



pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BAMR CAMBRIA OMM TASK FORCE
PASSIVE TREATMENT SYSTEM EVALUATION
PA DEP BUREAU OF ABANDONED MINE RECLAMATION
ACID MINE DRAINAGE ABATEMENT PROJECT

BD 2310 PA 1948
LAUREL RUN
PYROLUSITE® PASSIVE TREATMENT SYSTEM
COOK TOWNSHIP WESTMORELAND COUNTY

Prepared By:
Max Scheeler

August 30, 2011

PROJECT NUMBER: BD 2310
PROBLEM AREA: 1489
PROJECT NAME: Laurel Run
COUNTY: Westmoreland
MUNICIPALITY: Cook Township

RECEIVING STREAM: Laurel Run

CH 93 HYDROLOGICAL ORDER: Drainage List T

Laurel Run
White Oak Run
4 - Loyalhanna Creek
3 - Kiskiminetas River
2 - Allegheny River
1 - Ohio River

CH 93 PROTECTED WATER USES: HQ-CWF (Loyalhanna Creek Basin, Source to Laughlintown Run)

HYDROLOGIC UNIT PLAN (HUP)

HUP Name: Loyalhanna
HUP Number: HUP-04
Approved Date: January 18, 1996

USGS 7.5' QUADRANGLE: Stahlstown

SYSTEM LOCATION HORIZONTAL COORDINATES (NAD27): Lat 40° 07' 46.34" N Lon 79° 16' 35.66" W

PROPERTY OWNER: Commonwealth of Pennsylvania, Department of Conservation and Natural Resources
(DCNR), Bureau of Forestry, Forbes State Forest

PROJECT SUBMITTED BY: Loyalhanna Watershed Association, April 10, 1995

PROJECT CONSTRUCTED BY: DEP, Bureau of Abandoned Mine Reclamation (BAMR)
Cambria District Office, In-House Bituminous District (BD) Construction
Crew

CONSTRUCTION START DATE: August 19, 1997

CONSTRUCTION COMPLETION DATE: September 18, 1997

TOTAL PROJECT COST: \$121,722.05

PROJECT BACKGROUND

Laurel Run is a tributary of White Oak Run which is a southern headwater tributary of Loyalhanna Creek in south-eastern Westmoreland County, Cook Township. The Laurel Run watershed encompasses approximately 1,152 acres or 1.8 square miles with approximately 2.32 miles of stream length along the main stem of Laurel Run. The Kittanning coal seams were extensively mined throughout the surrounding area. The Kregar deep mine complex in the Middle Kittanning was mined by Blair Coal Company in the early 1900's up until the 1930's. After abandonment of this deep mine, the Kregar Mine discharge developed in the headwaters of Laurel Run at approximate stream mile 2.22 upstream from the mouth of Laurel Run. Approximately 0.4 mile downstream from the Kregar discharge, the Friedline discharge also developed from what is believed to be an abandoned portal into a small "country bank" type house coal deep mine in the Lower Kittanning. These two headwaters deep mine discharges severely degraded water quality, aquatic habitat and aquatic life in Laurel Run and subsequently within the headwaters of Loyalhanna Creek.

☀ *Project Location Map:* [Map Link](#)

The discharge of abandoned mine drainage into Laurel Run was first documented by the Loyalhanna Watershed Association (LWA) in the early 1990's. In 1995 LWA made a submission to BAMR for consideration of the Kregar Mine discharge as an Acid Mine Drainage Abatement Project under the Bureau's Set-Aside Program. The site was investigated and determined to meet Program guidelines in March 1996. Project development ensued and in September 1997 BAMR's Laurel Run Passive Treatment System was completed as an in-house project constructed by the Cambria District Office, BD construction crew. Also in 1997 the Friedline discharge was addressed by a passive treatment system constructed by LWA in cooperation with the USDA Natural Resources Conservation Service (NRCS). This original Friedline system proved to be undersized and ineffective at completely removing the acidity and aluminum load from the discharge into Laurel Run at the Friedline site. In May of 2004 BAMR completed construction of an additional treatment component for the Friedline system. The existing system was enhanced through the addition of a steel slag bed which introduced concentrated alkalinity into the treatment stream through the system.

The Laurel Run watershed is used by the Carnegie Museum of Natural History's local Powdermill Nature Reserve for biological, environmental and conservation research and education.

PROJECT GOALS

The Laurel Run project was undertaken with the goal of improving water quality, aquatic habitat and general aesthetics in Laurel Run and Loyalhanna Creek. The project is located upon lands of the Pennsylvania DCNR Bureau of Forestry which has a mission that includes preservation of the land for educational and recreational use. The project would also enhance educational and recreational programs conducted by the Carnegie Museum of Natural History's local Powdermill Nature Reserve including providing opportunities for the study of a mine drainage passive treatment system.

PROJECT DESCRIPTION

The Laurel Run passive treatment system consists of only one single unit. This single treatment unit is a Pyrolusite® limestone bed. Laurel Run was chosen as the initial trial site for assessment of the application of the Pyrolusite® biologically based technology. The basis of the Pyrolusite® process is the establishment of a population of microbes upon the rock surfaces within a limestone bed that is submerged with the mine drainage to be treated. The premise of the process is that the activity of these microbes residing on the surface of the limestone etches away at the stone creating a thin zone of highly concentrated alkalinity and elevated pH near the surface of the stone. This zone is then purported to be capable of treating the mine drainage including manganese which is not normally addressed with limestone-based systems. The precipitate of manganese most commonly associated with the process is named Pyrolusite® from which the name of the process is derived. The microbes are aerobic, hence the need to divert the water within the bed to the surface for atmospheric aeration. Under a contract with Allegheny Mineral Abatement, Inc. of Midland, Maryland, raw discharge water from the Kregar Mine discharge was collected. A variety of microbe species were tested to determine the best combination for treatment of this specific water. The selected species were then cultured to produce an adequate supply of the microbes for the size of the bed. The Laurel Run Pyrolusite® bed was then inoculated with the cultured microbes using pits temporarily excavated into the surface of the bed and plastic pipe ports installed in the limestone bed during construction.

The Laurel Run Pyrolusite® bed was designed for a flow of 30 gpm with a retention time of 2 ½ days. The dimensions of the bed are: 150 feet long x 40 feet wide x 5 feet deep. The bed is lined with a 40 mil polyethylene (PE) synthetic liner which was custom made in one piece and delivered to the site for installation. The bed is filled with an AASHTO No.57 limestone which is 1 ½ " to No.8 Sieve (2.36 mm) gradation. The limestone was specified to be no less than 87% calcium carbonate equivalent. Four baffles made from mine conveyor belt are embedded within the limestone across the width of the bed at even intervals along the length of the bed. These baffles are installed in an alternating pattern first at the top and then at the bottom of the bed in order to divert the flow vertically from top to bottom throughout the length of the bed. This vertically alternating flow pattern directs the flow to the surface for aeration to supply oxygen for microbe metabolism. Three inoculation ports fabricated from 4 inch corrugated plastic pipe are installed vertically from the surface into the limestone bed at even intervals along the length of the bed for introduction of the Pyrolusite® microbe culture. A loose-fit cap is installed at the surface on the opening of each port.

The Pyrolusite® bed is situated adjacent to the Kregar Mine discharge so that this raw water is directed by a short shallow channel into the surface of the stone at one corner of the bed. The flow is then directed by the baffles vertically up and down within the stone through the length of the bed to the effluent end. At the effluent end of the bed, the flow is directed to the surface where a shallow depression in the stone is located at the opposite corner from the raw water influent. A solid 8" PVC pipe then discharges the treated water from this surface depression and out of the bed.

☀ *Pyrolusite® Bed Plan and Sections:* [Link](#) (NOTE: Multiple page PDF file.)

Laurel Run Kregar Mine Discharge

Pre-Construction Representative Water Chemistry

(SIS Monitoring Point LR1)

Flow (gpm)	pH	Alkalinity (Mg/L)	Hot Acidity (Mg/L)	Total Iron (Mg/L)	Aluminum (Mg/L)	Manganese (Mg/L)	Sulfate (Mg/L)
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PROJECT INFORMATION

- ▶ Project No.: BD 2310
- ▶ Problem Area: 1948
- ▶ Project Name: Laurel Run
- ▶ County: Westmoreland
- ▶ Municipality: Cook Township
- ▶ Consultant Design: Allegheny Mineral Abatement, Inc., Box 246, Midland, Maryland, (301) 729-0741
- ▶ BAMR Project Development and Construction Oversight: Richard Beam, BAMR Cambria Office, Ebensburg, PA
- ▶ Constructed By: DEP, BAMR, Cambria District Office, In-House BD Construction Crew
- ▶ Construction Start Date: August 19, 1997
- ▶ Construction Completion Date: September 18, 1997
- ▶ Final Construction Cost: \$121,722.05
- ▶ Project Funding: SMCRA, Title IV, Set-Aside Program

PROPERTY OWNER INFORMATION

Treatment System Site

The property which the Laurel Run Passive Treatment System occupies is within Forbes State Forest.

Property Owner: Commonwealth of Pennsylvania, Department of Conservation and Natural Resources (DCNR)

Bureau of Forestry
Central Office
6th Floor, Rachel Carson State Office Building
P.O. Box 8552
Harrisburg, PA 17105-8552
Phone: 717-787-2703
Fax: 717-783-5109

Forbes State Forest
Field Office
P.O. Box 519
Laughlintown, PA 15655-0519
Phone: 724-238-1200
Fax: 724-238-5000

The Right of Entry Agreement obtained by the DEP, BAMR with the Bureau of Forestry for this project was by Memorandum of Understanding (MOU). This MOU consisted of a cover letter with signature spaces and attached Job Description and property map. The only reference within the MOU to any sort of provision for post-construction access to the site is wording within the Job Description which states, "Some additional clearing and access road construction will be necessary to allow access to the site. The road will remain after construction to allow for infrequent maintenance on the treatment system and to collect water samples on a monthly basis."

Even though this reference as to post-construction access to the site exists within the MOU with the Bureau of Forestry, the access road to the site is on a different property which is private. A

separate agreement for access only across this property was negotiated and has since expired.
(See the following property information.)

Site Access Only

Access to the Laurel Run treatment system site is across private property for which a separate Right of Entry Agreement was obtained. This agreement has since expired.

Property Owner: Franklin R. and Marlene V. Cairns
Box 170
Stahlstown, PA 15687

A standard BAMR Consent for Right of Entry Agreement for access only was negotiated for an access road across the Cairns property. This agreement contains an Addendum added by the Cairns with conditions for negotiation of the access road right-of-way (R.O.W.) across their property. The final condition of this Addendum states, "Any and all parts of this R.O.W. shall expire 3 years and three months from the signing of this consent of entry." The Cairns signature date on this agreement is July 11, 1997. On aerial photography taken in 2006 the Cairns property appears to have been significantly altered with extensive grading and construction of ponds around the residence. The original access road to the Laurel Run system appears to have, for the most part, been eliminated.

SYSTEM MONITORING

All monitoring of the Laurel Run passive treatment system is performed by the BAMR Cambria District Office. Samples are being submitted to the DEP lab under SIS Project ID: PA1948, SIS Project Name: Laurel Run. Currently there are 22 active monitoring points under this project in the DEP SIS system. Only two of these points are currently monitored as a normal sampling event for the Laurel Run passive treatment system. These two monitoring points are: LR1 – the mine drainage raw water influent to the system and LR2 – the treated effluent from the system. The remainder of the monitoring points under SIS Project ID PA1948 include the Friedline Passive Treatment System and various stream monitoring points on Laurel Run and White Oak Run. Some combination of a number of these additional monitoring points is usually included during a monitoring event of the Laurel Run system.

Flow through the Laurel Run passive treatment system is measured by bucket and timer at the effluent end of the 8" PVC discharge pipe from the Pyrolusite® bed. The fall from the end of this pipe is approximately 4 feet and average flow from the system has been approximately 13.5 gpm both of which aid in bucketed flow measurement. No flushing capability exists for the Laurel Run Pyrolusite® bed.

Monitoring of the Laurel Run passive treatment system tapered off drastically following expiration of the access agreement across the Cairns property in late 2000. Since expiration of this agreement, access to the Laurel Run site has been by foot from the Friedline system approximately ½ mile downstream. This ½ mile hike between the Friedline and Laurel Run systems is cross country through woods over rocky terrain without trail or roadway. After expiration of the Cairns access agreement, monitoring of the Laurel Run system dropped to twice yearly in 2002 and 2003. After 2003 no monitoring of the system occurred at all until 2008. Through 2008, 2009 and 2010 the Laurel Run system was monitored once each year.

☀ *Laurel Run SIS Monitoring Points:* [List Link](#)

☀ *Discharge Pipe Effluent & Flow Measurement Point (LR2):* [Photo Link](#)

SYSTEM PERFORMANCE

Flow through the Laurel Run passive treatment system has averaged approximately 13.5 gpm since the completion of construction. Flow range has been from a minimum of 0.6 gpm to a maximum of 75 gpm, although this maximum flow is an outlier with the next highest recorded flow at 25 gpm. Average flow with the 75 gpm outlier eliminated is 10.2 gpm. The most frequent flow recorded is 18 gpm.

For the first 11 years of operation the Laurel Run passive treatment system produced a net alkaline effluent and eliminated essentially all metals from the water it treated. However, since the monitoring event of July

8, 2009, analysis has shown a trend of decreasing alkalinity, increasing metals and increasing hot acidity in the system effluent with the first ever net acid discharge and lowest ever pH and alkalinity recorded on April 28, 2010. Inspection of the site on July 20, 2010 revealed apparent clogging of the stone at the influent end of the Pyrolusite bed. The raw water influent enters the bed at the surface, as designed, but the clogged stone in this area is currently causing the flow to remain on the surface where it is diverted to one side of the bed. At the edge of the bed this flow has armored the surface stone and remains on the surface in a drainage course that travels the edge of the bed to the discharge pipe on the surface at the opposite end of the bed.

☀ *Clogged Stone Causing Surface Flow Across Bed:* [Photos Link](#) (NOTE: Multiple page PDF file.)

Analysis of the Laurel Run passive treatment system water sample data set revealed one peculiarity with respect to system performance. From the very beginning of system monitoring, for a considerable majority of the samples taken, the treatment bed effluent analysis shows increased sulfate concentration from that in the raw water influent samples. At the time of data collection for the subject report, the analyses for 31 sampling events were available for the Laurel Run system. Of these 31 analyses 26, or 84%, showed increased sulfate concentration in the effluent samples. The overall average increase for all 31 samples was 58.7 mg/l or a 25.6% increase in sulfate concentration. Of the 26 samples that showed increased sulfate in the effluent, the average increase was 76 mg/l or a 33% increase in sulfate concentration from the raw water influent average for these same 26 sampling events.

☀ *Sulfate Analysis:* [Chart Link](#)

Laurel Run Passive Treatment System Performance **Representative Water Quality Averages**

	Flow (gpm)	pH	Alkalinity (mg/L)	Hot Acidity (mg/L)	Total Iron (mg/L)	Aluminum (mg/L)	Manganese (mg/L)	Sulfate (mg/L)
Raw Water Influent	-	3.61	0	89.9	4.56	7.14	10.88	229.12
Treated Effluent	13.5	7.45	110	-43.1	0.03	0.29	0.47	287.78
Difference	-	+3.84	+110	-133	-4.53	-6.85	-10.41	+58.66
% Difference	-	+106%	-	-148%	-99%	-96%	-96%	+25.6%

☀ *Laurel Run System Water Sample Analysis:* [Charts Link](#) (NOTE: Multiple page PDF file.)

AQUATIC ECOSYSTEM INTEGRITY

Pennsylvania Code, Title 25, Chapter 93.9t (Drainage List T) includes Laurel Run by reference under Loyalhanna Creek, Zone: Basin, Source to Laughlinton Run. There are two designated protected water uses listed for this zone: Special Protection – HQ; and Aquatic Life – CWF. The 2010 Pennsylvania Integrated Water Quality Monitoring and Assessment Report lists Laurel Run under the Category 2, Streams List of Waterbodies Attaining Some Uses. The Use Attained for Laurel Run reported on this list is Aquatic Life.

PA DEP recently adopted the Instream Comprehensive Evaluation (ICE) protocol to assess aquatic life uses of Pennsylvania wadeable waters. Under the ICE protocol benthic macroinvertebrates are sampled and scores for each of a series of six biological metrics are calculated. These scores are then standardized, adjusted and combined to produce an Index of Biological Integrity (IBI) for the benthic macroinvertebrate community at each sample station. The adjustment and standardization of the six biological metric scores provide for a final IBI score of between 0 and a maximum of 100. Such IBI scores are then used as an assessment tool for resource management including evaluation of the attainment of a stream's protected use designations. Under the IBI developed by PA DEP for benthic macroinvertebrate

communities in wadeable freestone streams, scoring benchmarks applied for assessment of protected use attainment are as shown in the following table:

Protected Use	IBI Scoring Benchmark Supporting Use
EV, HQ	>= 80.0
CWF	>= 63.0
TSF	
WWF	

Water Quality and Macroinvertebrate surveys were conducted on Laurel Run by the DEP BAMR using the ICE assessment protocol in both 2008 and 2010. The IBI scores for all stations in both of these surveys met or exceeded the benchmark score of 63 supporting attainment of the stream's CWF protected use.

Macroinvertebrate Survey Stations	IBI Scores	
	2008 Survey	2010 Survey
LRUS	63.9	64.6
LRDS	76.9	72.2
LR381	Not Sampled	69.0
LRM	80.9	79.1
WOUS	73.5	70.2
WODS	86.4	64.6

☀ *Laurel Run Macroinvertebrate Survey Stations Map:* [Map Link](#)

☀ *Laurel Run Macroinvertebrate Survey 2008:* [Link](#)

☀ *Laurel Run Macroinvertebrate Survey 2010:* [Link](#)

RECOMMENDATIONS

- New access to the Laurel Run Passive Treatment site should be established. The original Consent for Right of Entry Agreement for access only across the property of Franklin and Marlene Cairns has expired. Negotiation of this original agreement had been problematic. The agreement contained an Addendum added by the Cairns with conditions for negotiation of the access road right-of-way across their property including an expiration clause which has since transpired. On aerial photography taken in 2006 the Cairns property appears to have been significantly altered with extensive grading and construction of ponds around the residence. The original access road to the Laurel Run system appears to have, for the most part, been eliminated.

Access to the Friedline system, approximately ½ mile downstream from the Laurel Run site, is across property owned by the Carnegie Institute for operation of their Powdermill Nature Reserve. A standard BAMR Consent for Right of Entry Agreement was negotiated with the Carnegie Institute for the Friedline system. This agreement includes a "Block 10" clause for perpetual right of entry across the Carnegie property in order to maintain the Friedline system.

The Carnegie Institute property is contiguous with the Bureau of Forestry property upon which the Laurel Run system is located. This Carnegie property is upland from the Laurel Run and Friedline systems and contains open fields with dirt roads. One of these fields is located at the top of the forested western slope leading up from the Laurel Run site. From aerial photography this field appears to have a dirt road/quad trail running along the treeline above the Laurel Run site. This road is a branch leading from the main access road to the Friedline system and runs along the open ridge top within approximately 800 feet of the Laurel Run system.

The forested western slope from the Laurel Run site should be investigated to see if there are any old trails or roadways leading up through the woods to the open field above on the Carnegie property which might be developed as a new access road to the Laurel Run system. If such potential exists, the Carnegie

Institute should be approached for negotiation of an agreement similar to the Friedline system providing perpetual access to the Laurel Run system.

☀ *Property Owners & Access:* [Map Link](#)

- Clogging of the stone at the influent end of the Laurel Run Pyrolusite bed is causing the flow to remain on the surface where it is diverted to one side of the bed and travel the edge along the surface to the discharge pipe on the surface at the opposite end of the bed. Recent effluent sample analyses exhibit elevated metals and acidity and decreasing pH and alkalinity due to this short circuiting across the surface of the bed.

The stone in the Laurel Run Pyrolusite bed should be cleaned. A simple turning of the stone with a backhoe would probably return the flow subsurface through the stone once again at least temporarily. This situation at the Laurel Run system is similar to the same problem which had plagued the Squatter Falls Pyrolusite system on Glenwhite Run in Blair County, only Squatter Falls was on a much larger scale and more frequent occurrence. The solution which has worked the best at Squatter Falls was to slope the stone within the bed from the influent end upwards towards the effluent end. The stone at the influent end was lowered to where an open pool of standing water exists which created an open face across the full width of the bed for the flow to seep into the stone. Now as the stone clogs along this open slope the open pool can rise to a level where clean stone is encountered and the flow continues through the stone. The surface effluent point was also eliminated at Squatter Falls. A large perforated collection pipe was installed at the effluent end across the bottom width of the bed. This pipe was then connected to an inline style water level control box to allow adjustment of the pool within the bed. Where the Squatter Falls Pyrolusite bed had required maintenance at least annually and sometimes twice a year, the bed has now operated 3 years without maintenance since the described modifications.

The Pyrolusite bed at Laurel Run would benefit from the same modifications as constructed at Squatter Falls on Glenwhite Run. At Squatter Falls the clogged stone was removed and stockpiled for use on the site access road. The same might be done at Laurel Run. However with the much smaller size of the bed at Laurel Run the remaining stone within the bed may need to be cleaned with the cleaning water then pumped to a settling basin or filter bag. Use of a Flip-Screen Bucket might also be a possibility.

☀ *Proposed Modifications:* [Link](#)

APPENDIX

- ▶ [Loyalhanna Creek Watershed Assessment and Restoration Plan](#)
- ▶ [Forbes State Forest Map](#)
- ▶ [Powdermill Nature Reserve](#)