., PA.

Conceptual and Engineering Design of Passive Treatment System, Environmental Assessment, and Water Quality Monitoring

Brenner's Ecological Service, 789 N. Liberty Rd., Grove City, PA 16127
BRENNER, Fred, PhD, President (724) 748-4310

BioMost, Inc., 434 Spring Street Extension, Mars, PA 16046
DANEHY, Timothy, QEP; REICHARD, Kevin, PE; DUNN, Margaret, PG; BUSLER, Shaun, GISP;
DENHOLM, Cliff, Environmental Scientist; Danehy, Sylvia, Office Mgr. (724) 776-0161

Passive Treatment System Construction

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

Project Funding, Oversight and State Grant Administration

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

Watershed Assessment, Public Outreach, Volunteer Effort, Water Monitoring, O & M

Mercer County Conservation District, 747 Greenville Rd., Mercer, PA 16137
MONDOK, James, Manager; HEDGLIN, Shawn, Nutrient Management; SHANKEL, Jill, Watershed
Coordinator; MCDONALD, Robert, E & S Tech (724) 662-2242

Stream Restoration Incorporated, 434 Spring Street Extension, Mars, PA 16046
DANEHY, Timothy, QEP; REICHARD, Kevin, PE; DUNN, Margaret, PG; BUSLER, Shaun, GISP;
DENHOLM, Cliff, Environmental Scientist; Danehy, Sylvia, Office Mgr. (724) 776-0161

Aquatic Life and Wetland Monitoring

Grove City College, 100 Campus Dr., Grove City, PA 16127
BRENNER, Frederick, PhD, Biologist, Biology Dept. (724) 458-2113

Urban Wetland Institute [non-profit], 789 North Liberty Rd., Grove City, PA 16127
BRENNER, Frederick, President (724) 748-4310

Grant Administration

Stream Restoration Incorporated, 434 Spring Street Extension, Mars, PA 16046
DANEHY, Timothy, QEP; REICHARD, Kevin, PE; DUNN, Margaret, PG; BUSLER, Shaun, GISP;
DENHOLM, Cliff, Environmental Scientist; Danehy, Sylvia, Office Mgr. (724) 776-0161

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<i>Fox Run Restoration Area Phase II Operation & Maintenance Plan</i> (also online: www.datashed.org)	

(report with monitoring & maintenance updates available at www.datashed.org)

Fox Run Restoration Area – Phase II
FINAL TECHNICAL REPORT
A FOX RUN MINE DRAINAGE ABATEMENT PROJECT

submitted to

Pennsylvania Department of Environmental Protection (PA DEP)

Executive Summary

Since 2000, a public-private partnership effort has been spearheaded by the Mercer County Conservation District to address abandoned mine drainage issues within the Fox Run Watershed, a subwatershed of Yellow Creek, located in Mercer County, Pennsylvania. Project partner Stream Restoration Incorporated received funding from both the Growing Greener I and Growing Greener II County Environmental Initiative grant programs to install a passive system to treat a net-alkaline, iron-bearing, discharge (87-2) emanating from an old underground coal mine. 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.

This project was the second passive system to be constructed within the watershed and addresses the 87-2 discharge, which is the single largest source of mine drainage to Fox Run in terms of both flow rate and loading, contributing about 55 lbs/day of iron to Fox Run. Based on available water quality data, the minimum and maximum values of select parameters are the following: flow 300-1300 gpm, pH 6.0-6.8, alkalinity 185-267 mg CaCO₃/L, total iron 4-10 mg/L with total aluminum and manganese concentrations less than 1 mg/L.

The passive treatment system (25-year projected design life) consists of four major components which operate in series: an intake manifold collection system, a passive aerator, a 5,000-square foot Settling Pond and a 17,000-square foot aerobic wetland. In addition, the riparian area and upland areas have been restored. Planting of the riparian area, uplands, and wetlands were conducted in conjunction with volunteers as part of the education and outreach effort.

As planting of the wetland was being conducted during the writing of this report, water quality samples have yet to be collected following establishment of thick wetland vegetation, which acts as a filter. Results, therefore, are preliminary and are expected to improve over time. Currently the system is removing 10-20 lbs/day of iron which equates to 3650 lbs to 7200 lbs of iron per year. Together the Phase 1 and 2 systems may result in the removal of Fox Run (designated use: Trout Stocked Fishery) from the list of impaired waters, possibly before completion of the TMDL. 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).

(report with monitoring & maintenance updates available at www.datashed.org)

COMPREHENSIVE TIMELINE

Date	Description
12/17/02	Letter of Support for Fox Run Watershed Restoration received from Richard & Barbara Kish (Landowners)
01/10/03	Site investigation and water sampling conducted; Preliminary Conceptual Design development
01/24/03	Letter of Acknowledgement for Fox Run Watershed Restoration– Phase II received from Western Pennsylvania Coalition for Abandoned Mine Reclamation
01/27/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Mercer County Regional Planning Commission
01/28/03	Letter of Commitment for Fox Run Watershed Restoration– Phase II received from G and C Coal Analysis Lab Inc.
01/28/03	Letter of Support/In-Kind/Matching for Fox Run Watershed Restoration– Phase II received from McClymonds Supply & Transit Co., Inc.
01/29/03	Letter of Support/In-Kind for Fox Run Watershed Restoration– Phase II received from Quality Aggregates Inc.
01/29/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Rod E. Wilt, PA State Representative
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Working On People’s Environmental Concerns
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Grove City College
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Mercer County Conservation District
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Urban Wetland Institute
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Fred J. Brenner, PhD (Consulting Ecologist and Biologist)
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Robert D. Robbins, Majority Caucus Secretary, Senate of Pennsylvania
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II from BioMost, Inc.
01/30/03	Letter of Support for Fox Run Watershed Restoration– Phase II from Stream Restoration Inc.
02/03/03	Growing Greener Grant Proposal for Fox Run Restoration Area - Phase II sent to DEP Grants Center;
02/03/03	Letter of Support for Fox Run Watershed Restoration– Phase II received from Timothy W. Lockley, Building Trades Instructor, George Jr. Republic Vo-Tech
02/20/03	Letter of Commitment for Fox Run Watershed Restoration– Phase II received from G and C Coal Analysis Lab Inc.
09/26/03	Growing Greener Grant application not accepted by PA DEP to receive Environmental Stewardship and Watershed Protection (Growing Greener) Grant
02/20/04	Updated Letter of Acknowledgement for Fox Run Watershed Restoration– Phase II received from Western Pennsylvania Coalition for Abandoned Mine Reclamation

(report with monitoring & maintenance updates available at www.datashed.org)

02/27/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Richard & Barbara Kish (Landowners)
02/27/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Mercer County Conservation District
02/27/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Mercer County Regional Planning Commission
03/01/04	Updated Letter of Commitment for Fox Run Watershed Restoration– Phase II received from Stream Restoration Inc.
03/01/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from BioMost, Inc.
03/01/04	Updated Letter of Support/In-Kind/Matching for Fox Run Watershed Restoration– Phase II received from Quality Aggregates Inc.
03/02/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Urban Wetland Institute
03/02/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Fred J. Brenner, PhD (Consulting Ecologist and Biologist)
03/02/04	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Grove City College
03/05/04	Proposal for Fox Run Restoration Area – Phase II submitted to PA DEP Grants Center
11/08/04	Environmental Stewardship and Watershed Protection Grant formally approved by PA DEP for No. KD040173 – Fox Run Restoration Area Phase II
01/06/05	30-day extension request to complete grant agreement documents submitted to DEP Grants Center
02/10/05	Transmittal Letter, Scope of Work, Simplified Budget and Detailed Budget sent to OSM via e-mail
02/15/05	Updated Letter of Commitment from SRI for Fox Run Watershed Restoration– Phase II submitted to US OSM
02/16/05	Revised copy of Scope of Work sent to PA DEP via e-mail
02/18/05	Proposal requesting construction funding of Fox Run II sent to OSM
05/06/05	Executed Grant Agreement for Document No. 4100028773 received from PA DEP
07/12/05	Quarterly Report submitted to PA DEP
08/26/05	Working Capital Request sent to PA DEP
08/29/05	Working Capital Advance request for No. KD040273, Document No. 4100028773 approved by DEP
10/14/05	Quarterly Report submitted to PA DEP
01/20/06	Quarterly Report submitted to PA DEP
02/24/06	Grant received from Community Foundation for the Alleghenies on behalf of Western PA Watershed Program
03/01/06	Updated Letter of Commitment for Fox Run Watershed Restoration– Phase II sent to DEP Grants Ctr. BioMost, Inc.
03/01/06	Updated Letter of Support/In-Kind/Matching for Fox Run Watershed Restoration– Phase II received from Quality Aggregates Inc.
03/01/06	Updated Letter of Commitment for Fox Run Watershed Restoration– Phase II sent to DEP Grants Ctr. Stream Restoration Inc.
03/02/06	Copies (5) of Growing Greener application sent to James Mondok, District Manager, Mercer County Conservation District

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03/03/06	Proposal seeking to obtain remaining funding needed from County Environmental Initiative Program to complete Fox Run – Phase II submitted to PA DEP Grants Center at request of Mercer County
04/07/06	Quarterly Report submitted to PA DEP
06/29/06	Updated Support Letter for Growing Greener application from Western Pennsylvania Coalition for Abandoned Mine Reclamation sent to DEP Grants Center as requested
07/05/06	Quarterly Report submitted to PA DEP
10/11/06	Quarterly Report submitted to PA DEP
12/14/06	Request for follow up on paperwork of Fox Run – Phase II received from Norma Anderton, Chief Clerk, Mercer County
01/15/07	Quarterly Report submitted to PA DEP
01/12/07	Updated County Environmental Initiative application sent to Wayne Lingle as per his request
01/12/07	Copy of updated Growing Greener 2 County Environmental Initiative application sent to Norma Anderton, Chief Clerk, Mercer County
01/25/07	Request for time extension submitted to PA DEP for Grant Application of Growing Greener Project No. KD040173, Document No. 4100028772
01/29/07	Request for time extension approved by PA DEP for Grant Application of Growing Greener Project No. KD040173, Document No. 4100028772
02/01/07	Updated and revised Letter of Support/In-Kind/Matching for Fox Run Watershed Restoration– Phase II received from Quality Aggregates Inc.
02/01/07	Updated and revised Letter of Commitment for Fox Run Watershed Restoration– Phase II sent to DEP Grants Center Stream Restoration Inc.
02/01/07	Updated and revised Letter of Commitment for Fox Run Watershed Restoration– Phase II sent to DEP Grants Center BioMost, Inc.
02/05/07	Updated Letter of Support for Fox Run Watershed Restoration– Phase II received from Mercer County Conservation District
02/06/07	Updated Letters of Support sent to Wayne Lingle
02/23/07	Grant Agreement, Scope of Work, Simplified Budget, Detailed Budget, Landowner Access Consent Letter and Goals and Accomplishments Worksheet sent to PA DEP Grants Center
04/27/07	Quarterly Report submitted to PA DEP
07/26/07	Quarterly Report submitted to PA DEP
08/27/07	DEP Grant Agreement for Environmental Stewardship and Watershed Protection Grant executed & submitted
08/28/07	DEP Grants Center completed processing on County Environmental Initiative Grant Agreement for Fox Run Restoration Area – Phase II, Identifier KD060132CEI, Document # 4100041161
09/26/07	Request for extension of Grant termination date for Document No. 4100028773 approved by PA DEP
10/23/07	Water quality samples collected
10/24/07	Quarterly Report submitted to PA DEP
10/25/07	Routine Wetland Determination performed at Fox Run II site
11/09/07	Wetland areas identified
01/14/08	Application for Reimbursement (1 st) sent to Bureau of District Mining Operations
01/17/08	Quarterly Report submitted to PA DEP
01/18/08	Application for Reimbursement (1 st – revised) sent to Bureau of District Mining Operations
02/05/08	Water quality samples collected; site investigation; GPS of wetlands; conducted property corner search
02/19/08	Deed and easement search performed; soil probes taken at access road

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02/21/08	Request for waiver under Section 105.12(a)(16) for Fox Run Restoration Area - Phase II submitted to Richard Neville, Wetlands Biologist Supervisor for PA DEP
03/07/08	Application for Reimbursement (2 nd) sent to PA DEP
03/26/08	Species Impact Review (SIR) for Fox Run II Restoration Area received from Pennsylvania Fish and Boat Commission
04/23/08	Quarterly Report submitted to PA DEP
05/20/08	Field meeting with Landowner, BMI, and Quality Aggregates
05/30/08	Waiver of Permit Requirements for DEP File No. WL43-08-602 granted from PA DEP
06/04/08	Meeting/review of plans at site with BMI, Quality Aggregates, Mercer County Conservation District, and First Energy
06/16/08	Meeting at site with Landowners, BMI, Quality Aggregates, and Mercer County Conservation District
06/27/08	Request for Budget Revision for Growing Greener Project No. KD040173, Document No. 4100028773 submitted to PA DEP
06/30/08	Request for Budget Revision for Growing Greener Project No. KD040173, Document No. 4100028773 approved by PA DEP
07/08/08	Site investigation; construction of precipitation pool near outlet; access road built toward outlet of wetlands; all trees and stumps cleared from site
07/09/08	Area for trees laid out; center line between transmission towers marked
07/18/08	Quarterly Report submitted to PA DEP
08/04/08	Field meeting conducted; building of intake manifold begun; by-pass channel for Fox Run constructed; constructed wetland cells
08/21/08	Water quality samples collected, delivered Warm Season Grasses and Wildflower seed to Tim Bliss of Bliss Reclamation.
10/14/08	Final Report for Growing Greener Grant Project No. KD040173, Document No. 4100028773 submitted to PA DEP
10/17/08	Quarterly Report submitted to PA DEP
11/04/08	Upland planting of hemlock, alder, willow, aspen, elderberry, silky dogwood, red-osier dogwood
01/26/09	Quarterly Report submitted to PA DEP
04/09/09	Quarterly Report submitted to PA DEP
05/29/09	Design, purchase, and construction of Aerator begins
06/22/09	Installation of Aerator begins
06/24/09	Aerator installation completed
06/29/09	Site inspection & water monitoring including Phase I & II with selected stream sample point locations
07/13/09	Water monitoring of Phase II with selected stream sample point locations
07/22/09	Harvesting of wetland plants from PA State Gamelands #284 and planting at Fox Run Phase II wetland

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FINAL REPORT

The elements requested in the 1000-FM-OA0056 Rev. 2/2008 PA DEP Final Report Guidelines are addressed item-by-item. The PA DEP Guidelines are in bold with the response in plain type.

A. Technical Report - (4 or 5 pages)

1. Narrative Description of Project (please include brief answers to the following questions):

a. What was the project supposed to accomplish?

The Fox Run AMD Remediation-Phase II project was initiated to address the most pollutive abandoned mine discharge (87-2) in the Fox Run Watershed. Prior to installation of the treatment system, discharge 87-2, which issues from an old underground coal mine, directly entered Fox Run and contributed ~55 lbs/day of total iron to the stream. As depicted in the following table, 87-2 significantly increased the total iron and sulfate content of Fox Run as well as the alkalinity.

Characteristics of Fox Run and Discharge 87-2 Prior to Treatment System Installation

average
 minimum/maximum

Point	Flow (gpm)	Lab pH	Alkalinity (mg/L)	Acidity (mg/L)	TFe (mg/L)	TMn (mg/L)	TAI (mg/L)	SO ₄ ⁻² (mg/L)
Fox Run upstream (87-1)	1192 0/4435 (n=18)	7.0 6.5/7.9 (n=8)	30 9/125 (n=8)	0 -6/3 (n=8)	0.6 0.1/2.2 (n=8)	0.1 0.0/0.3 (n=8)	0.1 0.0/0.3 (n=8)	45 26/82 (n=8)
AMD discharge (87-2)	723 320/1286 (n=18)	6.6 6.5/6.8 (n=10)	235 211/267 (n=10)	-20 -203/0 (n=10)	6.7 5.3/10.3 (n=10)	0.7 0.7/0.8 (n=10)	0.0 0.0/0.2 (n=10)	230 194/313 (n=10)
Fox Run downstream (87-6)	2312 742/6680 (n=18)	7.3 6.9/7.6 (n=9)	132 35/228 (n=9)	0 0/0 (n=9)	3.2 0.9/6.9 (n=9)	0.5 0.2/0.7 (n=9)	0.1 0.0/0.2 (n=9)	133 63/227 (n=9)

Data set provided in 3/5/04 Growing Greener grant application; acidity measurements in most cases reported as "0" where net alkaline; See water monitoring in appendix. One pre-construction monitoring event conducted by Stream Restoration Inc. all others provided in MCCD, 2000, Fox Run Watershed Abandoned Mine Drainage Survey, funded by US EPA Section 104(b)(3)

The Fox Run Phase II restoration effort was supposed to substantially decrease the impact of the 87-2 AMD on Fox Run. The anticipated result is the substantial improvement (combined with the success of the Phase I passive system installed in 2004) in 2.89 miles of Fox Run, the entire length of Fox Run (Segment ID 8523; HUC 05030102) identified in the PA List of Impaired Waters as degraded by AMD metals. These combined efforts may further enable Fox Run (1) to attain the designated use as a Trout Stocked Fishery (PA Code Title 25, Chap. 93) and (2) to be removed from the PA List of Impaired Waters relating to AMD.

The Phase II project is a continuation of on-going restoration efforts initiated by Mercer County Conservation District (MCCD) personnel working to address AMD impacts in the Fox Run Watershed. "The Fox Run Watershed Acid Mine Drainage Survey", completed in 2000 by Shawn Hedglin of the MCCD, identified three discharges that contributed the majority of AMD
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pollution to the stream. The Phase I restoration project, completed in 2004, included the first system installed to treat one of these discharges and the Phase II system is now providing treatment to the largest of the three.

Even though not originally targeted as a goal to be addressed, the passive treatment of 87-2 has resulted in a substantial increase in dissolved oxygen to Fox Run. (See later discussions.)

b. What you actually did and how it differs from your plan?

A passive treatment facility consisting of an intake manifold collection system, a passive aerator (added after final design), a 5,000-square foot Settling Pond, and a 17,000-square foot aerobic wetland has been installed and the riparian area has been restored. The site was seeded ca. 8/2008 with a mixture of Warm Season Grasses and native wildflowers. (See “As-Built” in appendix.) Riparian and upland areas and aerobic wetlands were planted by volunteers as part of the education and outreach effort. (Uplands planted 11/4/08 with hemlock, alder, willow, aspen, elderberry, silky dogwood, and red-osier dogwood. Limited planting of the aerobic wetlands was conducted on 7/22/09. See attached comprehensive timeline.) Due to the time needed to gather the resources necessary to implement the project, the system completion of the project was delayed.

Although not considered at the time of the grant application and design & construction of the passive system, the 2008 PA List of Impaired Waters also identified the same segment (2.89 miles) of Fox Run as being impaired by “Natural Sources” which cause “Organic Enrichment/Low D.O.”. This impairment appears to be related to the large (>500 acres), natural wetland known as Pine Swamp. (See Location Map.) Prior to treatment, discharge 87-2 contributed to the low DO in Fox Run, as the raw water, based on current analyses, has a DO content of ~0.1 mg/L with an average chemical oxygen demand of ~1 mg/L relating to oxidation of ferrous iron (~6 mg/L avg.) contained in the discharge.

Even though upstream of 87-2 Fox Run contains ~7 mg/L DO (n=3), dissolved iron from sources other than AMD is present in the stream. Apparently related to the high organic content as observed by the “tea” color of Fox Run, iron remains dissolved, even with significant alkalinity, possibly due to the biochemical oxygen demand. Note that the total iron content in Fox Run above 87-2 appears to have recently increased from an average of 0.6 mg/L (range: 0.1 to 2.2 mg/L; n=8) to an average of 4.8 mg/L (range: 4.7 to 5.0 mg/L; n=3). Interestingly, the sulfates have decreased for the same monitoring intervals from an average of 45 mg/L (range: 26 to 82 mg/L; n=8) to the recent average of 4.0 mg/L (range: 3.7 to 4.6 mg/L; n=3). (See water monitoring data in appendix.)

Decreasing the chemical oxygen demand through formation of iron solids in the passive system as well as increasing the DO in the final effluent to ~5 mg/L (very roughly an estimated 40 lbs/day) is expected to assist in ameliorating the impact to Fox Run from the upstream sources. (See water monitoring data in appendix.)

c. What were your successes and reasons for your success?

Through a team-based approach, a passive treatment system was successfully installed that resulted in immediate measurable improvements to the Fox Run Watershed. The support and

(report with monitoring & maintenance updates available at www.datashed.org)

knowledge of Dr. Fred Brenner, Biologist, Grove City College, greatly contributed to the success of the project. (Reference: Brenner, F. J., Hedglin, S., Alexander, S., Busler, S., 2004, Chemical and Biological Analysis of Fox Run Watershed, Mercer Co., PA: *in proceedings of 2004 American Society of Mining & Reclamation*, 10pp.) M CCD personnel were instrumental in gathering the background data needed to identify and define the source of pollution. The M CCD also assembled many of the partners needed to develop the project and install the treatment system. Of course, none of this would have been possible without the funding and administrative support from the PA DEP. The Fox Run Phase II project came to fruition because of the vision and dedication of all the project partners.

Current successes associated with improvement in water quality include (1) the elimination of the impact of 87-2 on a segment of Fox Run ~500 feet in length by conveying the raw discharge beneath Fox Run to the passive system; (2) a decrease in iron loading to Fox Run by more than 2 tons/year from passive treatment of 87-2; and (3) an increase in dissolved oxygen loading to Fox Run by an estimated 40 lbs/day from passive treatment of 87-2. Furthermore, additional decreases in iron loading to Fox Run are projected upon mature vegetation being developed in the wetland.

This project also enabled the successful restoration of ~250 feet of riparian area and the ability to provide education and outreach opportunities to raise public awareness of abandoned mine drainage issues.

d. What problems were encountered and how you dealt with them?

Only minor scheduling issues were encountered during the project. The initial grant awarded in May of 2005 provided about ¾ of the requested funding needed to install the passive treatment system. An application for the remaining necessary funds (this grant) was submitted March 2006 and a contract through the County Environmental Initiative was finalized by DEP 08/28/2007 (Project #KD060132CEI). An extension of time for the initial grant (KD040173) was approved 09/26/07 allowing the work to be completed by 06/30/08. Except for additional wetland plantings, final work has been completed under this grant. Once all the contract-related approvals were in-place, permitting work was initiated and a restoration waiver request was submitted to the PA DEP, NWRO 02/21/08. The waiver (WL43-08-602) was issued 05/30/08 and the system was installed within about 1 month.

e. How your work contributed to solution of original problems?

The original problem as identified by M CCD personnel was the impact of mine drainage on the Fox Run Watershed. As noted above, this project is part of an on-going effort to restore the stream and enable the removal of Fox Run from the 303(d) list of impaired waters. Effective treatment of the 87-2 discharge represents the second major “on-the-ground” step towards the goal of significantly reducing the impacts of non-point source pollution in the watershed. Based on limited preliminary monitoring data acquired before planting the wetland, the treatment system is currently decreasing the dissolved and total iron concentrations by ~45% (~25 lbs/day) and ~22% (~12 lbs/day), respectively. Upon establishing the vegetation in the aerobic wetland, both the dissolved and total iron removal rates are expected to be further increased.

Dissolved Iron: Raw vs. Treated

Point	08/21/08	06/22/09	06/29/09	07/13/09
Influent (raw) 87-2	5.7	5.0	5.4	5.7
Final effluent 871-WL	2.5	3.2	3.1	3.4

Dissolved iron (mg/L); 6/22/09 dissolved iron as measured in field; all other values as measured in lab; analyses in appendix

f. What else needs to be done?

While riparian, upland, and wetland plantings have been conducted, additional wetland plantings are to be scheduled as needed. An aeration device has been recently designed, fabricated, and installed on the outlet of the 18” SDR35 PVC intake manifold pipe. With the help of the aeration device and establishment of the wetland plants, iron removal and overall passive treatment system performance should be enhanced. Additional water monitoring will be conducted over the next year through WPCAMR’s FACTS program. This is especially important as the system has yet to be sampled following planting of the aerobic wetlands which should improve the functionality of the system. Long-term operation and maintenance work will be spearheaded by MCCD with assistance from the numerous project partners as outlined in the attached Operation and Maintenance Plan.

g. What are your plans for disseminating the results of your work?

The plantings mentioned above have been and will continue to be completed with the help of student and local volunteers, which provides not only the opportunity to disseminate information about the restoration efforts but also the opportunity for volunteers to contribute to the improvement of the Fox Run Watershed through hands-on activities. In addition, MCCD personnel will include the Fox Run Phase II site on tours given as part of on-going environmental education and outreach efforts. A web page has been created for the Fox Run Phase II site (www.datashed.org) and additional information regarding the location, operation and maintenance and long-term performance will be posted on the internet. This information can be accessed by anyone interested in the restoration of abandoned mines in general and the Fox Run Watershed in particular. Newsletter articles will also be written by the project partners for such periodicals as “The Catalyst” published monthly by Stream Restoration Incorporated.

h. How well did your spending align with your budget request?

The project was successfully completed within the approved budget amount. As noted above, education and outreach efforts are being initiated at the time of final report preparation and the related costs are being “covered” by in-kind and matching contributions from the various project partners. In order to accommodate scheduling constraints of the various grants, minor adjustments to the KD040173 and KD060132CEI projects were made. Overall, the construction costs were higher than expected due to increased fuel prices; however, significant matching and in-kind contributions were made by the project team to accommodate these conditions. There were no “change orders” requesting additional funds.

2. Summary in 50 words or less suitable for sharing with the public

The largest source of abandoned mine drainage pollution to Fox Run is being treated by natural processes in a constructed wetland, preventing more than 2 tons/year of iron from entering the stream. Located within the Neshannock Creek Watershed, the goal is for Fox Run to be a Trout

(report with monitoring & maintenance updates available at www.datashed.org)

Stocked Fishery. The Mercer County Conservation District has been working for over eight years to reduce pollution from abandoned mines to Fox Run. Funding was provided by Pennsylvania’s Growing Greener Program and the Foundation for Pennsylvania Watersheds with contributions and support by Mercer County, Quality Aggregates Inc., and many others.

3. Accomplishment Worksheets

(See Attached.)

4. Photographs (Digital are preferred)

(See attached.)

5. Detailed Technical Reports where applicable (e.g., assessments, data, rehabilitation plans, stream channel designs, watershed protection and restoration plans) - (Filed at Regional Office or with Project Advisor)

(Not applicable.)

6. Operation, Maintenance, and Replacement Plans

(See attached.)

B. Financial Report Final Application for Reimbursement Following Standard Procedures

(The Financial Report has been submitted under separate cover.)

C. Pennsylvania Stream ReLeaf - Project Data Sheet (if required)

(This project was not included under the Pennsylvania Stream ReLeaf initiative.)

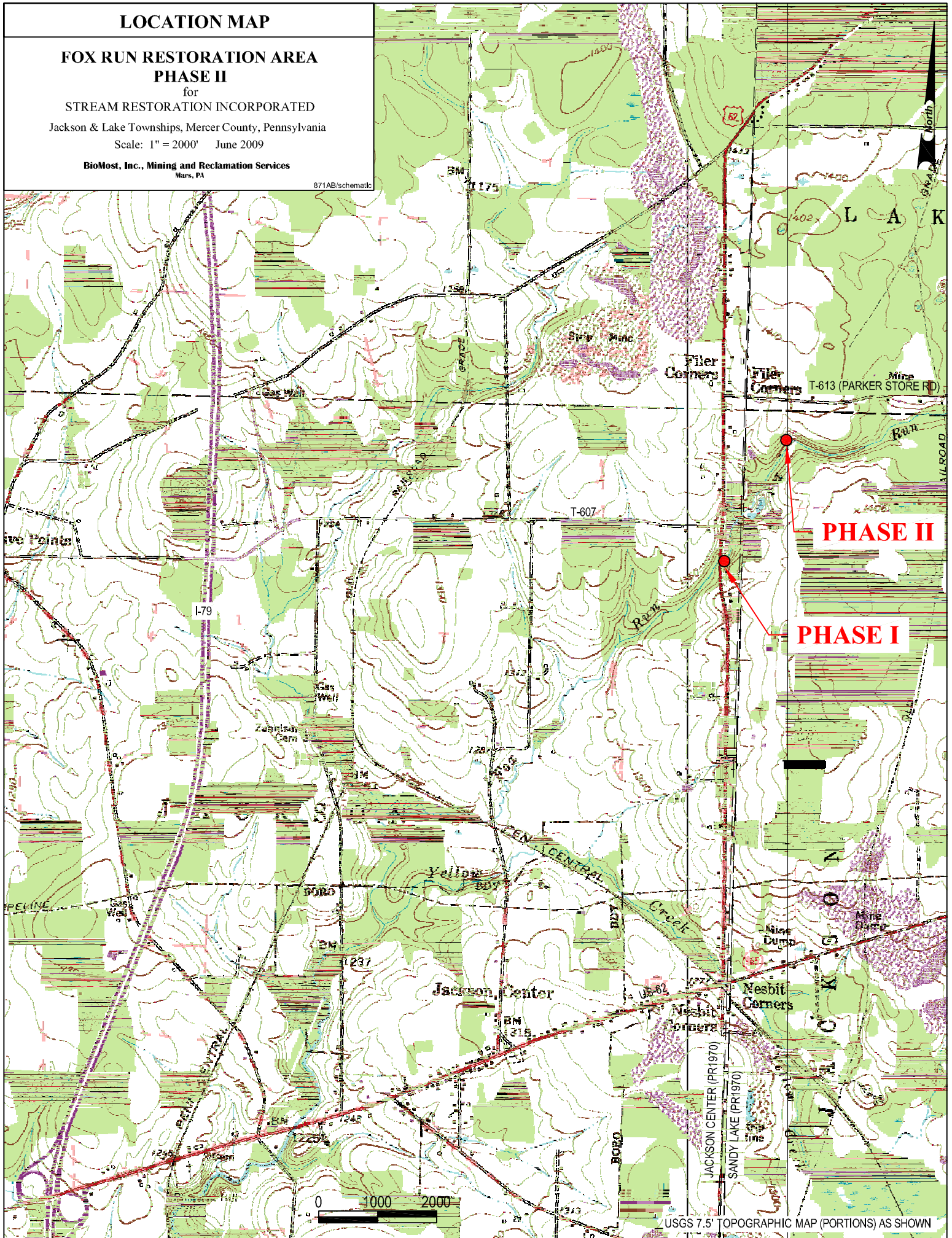
LOCATION MAP

FOX RUN RESTORATION AREA PHASE II

for
STREAM RESTORATION INCORPORATED
Jackson & Lake Townships, Mercer County, Pennsylvania
Scale: 1" = 2000' June 2009

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

871AB/schematic

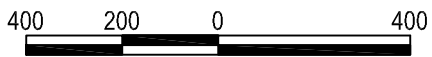




PROJECT LOCATION - PAMAP DIGITAL ORTHOPHOTO (3/2006)
FOX RUN RESTORATION AREA - PHASE II

Approximate Center of Project (deg-min-sec)
41-18-06 latitude 80-07-20 longitude

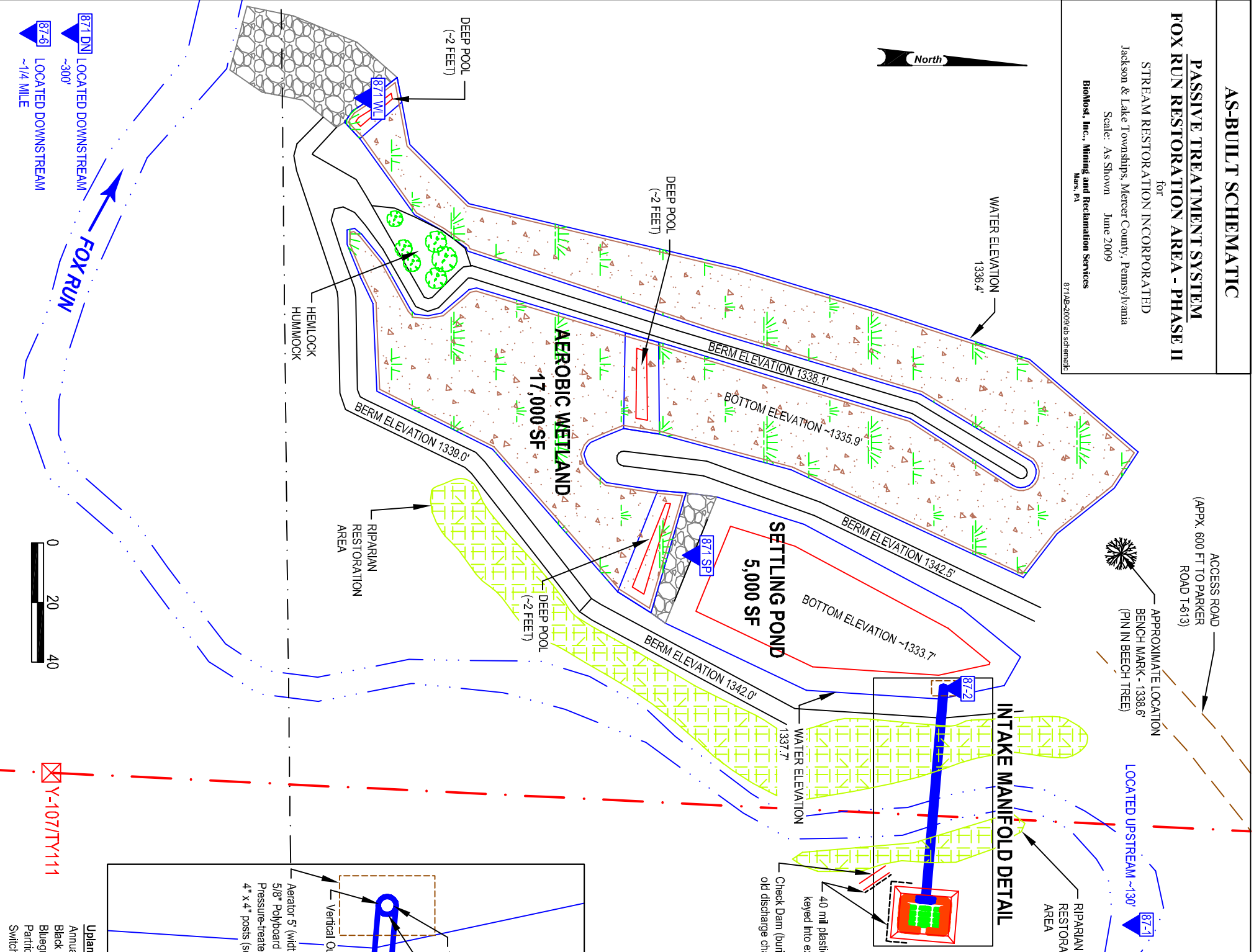
Fox Run Watershed
Jackson & Lake Townships, Mercer County, PA
Stream Restoration Incorporated
June 2009 Scale 1" = 400'



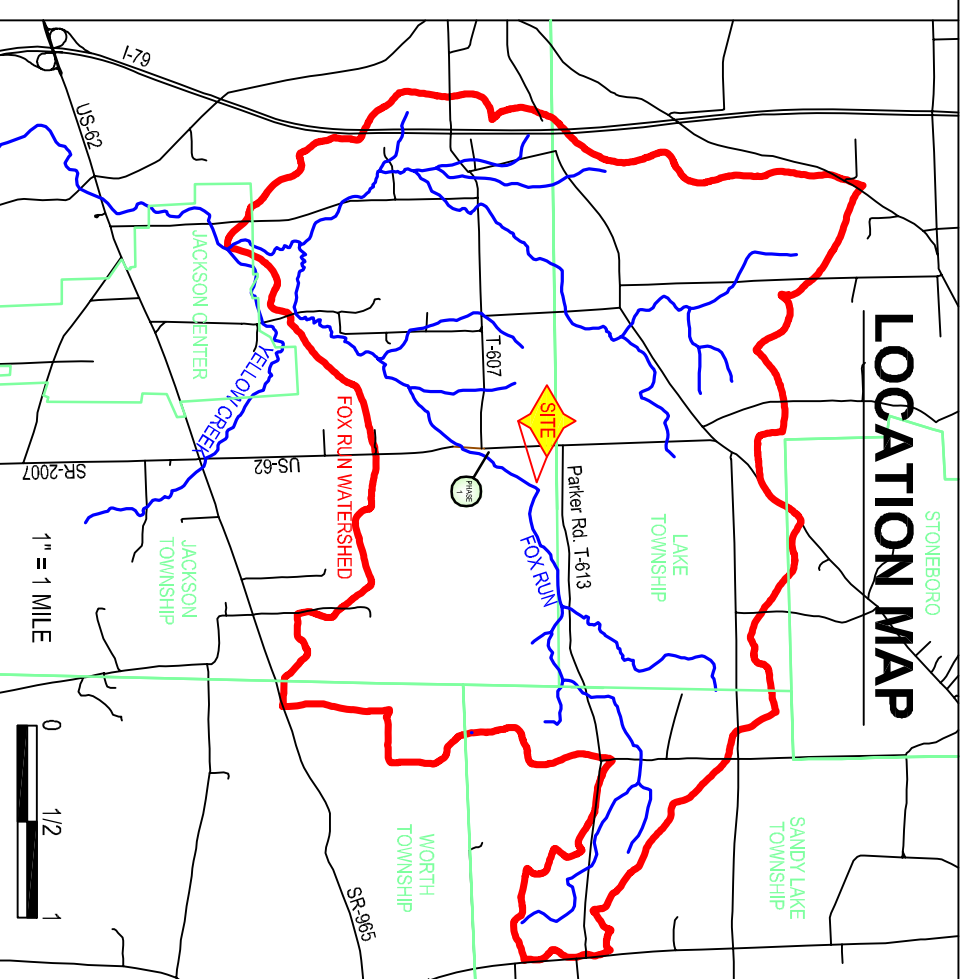
AS-BUILT SCHEMATIC

PASSIVE TREATMENT SYSTEM for FOX RUN RESTORATION AREA - PHASE II

STREAM RESTORATION INCORPORATED
Jackson & Lake Townships, Mercer County, Pennsylvania
Scale: As Shown June 2009
BioMost, Inc., Mining and Reclamation Services
Mesa, PA
877-AR-2009/ab schematic



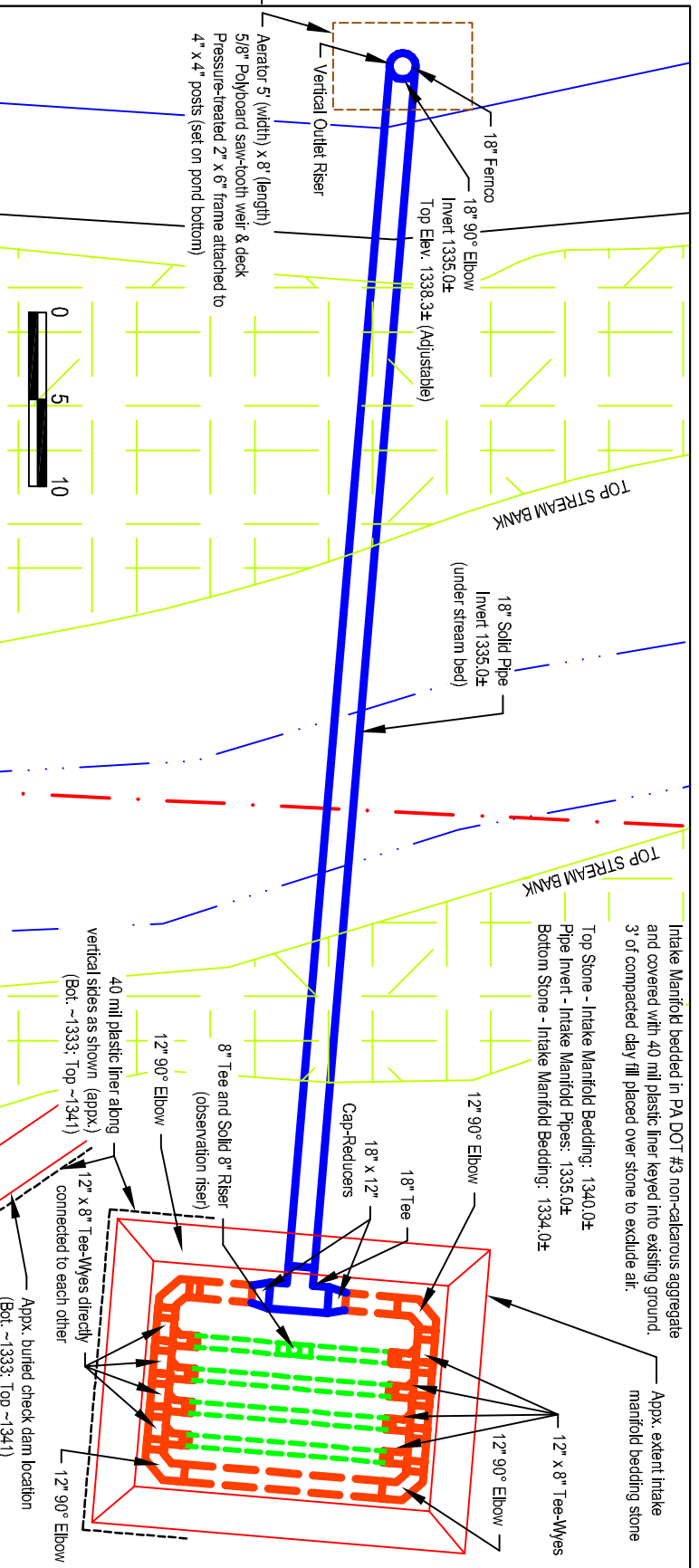
LOCATION MAP



LEGEND	
	WATER SURFACE ELEVATION
	FOX RUN
	TOP BERM/STREAMBANK
	PTS COMPONENT
	AEROBIC WETLAND
	RIP-RAP (R4)
	TRANSMISSION LINE & POLE
	FENCE (APPROXIMATE LOCATION)
	18" SOLID PIPE
	12" PERFORATED PIPE
	8" PERFORATED PIPE
	PTS WETLAND BOTTOM
	WATER SAMPLING POINT

Notes:
As-built information from 09/26/08 field inspection by BioMost, Inc. and Mercer County Conservation District using post-processed sub-meter GPS unit & laser level, and 06/22/09 site inspection by BioMost, Inc. as well as design information and is a reasonable representation of actual field conditions.
Water elevations may vary due to outlet spillway, weather and other factors.
Passive treatment system built on property of Richard & Barbara Kish.
All pipe is SDR35 PVC.
Stream location from aerial photography taken for the PAMAP program (Spring 2006) and sub-meter GPS unit.
Settling pond and wetland areas shown measured at top of water.
Total wetland area "foot print" ~3/4 Acre.

INTAKE MANIFOLD DETAIL Scale 1"=10'



Upland Areas Seed Mixture (Planted ~2 1/2 Acres at 15 lb/acre - Summer 2008) includes:
Annual Baby's Breath, Annual Galliardia (Indian Blanket), Atlantic Coastal Panic Grass, Bachlor's Button Tall Mixed/Comflower, Bigleaf Lupine, Black Eyed Susan, Brown Eyed Susan, California Poppy, Cornflower (Bachlor's Button), Cosmos, Dames Rocket, Eastern Gamma Grass, Fowl Bluegrass, Gray Headed Coneflower, Indiangrass, PA Ecotype, Lance Leaved Coreopsis, Little Bluestem, Ox Eye Daisy, Ox Eye Sunflower, Partridge Pea, Perennial Blue Flax, Perennial Galliardia (Blanket Flower), Plains Coreopsis, Purple Coneflower, Red Corn Poppy, Steller Switchgrass, Snowy Tick Trefoil, Sulphur Cosmos, Virginia Wild Rye, Wallflower, WI Ecotype Big Bluestem, Wild Bergamot

Upland Trees Planted (~50 Each species - Fall 2008):
Hemlock, Alder, Willow, Aspen, Elderberry, Sily Dogwood (~100 plants), Red-Osier Dogwood

Wetland Area Planted (Summer 2009) with species including:
Burreed, Button Bush and Softstem Bulrush.

Fox Run Restoration Project - Phase II Water Quality Report - 87-2

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
1999-12-29	--	--	234.92	--	--	0.02	--	9.6	554.7	--	9.05	--	0.76	--	6.61	6.39	773	200.9	6
2000-01-28	--	--	--	--	--	--	--	--	320.4	--	--	--	--	--	--	--	--	--	--
2000-01-31	--	--	242.78	--	--	0.02	--	9.8	556.06	--	10.25	--	0.75	--	6.77	6.28	782	211.4	9
2000-02-16	--	--	--	--	--	--	--	--	433.29	--	--	--	--	--	--	--	--	--	--
2000-02-28	--	--	234.78	--	--	0.02	--	9.6	556.06	--	5.9	--	0.77	--	6.83	6.36	757	220.4	8
2000-03-13	--	--	227.96	--	--	0.02	--	9.7	660.65	--	5.86	--	0.74	--	6.68	6.63	769	194.3	5
2000-03-27	--	--	--	--	--	--	--	--	770.42	--	--	--	--	--	--	--	--	--	--
2000-04-25	--	--	211.11	--	--	0.02	--	10.1	1190.06	--	5.34	--	0.67	--	6.56	6.33	768	221.5	7
2000-04-28	--	--	--	--	--	--	--	--	1286.32	--	--	--	--	--	--	--	--	--	--
2000-05-25	--	--	225.71	--	--	0.02	--	10.1	884.96	--	5.75	--	0.7	--	6.61	6.38	761	237.3	6

Fox Run Restoration Project - Phase II Water Quality Report - 87-2 (cont.)

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2000-05-30	--	--	--	--	--	--	--	--	943.91	--	--	--	--	--	--	--	--	--	--
2000-06-20	--	--	--	--	--	--	--	--	884.96	--	--	--	--	--	--	--	--	--	--
2000-06-28	--	--	231.43	--	--	0.02	--	10.1	973.79	--	5.42	--	0.71	--	6.62	6.33	761	254.7	9
2000-07-25	--	--	--	--	--	--	--	--	770.42	--	--	--	--	--	--	--	--	--	--
2000-07-31	--	--	235.28	--	--	0.02	--	9.9	660.65	--	5.92	--	0.71	--	6.61	6.27	760	235.7	4
2000-08-24	--	--	--	--	--	--	--	--	556.06	--	--	--	--	--	--	--	--	--	--
2000-08-28	--	--	243.24	--	--	0.02	--	10.2	530.77	--	6.18	--	0.74	--	6.5	6.42	783	205.4	4
2000-09-06	--	--	--	--	--	--	--	--	481.23	--	--	--	--	--	--	--	--	--	--
2003-01-10	--	-202.6	266.93	--	--	0.2	--	9	--	6.96	7.33	0.78	0.79	--	6.61	--	897	313.4	2
2007-10-23	--	-203.54	217.12	240	0.23	0.27	--	10	--	--	7.54	0.25	0.71	--	6.63	6.5	773	168	7

Fox Run Restoration Project - Phase II Water Quality Report - 87-2 (cont.)

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2008-02-05	--	-196.3	210.26	185	0.31	0.89	--	10	--	3.39	4.49	0.71	0.72	--	6.43	6	723	149.3	6
2008-08-21	--	-183.21	219.51	215	0.06	0.24	0.17	11.1	--	5.7	6.39	0.69	0.71	--	6.41	6.62	700	155.1	8
2009-06-22	--	--	--	221	--	--	0.09	10.5	--	--	--	--	--	--	--	6.7	--	--	--
2009-06-29	--	-184.08	217.17	242	0.07	0.05	0.06	10.4	800	5.44	5.18	0.67	0.67	--	6.96	6.58	750	165.1	19
2009-07-13	--	-191.64	207.37	219	0.02	0.02	0.07	10.5	800	5.74	5.93	0.72	0.73	--	6.61	6.77	750	160.8	3
Minimum:		-203.54	207.37	185	0.02	0.02	0.06	9	320.4	3.39	4.49	0.25	0.67	--	6.41	6	700	149.3	2
Maximum:		-183.21	266.93	242	0.31	0.89	0.17	11.1	1286.3	6.96	10.25	0.78	0.79	--	6.96	6.77	897	313.4	19
Average:		-193.5617	228.3713	220.3333	0.138	0.1233	0.0975	10.0375	730.7	5.446	6.4353	0.6367	0.7253	--	6.609	6.3935	767.1333	206.22	6.8667
Range:		20.33	59.56	57	0.29	0.87	0.11	2.1	965.9	3.57	5.76	0.53	0.12	--	0.55	0.77	197	164.1	17
Median:		-193.97	227.96	220	0.07	0.02	0.08	10.05	715.5	5.7	5.92	0.7	0.72	--	--	--	761	205.4	6

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Fox Run Restoration Project - Phase II Water Quality Report - 87-2 (cont.)

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
Loading (lb/day):		-1803.456	2014.8875	2212.8	0.432	0.2044	-	-	-	53.664	55.279	6.672	6.3771	-	-	-	-	-	-

Sample Point Description: Largest AMD source in Fox Run Watershed. Previously located on east side of Fox Run beneath a stand of hemlocks but now is collected & piped under stream to Phase 2 passive system; 10/23/07 D.Fe of 0.43 mg/L removed as considered spurious.

1. Records with no value are not included in statistical calculations.
2. Values lower than the minimum detection limit are assumed to be 0.
3. Median pH values are not shown because median pH is so easily misinterpreted.
4. Average pH is not calculated as a mean of pH values, but rather a mean of hydronium ion concentration.
5. Dissolved metals used for calculated acidity values when available. Acidities calculated from total metals may be exaggerated.
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Fox Run Restoration Project - Phase II Water Quality Report - 871-SP

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2008-08-21	--	-188.14	221.56	220	0.33	0.66	0.92	11.9	--	5.34	6.78	0.69	0.86	--	6.44	6.4	706	163.7	9
2009-06-22	--	--	--	215	--	--	1.66	11.4	--	--	--	--	--	--	--	6.82	--	--	--
2009-06-29	--	-186.26	200.04	271	0.07	0.09	1.43	11.6	800	5.05	5.73	0.68	0.68	--	6.90	6.65	769	150.8	3
2009-07-13	--	-202.78	205.98	218	0.02	0.02	2.94	11.3	--	5.53	5.63	0.7	0.73	--	6.7	6.67	761	159.7	12
Minimum:		-202.78	200.04	215	0.02	0.02	0.92	11.3	800	5.05	5.63	0.68	0.68	--	6.44	6.4	706	150.8	3
Maximum:		-186.26	221.56	271	0.33	0.66	2.94	11.9	800	5.53	6.78	0.7	0.86	--	6.90	6.82	769	163.7	12
Average:		-192.3933	209.1933	231	0.14	0.2567	1.7375	11.55	800	5.3067	6.0467	0.69	0.7567	--	6.6392	6.6077	745.3333	158.0667	8
Range:		16.52	21.52	56	0.31	0.64	2.02	0.6	0	0.48	1.15	0.02	0.18	--	0.46	0.42	63	12.9	9
Median:		-188.14	205.98	219	0.07	0.09	1.545	11.5	800	5.34	5.73	0.69	0.73	--	--	--	761	159.7	9
Loading (lb/day):		-1788.096	1920.384	2601.6	0.672	0.864	--	--	--	48.48	55.008	6.528	6.528	--	--	--	--	--	--

Sample Point Description: Effluent of settling pond (871-SP) prior to entering the wetland.

1. Records with no value are not included in statistical calculations.
2. Values lower than the minimum detection limit are assumed to be 0.
3. Median pH values are not shown because median pH is so easily misinterpreted.
4. Average pH is not calculated as a mean of pH values, but rather a mean of hydronium ion concentration.
5. Dissolved metals used for calculated acidity values when available. Acidities calculated from total metals may be exaggerated.
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Fox Run Restoration Project - Phase II Water Quality Report - 871-WL

Date	Method of Flow (NF) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2008-08-21	--	-187.54	217.3	211	0.04	0.21	5.21	17.4	--	2.53	3.72	0.68	0.7	--	6.58	6.9	687	141.7	5
2009-06-22	--	--	--	215	--	--	5.43	12.7	--	--	--	--	--	--	--	6.85	--	--	--
2009-06-29	--	-183.88	195.05	124	0.12	0.06	4.46	14.2	800	3.08	5.17	0.66	0.67	--	7.09	6.71	749	156.3	13
2009-07-13	--	-197.21	201.6	252	0.02	0.02	5.16	13	800	3.37	3.82	0.7	0.71	--	6.82	7.05	742	162	3
Minimum:		-197.21	195.05	124	0.02	0.02	4.46	12.7	800	2.53	3.72	0.66	0.67	--	6.58	6.71	687	141.7	3
Maximum:		-183.88	217.3	252	0.12	0.21	5.43	17.4	800	3.37	5.17	0.7	0.71	--	7.09	7.05	749	162	13
Average:		-189.5433	204.65	200.5	0.06	0.0967	5.065	14.325	800	2.9933	4.2367	0.68	0.6933	--	6.7819	6.8607	726	153.3333	7
Range:		13.33	22.25	128	0.1	0.19	0.97	4.7	0	0.84	1.45	0.04	0.04	--	0.51	0.34	62	20.3	10
Median:		-187.54	201.6	213	0.04	0.06	5.185	13.6	800	3.08	3.82	0.68	0.7	--	--	--	742	156.3	5
Loading (lb/day):		-1829.232	1903.92	1804.8	0.672	0.384	--	--	--	30.96	43.152	6.528	6.624	--	--	--	--	--	--

Sample Point Description: Final Effluent of Fox Run Phase 2 passive system; sampled at the wetland outlet spillway.

1. Records with no value are not included in statistical calculations.
2. Values lower than the minimum detection limit are assumed to be 0.
3. Median pH values are not shown because median pH is so easily misinterpreted.
4. Average pH is not calculated as a mean of pH values, but rather a mean of hydronium ion concentration.
5. Dissolved metals used for calculated acidity values when available. Acidities calculated from total metals may be exaggerated.
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Fox Run Restoration Project - Phase II Water Quality Report - 87-1

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
1999-12-29	--	--	124.99	--	--	0.02	--	0.9	389.1	--	0.42	--	0.27	--	7.89	7.6	549	81.6	5
2000-01-28	--	--	--	--	--	--	--	--	229.3	--	--	--	--	--	--	--	--	--	--
2000-01-31	--	--	13.4	--	--	0.1	--	0.1	178	--	0.12	--	0.03	--	6.76	6.93	213	56.1	13
2000-02-16	--	--	--	--	--	--	--	--	4097.1	--	--	--	--	--	--	--	--	--	--
2000-02-28	--	1.83	8.75	--	--	0.12	--	3.7	4434.6	--	0.19	--	0.12	--	6.6	7.3	130	45.6	5
2000-03-13	--	--	11.32	--	--	0.11	--	3.9	2218.9	--	0.11	--	0.06	--	7	7.25	159	36	2
2000-03-27	--	--	--	--	--	--	--	--	1523.07	--	--	--	--	--	--	--	--	--	--
2000-04-25	--	--	16.7	--	--	0.12	--	13.4	935.2	--	0.52	--	0.03	--	7.05	7.28	128	26	4
2000-04-28	--	--	--	--	--	--	--	--	472.28	--	--	--	--	--	--	--	--	--	--
2000-05-25	--	3.49	20.82	--	--	0.23	--	14.7	2521.27	--	1.2	--	0.08	--	6.94	6.94	115	26.6	11

Fox Run Restoration Project - Phase II Water Quality Report - 87-1 (cont.)

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2000-05-30	--	--	--	--	--	--	--	--	657.88	--	--	--	--	--	--	--	--	--	--
2000-06-20	--	--	--	--	--	--	--	--	1252.02	--	--	--	--	--	--	--	--	--	--
2000-06-28	--	--	30.34	--	--	0.21	--	18.7	2450.96	--	2.2	--	0.25	--	7.05	6.92	132	25.8	10
2000-07-25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2000-07-31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2000-08-24	--	--	--	--	--	--	--	--	87.5	--	--	--	--	--	--	--	--	--	--
2000-08-28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2000-09-06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2003-01-10	--	-5.8	15.13	--	0.18	0.25	--	--	--	0.21	0.24	0.04	0.04	--	6.54	--	168	58.8	1
2007-10-23	--	8.11	5.81	7	0.14	0.41	--	14.5	--	0.08	0.2	--	0.25	--	5.95	6.6	91	13.3	4

Fox Run Restoration Project - Phase II Water Quality Report - 87-1 (cont.)

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2008-02-05	--	3.68	9.75	19	0.36	0.64	--	1	--	0.26	1.09	--	0.04	--	6.15	--	93	14.5	6
2008-08-21	--	-11.23	41.12	40	0.08	0.48	7.5	17.4	--	2.36	4.69	0.02	0.02	--	6.49	7.85	129	3.8	4
2009-06-29	--	-11.54	39.23	43	0.32	0.4	7.59	17.4	--	4.4	5.01	0.01	0.02	--	7.32	7.5	110	4.6	5
2009-07-13	--	-18.91	40.48	49	0.02	0.02	7.43	16.3	--	3.3	4.95	0.01	0.05	--	7.15	7.73	111	3.7	4
Minimum:		-18.91	5.81	7	0.02	0.02	7.43	0.1	87.5	0.08	0.11	0.01	0.02	--	5.95	6.6	91	3.7	1
Maximum:		8.11	124.99	49	0.36	0.64	7.59	18.7	4434.6	4.4	5.01	0.04	0.27	--	7.89	7.85	549	81.6	13
Average:		-3.7963	29.0646	31.6	0.1833	0.2392	7.5067	10.1667	1531.9	1.7683	1.6108	0.02	0.0969	--	6.5835	7.1109	163.6923	30.4923	5.6923
Range:		27.02	119.18	42	0.34	0.62	0.16	18.6	4347.1	4.32	4.9	0.03	0.25	--	1.94	1.25	458	77.9	12
Median:		-1.985	16.7	40	0.16	0.21	7.5	13.95	1093.6	1.31	0.52	0.015	0.05	--	--	--	129	26	5
Loading (lb/day):		101.4873	441.2783	--	--	3.4434	--	--	--	--	17.4435	--	2.774	--	--	--	--	--	--

Sample Point Description: Fox Run; Located ~130' upstream of Fox Run passive treatment system

1. Records with no value are not included in statistical calculations.
2. Values lower than the minimum detection limit are assumed to be 0.
3. Median pH values are not shown because median pH is so easily misinterpreted.
4. Average pH is not calculated as a mean of pH values, but rather a mean of hydronium ion concentration.
5. Dissolved metals used for calculated acidity values when available. Acidities calculated from total metals may be exaggerated.
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Fox Run Restoration Project - Phase II Water Quality Report - 871-DN

Date	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab
2003-01-10	--	-35.4	54.18	--	0.17	0.18	--	--	--	1.19	1.27	0.16	0.16	--	6.67	--	288	86.7	1
2007-10-23	--	-172.46	210.07	235	0.18	0.22	--	10	--	6.5	7.41	0.67	0.7	--	6.66	6.5	727	161.3	9
2008-02-05	--	0.55	11.64	19	0.36	0.62	--	0.5	--	0.34	1.12	--	0.04	--	6.18	5.75	107	16.2	7
2008-08-21	--	-170.41	217.3	204	0.04	0.33	7.37	16.1	--	2.31	4.74	0.65	0.71	--	6.58	6.9	654	143	6
2009-06-29	--	-177.91	187.79	194	0.11	0.15	6.73	14.2	--	2.48	3.75	0.55	0.56	--	7.24	6.73	649	157.4	9
2009-07-13	--	-189.25	192.28	230	0.02	0.02	7.20	12.9	--	2.54	3.53	0.02	0.62	--	7.13	6.57	677	141.2	5
Minimum:		-189.25	11.64	19	0.02	0.02	6.73	0.5	--	0.34	1.12	0.02	0.04	--	6.18	5.75	107	16.2	1
Maximum:		0.55	217.3	235	0.36	0.62	7.37	16.1	--	6.5	7.41	0.67	0.71	--	7.24	6.9	727	161.3	9
Average:		-124.1467	145.5433	176.4	0.1467	0.2533	7.1	10.74	--	2.56	3.6367	0.41	0.465	--	6.6056	6.2715	517	117.6333	6.1667
Range:		189.8	205.66	216	0.34	0.6	0.64	15.6	--	6.16	6.29	0.65	0.67	--	1.06	1.15	620	145.1	8

Fox Run Restoration Project - Phase II Water Quality Report - 871-DN (cont.)

	Method of Flow (NA) - Metadata	Acidity (mg/L) - Lab	Alkalinity (mg/L) - Lab	Alkalinity (mg/L) - Field	Aluminum (Dissolved) (mg/L) - Lab	Aluminum (Total) (mg/L) - Lab	Dissolved Oxygen (mg/L) - Field	Field Temperature (C) - Field	Flow (gal/min) - Field	Iron (Dissolved) (mg/L) - Lab	Iron (Total) (mg/L) - Lab	Manganese (Dissolved) (mg/L) - Lab	Manganese (Total) (mg/L) - Lab	ORP (mvolts) - Lab	pH (S.U.) - Lab	pH (S.U.) - Field	Specific Conductance (umhos/cm) - Lab	Sulfate (mg/L) - Lab	Total Suspended Solids (mg/L) - Lab	
Date																				
Median:		-171.435	190.035	204	0.14	0.2	7.20	12.9	--	2.395	3.64	0.55	0.59	--	--	--	651.5	142.1	6.5	
Loading (lb/day):		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Sample Point Description: Fox Run; located about 300' downstream of Fox Run Phase 2 passive system; Includes 87-13 which was the former downstream sampling point located ~200' below 87-2 discharge near fence line.

1. Records with no value are not included in statistical calculations.
2. Values lower than the minimum detection limit are assumed to be 0.
3. Median pH values are not shown because median pH is so easily misinterpreted.
4. Average pH is not calculated as a mean of pH values, but rather a mean of hydronium ion concentration.
5. Dissolved metals used for calculated acidity values when available. Acidities calculated from total metals may be exaggerated.
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Growing Greener Goals and Accomplishments Worksheets

Project Name Fox Run Restoration Area – Phase II

Project Number KD060132CEI County Mercer

State Watershed Plan Name and Code Shenango River – 20A
(e.g., Clark-Paxton Creeks – 7C)

Date Prepared 06 / 30 / 2009 (month/day/year)

This Report is (*choose one*):

- Project Goals
- Project Accomplishments (*to be submitted with final report*)

Project Type (*check all that apply*)

- Organization of a Watershed Group (*fill out Sheet A**)

Watershed Assessments and Development of Restoration and/or Protection Plan
(*check all that apply and fill out sheet B**)

- AML/AMD
- Non-Point Source
- Assessment
- Development of Restoration Plan
- Development of Protection Plan

Implementation of Watershed Restoration and/or Protection Project
(*check all that apply and fill out Sheets C, D, E, F, and G**)

- AML/AMD
- Oil and Gas
- Non-Point Source
- Restoration
- Protection

- Demonstration (*fill out Sheet H**)

- Education/Outreach (*fill out Sheet I**)

*Please fill out all the appropriate information on the sheets corresponding to your project type. Leave blank any sheets or information on the sheets that do not apply to your specific project. If you have any questions call the Grants Center at 717-705-5400.

Receiving Stream Fox Run _____ name/location

Receiving Stream Benefits

<u>Upstream Quality</u>		<u>Downstream Quality</u>	
Before	After	Before	After
Iron _____ 0.6	_____ 4.9 mg/L	Iron _____ 3.2	_____ 4.0 mg/L
pH _____ 7.1	_____ 7.7 S.U.	pH _____ 7.1	_____ 7.0 S.U.
Acid _____ 2	_____ -14 mg/L as CaCO ₃	Acid _____ (neg)	_____ -179 mg/L as CaCO ₃
Alk _____ 26	_____ 44 mg/L as CaCO ₃	Alk _____ 132	_____ 209 mg/L as CaCO ₃
Al _____ 0.2	_____ 0.3 mg/L	Al _____ 0.1	_____ 0.2 mg/L
Mn _____ 0.1	_____ 0.0 mg/L	Mn _____ 0.5	_____ 0.6 Mg/L

Sheet C

AMD Treatment	AML	Oil and Gas
<input type="checkbox"/> Anoxic Limestone Drain _____ tons Limestone(LS) <input type="checkbox"/> Successive Alkalinity Producing System (SAP) _____ tons (LS) _____ tons organic matter <input checked="" type="checkbox"/> Wetlands _____ 1/2 aerobic acres _____ anaerobic acres <input type="checkbox"/> Diversion Wells _____ # _____ total LS capacity <input type="checkbox"/> Settling Ponds _____ # _____ capacity (gpm) <input type="checkbox"/> Limestone Channel _____ ft. OLC _____ ft. MOLC <input type="checkbox"/> Limestone Dosing/Dumping _____ tons LS <input type="checkbox"/> Reverse Alkalinity Producing Systems _____ # <input type="checkbox"/> Bactericide Remediation _____ lbs/acre <input type="checkbox"/> Beneficial Use of Dredged Material _____ tons <input type="checkbox"/> Manganese Oxidizing Bacteria Systems _____ # <p>Total Treated Flow Rate _____ 730 gpm average _____ 1300 gpm high Predicted lifespan of system _____ 25+ years Sludge Capacity _____ 25 years Contaminants removed/Contained by system (average) Iron _____ 15 ppd Al _____ ppd Mn _____ ppd Acid _____ ppd Excess Alkalinity added _____ ppd pH change _____ 6.6 influent _____ 6.9 effluent</p>	<input type="checkbox"/> Openings Closed _____ # <input type="checkbox"/> High Walls Removed _____ Feet <input type="checkbox"/> Land Remined _____ Acres <input type="checkbox"/> Wildlife Habitat Improved _____ Acres <input type="checkbox"/> Trees Planted _____ # <input type="checkbox"/> Sealing Mine Portals _____ # _____ wet or dry seal <input type="checkbox"/> Revegetation _____ acres <input type="checkbox"/> Grout Injection _____ tons <input type="checkbox"/> Mine Capping _____ acres	Wells Plugged _____ # Total Flow Before _____ gpm Total Flow After _____ gpm <p>Contaminants Removed/Prevented Iron _____ (ppd) pounds per day Acidity _____ (ppd) Alkalinity _____ (ppd) Wildlife Habitat Created _____ acres</p>
<p>Describe Activities to Date: A passive treatment facility consisting of an intake manifold collection system, a passive aerator (added after final design), a 5,000-square foot Settling Pond, and a 17,000-square foot aerobic wetland has been installed and the riparian area has been restored. The site was seeded ca. 8/2008 with a mixture of Warm Season Grasses and native wildflowers. Riparian and upland areas and aerobic wetlands were planted by volunteers as part of the education and outreach effort. Uplands were planted 11/4/08 with hemlock, alder, willow, aspen, elderberry, silky dogwood, and red-osier dogwood. Limited planting of the aerobic wetlands was conducted on 7/22/09.</p> <p>In addition to the decrease in total iron, dissolved oxygen as been increased in the discharge from ~0.1 mg/L in the raw water to ~5 mg/L in the treated effluent. This is important in the improvement of Fox Run due to the low DO as noted in the 2008 List of Impaired Waters.</p>		

Streams

Name of Project: Fox Run Restoration Area – Phase II **303D Listed** Yes No

Chapter 93 Designation			
<input type="checkbox"/> WWF	<input type="checkbox"/> CWF	<input checked="" type="checkbox"/> TSF	
<input type="checkbox"/> HQ	<input type="checkbox"/> EV		

Riparian buffers installed 1 length (ft) 250
 avg width (ft) 20 grasses type (trees, shrubs, grasses)
(Report both sides of stream if appropriate)

Latitude 41.30162519 Longitude 80.12192508

Prior land use where established _____ type

Filter Strips installed _____ length (ft) _____ avg width (ft)

Land use where established _____ type

Stream bank protection with fencing _____ length (ft) _____ avg. width (FT)

Stream bank protection without fencing _____ length (ft) _____ avg. width (FT)

Barerooted plantings _____ type/species (trees, shrubs, grasses)

Container grown plants _____ type/species (trees, shrubs, grasses)

Protected root stock _____ type/species (trees, shrubs, grasses)

Weed control _____ type/species (trees, shrubs, grasses)

Invasive species removed _____ type/species (trees, shrubs, grasses)

Dams removed _____ number _____ length (ft) _____ height (ft)

Fluvial Geomorphology (FGM) _____ (ft)

Stream channel restoration _____ length (ft)

Fish structures _____ number _____ type

Rootwads _____ length

J-hook vanes _____ number

Trash removed _____ tons _____ number of sites

Protection Measures Implemented (describe below)

Please describe activities to date: (include sources of technical assistance)

The site was seeded ca. 8/2008 with a mixture of Warm Season Grasses and native wildflowers. Riparian and upland areas and aerobic wetlands were planted by volunteers as part of the education and outreach effort. Uplands were planted 11/4/08 with hemlock, alder, willow, aspen, elderberry, silky dogwood, and red-osier dogwood. Limited planting of the aerobic wetlands was conducted on 7/22/09.

The AMD was also relocated by conveyance into the passive system, essentially eliminating the AMD impacts to 500 feet of Fox Run.

Sheet F

Pre-Construction



Discharge 87-2 (Above) from an abandoned underground coal mine flowed directly into Fox Run (Below) prior to installation of the Phase II system.



Pre-Construction



The 87-2 abandoned mine discharge significantly impacted Fox Run. During low flow periods, the discharge is the primary contributor of flow to the headwaters portion of the stream.



Pre-Construction



Working with the Mercer County Conservation District prior to construction, a wetland delineation, construction control point establishment, and 6/4/08 meeting with First Energy personnel were conducted to ensure a successful project.



Construction



Following completion of the design and permitting, the passive treatment system was constructed by project partner Quality Aggregates, Inc. Field meetings and inspections were conducted by project partners including BioMost, Inc., Mercer County Conservation District, and Quality Aggregates, Inc.



Construction



Assembling the Intake Manifold to capture and convey the 87-2 discharge under Fox Run to the passive system (Summer 2008).



Construction



The only evidence of the buried Intake Manifold is the observation riser (Above). The discharge is conveyed to the passive treatment system (Below) consisting of a settling pond and aerobic wetland. (Summer 2008)



Post- Construction



Water monitoring of the passive treatment system and Fox Run was conducted after completion of the passive treatment system. (Summer 2008)



Post- Construction



Above: Following construction, the entire site including the utility right-of-way used for access was seeded and mulched (Summer 2008). Below: View of the vegetated uplands (November 2008).



Post- Construction



An upland tree planting event was conducted on November 4, 2008 by Mercer County Conservation District, Stream Restoration Inc., and students from Slippery Rock University. Prior to the event, Shaun Busler explained the planting procedure. Below, Shaun is examining a Red Osier Dogwood before planting.



Post- Construction



Above: Site inspections are conducted on a regular basis to insure that the passive system is stable and functioning properly.
Below: Numerous Pickerel Frogs were observed 11/04/08.



Post- Construction



In order to enhance iron removal by the passive system, an aeration device consisting of a platform and saw-toothed weirs was installed. The aeration device encourages the degassing of CO₂, a raise pH and an increase iron oxidation rates as well as introducing dissolved oxygen into the water. (Summer 2009)



Post- Construction



Above: Wildflowers were included within the seed mix. (Summer 2009)
Below: View of Settling Pond following installation of the aerator. (Summer 2009)



Fox Run Watershed
Jackson & Lake Townships
Mercer County, Pennsylvania

Fox Run Restoration Area Phase II

Operation & Maintenance Plan



STREAM RESTORATION INCORPORATED

prepared by
BioMost, Inc.

Updated June 2009

OPERATION AND MAINTENANCE PLAN

This is the Operation and Maintenance Plan for the Fox Run Phase 2 passive treatment system located on the property of Richard and Barbara Kish in Jackson & Lake Townships, Mercer County, PA. This project is located along Fox Run. The hydrologic order is Fox Run → Yellow Creek → Neshannock Creek → Shenango River → Beaver River → Ohio River.

The passive treatment system consists of an Intake Manifold and conveyance pipe to collect the abandoned mine discharge and convey the water to the passive treatment system on western side of Fox Run, a 5,000 square-foot settling pond, and 17,000 square-foot aerobic wetland.

The Mercer County Conservation District (MCCD) will be responsible for the maintenance of all structures in order for the passive treatment system to continue to function properly. This AMD treatment system was designed, based on the best available knowledge and technology at the time, and implemented through a public-private partnership effort. Design of all structures focused on minimal operation and maintenance compared to conventional chemical treatment systems. In order, however, for these facilities to effectively treat the mine drainage, periodic inspections and maintenance are required. This Operation and Maintenance Plan is site specific and written to be user friendly and easily implemented in order to ensure the long-term sustainable treatment of the 87-2 abandoned mine drainage at Fox Run.

ACKNOWLEDGMENTS

This Operation and Maintenance Plan was completed through a public-private partnership effort coordinated by the Mercer County Conservation District and Stream Restoration Incorporated. Portions of this document were based upon an example provided by P.J. Shah of the Pennsylvania Department of Environmental Protection Bureau of Abandoned Mine Reclamation.

Public-Private Partnership Effort

BioMost, Inc.
Kish Family
Mercer County Conservation District
PA DEP – Knox District Mining Office
Quality Aggregates Inc.
Stream Restoration Incorporated

Primary Author: Clifford F. Denholm, IV, Environmental Scientist
Schematics: Shaun L. Busler, GISP
Contributors: Timothy P. Danehy, QEP; Margaret H. Dunn, PG

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OVERVIEW OF AMD AND PASSIVE TREATMENT

Historical Mining Impacts

Coal has been mined in western Pennsylvania, as well as much of the Appalachian Coal Basin, for more than 200 years. During this time, this natural resource has played a pivotal role in the Industrial Revolution, resulting in the United States becoming a major world power. Despite the increasing development of alternative energy, coal continues to be vital to our way of life by generating over half of Pennsylvania's and our Country's electricity. Electricity production alone accounts for over 90% of all the coal consumed in the US today. In addition, coal is used in iron- and steel-making processes and in the manufacture of chemicals, cement, glass, and paper, and in food processing.

While this utilization of coal has fueled our homes, industries, and economy, the methods formerly used in coal extraction created a legacy of severe environmental impacts and public safety issues. Small towns and villages of western Pennsylvania and Appalachia, which were once bustling coal communities supporting the steel industry and electricity production for such cities as Pittsburgh (PA), Johnstown (PA), Wheeling (WV), New Castle (PA), and Youngstown (OH), are now often non-existent ghost towns left with only scarred landscapes characterized by dangerous highwalls, barren coal refuse piles, and, of course, degraded mine drainage.

The degraded drainage from abandoned coal mines is the largest nonpoint source (diffuse sources; not a permitted discharge point) of stream impairment in Pennsylvania. According to the 2006 Pennsylvania Integrated Water Quality Monitoring and Assessment Report over 4,600 miles of streams are degraded. In addition, 45 of Pennsylvania's 67 counties are impacted by over 250,000 acres of unreclaimed mine lands, including 2.6 billion cubic yards of coal refuse piles. Pennsylvania also has approximately 7,800 abandoned or inactive underground mines, which are typically the largest contributors of mine drainage. In many cases, entire watersheds have been completely decimated.

The majority of stream degradation, however, appears to be related to historical mining. With knowledge of the cause, documentation of long-term stream impacts, development of environmentally-focused mining methods, and requirement of comprehensive permitting and oversight by enactment of the PA Surface Mining Conservation & Reclamation Act, Clean Streams Law, etc. and 1977 federal Surface Mining Control & Reclamation Act, only about 1% of modern operations have post-mining discharges requiring treatment. (PA DEP, 1999, Evaluation of Mining Permits Resulting in Acid Mine Drainage 1987-1996: A Post Mortem Study)

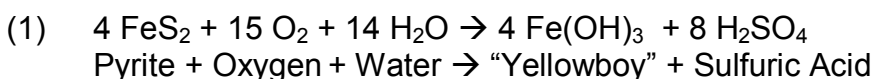
AMD Formation and Selected Monitoring Parameters

The following brief overview may be helpful to those unfamiliar with terms and concepts that are important in learning about mine drainage and passive treatment systems. This, however, should not be considered a comprehensive, authoritative, or complete undertaking. There are several parameters that are used to describe and characterize mine drainage.

What is AMD? **AMD** is an acronym typically used for **Abandoned Mine Drainage** or **Acid Mine Drainage**, although AMD can be acidic or alkaline in nature and can emanate from abandoned or active mines. There are different names and acronyms for AMD that are used throughout the world such as Coal Mine Drainage (CMD), Mine Drainage (MD), Mining Influenced Water (MIW)

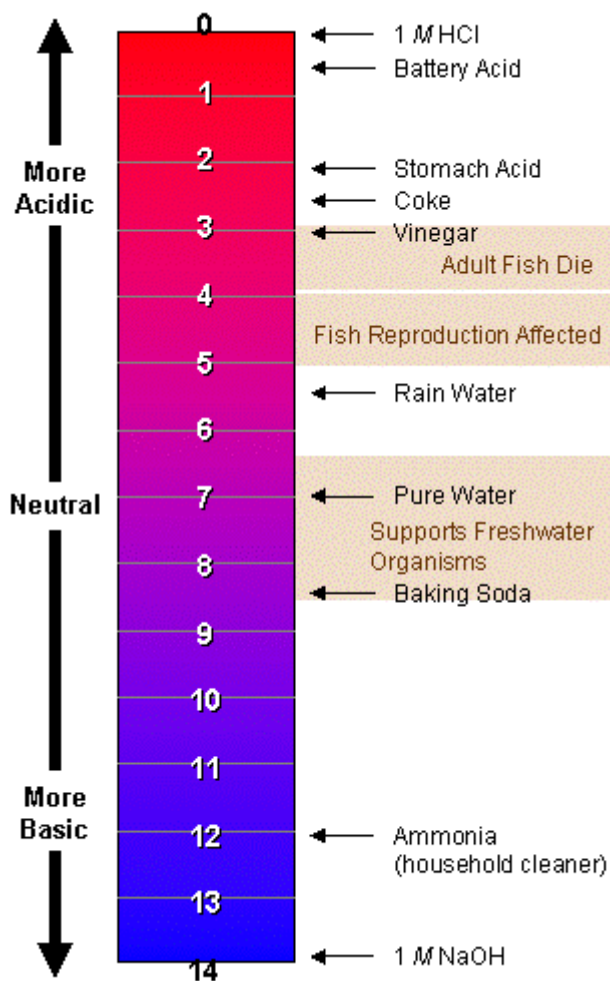
and Acid Rock Drainage (ARD). In Pennsylvania, degraded coal mine drainage is usually referred to as AMD.

The formation of mine drainage is essentially a weathering process that is a function of the geology, chemistry, biology, hydrology, and mining methods used at the site. Although the specific process may vary, AMD forms through a series of complex geochemical and, at times, microbial reactions that occur when water and oxygen contact sulfide minerals such as pyrite (FeS₂) which is typically present within coal and/or surrounding rock. The iron sulfide minerals “breakdown” (not unlike a nail rusting) in the presence of water and oxygen releasing iron and forming sulfuric acid. (Without the presence of water, oxygen, and sulfide minerals, AMD will most likely not form.) When the iron is further oxidized and hydrolyzed, iron compounds form and settle in ponds, wetlands, and streams. Due to the yellow, orange, and/or red color, these iron solids are often referred to as “Yellowboy”. Although there are a number of steps in the process, these reactions can be represented by the following general chemical equation:



The iron and sulfuric acid then reacts with other surrounding material to dissolve and release iron, aluminum, manganese, and other metals that might be present, such as zinc, nickel, cadmium, calcium, magnesium, etc. As the water becomes oxygenated and/or gains alkalinity some of the metals form solids (**precipitates**) that can also accumulate in ponds, wetlands, and streams. When streambeds become coated, the habitat of aquatic insects may be destroyed. As benthic macroinvertebrates are critical to the food chain, loss of this habitat may prevent fish from living and/or reproducing in the stream. In addition, AMD often causes the stream to be acidic with a low pH, which many organisms cannot tolerate.

pH is a measured value that indicates whether a solution is acidic, neutral, or basic (alkaline). pH is a way to express the hydronium (H₃O⁺)-ion [a.k.a., hydrogen(H⁺)-ion] concentration. The pH scale ranges from 0-14 with 0 being the most acidic, 7 being neutral, and 14 being the most basic. Note on the scale that vinegar has a pH of around 3 while household ammonia has a pH of around 12 and blood around 7.4. As pH is a negative log of the hydrogen-ion concentration, a change in one unit represents a 10-fold increase or decrease in hydrogen ions. For example, a solution with a pH of 4.0 has 10 times more hydrogen ions than a solution with a pH of 5. pH can be measured by using litmus paper, a color indicator solution (used in field kits), or with a calibrated, electronic pH meter.



The pH Scale

Source: <http://www.jacksonbottom.org>

Alkalinity is typically defined as the acid neutralizing or buffering capacity of a given volume of water. This refers to the ability of water (such as a stream) to neutralize acid (such as acidic mine drainage). Depending on how much alkalinity is present in the water, when an acid is added the pH will either decrease or remain the same. The pH of water with no or little alkalinity can change dramatically with the addition of a small quantity of acid while the pH of water containing significant alkalinity can maintain the same pH when a larger quantity of acid is added. The reason the pH does not change is because of the alkalinity present. In other words, the alkalinity neutralizes (buffers) the acid, similar to taking an antacid to neutralize stomach acid. As additional acid is added the pH will begin to be lowered. If enough acid is added, eventually all alkalinity will be consumed.

To measure alkalinity in most mine water, a relatively weak solution of sulfuric acid (H_2SO_4) is added “drop-by-drop” to a specified volume of water in order to lower the pH to 4.5. At pH 4.5, all bicarbonate alkalinity (HCO_3^-) has been consumed. (Bicarbonate alkalinity may be generated by natural processes including the weathering of limestone or other carbonate rock and/or bacterial reactions with sulfate and organic material.) The endpoint of pH 4.5 may be determined by a meter/kit or by a color change from green to pink after dissolving bromcresol green (an indicator powder) in the water. Alkalinity is usually expressed in milligrams of calcium carbonate per liter (mg $CaCO_3/L$). Calcium carbonate is the primary constituent of limestone and Tums© stomach antacid.



Laboratory Titration

Source: www.dartmouth.edu

Acidity is typically defined as the ability of a solution to neutralize alkalinity (base) of a given volume of water. Like alkalinity, acidity is usually expressed as mg $CaCO_3/L$. There are three types of acidity of interest. Proton acidity is associated with free H^+ ions and is measured by pH. Organic acidity is associated with dissolved organic compounds such as tannic acid. Mineral acidity is generated as dissolved metals form solids. The transformation of metals from a dissolved phase to a solid phase [When table salt (solid phase) is dissolved in tap water, sodium and chloride ions are in the dissolved phase.] will be discussed in more detail in the “Generalized AMD Treatment Chemistry” section. The mineral acidity is only generated during the transformation process meaning that as long as the metals are dissolved, the acidity has not actually been generated. Mineral acidity, therefore, is sometimes viewed as “potential” acidity.

While acidity can be measured in the field by titrating with sodium hydroxide (NaOH), this measurement does not take into consideration all of the potential mineral acidity. To measure most, if not all, of the mineral acidity associated particularly with dissolved iron, manganese, and aluminum, a laboratory method called “Hot Acidity” is conducted.

While the pH measurement only takes into account free H^+ ions without indicating the neutralizing capacity of acidity or alkalinity, the hot acidity measurement conducted by laboratories accounts for several types of acidity as well as any existing alkalinity to provide a value that may indicate, in general, whether the water sample is net-acidic (positive acidity value) or net-alkaline (negative acidity value). If the hot acidity measurement indicates the sample is net-acidic, the value provides an idea of how much additional alkalinity would be

required to neutralize all of the potential acidity that could be generated by the oxidation and hydrolysis of most of the metals of concern.

For instance, while a mine drainage sample could have a pH of 7, which would indicate that the water was neutral with no acidity, conducting a hot acidity test may reveal that metals dissolved in the water most likely to precipitate (given enough time and proper conditions) will produce acidity and actually result in the water being identified as a net-acidic.

Dissolved Oxygen (DO) is the measurement of the amount of oxygen dissolved in the water. It is determined either chemically (Winkler or iodometric methods) or with an electronic meter and is expressed in mg/L. DO is very important for several reasons. DO is important to aquatic organisms within a body of water. If no oxygen is present, fish and other aquatic life will die. Different species require different levels. Trout, for example, need relatively high concentrations. DO is also important in the treatment of AMD, which will be discussed later. Several factors can affect DO concentrations including the physical environment (lake or stream, shaded or open, temperature, aeration) as well as chemical and biological processes that consume (chemical reactions, decomposition of organic material, respiration) or add (photosynthesis) dissolved oxygen within the body of water. Temperature is very important due to the major role in the solubility of oxygen within water. For example, more oxygen can be dissolved in cold water than warm water. Field experience suggests, however, that water capped by ice (such as, a frozen pond) may have much less oxygen.

Sulfate (SO_4^{-2}) is measured through a variety of laboratory techniques and instrumentation. Although commonly present in acid rain, concentrations of the dissolved sulfate ion of >50 mg/L usually indicate coal mine drainage in western Pennsylvania. As discussed earlier, the sulfate ion is present in mine water typically because of the weathering (dissolving) of sulfide minerals. The sulfates may, in turn, be used to generate alkalinity as a by-product of the decomposition of organic material (such, as compost) by anaerobic (without oxygen) bacteria (known as sulfate-reducing bacteria). High sulfate and calcium concentrations may also result in the precipitation of the mineral gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) which may cause plugging problems within certain treatment components.

Specific Conductivity is used to measure the ability of water to carry an electrical current. This ability is dependent on several factors including the presence of ions and the temperature during measurement. Specific conductivity readings are automatically normalized to 25 °C to essentially eliminate the variability related to temperature. Specific conductivity is typically measured by an electronic meter and is expressed in micromhos per centimeter ($\mu\text{mho/cm}$). Low values indicate fewer dissolved ions while larger values indicate a higher number of dissolved ions. Although a large value does not necessarily mean pollution or a specific type of pollution, larger values do indicate that any pollutants present may be dissolved as opposed to solids floating in the water or sediment in the sample from disturbing the streambed.

Temperature, typically measured in either degrees Fahrenheit (°F) or Celsius (°C), is an important parameter affecting various physical as well as chemical processes. As previously discussed, temperature affects the solubility of dissolved oxygen and also the activity of certain organisms such as reptiles. Temperatures can even be used to indicate the source of pollution. For instance, a groundwater source can be distinguished from a surface water source as the groundwater is typically warmer in winter and cooler in summer compared to surface water.

Oxidation/Reduction Potential (ORP) is measured in millivolts (mV) using an ORP meter. The higher the value above zero, the more oxidizing the water, while the closer the value is to zero the more reducing. A value below zero is reducing. In AMD, high ORP values in water having a pH <3.5 may reflect the presence of high concentrations of dissolved ferric iron (Fe⁺³). In passive treatment, certain components are designed to create reducing conditions in order to promote bacterial sulfate reduction.

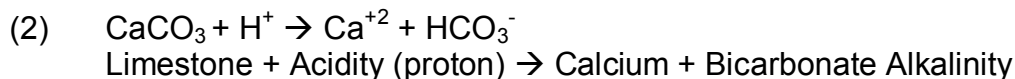
Total Suspended Solids (TSS) is the measurement of the amount of solids within a given volume of water, retained when passed through a certain pore-size filter. Typically, a 0.45-µm pore-size filter is used. **Total Dissolved Solids (TDS)** are the portion that passes through the filter. **Total Solids**, which includes both TSS and TDS, are usually measured by evaporating a water sample and then drying and weighing the remaining residue.

Metals, most commonly monitored in mine drainage are **iron (Fe)**, **manganese (Mn)**, and **aluminum (Al)**. Measurements are often performed by an analytical laboratory using Atomic Absorption (AA), Spectrophotometry, or Inductively Coupled Plasma (ICP). While not necessarily as accurate as the laboratory methods, iron, manganese, and aluminum concentrations can also be measured using certain field kits. Iron solids give mine drainage that typical red or orange color while aluminum solids are white in color. Aluminum solids can also give water a bright aquamarine blue color. Manganese solids have a dark brown or black color. Iron often coats the streambed suffocating the benthic macroinvertebrates resulting in the destruction of the food chain. Aluminum can clog the gills of fish and macroinvertebrates. Of the three, aluminum generates more mineral acidity per unit concentration. Manganese at typical concentrations has not been demonstrated to have significant ecological impact. Manganese can cause discoloration or impart a bad taste to drinking water.

AMD Treatment Chemistry

To make site inspections and water monitoring more meaningful, a brief review of some applicable chemical processes is helpful. Though the 87-2 discharge is net-alkaline, some of the following information provided will help the O&M practitioner develop an understanding of mine drainage treatment in general. Passive treatment of net-acid mine drainage essentially revolves around imparting alkalinity to mine drainage and then allowing (and possibly enhancing) natural chemical, biological, and physical processes to occur.

Limestone is commonly used when passively treating acid mine drainage. Limestone, which occurs in many areas of western Pennsylvania, is rock that has at least 50% calcium carbonate (CaCO₃). In reaction (2), the calcium carbonate (usually in the mineral form as calcite) reacts with the hydrogen ion (H⁺) and produces bicarbonate alkalinity (HCO₃⁻) and calcium (Ca⁺²).

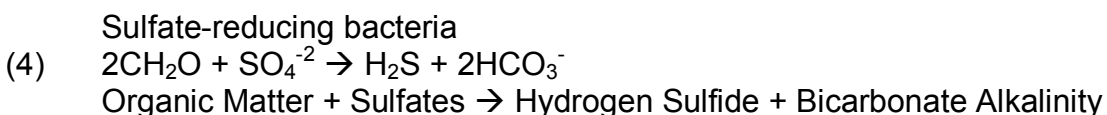


Not only is acidity consumed, but alkalinity is generated. The bicarbonate ion then goes on to neutralize additional hydrogen ions (H⁺) in reaction (3), which results in the production of water and carbon dioxide (CO₂). This is basically the same reaction that occurs in your stomach when you take an antacid such as the Tums©, which has calcium carbonate as the main ingredient. In an enclosed environment, the CO₂ cannot escape (similar to a carbonated beverage in a can

or bottle) and forms carbonic acid which makes the water more reactive resulting in more limestone being dissolved; thereby, allowing for more alkalinity to be generated.



Another potential source of alkalinity commonly used in passive treatment systems is bacterial sulfate reduction illustrated in reaction (4). As discussed previously, mine drainage contains sulfate ions. When the mine drainage comes into contact with organic matter in an **anaerobic** (no or very little oxygen present) environment certain bacteria can decompose or oxidize the organic matter using sulfates as an electron sink to form hydrogen sulfide gas (H₂S) and bicarbonate (HCO₃⁻) alkalinity. (Iron and other metal sulfides may also be formed.) Hydrogen sulfide gas is a gas that has a rotten-egg smell which is often noticeable in wetlands and vertical flow ponds with compost or other organic matter that are under anaerobic conditions. In this reaction 2 moles of bicarbonate are created for every mole of sulfate consumed.



As the alkalinity generated by the passive treatment components begins to neutralize the acidity, the pH begins to increase and other chemical reactions begin to take place. Besides pH and acidity the major contaminants that are of concern are metals. During the formation of mine drainage, metals exist in a dissolved state. To remove the metals, solids are formed. The design of a passive treatment system is based upon considering the various biogeochemical and physical processes that remove these metals. As previously mentioned, the three major metals of concern in coal mine drainage are iron, manganese, and aluminum.

Iron: The removal of iron can occur under multiple conditions and pathways. Dissolved iron may also exist in multiple valence states. (Valence deals with behavior of electrons; i.e., ferrous iron (Fe⁺²) is the reduced form of iron while ferric iron (Fe⁺³) is the oxidized form of iron with one less electron.) The most common state of dissolved iron in mine drainage is ferrous iron (Fe⁺²). Typically, except in the case of sulfides where sulfate-reducing bacteria are active, ferrous iron needs to be oxidized to ferric iron to be removed from the water. The oxidation of dissolved ferrous to dissolved ferric iron can occur with or without bacterial activity. Bacterial activity is important in mine water with low pH (≤3.5) while dissolved oxygen (1 mg/L DO needed to oxidize 7 mg/L ferrous iron) is important in mine water at higher pH. Once oxidized, ferric iron may be hydrolyzed (generally meaning reacts with water) to form the yellow to red-brown iron solids. At low pH, iron minerals may form that typically feel silty or are “crusty”. As these minerals do not need oxygen to form, plugging is a consideration when designing a passive system. Iron solids forming at a higher pH are amorphous and are typically “goeey” or slippery feeling. These solids are commonly collected in settling ponds and wetlands.

Reaction rates appear to be strongly influenced by pH. The higher the pH, the faster the reactions take place. If alkalinity is present in the water, often the pH of the water can be raised by agitating the water to degas dissolved CO₂ which suppresses pH. Agitating the water can be accomplished with step aerators, splashing, steep rock-lined spillways, etc. Also consider that when treating discharges with high concentrations of ferrous iron, dissolved oxygen is consumed; therefore, additional aeration steps are often required. Acidity is created as a result of the precipitation of iron.

Manganese: The removal of manganese is also challenging. Historically, removal of manganese has been difficult and for a period of time was thought to only be accomplished through chemical treatment by raising the pH above ~9. With the development of passive technology, dissolved manganese has been observed to form solids at a much lower pH (~6). The exact mechanism is not completely understood at this time, but biogeochemical factors such as low dissolved iron concentrations, high dissolved oxygen concentrations, available surface area, sufficient alkalinity, presence of certain microorganisms, and autocatalytic processes appear to play a significant role.

Aluminum: As the solubility of aluminum is strongly dependant on the pH, once the pH is raised to about 4.5, aluminum begins to form solids and precipitate out of solution. [Dissolve aluminum (Al^{+3}) is in the oxidized form; therefore, oxygen is not necessary to form solids.] By a pH of about 5, there is generally < 1 mg/L of dissolved aluminum present. The solids can then be collected in a settling pond or wetland. Recognizing this process becomes very important in choosing which passive component to use. Remember from the acidity discussion that the precipitation of dissolved metals, including aluminum, results in the release of hydrogen ions and thus the creation of acidity which can decrease pH. Sufficient additional alkalinity will need to be generated either prior to or after this reaction in order to neutralize the mineral acidity.

Overview of Passive Treatment System Components

Passive systems use no electricity, require limited maintenance, and use environmentally-friendly materials, such as limestone aggregate and spent mushroom compost in a series of constructed ponds, beds, ditches and wetlands to provide a cost-effective alternative to the conventional treatment of mine drainage which is labor and energy intensive and typically uses harsh chemicals. Passive systems add alkalinity to neutralize acidity while providing an environment suitable for beneficial chemical reactions and biological activity. For instance, dissolving limestone neutralizes the acidity and raises the pH after which dissolved metals, through chemical, biological, and physical processes, form particulates (solids) that are then retained in settling ponds and constructed wetlands. In some cases, however, there is sufficient alkalinity naturally in the mine discharge in which case only settling ponds and constructed wetlands are needed.

When designing a passive system, the goal is to include components that provide long-term effective treatment, are economical to install, and require minimal maintenance. There are several main types of passive treatment components that can be used, often in series and/or in parallel, to treat degraded mine drainage. These components are chosen based upon the mine drainage characteristics (quality and flow rate), preferred chemical or biological process, and available construction space. The following is a brief description of the passive treatment components at the Fox Run – Phase II site.

Design Parameters

Design parameters considered for the Fox Run – Phase II passive treatment system were based on available monitoring data for the 87-2 discharge.

Flow:	300 – 1300 gpm
pH:	6.3 – 6.6 s.u.
Alk:	211 – 267 mg/L (CaCO ₃)
Fe:	5 – 10 mg/L
Mn:	<1 mg/L
Al:	<1 mg/L

Notes: n = 20 samples (12/1999 – 10/2007); flow rate measured at weir; field pH; lab alkalinity; total metals (Monitoring conducted by Mercer County Conservation District and BioMost, Inc.)

The **Intake Manifold** was installed to collect the abandoned mine discharge (87-2) and convey the mine water underneath Fox Run to the passive system. The intake manifold (see As-built schematic) consists of several 8-inch and 12-inch perforated pipes interconnected with Tee-Wyes to collect the 87-2 abandoned mine discharge and feed into an 18-inch solid pipe which outlets into the settling pond.



The conveyance pipe discharges to a 5,000 square-foot **Settling Pond** (871-SP) which discharges to a 17,000 square-foot constructed aerobic **Wetland** (871 WL) via a riprap (i.e. rock lined) spillway. The Settling Pond and Wetland are used to allow for the oxidation, precipitation, and accumulation of metal iron solids that occur when alkaline drainage issues from a minesite or after acidic drainage has passed through an alkalinity-generating treatment component. Often Settling Ponds contain some type of baffle to maximize retention and prevent short-circuiting within the pond. An **Aerator** was installed at the inlet pipe of the settling pond to

degas CO₂ and increase dissolved oxygen in order to increase iron oxidation rates. Wetlands

can often provide a final polishing to the drainage before discharging to a stream. Although many treatment wetlands are angular-shaped, shallow ponds supporting predominantly cattails, they can be designed, built, and planted to look and function as a natural wetland with high species diversity that provides not only treatment but also exceptional wildlife habitat. Eventually the metal solids that accumulate will need to be removed and either recovered or disposed of properly.



GENERAL INSTRUCTIONS FOR MONITORING AND MAINTENANCE

Everyone involved in monitoring and maintenance should have a general understanding of, and the ability to perform, routine duties, such as site inspections that include evaluating channels, spillways, and passive treatment components. Training should be provided to those not experienced in conducting inspections, water monitoring, and simple maintenance tasks.

Field Equipment & Supplies

In order to successfully conduct a site inspection and complete tasks, a variety of field equipment, supplies, and tools will be necessary. At a minimum, the following field equipment should be taken on every site inspection:

Clipboard	Site Schematic	Calibrated Flow Bucket(s)	pH kit or pH meter
Inspection Sheets	Pencil	Stopwatch	Shovel

In addition, the following field equipment and supplies are highly recommended if available:

Dissolved Oxygen kit or meter	Alkalinity kit (i.e., Hach Digital Titrator or "drops")	Filter Syringe & 0.45µm filters	Folding Engineer's Rule
Iron kit	100 ml graduated cylinder	Sample bottles	Backpack
Manganese kit	Reagents and titrants	Wash bottle	
Thermometer	Volumetric flask	Safety goggles	
ORP meter	Sunblock/Insect Repellent	Digital Camera	

A pipe cleanout tool (described below) and various hand tools such as pipe saw, hammer, screwdrivers, nut drivers, wrenches, pry bar, channel locks, etc. may also be useful to perform, as needed, minor maintenance activities.

Pipe Clean-Out Tool

Most passive treatment systems have piping. For optimum treatment, these pipes should be relatively clear and free-flowing. Often these pipes accumulate metal precipitates, sediments, algae, and other debris. In some cases these pipes can be flushed, backflushed, or in extreme cases cleaned with a power snake. Other times, a simple clean-out tool can be used. A clean-out tool can be made using 1" (or similar size) PVC pipe. The clean-out tool is then pushed into the pipe to break up and/or dislodge the debris causing the blockage. When a longer clean-out tool is needed, multiple pieces of pipe can be connected using compression-type unions. It is recommended to have at least 50 feet of pipe available. PVC pipe and unions can be purchased at a local hardware store.



available. PVC pipe and unions can be purchased at a local hardware store.

Calibrated Bucket for Flow Measurements

Flow measurements are very important in both designing and monitoring passive treatment systems. Passive treatment systems are generally designed based on flow rates and concentrations of pollutants. As mentioned above, passive treatment systems often have pipes. Flows from pipes can be easily measured with the “bucket-and-stopwatch” method. A bucket of known volume, preferably with gradations, is used. A 1-gallon bucket with gradations can often be found in hardware stores in the painting supply section. Although very useful, a 1-gallon bucket will not be sufficient to accurately measure larger flows. It is recommended that several calibrated flow buckets be available to the inspector, such as 1-, 5-, and 15- or 20-gallon bucket. In some cases, however, even the large buckets will not be able to measure the flow accurately. Any bucket can be calibrated by following the directions below.

Calibrating a Bucket for Flow Measurements

1. You will need :
 - a. the bucket to be calibrated
 - b. a container of known volume (preferably 1-gallon; like an empty milk jug), and
 - c. a permanent marker.
2. Using the container of known volume, carefully (to eliminate splash) fill the bucket to be calibrated with 1 gallon of water.
3. Let the water settle and then mark the water level with a line on the inside and outside (if possible) of the bucket and write “1” for 1 gallon next to it.
4. Repeat steps 2 & 3 for each additional gallon that the bucket can hold. For a 5-gallon bucket, gradations should be labeled for each gallon. For larger buckets like a 20-gallon bucket it may be too difficult to mark 1-gallon gradations. A different gradation scheme may be desired such as marks at 5, 10, and 15 gallons. Other variations are possible and acceptable as long as relatively accurate measurements can be made.

Passive Treatment System O&M Inspection Report

In order to maintain the integrity of a passive treatment facility, the site should be inspected at regular intervals and after major precipitation events or other natural/manmade occurrences that may affect the performance or integrity of the structure. Regular site inspections should be conducted at least twice a year if not more frequently (quarterly is generally recommended). A qualified person should perform the inspection and complete the appropriate report(s). (See attached inspection report forms.) The inspector should keep the paper copy of the report in permanent files in chronological order. In addition, prior to filing the reports the data and other pertinent information is encouraged to be entered into the online, GIS-enabled, database via the website www.datashed.org. Passwords to the site as well as instructions and training can be obtained by contacting Stream Restoration Incorporated. (See the Datashed section.)

The report should include the inspection date, the inspector’s name, the organization with which the inspector is affiliated, and the start and end time of the actual inspection. The following sections correspond in general with the attached individual Passive Treatment System and Land Reclamation O&M Inspection Reports.

A. Site Vegetation

Vegetation (i.e. groundcover) is extremely important to provide wildlife habitat and to prevent erosion. Erosion can carry sediment into streams resulting in decreased water quality, turbidity, and siltation. Sediment entering passive components such as a Vertical Flow Pond or Settling Pond can cause loss of capacity and shorten the lifespan of the system. During the inspection, overall condition of the site vegetation should be observed and numerically rated from 0 to 5. If significant areas are barren, describe the action needed as well as the location. Normal husbandry practices (such as fertilizing, seeding, mulching, removing unwanted species, etc.) should be implemented, as necessary, to maintain a stable non-erosive ground cover and viable wildlife habitat on the site.

Rating	Description	Recommended Action
0	Site barren	Revegetate as soon as practicable; temporary seeding, installation of staked straw/hay bales, filter fabric, etc. may be necessary until stabilization with permanent approved seed mix
1	Site mostly barren. Only small isolated areas of vegetation present	(Same as for "0" rating)
2	Large area(s) barren	Outline approximate area(s) on Site Schematic; revegetate as described for "0" rating
3	Vegetation spotty; erosion gullies present	Outline approximate area(s) on Site Schematic; on poorly vegetated areas, seed, mulch, apply soil amendments, as necessary; install staked straw/hay bales, rip-rap, etc. in gullies to control erosion
4	Successful vegetation >70% groundcover; few, isolated, minor erosion features or areas with <70% groundcover	Identify potential problem areas; note changes on future Inspection Reports
5	Successful vegetation >70% groundcover	No remedial action required

B. Site Access and Parking

Access to the site is needed for maintenance, monitoring, and educational/outreach programs. There is currently no access road to the Fox Run – Phase II site. Access to the site is achieved by parking on a gravel area along Parker Road near the utility right-of-way. Follow the right-of-way down to the site.

On the inspection sheet:

- Is the parking area useable (Yes or No): Are there fallen trees or debris blocking access? Are there significant erosion gullies present?
- Maintenance required: Do portions need to be stabilized with aggregate? If so, identify area on Site Schematic. Is machinery required to remove debris?

C. Vandalism and Housekeeping

The passive treatment system is located on the property of the Kish Family. The landowner has **generously** allowed these facilities to be constructed on their property in order to help restore Fox Run. Please collect any litter you see during your inspection and dispose of it properly. Do not touch anything that you feel may be dangerous (such as, broken glass) or hazardous. Note these items and their location as a comment in the inspection report and make arrangements to have the material removed using appropriate methods. Although vandalism has not been a

problem at most sites, please record any type of vandalism or evidence of trespassing on the inspection reports. Note any damage to the passive treatment system or project site signs.

D. Ditches, Channels, and Spillways

All channels, ditches, and spillways should be inspected and maintained to minimize erosion and insure proper water handling. The channels should be kept free of obstructions/debris that would restrict water flow as this can cause the water to back up and overflow the berm. Any debris/obstructions should be removed. If disturbed or eroded areas are present, then these areas should be stabilized as soon as possible with riprap or plantings. Channels or ditches that carry mine drainage should be cleaned when precipitates reduce the capacity by one half. Particular attention should be paid to the stability of rock-lined channels and spillways to assure that the rock lining is intact. Vegetation should be removed from spillways.



Particular attention should be paid to the stability of rock-lined channels and spillways to assure that the rock lining is intact. Vegetation should be removed from spillways.

On the inspection sheet, for each identified channel, ditch, or spillway note:

- Significant erosion rills (Yes or No): Is the rip-rap or vegetative lining impaired or absent? Has the berm been overtopped or breached? Are there erosion rills/gullies?
- Significant debris/vegetation (Yes or No): Are there tree limbs, leaves, trash, etc. that could “dam” the water? Is there vegetation or debris in the riprap-lined spillways that would cause the water level to rise in the passive components?
- Maintenance performed (Yes or No): In the appropriate column mark yes or no as to whether maintenance was performed.
- Maintenance performed and remaining: Note any maintenance that was performed. Remember to indicate by number and letter, which ditch, channel, or spillway had maintenance conducted. Was the vegetation removed from the riprap-lined spillways? (Removal of plants from riprap-lined spillways on a regular basis as part of “general housekeeping” prevents overtopping of berms and loss of function of the facility.) Have tree limbs, leaves, trash, etc. been removed? Has the erosion been addressed (rocks placed in erosion features; sediment cleaned from ditches, dirt placed and compacted on berms of ditches and channels, etc.)? Also describe additional maintenance that is still needed. Indicate areas for additional maintenance on the Site Schematic.

E. Passive Treatment System Components

All passive treatment components such as settling ponds, wetlands, and collection systems that intercept, convey, and/or treat water need to be inspected for erosion, embankment (slope) stability, vegetation, siltation, leaks, etc. Any problem should be noted and corrected as soon as practicable.

Water inlets and outlets for all structures should be observed during each site inspection and kept free from sediment, leaves, and other foreign objects. This is very important for the efficient operation of the system. Any debris present in the water inlet/outlet areas should be removed.

All flow control structures should be maintained to be free-flowing. Plugged and partially plugged pipes need to be cleaned. Broken pipes need to be replaced.

The condition of the vegetation and the presence of any disturbed or eroded areas should be noted. Disturbed or eroded areas will need to be stabilized as soon as possible with staked straw/hay bales, riprap, plantings with accepted species, etc., whichever is appropriate.

Any signs of water overtopping or leaking through the berms should be noted and investigations conducted to determine the cause as soon as possible.

The intake manifold should be collecting almost all of the 87-2 discharge. If a significant flow (>10 gpm) is observed from the area of the intake manifold (east side of Fox Run), corrective measures should be taken immediately. Inspect the water level at the observation well, if the water level is near or above the surrounding ground surface elevation, a decrease in the outlet pipe capacity may be indicated. The outlet of the 18" pipe (vertical outlet riser) in the settling pond should be inspected and should be clear from all debris, sediment, precipitates or rocks (i.e. vandalism). If needed, clean the pipe at the outlet with shovel, hoe, cleanout tool etc. If this does not reduce or eliminate the flow on the east side of Fox Run, a bypass of the collection system may be occurring and excavation (with a mini excavator or similar piece of equipment) may be needed to install additional check dams and/or hydraulic barriers to enhance collection of the discharge.

On the inspection sheet, for each identified passive treatment component note:

- Erosion Rills (Yes or No): Do berms (inside & outside) have erosion gullies?
- Vegetation Problems (Yes or No): Are there significant areas on the berms (inside & outside) that need to be revegetated? Overall, does the vegetation appear unhealthy?
- Significant siltation/sedimentation (Yes or No): Is there significant sediment from erosion of berms or upland areas accumulating in the passive component?
- Are the embankments slumping/unstable (Yes or No): Is there any slumping? Are there cracks? Do the embankments or berms appear to be unstable?
- Significant change in water level (Yes or No): Is the water level rising or lowering in the passive component? Is there water discharging from the emergency spillway or over the berm? Is the water level appropriate (not too high or too low) for the plants in the wetlands? Has a pond been drained that should not be?
- Maintenance performed and needed: Describe any maintenance conducted or needed. Remember to identify the component. Do portions of the berms need to be stabilized with riprap and/or reconstructed? Does supplemental reseeding and mulching need to be completed? Do passive components or pipes need to be cleaned of sediment? Do valves need to be replaced? Are any pipes broken or plugged?

F. Field Water Monitoring and Sample Collection

In order to assess the efficiency and performance of a passive system, water monitoring of each component of the system should be completed. Water monitoring is perhaps the most important element of the O&M site inspection as it directly indicates whether the system is functioning properly and can help to identify problems that cannot be directly seen. If possible, water samples should be taken and analyzed by the PA State Lab or other approved laboratory using standard chemical testing procedures for the following water quality parameters.

Laboratory Water Quality Parameters

pH	Total Iron	Total Aluminum
Alkalinity	Dissolved Iron	Dissolved Aluminum
Acidity	Total Manganese	Sulfates
Specific Conductance	Dissolved Manganese	Total Suspended Solids

Total calcium might also be valuable. In addition to laboratory analyses, field tests should be completed including flow (as feasible), pH, temperature, and alkalinity. ORP measurements can also be a valuable indicator of system function. If water samples cannot be taken for laboratory analysis then, at a minimum, the following field tests should be completed: pH, temperature, alkalinity, and iron. Alkalinity is not completed when $\text{pH} \leq 4.5$.

Water sampling and field testing should be completed at locations identified on the O&M Inspection Sheet and Site Schematic. Water monitoring will enable evaluation of the degree of success of the passive components, individually and combined, in treating the mine drainage.

The monitoring program should include points other than the final effluent in order to provide a complete depiction of the water quality through the passive treatment system at the time of sampling. For instance, the untreated raw mine discharge (as close to the source as possible), each component (at the effluent), and the stream (above and below the system) should be monitored. These monitoring points are identified on the O&M Inspection Sheet, O&M schematic, and "As-Built" schematics. Monitoring of individual components is important to identify problems particular to the component that may not be noticed in the final effluent of the entire system.

In order to conduct laboratory analyses for pH, alkalinity, acidity, sulfates, conductivity, and total suspended solids, a 500-ml (or other volume specified by the laboratory), unfiltered, sample should be collected, stored in a cooler, and transported to the laboratory. In order to differentiate between dissolved and total iron, manganese, and aluminum concentrations, the laboratory requires two, 125-ml (or other specified volume) samples that are preserved with trace metal-grade nitric acid to ensure that the pH is <2 . The sample for total metals is not filtered. The sample for dissolved metals is filtered in the field using a 0.45- μm filter during sampling. At a minimum the filtering device should be rinsed three times with the water to be sampled. Each bottle should be labeled with a unique number.

For a single component that contains multiple discharge points (e.g. multiple effluent pipes from the same Vertical Flow Pond) a composite sample may be taken. This can be accomplished in several ways. One method would be to use a clean bottle or bucket and to capture a proportionate amount of sample from each discharge point and allow the waters to mix. This can be accomplished by timing or counting such that the water is collected for the same amount of time at each location, which will effectively proportionate the sample. If the multiple flows mix together in a spillway, the sample may be collected at the end of the spillway. Importantly, the various sources must be well mixed or the results could be skewed.

A record of every sample taken should be made directly on the inspection sheet, such as sampler's name, sample location, sample date, flow rate, field tests, and sample bottle identification. Pertinent information is then transferred from the inspection sheets to the laboratory's Record of Sample form or Chain of Custody form.

On the inspection sheet for each Sampling Point:

- Monitoring point field measurements recorded:
 Record readings to nearest whole number, except pH (record to nearest tenth).

Parameter	Method
Flow	Bucket & Stopwatch (where pipe discharge), weir, etc.
pH	HACH pH kit, pH meter, etc.
Temperature	Field thermometer, pH meter, etc.
ORP (optional)	ORP meter
Total Alkalinity	HACH Digital Titrator, etc.
Iron	HACH iron, etc.
Dissolved oxygen (optional)	HACH DO kit, DO meter, etc.

- Sample bottle data: If water samples are collected, assign and record bottle numbers on the inspection sheet. You will need to transfer this information to the laboratory's Record of Sample or Chain of Custody form.
- Comments: Observations such as sample color may be recorded under "Comments".

G. Flow Measurements

Four methods of measuring flow rate are described. In general, the "Bucket-and-Stopwatch" Method will be the most commonly used for monitoring the passive treatment system; However at Fox Run Phase 2 the vertical pipe weir method will be used at the inlet to the settling pond.



"Bucket-and-Stopwatch" Method

Flow measurements from pipes can be made using the "bucket-and-stopwatch" method. This method consists of timing (in seconds) the filling of a bucket of known volume (preferably calibrated in gallons). The flow rate in gallons per minute (gpm) can then be calculated utilizing the following formula:

$$\text{Flow (gallons/minute)} = \left(\frac{\text{Gallons}}{\text{Seconds}} \right) \times 60$$

Vertical Pipe Weir

Flow measurements can be made at vertical pipes that are level, which essentially creates a circular weir. At Fox Run Phase 2, this method can be used at the inlet pipe to the settling pond where the aerator is located. To use this method, measure the height of the water (in inches) which rises above the pipe. This number can then be used in the following equation:

$$\text{Flow (gallons/minute)} = 6.17d^{1.25}h^{1.35}$$

Where d is the diameter of the pipe in inches (in this case it is 18 inches) and h is the height of the water above the pipe in inches. The following table has been created to simplify the need to perform the calculation.

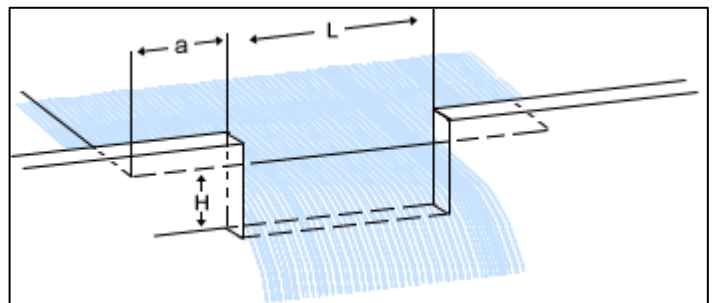
Height of water (inches)	Flow (gpm)	Height of water (inches)	Flow (gpm)	Height of water (inches)	Flow (gpm)	Height of water (inches)	Flow (gpm)
0.1	10	1.1	260	2.1	623	3.1	1054
0.2	26	1.2	293	2.2	663	3.2	1100
0.25	35	1.25	309	2.25	684	3.25	1123
0.3	45	1.3	326	2.3	704	3.3	1146
0.4	66	1.4	360	2.4	746	3.4	1194
0.5	90	1.5	395	2.5	788	3.5	1241
0.6	115	1.6	431	2.6	831	3.6	1289
0.7	141	1.7	468	2.7	874	3.7	1338
0.75	155	1.75	487	2.75	896	3.75	1362
0.8	169	1.8	506	2.8	918	3.8	1387
0.9	198	1.9	544	2.9	963	3.9	1437
1.0	229	2.0	583	3.0	1008	4.0	1486

Rectangular Weirs

Flow measurements can be made over any flat, level, rectangular surface or weir by using the Francis Formula below:

Formula: $Q = 3.33(L - 0.2H)H^{1.5}$

- Where:** Q = flow of water in cu. ft. per sec.
 L = width of weir opening in ft.
 (4 to 8 times H)
 H = head of weir in ft.
 (measured at least 6 ft. back of weir opening)



Source: <http://www.constructionwork.com>

a = at least 3H

(The LMNO Engineering website contains additional information, formulas, diagrams, and calculators for various weirs and flumes.

<http://www.lmnoeng.com/Weirs/vweir.htm>)

From cubic feet per sec (cfs), gpm can be

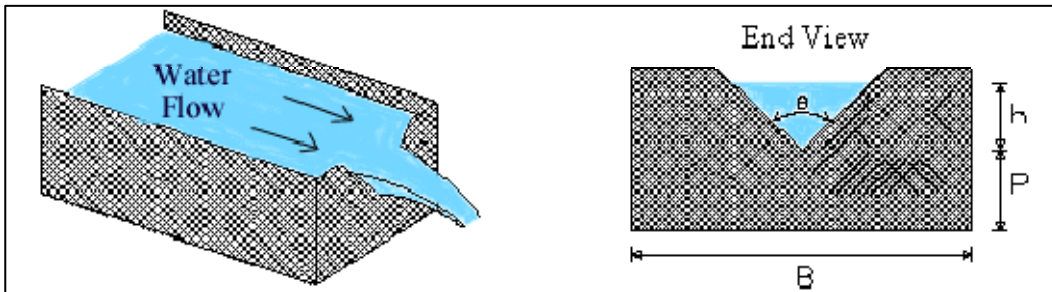
calculated: **gpm = cfs X 448.83 gpm/cfs**

Ideally a staff gauge should be set several feet behind the weir in the pool. Note, while commonly done, measuring the height of the water at the weir will typically produce a lower flow rate than the actual.

To accurately determine flow rate, iron precipitates, leaves, and other debris collected in or behind the weir should be removed prior to making a measurement. If significant sediment, metal precipitates and/or debris are removed, allow the flow to equilibrate before taking a final reading. In addition, the weir must be kept as close to level as possible both horizontally and vertically for accurate flow measurements. If water is going around or under the weir, repairs should be completed to correct the problem.

V-Notch Weirs

Flow measurements can be made using a V-Notch Weir.



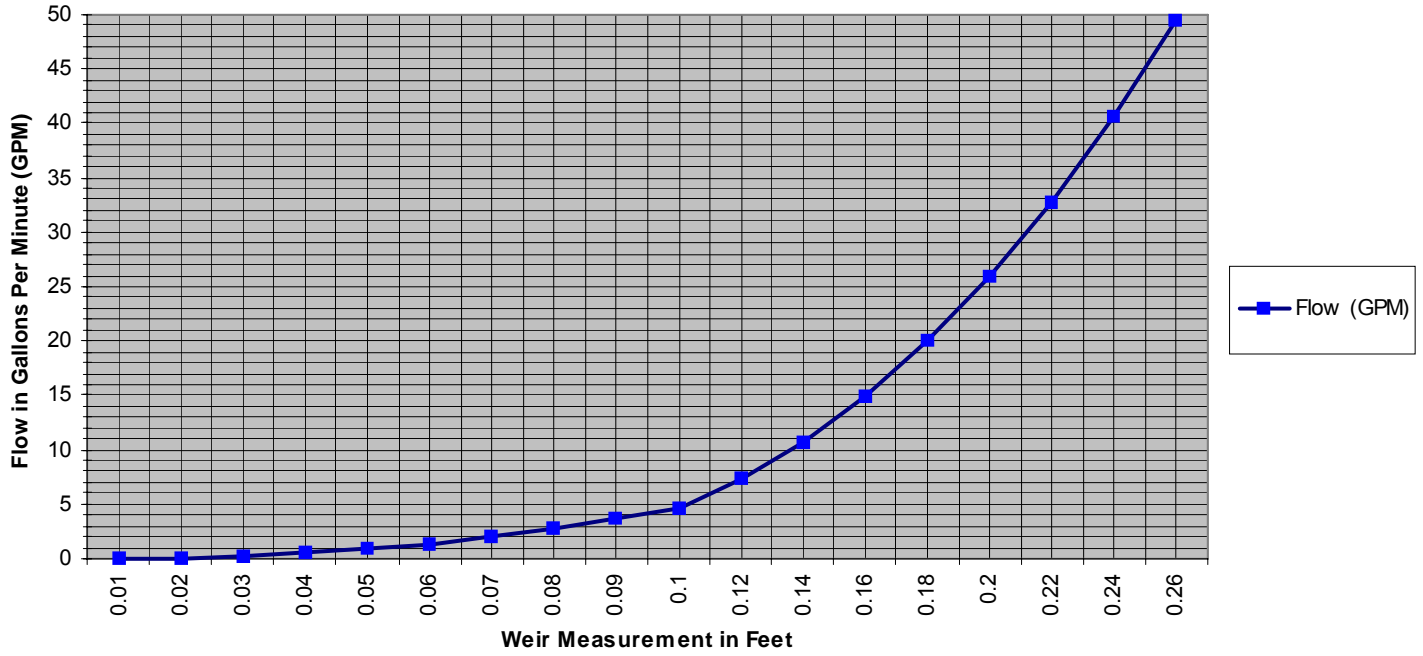
Source: <http://www.lmnoeng.com/Weirs/vweir.htm>

Like the Rectangular Weir, height of water should be measured with a staff gauge placed several feet behind the v-notch in the pool; however, height of water in the V-Notch is often measured. $Q = 2.50H^{2.50}$

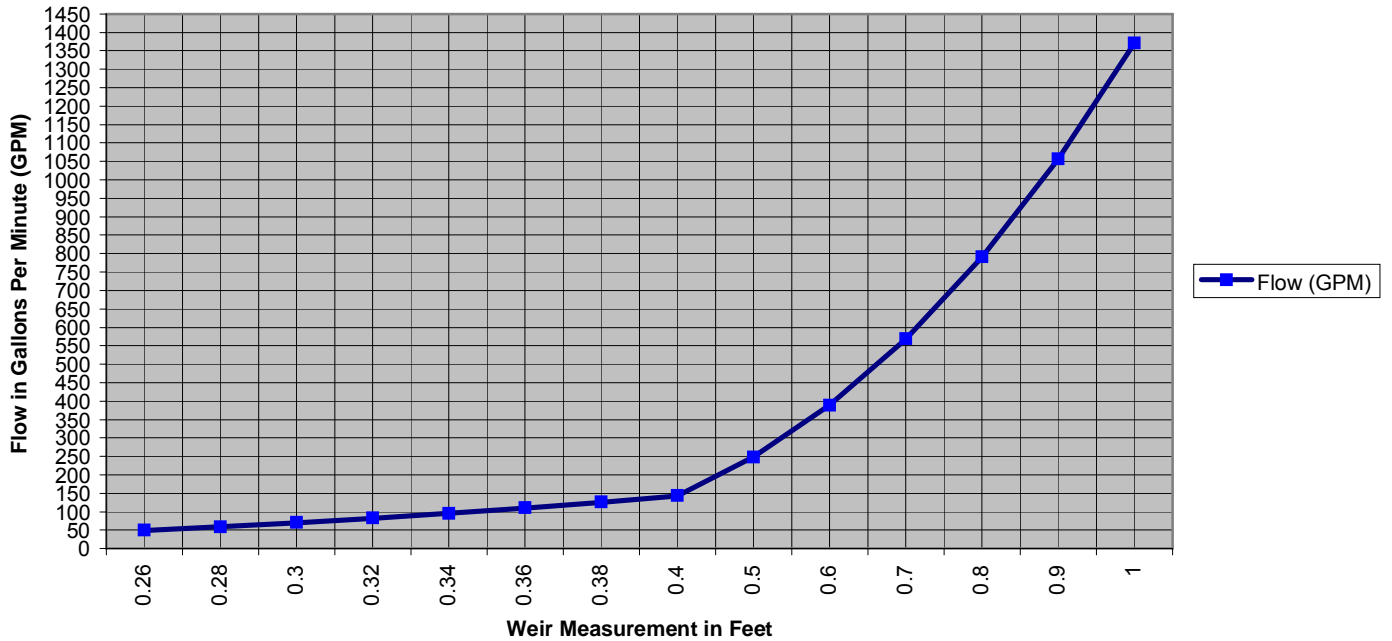
Flow in cubic feet/second can then be calculated using the above formula where H is the height (in feet not inches) of water (head) at the weir. As described in the previous section, gpm can then be calculated from cfs. In addition, the following table and graphs were developed to very generally describe flow rate by using a direct read at a V-notch weir. To convert inches into feet divide by 12.

Measurement (ft)	Flow (gpm)	Measurement (ft)	Flow (gpm)	Measurement (ft)	Flow (gpm)
0.01	0.02	0.14	10.74	0.36	110.28
0.02	0.09	0.16	14.93	0.38	126.01
0.03	0.24	0.18	19.96	0.4	143.00
0.04	0.49	0.20	25.88	0.5	247.93
0.05	0.85	0.22	32.74	0.6	388.68
0.06	1.33	0.24	40.57	0.7	568.43
0.07	1.94	0.26	49.43	0.8	790.11
0.08	2.70	0.28	59.34	0.9	1056.40
0.09	3.61	0.30	70.35	1.0	1369.83
0.10	4.68	0.32	82.48		
0.12	7.34	0.34	95.78		

**90-Degree V-Notch Weir Direct Read Flow Measurements
 For Low Flow (0-50 Gallons Per Minute) Conditions**



**90-Degree V-Notch Weir Direct Read Flow Measurements
 For High Flow (50-1400 Gallons Per Minute) Conditions**



Sludge Accumulation Assessment Report

In addition to the periodic O&M Inspection Reports, it is recommended that a Sludge Accumulation Inspection Report be completed every two years. The primary purpose of this inspection is to assess the type and amount of sludge accumulating within the passive treatment components. This can give an indication as to how the system is functioning and when action is needed to remove the sludge from the component. A proposed schedule and a general Sludge Accumulation Assessment Report has been included that can be used for all sites.

On the Sludge Accumulation Assessment Report, for each component provide:

- **Sludge description:** Note the color and depth (estimated) of the sludge. Typically, white, red, and black colors indicate precipitate rich in aluminum, iron, and black, respectively. Has the sludge filled the component to within 1 foot of the emergency spillway?
- **Comments:** For example: Is there significant organic debris in the sludge? Is there evidence of wildlife utilizing the component? Estimated depth of sludge?

Wetland Plant Diversity Report

Although not necessary to complete, a general Wetland Plant Diversity Report has been provided. The primary purpose of this report is to assess the diversity of plant species within a constructed treatment wetland in order to determine if species diversity is increasing or decreasing. Species diversity is believed to increase the health, productivity, and treatment capability of the wetland. In addition, increased plant species diversity should result in an increase in wildlife diversity. A secondary purpose is to identify if unwanted invasive plants have become established. These plants should be removed from the wetlands. On the report provide the common name and/or scientific name for each plant, the plot number, the location of the plot, and the population within that plot.

Miscellaneous Maintenance Considerations

All materials used in repairs should be of equal or better quality and have the same capacity and function as shown on the "As-Built" plans.

By-Passing Components for Conducting Maintenance

At times, it may become necessary to by-pass components in order to conduct certain maintenance activities such as repairing a broken pipe. Depending on the component this can be accomplished by several methods. One method is to use a pump that will pump the water from one component to another or towards the stream if necessary. It may also be possible to set up a siphon instead of a pump to accomplish the same effect.

Removal and disposal of accumulated precipitate or sediment

Precipitates from chemical reactions and other solids will be retained within the settling ponds, wetlands, channels and other components. This sludge should be removed when the volume of the component is reduced by one half. Inlets and outlets should be kept clear of debris and obstructions. Sludge removal is planned for every fifteen years or as desired. In addition, opportunities may be available to utilize the sludge for metal recovery or the sludge may be allowed to drain/dewater for disposal. (An Erosion and Sediment Pollution Control Plan should be completed for the placement area.)

Triggers to Initiate Maintenance Activities

Several maintenance triggers have been developed to help assist the Mercer County Conservation District and volunteers identify when maintenance is needed and what maintenance activity should be conducted.

Maintenance Action Item #1: Final Effluent pH below 6

As the mine discharge is exceedingly net-alkaline, the system is designed to discharge at a pH ≥ 6 from the final WL during all flow conditions. Routine inspections will include measuring the pH of the WL effluent in the field using a colorimetric kit or a pH meter. Effluent from the WL that has a pH < 6 will indicate that something significant has taken place such as a drastic change in water quality of the discharge. A thorough site investigation including water sampling should be conducted in order to evaluate the cause of the change in water quality and develop a plan to take corrective actions as necessary.

Maintenance Action Item #2: Water Levels

Sometimes, the accumulation of vegetation, debris, and metal sludge will result in creating a dam within a spillway. This will cause the water level within the pond or wetland to increase. Significant changes in water levels within the wetland can kill off certain plants and reduce species diversity. If water levels continue to rise, eventually water will over top the berm. Plants and debris should be regularly removed from the spillway especially if a significant change in water levels has occurred.

Maintenance Action Item #3: Sludge Accumulation

If sludge has accumulated in the Settling Pond or Wetland to a point where solids are (or about to be) carried out of the spillway during normal flow conditions, the component(s) should be cleaned. Several companies are currently developing markets for materials recovered from mine drainage treatment systems. One or more of these companies should be contacted to evaluate the potentially valuable commodities accumulating in the Fox Run system. If the material is determined not to be economically viable for recovery, then on-site placement is recommended. The material can be removed from the pond and/or wetland and placed on-site as feasible. There are a variety of mechanical means available including sludge pumping and/or excavation. There are commercial companies specializing in these types of services.

Replacement

All passive treatment systems are unique. The sludge storage capacity for passive components varies from component to component and over time with variable discharge characteristics. Design capacity is based upon available water quality monitoring data and published references. Higher flow rates and poorer water quality can substantially affect the design life. When the storage capacity of the system is diminished by approximately one half, the sludge should be removed. Prior to removal, the system and water quality should be evaluated to determine if reconstruction is necessary. Advances in technology and changes in raw drainage quality and quantity should be considered to determine if revisions to the size and/or design of the system is advantageous.

Replacement considerations include:

- Estimating Best Management Practice (BMP) design life;
- Determining replacement responsibility, including a successor, as necessary;
- Determining approximate costs for the following possible needs:
 - o removing accumulated sediments;
 - o replacing defective valves, water control structures, etc.;
 - o re-sizing the system to accommodate changed water quality or quantity;
 - o recharging organic matter in wetlands; and
 - o replanting wetlands.

Datashed

Datashed, www.datashed.org, is a fully-featured, GIS-enabled, internet database designed to assist watershed groups, academic institutions, private industry, and government agencies. Powered by open source software, this database provides a cost-effective and reliable solution to the management of data associated with environmental efforts. GIS capability allows users to easily view geographic data and directs users to additional content. Anyone with internet access can view the site and download information. This allows the website to function not only as a data management tool but also as part of the education/outreach effort associated with the project. Datashed was developed by Stream Restoration Incorporated, 241 Computer Services, and WPCAMR using the PHP programming language and open source software such as APACHE HTTP Server, MySQL database, and Map Server.

Datashed could be easily incorporated as a component of the O&M Plan. On Datashed, each restoration project has its own page within the website where users can not only view data but also download and print information needed to conduct O&M inspections such as site inspection sheets, site schematics, topographic maps, aerial photos, etc. In addition, those who conduct the inspections will be given passwords to allow direct online upload of collected field and laboratory data from the inspection.


To view, download forms, or upload data onto the site use the following directions below:













Viewing, Downloading, and Uploading Data to Datashed

1. Go to Datashed (www.datashed.org). To view data or download forms go to step 2. To upload data such as completing the online O&M form, you will need to first login using your assigned email address and password. If you do not have a password, contact Stream Restoration Incorporated.
2. Select the "Projects" tab.
3. A Project Search Query should appear. This feature allows the user to search for projects based on a variety of selections criterion. Once the criteria has been selected, click on the "List Projects" button
4. A list of available projects matching the criteria with short descriptions should appear.
5. Select the project that you wish to view, download forms, or upload data. The "Project Details" report page will automatically open.
6. Select:
 - "Maps and Directions" to get directions to the site
 - "Downloads" to obtain O&M forms, site schematics, location map, "as-builts", etc
 - "View Data" to view O&M submissions, graphs, reports, and data
 - "View Pictures" for project photos
 - "Partners" to view a list of partners involved in the project
 - "Submit Data" to access and upload data via the on-line O&M form
7. Enter the data from the O&M field inspection sheet. When finished, click submit button.

SITE INSPECTION & SLUDGE ACCUMULATION ASSESMENT SCHEDULE

Year: _____

 -Not conducted

Year	January- March	April- June	July – September	October - December	Sludge Accumulation
2009					
2010					
2011					
2012					
2013					
2014					
2015					
2016					
2017					
2018					
2019					
2020					
2021					
2022					
2023					
2024					
2025					
2026					
2027					
2028					
2029					
2030					
2031					
2032					
2033					
2034					
2035					

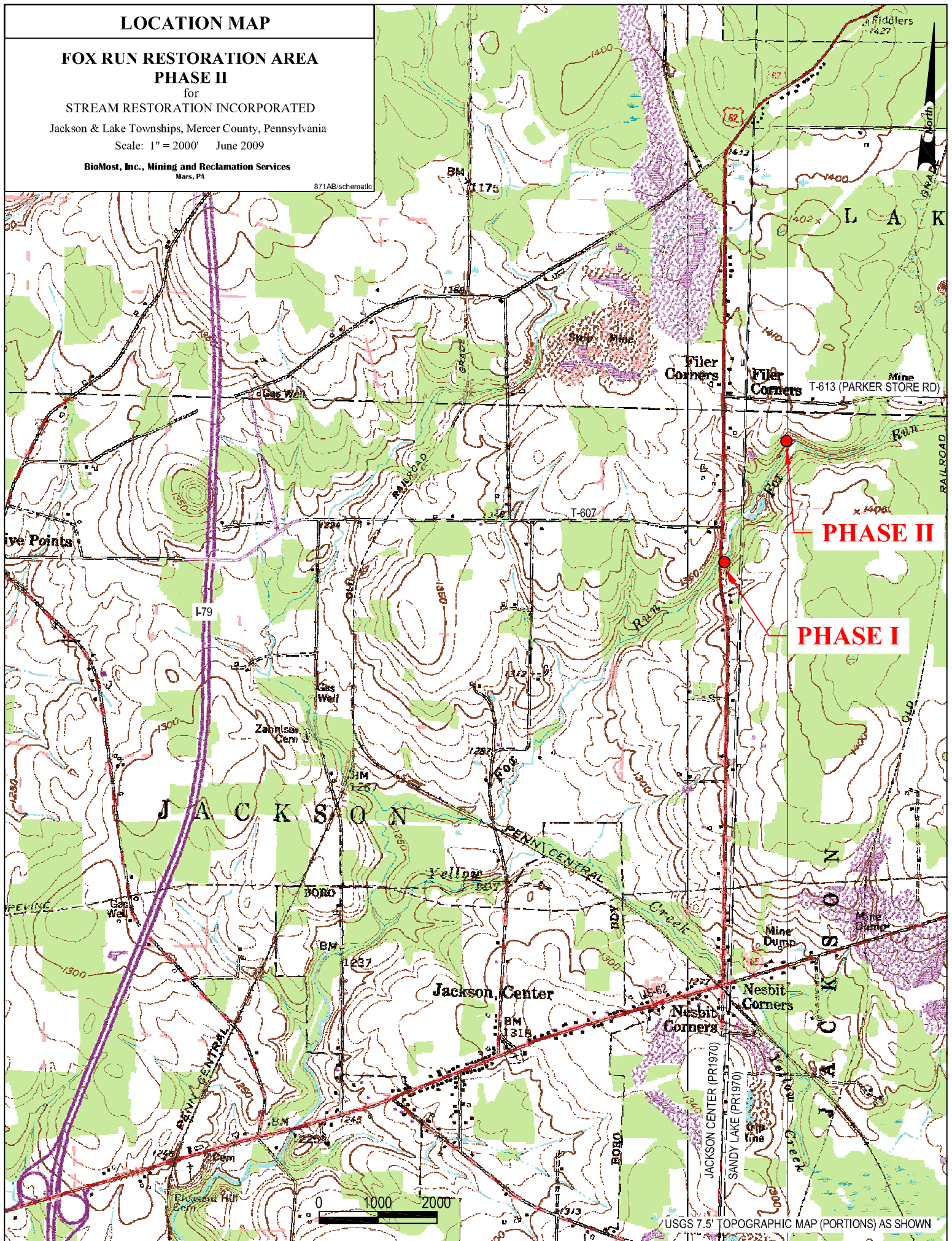
LOCATION MAP

FOX RUN RESTORATION AREA PHASE II

for
STREAM RESTORATION INCORPORATED
Jackson & Lake Townships, Mercer County, Pennsylvania
Scale: 1" = 2000' June 2009

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

871AB/schematic



FOX RUN – PHASE II PASSIVE TREATMENT SYSTEM

O&M INSPECTION REPORT

Rev. June
2009

Inspection Date: _____	Project Name: Fox Run Restoration Area – Phase II Passive Treatment System
Inspected by: _____	Municipality: Jackson & Lake Townships
Organization: _____	County: Mercer State: PA
Time Start: _____ End: _____	Project Coordinates: 41° 18' 6" Lat 80° 7' 20" Long
Receiving Stream: Fox Run	Subwatershed: Yellow Creek Watershed: Neshanock 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

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 Parking (Parking to site is a gravel pull-off along Parker Road near the power line right-away)

Was the parking area accessible/useable for operation and monitoring? Yes / No Maintenance performed/needed: _____

C. Vandalism and Housekeeping

Is there evidence of vandalism? Yes / No Is there litter around/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

D. Spillways

Ditch	Erosion Rills (Y/N)	Debris/Vegetation Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Needed (Y/N)	Describe Maintenance Performed or Needed
Settling Pond					
Wetland					

E. Passive Treatment Components

Component	Erosion Rills (Y/N)	Vegetation Problems (Y/N)	Significant Siltation (Y/N)	Embankments Slumping/Unstable (Y/N)	Water level Change or Overtopping Berm (Y/N)
Intake Manifold*					
Settling Pond					
Wetland					
Describe Maintenance Performed or Needed:					

Is there is significant flow (>10 gpm) entering Fox Run from the area of the intake manifold? Yes / No describe: _____

Does the wetland appear to be short-circuiting? Yes / No Were hay bales placed? Yes / No Do hay bales need to be placed? Yes / No

F. Field Water Monitoring and Sample Collection - Water sample locations as marked on the site schematic. For passive components the sample point is at the effluent of the named component. The following table provides the opportunity to conduct extensive monitoring if/when desired, however at a minimum, field parameters should be conducted at the following sample points during site inspections indicated by *. At a minimum the pH and field iron from the wetland (871 WL) and the discharge (87-2) should be measured during every site visit. Field iron and pH should be measured at stream monitoring points 87-1 and 871 DN. The system and stream should be monitored on a quarterly basis.

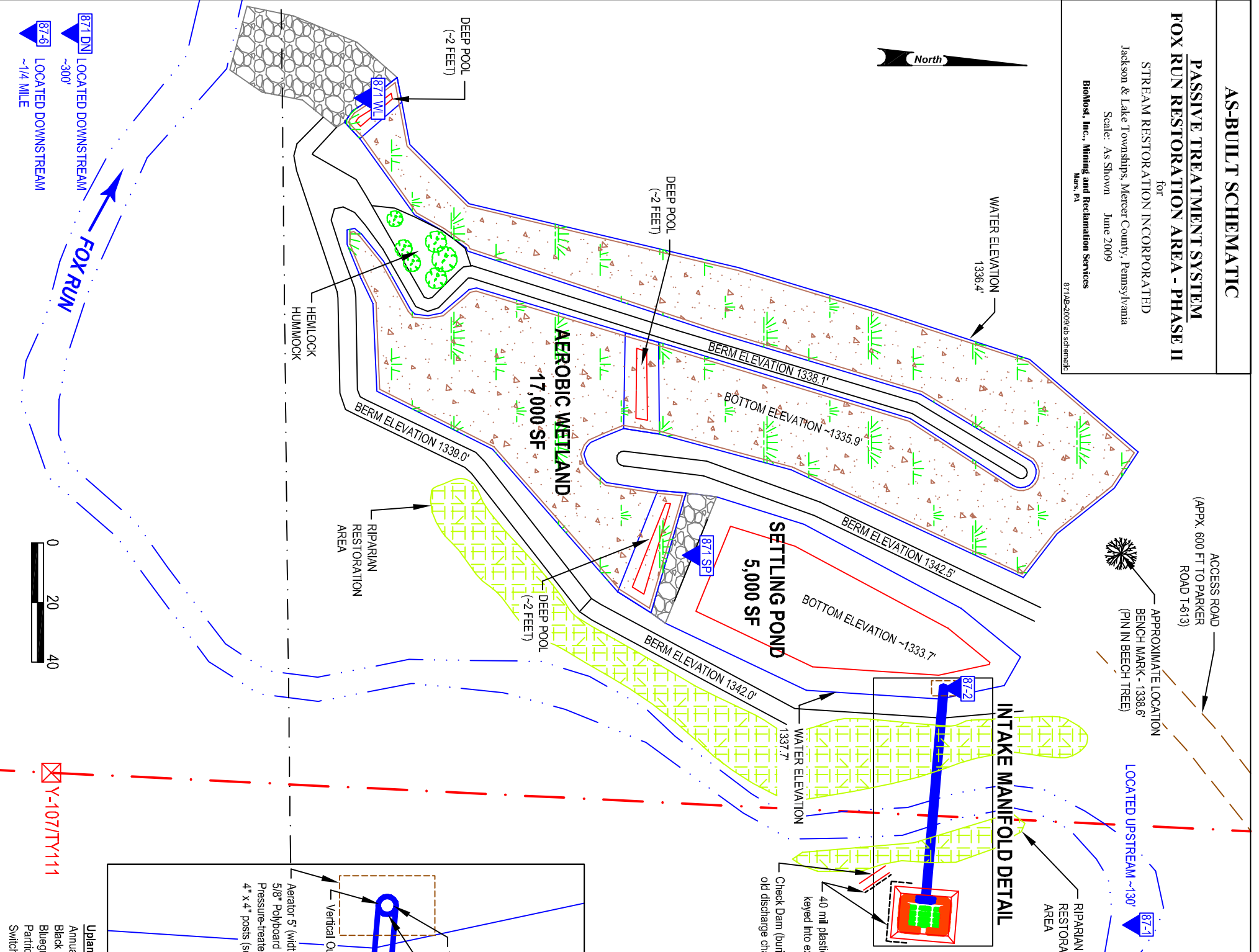
Sampling Point	Flow Measurements		Calculated Flow (gpm)	pH	Temp (°C)	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
87-2												
871-SP												
871 WL												
871 DN												
87-6												

G. Flow Measurements – Measurements should be performed as per flow measurement techniques described in the O& M Plan
Vertical Flow Pipe Weir at influent to Settling Pond _____ height in inches.

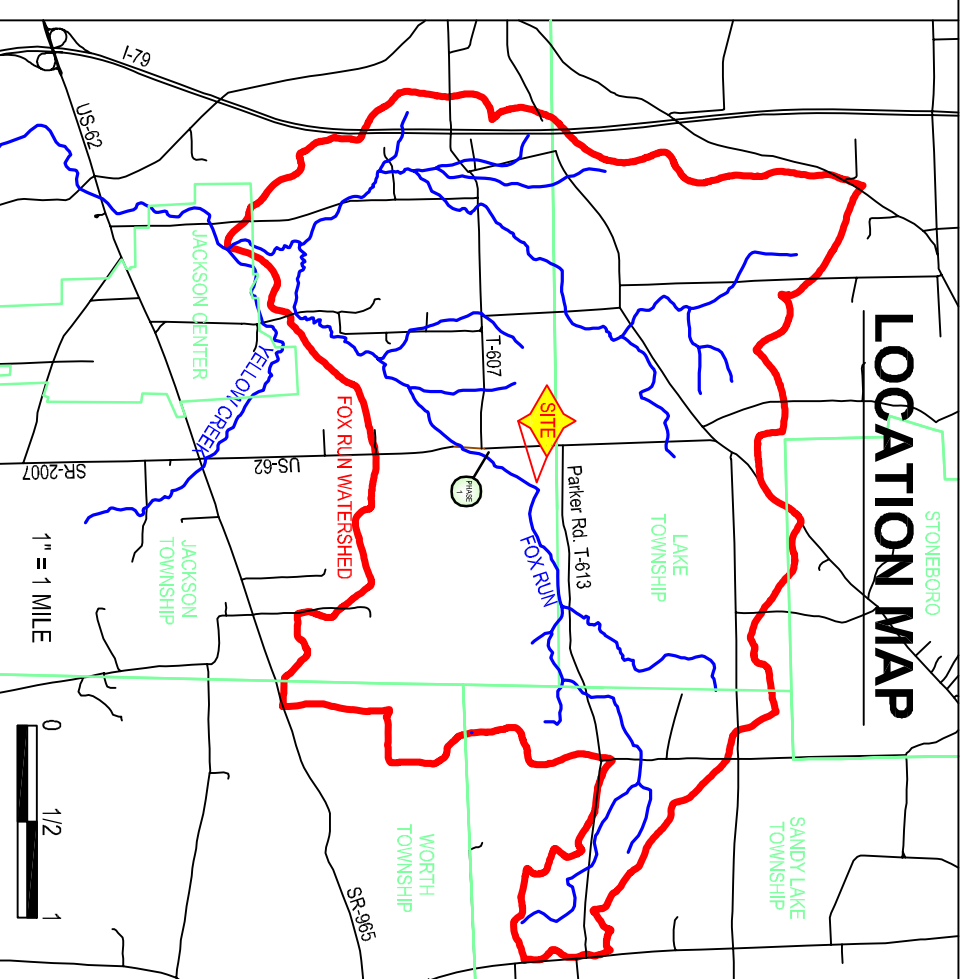
AS-BUILT SCHEMATIC

PASSIVE TREATMENT SYSTEM for FOX RUN RESTORATION AREA - PHASE II

STREAM RESTORATION INCORPORATED
Jackson & Lake Townships, Mercer County, Pennsylvania
Scale: As Shown June 2009
BioMost, Inc., Mining and Reclamation Services
Mesa, PA
877-AR-2009/ab schematic



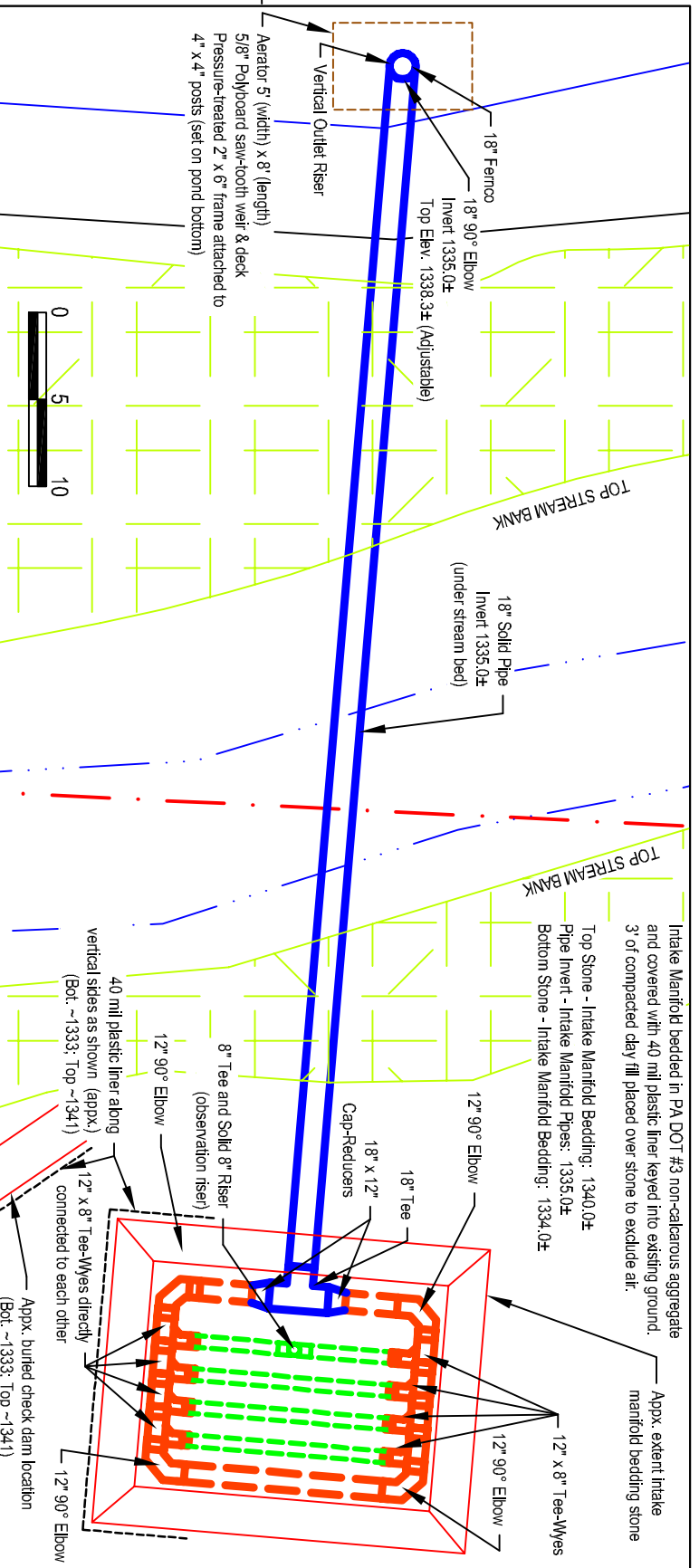
LOCATION MAP



LEGEND	
	WATER SURFACE ELEVATION
	FOX RUN
	TOP BERM/STREAMBANK
	PTS COMPONENT
	AEROBIC WETLAND
	RIP-RAP (R4)
	TRANSMISSION LINE & POLE
	FENCE (APPROXIMATE LOCATION)
	18" SOLID PIPE
	12" PERFORATED PIPE
	8" PERFORATED PIPE
	PTS WETLAND BOTTOM
	WATER SAMPLING POINT

Notes:
As-built information from 09/26/08 field inspection by BioMost, Inc. and Mercer County Conservation District using post-processed sub-meter GPS unit & laser level, and 06/22/09 site inspection by BioMost, Inc. as well as design information and is a reasonable representation of actual field conditions.
Water elevations may vary due to outlet spillway, weather and other factors.
Passive treatment system built on property of Richard & Barbara Kish.
All pipe is SDR35 PVC.
Stream location from aerial photography taken for the PAMAP program (Spring 2006) and sub-meter GPS unit.
Settling pond and wetland areas shown measured at top of water.
Total wetland area "foot print" ~3/4 Acre.

INTAKE MANIFOLD DETAIL Scale 1"=10'



Upland Areas Seed Mixture (Planted ~2 1/2 Acres at 15 lb/acre - Summer 2008) includes:
Annual Baby's Breath, Annual Galliardia (Indian Blanket), Atlantic Coastal Panic Grass, Bachelor's Button Tall Mixed/Comflower, Bigleaf Lupine, Black Eyed Susan, Brown Eyed Susan, California Poppy, Cornflower (Bachelor's Button), Cosmos, Dames Rocket, Eastern Gamma Grass, Fowl Bluegrass, Gray Headed Coneflower, Indiangrass, PA Ecotype, Lance Leaved Coreopsis, Little Bluestem, Ox Eye Daisy, Ox Eye Sunflower, Partridge Pea, Perennial Blue Flax, Perennial Galliardia (Blanket Flower), Plains Coreopsis, Purple Coneflower, Red Corn Poppy, Steller Switchgrass, Snowy Tick Trefoil, Sulphur Cosmos, Virginia Wild Rye, Wallflower, WI Ecotype Big Bluestem, Wild Bergamot

Upland Trees Planted (~50 Each species - Fall 2008):
Hemlock, Alder, Willow, Aspen, Elderberry, Sily Dogwood (~100 plants), Red-Osier Dogwood

Wetland Area Planted (Summer 2009) with species including:
Burreed, Button Bush and Softstem Bulrush.

FOX RUN PHASE 2 PASSIVE TREATMENT SYSTEM
SLUDGE ACCUMULATION ASSESSMENT REPORT

Inspection Date: _____	Project Name: Fox Run Restoration Area – Phase II Passive Treatment System
Inspected by: _____	Municipality: Jackson & Lake Townships
Organization: _____	County: Mercer State: PA
Time Start: _____ End: _____	Project Coordinates: 41° 18' 6" Lat 80° 7' 20" Long
Receiving Stream: Fox Run	Subwatershed: Yellow Creek Watershed: Neshanock Creek

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

Provide sludge assessment for each component including sludge description.

Component	Color	Estimated Depth	Comments
Settling Pond			
Wetland			

O&M SCHEMATIC








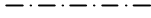






PASSIVE TREATMENT SYSTEM FOX RUN RESTORATION AREA - PHASE II

for
STREAM RESTORATION INCORPORATED
Jackson & Lake Townships, Mercer County, Pennsylvania
Scale: 1" = 40' June 2009

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

871AB-2009/o&m schematic

LEGEND

-  WATER SURFACE ELEVATION
-  FOX RUN
-  TOP BERM/STREAMBANK
-  PTS COMPONENT
-  AEROBIC WETLAND
-  RIP-RAP (R4)
-  TRANSMISSION LINE & POLE
-  FENCE (APPROXIMATE LOCATION)
-  18" SOLID PIPE
-  12" PERFORATED PIPE
-  8" PERFORATED PIPE
-  PTS WETLAND BOTTOM
-  WATER SAMPLING POINT
-  AERATOR

ACCESS ROAD
(APPX. 600 FT TO PARKER
ROAD T-613)

APPROXIMATE LOCATION
BENCH MARK - 1338.6'
(PIN IN BEECH TREE)

LOCATED UPSTREAM ~130'

RIPARIAN
RESTORATION
AREA

SETTLING POND
5,000 SF

AEROBIC WETLAND
17,000 SF

RIPARIAN
RESTORATION
AREA

0 20 40



871 DN LOCATED DOWNSTREAM
~300'

87-6 LOCATED DOWNSTREAM
~1/4 MILE

FOX RUN

Notes:

As-built information from 09/26/08 field inspection by BioMost, Inc. and Mercer County Conservation District using post-processed sub-meter GPS unit & laser level, and 06/22/09 site inspection by BioMost, Inc. as well as design information and is a reasonable representation of actual field conditions.
Passive treatment system built on property of Richard & Barbara Kish.
All pipe is SDR35 PVC.
Stream location from aerial photography taken for the PAMAP program (Spring 2006) and sub-meter GPS unit
Settling pond and wetland areas shown measured at top of water.
Total wetland area "foot print" ~3/4 Acre.