Successful acid mine drainage abatement – A case study

Joseph E. Mills

Skelly and Loy, A Terracon Company, Harrisburg, PA, USA, jmills@skellyloy.com

Abstract

Since 1979, forty-five passive Acid Mine Drainage (AMD) treatment systems have been constructed in the Six Mile, Sandy Run and Longs Run watersheds, located in Broad Top Township, Bedford County, Pennsylvania. The first AMD treatment system was funded by the Rural Abandoned Mine Program (RAMP). The success of this project and a growing community interest in AMD abatement prompted a watershed study that was completed in 1981. This study identified illegal garbage dumping, sewage, and AMD as the major problems in the study area.ntrations or for those that don't accompany alkalinity additions with anoxic conditions.

Broad Top Township has addressed the garbage and sewage by making garbage disposal affordable to all its residents and by taking ownership of the sewage management practices within the township. By the mid-1990s, additional RAMP and Bureau of Abandoned Mine Reclamation (BAMR) projects were completed. In 2005, a Watershed Implementation Plan (WIP) was completed for Longs, Sandy, and Six Mile Runs. Since then, over $6.5 million of Clean Water Act's Section 319 funds and over $0.5 million of Pennsylvania Department of Environmental Protection's (DEP) Growing Greener Grant money has been spent on AMD abatement projects in the watersheds.

All the systems constructed since 2005 have been designed to treat the high flow discharges for a minimum of 20 years. These AMD discharges vary in quantity and quality from site to site. The design goal of all the AMD treatment systems is to remove 85% of the metal and acid loads entering the streams. Challenging construction conditions were encountered at most of the treatment sites, including steep terrain, geology, and minimal land area availability due to some seeps close proximity to streams. The challenging conditions will be discussed.

A variety of passive treatment technologies have been employed. The technology chosen for each site is tailored for that site based on the chemistry and flow at that AMD seep location. In 2014, after construction of 13 AMD treatment systems and intense biological studies by DEP, Longs Run was no longer considered biologically impaired, and was delisted in the Pennsylvania Integrated Water Quality Monitoring and Assessment Report (Integrated Report).

Funding and construction restraints and the importance of following an operation and maintenance (O&M) plan for the systems as well as chemical and biological improvements will be discussed.

Keywords: Acid mine drainage, treatment systems, chemical improvements

Introduction

Since 1979, forty-five our passive Acid Mine Drainage (AMD) treatment systems have been constructed in the Six Mile Run, Sandy Run and Longs Run watersheds, Broad Top Township, Bedford County, Pennsylvania, an area of 48.5 square miles. Funding for these systems came mainly from the Environmental Protection Agency's Section 319 Grants and Pennsylvania Department of Environmental Protection's (PA DEP) Growing Greener Grant program.

To date, according to information provided by Broad Top Township, over $6.5 million of 319 Grant money and $0.5 million of Growing Greener Grant money have been expended in the construction of the AMD Treatment Projects. It should be noted that as of the passage of the Bipartisan Infrastructure Investment and Jobs Act

(BIL) in 2021, the PA DEP will no longer be awarding Growing Greener Grants for the AMD related projects. Those funds will be banked for DEP's use in the future. AMD related projects will be funded by BIL money, until that program ceases.

In 1977, under the Surface Mine Control and Reclamation Act, (SMCRA), the Rural Abandoned Mine Program (RAMP) was authorized and administered by the local conservation districts. SMCRA required Abandoned Mine Land Reclamation Funds to be collected through a surcharge placed on each ton of coal mined by either surface or underground methods. These funds were collected by the Federal Office of Surface Mining. Approximately 50% of the reclamation funds were distributed to the mining States and Tribes with mined lands with the other 50% being considered the "Secretary's Share". RAMP received approximately 20% of the "Secretary's Share". Funds have not been distributed through the RAMP program since the mid-1990's, and in 2006, SMCRA was amended, and the RAMP program was written out of the Act.

In 1979, at an AMD site located near a local church, the first AMD treatment system was constructed in Broad Top Township. This project was constructed using RAMP funding. The high visibility of this project is credited with spurring the interest of the citizens and the township supervisors to explore the recovery of the mine affected streams in Broad Top Township.

The growing interest in AMD abatement led to the development of a watershed study which was completed in 1981 (Bedford County Conservation District 1981). This study was sponsored by the three local conservation districts and relied heavily on community input. The study identified illegal garbage dumping, sewage, and AMD as the major problems in the study area. It took until the 1990s for the study to gain momentum leading to concerted efforts to address these problems.

In 1991, a Municipal Solid Waste Landfill began operation in the township and was expanded in 2011. Prior to beginning operation, an agreement was signed between the landfill and the Township. The Township negotiated numerous clauses into the agreement that were friendly to the citizens of Broad Top Township. The agreement has virtually eliminated illegal dumping in the watersheds.

In 1995, a Pennsylvania Sewage Facilities Act 537 Plan was completed (Tatman and Lee Associates 1995). Broad Top Township installed sewage treatment systems for between 800 and 850 homes. Broad Top Township owns and maintains the sewage treatment system, therefore there are no repair fees charged to the citizens and the Township assures that the systems are functioning. Before the implementation of the plan, 75% of the residents had malfunctioning sewage systems. The implementation of this plan has eliminated the nitrate and bacteriological problems in the streams.

Acid Mine Drainage

After the success of the RAMP project in 1979, three passive AMD treatment projects were constructed in the upper reaches of Sandy Run by Pennsylvania's Bureau of Abandoned Mine Reclamation (BAMR). These projects were completed in the mid-1990s. In 2005, an assessment of the streams was completed and remediation plan followed by a Watershed Implementation Plan (WIP) in 2005 (PSU 2005, Skelly and Loy 2005).

All the AMD treatment systems constructed since 2005 have been designed to treat the high flow discharges for a minimum of 20 years. These discharges vary from site to site with measured flow rates ranging from a low of 3 gpm to a high of 300 gpm. The chemical characteristics of each AMD also varies from site to site. The goal of each AMD treatment system is to remove 85% of the metal and acid loads entering the streams.

Construction of many of these projects often present challenges due to constraints caused by the steep streamside topography and/or the proximity of the AMD seep to the stream channel. Most of the projects are constructed between steep hill sides and flood plain boundaries. Occasionally, the seeps required piping or ditching the AMD hundreds of feet from the source to an area suitable for the construction.

A variety of passive treatment technologies

have been employed in the three watersheds. The technology chosen for each site is tailored for that site based on the chemistry and flow at that AMD seep location. The list of technologies utilized includes limestone channels, vertical flow limestone ponds, flushable limestone leach beds, wetlands, oxidation channels, automatic flushing devices (siphons and motor driven valves) and sediment removal basins.

Longs Run

Longs Run is the major tributary to Sandy Run. It is approximately 5.25 mi (8.4 km) long and discharges into Sandy Run approximately 0.5 mi (0.8 km) upstream of Sandy Run's confluence with the Raystown Branch of the Juniata River. Numerous mines, abandoned prior to the enactment of SMCRA, discharged acidic, metal laden water into Longs Run. AMD treatment systems were constructed at all but one known AMD drainages into Longs Run. The one lone seep that did not have a treatment system constructed to abate its drainage was small and has very little effect on the chemistry of Longs Run. Each AMD discharge was addressed beginning in the headwaters and working downstream. Most of the AMD discharges were concentrated near the headwaters of Longs Run. The final system in this watershed was completed in the early 2000s.

Longs Run Treatment Systems, Performance, and Environmental Effects

Thirteen AMD treatment systems were installed in Longs Run, a 5.25 mi (8.4 km) long tributary to Sandy Run. After completion of the final project in Longs Run, PA DEP conducted periodic, biological studies and in 2007 the first fish were documented in Longs Run. In 2014, based on data collected by PA DEP, Longs Run was delisted in the Pennsylvania Integrated Water Quality Monitoring and Assessment Report (Integrated Report) (PA DEP 2014). The Integrated Report is a comprehensive report of the water quality status of surface waters of the Commonwealth of Pennsylvania. It is comprised of the assessments for four protected uses of surface waters. Longs Run's protected use is aquatic life, which is defined as maintaining the flora and fauna indigenous to aquatic habitats. Longs Run was delisted with a Freestone Index of Biological Integrity (IBI) score of 78.3. Generally, any IBI score over 60 is considered to have attained cold-water fisheries status (PA DEP 2012).

Sandy Run

The Sandy Run watershed drains a considerably impaired portion of abandoned mine lands in Broad Top Township. The main stem of the stream flows approximately 5.25 mi (8.4 km) to its mouth near the town of Hopewell, where it enters the Raystown Branch of the Juniata River. Coal mining played a critical role in the industrial development of the region. Those mines are now abandoned, many are flooded and discharging into Sandy Run, and a few left spoil piles adjacent to the stream contributing to the contamination of Sandy Run and its tributaries. These abandoned mine land features are notable sources of water pollution within the watershed. Prior to 2014, Sandy Run was listed as impaired for both pH and metals in the Pennsylvania Integrated Water Quality Monitoring and Assessment Report, (Integrated Report) with a Total Maximum Daily Load (TMDL) established for the watershed as part of the Sandy Run Watershed TMDL (PA DEP 2014).

Sandy Run Treatment System Performance

Nine AMD treatment projects have been completed in the main stem of Sandy Run with another, SAO-D17, nearing completion at the time of this report. In 2019, Skelly and Loy evaluated these systems and their influence on Sandy Run (Skelly and Loy 2019). The three most upstream projects were designed and constructed by Pennsylvania's Bureau of Abandoned Mine Reclamation (BAMR). Any maintenance, on these projects, is also the responsibility of BAMR. Based on an assessment conducted by Skelly and Loy in the spring and fall of 2019, the three BAMR projects are all in need of maintenance and repair. One of the projects has breached and an estimated 90+% of the AMD is by-passing the system and flowing directly into Sandy

Run. The location of this input has a negative effect on the entirety of Sandy Run.

The other two BAMR projects are not very effective in treating their AMD discharges. One project discharges into the other project which discharges into a small, unnamed tributary to Sandy Run. The treated discharge was measured at 6.2 pH during low flow and 4.4 during high flow.

Communications with BAMR personnel indicate that these projects are being put on a maintenance schedule for the spring and summer of 2024.

The next six treatment systems in Sandy Run have discharge pH values over 7.0, which is an increase of 4.0 or more at each site. Each of the six systems are also discharging treated water with net alkalinity and lower metal concentrations.

Currently there are no other plans for future construction in Sandy Run, although known AMD sources, SA6-D1, D2 and D3, in an unnamed tributary are having severe effects on the chemistry of the unnamed stream and on Sandy Run, downstream of their confluence. This small tributary exhibits a pH below 4.0 and iron concentrations above 10.0 mg/L. These AMD sources are currently being studied for possible treatment in the future.

Sandy Run Stream Environmental Effects

The negative effects from the most upstream discharges are seen in the water quality analysis and the biological assessment of Sandy Run to its confluence with the Raystown Branch of the Juniata River. Additionally, the upper reaches of Sandy Run are also highly affected by sediment. The biological assessment of Sandy Run, conducted by Trout Unlimited (TU), shows the results of not only the sediment impairment but also the chemical impairment caused by the BAMR projects (TU 2019). TU's analysis of Sandy Run concluded that the benthic macroinvertebrate community and the fish community was impaired due to several potential stressors. TU identified those stressors as AMD and landfill effects (sediment).

Sandy Run Conclusions

Abatement of the effects of the unnamed tributary and revitalization of the three BAMR systems will remediate most of the existing chemical impairments in Sandy Run. An assessment of the sediment and erosion control system at the landfill may identify the source of the high sediment load in Sandy Run which would be the first step in correcting the sedimentation problem.

Six Mile Run

Six Mile Run flows 6.16 mi (9.9 km) from its headwaters to its mouth near the town of Defiance, where it enters the Raystown Branch of the Juniata River. Six Mile Run is listed as impaired for both pH and metals on PA DEP's Integrated List with a TMDL established for the watershed as part of the Six Mile Run Watershed TMDL.

Six Mile Run Amd Treatment Systems

Twenty-three AMD treatment systems have been installed in Six Mile Run. A study conducted by Skelly and Loy, in the spring and fall of 2017, showed all twenty-one of the constructed AMD treatment systems were discharging treated water that had a pH of 6.0 or greater with most discharging treated AMD greater than 6.5 pH (Skelly and Loy 2017).

One exception was a system (SXO-D16) in the lower section of the stream as it was discharging treated AMD with a pH of 5.07 during the sampling run conducted in March of 2017. The flow into the system on that date was approximately 50% greater than the system's design flow. Since 2017, other systems have been constructed downstream of SXO-D16. One system, SX10-D2, has discharged water below the 6.0 level, but is removing metals and acidity enough that the AMD no longer has a marked influence on Six Mile Run.

Six Mile Run Stream Effects

The study conducted in 2017 indicated that the chemistry of Six Mile Run is not severely influenced by any of the discharges from the constructed treatment systems. The pH of Six Mile Run was maintained between 6.0

and 7.3 from the headwaters to below the last constructed system. These data indicate that the constructed AMD treatment systems are accomplishing the goal set forth in the Watershed Implementation Plan developed in 2005.

The biological assessment of Six Mile Run, conducted by TU at the same time as the chemical assessment of the stream and treatment systems, indicate improvements throughout the stream but also indicate that biological impairment still exists (TU 2017). Moderate populations of brown trout were located at several locations, but no brook trout were found at any of TU's test sites. Young-of-the-year brown trout were found at a few sites, indicating the possibility that breeding is taking place.

Benthic measurements were taken at thirteen sites along the main stem of Six Mile Run. Six metrics were used to determine if the stream met the Aquatic Life Use (ALU) threshold for cold-water fishes, warm-water fishes, and trout stocked fishes. At three of the sites, the ALU was met and at two other sites the ALU was very close, and TU determined that those sites warranted further evaluation. At the remaining sites, the ALU was not met.

Biologic analysis indicated a problem around the system that was found to be discharging treated AMD at a pH below 6.0. The short term biological and chemical study and the data collected indicate that the system may be performing below expectations throughout much of the year. This system will be evaluated further in the future to determine if modifications can be made to improve its effectiveness.

Six Mile Run Conclusion

Many of the systems in Six Mile Run are nearing their design life and need refurbishing. Maintenance has been and is continuing to be performed by Township personnel. A maintenance grant was recently awarded to Broad Top Township and the maintenance on most of the systems in Six Mile Run has either begun or has been scheduled.

Conclusion

Much work has been completed in the watersheds within Broad Top Township, but studies indicate that more work is needed if the streams are ever going to approach the condition that existed prior to mining conditions in the watersheds. The studies, especially the studies conducted by TU, direct us to the areas in each stream that are in the most need of attention. Broad Top Township recently (2022) received a grant to specifically fund maintenance on the existing systems. Any maintenance work completed on the existing systems should improve the function of those systems which is expected to improve conditions in the receiving streams allowing for a more robust biologic recovery within the waters of Broad Top Township.

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