TANOMA SOUTH

Federal Office of Surface Mining
2002 AML Reclamation Award

Nomination Information

Project Name and Number:

Tanoma South Acid Mine Drainage Abatement Project, Project No. AMD 32(2447)101.1

Project Location:

The project is located in west-central Pennsylvania in the upper Crooked Creek watershed in Rayne Township, Indiana County, approximately 1/4 mile south of the small community of Tanoma near the intersection of Tanoma Road (SR 1005) and Rayne Church Road (SR 1007).

Submitted By:

Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation (DEP/BAMR)

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Construction Information:

Project Contractor: Casselman Enterprises, Inc. of Somerset, PA.
Project Start Date: June 4, 2000
Project Completion Date: December 8, 2000
Final Project Construction Cost: $358,902.31

Date Nomination Submitted:

March 2002

THE TANOMA BOREHOLE RECLAMATION PROJECT

EXECUTIVE SUMMARY

The Tanoma Borehole reclamation project was truly an innovative project that embodies the 21st century approach to watershed restoration by engaging the public and forging partnerships to achieve the greatest environmental benefit. Through the cooperation of a number of federal, state, and local government agencies working hand-in-hand with environmental groups and the general public, 3.5 miles of the upper Crooked Creek have been restored. This restoration has allowed for the re-establishment of indigenous aquatic life. Fish and macroinvertebrates have already begun to return to reclaim this waterway, once polluted by mine drainage. This project is exemplary because it demonstrated that a discharge, once thought to be untreatable due to its outfall location, could be relocated and successfully treated at a remote location. This was accomplished while carefully considering and mitigating for any potential negative impacts associated with the relocation, including impacts on local residents. The Tanoma passive mine drainage treatment system has functioned extraordinarily well since being put into service late in 2000.

MINING AND ABANDONED MINE PROBLEM HISTORY

The Clearfield Bituminous Coal Corporation operated a number of underground mines in the upper Crooked Creek Watershed. Three of these mines, the Barr Slope Mine, the Clymer No. 1 Mine, and the Clymer No. 3 Mine, Figure 1, contributed to the development of the Tanoma mine drainage discharges. The Barr Slope Mine opened around 1900, the Clymer No. 1 Mine opened in the 1910s and the Clymer No. 3 opened in the 1930s. The three mines operated in the Lower Freeport or "D" coal seam and are extensively interconnected such that they can be considered as a single abandoned underground mine complex. The mines closed in 1962, 1952 and 1956 respectively. The three mines all had two slope-type entries, with the Barr Slope entries located near the Village of Dixonville, the Clymer No. 1 entries located at the Village of Sample Run and the Clymer No. 3 entries located at the Village of Weimer. The complex covers an area of over 4,500 acres, and the average coal seam thickness was 42 inches. A large underground mine pool developed in the Clymer No. 1 and Clymer No. 3 mines following abandonment. Due to the down dip advance of the mining, the complex is approximately 50% inundated. The mine pool has been calculated to contain roughly two billion gallons of water. Figure 1 shows a map of the area with the location and extent of the three mines.

The most prominent outlet of mine drainage from the complex was a twelve-inch discharge borehole known locally as the 'Tanoma Borehole' or the C-7 borehole, Figure 2. The borehole was located within the Crooked Creek stream channel just upstream of the Village of Tanoma. The borehole had discharged continuously since shortly after mining operations at the two mines ceased in the 1950s. The discharge averaged 2,500 gallons per minute (3.6 million gallons per day) and contained significant dissolved iron (~20 mg/L) and some free acidity (~10 mg/L) which significantly degraded the quality within Crooked Creek for several miles below the discharge point.

Located near the Tanoma Borehole were several other boreholes which discharge mine water periodically. One of these is known as the C-6 borehole and consists of a 10-inch vertical borehole. Between boreholes C-6 and C-7, and located on the opposite bank from the boreholes, are two 27-inch overflow boreholes known as the MP-1 boreholes, Figures 1 and 2. Figure 1 shows the location of the various discharge boreholes and the approximate extent of the mine pool. The MP-1 boreholes are capped with steel grating and discharge seasonally when the mine pool rises due to spring rains and winter snow melts. Figure 2 shows photographs of both the Tanoma Borehole and the 27-inch (MP-1) overflow boreholes discharging large volumes of mine water directly into Crooked Creek. The MP-1 boreholes served as dewatering boreholes when the mines were actively operating. Water in the mines was pumped to a sump area at this location and then pumped to the surface through the MP-1 boreholes and discharged directly into Crooked Creek. Several other boreholes, openings, and man-ways into these two Clymer mines are known to exist, but none have been documented over the years to allow any significant discharge of mine drainage to local water courses.

Following closure of the mines, the discharge water quality from the Tanoma Borehole has improved. The discharge is now consistently alkaline (120 mg/L). The concentration of iron has also decreased slightly to approximately 15 mg/L. However, the volume of the discharge in relation to the normal base flow of Crooked Creek has resulted in significant iron precipitation that coated the stream bottom and colored it orange for several miles below the discharge during periods of low stream flow. Stream monitoring completed during 1996 and 1997 showed that the Tanoma Borehole discharge accounted for an average of 42% and a peak of 83% of the total stream flow within Crooked Creek. This sheer volume of contaminated mine water has had significant adverse impacts on the water quality and the associated density and diversity aquatic life in Crooked Creek for several miles downstream of the discharge.

PROJECT BACKGROUND

In 1995, the Crooked Creek Watershed Association approached the PA-DEP-BAMR with a request to consider abatement of the Tanoma discharges under the newly established AMD 10% Set-Aside Program. A detailed monitoring and evaluation program was established for the site since no detailed monitoring or analysis of the mine pool and discharges had been completed since the early 1970s.

From May 1996 through April 1997, all of the mine pool discharge points were extensively sampled and monitored. A summary of the findings of the study is as follows. The total combined flow of the discharges (from the C-6, C-7 and MP-1 boreholes) ranged from a low of 1,174 gpm in August 1996 to a peak of 5,397 gpm in December 1996. The average flow was just over 2,500 gpm. The total iron concentration ranged from a low of 7.9 mg/L to a peak of 22. 4 mg/L. The discharges were determined to be contributing an average of 233 lbs/day of iron to Crooked Creek. The in-stream iron concentration 1.5 miles downstream of the boreholes ranged from 1.50 mg/L to 7.81 mg/L, well above acceptable in-stream standards.

Macroinvertebrate surveys of Crooked Creek were completed in the fall of 1994 and in the early summer of 1996. Both surveys indicated good diversity and density of macroinvertebrates upstream of the Tanoma Borehole. The 1994 survey found very good diversity and large numbers of insects upstream of the discharges. Immediately below, there was

a drastic reduction in both the number of taxa and total insects, with partial recovery found at a station located approximately 2.5 miles below the discharges. The 1996 survey, which utilized the EPA's Rapid Bioassessment Procedures (RBP-III), had similar findings with 40 insects representing 11 taxa upstream, 17 insects representing seven taxa immediately below, and 35 insects representing 10 taxa downstream of the discharges. While the upstream samples in both surveys had good representation by the more pollution intolerant ephemeroptera/plecoptera/ trichoptera taxa (mayflies/stoneflies/cadisflies), these taxa were almost non-existent immediately below the discharge, and only trichoptera were represented further downstream. Fish habitat has also been negatively impacted by the mine drainage discharges. The Ken Sink Chapter of Trout Unlimited reported that the instream iron concentration exceeded the limits for trout stocking. Trout have been historically stocked in Crooked Creek upstream of the Tanoma Borehole, but not below.

PROJECT IMPLEMENTATION CHALLENGES

Several challenges were quickly evident soon after the monitoring and evaluation program got underway. First, the sheer volume of the discharges (1,174 to 5,397 gpm) was going to make treatment with passive mine drainage technology very difficult. To construct treatment ponds with any significant detention time, many acres of land would be needed. Second, the location of the discharges was a problem. The Tanoma Borehole (C-7) discharged directly into Crooked Creek at stream level. The 27-inch overflow boreholes (MP-1) as well as the C-6 borehole were also located close to the stream in an area with little land available for construction of a passive treatment system. Finally, many homes in the area relied on private wells for their water supply, and manipulation of the mine pool would require careful analysis to ensure protection of these good quality aquifers.

An extensive hydrogeologic study of the area was initiated in late 1996. The objective of the study was to evaluate the potential for relocating the primary discharge point of the mine pool to a point downstream where sufficient land was available for construction of a passive treatment system. A critical element of this evaluation also included the protection of the aquifer located well above the mine that was being used for domestic water supplies. The study concluded that it would be technically feasible to relocate the discharges approximately 1,000 feet downstream to an abandoned 10-acre pasture for construction of the passive treatment system.

A two-phase construction approach was recommended. The first phase would be to drill new boreholes at the proposed treatment location with valves for control of the discharge. The new wells would be carefully constructed by casing and grouting the boreholes down to the elevation of the mine. This would ensure protection of the upper aquifer that was heavily relied upon by local residents as a source for their domestic water wells. Once the wells were constructed and demonstrated to adequately redirect the discharges of the mine pool, the second phase of the project could be undertaken.

The second phase included construction of passive mine drainage treatment facilities at the downstream site, opening of the valves on the new wells to redirect the mine pool discharge to the newly constructed treatment system, and finally, the sealing of the Tanoma Borehole (C-7) and the C-6 borehole. The 27-inch overflow boreholes (MP-1) would be left open to provide for

monitoring of the mine pool and for mine pool discharge in the unlikely event that the pool would rise that high in the future.

A significant observation during the study involved the relationship of the volume of the mine drainage discharges to the in-stream iron concentration as measured downstream of the borehole locations. The periods when the discharge volume was the highest (winter and spring), the in-stream iron concentration was the lowest due to the normally high base flow in the stream. During the drier summer and fall months, the discharge volume dropped off, but the in-stream iron concentration rose to levels (> 1.5 mg/L total Fe) intolerable for most aquatic life. This was due to the relatively low stream base flow relative to the mine drainage discharge volume. This relationship was key in determining the design criteria that would be used for the development of the final project plan.

Other design challenges developed at the newly selected treatment area. First, the property owner was unwilling to allow the construction of a treatment system on his property without compensation. He was willing, however, to sell the property to the Department or any other conservation group for the purpose of constructing the treatment system. The site also had a private water line and two gas well gathering lines which bisected the site. Coordination with the gas companies and water line owner would need to be completed such that these facilities would remain functional and accessible following construction of the treatment system.

PROJECT DESIGN APPROACH

Analysis of the mine drainage discharges consistently indicated that the mine water was net alkaline with a moderate to high concentration of dissolved iron. From a passive mine drainage treatment perspective, this is the easiest mine water to treat. The engineering difficulties at this site involved the complete relocation of the discharges and the need to treat from 1.5 to 8.0 million gallons per day (MGD) of mine water. Even at the downstream location selected for treatment, less than 10 acres of land was available for construction of the system.

Using the inverse relationship of discharge flow rate to in-stream iron concentration discussed in the previous section, a decision was made to select a maximum design flow rate which would maintain a constant in-stream iron concentration of 1.5 mg/L or less. The hydrogeologic study determined that this equated to a maximum flow rate of 2,500 gpm or 3.6 MGD. A decision was also made to target the maximum iron concentration observed during the pre-design discharge monitoring of 22.4 mg/L.

The design of the passive treatment system was completed using the above design criteria. Due to the limitations of the proposed project site, including topography, utility lines, and proximity to the stream, a passive treatment system consisting of an approximate one acre settling pond followed by two multi-chambered aerobic wetlands was laid out. The system was designed to allow for the rapid aeration of the mine water and for the necessary detention to allow for the oxidation, hydrolysis and precipitation of the iron sludge. The two wetland treatment cells total approximately 7.5 acres. Analysis of the on-site soils for engineering properties indicated that the material would be ideal for construction of the earthen pond embankments.

CONSTRUCTION SUMMARY

The relocation of the Tanoma discharges to the proposed downstream treatment area began with drilling of three new six-inch diameter wells in the summer of 1998. The wells were cased and pressure grouted down through the upper aquifer that was being used for several nearby residential water wells. The upper frame of Figure 3 shows the drill rig working during installation of the new discharge wells. Mine water was drawn from the wells to demonstrate that the new wells were indeed hydrologically connected to the Tanoma mine pool. Following installation of the wells, monitoring of all nearby water wells was conducted, and it was determined that the private water wells would not be impacted by the relocation of the deep mine discharge.

After the successful installation of the new discharge wells, the PA-DEP-BAMR began negotiations with the property owner for the subdivision and purchase of the property required for treatment. Approximately 10.1 acres was subdivided from a larger tract and sold to the Southern Alleghenies Conservancy (SAC), a local environmental stewardship group that agreed to take ownership of the property. The PA-DEP-BAMR funded this property acquisition with funds from the AMD 10% Set-Aside Program. The survey for the subdivision was completed in October 1999, and the sale of the property was finalized in the spring of 2000.

While the property was being secured, final design for the project including permitting, development of detailed plans and specifications, and the obtaining of construction easements from the gas companies, water line owner and SAC were being finalized. The project was let, and construction on the passive treatment system began on June 4, 2000. The contractor was Casselman Enterprises of Somerset, PA. The lower frame of Figure 3 shows the wetland treatment cells under construction in the early fall of 2000. Once the treatment facilities (settling pond and two aerobic wetlands) were constructed, a portion of the mine water was redirected from the new discharge boreholes via pipes with flow control valves into the newly completed treatment system. Finally, the Tanoma Borehole (C-7) and the C-6 borehole were permanently sealed thus beginning the restoration of a 3.5 mile reach of Crooked Creek. A final inspection for the project was held on December 8, 2000. The final project costs are as follows: installation of new discharge boreholes - $19,783.50; property acquisition cost - $38,000; sealing abandoned Tanoma boreholes - $7,535; and construction of the passive treatment system - $351,367.31.

POST CONSTRUCTION MONITORING AND STREAM RESTORATION RESULTS

Flow into the completed treatment system was limited to approximately 200 gpm for the first six to eight months of operation to allow for the wetland plants to acclimate and to get established. On June 8, 2001, the valves controlling the influent were opened completely, allowing the full volume of the discharges to enter the treatment system. Figure 5 shows the inlet wells and the settling pond during January 2001. Since full-scale treatment began, the treatment system has experienced flows ranging from 77 gpm in December 2001 to 1,792 gpm in June 2001. Flows have been somewhat lower than expected due to a general drought condition over much of Pennsylvania during 2001. The influent mine discharge has averaged 12.5 mg/L of iron, and the treatment system has removed an average of 90.5% of the total iron. The iron concentration in the final effluent from the treatment system has been consistently under 1 mg/L since September 2001. The treatment system has, on average, removed 75.6 lbs/day of iron, and

has removed over 11 tons of iron since the beginning of 2001. Figure 6 shows a table with a summary of the treatment performance of the Tanoma passive mine drainage treatment system.

The most important result of the treatment system operation to date is that the in-stream iron concentration, as measured downstream of the effluent, has consistently been lower than 1 mg/L since full-scale operation of the system began in June 2001. This period includes the historically worst months (the summer and fall months) for water quality impacts from the Tanoma discharges. The highest measured in-stream iron concentration was 0.832 mg/L in August 2001 and the lowest measured in-stream iron concentration was 0.158 mg/L. The target concentration selected during project planning and design was an in-stream iron concentration not to exceed 1.5 mg/L. The table in Figure 6 also shows a summary of the downstream monitoring of the total iron concentration.

Domestic water wells in the vicinity of the project have been monitored periodically since the completion of the project. The relocation and treatment of the Tanoma discharges has not had any negative impact on the quantity or quality of the water supplies. The MP-1 boreholes have also been monitored since full-scale treatment began in early June 2001. The mine pool steadily dropped once the new discharge wells were fully opened, and by the end of December, the mine pool was more than eight-feet below the top of the MP-1 boreholes. The new discharge wells have a greater discharge capacity than the old Tanoma Borehole and are located some nine-feet lower in elevation than the collar of the 27-inch (MP-1) overflow boreholes. This greater discharge capacity should help to make the mine pool more stable by providing for more relief during the periods of high mine pool recharge (winter and spring months). While the MP-1 boreholes would have historically discharged from December through April, as of the end of January 2002, the mine pool was still nearly six-feet below the collar elevation of the boreholes. Due to the lower average mine pool elevation, there is a strong likelihood that the pool will no longer rise high enough to discharge from the MP-1 boreholes.

Finally, surveys of the stream are showing that the water quality in the upper Crooked Creek is rapidly improving and the density and diversity of aquatic life is already recovering. Several species of fish have been observed in areas where the stream was nearly devoid of life only a short time ago. The stream bottom no longer has the brilliant orange coloration associated with the iron precipitates that smothered the life of many of the streams bottom dwellers. A macroinvertebrate survey of the stream was completed in late October 2001. The results are very positive and extremely encouraging. Upstream of the treatment system, 107 insects were collected representing 14 different taxa. Downstream of the treatment system 100 insects were collected representing 14 taxa also. Thirty-three of the downstream insects collected belong to the pollution intolerant taxa of mayflies/cadisflies/ stoneflies, which shows a dramatic improvement of the pre-construction sampling.

In conclusion, the Tanoma Borehole reclamation project and the documented restoration of 3.5 miles of the upper Crooked Creek watershed is a unique example of exemplary abandoned mine reclamation and creative problem solving that lead to the elimination of impacts from abandoned mines and resulted in a dramatic improvement to the environment. The project analysis and reclamation techniques used in the Tanoma South reclamation project can be duplicated at other mine drainage discharge sites once thought to be untreatable. Upper Crooked Creek, for the first time in nearly 100 years, has been restored to near pre-mining water quality and now supports fish and other aquatic life.