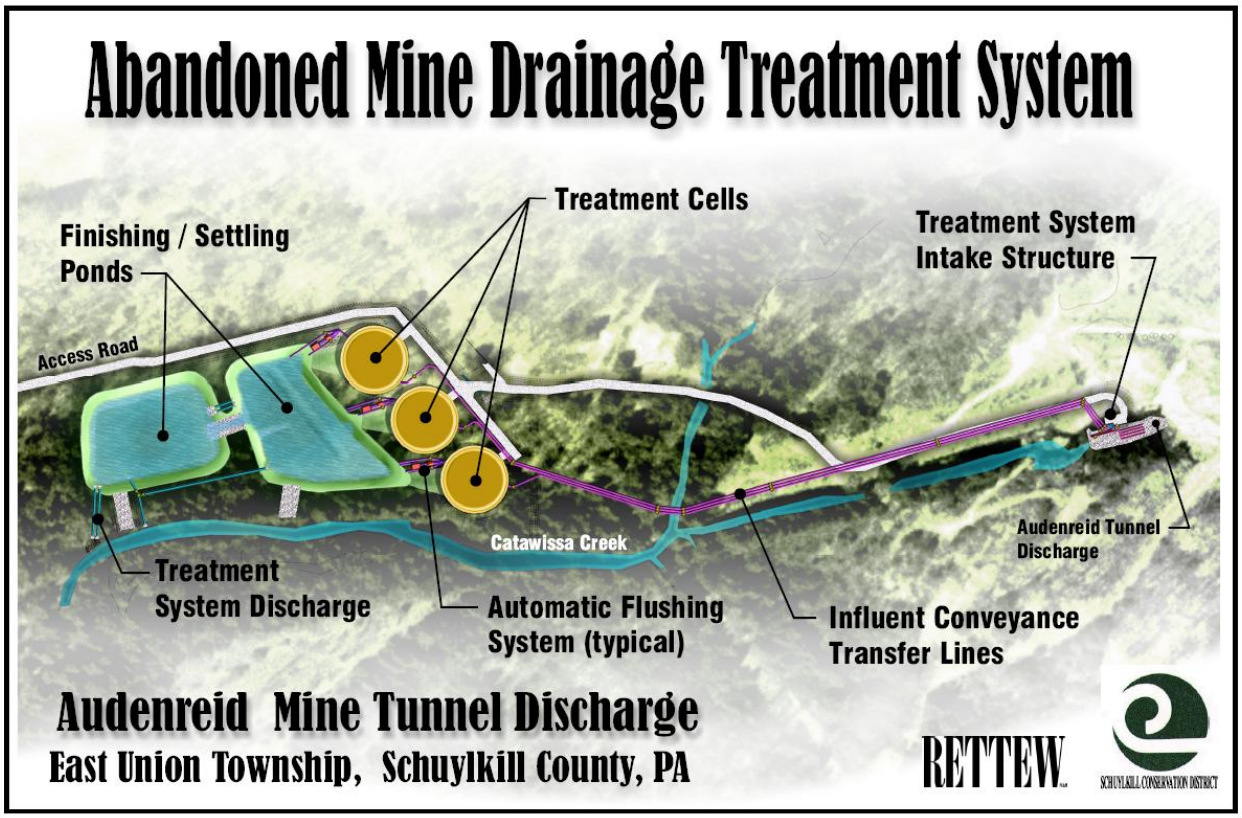
We answer to you.

OPERATIONS AND MAINTENANCE PLAN
FOR
AUDENREID MINE TUNNEL
ABANDONED MINE DRAINAGE REMEDIATION PROJECT

EAST UNION TOWNSHIP
SCHUYLKILL COUNTY, PENNSYLVANIA
RETTEW PROJECT NO. 04-03883-001



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OPERATIONS AND MAINTENANCE PLAN

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SITE BACKGROUND

The Audenreid Mine Tunnel Discharge is located in East Union Township, Pennsylvania, west of I-81 and east of the town of Sheppton. It is one of the largest abandoned mine drainage (AMD) discharges within the Eastern Middle Anthracite Field and it is the largest AMD contributor to the Catawissa Creek. The Audenreid Discharge is located in the headwaters of the Catawissa Creek and impacts the entire Catawissa Creek Watershed up to and including the Susquehanna River.

AMD comes from storm water runoff entering abandoned mines and the mine pool, flooding it and acquiring acidity, sulfate, aluminum, and other metals and eventually discharging from mine shafts, tunnels and topographically low points. The low pH, chemical, and metal content are hazardous to fish, macro-invertebrates and other animal and plant-life within the watershed and downstream locations.

Construction on the mine tunnel treatment system began in the spring of 2005 and was completed in January 2006. This passive treatment system directs the tunnel's discharge water into three large circular treatment tanks filled with limestone. The discharge dissolves the limestone, adds alkalinity to the water and raises the pH. From the treatment tanks the water enters two successive settling ponds where much of the metals are allowed to settle and drop to the bottom of the ponds before the water returns to the Catawissa Creek. As a result of this system, the amount of pollution entering the headwaters of the Catawissa Creek is reduced and wildlife habitat is improved.

CHEMISTRY/FLOW DATA

The Catawissa Creek is listed on the Pennsylvania Department of Environmental Protection (DEP) 303(d) list of impaired waters with the source being abandoned mine drainage, and the cause of impairment listed as metals. Water quality monitoring has shown the average quality of the Audenreid Mine Tunnel Discharge to be: 8,478.40 gpm, pH 4.03, alkalinity 2.31 mg/l, acidity 68.08 mg/l, iron 0.70 mg/l, aluminum 7.93 mg/l, and sulfates 136.25 mg/l. A 1982 report from GEO-Technical Services Consulting Engineers and Geologists (DER Project SL 135-11-101.6) stated that 84% of the acid load to the Catawissa Creek is due to the Audenreid Mine Tunnel Discharge.

RECEIVING STREAM

The Audenreid Mine Tunnel Discharge empties the western side of the Jeansville mine pool basin (approximately 4,856 acres) through an approximately 16,150-foot long tunnel, allowing AMD into the headwater tributaries to the Catawissa Creek. The Catawissa Creek then drains westward approximately 41 miles through Schuylkill and Columbia Counties to the Susquehanna River near the Borough of Catawissa, and eventually into the Chesapeake Bay.

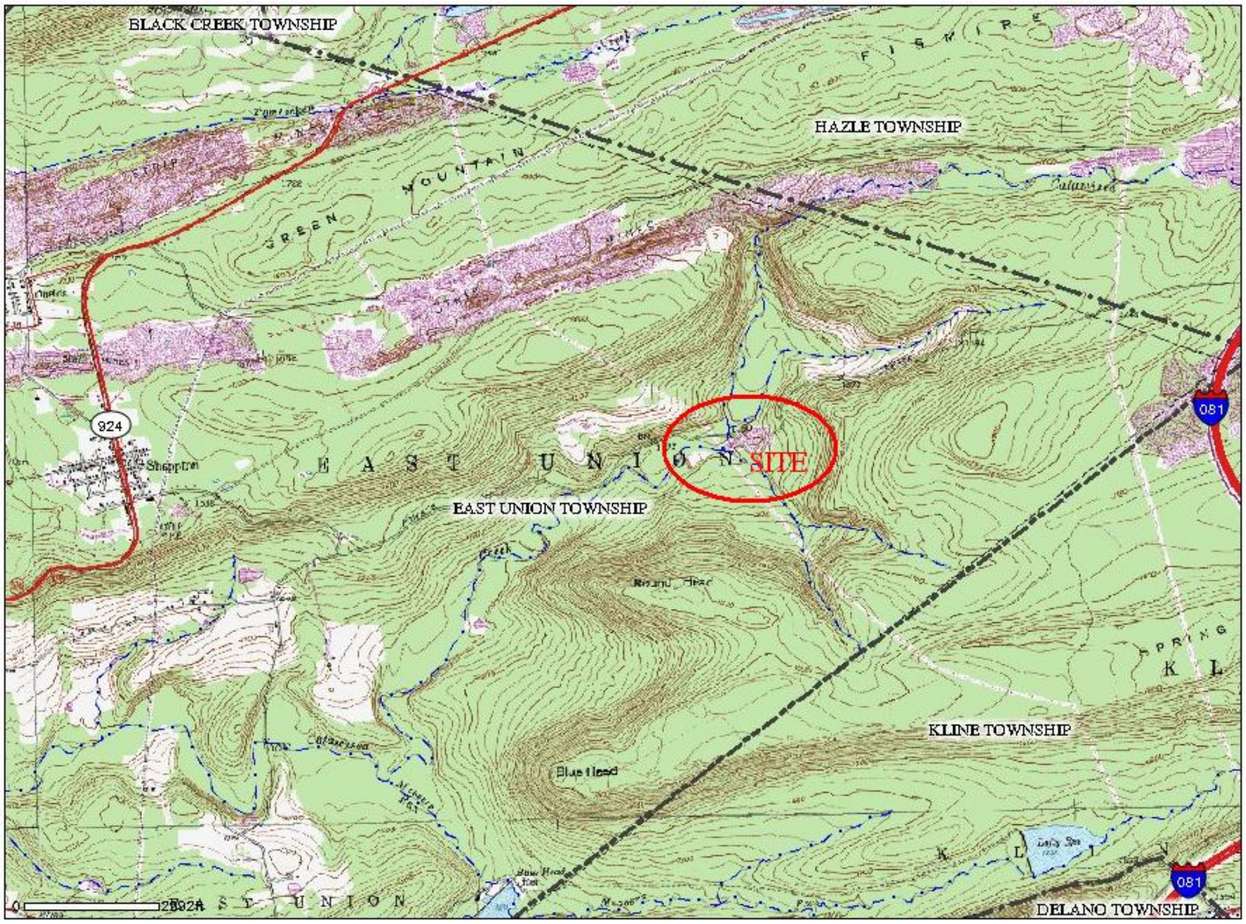
TREATMENT SYSTEM PARTNERS AND GRANTS

Schuylkill Conservation District (SCD) - Responsible for project administration, grant oversight, operations and maintenance, educational and outreach activities.
Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) - Assist with grant administration and oversight, educational and outreach activities.
Catawissa Creek Restoration Association (CCRA) - Assist with grant administration and oversight, construction observation, water quality monitoring, and educational and outreach activities.
Susquehanna River Basin Commission (SRBC) - Assist with water quality monitoring, and educational and outreach activities.
PA Fish & Boat Commission (PFBC) - Assist with water quality monitoring, and educational and outreach activities.

Budget and Schedule for the Audenreid Tunnel Treatment Project					
Category	**Schedule**	**Total**	**Match**	**Source**	**Growing Greener**
Design/Oversight/Permitting	First Year	$125,000	$25,000	CCRA	$100,000
Construction	Second Year	$1,458,410	$20,000 $138,500	CCRA, OSM	$1,299,910
Monitoring/Education/Outreach	Entire Project	$44,300	$15,000 $24,300 $5,000	SRBC, CCRA, PFBC	
Grant Administration	Entire Project	$21,500	$1,500	OSM to EPCAMR	$20,000
Totals		$1,649,210	$229,300		$1,419,910

SYSTEM LOCATION

The Audenreid Mine Tunnel Discharge is located at 40.898025º North and 76.069808º West by GPS. It is accessed by driving in through private property owned by the Blue Nob Rod and Gun Club, which tees off of Phinneyville Road near Sheppton, Schuylkill County. There are two gates along the western end of the access road and Wayne Lehman from the Schuylkill Conservation District or his designee and/or successor can assist in gaining access to the site.



SYSTEM COMPONENTS

This passive treatment system consists of an infiltration collection system located just downstream of the mine tunnel portal which collects and evenly distributes the design flow rate into the three separate 18" influent conveyance lines while allowing flow rates in excess of the design flow to by-pass the treatment system. Each of the 18" influent conveyance lines supplies one of the limestone treatment cells where limestone is used to raise the pH and alkalinity of the AMD and convert the metals within the AMD from being in solution to a precipitate. The limestone treatment tanks are flushed to prevent precipitated metals build-up and potential clogging by using either an automatic siphon mode or a more labor intensive manual mode. The last stage of the treatment system includes two settling ponds which provide detention time to allow the precipitated metals, especially the aluminum, to settle out before the treated water is discharged back into the Catawissa Creek.

Mine Tunnel Portal

The mine tunnel portal has been stabilized with concrete box culvert sections to prevent further collapse. The tunnel portal has a hinged stainless steel gate on the headwall to prevent entry into the tunnel but still allow large objects such as support timbers from within the tunnel to exit the tunnel without causing a blockage of the tunnel. The gate is hinged to swing outward from the tunnel allowing the large objects to exit by being pushed by the water behind the object.

Infiltration Collection System

The infiltration collection system was placed near the tunnel portal to prevent excess debris such as leaves from clogging the system and to minimize the amount of excavation needed to construct the treatment cells and settling ponds. The design of the infiltration collection system included the need to capture the design flow of 8,000 gpm, while safely by-passing flows in excess of the design flow and up to 375,000 gpm, the estimated 100-year flow rate. The design includes a ponded area, which allows incoming waters to infiltrate through AASHTO #3 stone into Stormtech® underground void chambers. In the collection system the Stormtech® chambers work in reverse of their usual configuration, water percolates through the stone and enters the chambers and connected piping to be conveyed to the treatment tanks. The non-calcareous stone serves the purpose of filtering out leaves and other large particulate waste so as to help prevent clogs within the treatment system. The stone is not intended to be a pH raising system at this stage because raising the pH at this stage would cause clogging of the system where it is not flushable.

The four Stormtech® chambers which lay parallel to the mine discharge channel are manifolded together into a 36” smooth lined corrugated plastic pipes (SLCPP) pipe which lays perpendicular to the channel. Along the 36” pipe there is a 24” tee which serves as a valved by-pass for when the system needs to be completely shut-down for maintenance. The 36” pipe turns 90º at a manhole located behind the channelizing berm and enters the influent flow chamber. The influent flow chamber, also located behind the channelizing berm, limits and distributes the infiltrated flow going into the three influent conveyance lines with a stainless steel perforated baffle in the center of the tank. On the upstream side of this baffle there is an overflow weir, collection box, and 48” conveyance pipe which directs flow in excess of the design flow back into the discharge channel. Additionally, the influent flow chamber contains an 8” valved drain pipe should maintenance be required.

In times of excessive flow, the downstream berm of the influent collection area will pass the estimated 100-year flow rate. The berm and downstream channel are armored with grouted rip-rap to prevent erosion and the channelizing berm provides the capacity required to convey the flow without overtopping. Any surcharge flow will be passed untreated into the drainage tributary to the Catawissa Creek, as it did prior to the construction of this treatment facility, thus preventing damage to the treatment facility.

Influent Conveyance Lines

The conveyance lines take the place of the original manmade channel, in that three 18-inch SLCPP carry the discharge waters downstream from the influent collection chamber to the limestone treatment cells. Each pipe supplies its own treatment cell and each is valved just outside of the influent flow chamber so that the line may be shut down and diverted for maintenance or emergencies. SLCPP risers are positioned along these conveyance lines to allow cleaning of the lines should they become clogged. Also noteworthy is that the conveyance lines crossed beneath the Catawissa Creek and a six-inch, high-pressure petroleum products pipeline owned by Sunoco Pipeline LP.

Limestone Treatment Cells

Each limestone treatment cell is 120 feet in diameter and 12 feet deep and contains separate underdrain networks for influent flow and flushing operations and a 9’ 9” thick bed, approximately 5,600 tons, of AASHTO #3 limestone. Water enters the cells through influent underdrain networks consisting of an 18” header pipe and 13 - 8” perforated laterals. The flow can exit the cells in three different conveyances depending on the operating mode. The operating modes include a manual mode and an automatic mode which are described below.

Manual Mode – From the influent underdrain network the water flows upwards through the limestone bed and out of the tank through the overflow weir in the side of the treatment tank, down the rip-rapped channel, and into the settling pond. In this operating mode the two 24” gate valves are in the closed position and the Agri Drain™ structures have stop logs inserted to above the overflow weir elevation. Flushing of the system while in this mode is accomplished by opening the two 24” gate valves and allowing the tank to drain completely and quickly into the settling pond. Upon completing the flush the 24” valves are closed to put the treatment cell back into treatment mode.

Automatic Mode – Influent enters the treatment cells in the same manner as the manual mode but the effluent from the treatment cells is conveyed in a different manner. In automatic mode the 24” bypass valves are closed and, under normal flow conditions, water does not flow over the overflow weir. The Agri Drain™ stop logs are removed and water coming from the effluent underdrains in the cells enters the siphon chambers (one siphon chamber for each treatment cell). When the water level in both the cells and the siphon chambers are at the predetermined elevation, the siphon bell on the automatic siphons (three working in unison for each cell) trip and then drain each tank through the bottom, flushing the limestone ballast with each cycle. Water from the siphon chamber then flows into the settling ponds. This design provides a retention time of approximately 1.5 to 2 hours in each of the cells. When enough water drains from the treatment cells, the siphon bells reset themselves, repeating the process. More information on the operation of automatic siphons can be found at http://www.siphons.com/operation.html. Although the siphons flush the tanks with every cycle, they are not capable of flushing the entire treatment tank due to their limited operating range. Therefore, there is a potential for accumulation of aluminum precipitate below the operating range of the siphons. To clear these accumulations the system should be switched into manual mode and a manual flush conducted on a periodic basis.

Settling Basins

After exiting the treatment tanks the water is drained into two settling basins arranged in series. A sediment curtain and serpentine berms slow the travel of the effluent, allowing for settling of the aluminum precipitate and other particulates. The berms also exist as work platforms such that small excavating equipment can extend their reach into the pond for cleanout operations. A dual

24" pipe culvert connects each of the settling ponds, as well an emergency spillway between the ponds for high flow conditions. Additionally, each pond is equipped with an Agri Drain™, which, when all the stop logs are removed, will completely drain each pond. This is necessary during maintenance or for removal of the precipitate sludge. At the end of the second settling basin, water is then discharged into a small stilling pond via two 24" SLCPP lines where velocities are reduced prior to joining the Catawissa Creek. Riprap lined overflow spillways also exist between each of the ponds and the Catawissa Creek to allow surplus waters to spill into the streambed with as little erosion as possible.

PROJECT CONCLUSIONS

This project represents possibly the largest passive treatment facility of its kind anywhere in the United States and uses many innovative techniques to accomplish its goals. It received the Honor Award from the American Council of Engineering Companies-PA, the Governor's Award for Engineering Excellence, and the Northeastern PA Nonprofit and Community Assistance Center Community Award, all in 2007. It serves as a showpiece demonstrating what can be done to solve the AMD problem in Pennsylvania's Anthracite Coal Region.

Through this project and projects like it, miles of lifeless streams and rivers rendered aquatically useless due to AMD will be revitalized. The recreational value will be returned to the land and the public will be able to enjoy activities, such as hiking, fishing, and boating. Ecotourism will increase and with it comes economical returns. The Pennsylvania Fish and Boat Commission has estimated the recreational value of the restored fishery to be $1,395,500.

The major components of this treatment system have been designed to last for years to come with only the limestone being a consumable in the treatment system. The accumulation of aluminum precipitate sludge in the settling ponds will need to be removed periodically and options for the possible reuse of the aluminum precipitate in an industrial process are being researched.

Dissolution reactions between the influent AMD and the limestone in the cells and aluminum oxidation and hydrolysis reactions within the water column and on limestone, caused the effluent from the outlet pipes draining the limestone beds to have increased pH; increased concentrations of calcium, magnesium, and alkalinity; and decreased concentrations of dissolved aluminum, iron, and manganese compared to the influent or the effluent from the spillways. Continued aluminum oxidation and hydrolysis reactions within the oxidation pond promoted additional metals removal.

MAINTENANCE ACTIVITIES

One may hypothesize the treatment system will fail eventually because of depletion of the calcitic limestone in the cells or the clogging of the limestone beds with aluminum precipitate. The latter problem is being managed through periodic monthly flushing of solids from the treatment cells. However, the depletion of limestone is another matter than can only be remedied by replacing the material that has dissolved.

√	Activities	Description	Frequency
	Examine Siphon Chambers	Ensure proper operation. Inspect piping, siphon equipment, etc. for corrosion or damage.	Monthly
	Inspect Grounds	After intense storm events, inspect the grounds for damage or erosion including ponds, inlets, outlets, access roads, etc. which may affect system operations.	As needed (Minimum Annually)
	Inspect Intake Structures	Determine if clogging is present in the intake system near the mine tunnel discharge. Inspect both on the surface and through inspection ports. Remove/dispose of accumulated debris.	Monthly
	Inspect Tunnel Gate	Check inside box culvert at mine tunnel portal for debris and remove/dispose.	Monthly
	Check Spillways/Outlets for Debris Accumulation	Remove debris and dispose of properly.	Monthly
	Flushing of Tanks (Manual Mode)	Fully open both 24" valves on one treatment tank at a time. Let drain until the tank is empty then shut both valves.	Monthly
	Flushing of Tanks (Automatic Siphon Mode)	Though the siphons flush the treatment tanks automatically, they do not achieve a full flush, so occasionally the tanks must be manually flushed. This aids in removing more particulate build-up than Automatic Mode. Insert Agri Drain™ stop logs to fill the treatment tank to the overflow weir then flush using the Manual Mode flushing procedure. Once the flush is complete, remove the stop logs to place the system back into Automatic Mode. This operation should be conducted on one treatment tank at a time	Quarterly
	Remove Aluminum, or Other Particulate Precipitate	Metals, especially aluminum, will accumulate on the bottom of the finishing/settling ponds and periodically will need to be removed.	As needed (est. 5-10 yrs)
	Limestone Ballast	As limestone dissolves, the tank level settles. Also, scale buildup may reduce maximum reactivity. Limestone will eventually need to be replaced.	Est. 5-15 years

RESOURCES

http://audenreid.blogspot.com/ - courtesy of Tom Davidock (formerly of Schuylkill Conservation District).

Treatment System GGGrant App_1.29.03.doc – courtesy of RETTEW Associates, Inc.
Project Narrative 10-17-06.doc – courtesy of RETTEW Associates, Inc.

http://maps.google.com/maps?q=Sheppton,+PA,+United+States+of+America&sa=X&oi=map&ct=title – for maps and aerial photos

http://www.wikimapia.org/#lat=40.898349&lon=-76.068596&z=17&l=0&m=a&v=2

http://www.siphons.com/operation.html - Fluid Dynamic Siphons, Inc.

APPENDIX A

OPERATIONS AND MAINTENANCE LOG

AUDENREID MINE TUNNEL
ABANDONED MINE DRAINAGE REMEDIATION PROJECT

OPERATIONS AND MAINTENANCE LOG

PERSON(S) PERFORMING MAINTENANCE: ______________________________ **DATE:** ____________________

MAINTENANCE TASK	MAINTENANCE INTERVAL	√ COMPLETED TASKS	COMMENTS
Examine Siphon Chambers	Monthly		
Inspect Grounds	As Needed (Minimum Anually)		
Inspect Intake Structures	Monthly		
Inspect Tunnel Gate	Monthly		
Check Spillways/Outlets for Debris Accumulation	Monthly		
Flushing of Tanks (Manual Mode)	Monthly		
Flushing of Tanks (Automatic Siphon Mode)	Quarterly		
Remove Aluminum, or Other Particulate Precipitate	As Needed (Est. 5-10 years)		
Limestone Ballast	As Needed (Est. 5-15 years)		

	Before Flush	After Flush
Tank #1 Flow Depth over Weir (in)		
Tank #1 Estimated Flow Rate (gpm)		
Tank #2 Flow Depth over Weir (in)		
Tank #2 Estimated Flow Rate (gpm)		
Tank #3 Flow Depth over Weir (in)		
Tank #3 Estimated Flow Rate (gpm)		

APPENDIX B

ESTIMATED FLOW RATE CHART

AUDENREID MINE TUNNEL
ABANDONED MINE DRAINAGE REMEDIATION PROJECT

TREATMENT TANK WEIR - ESTIMATED FLOW RATE CHART

Head Above Weir (in)	Head Above Weir (ft)	Flow (CFS)	Flow (gpm)
0.25	0.02	0.06	27
0.5	0.04	0.17	76
0.75	0.06	0.31	140
1	0.08	0.48	215
1.25	0.10	0.67	300
1.5	0.13	0.88	395
1.75	0.15	1.11	497
2	0.17	1.35	607
2.25	0.19	1.61	724
2.5	0.21	1.89	847
2.75	0.23	2.18	976
3	0.25	2.48	1112
3.25	0.27	2.79	1253
3.5	0.29	3.12	1399
3.75	0.31	3.45	1550
4	0.33	3.80	1707
4.25	0.35	4.16	1868
4.5	0.38	4.53	2034
4.75	0.40	4.91	2204
5	0.42	5.30	2378
5.25	0.44	5.70	2557
5.5	0.46	6.10	2740
5.75	0.48	6.52	2927
6	0.50	6.95	3118
6.25	0.52	7.38	3312
6.5	0.54	7.82	3510
6.75	0.56	8.27	3712
7	0.58	8.73	3918
7.25	0.60	9.19	4126
7.5	0.63	9.67	4339
7.75	0.65	10.15	4554
8	0.67	10.63	4773
8.25	0.69	11.13	4995
8.5	0.71	11.63	5220
8.75	0.73	12.14	5448
9	0.75	12.65	5679
9.25	0.77	13.17	5913
9.5	0.79	13.70	6150
9.75	0.81	14.24	6390
10	0.83	14.78	6632
10.25	0.85	15.32	6878
10.5	0.88	15.88	7126
10.75	0.90	16.44	7377
11	0.92	17.00	7630
11.25	0.94	17.57	7886

APPENDIX C

PLAN SET (SHEETS 1-12) AMD REMEDIATION PROJECT FOR THE AUDENREID MINE TUNNEL

APPENDIX D

PLAN SET (SHEETS 1-11) FLOOD DAMAGE REPAIRS FOR THE AUDENREID MINE TUNNEL