THE TOP-20 PLAN

Using the Top-10 Tables 4-7 and scoring each discharge listed (ten points for ranking first and one point for ranking tenth), a prioritization system was constructed according to combined impact. Twenty discharges throughout the Susquehanna River Basin Anthracite Region should be a focal point to begin basin-scale watershed restoration.

These 20 discharges, representing only 6 percent of the 320 total discharges, contribute 57.6 percent of the total discharge flow, 70.0 percent of the total iron loading, 72.0 percent of the total manganese loading, 80.8 percent of the total aluminum loading, and 63.0 percent of the total acidity loading entering the Susquehanna River Basin from the Anthracite Region (Table 8).

As mentioned, this Top-20 Plan is for basin-scale restoration. Even though the Top-20 Plan addresses a vast majority of the AMD pollution loading in the Northern and Eastern-Middle Fields, the plan offers less watershed-scale restoration in the Western-Middle and Southern Fields.

When analyzing the watershed-scale improvements that would occur if the Top-20 Plan is implemented, Nescopeck Creek, Lackawanna River, Solomon Creek, and Nanticoke Creek would be virtually restored. Catawissa Creek and the Susquehanna River proper would be nearly restored. Wiconisco Creek and Mahanoy Creek would be significantly improved. Newport Creek would be partially improved. No improvement would occur in Swatara Creek, Shamokin Creek, and Stony Creek. Due to the Rausch Creek Treatment Plant, no additional treatment is needed within the Mahantango Creek Watershed.

Of the three watersheds where no improvement would occur, only Shamokin Creek has a significant impact to the Susquehanna River Basin. Swatara Creek is impaired mainly in the headwaters and is completely restored by its confluence with the Susquehanna River. Stony Creek is impaired by mildly acidic discharges that contain virtually no metal concentrations. In addition, Rausch Creek, which is one of the AMD impacts to Stony Creek, is treated via limestone diversion wells constructed and maintained by the Doc Fritchey Chapter of Trout Unlimited. Consequently, only Shamokin Creek should gain secondary focus post Top-20 Plan implementation.

Table 8. Top-20 Prioritized Discharges within the Anthracite Region of the Susquehanna River Basin and Their Separated Pollution Contribution Percentages

Discharge	Field	Watershed	Flow %	Fe Load %	Mn Load %	Al Load %	Acid Load %	Loading Average %
Jeddo Tunnel	Eastern-Middle	Nescopeck Creek	9.78	3.45	11.30	42.92	13.41	17.8
Old Forge Borehole	Northern	Lackawanna River	11.45	16.78	13.36	1.87	2.49	8.6
Nottingham-Buttonwood Airshaft	Northern	Solomon Creek	4.60	7.85	5.22	0.53	7.40	5.3
Solomon Creek Boreholes	Northern	Solomon Creek	4.70	9.07	4.77	0.34	4.30	4.6
Gowen Tunnel	Eastern-Middle	Nescopeck Creek	3.00	0.19	4.50	10.46	3.76	4.7
Duryea Breach	Northern	Lackawanna River	4.17	7.40	5.72	0.42	0.88	3.6
Audenreid Tunnel	Eastern-Middle	Catawissa Creek	3.00	0.26	2.05	9.56	8.75	5.2
Packer #5 Breach and Boreholes	Western-Middle	Mahanoy Creek	3.04	3.72	6.07	0.08	2.54	3.1
Gilberton Pump	Western-Middle	Mahanoy Creek	2.18	4.65	5.11	0.63	1.72	3.0
Centralia Tunnel	Western-Middle	Mahanoy Creek	1.27	0.49	2.48	3.76	2.54	2.3
Dundee Outfall	Northern	Nanticoke Creek	0.72	4.50	0.92	0.00	2.89	2.1
Derringer Tunnel	Eastern-Middle	Nescopeck Creek	0.78	0.04	1.09	2.82	1.16	1.3
Mocanaqua Tunnel	Northern	Susquehanna River	0.62	2.02	1.85	1.48	3.64	2.2
Porter Tunnel	Southern	Wiconisco Creek	0.17	0.82	0.34	2.03	1.40	1.1
West Penn Breaker Plant Discharge	Western-Middle	Mahanoy Creek	0.27	0.96	0.75	1.71	0.40	1.0
Jermyn Slope	Northern	Lackawanna River	2.72	0.25	0.31	0.12	0.27	0.2
Doutyville Tunnel	Western-Middle	Mahanoy Creek	1.49	0.47	0.88	1.54	1.07	1.0
Continental Plant Bypass	Western-Middle	Mahanoy Creek	1.48	1.36	3.00	0.18	1.80	1.6
Susquehanna #7 Shaft	Northern	Newport Creek	1.43	3.30	1.70	0.23	0.49	1.4
Plainsville Outlet	Northern	Susquehanna River	0.69	2.41	0.62	0.14	2.08	1.3
		Total %	57.6	70.0	72.0	80.8	63.0	

Due to the massive flows and pollution loadings of its discharges, the Anthracite Region cannot be restored via typical passive treatment systems. Given the nature of AMD pollution in the Anthracite Region, active treatment, like the Rausch Creek Treatment Plant in the Mahantango Creek Watershed, is the most feasible restoration option to truly restore the waters in the Anthracite Region.

Strategic treatment plant site selections would allow, in some cases, several Top-20 discharges to be treated at the same plant, thus reducing capital, operation, and maintenance costs. Strategic treatment plant site selections would also allow, in some cases, adjacent discharges not in the Top-20 Plan to be incorporated into the treatment plant, increasing the percentage of total Anthracite loading being treated. The following are some possible active treatment plant scenarios.

Conceptual Plant #1 – Lackawanna River

The Old Forge Borehole (#2) and Duryea Breach (#7) are the largest and fourth largest producers of iron loading, respectively, within the Susquehanna River Basin Anthracite Field. Combined, nearly 25 percent of the iron loading and 20 percent of the manganese loading produced in the Susquehanna River Basin Anthracite Fields originates from these two discharges alone. At the watershed-scale, the Old Forge Borehole and Duryea Breach contribute 98.7 percent of the iron loading that enters the Lackawanna River Watershed.

The Old Forge Borehole from the western bank of the Lackawanna River.

With the circum-neutral character of the discharges, the cumulative iron and manganese loading captured, and the fact that these two discharges are in proximity to one another (1.7 miles), the collection and piping of both discharges to a centralized treatment plant could be a logical plan (Figure 7 and Table 9).

Both discharges, due to size of mine pool and flows, may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design. The Lackawanna River Corridor Association, EPCAMR, and SRBC are currently completing a flow monitoring project on the Old Forge Borehole to assess this potential.

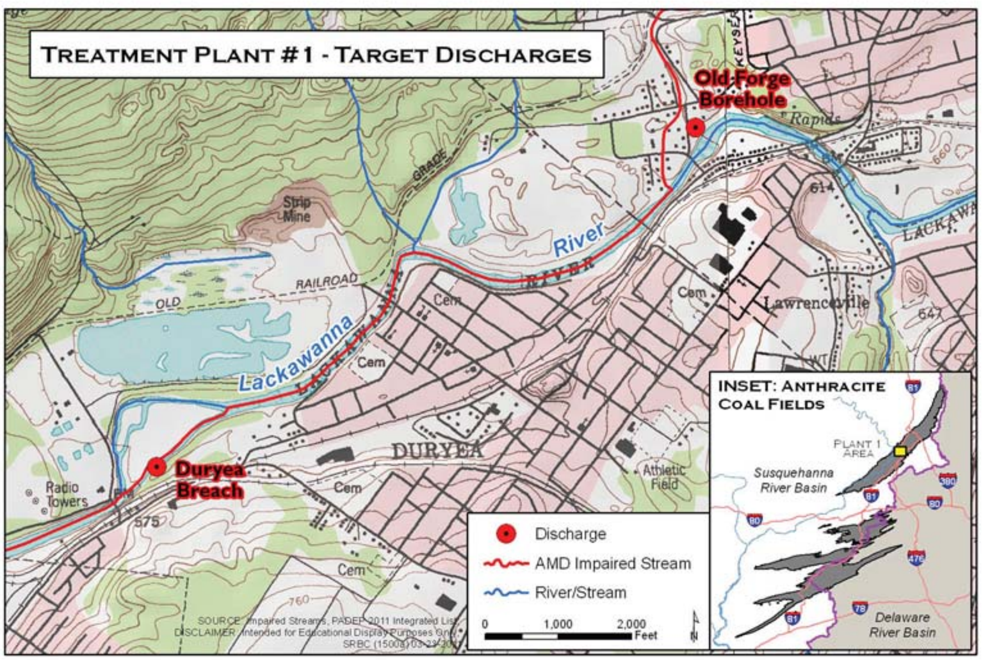

Figure 7. Treatment Plant #1 - Target Discharges

Table 9. Average Flow, Concentrations, and Loadings of Plant #1 Discharges and Plant #1 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Old Forge Borehole	75.95	5.96	30.25	4.21	0.41	84.44	11.53	12,393.02	1,726.76	167.77	34,596.49	4,726.07
Duryea Breach	27.66	5.97	36.62	4.96	0.25	87.07	11.16	5,464.45	739.48	37.25	12,991.83	1,664.95
Mixed	103.61	~5.96	31.95	4.41	0.37	85.14	11.43	17,857.47	2,466.24	205.02	47,588.32	6,391.02

Conceptual Plant #2 – Solomon Creek

Only 0.8 miles separate the Solomon Creek Boreholes (#4) and the Nottingham-Buttonwood Airshaft (#3) (Figure 8). Both discharges enter Solomon Creek just south of Wilkes-Barre. Combined, nearly 17 percent of the iron loading and 10 percent of the manganese loading produced in the Susquehanna River Basin Anthracite Fields originates from these two discharges.

Combining these discharges into one treatment plant creates a large flow; however, the chemistry should be circumneutral with a high iron concentration (37.55 mg/l) and low concentrations of manganese and aluminum (Table 10). Consequently, treatment of the water chemistry should not be difficult.

Due to the flow of these two discharges and the scale of the mine pools fueling the flow, the Solomon Creek Boreholes and the Nottingham-Buttonwood discharges may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design.

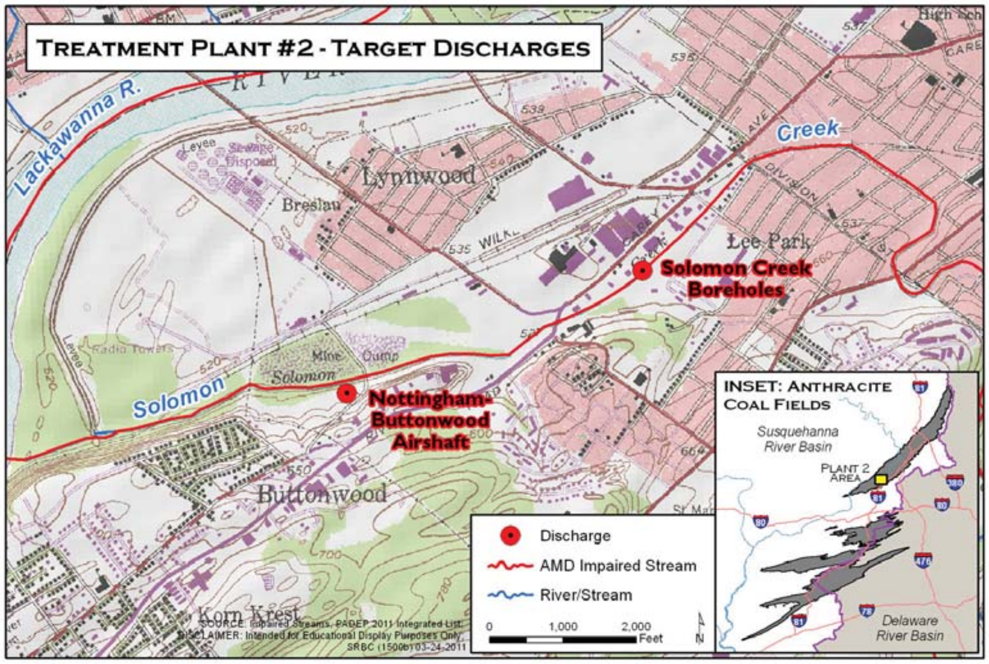

Figure 8. Treatment Plant #2 - Target Discharges

Solomon Creek borehole.

Conceptual Plant #3 – Nanticoke

Of all the Top-20 Discharges, the Dundee Outfall (#11) and the Susquehanna #7 Shaft (#17) have the most potential at being treated separately in passive treatment systems. However, several issues create a situation where combination into one active plant may be more favorable.

First, passive treatment on a portion (33 percent of average flow) of the Dundee Outfall has been attempted and has been mostly unsuccessful. A Phase II passive treatment system is being considered in the Nanticoke Creek floodplain. Due to size of flow, and the placement and available area for the passive treatment system, Phase II has a high probability of failure as well.

Solomon Creek near its confluence with the Susquehanna River.

Table 10. Average Flow, Concentrations, and Loadings of Plant #2 Discharges and Plant #2 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Solomon Creek Boreholes	31.22	6.3	39.78	3.66	0.18	172.31	48.37	6,700.92	616.21	30.31	29,021.03	8,147.17
Nottingham-Buttonwood Airshaft	30.51	6.1	35.23	4.10	0.29	451.54	85.21	5,798.45	674.81	47.73	74,318.31	14,024.59
Mixed	61.73	~6.2	37.55	3.88	0.23	310.47	66.61	12,499.37	1,291.02	78.04	103,339.34	22,171.76

The Susquehanna #7 Shaft Discharge contains land area nearby where a passive treatment system could be constructed. However, these properties are held by multiple entities. In addition, drilling into the mine pool to create another outfall may have to be completed to access all the land area needed for passive treatment.

With a distance of only 2.1 miles between the discharges, the mix water being circumneutral with a high iron concentration (37.55 mg/l) and low concentrations of manganese and aluminum, and the smaller footprint offered, an active plant may have a better cost/benefit ratio than two very large passive treatment systems that have a high failure probability (Figure 9 and Table 11).

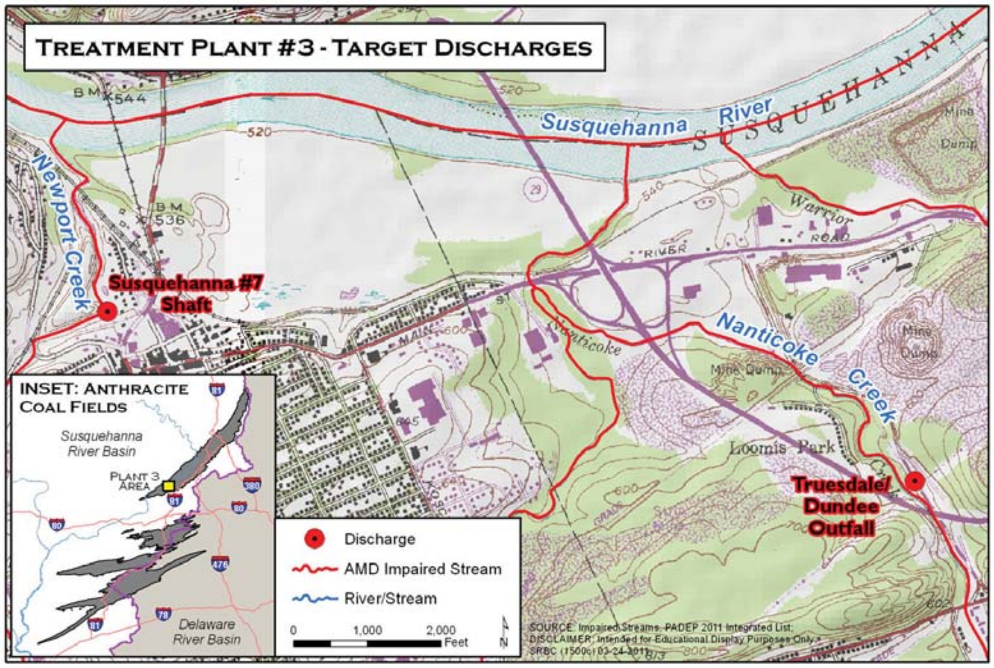

Figure 9. Treatment Plant #3 - Target Discharges

Table 11. Average Flow, Concentrations, and Loadings of Plant #3 Discharges and Plant #3 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Dundee Outfall	4.71	5.28	130.53	4.67	0.03	98.58	197.50	3,316.87	118.63	0.77	2,505.00	5,018.45
Susquehanna #7 Shaft	9.46	6.35	47.70	4.31	0.41	129.77	18.35	2,434.14	220.01	20.70	6,621.92	936.37
Mixed	14.17	~6.0	75.23	4.43	0.28	119.40	77.90	5,751.01	338.61	21.47	9,126.92	5,954.82

As with all the other mine pools, the Dundee Outfall and Susquehanna #7 Shaft discharges may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design.

Completion of Conceptual Plant #1, #2, and #3 could remove up to 46.6 miles from the PADEP Integrated List of AMD impaired waters. This would include 37.3 miles of the Susquehanna River mainstem, 4.0 miles of Solomon Creek mainstem, 2.78 miles of Nanticoke Creek mainstem, and 2.58 miles of Lackawanna River mainstem.

The outfall of the Susquehanna #7 Discharge.

Conceptual Plant #4 – Jeddo Tunnel

Due to its very high average flow, the Jeddo Tunnel (#1) is the largest acidity (13.4 percent) and aluminum loading producer (42.9 percent), second largest manganese producer (11.3 percent), and eighth largest iron producer (3.5 percent) in the entire Susquehanna River Basin Anthracite Fields.

The Jeddo Tunnel is by far the largest contributor of AMD loading to Nescopeck Creek, contributing 91.5 percent of the iron loading, 66.4 percent of the manganese loading, 76.2 percent of the aluminum loading, and 70.6 percent of the acidity loading.

Even though the Jeddo Tunnel has a high average flow of 64.9 cfs (only the Old Forge Borehole has a higher average flow), the concentration of

The Jeddo Tunnel flow entry to Little Nescopeck Creek. The Jeddo Tunnel is by far the largest contributor of AMD loading to Nescopeck Creek, contributing 91.5 percent of the iron loading, 66.4 percent of the manganese loading, 76.2 percent of the aluminum loading, and 70.6 percent of the acidity loading.

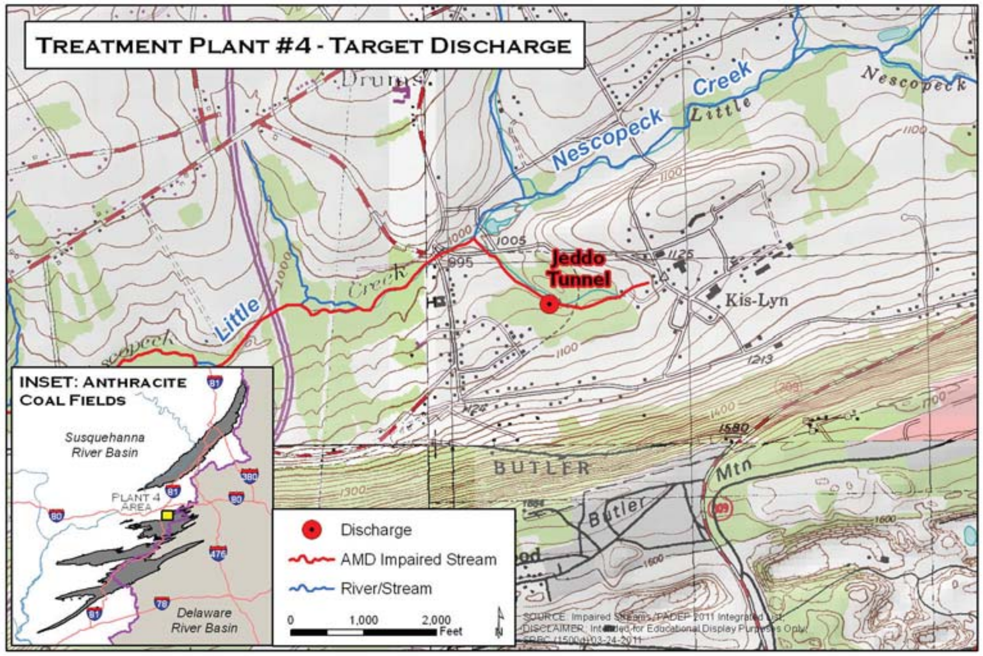

Figure 10. Treatment Plant #4 - Target Discharges

AMD parameters are relatively benign (Table 12). Consequently, treatment via an active treatment plant is plausible (Figure 10).

The Jeddo Tunnel is the largest of the Anthracite drainage tunnels. Construction of the Jeddo Tunnel system started in 1891 and was completed in 1934. The Jeddo Tunnel system is nearly 9 miles in length and branches out to drain more than 32 square miles from four major coal basins: Big Black Creek, Little Black Creek, Cross Creek, and Hazleton (PADEP, 2005). SRBC and Wildlands Conservancy completed a very detailed study of the Jeddo Tunnel Complex in 1999 entitled *Assessment of Conditions Contributing Acid Mine Drainage to the Little Nescopeck Creek Watershed, Luzerne County, Pennsylvania and an Abatement Plan to Mitigate Impaired Water Quality Within the Basin* that should be used when progression of a plan to treat the Jeddo Tunnel flow is initiated.

The Eastern-Middle Anthracite Region Recovery Inc. (EMARR) out of Hazleton has been studying the consumptive water use mitigation, hydroelectric, and geothermal potential of this intricate set of connected tunnels that contribute AMD water to the Jeddo Tunnel. EMARR believes that this potential is real and significant, particularly in the area of the Hazelton Shaft. If treatment of the Jeddo Tunnel via an active treatment plant moves forward, EMARR should be contacted so that their opinions could be validated and possibly incorporated into the plant design.

Conceptual Plant #5 – Black Creek

The Gowen Tunnel (#5) and Derringer Tunnel (#13) are only separated by slightly over a tenth of a mile (Figure 11). Both discharges are very similar in water quality; however, the Gowen Tunnel is nearly four times the flow of the Derringer Tunnel (Table 13).

The Gowen and Derringer Tunnels are the only significant discharges on Black Creek, the largest tributary to Nescopeck Creek. They are also the second and third most impacting discharges to the Nescopeck Watershed behind the Jeddo Tunnel. Together, Gowen and Derringer contribute 6.1 percent of the iron loading,

Table 12. Average Flow, Concentrations, and Loadings of Jeddo Tunnel (Plant #4)

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Jeddo Tunnel	64.89	4.38	7.27	4.17	10.99	8.46	72.59	2,544.26	1,461.01	3,847.62	2,960.55	25,410.56

Table 13. Average Flow, Concentrations, and Loadings of Plant #5 Discharges and Plant #5 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Gowen Tunnel	19.94	3.92	1.29	5.41	8.72	19.72	66.29	139.26	582.27	937.87	2,121.76	7,130.31
Derringer Tunnel	5.15	4.15	1.11	5.06	9.11	5.02	78.89	30.73	140.70	253.13	139.44	2,191.58
Mixed	25.09	~3.97	1.26	5.34	8.80	16.71	68.87	169.99	722.97	1,191.00	2,261.20	9,321.89

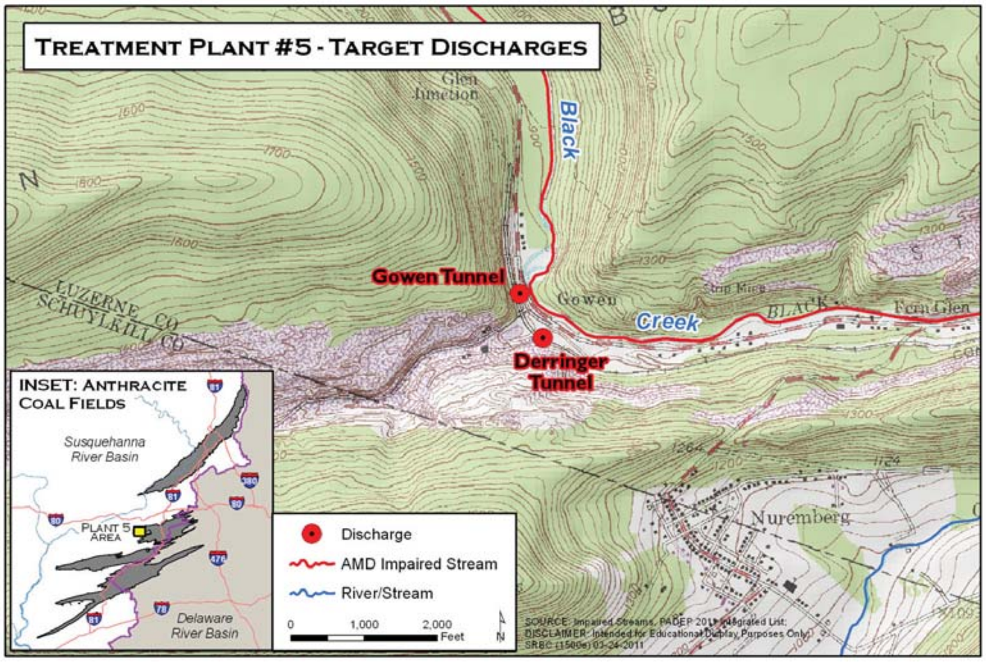

Figure 11. Treatment Plant #5 - Target Discharges

32.9 percent of the manganese loading, 23.6 percent of the aluminum loading, and 25.9 percent of the acidity loading to Nescopeck Creek.

Combining the effects of Conceptual Plant #4 and Plant #5, 29.51 miles could be removed from the PADEP Integrated List of AMD impaired waters. This would include 6.33 miles of Little Nescopeck Creek, 5.37 miles of Black Creek, and 17.8 miles of the Nescopeck Creek mainstem.

In addition, much of Nescopeck Creek upstream of the AMD impacts is listed as a HQ-CWF (Commonwealth of Pennsylvania, 2005). Several Nescopeck Creek tributaries are also listed as containing Class A populations of trout, the highest rating achieved (PBFC, 2010). Consequently, cold water species recolonization could be quick upon AMD treatment.

As with all the other mine pool discharges, due to the size of the mine pools and flows, the Gowen and Derringer Tunnels may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design.

Conceptual Plant #6 – Catawissa Creek

A vast majority of the AMD pollution impacting Catawissa Creek originates from just one tunnel discharge. The Audenreid Tunnel (#6) contributes 85.2 percent of the iron loading, 88.5 percent of the manganese loading, 88.8 percent of the aluminum loading, and 88.6 percent of the acidity loading that impacts Catawissa Creek. Four other smaller tunnel discharges (Catawissa, Green Mountain, Oneida #1, and Oneida #3) comprise a majority of the balance.

Passive treatment has been attempted on three of the tunnel discharges. Two have been successful at Oneida #1 and #3. These systems have restored much of Tomhicken Creek, a large tributary to Catawissa Creek. The passive system at Audenreid has been significantly less successful. Soon after becoming operative, a significant storm created a tremendous flow exiting the Audenreid Tunnel, estimated at 300,000 GPM (Davidock, 2006). This flow, and the sediment plume it created, inundated the passive treatment system to the point that it is still not fully operational five years later.

Passive treatment was selected as the treatment method at Audenreid due to a lack of infrastructure near the discharge, namely electricity. However, flow volumes the size of Audenreid (average 19.93 cfs) are very difficult if not impossible to treat using present day passive treatment system technologies. SRBC is recommending that an active system be considered as a Phase II alternative to the passive system at Audenreid.

Another reason that an active plant should be considered is that the two other tunnel discharges currently not treated, Catawissa and Green Mountain, are extremely close to Audenreid (Figure 12).

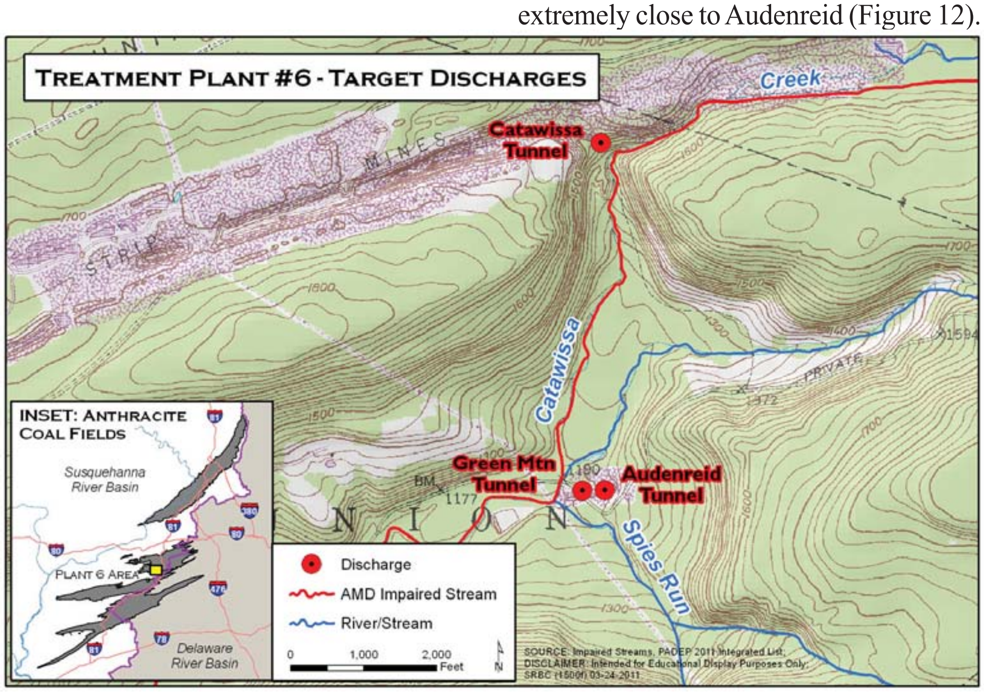

Figure 12. Treatment Plant #6 - Target Discharges

Cold water fishery habitat of Catawissa Creek.

The Green Mountain Tunnel is only 328 feet from the Audenreid Tunnel and the Catawissa Tunnel is 0.9 miles upstream. The remoteness of these three discharges is the limiting factor for combining the discharges into a centralized plant. However, the benefit is a completely restored Catawissa Creek, which is considered by many to be one of the most scenic and habitat-expansive tributaries of the Anthracite Region (Table 14).

The Pennsylvania Fish and Boat Commission (PFBC) has surveyed the mainstem of Catawissa Creek three times. In 1957, the first survey concluded that Catawissa Creek has excellent physical characteristics and water temperatures for trout management but was devoid of significant aquatic life due to AMD impairment. Chemical surveys of the stream in 1966 and 1976 found that it was still severely degraded. In the summer of 1997, the PFBC studied the Catawissa Creek Watershed to assess the level of management the streams in the watershed needed and their potential as fisheries, since they had never been documented. The study found substantial wild trout populations in the streams where water quality had not been severely AMD-impaired. The PFBC noted the Catawissa Creek's tremendous potential for cold water management if AMD pollution were remedied (Wnuk, 1998).

The hydroelectric and geothermal potential at the Audenreid discharge is real and already being utilized. EMARR recently completed a project to capture the power supplied by the flow of the Audenreid Tunnel Discharge to increase the automation of the passive treatment system. This micro-hydro project creates more energy than is required for the treatment system, but the lack of electrical infrastructure near the discharge prevents the productive use of the energy balance. Instead, the energy balance is currently converted to heat and extinguished to the atmosphere. A project like this could serve as an example of how energy from these discharges could be captured and used to offset the energy needs of an active system.

Combining the effects of Conceptual Plant #6 and the success of the Oneida passive treatment systems, 39 miles of the Catawissa Creek mainstem could be removed from the PADEP Integrated List of AMD impaired waters. Catawissa Creek would also become a cold water fishery destination.

Conceptual Plant #7 – Mahanoy Creek Plant #1

The first massive discharge to impact Mahanoy Creek is the Gilberton Pump Discharge (#9). The Gilberton Pump Discharge was installed to reduce basement flooding and runs about 40 percent of the time (Growitz et al., 1985). According to the historical data, when pumped, the flow of the discharge is around 22.3 cfs; however, the average flow is closer to 14.47 cfs due to the irregular pumping schedule. The Gilberton Pump Discharge is circumneutral and is the largest source of iron (25.8 percent) and second largest source of manganese (19.8 percent) to Mahanoy Creek.

The West Penn Breaker Discharge (#15) is less than one mile downstream of the Gilberton Pump Discharge (Figure 13). The discharge is slightly net acidic with a relatively low flow containing high concentrations of iron and aluminum. It is the second largest aluminum loading producer in the Mahanoy Creek Watershed, and eighth largest in the entire Susquehanna Basin Anthracite Field.

Due to the relative low flow of the West Penn Breaker Discharge, especially in comparison to the Gilberton Pump Discharge flow, they could be easily combined for optimal treatment (Table 15).

The Gilberton Pump Discharge may have potential as a source of consumptive use mitigation water. According to SRBC, the Gilberton Mine Pool stores 1.86 billion gallons of water (Pytak, 2010). On average, the mine pool is pumped 146 days per year at 22.3 cfs. The period of the time (60 percent) that the mine pool is not pumped probably coincides with the dry summer months when consumptive use mitigation water is needed. The question then arises, can the mine pool be pumped at a rate of 8.92 cfs for 365 days per year and still maintain a level to eliminate basement flooding? If this or a different change in pumping rate is possible without causing property damage, then summer flows could be increased on Mahanoy Creek.

Table 14. Average Flow, Concentrations, and Loadings of Plant #6 Discharges and Plant #6 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Audenreid Tunnel	19.93	3.74	1.77	2.47	7.97	0.73	154.13	190.28	265.45	856.61	78.36	16,570.82
Catawissa Tunnel	1.31	4.01	1.45	0.31	1.27	2.11	28.81	10.26	2.18	9.00	14.87	203.68
Green Mountain Tunnel	1.75	3.91	0.51	0.65	2.94	1.17	51.73	4.79	6.18	27.77	11.04	488.29
Mixed	22.99	~3.77	1.66	2.21	7.20	0.84	139.19	205.33	273.81	893.38	104.27	17,262.79

Table 15. Average Flow, Concentrations, and Loadings of Plant #7 Discharges and Plant #7 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Gilberton Pump Discharge	14.47	6.14	44.01	8.46	0.73	67.36	41.62	3,435.41	660.77	56.76	5,258.37	3,249.19
West Penn Breaker Discharge	1.78	4.76	73.87	10.11	16.01	15.09	78.98	709.17	97.04	153.68	144.91	758.16
Mixed	16.25	~6.00	47.28	8.64	2.40	61.64	45.71	4,144.58	757.81	210.44	5,403.28	4,007.35

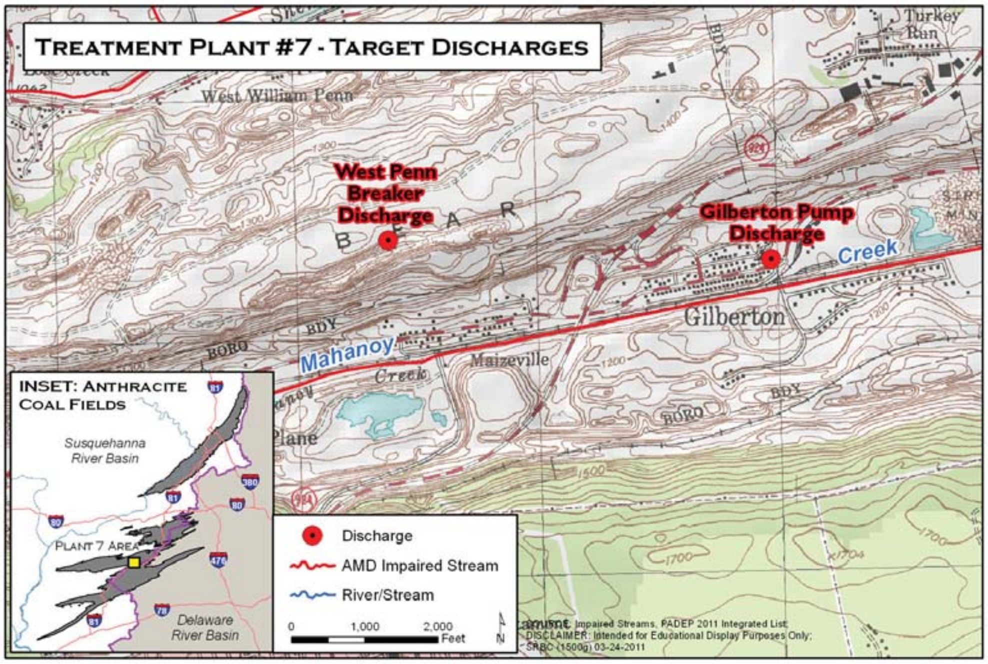

Figure 13. Treatment Plant #7 - Target Discharges

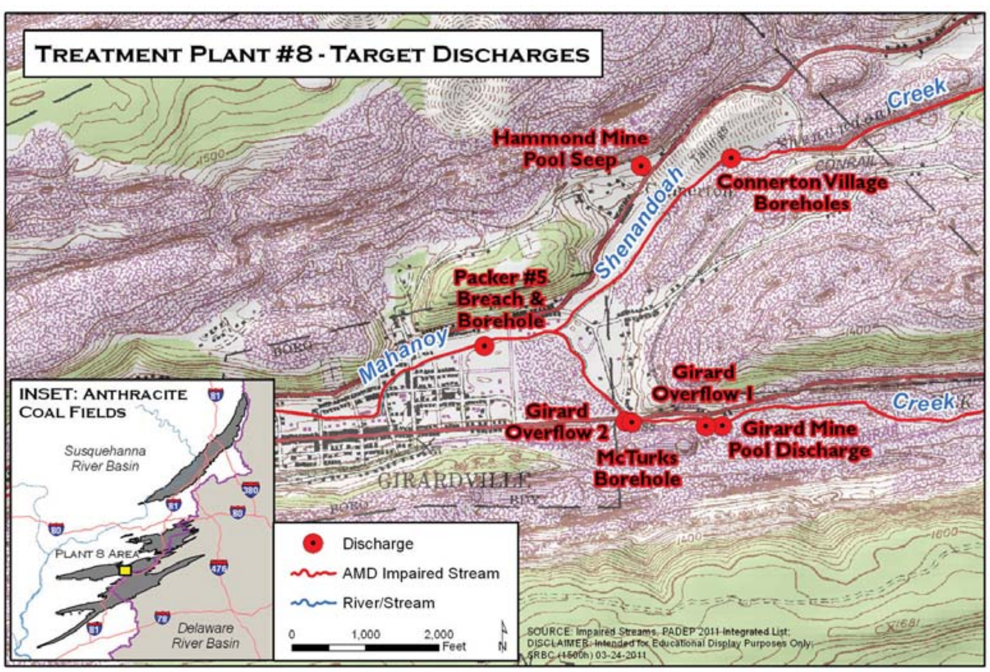

Figure 14. Treatment Plant #8 - Target Discharges

The Oakland Tunnel entry to Mahanoy Creek.

Conceptual Plant #8 – Mahanoy Creek Plant #2

Just upstream of the town of Girardsville is the second major impact to Mahanoy Creek, the Packer #5 Breach and Borehole (#8) and several other discharges in close proximity (Figure 14).

Similar to the Gilberton Pump Discharge, Packer #5 Breach and Borehole is circumneutral. It is the second largest producer of iron (20.6 percent) and largest producer of manganese (23.6 percent) to Mahanoy Creek. The Packer #5 complex could drain or partially drain as many as 14 different mine pools (PADEP, 2007).

There are several other low to moderate flow discharges in close proximity to the Packer #5 Breach and Borehole. The Girard Mine Pool Discharge, two Girard Mine Pool Overflows, and the McTurks Borehole are located less than one-half mile upstream on Mahanoy Creek. The Hammond Mine Pool Seep and Connerton Village Boreholes are located 0.8 miles upstream on Shenandoah Creek, which confluences with Mahanoy Creek at the Packer #5 Breach and Borehole site. Due to their proximity and the fact that mixing the discharges creates

Table 16. Average Flow, Concentrations, and Loadings of Plant #8 Discharges and Plant #8 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Packer #5 Breach and Borehole	20.19	6.49	25.21	7.21	0.07	164.41	44.11	2,746.11	785.01	7.12	17,907.26	4,804.65
Girard Mine Pool Discharge	3.52	6.05	23.22	3.99	0.43	57.89	60.56	440.91	75.86	8.19	1,099.29	1,150.07
Girard Overflow #1	0.97	6.40	18.65	nd	nd	48.50	44.93	97.54	nd	nd	253.67	234.96
Girard Overflow #2	0.09	3.70	10.69	nd	nd	0.00	99.20	5.24	nd	nd	0.00	48.61
McTurks Borehole	0.43	5.95	15.53	nd	nd	22.30	60.08	36.03	nd	nd	51.74	139.38
Connerton Village Borehole	3.48	6.26	45.29	nd	nd	198.10	124.60	850.12	nd	nd	3,718.30	2,338.70
Hammond Pool Seep	0.16	6.55	13.60	5.65	0.45	149.79	-7.17	11.70	4.86	0.39	128.82	-6.17
Mixed	28.84	~6.30	26.92	5.56	0.10	148.86	55.99	4,187.65	865.73	15.70	23,159.08	8,710.20

a circumneutral elevated iron water product, the combination and conveyance of these discharges to a centralized plant should be considered (Table 16).

As with all the other mine pool discharges, due to size of the mine pools and flows, the mine pool discharges that contribute flow to Conceptual Plant #8 may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design.

Conceptual Plant #9 – Mahanoy Creek Plant #3

Between the towns of Girardsville and Ashland, another set of discharges are located in close proximity to one another, including the Centralia Tunnel (#10) and the Continental Treatment Plant Bypass (#16) (Figure 15). In this group of discharges, the Centralia Tunnel is centralized. The furthest east discharge, Preston Tunnel, is 1.6 miles upstream on Mahanoy Creek. The furthest west discharge, Orchard Drift Overflow, is 1.1 miles downstream on Mahanoy Creek. The furthest discharge north, the treated portion of the Continental Discharge, is 1.4 miles upstream of an unnamed tributary to Mahanoy Creek. In comparison, the amount of pipeline set to convey the 21 discharges to the Hollywood Treatment Plant on the Bennett Branch Sinnemahoning Creek totals nearly 3.5 miles (Cavazza, 2011).

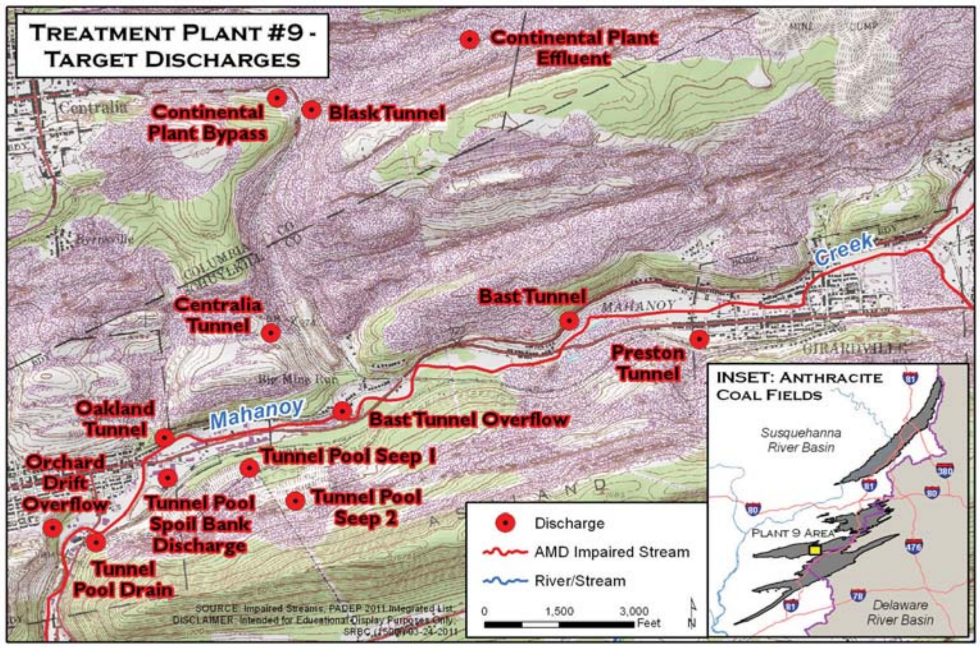

Figure 15. Treatment Plant #9 - Target Discharges

Negatives of this grouping include the number of discharges mixed (13), several discharges that have no flow analysis, and the fact that a majority are of acidic character, which creates a slightly net acidic mix water. Positives include the amount of discharges and loading that can be captured and conveyed in a relatively small area to a centralized active treatment plant and the possible use of the actively treated portion of the Continental Discharge as a dilution/alkaline solution. Adding the treated portion of the Continental Discharge, the eventual mix water ends slightly net acidic with only a moderate iron concentration of 11.17 mg/l and relatively low concentrations of manganese and aluminum (Table 17).

Conceptual Plant #9, just due to the sheer number of discharges and their differing chemical characteristics, is arguably the most difficult of the treatment plants suggested for consideration. However, it also captures a significant amount of AMD loading that presently enters the Mahanoy Creek Watershed.

The discharges combined contribute 18 percent of the iron loading, 29.6 percent of the manganese loading, 39 percent of the aluminum loading, and 34.3 percent of the acidity loading currently impacting the Mahanoy Creek Watershed.

Table 17. Average Flow, Concentrations, and Loadings of Plant #9 Discharges and Plant #9 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Centralia Tunnel	8.41	3.79	8.01	7.07	7.43	3.75	105.90	363.62	320.77	337.01	169.97	4,804.59
Preston Tunnel	1.54	6.39	13.35	1.15	0.10	68.94	43.74	110.90	9.56	0.79	573.34	363.44
Bast Tunnel	0.69	3.27	30.32	3.40	2.50	2.71	297.98	112.78	12.64	9.29	10.09	1,108.49
Bast Tunnel Overflow	1.12	nd	8.55	2.78	0.55	99.45	21.88	51.66	16.82	3.30	600.69	132.15
Oakland Tunnel	4.53	6.30	26.41	3.09	0.74	123.83	84.97	645.65	75.62	18.05	3,026.46	2,076.60
Orchard Drift Overflow	0.27	6.33	1.18	0.83	0.44	16.26	9.86	1.73	1.21	0.64	23.74	14.40
Blask Tunnel	nd	3.72	8.14	6.02	7.53	0.25	84.73	nd	nd	nd	nd	nd
Continental Plant Bypass	9.80	5.27	18.97	7.34	0.30	13.98	64.58	1,003.13	388.23	15.84	739.15	3,414.15
Continental Plant Effluent	12.96	8.33	0.83	2.25	0.54	73.68	2.12	57.97	157.24	38.07	5,151.23	148.43
Tunnel Pool Drain	0.25	7.07	12.16	1.79	0.02	315.27	15.22	16.41	2.41	0.03	425.61	20.55
Tunnel Pool Spoil Bank Discharge	0.16	6.07	37.21	2.73	0.35	29.97	85.63	32.00	2.35	0.30	25.77	73.64
Tunnel Pool Seep #1	nd	5.55	16.83	3.38	4.77	30.46	31.24	nd	nd	nd	nd	nd
Tunnel Pool Seep #2	nd	6.73	11.34	3.18	0.42	94.31	1.71	nd	nd	nd	nd	nd
Mixed	39.73	~6.40	11.18	4.60	1.98	50.14	56.71	2,395.85	986.85	423.32	10,746.05	12,156.44

As with all the other mine pool discharges, due to the size of the mine pools and flows, the mine pool discharges that contribute flow to Conceptual Plant #9 may also contain consumptive water use mitigation, hydroelectric, and geothermal potential that could be incorporated into the active treatment plant design.

Conceptual Plant #10 – Mahanoy Creek Plant #4

Besides the North Franklin Mine Pool Discharge impacts to Zerbe Run and the Potts Mine Pool Discharges, the final major impact to Mahanoy Creek is from the Doutyville (#18) Tunnel and the adjacent Helfenstein Tunnel. Both drain the Locust Gap Mine Pool. The Helfenstein Tunnel is 2.2 miles upstream of the Doutyville Tunnel (Figure 16). Both discharges are circumneutral with elevated iron concentrations (Table 18).

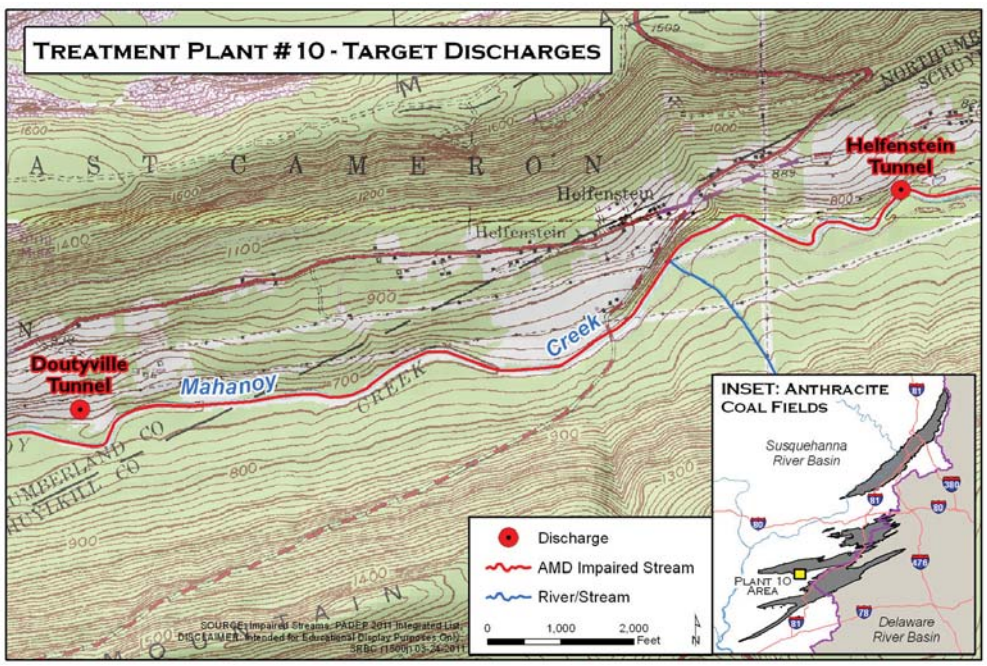

Figure 16. Treatment Plant #10 - Target Discharges

Table 18. Average Flow, Concentrations, and Loadings of Plant #10 Discharges and Plant #10 Mix Water

Discharge	Flow	pH	Fe	Mn	Al	Alk	Acid	Fe Load	Mn Load	Al Load	Alk Load	Acid Load
	cfs	SU	mg/l	mg/l	mg/l	mg/l	mg/l	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Doutyville Tunnel	9.86	6.05	6.52	2.14	2.60	6.23	38.10	347.05	113.90	138.41	331.46	2,026.37
Helfenstien Tunnel	5.64	6.46	12.89	3.61	0.88	63.52	13.73	392.50	109.91	26.79	1,932.96	417.75
Mixed	15.50	~6.20	8.84	2.68	1.98	27.08	29.23	739.55	223.81	165.20	2,264.42	2,444.12

Combined, Doutyville and Helfenstein contribute 5.5 percent of the iron loading, 6.7 percent of the manganese loading, 15.2 percent of the aluminum loading, and 6.9 percent of the acidity loading presently entering the Mahanoy Creek Watershed.

Due to the fact that both tunnels drain the same isolated mine pool, there could be a way to create a condition where all water exits one tunnel with the mine pool then manipulated for consumptive water use mitigation.

Even though the four conceptual plants suggested for Mahanoy Creek do not treat every large discharge (Vulcan-Buck Mountain Pool Discharge, Pott Mine Pool Discharges, and the North Franklin Mine Pool Discharge), there is the potential to remove about 45 miles from the PADEP Integrated List of AMD impaired waters. This is because the four conceptual plants would treat 86 percent of the iron loading, 85.1 percent of the manganese loading, 75.1 percent of the aluminum loading, and 77.2 percent of the acidity loading presenting impacting Mahanoy Creek.

Other Conceptual Plants – Jermyn Slope, Mocanaqua Tunnel, Porter Tunnel, Plainsville Outlet

The treatment of the four final Top-20 Discharges is significantly less important than the combination of discharges suggested for treatment in the ten conceptual active treatment plants.

When analyzing from the basin-scale, the discharges combined into the ten conceptual active treatment plants comprise 68.3 percent of the iron loading, 72.6 percent of the manganese loading, 78.7 percent of the aluminum loading, and 60.1 percent of the acidity loading created in the Anthracite Region of the Susquehanna River Basin.

The Jermyn Slope (#19) is the ninth largest flow discharge in the Susquehanna River Basin Anthracite Fields; however, the water quality of the Jermyn Slope is fairly good. Besides a slight concentration of average acidity (5.33 mg/l) and an average iron concentration (1.88 mg/l) that is just slightly higher than the water quality standard of 1.50 mg/l, all other parameters are within standards.

You can even argue that the Jermyn Slope is a resource to the Lackawanna River due to the large cold water flow it provides that allows the Lackawanna River to be a viable cold water fishery throughout its length until the entry of the Old Forge Borehole. Consequently, the only restoration measure that should be considered for the Jermyn Slope is alkaline addition to remove the slight concentration of acidity. The pH increase will then assist in the quick precipitation of iron from the discharge in the Lackawanna River, where it should not cause a significant problem.

No impoundments should be considered for this discharge as atmospheric heating of the water will diminish the large cold water benefit of the Jermyn Slope to the Lackawanna River.

The Mocanaqua Tunnel (#12) is the last major Northern Field discharge to impact the Susquehanna River. The tunnel drains the West End Basin Mine Pool and it is the seventh highest acidity loading producer in the Susquehanna River Basin Anthracite Fields.

However, the Mocanaqua Tunnel is less important from the other Top-20 Discharges because it does not impact a tributary, and if the other major discharges of the Northern Field are treated, the loading of the tunnel is not at an amount that would impact the Susquehanna River significantly enough to be listed as impaired by PADEP.

Due to the fact that the Mocanaqua Tunnel may drain an isolated mine pool, it may serve as a site for consumptive water use mitigation, and this potential may increase the attractiveness of treatment.

The Porter Tunnel (#14) is the largest AMD impact to Wiconisco Creek. The tunnel contributes 47.3 percent of the iron loading, 37.4 percent of the manganese loading, 90.6 percent of the aluminum loading, and 68.9 percent of the acidity loading that impacts the Wiconisco Creek Watershed.

According to the Wiconisco Creek Restoration Association web site, the Porter Tunnel has recently been treated via a calcium oxide pellet dosing system that increases the pH of the discharge before it enters a pond/wetland system for metals precipitation (Wiconisco Creek Restoration Association, 2008). Consequently, no future restoration action is needed unless the alkaline dosing system ceases to function.

The Plainsville Outlet (#20) is a very similar situation to the Mocanaqua Tunnel. It impacts no tributary, entering the Susquehanna River proper. Likewise, the loading of the outfall is not at an amount that would impact the Susquehanna River significantly enough to be listed as impaired by PADEP. In addition, the outlet enters a large impoundment, which may allow for significant iron hydroxide precipitation before entering the Susquehanna River.

POTENTIAL CONSUMPTIVE WATER USE MITIGATION SITES

Consumptive water use mitigation projects using mine pools are already underway in the West Branch Susquehanna River Subbasin.

Beyond the low flow mitigation benefits, the three projects together – Lancashire #15, the Hollywood Plant, and the proposed Cresson Plant – will result in the restoration and improvement of large stretches of streams within the Susquehanna River Basin.

Given the vastness of the mine pools and the relatively better discharge water chemistry that exists in many of the Bituminous Region mines, the implementation of similar projects that combine water quality improvements with low flow mitigation in the Anthracite Region would be of great significance.