MANAGEMENT AND CONTROL OF ABANDONED MINE POOL DISCHARGES – PA CASE STUDIES

Patrick Webb, P.E. and Richard Beam, P.G.
Abandoned underground mine pools and associated AMD discharges in Pennsylvania frequently present substantial challenges in terms of both mitigation of environmental damage and alleviating health and safety impacts to residents and public infrastructure.

Over the years, the PA-DEP’s, Bureau of Abandoned Mine Reclamation has employed a variety of methods to address these problems.
Mine Pool Management Methods (to be Discussed in this Presentation)

- Discharge / Outfall Relocation
- Mine Pool Dewatering
- Drilling
- Mine Pool Stabilization / Mine Blowout Prevention
- Beneficial Use of Mine Pool Water
- Mine Pool Transfer
- Treatment
Case Studies

- Lancashire
- McDonald
- Solar Mine (Cooperative Project with the PA Turnpike Commission)
When things don’t go as planned

• Elizabeth Township
Project Included:

• Discharge / Outfall Relocation
• Vertical Drilling / Hydrogeologic Study
• Mine Pool Stabilization / Mine Blowout Prevention
• Treatment and Beneficial Use of Mine Pool Water
• Lancashire 15 underground coal mine is approximately 6,600 acres or 10 square miles.

• However, mines that may contribute to the mine pool encompass over 14,000 acres or more than 22 square miles.

• Barnes & Tucker Coal Company closed Lancashire 15 on July 14, 1969 (pumps shut off) and it began to flood.

• There was a major blowout in late June or early July, 1970, when the mine water level reached 1510’ msl.
• The blowout was about 8 million gallons per day (>5,500 gpm).

• The West Branch of the Susquehanna River had an in-stream acid load of 210,000 lbs. per day (as CaCO$_3$).

• The West Branch was significantly impacted at least 100 miles downstream. Enough to cause a major fish kill.

• In November of 1970, Barnes & Tucker began pumping the mine pool down and eliminated the discharge to the West Branch
• Subsequent Litigation conducted from 1970 – 1974 determined the Barnes and Tucker Coal Company responsible for perpetual treatment of the discharge (Landmark mine drainage case law)

• They pumped and treated the mine water until bankruptcy (September 2001). The Commonwealth then took over treatment
Duman Treatment Plant
Proposed New Treatment Area
Eastern Continental Divide
Duman Treatment Plant
### Old Treatment Location

- **Pump rate**: 5000 gpm
- **pH**: 6.6
- **Fe**: 42 mg/L
- **Alkalinity**: 172 mg/L as CaCO₃
- **Hot Acidity**: -98 mg/L as CaCO₃

### New Treatment Location

- **pH**: 3.8
- **Fe**: 118 mg/L
- **Al**: 10.4 mg/L
- **Mn**: 3.8 mg/L
- **Hot Acidity**: 276 mg/L as CaCO₃
Borehole Pumps at original treatment site
• In November 2011, the Commonwealth completed the construction of a new hydrated lime treatment facility which replaced the original Barnes and Tucker system.

• The treatment process includes:
  – preaeration to exsolve CO$_2$(aq) from raw mine water
  – dense sludge recirculation
  – Polymer addition

• Initial net acidic influent is now net alklaine
New Location: Lancashire Treatment Plant

• Primary Consultant: Michael Baker Corp., Pittsburgh Pa
• Process Design: Veolia North America
• Contractor: HRI Inc.
• Date Completed: Nov. 2011
• Treatment strategy had to consider net acidic conditions at the edge of the mine pool

• Max. Design Capacity: 12.5 MGD (8,680 gpm)

• Design Water Quality

  pH = 3.8  
  Fe = 118 mg/L  
  Al = 10.4 mg/L  
  Mn = 3.8 mg/L  
  Hot Acidity = 276 mg/L as CaCO₃
Lancashire: Dense Sludge Treatment

Pre-Aeration Basin

Ferrous Reactor Basin

Floc. Clarifier/Thickener

Sludge Conditioning Reactor

Polishing Pond

Hydrated lime

Q_{ave.} = 7.4 \text{ MGD (5,138 gpm)}

to receiving stream

Polymer

Underflow disposal
146,000 gal Decarbonation tank with Westech Landy 7 surface aerator

305,000 gal Ferrous Reactor Tank w/ Westech Landy 7 surface aerator

180 ft Westech THC 30 thickener, 2,855,142 gal

NEFCO density baffle

146,000 gal Decarbonation tank with Westech Landy 7 surface aerator
• Under normal flow conditions (4000 gpm)
  – 5 Tons/day of Ca(OH)\textsubscript{2} were needed to meet plant effluent goals
  – Current Hydrated lime cost is $160.00/ton
  – Lime product costs have risen significantly over the past 5 years and are likely to continue to do so

• Evaluation showed that only 36% of the lime added was being consumed by pH & mineral (iron) acidity reactions.

• Remaining lime consumed by nuisance reactions
  – Calcite Formation – 29%
  – CO2 and Hydroxylation acidity - 35%
Alternative treatment: Hydrogen Peroxide (H$_2$O$_2$)

- Near instantaneous iron oxidation without pH adjustment
- No nuisance reactions
- Only minor plant modifications required
- Additional electrical & sludge disposal savings
U.S. Peroxide “Turn Key” System

- All capital equipment and installation provided
- 90 day trial period with option to extend 1 year at current cost ending December 2014
- 3 year agreement 12/14 – 12/17
Site testing began September 9, 2013. operated at 4000 gpm under varied polymer and sludge return rates.

Oct. 23rd to Nov. 6th operated at plant design capacity 7000 gpm

Currently operating at 3000 gpm
**Lancashire Site Effluent**

<table>
<thead>
<tr>
<th>CaOH₂</th>
<th>H₂O₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 8.1 – 8.5</td>
<td>pH 7.0 – 7.6</td>
</tr>
<tr>
<td>Total Fe 1.0 - 1.6 mg/l</td>
<td>Total Fe 0.3 – 1.5 mg/l</td>
</tr>
<tr>
<td>TDS 650 - 700 mg/l</td>
<td>TDS 600 - 640 mg/l</td>
</tr>
</tbody>
</table>
Lancashire Site Summary

- Superior performance under all tested conditions
- Reduced plant maintenance
- Significant sludge volume reduction
- Likely need to use lime under extended drawdown conditions
Lancashire Site Summary

- Annual Chemical Cost Savings - $182,500.00
- Annual Electrical Cost Savings - $30,000.00
- Total Cost reduction - $212,500.00/year

www.cleanstreams.net/status

Lancashire #15 Plant Data
Project Included:

• Discharge / Outfall Relocation
• Vertical Drilling
• Hydrologic Investigation
• Mine Pool Stabilization / Mine Blowout Prevention
Jan 25th 2005 a mine pool blowout occurred in the town of McDonald, Washington County Pennsylvania.

- 8000 to 10000 gallon per minute of mine water
- Blowout location was near the down dip cropline of the Pittsburgh Coal Seam (~ 15 ft of overburden)

- 1930’s era underground mine owned by the Pittsburgh Coal Company.
- The mine was called the Nickel Plate Mine.
• PA DEP Emergency Response staff, Borough Officers and staff and several local volunteer fire departments responded

• OSM and PA DEP BAMR worked cooperatively to evaluate and manage the problem

• OSM developed a short term plan/project to address the immediate emergency

• BAMR assisted in the initial effort and committed to implement a plan/project to manage the long term impacts of the abandoned mine and the discharge.
BAMR implemented an emergency contract to construct drainage control facilities so as to prevent mine water discharges unto borough streets and/or private residences.

The contract scope of work included:

I. Assessing the mine pool blowout and determine information adequacy, and needs

II. Developing a list of options to manage, control and convey the mine pool discharge

III. Providing all necessary equipment and personnel to pump the mine pool from the existing blowout location as necessary to prevent an uncontrolled discharge
iv. Developing and implementing an exploratory drilling and monitor well installation program to assess potential mine pool water management locations and strategies.

v. Participating in conjunction with BAMR in municipal and/or public meetings in order to provide information and project status reports.

vi. Design and construct (with BAMR review and approval) facilities to permanently manage, control and convey the mine pool water.
Tasks accomplished included:

I. Maintaining a 6-inch diesel pump at the blowout location on Liberty Street and pumping the mine pool as necessary

II. Designing and implementing an exploratory drilling and monitor well installation program

III. Collecting and evaluating all Geologic and Mine Map information available for the area.

IV. Developing detailed geologic structural contour maps from the newly acquired exploratory drilling data
• Tasks Accomplished – (cont.)

v. Acquiring right of entry documents from landowners where exploration activities were occurring.

vi. Performing mine pool drawdown and recovery tests to confirm hydraulic continuity within the mine complex.

vii. Providing status reports to Borough Officials, the public and the media
• The evaluation of the mine pool complex revealed several areas, one on the east side and one on the west side of the town, that had potential for development of a gravity drain system to control the mine pool.

• The area just east of the borough was selected as the preferred location
Primary gravity drain structure
Secondary emergency overflow drain structure
Stabilize and install an observation well at the blowout site
Data loggers installed at blowout area and primary drain structure
Project completed June 15, 2005
Mine pool pumping: $21,840.00
Development & Design: $82,914.00
Construction: $297,749.00
Total Cost: $402,503.00
Contract Start Date: Feb. 28, 2005
Project completed: June 15, 2005
News Coverage

WHEEL OF FORTUNE

TONIGHT AT 7:30 PM

WPXI

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION
Project Included:

– Discharge Relocation
– Mine Pool Dewatering and Treatment
– Mine Pool Stabilization
Mine Pool Discharges Encountered During Highway Construction
• Highway Construction required daylighting portions of the abandoned mine
• Limestone underlying Pittsburgh Coal Seam
• Modified ALD with open joint pipe to convey discharge and provide treatment
• PTC consulted with DEP BAMR to modify design
• Existing sedimentation ponds were used for passive treatment
• Construction management, change orders and all additional cost (~ $150,000.00 ) covered by PTC
Project Included:

- Discharge Relocation
  (OSM Emergency Projects)
- Horizontal Drilling and Pipe Line
- Mine Pool Stabilization
- Uncontrolled Mine Pool Release
Elizabeth Township Case Study
Elizabeth Township Case Study
Elizabeth Township Case Study

- Warden Mine opened in 1925 by Pittsburgh Coal and Coke Company
- Ocean Mine #2 interconnects with the Warden Mine
- Mining conducted in the Pittsburgh Coal Seam
- Mine Closed in 1954
- Blow out in 1960s
Elizabeth Township Case Study

1970

24” Mine Drain
Elizabeth Township Case Study

• June 1970 - Drainage problems developed with the existing 24” Vitrified Clay Pipe (VCP) mine drain, therefore, B-134 (B-9) Project cleaned the existing 24” VCP mine drain (1000 gpm), installed a concrete catch basin and installed a 24” Reinforced Concrete Pipe (RCP) to safely convey the Alkaline mine discharge from the Warden Mine workings through the 24” VCP to the catch basin and then through the 24” RCP to Douglas run at a cost of $3,342.

• Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning
  • 4/1972 – DEP Pipe Cleaning Contract
  • 4/1978 - DEP Pipe Cleaning Contract
Elizabeth Township Case Study

• Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning
  • 1/1979 - DEP Pipe Cleaning Contract
  • 4/1982 - DEP Pipe Cleaning Contract
  • 4/1984 - DEP Pipe Cleaning Contract
  • Mine Blows out in 1986
Elizabeth Township Case Study

Manhole

1986
Elizabeth Township Case Study

• Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning
  • Mine Blows out in 1986
  • 4/1986 - PA-86-064 - OSM Emergency Project to stabilize a dangerous slide with the construction of: a concrete lagging wall, horizontal drilling mine drains began, but during construction the min pool blew out,
  • 5/1988 – DEP BD Pipe Cleaning
Elizabeth Township Case Study

- Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning
  - 12/1992– DEP BD Pipe Cleaning
  - 10/1993– DEP BD Pipe Cleaning
Elizabeth Township Case Study

1996

[Sketch of Elizabeth Township Case Study]

PROPERTY OF:
DR. ROMA & BERTHA DONOCHIE
SEEP AREA

WARDEN LEVEL (SEALED)

CLEAN-OUT,
APPROX. 1/2 TO 2 DEEP

24" R.C.P

MAN HOLE,

24" DEEP

DOUGLAS RUN ROAD

DOUGLAS RUN ROAD

SKETCH
NO SCALE

INQUIRY NO. 96-06-223

WIRE DRAINAGE

ELIZABETH TOWNSHIP

ALLEGHENY COUNTY
Elizabeth Township Case Study

- Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning
  - 3/1997 – DEP BD Pipe Cleaning
  - 4/1998 – PA-98-041 - OSM Emergency pipe cleaning performed
  - 5/2000 – PA-00-047- OSM Emergency pipe cleaning performed
  - 6/2003 – DEP BD Pipe Cleaning
  - 4/2004 – DEP BD Pipe Cleaning
  - 5/2004 – PA-04-060 - OSM Emergency pipe cleaning performed
  - 6/2006 – DEP BD Pipe Cleaning
  - 1/2011 – DEP BD Pipe Cleaning
Elizabeth Township Case Study

2011
Numerous modifications undertaken by both PA DEP and OSM over the years, Drain required annual maintenance and cleaning

- 3/21/2011 – Mine Blows out
- 3/21/2011 routine pipe cleaning was being performed due to mine water bleeding out of the hillside in numerous places along the outcrop behind several homes in the area
- During the cleaning, it was apparent that the pipe was clogged upstream of the man hole, once the pipe cleaner worked its way into the clogged area, it unleashed the impounded mine pool and the man hole/pipes were overcome by the impounded mine pool (water spouted 2 feet high) which flooded the man hole and downstream topography. Mine pool water entered the unfinished basement of the Soncini Property that was being rented by Bill Hinerman
- 9/2011– DEP BD Pipe Cleaning
- 6/2012– DEP BD Pipe Cleaning
- 11/2012– DEP BD Pipe Cleaning
- 4/2014– DEP BD Pipe Cleaning