Catawissa Creek Watershed Restoration Plan Update
Addressing the TMDL

Identification and Summary of Problem and Pollution Sources

The Catawissa Creek watershed is a very rural, relatively remote, largely forested watershed, with little agricultural land. The only urbanized area is the Borough of Catawissa, at the mouth of Catawissa Creek. Ringtown Borough, in the upper Little Catawissa Creek watershed, is the only other incorporated municipality in the watershed. Several small villages are scattered through the watershed. Little new development exists in watershed except for Eagle Rock Resort, a development of mostly second and retirement homes in the upper Tomhicken Creek watershed. Farms consist of mostly pasture, with the few row crops planted mostly in corn.

Impairment of Water Quality and Aquatic Life

The major pollution source in the Catawissa Creek watershed is abandoned mine drainage from five deep mine tunnels located in the upper third of the watershed. A total of 44.5 miles of Catawissa Creek watershed, 11 miles of Tomhicken Creek, and 3.4 miles of Sugarloaf Creek are listed as impaired by metals from abandoned mine drainage on the DEP 303d list of impaired waters.

The DEP North Central Regional Office completed the assessment of the entire Catawissa Creek watershed through the DEP Unassessed Waters Program in fall 2004. In addition to the areas already listed as impaired by abandoned mine drainage, several tributaries originating on Catawissa Mountain in the lower watershed were determined to be impaired by acid deposition and will be placed on the 303d list. This is not surprising since nearly the entire watershed is lowly buffered and slightly acidic. A TMDL is not likely to be completed for the acid deposition impaired segments for several years. While other small, localized problems may exist, no other pollution sources were significant enough to warrant impairment status or placement on the 303d list.

The Catawissa Creek Restoration Association (CCRA) has discussed applying for a DCNR Rivers Conservation Plan (RCP) grant to investigate and address issues other than mine drainage. Issues preliminarily identified for investigation include completion of a sewer system for the Village of Nuremberg, better erosion and sedimentation controls at Eagle Rock Resort, identification of potential areas prone to future development, protection of the aesthetics of the watershed, ensuring that development progresses in a manner that will protect the wooded and rural nature of the watershed, and contacting landowners about additional public access for fishing and other recreation. Any additional problem areas identified and recommendations from the RCP will incorporated into this implementation plan.

The Catawissa Creek watershed is affected by pollution from abandoned mine drainage (AMD), which causes high levels of metals and low pH in the main stem of Catawissa Creek, Tomhicken Creek and Sugarloaf Run. The sources of mine drainage are five drainage tunnels that were completed in the 1930s, which dewater anthracite coal fields in and to the east of the Catawissa Creek watershed. Four of these tunnels (Oneida #1, Oneida #3, Green Mountain, and Catawissa) dewater the North and South Green Mountain Coal Basins, which underlies an area north of the village of Oneida. The villages of Oneida and Sheppton lie on opposite sides of the South Green Mountain Coal Basin. The largest tunnel, the Audenreid, drains the western portion of Jeansville Coal Basin that lies mainly to the east of the watershed, between Hazleton and McAdoo.

Mining operations in the Jeansville Coal Basin affect the headwaters of Catawissa Creek. Deep mining, and the subsequent collapse of the underground workings, and extensive strip mining have destroyed the natural drainage patterns. Catawissa Creek and its tributary Hunkydory Creek lose their entire surface headwater flow into deep mines. They infiltrate through the broken strata or surface mine pits and are then conveyed as AMD through the Audenreid drainage tunnel back into Catawissa Creek. Other tunnels that discharge into the headwaters of Catawissa Creek are the Catawissa Tunnel, upstream of the Audenreid, and the Green Mountain Tunnel downstream of the Audenreid.

The Oneida #1 tunnel discharges into Sugarloaf Creek between the Lake Susquehanna and Lake Choctaw impoundments. The Oneida #3 tunnel discharges into Tomhicken Creek after the confluence of Little Tomhicken Creek.

Little Tomhicken Creek is also a source of AMD to Tomhicken Creek. The headwaters of Little Tomhicken Creek begin in a surface mined area of the South Green Mountain Coal Basin and flows disappears into underground mine workings. Little Tomhicken Creek enters Tomhicken Creek upstream of the Oneida #3 tunnel discharge.

The PA Fish and Boat Commission conducted an aquatic investigation of the Catawissa Creek watershed in summer 1997. They found that the entire main stem Catawissa Creek was degraded by acid mine drainage from tunnel discharges in the headwaters and in Tomhicken Creek watershed. Sampling at 15 locations yielded only 6 fish species. Fish populations were also severely depressed and occurred only near the confluence of tributaries or in the lower reaches where the impacts of mine drainage had been diluted by the combined influence of a number of unaffected tributaries.

The PFBC had also examined the Tomhicken Creek and its four tributaries, the Little Tomhicken, Sugarloaf, Raccoon, and Little Crooked Run Creeks. The Little Tomhicken Creek and Sugarloaf Creeks have been severely impacted by AMD, and no fish species were found in either stream. The Tomhicken Creek was sampled in two reaches, with the upstream reach producing 4 species of fish, and second reach no fish at one site and 5 species between two other sites.

Several tributaries in the watershed had excellent fish populations. Little Crooked Run only had brook trout present, but enough for Class A Wild Trout status- the highest category in the Fish and boat Commission’s ranking of naturally reproducing trout streams. Raccoon Creek had seven species of fish present, with a large number of brook trout, and was also classified as a Class A wild brook trout stream. The majority of the agricultural lands are near the Borough of Ringtown. Several tributary streams are designated as Wilderness Trout Streams by the Pennsylvania Fish and Boat Commission and as Exceptional Value in Chapter 93 of Department of Environmental Protection’s Regulations.

The PFBC stated that if AMD pollution can be reduced through reclamation of mine impacts, Tomhicken Creek would have a great potential for coldwater fish management and that a substantial recreational fisheries would likely develop in the Catawissa and Tomhicken Creeks, with potential for gaining 24.5 miles of wild trout water.

Aquatic macroinvertebrates are depressed in the main stem; however, Catawissa Creek is not dead. Healthy numbers adult winter stoneflies of the genera *Allocapnia* and *Taeniopteryx* were collected at several locations on the main stem upstream and downstream of Tomhicken Creek and on Tomhicken Creek near Zion Grove in March 2003. An adult *Sweltsa*, a Chloroperlid stonefly, was collected at Tomhicken Creek in May 2003. Many adult *Amphinmeura* and *Leuctra* stoneflies were captured in early June 2004 from upper Catawissa Creek immediately downstream of the Audenreid and Green Mountain discharges. These stoneflies can be a major component of the macroinvertebrate fauna of acidic streams and do not by themselves indicate a balanced or healthy aquatic community. The Susquehanna River Basin Commission conducted an investigation of the macroinvertebrates in summer 2004. That investigation will establish a baseline for evaluation of the effects of implementation of treatment systems and determine what other macroinvertebrates are present.

Elevated aluminum and low pH are the major factors restricting aquatic life in main stem Catawissa Creek and its major tributary Tomhicken Creek. Reduction in aluminum loading and increasing the pH and alkalinity will help reestablish fish and aquatic macroinvertebrates. Since raising the pH will precipitate aluminum, of great importance is removal of aluminum from the stream system as the pH is raised. Precipitated aluminum can be toxic to macroinvertebrates and fish and can render the stream substrate unsuitable for macroinvertebrate colonization.

The goals of the CCRA are to restore aquatic life to the impaired portions of the watershed, including brook trout. The watershed is largely forested and water temperatures are low enough for the reproduction of brook trout. Several small tributary streams have an abundance of brook trout and macroinvertebrates that would act as a source of aquatic life to colonize the presently degraded stream sections.

The TMDL

The TMDL for Catawissa Creek was prepared for DEP by the Susquehanna River Basin Commission (SRBC). The draft TMDL was approved by EPA and finalized in May 2003. The TMDL was based on impaired streams segment on the 1996 303d list.

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for comparison between observed instream conditions and conditions that are expected to restore designated uses. The endpoint is based on either the narrative or numeric criteria available in water quality standards.

The TMDL components were expressed as load allocations that were specified above a point in the stream segments and at the tunnel discharges. All allocations were specified as long-term average daily concentrations. These long-term average daily concentrations were expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25 Chapter 96.3(c) specifies that the water quality standards must be met 99 percent of the time. The TMDLs for iron were expressed as total recoverable as the iron was reported as total recoverable.

Applicable Water Quality Criteria		
Parameter	***Criterion Value (mg/l)***	***Total Recoverable/Dissolved***
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50 0.3	30-Day Average Total Recoverable Dissolved
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	N/A

*The pH values shown will be used when applicable. In the case of freestone streams with little or no buffering capacity, the TMDL endpoint for pH will be the natural background water quality. These values are typically as low as 5.4 (Pennsylvania Fish and Boat Commission).

<u>TMDL Segments</u>

The TMDL segments appear on a watershed map in Appendix A. Load reduction calculations are in Table 5 of the TMDL, which is reproduced here in Appendix B. The load reductions for several stream segments in the TMDL are not included in Table 5. These reductions and a summary of the loads affecting those stream points are in Tables E6, E7, E9, E10, E12, E13, E17, E18, E20, E21, E23, E24 of the TMDL, which are also copied from the TMDL into Appendix B.

<u>Upper Catawissa Creek (CC1)</u>

The headwaters of Catawissa Creek begin near McAdoo. Near Kelayres an unnamed tributary to Catawissa Creek and Hunkydory Creek join with Catawissa Creek and flow in a westerly direction. Mining has severely disturbed the land surface and underground structure in this portion of the watershed. The surface waters now seep into the deep mine pools through abandoned strip pits or fractures in the strata caused by mines subsidance. The Catawissa Creek streambed has almost been completely destroyed. Likewise, Hunkydory Creek and an unnamed tributary to Catawissa Creek lose all of their flow into the abandoned mine lands outside of Kelayres. Most of this flow likely joins Catawissa Creek through the Audenreid drainage tunnel.

TMDL point CC1 was located where Catawissa Creek reemerges in an iron stained pool on the west side of Interstate 81. Flow measurements were not available for CC1; therefore loading values could not be calculated at this point. The concentrations of metals and acidity indicate that the stream is not meeting water quality standards at this station. Chemical parameters not meeting criteria at this segment are manganese (1.74 mg/l) and aluminum (3.2 mg/l), and acidity (34 mg/l).

Catawissa Tunnel

The Catawissa drainage tunnel was driven approximately 840 feet northward from the Catawissa Creek valley into the deep coal mines of the adjacent South Green Mountain Coal Basin to dewater the mines by gravity. This is the most upstream tunnel to discharge into Catawissa Creek. Like the other tunnel discharges in the watershed, the Catawissa Tunnel flow has been measured in the thousands of gallons per minute: 4,000 gpm to 10,000 gpm, although higher flows during rainfall events have reached 18,000 gpm. An average flow of 0.82 mgd was calculated from available flow data for the TMDL point Catawissa Tunnel.

Chemical sampling indicated an iron concentration of 1.01 mg/l, aluminum of 1.27 mg/l, and acidity of 18.4 mg/l; therefore, the TMDL for the Catawissa Tunnel requires that a load allocation be made for total iron, total aluminum, and acidity. Since a pH ranging between 3.8 and 4.5 was measured at the tunnel, pH was also addressed in the TMDL.

Audenreid Tunnel

The Audenreid Tunnel is the largest of the AMD discharges into Catawissa Creek. The tunnel was driven in a westerly direction from the Audenreid Mine in the Jeansville Coal Basin approximately 16,150 feet to the Catawissa Creek watershed. The Audenreid tunnel drains the western portion of the Jeansville Coal Basin that lies between Hazleton and McAdoo. The Audenreid tunnel contributes up to 84% of the acid and a significant amount of aluminum loading to Catawissa Creek. The acid and aluminum loadings severely limit the aquatic life in the main stem for nearly its entirely length, over 40 miles.

An average flow measurement was calculated from available flow data as 8,000 gpm or 22 mgd, with a maximum of 19,000 gpm. Chemical sampling indicates pH ranging from 3.2 to 4.0 and average concentrations of acidity of 66 mg/l acidity, 8 mg/l aluminum, 2.3 mg/l manganese, and less than 1 mg/l iron. Due to the elevated flows, the TMDL for the Audenreid tunnel contains load allocations for total iron, manganese, aluminum, and acidity. The average iron concentration in the discharge, however, is already below the applicable water quality criteria value of 1.50 mg/l and much lower than what is normally achieved through use of treatment systems. Iron, therefore, is not appropriate or necessary to be to be addressed through a treatment system since any adverse effects of iron loading would be negligible if alkalinity is raised.

Since elevated aluminum concentrations and low pH are the primary limiting factors for aquatic life in Catawissa Creek, addressing the TMDL and design of a passive treatment for the Audenreid Tunnel should concentrate on removal of aluminum and addition of alkaline materials to raise the pH.

Green Mountain Tunnel

The Green Mountain drainage tunnel is the downstream-most discharge on main stem Catawissa Creek. The tunnel was driven approximately 4,100 feet to the north to intercept a low point to dewater the deep mines of the eastern portion of the South Green Mountain Coal Basin. The Green Mountain Tunnel has similar water quality to the Audenreid Tunnel, but has a lower flow volume, averaging 1,000 gpm or 1.44 mgd.

The TMDL for the Green Mountain tunnel requires that a load allocation be made for total iron, total manganese, total aluminum, and acidity. The average concentrations of iron (0.44 mg/l) and manganese (0.64 mg/l), however, are already below the applicable water quality criteria values of 1.50 mg/l for Fe and 1.0 mg/l for Mn. The modeling and development of TMDLs for these two metals was based on calculated loadings. It would be inappropriate to try to develop plans for a treatment system to remove Fe and Mn and address their TMDLs since their average values are already much lower than what is normally achieved through use of treatment systems.

Since elevated aluminum concentrations and low pH are the primary limiting factors for aquatic life in Catawissa Creek, addressing the TMDL and design of a passive treatment for the Green Mountain Tunnel should concentrate on removal of aluminum and addition of alkaline materials to raise the pH.

Catawissa Creek at point CC6

Catawissa Creek at point CC6 (Township Road 818, north of Girard Manor) represents the stream after the three tunnel discharges to the main stem have entered and after the confluence of Messers Run, a HQ-CWF stream. The TMDL for this section of Catawissa Creek consists of a load allocation to the watershed area between CC6 and CC1. Addressing the mining impacts between these points addresses the impairment for the stream segment.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at CC6. The loading reductions for the points C Tunnel, A Tunnel, and GM Tunnel were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC6. The TMDL for point CC6 does not require a load allocation for total iron, total manganese, total aluminum, and acidity. All necessary reductions would be made upstream of this point by addressing the upstream discharges.

Catawissa Creek at point CC7

Catawissa Creek at point CC7 (PA Route 924 north of Brandonville) is located after the confluence of Davis Run, a HQ-CWF stream. The TMDL for Catawissa Creek at point CC7 consists of a load allocation to the watershed area between points CC6 and CC7. The TMDL for point CC7 does not require a load allocation for total iron, total manganese, total aluminum, and acidity. All necessary reductions have been made upstream of this point.

Catawissa Creek between points CC7 and CC8

Catawissa Creek at point CC8 represents Catawissa Creek after the confluence of Rattling Run, Dark Run, and Little Catawissa Creek, but before the confluence of Tomhicken Creek. The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC7 and CC8. Addressing the mining impacts between these points addresses the impairment for the segment.

The TMDL for Catawissa Creek at point CC8 requires a load reduction for all areas between CC7 and CC8 for total iron and total manganese. A load reduction is not necessary for total aluminum and acidity. All necessary reductions have been made upstream from this point.

Upper Tomhicken Creek (TC5)
The headwaters of Tomhicken Creek begin north of the main stem of Catawissa Creek and flow to the west joining Catawissa Creek downstream of the village of Zion Grove. Point TC5 represents Tomhicken Creek before the confluence of Little Tomhicken Creek, the Oneida #3 tunnel, and Sugarloaf Creek. The headwaters of Tomhicken Creek flow through abandoned mine lands partially reclaimed by DEP BAMR.

The TMDL for the headwaters of Tomhicken Creek consists of a load allocation to all of the watershed area above point TC5. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was not available for point TC5; the average flow was derived using the unit area method was 1.16 mgd or 10,681 gpm. The average flows from the tunnel discharges were subtracted from the flow at TC1 to yield an average of 6,456 gpm.

The TMDL for point TC5 requires that a load allocation be applied to all areas of Tomhicken Creek above TC5 for total iron and total aluminum. A load reduction is not necessary for total manganese and acidity at this point. The average aluminum and iron concentrations, however, are extremely low and already below the applicable water quality criteria. The creek is also net alkaline at this point. The TMDL for this segment can be addressed in upper Tomhicken Creek by backfilling abandoned mine lands and through reclamation and revegation of lands surfaces disturbed by mining activities and with refuse piles; however, because of the low metals and net alkaline conditions in the upper watershed, this section of the watershed would be at the bottom of the list of priorities for remediation.

Oneida #3 Tunnel
The Oneida #3 tunnel drains portions of the South Green Mountain Coal Basin. The tunnel was driven approximately 7,000 feet north from the mine to discharge into Tomhicken Creek. The parameters for the Oneida #3 discharge are a pH of 4.6, net acidity 15 mg/l, total aluminum 2 mg/l, total iron 0.2 mg/l, total manganese 0.5 mg/L, and an average flow of 4,000 gpm or 3.82 mgd. The Oneida #3 discharge is the second largest discharge by volume to the Catawissa Creek watershed.

Eleven miles of the Tomhicken Creek are degraded by abandoned mine drainage from the Oneida #1 and #3 Tunnels. Passive treatment of the Oneida #3 discharge would eliminate the largest discharge to the Tomhicken Creek. Construction of this treatment system along with treatment of the Oneida #1 discharge on Sugarloaf Creek should raise the pH, eliminate the aluminum loading, and restore the aquatic habitat of the Tomhicken Creek watershed.

Tomhicken Creek near Zion Grove Downstream of Discharges (TC1)
Tomhicken Creek at TMDL point TC1 represents the stream at its mouth, after the confluence of Little Tomhicken Creek, Sugarloaf Creek, and the Oneida #3 tunnel. The TMDL for this section of Tomhicken Creek consists of a load allocation to all of the watershed area between points TC5 (headwaters) and TC1. Addressing the mining impacts between these points addresses the impairment for the segment. An average instream flow measurement was calculated from

available flow data for point TC1 (15.39 mgd). Tomhicken Creek is already meeting water quality criteria at TC1 for metals; however, acidity exceeds the alkalinity.

The TMDL for the segment of Tomhicken Creek between TC5 and TC1 requires a load reduction only for acidity. A load reduction is not necessary for total iron, total manganese, and total aluminum. All necessary reductions would have been made upstream of this point for metals and acidity through treatment of the additional upstream discharge, Oneida #3. This TMDL can therefore be addressed through construction of the proposed Oneida #3 treatment system.

<u>Catawissa Creek downstream of Tomhicken Creek (CC9)</u>
Catawissa Creek TMDL point CC9 (PA Route 339 at Zion Grove) was established to represent the creek downstream of confluence of Tomhicken Creek and all tunnel discharge. The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC9 and CC8, upstream of Tomhicken Creek.

The loading reductions for points Catawissa Tunnel, Audenreid Tunnel, Green Mountain Tunnel, Oneida #3 Tunnel, and stream TMDL points were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC9. This value was compared to the allowable load at point CC9. Reductions at point CC9 are necessary for any parameter that exceeds the allowable load at this point. The TMDL for Catawissa Creek at point CC9 requires a load reduction for acidity. A load reduction is not necessary for total iron, total manganese, and total aluminum since all necessary reductions would have been made upstream of this point. Remediation of mining impacts above this point addresses the impairment for the segment.

<u>Catawissa Creek near mouth (CC10)</u>
Catawissa Creek at TMDL point CC10 represents the stream at its mouth before it joins the Susquehanna River. The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC10 and CC9. Calculations showed that any necessary loading reductions at this TMDL point would be accomplished through construction of treatment systems on the upstream discharges; therefore, no action is necessary to address this TMDL point.

<u>Prioritization of Remediation Initiatives</u>

- The Audenreid Tunnel is the top priority for treatment for watershed restoration and addressing the TMDL since it is the main pollution source to the main stem Catawissa Creek. Restoration of the watershed will not be achieved without successful treatment of at least a major portion of this discharge.
- The second priority for a treatment system would be for the Oneida #3 Tunnel discharge, the largest remaining discharge in the Tomhicken Creek portion of the watershed. Successful treatment of this discharge will restore the remaining portion of Tomhicken Creek and will additionally help in restoration of downstream Catawissa Creek.
- The third treatment system would be for the Green Mountain Tunnel discharge; located about ¼ mile downstream of the Audenreid Tunnel. This is discharge is of lesser flow

than the first 2 priority discharges. Determination of treatment for this discharge is dependent on an evaluation of the treatment system to be installed for the Audenreid Tunnel.

- The last treatment system to be developed would be on the Catawissa Tunnel. This discharge is of minor significance compared to the other 3 remaining tunnel discharges. Determination of a proper treatment system is dependent on the results of land reclamation upslope of the tunnel, which will affect access to the tunnel and may affect the flow volume of the tunnel.

Land Reclamation

DEP BAMR has several land reclamation jobs planned in the watershed. The Oneida south Basin and the Green Mountain tracts have been mapped and will probably encompass about 5 to 7 reclamation projects over the next 5 to 10 years. These are areas where easements have been signed and full property owner cooperation has been established. These sites lie from east to west between Oneida and Sheppton in the headwaters of Catawissa and Tomhicken Creeks. BAMR is also considering some sort of treatment project on the Green Mountain Tunnel during reclamation of these areas.

Pollutant Load Reductions Required to Meet TMDL

Table 5 of the TMDL lists identified load reductions necessary for the watershed and which are summarized below.

- Catawissa Tunnel: The TMDL for Catawissa Tunnel established load reductions of 43% for iron, 69% for aluminum, and 90% for acidity.
- Audenreid Tunnel: The TMDL for this discharge established load reductions of 21% for iron, 73% for manganese, 95% for aluminum, and 99% for acidity.
- Green Mountain Tunnel: The TMDL for this discharge established load reductions of 49% for iron, 3% for manganese, 89% for aluminum, and 92% for acidity.
- Tomhicken Creek Headwaters (TC5): The TMDL for this point established load reductions of 21% for iron and 89% for aluminum.
- Oneida #3 Tunnel: The TMDL for this discharge established load reductions of 79% for manganese, 71% for aluminum, and 89% for acidity.
- Tomhicken Creek near Zion Grove (TC1): The TMDL for this point established a load reduction 82% for acidity.

Management Measures Required to Achieve Prescribed Load Reductions

Successful treatment of the discharges and attainment of the TMDL load reductions in the Catawissa Creek watershed will be a challenge. The major problem in treating the discharges is the huge volume of the discharges. All the discharges average over 1000 gpm, many average over 4,000 gpm, and maximum discharge volumes have been measured at 19,000 gpm at the Audenreid Tunnel. No passive treatment systems have been constructed to treat discharges of this magnitude. Previous treatment systems that have successfully treated such discharges have been active treatment systems that are expensive to build and require staff to operate and maintain the systems. The cost of chemicals is prohibitively expensive. The remote locations of the tunnel discharges would also make active treatment facilities difficult to operate. On the other hand, potential passive treatment options do exist for these high volume discharges because of the relatively low acidities requiring neutralization and the relatively low concentrations of aluminum.

Ideal treatment approaches should focus on generating acid and aluminum-free discharges through appropriate passive treatment facilities. Additional backup treatment generating additional instream net alkalinity through limestone addition is an option that could be pursued to provide a cushion in case of system failure or breakdown or if earlier treatment systems constructed indicate that full passive treatment is not necessary at the lower volume discharges.

One advantage noted in development of the restoration plan is that mining was concentrated in a relatively small percentage of the watershed, near the headwaters, that only 5 major discharges have been identified, and that limited surface mining has occurred. The rest of the watershed lies outside the coal measures. Another advantage noted is that metals concentrations are relatively low, with aluminum the major pollutant identified as necessary to be removed for restoration of aquatic life. Another advantage is the large public response in favor of restoration of the watershed, the large number of partners identified, and the established support system.

Appropriate treatment systems to address the load reductions in the Catawissa Creek watershed will be based on passive treatment systems used previously in Pennsylvania and through innovative designs under development for high volume discharges. The first passive treatment system constructed in the watershed, on the Oneida #1 Tunnel, shows that the first attempt at treating the high volume discharges in the watershed was not only possible but also successful. Because of the remote locations of the tunnels, industrial use of the discharges is unlikely.

Constructed Treatment Systems

Oneida #1 Discharge

The Oneida #1 discharge tunnel drains the North Green Mountain Coal Basin, the only tunnel that drains the mine workings in that basin. The Oneida #1 discharge has pH ranging from 3.6 to 4.2, very low alkalinity (0-3.4 mg/l), some acidity (40-52 mg/l), negligible iron, and a moderate amount of aluminum (1.4-4.9 mg/l). The flow of the tunnel discharge ranges from 560 gpm in the late summer-fall months to 3,000 gpm during storm events. The Oneida #1 tunnel drains into Sugarloaf Creek between the Lake Susquehanna and Lake Choctaw impoundments. The tunnel is the only addition of AMD to Sugarloaf Creek.

In July of 2001, a passive treatment system was constructed through the efforts of the CCRA and their partners, including the Schuylkill and Columbia County Conservation Districts, Natural Resource Conservation Service (NRCS), Office of Surface Mining (OSM), Eastern Pennsylvania Council on Abandoned Mine Reclamation (EPCAMR), DEP BAMR, the Eagle Rock Homeowner’s Association, and the landowners Double Diamond Development Corporation.

The treatment system consists of three series of buried limestone cells where the acidity in the discharge water is neutralized and the pH and alkalinity are increased. Prior to treatment the discharge had low pH (3.6 to 4.2), no alkalinity, acidity (40 to 50 mg/1), negligible iron, and aluminum (1.4 to 4.9 mg/1). The discharge water requires relatively little detention time in order to successfully add the necessary alkalinity and raise the pH and remove the aluminum.

DEP BAMR has been monitoring water chemistry above and below and within this treatment system quarterly since construction was completed. The treated water now averages a pH of 6.5, alkalinity of 9 to 26 mg/1, and iron and acidity has been reduced to zero. The aluminum has also been reduced to two thirds of its prior levels to, on average, 0.70 mg/L. The discharge from the treatment system does not always achieve the applicable water quality criteria for aluminum; however, considering the large discharge volume and the limited area available for construction, the passive treatment is working as well as expected. Further dilution is achieved as the discharge flows through Lake Choctaw, which receives the treated water from the system and acts as a final polishing pond and oxidation/precipitation basins to remove the remaining aluminum.

Monitoring data from the spillway of Lake Choctaw shows good water quality with a high pH, alkalinity, and virtually no acidity or aluminum. Lake Choctaw and downstream Sugarloaf Creek are now alkaline instead of acidic. Water quality has improved for 16 miles between Sugarloaf Creek and Tomhicken Creek. Lake Choctaw, which was once acidified and devoid of fish, now supports a stocked fish population.

Treatment Options for other Tunnel Discharges (Listed by Priority for Treatment)

Audenreid Tunnel

The large volume of the Audenreid Tunnel discharge and the presence of aluminum make treating this discharge with conventional passive treatment systems prohibitively expensive and area-intensive; therefore, an innovative treatment system method and design has been proposed. Since metals average concentrations are low, treatment should concentrate on raising the pH and alkalinity and removal of aluminum, which are the major limiting factors for aquatic life. Average total iron concentrations are already below water quality criteria; therefore, treatment to address the iron TMDL endpoint would be inappropriate since achieving a lower average concentration for iron would not be feasible or necessary.

A conceptual design for a passive treatment system for the Audenreid Tunnel discharge was completed through a Growing Greener Technical Assistance Grant to the Pennsylvania Association of Conservation Districts (PACD) and. to Hedin Environmental consultants through Stream Restoration, Inc. In 2003, the Schuylkill County Conservation District received a $1.4 million grant through the Section 319 of the Clean Water Act program for development of full design plans and construction of a treatment system. Additional funding will be through OSM and BAMR.

Treatment would require addition of alkalinity through contact with limestone in order to raise the pH and precipitate the aluminum. A modified limestone drain passive treatment system, which has been used successfully to treat acid mine discharges elsewhere in the Anthracite region, is proposed to treat the discharge. The discharge will be diverted into a series of concrete treatment cells filled with limestone, then into a large settling pond to receive the aluminum precipitate. Wetlands would provide final polishing before the water is returned to the creek. High aluminum loading could cause plugging of the treatment system through accumulation of aluminum hydroxide. Several flushing options were evaluated to keep the treatment capacity of the cells at an optimal level.

The innovative components of this system will be a relatively short limestone retention time of 1 to 2 hours compared to the 12 to 48 hours proven to be effective in bituminous coal field treatment systems, unique treatment system concrete tank components instead of earthen ponds, and extensive and frequent flushing to manage the aluminum solids and keep them out of the stream. The large volume of water to be treated also adds to the complexity and innovation of this design. The adjustable retention times, flushing frequency, and mixing ratio of untreated to treated water will make extensive studies and evaluation of the effectiveness of the treatment system possible.

The full impact of construction of the proposed treatment system on aluminum loading is unknown. Since this high a discharge volume and aluminum loading has not previously been attempted with a passive treatment system, reaching the full load reductions established in the TMDL may not be feasible. Partial treatment of the Audenreid Tunnel will, however, provide significant benefits for the whole watershed. Since the water quality of the Audenreid discharge is similar to the lower volume Oneida #1 discharge, which has been successfully treated through passive treatment, significant reductions in aluminum loading and increases in pH are expected, which should result in at least a partial recovery in aquatic life. Brook trout are known to be able to survive and reproduce in acidic pH conditions. Many stoneflies, caddisflies and dipterans also will return to the stream with partial remediation.

Passive treatment for removal of aluminum and alkaline addition would negate any adverse effects of iron loading on aquatic life. The objective would be to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time, or an acid loading reduction that equates to meeting standards for pH. Treatment of the Oneida #3 discharge on Tomhicken Creek will also help remediate the effects of the Audenreid discharge on the Catawissa Creek downstream of Tomhicken Creek. Additional alkaline addition devices such as diversion wells could also be used to supplement the alkalinity produced by the larger scale passive treatment facilities. Construction and evaluation of treatment efficiency of the proposed passive treatment system is an extremely important first step in the recovery of Catawissa Creek watershed.

<u>Oneida #3 Tunnel</u>

Damariscotta consultants developed a conceptual design for a passive treatment system for the Oneida #3 Mine Tunnel discharge, through funding with a FY 2001 US EPA Section 319 grant to Schuylkill County Conservation District. The treatment system was designed to raise the pH to precipitate aluminum, retain precipitated aluminum, have a reasonable operation and maintenance, and provide a source of alkalinity commensurate with the acid load and design life of the system.

The total available work area at the site is slightly less than 3.5 acres. An approximate 50-foot buffer is to be maintained off of the western edge of Tomhicken Creek. A drainage channel associated with Little Crooked Run constrains the eastern edge of the available work area. The Schuylkill County Soil Survey suggested the work area site could effectively excavate to a depth of about 70 inches for construction of the ponds. Since the discharge tunnel lies between a steep hillside and the Tomhicken Creek, the mine discharge would need to be piped beneath Tomhicken Creek to the available flat construction area on the opposite side. A conceptual design was developed using concrete tanks as the primary treatment components. Due to the thin, rocky soil conditions, this approach is not only necessary, but will also provide a cost competitive alternative to a conventional, lined pond construction. More information on the proposed treatment is in the final report for the 319 project.

The construction of the proposed Oneida #3 Mine Tunnel Discharge passive treatment system will effectively increase the pH of the Oneida #3 discharge, and reduce the amount of metals and acidity loading to the Tomhicken Creek. The treatment system will effectively reduce the amount of pollution loading to the Catawissa Creek downstream of the confluence with the Tomhicken Creek as well. The results will coincide with the recommendations and reductions in the TMDL, and may result in the removal of the Tomhicken Creek from the 303(d) list.

Construction of the second treatment system on the Tomhicken Creek, at the Oneida #3 Tunnel is expected to have an additive beneficial effect on downstream Catawissa Creek. Maintaining net alkaline conditions through the entire 15 miles upstream of Tomhicken Creek should ensure that net alkaline conditions are maintained in downstream main stem Catawissa Creek. The natural buffering capacity of the watershed is very low and the man stem receives little to no buffering from the inflow of tributaries except for Little Catawissa Creek, which has some agricultural activities that add alkalinity to the water. Indeed some lowly buffered tributaries may actually cause a slight reduction in pH after their confluence with Catawissa Creek.

<u>Green Mountain Tunnel</u>

The Green Mountain Tunnel discharge could be treated by one of two methods: construction of a 2.75-acre combination SAPS (successive alkalinity producing system)/ anoxic limestone drain (ALD) wetland system, or by incorporating the Green Mountain Tunnel into the passive treatment system constructed for the Audenreid Tunnel. Determination of which treatment method to follow will be made once the treatment system for the Audenreid Tunnel is constructed and evaluated.

Water quality improvement will result from generation of alkalinity from the limestone used for construction of the wetland system, and precipitation of dissolved aluminum. Because of increased alkalinity, the pH of the stream will increase and toxic metals will be removed. Aquatic would provide increased habitat enhancement, increased filtration, and buffering capacity to the stream. The final element of the system would be a downstream marsh south of the project area, suitable for detention and storage of floodwaters. Treatment of the Green Mountain Tunnel has the potential to improve water quality of 3 miles of a headwater tributary to the Catawissa Creek, add alkalinity to the main stem, and restore an old mining sedimentation basin to wildlife habitat.

Catawissa Tunnel

A system designed to handle a maximum of 3,000 gpm would be adequate for the Catawissa Tunnel discharge; however, no passive treatment systems have ever been constructed to handle a discharge of this magnitude. Using data supplied by PA DEP BAMR, remediation would require about 1,750 tons of high calcium carbonate limestone rock per year. If the cost of the limestone averages $8 per ton plus hauling, and planning for a 20-year life of the system, the cost of the limestone alone would be about $360,000. Land reclamation in the recharge area of the tunnel may help reduce the flow of the discharge and allow for effective treatment using a system designed for the lowest measured flows or less, when considered and evaluated in combination with other treatment systems to be installed.

Since the metals concentrations in the Catawissa Tunnel discharge are relatively low compared to the other tunnel discharges in the watershed and the tunnel is inaccessible, this discharge has a low priority for construction of a passive treatment system. The plan is to not treat the Catawissa AMD Tunnel until after construction and evaluation of the Audenreid AMD Tunnel Passive Treatment System. An assessment will then be made on how the Catawissa Tunnel raw water mixes with treated water from the Audenreid Tunnel passive treatment system to determine if treatment of the Catawissa Tunnel is needed. DEP BAMR plans to restore the surrounding land to a more natural, less steep contour. The restoration may make the immediate area around the tunnel more accessible and flatter and more feasible for passive treatment. BAMR is also considering the option of designing and constructing a passive treatment system as part of their land reclamation activities at the tunnel area.

Land Reclamation

Land reclamation should be conducted wherever possible in conjunction with construction of treatment systems. Reclamation should involve restoring the stream to surface flow through land reclamation, filling abandoned surface mine pits and sealing under the new surface channel so that flow remains on the surface. Alkaline material should be added to the backfill material and instream to raise the pH and alkalinity. Reclamation would be of most benefit in the headwaters portion of Catawissa, Tomhicken, and Little Tomhicken Creeks.

Little Tomhicken Creek flows through a refuse area and disappears into abandoned deep mines. DEP BAMR has been reclaiming the land in the headwaters of Little Tomhicken Creek, with the eventual goal of returning the creek to surface flow. If successful, the amount of AMD coming out of the Oneida #3 tunnel would be reduced by the amount of water put back on the surface, which should be a considerable difference in the discharge and have a positive effect on the Tomhicken. This should also reduce the size and cost of any treatment system to be built on the Oneida #3 discharge. This information would also mean that the discharge flow rate and chemistry would have to be monitored to determine the new loading rates to Tomhicken Creek.

The amount of land reclamation completed in the Catawissa Creek watershed is dependent on funding for DEP BAMR activities and the priorities established for use of those funds. The budget is very small compared to the magnitude of the abandoned lands in Pennsylvania. Continued funding of land reclamation is dependent on the reauthorization of the federal Surface Mine Reclamation Act and the allotments given to the various states.

Other impairments

The DEP North Central Regional Office determined that a few streams segments originating on Catawissa Mountain in the lower watershed are impaired by acid deposition. Additional localized problem areas will be investigated and documented by the watershed association and will be incorporated in this restoration plan.

Technical and Financial Assistance

Estimate of Remediation Costs

- Design and construction for treatment of the Oneida #1 Tunnel discharge cost $375,000.
- Construction of a passive treatment system for the Audenreid Tunnel discharge is estimated to cost around $1.6 million for treatment of the entire discharge.
- A conceptual design has been completed for the Oneida #3 Tunnel discharge. Treatment construction and detailed design costs were estimated at $1.1 million. A working cost estimate for the construction of one 100-foot diameter, 10-foot deep concrete tank (on an already prepared pad), would be approximately $50,000. This estimate may change with land reclamation and if the Little Tomhicken Creek is put back on the surface.
- The amount for design and construction of a treatment system for the Green Mountain Tunnel discharge is unknown at this time. Design parameters will depend on the evaluation of the treatment system to be constructed for the Audenreid Tunnel discharge.
- Results of the construction of the Oneida #3 and Audenreid treatment systems will aid in determining the amount and costs of limestone needed for future treatment systems.
- The cost for a Catawissa Tunnel treatment system, if constructed at all, will also depend on the success of the Audenreid Tunnel treatment system.
- Based on the treatment costs developed for the Audenreid and Oneida #1 Tunnel discharges, pre-design evaluation, design, and construction of treatment systems for the AMD discharges in the entire watershed could cost more than $3 million.

Estimated land reclamation costs are unavailable at this time.

Funding Sources

Sources of funding for restoration design and construction have been identified and secured for portions of the required restoration measures. These same funding sources are expected to be available for design and construction of the additional treatment systems required.

Funding or in-kind support for watershed restoration and environmental education efforts in the Catawissa Creek watershed has been provided by:

- EPA Environmental Education, Brownfields Initiative, and Section 319 programs
- OSM Appalachian Clean Streams Initiative and Summer Internship
- Title IV Abandoned Mine Land programs

- PA DEP Growing Greener Environmental Stewardship/Watershed Protection and Technical Assistance Grant (TAG) Programs
- EPCAMR Regional Watershed Support Initiative

<u>Additional Support for Watershed Restoration Efforts</u>

- The U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) provided technical assistance in remediation site review, survey and design and through the Rural Abandoned Mine Land Program.
- The U.S. Geological Survey provided projection of parameters for design, monitoring, and technical expertise
- The PA DEP Bureau of Abandoned Mine Reclamation (BAMR) provided engineering assistance, flow, and water quality data and reclaimed hundreds of acres in the watershed. BAMR is planning to fund construction of additional land and stream channel reclamation activities in the watershed worth approximately $5 million over the next three years.
- PA DEP Bureau of Dams & Waterways Engineering provided technical assistance on permitting and wetlands identification and delineation.
- The PA DEP Bureau of Watershed Management assisted in providing EPA Section 319 and other funding for mine drainage abatement projects.
- PA DEP Bureau of Mining and Reclamation contributed historical mining data and Scarlift Reports.
- PA DEP District Mining Operations Pottsville Office coordinated and assisted with data collection, acquiring funding for abatement projects and working with the local community, encouraged remining, provided technical assistance and project design.
- The PA Fish & Boat Commission conducted aquatic surveys and water monitoring. The PA Association of Conservation Districts
- Hedin Environmental consultants provided technical assistance for conceptual design and engineering through Growing Greener Technical Assistance Grants.
- The Schuylkill County Conservation District (SCCD) provided technical assistance in project design, coordinating water quality improvement efforts, data collection, and in acquire funding.
- Columbia and Luzerne County Conservation Districts provided support and publicity.
- Municipalities and agencies in Schuylkill, Columbia, and Luzerne Counties assisted with identification of landowners, seeking funding for stream improvement projects and in project design.
- Beaver Township, Ringtown Fire Hall, Brandonville Fire Company, and Catawissa American Legion hosted public meetings.
- The Susquehanna River Basin Commission and Bloomsburg University assisted with biological studies, monitoring, GIS mapping, and research.
- The Wildlands Conservancy, North Central PA Conservancy and the Schuylkill County Conservancy provided assistance with landowner consent, acquisition, lease, and easements.

Public Information and Participation

A full network of public participation has been established. General membership and Board meetings of the Catawissa Creek Restoration Association are regularly scheduled to discuss restoration of the Catawissa Creek watershed. A Technical Advisory Committee consisting of watershed association members, state, federal and local agencies, and consultants was established to consider and evaluate plans, treatment options, design criteria, successes and failures. The Technical Committee met monthly during the design phase of the Audenreid passive treatment system and plans to continue to meet at least quarterly once construction begins and after construction is completed to evaluate the effectiveness of the system and to determine if he milestones set in the implementation plan are met. The committee will continue to meet in a similar manner as each component of the implementation plan is begun.

<u>Partners and stakeholders</u>

The Catawissa Creek Restoration Association held it's first public meeting on February 26, 1997, at the Ringtown Fire Company. Over one hundred people attended the meeting including representatives from many local and state government agencies. Staff of the following agencies also attended: DEP Bureau of Abandoned Mines, PA Dept. of Conservation & Natural Resources, Schuylkill County and Columbia County Conservation Districts, PA Fish & Boat Commission, Congressman Tim Holden's office, Senator Helfrick's Administrative Assistant. The current membership of the CCRA is around 100 members.

The Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) EPCAMR has an early stakeholder in restoration of Catawissa reek watershed. EPCAMR has been involved with restoration of the Catawissa Creek watershed for the since the 1990’s. EPCAMR provided the major project coordination and construction oversight for the first passive treatment system constructed in the watershed on the Oneida #1 Tunnel.

Watershed restoration efforts have received strong endorsements from U.S. Congressmen Paul Kanjorski and Tim Holden, Pennsylvania Representatives Dave Argall, Todd Eachus, and John Gordner and Pennsylvania Senators Jim Rhoades and Ed Helfrick.

Additional support and assistance have been provided by many local groups or businesses including the Catawissa Creek Restoration Association, Schuylkill County Trout Unlimited, Eagle Rock Community Association, Con-Lime and Carmeuse Limestone Quarries, Gezunt Nursery, Blue Knob Sportsmen’s Club, and Catawissa Municipal Water Authority. Butler Enterprises and PCA Corporation, landowners, and Paragon Adventure Park, land lessee, have given approval for construction of the treatment system. These groups and landowners are expected to continue their roles in support of the watershed restoration plan.

<u>Outreach Activities</u>

Public meetings of the Catawissa Creek Restoration Association (CCRA) are held bimonthly at Beaver Twp. Volunteer Fire Co., Eagle Rock, Ringtown, Brandonville, Park Crest, Beaver Township, Mainville, and Catawissa have all had a meeting or two. Beaver Township Fire Company may become the permanent open meeting place. The location is just about the halfway point and makes it easier for members from Columbia County and Schuylkill County to meet without traveling too far. The CCRA website address is www.columbiapa.org/ccra. The organization shares a booth annually at the Bloomsburg Fair with EPCAMR for public outreach. Hundreds of brochures are handed out each year.

Knowledge gained from restoration efforts in the Catawissa Creek watershed will continue to be distributed through the World Wide Web, PowerPoint presentations, the PA DEP Water Management Nonpoint Source Liaison Work Group, and presentations at the Annual Statewide Conference on AMD/AMR.

Websites include: www.dep.state.pa.us, www.luzerneconservationdistrict.org, www.amrclearinghouse.org, www.srbc.net, www.columbiapa.org/ccra, and www.epcamr.org. EPCAMR, CCRA, PA DEP, and the Conservation Districts will continue to coordinate watershed field tours for public officials, community members, and school students. EPCAMR also has a quarterly newsletter, the "EC Express", which will highlight the progress of the project. SRBC will make presentations to community members on the analyses of the water quality data that will be collected during the project and will assist volunteers with establishing watershed stream cleanup and monitoring projects. Other opportunities for sharing of information include presentation videos on Greenworks TV and at the Statewide Growing Greener Watershed Conference.

Members of the public, local community organizations and the media will be invited to attend meetings and provide press releases for important events such as review of final designs, contract bidding, groundbreaking, and dedication of the completed treatment system.

Schedule and Evaluation

Implementation Schedule

- Audenreid Tunnel discharge: Phase I of the implementation plan is underway. The Schuylkill County Conservation District received a $1.4 million 319 grant for design and construction of a passive treatment system at the Audenreid Tunnel in September 2003. Design and engineer plans were completed by the end of 2004. The access road was regarded and stabilized in September 2004. An RFP to hire a contractor to develop detailed design and blueprints for the project was selected. Construction is planned for late summer 2005.
- Oneida #3 Tunnel discharge: Phase II of the implementation plan has been started. Conceptual design plans were developed for this discharge through a FY 2001 319 grant. A proposal for a complete design and construction of a passive treatment system was submitted for funding to Growing Greener in 2003. Funding was not received. The proposal will be resubmitted in an upcoming round. Construction of this treatment system will be pursued through a grant application after completion of the Audenreid Tunnel project in 2005. The treatment design may need to be modified if land reclamation successfully reduces surface water recharge to the mine pool. Construction is planned for after 2006.

- Green Mountain Tunnel discharge: Plans for development of this system is dependent on the results of the evaluation of the passive treatment system constructed on the Audenreid Tunnel. Construction of a treatment system planned for after 2008.
- Catawissa Tunnel: Designs for this tunnel are dependent on evaluation of restoration of the land area near the tunnel and how water from this tunnel mixes with treated water from the Audenreid and Green Mountain Tunnel discharges. Construction after 2010.

Milestones to Determine if Implementation Measures are Being Met

Meetings of the Catawissa Creek Technical Advisory Committee were held monthly through spring and summer 2004 to review the progress of the design phase of the Audenreid treatment system. At these meetings representatives of Rettew, their consultant, presented updated design plans and solicited comments and suggestions from the Committee. Meetings will be held quarterly to follow the progress of the construction phase of the project.

The implementation projects planned for each year will serve as the implementation milestones of the restoration plan. CCRA and the Schuylkill County Conservation District will continue their regular meetings to follow the progress of the implementation plan and to determine if the milestones are being met. Meetings of the Technical Advisory Committee will be scheduled as needed after receipt of grants for additional phases of the restoration plan to determine if the milestones associated with those phases are still appropriate. The Technical Advisory Committee will be keenly aware of the progress of the plan and will adjust the schedule and milestones as necessary.

Progress on the implementation schedule will be noted on a quarterly basis at the CCRA regular meetings. Since the mine discharges are large and difficult to treat, and passive treatment technology is experimental in nature, implementation of the next project in line is dependent on the evaluation of the success of the previous project. When construction of a project is complete, the evaluation process will begin and the conceptual designs of the next project will be reconsidered to determine if changes should be made prior to submittal of a proposal for the next grant. Difficulties in successful completion of projects may slow the implementation schedule.

Maintaining the implementation schedule is also dependent on the availability of funds. If funding sources receive less money than expected, then some of the proposed projects may not be funded according to schedule. In addition, competition for the limited grant funds increases every year as more watershed associations develop their own restoration plans and submit proposals for implementation projects. In these cases, the project proposals would be submitted again the following year, but the implementation schedules would have to be changed.

Evaluation and Monitoring

Quarterly chemical monitoring has followed the efficiency and progress of the Oneida #1 treatment system. DEP Wilkes Barre BAMR staff has collected chemical samples upstream of the discharge in Lake Susquehanna, the raw water out of the Oneida #1 Tunnel, the treated water from the passive treatment system, and downstream in Lake Choctaw. The samples are shipped to the DEP laboratory in Harrisburg for analysis. The watershed association collects additional instream samples for field analysis.

Additional monitoring is planned to establish background conditions and evaluate the effects of implementation of passive treatment systems on the major discharges, the Audenreid and Oneida #3 Tunnels.

The PA DEP Wilkes Barre Regional Office will continue chemical monitoring of the Audenreid Mine Tunnel and three downstream Catawissa Creek locations on a quarterly basis. Chemical parameters tested will be the typical compounds or ions analyzed in mine drainage samples, including pH, alkalinity, acidity, sulfate, aluminum, and iron. CCRA, EPCAMR, and the Conservation Districts will continue their water quality monitoring following the procedures of the DEP Citizen Volunteer Monitoring Program.

The effects of treatment systems on recovery of aquatic life will be tracked thorough pre and post-construction monitoring. Macroinvertebrate surveys will be conducted at several locations by the SRBC using Rapid Bioassessment Protocol and analyzing for macroinvertebrate community metric components, such as taxa richness, percent mayflies, stoneflies, and caddisflies, and the Hilsenhoff Biotic Index. Monitoring of the adult stonefly emergence will continue in 2004 and one to two years after construction of treatment systems. The Pennsylvania Fish and Boat Commission will assess the water quality and fisheries in main stem Catawissa Creek beginning one year after completion of construction and compare results with their pre-construction 1997 aquatic investigation.

The SRBC and other partners will analyze water quality and aquatic communities data. Quarterly progress reports will be completed and submitted to EPA and placed on the EPCAMR, Schuylkill County Conservation District, Luzerne County Conservation District, and CCRA websites.

Since the TMDL established load reductions for each of the discharges in the Catawissa Creek watershed, these load reductions are the targets to be met in evaluating stream recovery. The Technical Committee will meet annually to evaluate the progress and milestones of the monitoring to determine if these TMDL load reductions are being met. Results of the previous year's monitoring will be used to calculate the loadings and percent reductions the completed projects achieve. The newly calculated loadings will be compared with the overall required TMDL loading reductions for the TMDL points for that discharge. The effects of the individual treatment systems on the watershed will be evaluated by comparisons with the downstream TMDL points. The comparisons and load reduction achievements will be used to determine what type of additional implementation measures are necessary to achieve the desired load reductions or if any improvements to the treatment system efficiency need to be considered.

<u>Remedial Actions</u>

All the discharges present challenges to full treatment using current technologies because of the high flow volumes. If the proposed treatment systems do not achieve the desired results of load reductions, additional measures would be considered to raise the pH and alkalinity. One option would be diversion wells as a means to add additional alkalinity; however, diversion wells are generally most effective in streams smaller than the Catawissa Creek. To achieve better results, the best option might be to use additional treatment cells at the Audenreid Tunnel, if enough room exists, and to use a bigger passive treatment system on the Green Mountain Tunnel. Remedial actions are subject to funding constraints and the consent of the private landowners who generously allow their properties to be used for treatment system construction.

Table 5 (From TMDL). Summary Table–Catawissa Creek Watershed Load Reductions

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
CC1	Fe	0.34	-	0.34	-	0
Catawissa	Mn	1.74	-	0.001	-	99.9
Headwaters	Al	3.20	-	0.38	-	88
	Acidity	34.50	-	0.03	-	99.9
	Alkalinity	0.17	-			
Catawissa	Fe	1.01	6.9	0.58	4.0	43
Tunnel	Mn	0.31	2.1	0.31	2.1	0
	Al	1.27	8.7	0.39	2.7	69
	Acidity	18.44	126.1	1.84	12.6	90
	Alkalinity	4.11	28.1			
Audenreid	Fe	0.70	71.3	0.56	57.1	21
Tunnel	Mn	2.28	232.4	0.61	62.2	73
	Al	7.93	808.2	0.40	40.8	95
	Acidity	68.08	6938.4	0.68	69.3	99
	Alkalinity	2.31	235.4			
Green Mt.	Fe	0.44	5.3	0.23	2.8	49
Tunnel	Mn	0.64	7.7	0.62	7.4	3
	Al	2.97	35.7	0.33	4.0	89
	Acidity	28.06	337.0	2.25	27.0	92
	Alkalinity	3.29	39.5			
CC6	Fe	0.25	46.8	0.25	46.8	0*
Catawissa	Mn	1.05	196.5	0.40	74.9	0*
at T-818	Al	3.62	677.5	0.29	54.3	0*
	Acidity	33.26	6224.6	0.10	18.7	0*
	Alkalinity	0.41	76.7			
CC7	Fe	0.22	46.7	0.22	46.7	0*
Catawissa	Mn	0.93	197.4	0.34	72.2	0*
PA 924	Al	3.28	696.2	0.23	48.8	0*
	Acidity	28.58	6066.2	0.60	127.4	0*
	Alkalinity	1.24	263.2			
CC8	Fe	1.51	507.9	0.09	30.3	94*
Catawissa	Mn	0.85	285.9	0.12	40.4	65*
Zion Grove	Al	1.97	662.6	0.18	60.5	0*
	Acidity	16.77	5640.6	0.34	114.4	0*
	Alkalinity	2.78	935.1			
TC5	Fe	0.50	4.8	0.40	3.9	21
Tomhicken	Mn	0.08	0.8	0.08	0.8	0
Upper	Al	0.69	6.7	0.07	0.7	90
	Acidity	0.83	8.0	0.82	7.9	0
	Alkalinity	23.37	226.1			

Table 5 (From TMDL). Summary Table–Catawissa Creek Watershed Load Reductions						
Station	**Parameter**	**Measured Sample Data**		**Allowable**		**Reduction Identified**
		Conc. (mg/l)	**Load (lb/day)**	**LTA Conc. (mg/l)**	**Load (lb/day)**	**Percent**
Oneida 3	Fe	0.18	5.7	0.18	5.7	0
Tunnel	Mn	0.59	18.8	0.12	3.8	79
	Al	1.59	50.7	0.46	14.7	71
	Acidity	17.35	552.8	1.91	60.9	89
	Alkalinity	7.40	235.8			
TC1	Fe	0.15	19.3	0.15	19.3	0*
Tomhicken	Mn	0.17	21.8	0.17	21.8	0*
Near mouth	Al	0.42	53.9	0.30	38.5	0*
	Acidity	10.92	1401.6	1.31	168.1	82*
	Alkalinity	6.04	775.2			
CC9	Fe	0.10	48.8	0.10	48.8	0*
Catawissa	Mn	0.53	258.7	0.40	195.2	0*
Dn of Tomh.	Al	1.30	634.5	0.27	131.8	0*
	Acidity	23.88	11654.8	0.24	117.1	96*
	Alkalinity	2.16	1054.2			
CC10	Fe	0.11	82.2	0.11	82.2	0
Catawissa	Mn	0.33	246.6	0.33	246.6	0
Near mouth	Al	0.85	635.2	-	-	-
	Acidity	12.80	9,565.0	-	-	-
	Alkalinity	18.16	13,570.3			

*
The percent reduction for CC6, CC7, CC8, TC1, CC9 are found in Attachment E Tables: E7, E10, E13, E18, E21 below.
No load reductions necessary at these points because all reductions would have been made upstream.

Table E6. Summary of Loads Affecting Point CC6				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0

Table E7. Reductions Necessary at Point CC6				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at CC6	46.8	196.5	677.5	6,224.6
Total Load Reduction (Sum of C, A, and GM Tunnels)	19.6	170.5	805.1	7,292.6
Remaining Load	27.2	26.0	0	0
Allowable Loads at CC6	46.8	74.9	54.3	18.7
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

Table E9. Summary of Loads Affecting Point CC7				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0

Table E10. Reductions Necessary at Point CC7				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at CC7	46.7	197.4	696.2	6,066.2
Total Load Reduction (Sum of C, A, and GM Tunnels and CC6)	19.6	170.5	805.1	7,292.6
Remaining Load	27.1	26.9	0	0
Allowable Loads at CC7	46.7	72.2	48.8	127.4
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

Table E12. Summary of Loads Affecting Point CC8				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0

Table E13. Reductions Necessary at Point CC8				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at CC8	507.9	285.9	662.6	5,640.6
Total Load Reduction (Sum of C, A, and GM Tunnels, CC6, and CC7)	19.6	170.5	805.1	7,292.6
Remaining Load	488.3	115.4	0	0
Allowable Loads at CC8	30.3	40.4	60.5	114.4
Percent Reduction	94	65	0	0
Load Reduction	458.0	75.0	0	0

Table E17. Summary of Loads Affecting Point TC1				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9

Table E18. Reductions Necessary at Point TC1				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at TC1	19.3	21.8	53.9	1,401.6
Total Load Reduction (Sum of TC5 and O3 Tunnel)	0.9	15.0	42.0	491.9
Remaining Load	18.4	6.8	11.9	909.7
Allowable Loads at TC1	19.3	21.8	38.5	168.1
Percent Reduction	0	0	0	82
Load Reduction	0	0	0	741.6

Table E20. Summary of Loads Affecting Point CC9				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0
CC8				
Load Reduction	458.0	75.0	0	0
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9
TC1				
Load Reduction	0	0	0	741.6

Table E21. Reductions Necessary at Point CC9				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at CC9	48.8	258.7	634.5	11,654.8
Total Load Reduction (Sum of C, A, GM, and O3 Tunnels, CC6, CC7, CC8, TC5, TC1)	478.5	260.5	847.1	8,526.1
Remaining Load	0	0	0	3,128.7
Allowable Loads at CC9	48.8	195.2	131.8	117.1
Percent Reduction	0	0	0	96.0
Load Reduction	0	0	0	3,011.6

Table E23. Summary of Loads Affecting Point CC10				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0
CC8				
Load Reduction	458.0	75.0	0	0
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9
TC1				
Load Reduction	0	0	0	741.6
CC9				
Load Reduction	0	0	0	3,011.6

Table E24. Reductions Necessary at Point CC10				
	Iron (lb/day)	**Manganese (lb/day)**	**Aluminum (lb/day)**	**Acidity (lb/day)**
Existing Loads at CC10	82.2	246.6	635.2	13,570.3
Total Load Reduction (Sum of C, A, GM, and O3 Tunnels, CC6, CC7, CC8, TC5, TC1, and CC9)	478.5	260.5	847.1	11,537.7
Remaining Load	0	0	0	2,032.6
Allowable Loads at CC10	82.2	246.6	-	-
Percent Reduction	0	0	-	-
Load Reduction	0	0	-	-