IV. Problem Definition

Overview

This section addresses the specific AMD problems found during the assessment. Problems defined under this section are written specifically to address the TMDLs developed and approved in the 2004 publication, *Anderson Creek Watershed TMDL*, by the Susquehanna River Basin Commission (SRBC). Although many of the problems identified during this assessment were also identified by the TMDL study, a great many others exist that were not specifically mentioned in the TMDL study. This assessment attempts to identify as many of the other problem sites as possible, but does not capture them all. To do so would require an effort far beyond the scope of this assessment. As in the TMDL study, the watershed is divided into sub-basins, which are then divided into manageable stream segments. Each segment is identified with the type and relative location of impairment affecting that portion of the stream. Anderson Creek is listed for both metals and low pH as being the cause of degradation to the stream (SRBC 2002).

TMDLs for all of Anderson Creek consist of load allocations for AMD constituents, primarily pH, metals, and acidity. Individual TMDLs identify the specific types of pollutants requiring reduction, such as iron, aluminum, and manganese. Not all AMD constituents were included in every required TMDL load reduction. Often there were not enough samples to measure the individual constituent to accurately develop a proper load reduction. Often in those instances, reducing one pollutant, such as iron, will assure aluminum will be removed as well.

Because AMD is the chief impairment on most segments, descriptions of the discharge locations are given for areas directly affecting the stream segment. Since many areas have been extensively deep mined and surface mined for both coal and clay, often on numerous occasions, pollution sources can be very difficult to pinpoint as they occur over large and diffuse areas. Present on-the-ground conditions also create problems in developing reasonable solutions for remediating impaired areas, for often site conditions and water quality varies considerably within relatively small areas. In some instances, the water quality of pollution sources can change drastically in very short distances; or it can be of different water quality. In one particular instance, four AMD discharge points, located within a 20-foot radius, had distinctly different water quality characteristics. In some instances, land activities or disturbances cause problems in areas much lower in elevation than the disturbance site itself. As will be seen, all of these varying conditions have often led to conditions that necessitate detailed studies beyond the scope of this watershed assessment. In those instances, such recommendations will be identified.

For the TMDL, SRBC identified 10 AMD discharges, load allocations for six tributaries, and one sampling point along the stream as the focal points of the study. The method used to label TMDL stream segments used a “headwaters to mouth” approach, for lack of a better term. Beginning in the headwater areas of Anderson Creek and its tributaries, segments were labeled with alphabetic letters that are consistent with the stream's name and a descending numeric value as points were located further downstream. For example, the designation given to the most upstream reach in Little Anderson Creek was LA1 and it represents the segment of Little Anderson Creek before the confluence with the first unnamed tributary. The next monitoring point downstream is labeled LA2, and so on. Similarly, the designation given to the first unnamed tributary in the uppermost reach of Little Anderson Creek was designated UNT (unnamed tributary) LA1 and it accounts for the entire reach of the uppermost unnamed tributary. The next unnamed tributary downstream was labeled UNT LA2 with point LA2 being just upstream of the unnamed tributary. Not all unnamed tributaries were given labels or in-stream points located at the mouths of the named tributaries. It is necessary to use the map developed by SRBC to clearly identify segments used by the TMDL study.

Tributary Reports:

Little Anderson Creek

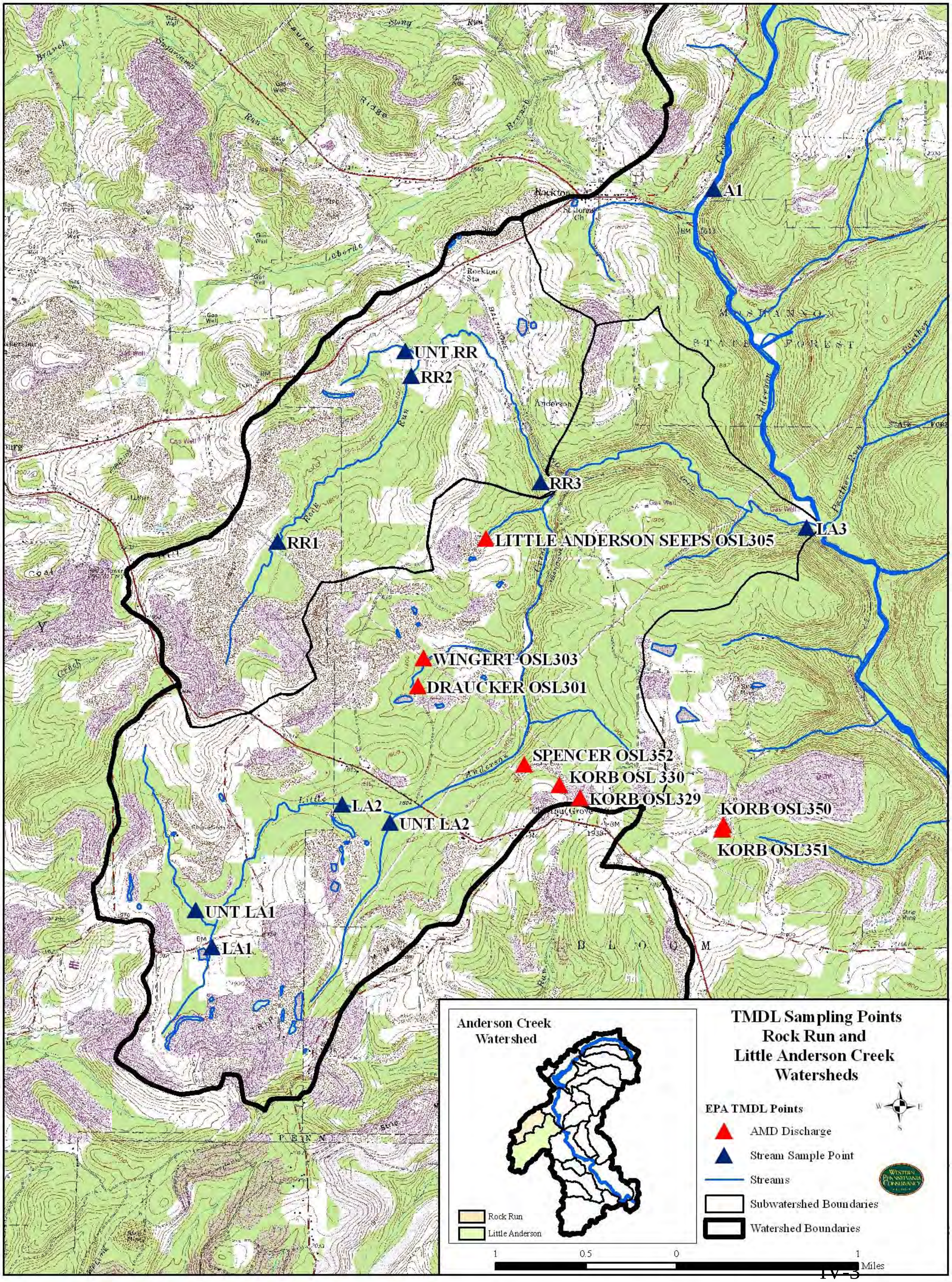
The headwaters of Little Anderson Creek are located approximately two miles west of Chestnut Grove and two miles southeast of Luthersburg. The headwater area begins in Brady Township, just northwest of the juncture of Brady, Penn, and Bloom townships, and is practically surrounded by areas previously disturbed by surface mining. Some of the surface mines have remained unreclaimed since the 1940s and 1950s. The surface mines have had a significant impact on the water quality of the stream at many of its highest reaches.

The headwaters area drains the western portion of the watershed. Little Anderson Creek flows in a northeasterly direction, crossing PA Route 219 just west of Chestnut Grove, and joins with Rock Run two miles downstream. From its confluence with Rock Run, Little Anderson Creek flows in a southeasterly arc, through a steep valley for another two miles, to its confluence with Anderson Creek.

Much of Little Anderson Creek is severely degraded from mineral resource extraction activities, more so than any other sub-basin in the entire watershed. Several abandoned underground clay mines are associated with high-flow AMD discharges, which pollute Little Anderson Creek. These discharges are especially damaging to aquatic life because of their high levels of acidity and aluminum. Additionally, extensive areas have been surface mined for clay and coal throughout the watershed. Many of those surface mines, both reclaimed and unreclaimed, are also associated with AMD discharges.

Little Anderson above TMDL point LA1

This stream segment represents the absolute headwaters of Little Anderson Creek. It is located approximately six miles upstream from the mouth of Little Anderson Creek and is about 4,000 feet in length. The stream is low gradient and is characterized by very large wetland areas surrounding the entire segment.



A1
UNT RR
RR2
RR3
LA3
RR1
LITTLE ANDERSON SEEPS OSL305
WINGERT OSL303
DRAUCKER OSL301
SPENCER OSL352
KORB OSL 330
KORB OSL329
KORB OSL350
KORB OSL351
LA2
UNT LA2
UNT LA1
LA1
Anderson Creek Watershed
Rock Run
Little Anderson
TMDL Sampling Points
Rock Run and
Little Anderson Creek
Watersheds
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Subwatershed Boundaries
Watershed Boundaries
1
0.5
0
1
Miles

Most of the area above the segment, which is located south of the bridge on State Route (SR) 4010, has been surface mined and reclaimed, though some unreclaimed or poorly reclaimed land is present. Some of the areas have been remined. A very large wetland area is located within this section of the stream. According to the landowner (Mr. Peterman) where the segment is located, the wetland area was once farmed but is now saturated with groundwater, rendering farming impossible. There is one area in the upper end, below Shaffer Road and above the Peterman farm along SR 4010 that had low field pH readings, indicating acidic conditions. Vegetation in the area was obviously affected by the acidic water. The seep zone was visually estimated to have a total flow of approximately 15 gallons per minute (gpm). An accurate measured reading could not be collected due to the diffuse nature of the seeps. This site clearly had negative impacts locally, but there was enough net alkaline groundwater (albeit polluted with iron) that it was neutralized after a fairly short distance. Because it is an acidic discharge, neutralization of the acidic discharge would likely improve the water quality in the stream.

A possibility exists that other low-pH seeps in the area are impacting the stream. The riparian area is generally saturated by groundwater and distinct sources of low-pH water were unable to be identified.

Most of the surface water within this section of the stream has a field pH above 6.0, but is polluted by iron. Elevated levels of iron also likely pollute groundwater, as iron staining is visible throughout the wetland in many areas where no flowing surface water exists. Iron was also observed being mobilized while walking in the wetlands, during the visual assessment.

The small valley south of the Peterman farm was not completely assessed because the land was posted, though a majority of it was completed. As with the area surrounding the Peterman farm portion of this segment, extensive wetlands existed adjacent to the small stream channel and iron stained the water in the channel. Field readings of 6.0 pH were found in this reach. The upper portion of the valley was marked with “No Trespassing” signs and the property owner was not identified. Based on the observations to that point, it is likely the area is very much like that near the Peterman farm.

Elevated levels of iron were observed throughout the entire wetland area during the assessment of this segment. Several areas were marked by remnants of old beaver ponds. Field readings showed that most of the water had a field pH reading of 6.0 or higher.

TMDL for Above LA1

A load allocation reduction for total iron, total manganese, total aluminum, and acidity is required for all areas above LA1 (SRBC 2004). Table G1, taken from the TMDL study, shows the load reductions required for Little Anderson Creek above TMDL point LA1.

Table G1. Reductions for Little Anderson Creek Above LA1						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
LA1	Fe	3.73	4.67	0.15	0.19	96
	Mn	5.09	6.37	0.15	0.19	97
	Al	0.25	0.31	0.21	0.26	16
	Acidity	24.91	31.16	1.49	1.86	94
	Alkalinity	10.87	13.60			

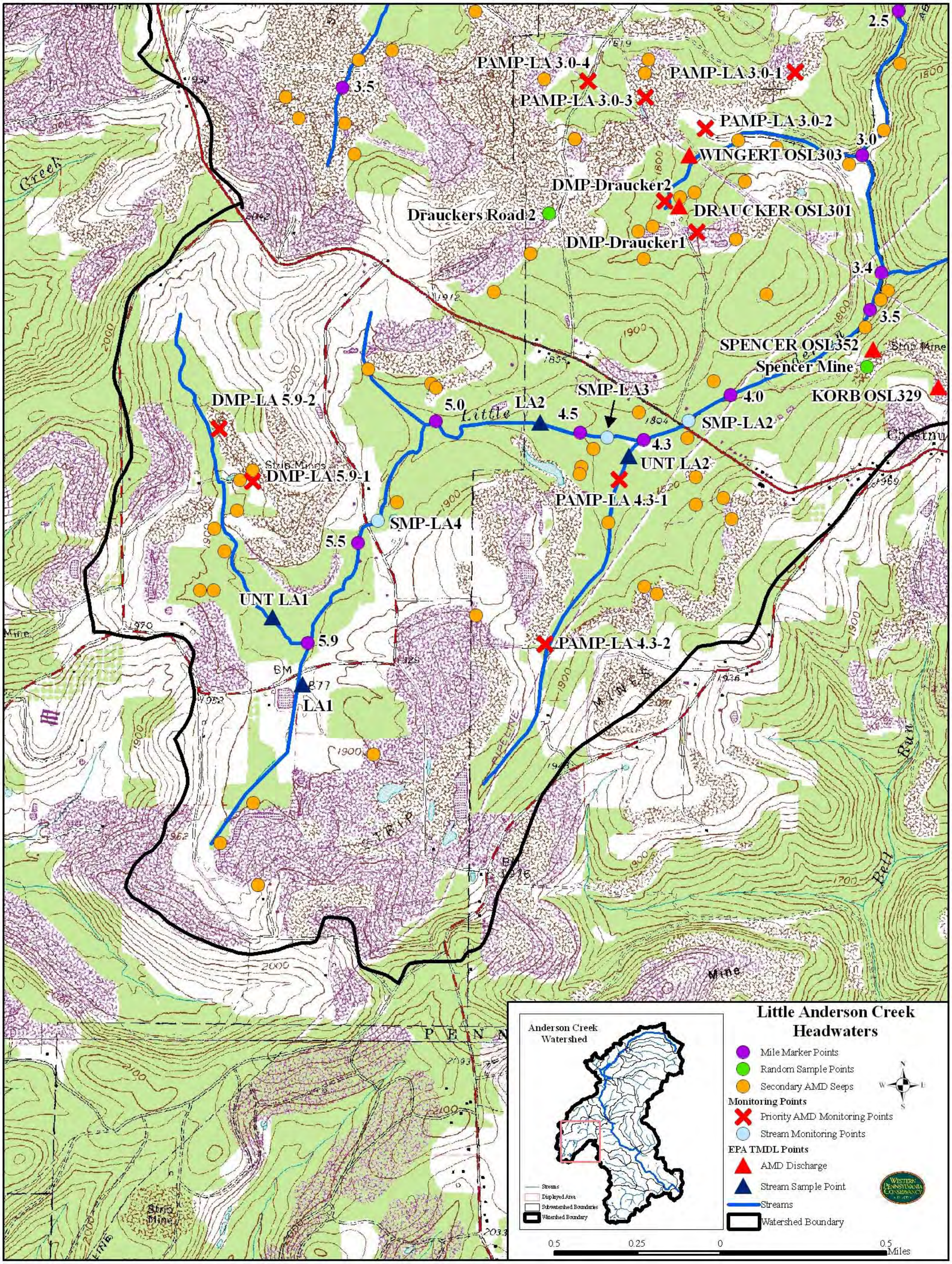
All values shown in this table are long-term average daily values.

Recommendations for Little Anderson Creek above TMDL point LA1

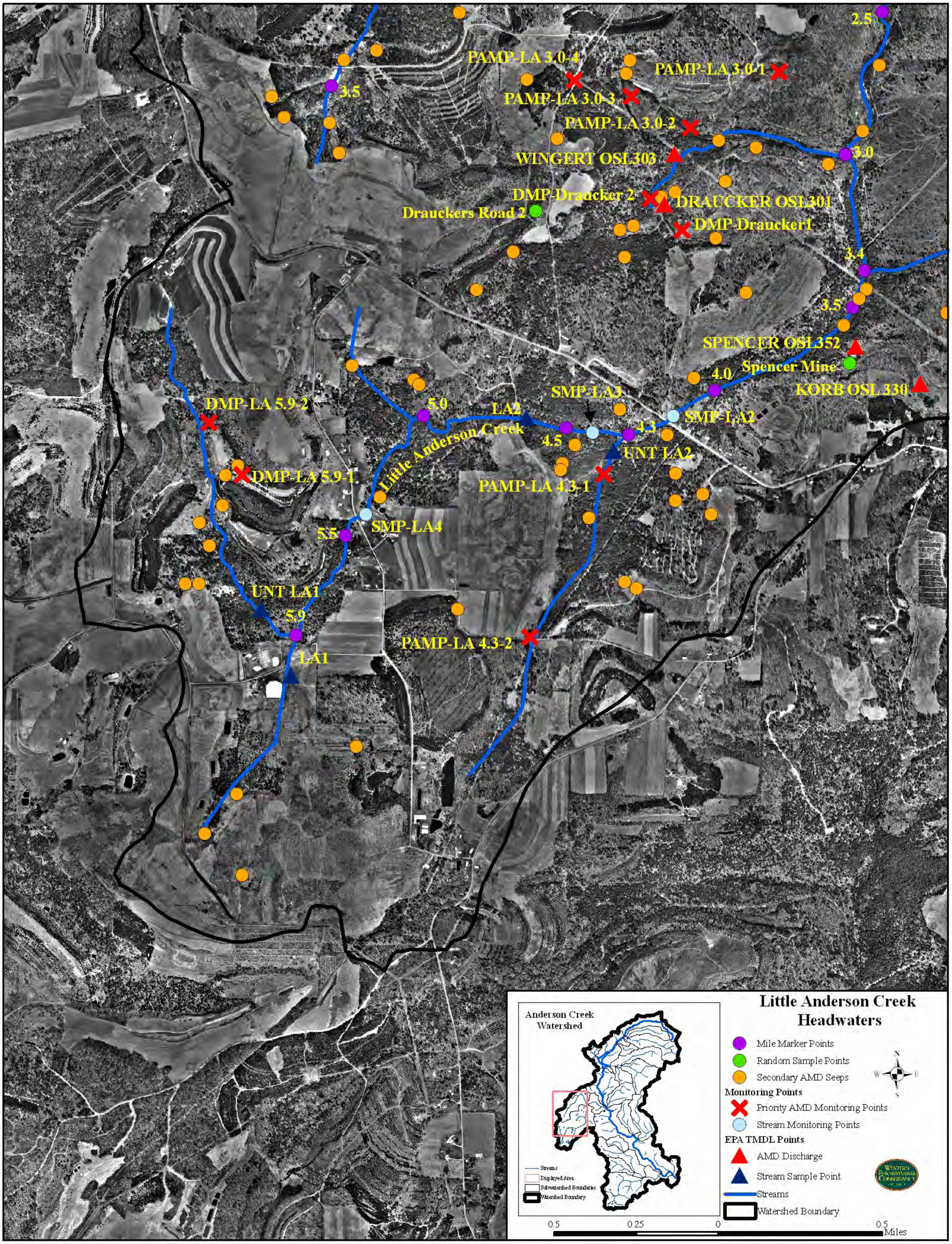
Realistically, it would be extremely difficult to prevent this segment from becoming polluted or reducing pollutants to required reduction levels. Most of the land area surrounding the segment has been surfaced mined and reclaimed, and likely adds to the iron polluting the stream through groundwater sources that surface within the extensive wetlands. Remediating such conditions would be nearly impossible.

Because much of the polluted area appears to have net alkaline water (containing enough alkalinity to remain net alkaline once metals are removed), one way to improve in-stream water quality would be to increase retention time within the wetlands. A simple solution could be the installation of a low-impact dike system throughout the wetland area, similar to silt fencing constructed for erosion and sediment control. Such a system could break up direct flow paths to the stream and improve retention time within the wetland, affording more of an opportunity for metals to be removed from the water. Such a system would be extensive but could be installed by unskilled labor using hand tools. Because there is a large drainage area above the wetlands, surface runoff during heavy storms could be a problem with a lightweight dike system. Using mechanical equipment within the wetland area would be very difficult. Of course, permitting requirements to install such a system within a wetland would require careful evaluation.

The acidic discharge located within this segment could be treated to remove acidity and metals using a passive treatment technique. It appears that ample area exists on site for construction of the required treatment cells. Presently, there is not sufficient water quality and flow data about this particular discharge to develop a conceptual treatment plan. Such data usually requires the installation of a flow measurement device, such as a V-notch weir, and collection of monthly chemistry and flow data for 12 months, or a sufficient time to assure measurement of high- and low-flow situations. Installation of a flow measuring device and 12 continuous months of chemistry and flow data is recommended before any treatment plan is developed.



Little Anderson Creek Headwaters
Anderson Creek Watershed
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5
0.25
0
0.5
Miles
PAMP-LA 3.0-4
PAMP-LA 3.0-1
PAMP-LA 3.0-3
PAMP-LA 3.0-2
WINGERT OSL303
DMP-Draucker2
DRAUCKER OSL301
Drauckers Road 2
DMP-Draucker1
SPENCER OSL352
Spencer Mine
KORB OSL329
SMP-LA3
SMP-LA2
LA2
UNT LA2
DMP-LA 5.9-2
DMP-LA 5.9-1
PAMP-LA 4.3-1
SMP-LA4
UNT LA1
LA1
PAMP-LA 4.3-2
2.5
3.5
3.0
3.4
4.0
4.5
4.3
5.0
5.5
5.9



2.5
3.5
PAMP-LA 3.0-4
PAMP-LA 3.0-1
PAMP-LA 3.0-3
PAMP-LA 3.0-2
WINGERT OSL303
3.0
DMP-Draucker 2
DRAUCKER OSL301
Drauckers Road 2
DMP-Draucker1
3.4
3.5
SPENCER OSL352
Spencer Mine
KORB OSL330
4.0
SMP-LA3
SMP-LA2
5.0
LA2
4.5
4.3
UNT LA2
DMP-LA 5.9-2
Little Anderson Creek
DMP-LA 5.9-1
PAMP-LA 4.3-1
SMP-LA4
5.5
UNT LA1
5.9
PAMP-LA 4.3-2
LA1
Little Anderson Creek Headwaters
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
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Due to the close proximity of the stream channel and wetland area and the relatively flat topography at the location of the discharges, passive treatment options will be limited. Even though this discharge lowers the pH of the upper reaches of this segment, it is not significant enough to degrade the entire segment. Small fish were observed in the stream at the uppermost bridge on SR 4010, at the lower end of the segment. Any reduction of acidity will be beneficial to the stream because the stream will be able to maintain its alkalinity further downstream and help buffer more significant acidic discharges that enter the stream.

Based on the present site conditions, a small passive alkalinity generating system could be employed. Additional sampling would be necessary to determine the appropriate type. Because there are significant wetlands in this segment, construction of settling ponds may be difficult to permit or even unnecessary. Neutralized water could be simply discharged into the wetland area and allowed to filter through them, where iron would be deposited, as is presently occurring.

TMDL point UNT LA1 (UNT LA 5.9)

This segment could also be called the very headwaters of Little Anderson Creek. It flows in a southerly direction from SR 4008, just off of Route 219 near Coal Hill, and joins with the previously described segment just above the second SR 4010 Bridge. The uppermost portion of this headwater segment is free from surface mining and the water quality in-stream is quite good. A short distance downstream, water quality becomes impaired from discharges emanating from areas of unreclaimed, poorly reclaimed, and reclaimed surface mines. A large wetland exists in the upper one-third of the tributary. Just downstream from the wetland, a major portion of the stream now flows through a nearly half-mile long strip-cut, apparently dug in preparation for surface mining activities, according to a local miner who worked at the site. Mining at that particular operation never commenced and the diversion was abandoned. Some time after the site was abandoned, the stream broke into the cut and began flowing through it, exiting near SR 4010 and into Little Anderson Creek after the confluence of LA1 and UNT LA1 (LA-5.9 and UNT-LA 5.9). Spoil is placed downslope of the cut and it appears some of the water is filtering through the spoil and into both UNT LA1 and Little Anderson Creek.

The first mine drainage of any significance comes from an area that was previously surface-mined east of the tributary and above the strip cut. An acidic seep (DMP-LA5.9-2) flows from the base of a small ravine. An old V-notch weir was found already installed at the discharge and appears to have been placed during the Scarlift assessment in 1973. It appears to be monitoring point 345. Flows measured during Scarlift were significantly higher during the same time of the year than those measured presently, even with the wet conditions experienced during this assessment. (It may be possible that surface contours above the site were significantly altered sometime after 1973.) No discharge is indicated at the location on the latest BAMR Problem Area maps.

A second significant discharge was located south of DMP-LA5.9-2. DMP-LA5.9-1 has water quality somewhat similar to DMP-LA5.9-2. Each is low iron and aluminum and relatively low manganese. DMP-LA5.9-1 has nearly twice the acidity, iron, aluminum, and manganese as that of DMP-LA5.9-2. It also flows into a very large depression of standing water created during mining. This area appears to serve as a significant recharge area as there is no outlet to the pond. It is very likely the polluted water in the pond eventually enters the stream as polluted groundwater.

Downstream of both of the sites is the half-mile long strip-cut area previously described. As mentioned, sometime in the past, the stream broke into the cut and now flows through it. Additional water also flows in the original channel, with more flow entering the channel as it flows southward. It is impacted by iron pollution, but it maintains enough alkalinity to support life. Minnows were observed throughout the reach of the tributary.

Seeps containing high levels of iron appear adjacent and within a large wetland area about 2,000 feet upstream of the confluence of the unnamed tributary with Little Anderson Creek. The seeps, which seem to emanate from a reclaimed strip mine just west (river right) of the lower portion of UNT LA1 (UNT-LA 5.9), do not appear to be very acidic, according to pH readings taken in the field. The seeps are diffuse and appear as polluted groundwater, similar to those in the adjacent tributary, LA1 (LA 5.9). This area also contains a significant forested wetland and floodplain area, which is also impacted by iron-polluted groundwater. Throughout the entire area, iron staining was noted in practically every area of standing water or saturated soil conditions.

TMDL for Above UNT LA1

A load allocation reduction for total iron and total manganese is required for all areas above LA1 (SRBC 2004). Table G2, taken from the TMDL study, identifies the load reductions required for UNT LA1.

Table G2. Reductions for Little Anderson Creek Above UNT LA1

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
UNT LA1	Fe	2.02	2.53	0.36	0.45	82
	Mn	3.54	4.43	0.18	0.23	95
	Al	0.11	0.14	0.11	0.14	0
	Acidity	0.43	0.54	0.44	0.55	0
	Alkalinity	27.52	34.43			

All values shown in this table are long-term average daily values.

Recommendations for TMDL point UNT LA1 (UNT-LA5.9)

The significant amount of surface-mined areas within the higher elevations of this tributary, make it very difficult to prevent pollution from occurring or to eliminate pollutants altogether. Several projects can be undertaken that would reduce the amount of pollution entering the stream.

Clearly, the first action taken on this segment should be to return the stream to its natural channel where it enters the long open channel dug in preparation for surface mining adjacent to the stream. Doing so will prevent the stream from coming into contact with the materials placed downslope of the dug channel. In addition, the dug channel should be refilled and, if necessary, combined with additional alkaline material to neutralize the effects of acidic spoil that may be present. A permit to mine the area near the open channel was approved years ago, according to the property owner. The company never began the mining operation. Perhaps a Government Financed Construction Contract (GFCC) could be developed for the area, which would allow for reclamation of the site in exchange for taking additional coal from the site.

The two acidic discharges east of the stream channel should then be addressed. The water quality samples for both discharges indicate relatively low levels of metals, in particular aluminum, which means that it is likely anoxic limestone drains (ALD) could be used to eliminate acidity and substantially increase the alkalinity of the discharges. Settling ponds and polishing wetlands would be included as part of the treatment system for each discharge. For DMP-LA5.9-1, the outflow of the system would be redirected away from the large surface depression, into which it presently flows. Open limestone channels could be used at the outfall of the treatment system to improve manganese reduction or perhaps small, buried limestone beds could be used, which would also reduce the temperature of the water leaving the system.

As part of the restoration efforts, the large surface depression, into which DMP LA5.9-1 flows, should be filled and positive surface drainage established where possible throughout the entire reach, to prevent water from infiltrating into the disturbed soils and becoming polluted.

The iron seeps located west of the stream channel in the lower one-third of the stream segment could possibly benefit from the installation of a low-impact dike system, as described for section LA1. Improving detention time within the present wetland should help remove some of the iron entering the stream.

Water quality was not specifically monitored on UNT-LA 5.9 during this assessment. A monitoring point was established downstream of the confluence of UNT-LA 5.9 and the headwaters of Little Anderson Creek just downstream of SR 4010 nearest to Route 219 and was designated SMP-LA4. This monitoring site would include all of the pollution sources on the very headwaters of Little Anderson Creek identified by TMDL points LA1 and UNT LA1.

Average water quality measured at SMP-LA4

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-LA4	**0.70**	**4.8**	**6.61**	**23.5**	**0.19**	**0.8**	**4.50**	**-6.9**	**12**	**90.5**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

TMDL LA1 to LA2 (SMP-LA3)

TMDL point LA2 represents the combination of TMDL points LA1 and UNT LA1 to the point just above the confluence with TMDL UNT LA2. LA2 is also represented by SMP-LA3, monitored under this assessment. As mentioned previously, the flow from the long surface mine cut enters near the beginning of this section, upstream of SR 4010. Throughout this segment downstream of SR 4010 and the Cramer farm, a number of small seeps enter the stream, mostly from two areas on either side of the stream.

Several seeps and numerous wet areas containing standing water with noticeable iron staining were located on the river-right of the stream channel. The area is wooded and could likely be classified as a wooded wetland. It appears similar to the wooded wetland area of UNT LA1, and is likely impacted by polluted groundwater emanating from previously surface mined areas at higher elevations surrounding the tributary.

Further downstream, additional polluted seeps enter the stream from the river-left side of the stream. A reclaimed surface mine is located on that side of the stream and, similar to many areas within the watershed, an unnaturally steep, high slope exists along the lower end of the mined area. At the base of this steep slope or toe-of-spoil, as they are sometimes called, numerous AMD discharges appear. Some appear as diffuse discharges while others are more distinct. One discharge, behind a relatively newly built log house, had a field pH of 3.9 and had a higher flow. Another discharge, which is likely the poorest quality discharge appearing in this section, based on initial field testing, was identified in a steep ravine slightly further east**.** It appears to be associated with another poorly reclaimed surface mine just south of the area, which has sparse vegetation and likely serves as a recharge area into the reclaimed mine spoil during rain events. The discharge flows through a wooded area, eventually entering Little Anderson Creek above UNT-LA 4.3. It is not bad enough to seriously degrade Little Anderson Creek where it enters the stream. Although its low field pH reading and apparent high iron concentration made it worth noting, the discharge was considered a low priority based on the impacts from other discharges in the watershed. None of the discharges in this section downstream of SR 4010 appear to have been identified by the TMDL study.

Beyond the above-mentioned surface mines and their associated discharges and to the confluence of the next major unnamed tributary on the river-right, UNT-LA 4.3, no mine discharges of significance enter the stream. With the entry of UNT-LA 4.3-the worst pollution source on Little Anderson Creek upstream of Route 219-the main stem of the stream becomes severely degraded and is essentially dead below.

TMDL for LA2

The TMDL for Little Anderson Creek consists of a load allocation to Little Anderson Creek between point LA1 and point LA2. Addressing the mining impacts above this point addresses the impairment for the segment. An in-stream flow measurement was not available for LA2; therefore, the flow was determined using the

AVGWLF model (1.55 mgd) (SRBC 2004). Table G3, taken from the TMDL study, identifies pollution loads for Little Anderson Creek above TMDL monitoring point LA2.

Table G3. Long Term Average (LTA) Concentrations for Little Anderson Creek Above LA2

Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
LA2	Fe	0.52	6.72	0.34	4.40
	Mn	3.56	46.02	0.25	3.23
	Al	0.32	4.14	0.21	2.71
	Acidity	2.66	34.39	1.38	17.84
	Alkalinity	12.61	163.01		

All values shown in this table are long-term average daily values.

The TMDL for Little Anderson Creek at point LA2 requires that a load allocation be made for total manganese and total aluminum. The TMDL for Little Anderson Creek at point LA2 does not require a load allocation to be made for total iron and acidity (SRBC 2004). Tables G4 and G5, taken from the TMDL study, identifies the summary of loads and the reductions necessary at TMDL monitoring point LA2.

Table G4. Summary of Loads Affecting Point LA2

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
LA1				
Existing Load	4.67	6.37	0.31	31.16
Allowable Load	0.19	0.19	0.26	1.86
Load Reduction	4.48	6.18	0.05	29.30
UNT LA1				
Existing Load	2.53	4.43	0.14	0.54
Allowable Load	0.45	0.23	0.14	0.55
Load Reduction	2.08	4.20	0	0

Table G5. Reductions Necessary at Point LA2

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at LA2	6.72	46.02	4.14	34.39
Total Load Reduction (LA1 and UNT LA1)	6.56	10.38	0.05	29.30
Remaining Load	0.16	35.64	4.09	5.09
Allowable Loads at LA2	4.40	3.23	2.71	17.84
Percent Reduction	0	91	34	0

The TMDL for the unnamed tributary to Little Anderson Creek at point UNT LA2 requires that a load allocation be made for all areas above UNT LA2 for total iron, total manganese, total aluminum, and acidity (SRBC 2004).

Recommendations for TMDL LA1 to LA2 (SMP-LA3)

Additional pollution enters Little Anderson Creek from several sources between TMDL points LA1 and LA2. Some will be very difficult to remediate because it appears that AMD enters through polluted groundwater sources over a diffuse area. Iron staining was observed in standing water in the forested area immediately below the SR 4010 Bridge on the river-right side of the stream. It is assumed the pollution is migrating to the area from higher elevations previously surface mined and hydrologically connected. It appears, through field pH sampling, the sources were net alkaline or nearly so. A more detailed study of the area is required to determine both the source of the pollution and the water chemistry associated with it. Because the area is likely considered a forested wetland, obtaining proper permitting for the construction of a treatment system at the site may be difficult. If the pollution source(s) is net alkaline, it may be possible to install a low-impact dike system to improve retention of the pollution within the existing wetland area.

An area associated with a poorly reclaimed surface mine, located approximately one-half mile on the river-left below the SR 4010 Bridge, was noted as a pollution source. Seeps appear at the toe of the spoil from several areas. This area of pollution appears to be having the most impact to Little Anderson Creek in this segment of the stream. At least two areas appear to be candidates for remediation. Neither of the sites is having a significant impact on Little Anderson Creek, and should be considered a medium- to low-priority situation. Developing treatment systems for the sites would likely improve the water quality in Little Anderson Creek, in this segment, by removing acidity, metals, and adding alkalinity to the stream. There has not been sufficient water quality data collected to determine the proper treatment system for either of the areas. Additional detailed studies of the sites, that would include both water quality and flow data in a sufficient amount to characterize both the low-flow and high-flow conditions of the discharges, are recommended.

Numerous small fish were observed in Little Anderson Creek at SMP-LA3, even though metals and acidity from AMD sources upstream degrade it. Addressing the abandoned mine problems associated with DMP-5.9-1, DMP-5.9-2, redirecting the stream into its original channel on UNT LA5.9, and remining and/or re-contouring and re-vegetating abandoned mine lands to promote proper drainage and limit water contact with disturbed soils, should significantly reduce pollutant loads and improve water quality in Little Anderson Creek at SMP-LA3.

Average water quality measured at SMP-LA3

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-LA3	**0.82**	**1.8**	**3.47**	**9.5**	**0.25**	**0.6**	**6.20**	**23.2**	**9**	**26.8**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

TMDL for UNT LA2 (UNT-LA4.3)

TMDL UNT LA2 (UNT-LA4.3) is the worst polluted tributary upstream of Route 219. Upon entering Little Anderson Creek, approximately 600 feet upstream of Route 219, this tributary essentially kills the stream. Similar to the other tributaries, much of the higher elevations surrounding the tributary have been surface mined and reclaimed with varying degrees of success. Conditions indicate that some remining of previously-mined areas has occurred.

The stream above Cramer Road, which connects SR 3011 with SR 4010, is impaired but not significantly. Below Cramer Road, the tributary becomes highly polluted from a reclaimed surface mine on the river-right side of the stream, termed by DEP as the Smouse strip mine. Numerous discharges emanate from the reclaimed surface mine, mostly near the toe of the mine spoil. Two large, interconnected detention ponds, which were part of the mining operation, remain at the lower end of the reclaimed mine site. The one at the higher elevation appears to hold water only in very wet conditions, while the lower and larger of the two had a small pool of standing water present at the time of investigation. Many of the discharges appear to be associated with the locations of the ponds, because they appear directly downslope of the ponds.

Similar to many other reclaimed sites within the Anderson Creek watershed, a large steep slope, estimated to be 20 feet high or more, was created at the downslope edges of the surface mine. Discharges appear at or near the original surface level, and, in this particular instance, also at elevations lower than original surface level and within a large, degraded wetland downslope of the mine. These may be more related to the actual depth of the mining that occurred or at the level of the coal seam. The elevation of the discharges may also be related to the presence of an aquatard or aquaclude, such as a clay layer, which prevents the water from penetrating deeper below the surface, and has been observed elsewhere in the watershed. No detailed site investigations were performed to make that determination.

Vegetation appeared to be impaired by acidic groundwater conditions at numerous areas leading to the detention basins and can be observed as areas of dead, withered, or nonexistent plant life. A very large kill zone developed where there are AMD discharges on the adjacent property, creating a severely degraded wetland. Green and brown filamentous algae abounds. It is very difficult to estimate how much water is being produced within the degraded wetland. It appears that most of the AMD surfaces are near the toe of the mine spoil. There is also a large pond of AMD-polluted water located at the toe of the spoil. The depth of

Large "kill zone" caused by AMD seeping out immediately downslope of a large surface mine known as the Smouse Strip, located on UNT-LA 4.3.

the pond was not measured and is unknown.

Another discharge associated with the same surface mine is located in the wooded area south of the mine site and is the first very acidic AMD discharge to enter UNT LA2 (UNT LA4.3) from the mine site. The unnamed tributary becomes seriously degraded at this point. As the tributary flows towards Little Anderson Creek it mixes with the discharges draining into the wetland and those surfacing within the wetland. Combined, these pollution sources account for the major portion of the pollution in UNT LA2 (UNT-LA4.3) and Little Anderson Creek above Route 219.

TMDL for Above UNT LA2 (PAMP LA-4.3)

Table G6, taken from the TMDL study, identifies the load reductions required at TMDL point UNT LA2. It is very important to note that loading values for the tributary do not include the specific amounts attributed to the Smouse surface mine. There was not sufficient flow data to develop the calculations so they were not included in the estimates. The loadings are included in the TMDL point Little Anderson 3 (LA3).

Table G6. Reductions for Unnamed Tributary for Little Anderson Creek above UNT LA2

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
UNT LA2	Fe	0.63	0.47	0.25	0.19	60
	Mn	2.27	1.70	0.16	0.12	93
	Al	1.48	1.11	0.07	0.05	95
	Acidity	10.44	7.84	1.35	1.01	87
	Alkalinity	11.93	8.95			

All values shown in this table are long-term average daily values.

The TMDL for the unnamed tributary to Little Anderson Creek at point UNT LA2 [LA-UNT 4.3] requires that a load allocation be made for all areas above UNT LA2 for total iron, total manganese, total aluminum, and acidity (SRBC 2004).

The water quality for monitoring point PAMP-LA 4.3-1 measured by this study represents the same location as TMDL monitoring point UNT LA2. A weir was installed on the unnamed tributary to gather accurate flow data. During the assessment, a flood event rendered the weir unusable. Following the flood event, flow measurements were taken using a flow meter. During periods of very low flow, volumes could only be visually estimated.

In order to determine the total loading attributed to the Smouse surface mine, two monitoring points were established on UNT-LA4.3, one above and one below the Smouse surface mine. The pollution load from the monitoring point above the site was subtracted from the monitoring point pollution load below the site to determine the total loads created at the site. The following chart identifies the total pollution load attributed to the Smouse surface mine.

Average water quality measured at PAMP-LA4.3

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-LA4.3	**8.80**	**11.73**	**9.98**	**15.48**	**9.28**	**14.56**	**115**	**167.29**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for PAMP LA-4.3 (Smouse surface mine)

Remediating the AMD from this tributary is a key to reducing pollution to UNT-LA 4.3, upper Little Anderson Creek, and Anderson Creek. In particular, the Smouse surface mine discharges must be remediated to bring the tributary back to a point where it will support life and meet the TMDL goal. These discharges were not included in the TMDL because of a lack of proper flow and chemistry data. The loadings from the Smouse strip mine were included in the next downstream TMDL site, LA3. For the purpose of this study, recommendations for UNT LA2 (UNT-LA 4.3) will include the Smouse surface mine site discharges.

Monitoring performed under this assessment measured the total amounts of flow and concentrations of pollutants in-stream at points above the Smouse surface mine and at the mouth of UNT-LA4.3. Because there are so many individual discharges emanating from the Smouse strip mine, and there were no significant other sources entering the tributary, the entire site was considered as a “problem area.” By monitoring pollution loads at the mouth of the stream and subtracting the amount of pollution in the tributary above the site, the difference was considered to be the pollution loads from all the discharges at the Smouse strip mine. This would also account for pollution entering directly into the streambed through polluted groundwater sources. That amount will likely be much less in comparison to the amount entering from the visible discharges. It should be noted that during this study, high flows rendered the weir installed on the tributary unusable. In-stream flows were then determined using a flow meter. Readings at low flow levels on such a small tributary become less accurate when a flow meter is used. Flow readings measured using a flow meter for such periods should not be considered highly accurate. At very low flow periods, volumes were visually estimated for this monitoring point.

Reducing or eliminating pollution from the Smouse strip mine will be very difficult for several reasons, including: the exact locations of the areas on the mine site responsible for producing the pollution have not been identified specifically; the number of discharges coming from the site is extensive and diffuse; the numerous discharges coming from the site vary in chemical makeup and flow quantities and would require collecting or channeling flows in order to measure each; individual passive treatment systems would likely have to be designed for each individual discharge, unless some are combined or active treatment is used; the excessive height of the spoil at the perimeter of the surface mine will make it difficult to treat the water on the property associated with the actual mining activities; and much of the reclaimed land is in use as pasture land, and the property owners may not be open to the idea of disturbing it or using it for treatment.

Two large settling/detention ponds remain on the lower end of the reclaimed surface mine. A large portion of the surface is graded to drain to the area where the detention ponds are located. It appears from the vegetation on the surface that acidic groundwater is affecting the vegetation at numerous locations up gradient of the ponds. Several of the discharges appear to be directly related to the detention pond areas and appear at the toe of the spoil down gradient of them. This study did not determine whether the pit floor of the reclaimed surface mine coincides with the contour of the surface and also dips to the pond areas at the lower end of the site. Further investigation of the permit information is recommended to help determine the subsurface flow paths. The ponds did not appear to retain much water. Only the pond lowest in elevation contained any standing water when inspected in early May 2005, after a relatively wet winter and spring.

A third pond exists below the spoil terminus at the southeastern corner of the reclaimed property. This pond is of unknown depth and retains AMD. It flows into the large kill zone created below the reclaimed mine site. The assessment identified it as one of five main sources of pollution from the site, although other small flow discharges are present. In addition, another main source of AMD to UNT-LA 4.3 emanates from the base of the spoil along the southeasterly portion of the mine site. It is the first discharge to seriously degrade the tributary. It appears to follow what may be an old drift mine entry that disappears under the spoil, but that was not confirmed.

Treatment options for the site might include:

- Subsurface electromagnetic mapping and characterization of the reclaimed mine site to determine locations of “hot spots,” which could be targeted for in-situ remediation to reduce or eliminate acid production. High-alkaline materials could be injected into the hot spots to help neutralize acidic material or encapsulate acid-producing materials.
- Excavation of acidic hot spot materials to segregate or encapsulate it in order to reduce or eliminate contact with water.
- Strategic placement of steel slag (or other high-alkaline material) surface ponds, which would catch runoff, increase its alkalinity, and then allow infiltration of the alkaline water into subsurface hotspots.
- Subsurface Sulfate Reducing Bioreactors located along water flow paths determined by the electromagnetic mapping.
- Surface Sulfate Reducing Bioreactors located at discharge points or at a combination of discharge points.
- Installation of J-channels, which are six-foot-deep channels dug along the toe of the mine spoil filled with lime kiln dust or other high-alkaline material that are used to collect and control acid water and impart alkalinity to it.
- Open limestone channels (OLC), used to increase alkalinity to surface waters. OLCs have been successfully used to add alkalinity to surface water with low iron content. They have also been reported to work on AMD, but lose efficiency when the limestone becomes coated with iron. Some studies have shown OLCs can still provide some alkaline addition when coated with iron, but others have been shown to become non-effective.

- Passive AMD treatment systems that utilize methods that can handle high aluminum discharges, such as Sulfate Reducing Bacteria Bioreactors, SAPS, Upflow Limestone Ponds, and other such systems.
- Low-cost active treatment technology merely to treat the discharges to eliminate acidity, allowing metals to leave the site.
- Standard active treatment technology that would treat the discharges, collect the metals on site, and discharge effluent water meeting water quality standards. Such a system would require an operator to periodically remove the collected metals from the treatment system and properly dispose of them. Such a system would likely require substantial annual operating costs, but may be the only viable solution for this site.

TMDL for LA2 to LA3 (SMP-LA 4.3 to the mouth of Little Anderson Creek)

This segment is the most heavily polluted portion of Little Anderson Creek and represents nearly seventy percent of the main stem's length. It receives AMD discharges from many surface mines, both reclaimed and unreclaimed, and several deep mines. This segment also receives AMD from all of the sources on Rock Run as well. The water quality of Rock Run is not quite as bad as that of Little Anderson Creek.

AMD from two sources enters Little Anderson Creek just downstream of UNT LA 4.3 from river-right. The first is a larger source and is located in a gully at the toe of a reclaimed surface mine site on the opposite side of the tributary from the Smouse discharges. It may be the site of an old deep mine entry, but that could not be confirmed during the study. No water samples were taken of the discharge, but field pH readings of 4.5 were taken. There appeared to be ample room for passive treatment and this site would likely be a good candidate for remediation in the future. Both flow and chemistry monitoring would have to be performed prior to any treatment design recommendations. It was not identified for monitoring under this study because of its lower flows and better water quality in comparison to many other sites within this stream segment.

The second discharge enters Little Anderson Creek just upstream of Route 219 from river-right. It also appears from a gully at the toe of the spoil. In this case, the AMD emanates from a plastic corrugated pipe, which may have been part of a reclamation project. This is the uppermost discharge of several in the watershed that display unique characteristics. The water exits the pipe at what appears to be a chemically net alkaline condition, as indicated by its field pH of 6.1. In a very short distance the discharge quickly turns acidic with a field pH of 3.5. Apparently, another AMD discharge source, likely from a slightly lower coal seam or clay seam discharges in the very same location. This second source is much more acidic, and completely changes the chemistry of the water in a very short distance. Once the two AMD sources mix, the water remains acidic for the remainder of its flow into Little Anderson Creek. Several other small flows also enter this drainage. They are insignificant in comparison to the flows at the source and are not believed to add significant additional pollution to the drainage. Further investigation of the area's geology and prior mining would need to be performed to determine the exact cause of the drastic change in water quality near the source.

Little Anderson Creek continues to pick up metals and acidity from many different sources, some very significant, some much less so, once crossing under Route 219. Just downstream of the bridge a small flow of acidic water enters from river-left. This flow is associated with a large surface mine and deep mine, part of which drains to Little Anderson Creek at this point. At an estimated flow of about 5 gpm, the discharge was significant enough to be noted, but not large enough to be considered for monitoring under this study. The discharge likely does affect the stream, even if to a smaller extent than other discharges entering Little Anderson Creek further downstream. It appeared there was ample room for treatment of the discharge at this site. Like the two mentioned above, it would likely be a good candidate for remediation some time in the future. Further monitoring of flow and chemistry would be necessary to properly characterize the discharge for treatment. Also, in the same area but on the opposite side of the stream (river-right), smaller iron seeps were identified in a low-lying area along the stream. The seeps were insignificant and did not appear to be significantly impacting the stream, though they were discharging some iron into the stream.

Discharge from main entry of the Spencer mine at low-flow conditions.

TMDL for Spencer Mine Discharges - OSL 352 and OSL 330 (DMP Spencer)

The next AMD source to enter the stream is from the Spencer mine. The Spencer mine was an underground clay mine located adjacent to the Korb mine in Chestnut Grove. The mine is located just north of Route 219 and west of Viaduct Road. Presently, some of the mine has been surface mined and mostly reclaimed, but with pine tree plantings and little ground cover. Surface drainage is fair. A portion of a highwall exists and the area near the former mine opening remains unreclaimed. Immediately above the highwall area and below a pasture field, there is a significant area of mine subsidence with dangerous depressions, especially since there are homes with young children nearby. AMD is draining out of what appears to be the former main mine entrance nearby. Un-vegetated spoil piles are also located in the mine entry area.

The TMDL study identified two discharges associated with the Spencer mine. They are identified as discharge OSL 352 and OSL 330 in the Scarlift report and the TMDL report (SRBC 2004).

Tables G7 and G9, taken from the TMDL report, identify the load reductions required for the Spencer discharges (OSL 352 and OSL 330).

Table G7. Reductions for Spencer Discharge (OSL 352)						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL 352	Fe	78.80	26.29	0.63	0.21	99.2
	Acidity	860.00	286.90	0	0	100
	Alkalinity	0	0			

All values shown in this table are long-term average daily values.

The TMDL for the Spencer 352 Discharge requires that a load allocation be made for OSL 352 for total iron and acidity (SRBC 2004).

Table G9. Reductions for the Spencer Discharge (OSL 330)						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL330	Fe	1.82	0.15	0.42	0.04	77
	Acidity	201.40	16.80	0	0	100
	Alkalinity	0	0			

All values shown in this table are long-term average daily values.

The TMDL for the Spencer 330 Discharge requires that a load allocation be made for OSL 330 for total iron and acidity (SRBC 2004).

During the visual assessment, water was flowing out of the mine opening, but not at a high flow rate. Site conditions indicated that flows might be more significant at other times. A significant portion of the AMD from the mine appears to be infiltrating into the groundwater table and entering the Little Anderson Creek at stream level below the site. Several seep areas were located directly adjacent to the stream, at what appears to be the top of a clay layer located at that elevation. Field readings of 2.7 pH were noted during the assessment.

The Spencer mine discharge was not regularly sampled as part of this study. It was determined that it would be very difficult to accurately measure the actual flow volumes coming from the mine because of the various diffuse seep areas along Little Anderson Creek. Two samples were taken at low flow at the mine opening to determine the AMD chemistry at its most concentrated form. It would be extremely difficult to measure flow or even impact to Little Anderson Creek because of the locations of the seeps near the stream and in relation to where the next major source of AMD, DMP Korb 4, enters just downstream of the seeps. Taking upstream samples on Little Anderson Creek and then downstream samples would not likely give an accurate measurement of the flows coming from the Spencer mine because the Korb 4 and Spencer mine AMD sources are too close. The Spencer mine discharge seeps do not have time to mix in the stream before the Korb 4 discharge enters, thus making it nearly impossible to differentiate the impacts to Little Anderson Creek between the two.

Recommendations for Spencer Mine

Numerous, very low-pH seeps appear just above the streambed of Little Anderson Creek far below the elevation of the Spencer mine.

The Spencer mine is likely having a severe negative effect on Little Anderson Creek. How much so is very difficult to determine at this time. The discharge from the mine opening flows on the surface only at high groundwater periods. There appears to be a significant amount of water that also enters the groundwater table and appears as severely polluted seeps adjacent to Little Anderson Creek, downslope of the Spencer mine. During low flows, the AMD infiltrates completely into the ground and appears as a series of seeps directly adjacent to the stream. Locations of the seeps make it nearly impossible to accurately measure the total actual flows entering Little Anderson Creek.

Contact was made with the property owner of the Spencer mine site. The property owner is very interested in reclaiming as much of his property as possible. He indicated that he would be open to remining the site and would donate a portion of his property for the development of an AMD treatment system and supports the efforts of the Anderson Creek Watershed Association (ACWA) to clean up the stream.

There are several things that could be done to improve the impacts from the Spencer mine:

- Land reclamation should be undertaken to remove the highwall, eliminate the unreclaimed spoil piles, limit contact of acid materials and water, and promote positive surface drainage. The large area of dangerous subsidence holes should be remined and reclaimed if possible. It is not known whether the pasture area above the subsidence area contains enough coal to be economical for remining or if the landowner would be willing to remine the area if it does. Negotiations with the landowner about reclamation should be initiated. Adding high amounts of alkaline material when reclaiming the site would very likely improve groundwater quality.
- Removal of clay layer and special handling of acid material to remove from contact with groundwater to reduce the amount of aluminum leached into the groundwater.
- Installation of an impermeable alkaline barrier on the pit floor to prevent acid water from infiltrating into the groundwater.
- Re-grading other areas upslope of the mine to improve surface runoff and addition of high-alkaline materials to buffer acidity in this area as well.
- Installation of open limestone trenches to impart alkalinity to surface runoff.

- Re-vegetate areas above the mine to develop a thick groundcover and reduce groundwater infiltration. Incorporate high-alkaline material or biosolids to enhance growth, improve water quality, and reduce surface water infiltration.
- Reduce the production of AMD at the source. In addition to incorporating high-alkaline material into the backfill, subsurface limestone drains should be incorporated into the highwall area to capture groundwater, increase alkalinity, and perhaps redirect it to a specific area for passive treatment, if necessary.
- Install high-alkaline surface trenches to intercept surface water and redirect into the groundwater.
- Close monitoring of AMD seeps at the stream elevation of Little Anderson Creek to determine success of reclamation measures. Installation of alkaline drains at seep zone, if necessary.
- Passive treatment of remaining AMD at the surface mine elevation once other reclamation measures are performed.
- Active treatment of the mine opening discharge if water chemistry indicates it is the best option.

The #2 priority Korb 4 discharge, draining from the abandoned Korb mine in Chestnut Grove.

TMDL for the Korb Mine Discharge OSL 329 (DMP Korb4)

This Korb mine discharge is located north of Route 219 and just west of Viaduct Road, in the village of Chestnut Grove. This is a major contributor of AMD to Little Anderson Creek and is being monitored under this assessment. It was identified in the Anderson Creek Scarlift Report and the TMDL report as OSL 329. This study identifies it as DMP Korb4.

Korb mine is an underground clay mine (Scarlift Project Area XXXIX, Project Map 13), which is overlain by a coal seam. Some of the Korb mine underground clay mine has been remined by surface mining, but never reclaimed. Much of the clay mine workings remain. Of special concern is the fact that coal seams lie above the clay mines and in much of the area have subsided into the clay mine. This has created an especially troublesome condition because the coal and its overburden collapsed into the clay mine are known to produce high levels of acid and aluminum in their AMD. The Korb 4 discharge emanates from a deep ravine that is connected to the underground Korb mine workings, and was part of the reclamation effort after surface mining. This site was identified as priority #3 by the TMDL study. Collectively, all the discharges from the Korb mine were ranked as priority #4 by the Scarlift study. Korb 4 is identified as priority #2 by this study.

The TMDL for the Korb Discharge OSL 329 used data available from the Scarlift Report. There were fewer manganese and aluminum data than necessary for this discharge to conduct a proper analysis, therefore, they were not evaluated for this TMDL. However, observations for manganese and aluminum in the downstream segments of Little Anderson Creek indicate that they also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of manganese and aluminum (SRBC 2004).

Table G8, taken from the TMDL report, identifies the load reductions required for the Korb Discharge (OSL 329).

Table G8. Reductions for the Korb Discharge (OSL 329)

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL 329	Fe	143.02	143.13	0.57	0.57	99.6
	Acidity	760.00	760.61	0	0	100
	Alkalinity	0	0			

All values shown in this table are long-term average daily values.

The TMDL for the Korb 329 Discharge requires that a load allocation be made for OSL 329 for total iron and acidity (SRBC 2004).

Average water quality measured at DMP-Korb4

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-KORB4	**43.96**	**37.59**	**8.76**	**7.43**	**30.95**	**20.47**	**382**	**338.51**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for DMP-Korb4

The Korb mine is an underground clay mine and is identified in the Scarlift Report as Project Area XLVI, Project Map 13. The mine is located in the Chestnut Grove area adjacent to the Spencer mine and is noted as being interconnected to it. The Korb mine complex is uniquely situated on the axis of the Chestnut Ridge Anticline, an elongated, dome-like geologic structure. AMD from the Korb mine drains from opposite sides of the dome (anticline). One large discharge, TMDL OSL 329, drains to the west [DMP-Korb4] and three discharges [DMP-Korb1, DMP-Korb2 and DMP-Korb3] drain to the east (Scarlift Report 1974).

The Korb mine discharges are identified as priority discharges under both the Scarlift study and the TMDL study. DMP-Korb4 drains into a valley that empties into Little Anderson Creek. The other Korb discharges drain the other side of the anticline to the east and into the main stem of Anderson Creek via UNT-AC 8.2. This tributary also receives discharges from two other large surface mines, one reclaimed, one unreclaimed, located on either side of the stream. The discharges appear very near and on opposite sides of the stream approximately one-half mile below the Korb Mine Road. The combination of the discharges from the Korb mine and the seeps from surface mines into UNT-AC 8.2 likely causes it to carry the highest pollution load into Anderson Creek after Little Anderson Creek enters. The total pollution load at the mouth of UNT-AC 8.2 was not measured regularly under this study but is recommended for further study. Remediating the discharges entering the stream will likely result in significant improvements to water quality in the main stem of Anderson Creek. Remediation of the Korb discharges, along with the Spencer mine discharges, would make a significant improvement to the water quality of Anderson Creek. The two mines account for two of the top five priorities identified by the Scarlift report and five of the top ten priorities identified in the TMDL study.

At the time of this assessment, a mining company has proposed to remine a portion of the Korb mine in Chestnut Grove as a reclamation project. The company proposed to unearth a hilltop that is underlain by the underground mine workings and containing significant subsidence areas, remove the remaining clay mine workings and associated overlying coal, place additional alkaline materials on-site, and replace and re-grade the overburden materials to promote positive surface water drainage off-site. The mining company, in cooperation with DEP, performed preliminary drilling and overburden analysis of a portion of the site. An analysis of the findings has shown that because of the very acidic nature of the materials above the clay mine, remining would be very costly and may not be successful at reducing or eliminating the acid being produced at the site. Therefore, remining is presently not being viewed as an option.

Because of the location and the water chemistry of the DMP-Korb4 discharge, one option may be a self-flushing limestone pond. This technology has recently been successfully demonstrated as a possible treatment option for AMD containing aluminum. This system is similar to an Upflow Limestone Pond but differs in it that automatically drains itself after imparting alkalinity to the acidic water and before aluminum has an opportunity to precipitate in the limestone. Other passive AMD treatment system options that utilize methods that can handle high aluminum discharges, such as Sulfate Reducing Bacteria Bioreactors, SAPS, Upflow Limestone Ponds, and other such systems, might also be

Combined Korb2 and Korb3 discharges draining into an unnamed tributary to Anderson Creek (UNT AC8.2).

incorporated. These systems have limitations and must be closely evaluated before a treatment option is chosen. Lastly, active chemical treatment is an option. High operation and maintenance costs are often a limiting factor when this option is chosen.

Another polluted unnamed tributary enters Little Anderson Creek from river-right, just downstream from where the Spencer mine and DMP-Korb4 enter the stream. This AMD emanates from an area adjacent to the Korb mine and is likely associated with poorly reclaimed surface mines located further north and west of Viaduct Road. At the time of this assessment, a mining company was remining a portion of the area adjacent to the affected tributary. No suggestion for remediation of the tributary area is recommended until further investigations are made once the remining project is completed.

Little Anderson Unnamed Tributary 3.0 (UNT-LA 3.0)

The next polluted unnamed tributary to enter Little Anderson Creek is the most polluted in the entire subwatershed, Little Anderson Unnamed Tributary 3.0 (UNT LA 3.0). Several reclaimed and unreclaimed surface mines, as well as deep-mined areas, drain to this tributary.

Drauckers Bottom Road near Route 219

Beginning in the uppermost reaches of the tributary, upslope from Drauckers Bottom Road and very near Route 219, unreclaimed surface mines have created many discharges, which eventually drain to UNT-LA 3.0. This area is also the ridgeline boundary between Rock Run and Little Anderson Creek. Just north of the intersection of Drauckers Bottom Road with Route 219, the unreclaimed surface mines collect water behind spoil piles and cause the water to filter beneath and through the spoil, eventually polluting the surface water draining the area. Two small intermittent streams drain the area towards the east and cross under Drauckers Bottom Road in culverts a short distance from Route 219. Eventually, the two small streams lead to an area where two discharge monitoring points have been established as part this study. DMP-Drauckers 1 and DMP-Drauckers 2, are two very significant pollution sources being sampled under this study that eventually combine and drain into UNT-LA3.0.

Although the unreclaimed surface mine area upslope of Drauckers Bottom Road near the Route 219 intersection is causing AMD, it is not being monitored because it was not considered a significant pollution source in comparison to other sources entering UNT-LA 3.0 further downstream. The area should be further investigated and considered for restoration activities some time in the future.

Recommendations for Drauckers Bottom Road near Route 219

This area is considered a low priority at this time. It is recommended the area be studied for possible remining or reclamation. During such activities, the area should be re-graded to eliminate any possibility of surface and groundwater pooling behind the mine spoil.

Reclamation should be done to promote positive surface water drainage from the area and replanted with a heavy vegetative cover to reduce infiltration into the subsurface. Any alkaline addition that could be incorporated into the reclamation would also be very beneficial. It may be possible to incorporate open limestone channels or subsurface limestone drains into the reclamation effort as well to increase alkalinity in surface and groundwater. Any additional alkalinity would help improve the water quality in UNT-LA 3.0.

The Drauckers Discharges

TMDL for OSL 301 (DMP-Drauckers1)

The Drauckers discharges are associated with two distinct abandoned underground clay mines, which drain into UNT-LA 3.0. TMDL point OSL 301 is identified as the largest single contributor of pollution to Little Anderson Creek. This assessment has also identified this discharge, DMP-Drauckers1, as being the highest priority for restoration.

The TMDL for the Drauckers Discharge consists of a load allocation to OSL 301. Addressing the mining impacts for this drainage addresses impairment for the discharge. An in-stream flow measurement was available for OSL 301 (0.20 mgd) (SRBC 2004).

There were fewer manganese and aluminum data than necessary for this discharge to conduct Monte Carlo analysis; therefore, they were not evaluated for this TMDL. However, the observations for manganese and aluminum in the downstream segments of Little Anderson Creek indicate that they also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of manganese and aluminum (SRBC 2004).

Table G10, taken from the TMDL report, identifies the load reductions required for the Drauckers Discharge (OSL 301).

Table G10. Reductions for the Drauckers Discharge (OSL 301)

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL 301	Fe	153.13	255.42	0.61	1.02	99.6
	Mn	19.79	33.01	-	-	-
	Al	46.67	77.85	-	-	-
	Acidity	929.33	1,550.12	0	0	100
	Alkalinity	0.47	0.78			

All values shown in this table are long-term average daily values.

The TMDL for the Drauckers Discharge requires that a load allocation be made for OSL 301 for total iron and acidity (SRBC 2004).

As previously mentioned, DMP Drauckers1 and DMP Drauckers2, which are being monitored for water quality and flow under this study, also drain into UNT-LA 3.0. These two distinct and significant discharge areas severely degrade Little Anderson Creek.

DMP-Drauckers1 emanates from an underground clay mine, which has also been partially surface mined (Scarlift Project Area XXIII & XXV, Project Map 15). DMP-Drauckers1 is the most significant source of pollution to Little Anderson Creek and the Anderson Creek watershed. Because there is a significant area of unreclaimed mine spoil associated with the discharge, it is also a significant source of runoff pollution. Typical for this area draining into UNT-LA 3.0, a coal seam overlies the clay seam. When the clay was surface mined, the coal was not considered valuable and was intermixed with the excavated material, adding to the pollution problem created by the unreclaimed spoil.

Large flows of very acidic AMD and unreclaimed mine lands make reclamation very challenging for Drauckers1—the highest priority site in the Anderson Creek watershed.

DMP-Drauckers1 flows through an unreclaimed area of mine spoil. It joins with the two previously mentioned intermittent streams draining the area near the intersection of Drauckers Bottom Road and Route 219 before combining with DMP-Drauckers2 in a large wetland area. The polluted water eventually combines with several other AMD sources and additional surface water to form UNT-LA 3.0, which eventually joins Little Anderson Creek.

Average water quality measured at DMP-Drauckers1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-Drauckers1	**78.63**	**89.34**	**21.43**	**24.95**	**57.06**	**71.68**	**624**	**781.71**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for DMP-Drauckers 1

Many options for addressing the problems associated with DMP-Drauckers1 exist. Perhaps the best option is to explore the feasibility of remining the site and incorporating alkaline addition into the reclamation of the land area during the remining. As with other unreclaimed areas associated with UNT-LA 3.0, conditions at the site are not conducive to easy remining, otherwise the sites would have likely already been remined. According to one nearby property owner, strata associated with the coal seam contain nodules of high sulfur and iron. These nodules can be seen throughout the spoil and within associated strata at the remaining highwall. Such conditions cause concerns for mining companies because they reduce the desirability of the coal and increase the likelihood of creating AMD discharges. A detailed drilling and overburden analysis of the site is recommended to determine the feasibility of remining.

DEP has embarked on a program, in association with EPA, to address such issues. The original program was given the name "Project XL." The program would allow remining and reclamation of such areas by cooperatively developing a reclamation plan between DEP and the mining company that would use the best available techniques to reduce the possibility of creating additional pollution sources. Remining would be performed by strictly following the agreed-upon plan. If the remining were performed according to the plan, the mining company would not be liable for any unforeseen circumstances that would make the pollution worse. Presently, DEP is testing the program. DMP Drauckers1 should be seriously considered for the program.

Another issue associated with remining a site is willingness of the property owner to support the idea. Presently, the property owner has indicated a willingness to entertain the idea of remining the site. The property owner is an avid sportsman and considers the wooded area near the abandoned mine site as prime habitat for wildlife. It may be possible to incorporate the "reforestation initiative," recently developed between the Office of Surface Mining and DEP, as part of the reclamation. That initiative uses alternative reclamation techniques that promote the cultivation of valuable hardwoods. Such techniques reduce the costs of reclamation and eventually produce trees that can be harvested for profit. The property owner may be even more inclined to support a reclamation project if he knows the area would be planted in hardwoods afterwards. Presently, most reclamation is done using techniques that inhibit the growth of trees, but that promote grass cover. A cooperative agreement with the mining company to use the reforestation initiative techniques would need to be developed, and the new techniques closely followed in order to ensure successful implementation of the program.

Barring remining the site, several reclamation techniques could be considered for the site. Land reclamation at the site is highly desirable, considering that present conditions are causing the formation of AMD and sedimentation because of the lack of proper surface drainage and vegetation. In addition, treatment of DMP-Drauckers1 would greatly reduce the metals and acidity load entering UNT-LA3.0. There appears to be ample area for passive treatment. Because of the high acidity and high levels of aluminum in the discharge, passive treatment would likely necessitate the use of treatment systems able to handle those levels without the likelihood of premature failure. Modified Vertical Flow Systems, Sulfate Reducing Bioreactors, and

Drauckers2 discharge prior to mixing with acidic groundwater.

Upflow Limestone Ponds are some possibilities. Active treatment of the discharge using chemicals might also be desirable or the only viable treatment option.

DMP-Drauckers2

DMP-Drauckers2 also emanates from an underground mine and associated surface mines (Scarlift Project Area XXIV, project map 15). This discharge was not specifically addressed by the TMDL study but should be included in TMDL point LA3, which includes all of the AMD sources in the Little Anderson Creek watershed.

DMP-Drauckers2 is also a significant source of pollution to Little Anderson Creek. It is similar in characteristics to the previously mentioned discharges located upstream of Route 219, in that the chemistry of the discharge changes dramatically in a relatively short distance. Similar to the previously mentioned discharge, this discharge appears as net alkaline water in a defined channel. After the discharge travels a short distance, the water becomes acidic and picks up volume from numerous, undefined seeps. Trees and plants adjacent to the acidic discharges are noticeably impacted and many have died. As with the similar discharges upstream of Route 219, it is presently unknown what is causing the chemical change of the discharge and additional study of the site is necessary to determine the exact causes. Based on other acid discharges in the area, it is very likely connected to the abandoned Drauckers #2 underground clay mine.

Average water quality measured at DMP-Drauckers2

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-Drauckers2	**2.41**	**3.43**	**4.24**	**9.50**	**1.01**	**3.36**	**29**	**69.03**	**1**	**3.13**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for DMP-Drauckers2

As noted previously, the DMP-Drauckers2 discharge exhibits peculiar characteristics, in that it first appears as a net alkaline discharge but very quickly turns acidic as it reaches a slightly lower elevation. A detailed investigation of the site-specific conditions is necessary to fully understand why this happens. Such an investigation was beyond the scope of this assessment. It is recommended that further studies be performed to better understand conditions at this site and other similar sites in the watershed.

First segregating the alkaline water from the acidic water and then treating them separately could address AMD from DMP Drauckers2. Since the alkaline water appears at a higher elevation and from a more distinct source, it should be possible to capture the water prior to it reaching the area where the acidic water appears and then degrades the discharge. A significant issue will be finding area to treat passively the net alkaline discharge. Although passive treatment of net alkaline water is easier than acidic discharges, it still requires significant space for passive aeration, a settling pond, and polishing wetlands. Site conditions limit the area for treatment. The area is constricted by the location of an intermittent stream on one side, and the location of the acidic discharges down slope. It may be possible to build a small settling pond near its present location and then gain additional treatment area by diverting the discharge under the intermittent stream and to the opposite side of the stream. Wetland issues will be a consideration whatever the treatment design will be.

Once the net alkaline water is segregated from the acidic water, the acidic water could likely be treated using the same methods identified in the DMP Drauckers1 recommendations (SAPS, Vertical Flow Systems, Sulfate Reducing Bioreactors, Upflow Limestone Ponds, etc., as well as active chemical treatment). Wetlands will also be an issue, since there is a large wetland just downslope of the acidic discharges. It is recommended to pursue the use of a Wetlands Waiver 16, which is an agreement between BAMR and the U.S. Army Corps of Engineers that limits mitigation requirements in wetlands impaired by AMD. The waiver was successfully used in the past, but recent efforts to take advantage of the waiver have not been very successful. It is very likely that any impacts to the present wetlands will require wetland mitigation on at least a 1:1 basis and the development of a wetland mitigation plan.

Other UNT-LA 3.0 Problem Areas

Three other significant problem areas impact UNT-LA 3.0. The problems again begin within the upper reaches of the tributary, west of Drauckers Bottom Road and just north of the previously mentioned unreclaimed surface mine area near the Route 219 intersection. This area was also heavily surface mined and its highest elevations continue to form the boundary between Rock Run and Little Anderson Creek. This area is much more significant than that further south and was identified as a site for monthly monitoring by this assessment. It is designated PAMP-LA 3.0-4.

PAMP-LA 3.0 - 4

Because there are several discharge areas located in the area, the entire area above Drauckers Bottom Road was considered as a whole and designated Problem Area LA 3.0 - 4. A monitoring point for this study was established where all the drainage from the area crosses beneath Drauckers Bottom Road and given the designation PAMP-LA 3.0 - 4. The uppermost discharges appear in a deep ravine at the toe of the spoil of a reclaimed surface mine and near a power line, which bisects the area. Once again, the discharges exhibit an interesting and similar pattern to that described before. In this case, there are four distinct discharges, which appear at the head of the deep ravine within approximately 25 feet of one another. Each had a distinctly different field pH, with a range that would indicate a net alkaline condition to one of net acidic, although no individual lab samples of the discharges were taken to verify their chemistry makeup. The field pH of the combined discharges was 5.2 . Once

Combined discharges at PAMP-LA 3.0-4.

again, as the water traveled down gradient, and a relatively short distance, it gathered significantly more water and the field pH dropped to 3.3. Just upstream of the road, additional mine drainage enters from a surface-mined area to the south. Monitoring point PAMP-LA 3.0 - 4 is a combination of all the discharges upslope of the site.

Average water quality measured at PAMP-LA3.0-4

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-LA3.0-4	11.95	11.55	10.89	10.66	0.56	0.78	62	55.45	0	0.00

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for PAMP-LA 3.0 - 4

Because of the nature of the varied discharges and the changes that take place in the chemistry of the discharges, a more detailed investigation of the site is recommended. Once again, the changes in chemistry are similar to other impacted areas within the Little Anderson Creek subwatershed and conclusions drawn from a more detailed study of this site or the other sites might be common to all.

As a result of the different areas that contribute AMD, the number of discharges, the differing chemistry of the individual discharges, wetland issues, site constraints, and the likelihood that polluted groundwater also adds to the pollution load, it will be very difficult to treat passively the individual discharges associated with this problem area. It is recommended to chemically treat the combined flows of the discharges at their convergence point at or near the culvert conveying them under Drauckers Bottom Road. Doing so will provide the most economic and feasible way to address this area. A number of different types of active treatment systems are available and each has their advantages and disadvantages. A system that operated without electricity and required little maintenance would be best. These systems are available commercially and could be set up with minimal construction costs. They usually incorporate some type of silo in which the chemical is stored on-site to reduce operation and maintenance costs.

Ideally, the treated water would enter a settling pond to collect the metals as they precipitate. Usually, active treatment generates high volumes of precipitate and requires the settling ponds to be cleaned out fairly often, leading to high operation and maintenance (O&M) costs. There have also been cases where, due to the magnitude of the problem and the limited amount of funding available for O&M, the precipitates have been allowed to settle out in the stream. In essence, a tributary is somewhat sacrificed for the greater good of the main stem of the stream. Presently, this may be the best option for PAMP-LA 3.0 - 4 because the tributary is essentially dead for its entire reach. Treating in the headwater area allows more opportunities for metals to settle out, excess alkalinity generated to affect areas downstream, and there are other areas of higher priority that will require a substantial amount of funding to reclaim.

The Wingert Site

Downstream of the headwaters area of PAMP-LA 3.0 - 4 is a very large area of abandoned deep mines, and unreclaimed surface mines that contains numerous large, un-vegetated spoil piles, water-filled pits, and dangerous highwalls. It is known locally as the Wingert site. It is perhaps the worst unreclaimed site in the entire Anderson Creek watershed. UNT-LA 3.0 actually flows directly off of a highwall and into the unreclaimed surface mine. Numerous AMD discharges exist throughout the site. Deep, dangerous, water-filled pits likely pollute the groundwater and also discharge into surface waters. The site is identified in the Scarlift Report as Problem Areas XXVI and XXVII.

TMDL for the Wingert Discharge (OSL 303)

The Wingert Discharge originates from two ponds formed in the strip cuts left behind after extensive strip mining of the area. The headwaters of an unnamed tributary to Little Anderson Creek add a continual recharge to the system by flowing over the highwall and into the ponds. A small deep mine, known as Wingert mine, also is present, though dry (Lincoln 1999). The ACWA considers this site a reclamation priority (Smeal 2001; SRBC 2004).

The TMDL for the Wingert Discharge consists of a load allocation to OSL 303. Addressing the mining impacts for this drainage addresses the impairment for the discharge. An in-stream flow measurement was available for OSL 303 (0.38 mgd) (SRBC 2004).

There were fewer manganese and aluminum data than necessary for this discharge to conduct Monte Carlo analysis; therefore, they were not evaluated for this TMDL. However, the observations for manganese and aluminum in the downstream segments of Little Anderson Creek indicate that they also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of manganese and aluminum (SRBC 2004).

Table G11, taken from the TMDL report, identifies the load reductions required for the Wingert Discharge (OSL 303).

Table G11. Reductions for the Wingert Discharge (OSL 303)

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL 303	Fe	20.66	65.48	0.41	1.30	98
	Mn	8.00	25.35	-	-	-
	Al	7.48	23.71	-	-	-
	Acidity	232.62	737.22	0	0	100
	Alkalinity	0	0			

All values shown in this table are long-term average daily values.

The TMDL for Wingert Discharge requires that a load allocation be made for OSL 303 for total iron and acidity (SRBC 2004).

Once again, rather than attempt to collect water samples at each individual discharge, monitoring points were established to determine the pollution load generated by the entire site. Two monitoring points were established, one above the point where the tributary drops off the highwall, identified as PAMP-LA 3.0 - 3, and one at a point where all of the water from the site enters the main flow of the tributary, labeled PAMP-LA 3.0 - 2.

The Wingert site is similar to DMP- Drauckers1 in that the area was deep mined for clay and then was surface mined. The coal, which is located above the clay, was not removed during surface mining and was just mixed in with the spoiled overburden. Highwalls, large un-vegetated spoil piles, and poorly vegetated mounds of unreclaimed overburden remain. Water quality is not quite as acidic and does not contain as high of a concentration of metals as DMP-Drauckers1. This site is much more extensive and will require considerable land reclamation.

Average water quality measured at PAMP-LA3.0

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-LA3.0	**3.43**	**2.82**	**1.57**	**2.22**	**3.61**	**9.84**	**24**	**99.83**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for Wingert Site

The Wingert site is perhaps the worst abandoned surface mine site in the Anderson Creek watershed. Here an unnamed tributary flows off the highwall into the open pit.

As with DMP- Drauckers1, perhaps the best option for the Wingert site is to explore the feasibility of remining the site and incorporating the reclamation of the land area during the remining. Conditions at this site are not conducive to remining, otherwise it would have likely already been remined as well. The strata associated with the coal seam also contain nodules of high sulfur and iron. These nodules can be seen throughout the spoil and within associated strata at the exposed highwalls. Like DMP-Drauckers1, remining and reclamation by cooperatively developing a reclamation plan between DEP and the mining company, using the best available techniques to reduce the possibility of creating additional pollution sources, would be the best option. Remining would strictly follow the agreed upon plan and the mining company would not be liable for any unforeseen circumstances should the pollution become worse. DEP would then assume responsibility for treating the water. The landowner is very interested in any proposal that would reclaim the land, eliminate the water-filled pits and highwalls, re-vegetate the site, and treat the AMD. Before any remining option is pursued, a detailed drilling and overburden analysis of the area must be performed to determine the feasibility of successful remining.

Again, barring remining of the site, several reclamation techniques could be considered. Land reclamation is an absolute necessity, considering the extent of the deplorable conditions on the site. The site is extremely dangerous with its water-filled pits and numerous vertical highwalls. The addition of alkaline materials during reclamation is highly recommended. With the construction of the new waste-coal-fired cogeneration plant being planned for the Karthus area, a ready supply of high-alkaline ash should be available for use on the site. Mine spoils containing highly acidic materials could be encapsulated in alkaline ash, which can harden and prevent infiltration of water into the acidic material. Reclaiming and re-grading the site to promote surface water runoff, rather than allowing the water to infiltrate into the mine spoil, would also greatly reduce AMD production. The combination of encapsulation of acidic mine spoil combined with proper control of surface waters would greatly reduce the metals and acidity load entering into UNT-LA 3.0 from the Wingert site. Any remaining discharges would likely contain much less metals and acidity.

There appears to be ample area for passive treatment, should that option be viable. Because of the high acidity and high levels of aluminum in the present discharges, passive treatment would likely necessitate the use of treatment systems able to handle that type of water. Modified Vertical Flow Systems, Sulfate Reducing Bioreactors, and Upflow Limestone Ponds are again some possibilities. Active treatment of the discharges or the entire amount of water draining from the site using chemicals might also be an option, especially if remining is not viable. Excess alkalinity could be generated from active treatment, which would provide additional benefits downstream. Operation and maintenance would again be a consideration if active treatment was employed, and a system that would not use electricity would be very desirable.

PAMP-LA 3.0-1

Just east of the Wingert site is another, which contains abandoned clay mines, both underground and surface. The site is similar to the Wingert mine, but smaller in size and without the significant water problems of the Wingert site. One monitoring point was established on the site as part of this study, PAMP-LA 3.0-1. During periods when the water table is high, a consistent flow of AMD discharges from the site. As the water table drops and the weather dries, the

Lack of proper surface drainage allows water to seep through poorly vegetated and un-reclaimed mine spoil.

discharge disappears. A significant area of high, steep, un-vegetated mine spoil piles exists on the site. An open pit and highwall remain as well. As with DMP-Drauckers 1 and the Wingert site, a coal seam lies above the clay seam. Once again, the coal was simply discarded on site and mixed with the overburden material lying above the clay. And, like the other sites, the sulfur and iron nodules are present, and are visible in the highwall and mixed in with the spoil. During periods of high water, the pit of the surface mine collects water, allowing some of it to filter through the mine spoils, creating AMD that eventually reaches the stream. The monitoring point is located to measure the water that flows from the pit and into UNT-LA 3.0.

Average water quality measured at PAMP-LA3.0-1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-LA3.0-1	**1.29**	**0.13**	**3.50**	**0.39**	**16.30**	**1.88**	**124**	**14.39**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for PAMP-LA 3.0 -1

Similar to Drauckers1 and the Wingert site, the best possible solution to the problems on the site is remining and reclamation, perhaps as a government-financed construction contract (GFCC). It is also recommended to perform on-site alkaline addition, acidic material encapsulation with cogen flyash, and passive treatment of any remaining AMD during the remining process. Once again, conditions at this site are not conducive to remining, otherwise it would have likely already been remined, so developing or using economic incentives to remine and reclaim the site are recommended. Barring remining, a land reclamation project that is combined with alkaline addition, acidic material encapsulation, and passive treatment of remaining discharges are recommended. Modified Vertical Flow Systems, Sulfate Reducing Bioreactors, and Upflow Limestone Ponds are again some possibilities. Active treatment of the discharges for the entire amount of water draining from the site using chemicals might also be an option, especially if remining is not viable. Excess alkalinity could be generated from active treatment, which would provide additional benefits downstream. Operation and maintenance would again be a consideration if active treatment was employed and a system that would not use electricity would be very desirable.

PAMP-LA 2.10

Downstream of UNT-LA 3.00 approximately .9 miles, UNT-LA 2.10 enters from river-left. This unnamed tributary drains an area previously surface mined and poorly reclaimed. A large area of mine spoil is placed in such a way that it prevents positive surface water draining and backs up water behind the spoil. This area serves as a groundwater recharge zone that likely produces AMD as it flows through the spoil material. Several areas of AMD seeps were noted. Vegetation growing on the site is sparse and probably increases the amount of AMD being produced. The Scarlift Report identified the site as being controversial because it was not known whether a recent surface mine operation, at the time, would be held liable for the discharges. Apparently, that was not the case or perhaps the company has since gone out of business, because there is no evidence of prior treatment activities at the site. No recommendations were given for the site in the Scarlift Report because of the question of liability.

For much of the assessment, this site was not monitored. Several samples and flows were recorded toward the end of the study (PAMP-LA 2.10). Additional samples and flows should be collected during periods of high groundwater to better determine this problem area’s contribution of pollution to Little Anderson Creek at high flows. Based on the data collected, it may be a moderate pollution source.

Average water quality measured at PAMP-LA 2.10

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-LA2.10	**1.63**	**0.26**	**7.19**	**1.70**	**6.46**	**1.63**	**70**	**16.44**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment. (It should also be noted that this site was not sampled during the time when flows would be their highest. This site likely accounts for higher pollution loads than identified by this chart.)

Recommendations for PAMP-LA 2.10

Large abandoned mine site at headwaters of UNT-LA2.10 appears to serve as a major source for AMD during wet periods.

This problem area is recommended for land reclamation and AMD treatment. It is recommended that land reclamation take place first, in order to reduce the amount of AMD being produced by the site. It is not known at this time whether remining is an option at this site, and investigation of that possibility should be pursued. If it is feasible, it may be possible to reclaim the site under a government financed construction contract (GFCC), which would reduce the cost of reclamation. As previously mentioned, re-contouring of the land to promote proper draining of surface water will help prevent that water from infiltrating into the mine spoil and creating higher volumes of AMD. In addition, the vegetation on the poorly reclaimed surface mine is very sparse and developing a thick mat of vegetation will also help to reduce water infiltration into the mine spoil, further reducing the flows of AMD. The addition of alkaline material into the spoil during reclamation will also serve to limit the production of AMD. Treatment of the AMD seeps is not recommended until land reclamation takes place.

Rock Run TMDL Sites

TMDL for Rock Run 1 and above (RR1)

TMDL point RR1 is located at the point where Rock Run crosses in a pipe beneath a gated road, approximately three miles upstream from its mouth. The TMDL for Rock Run above R1 identifies the mining impacts in the headwaters area as the cause of impairment, which is pH and metals impairment. Table G13, taken from the TMDL report, identifies the load reductions required for Rock Run above RR1.

Table G13. Reductions for Rock Run above RR1

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
RR1	Fe	2.17	15.02	0.54	3.74	75
	Mn	18.86	130.55	0.38	2.63	98
	Al	2.70	18.69	0.32	2.22	88
	Acidity	82.54	571.36	0.25	1.73	99.7
	Alkalinity	0.69	4.78			

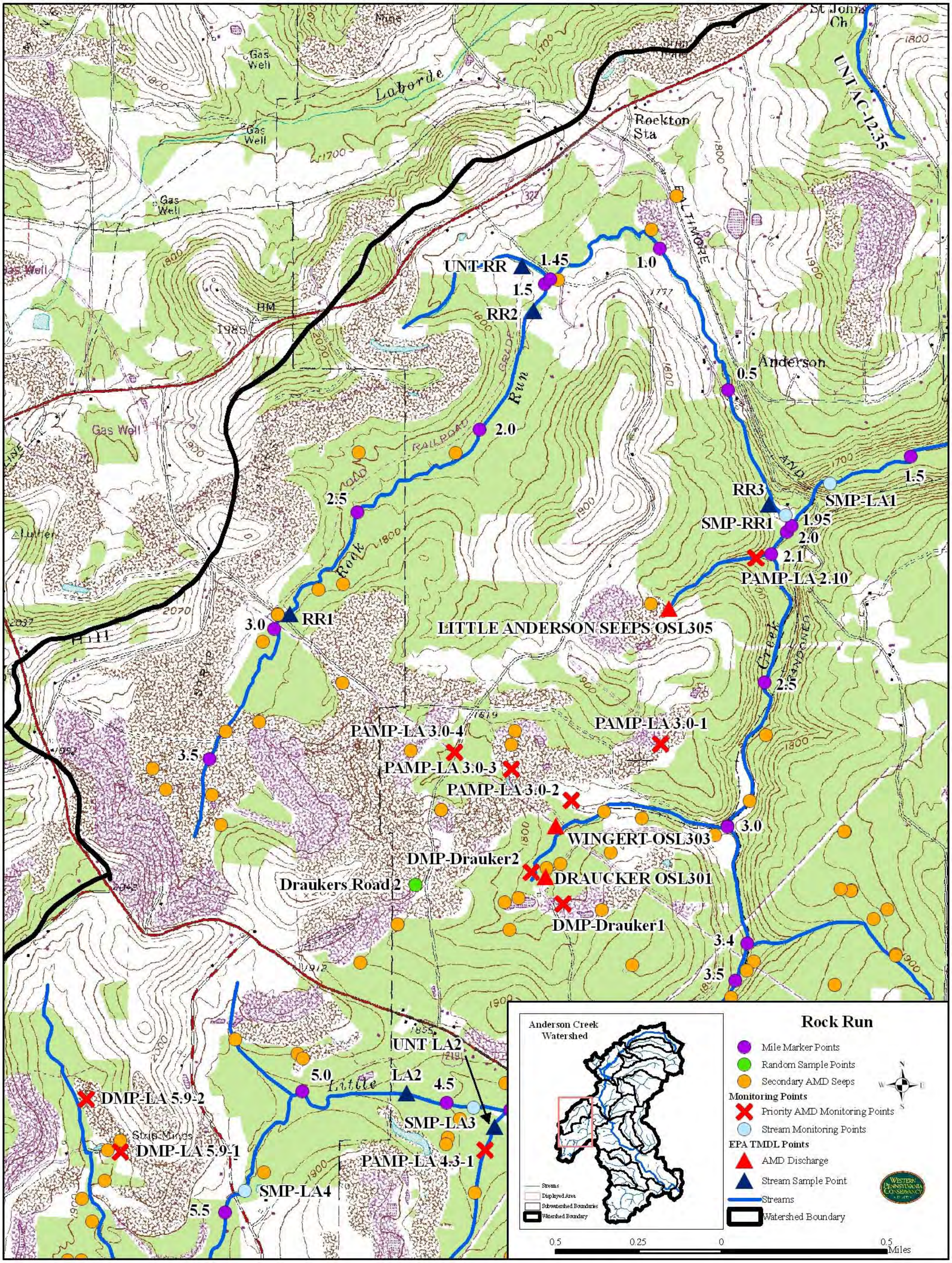
All values shown in this table are long-term average daily values.

The TMDL for Rock Run at point RR1 requires that a load allocation be made for all areas above RR1 for total iron, total manganese, total aluminum, and acidity.

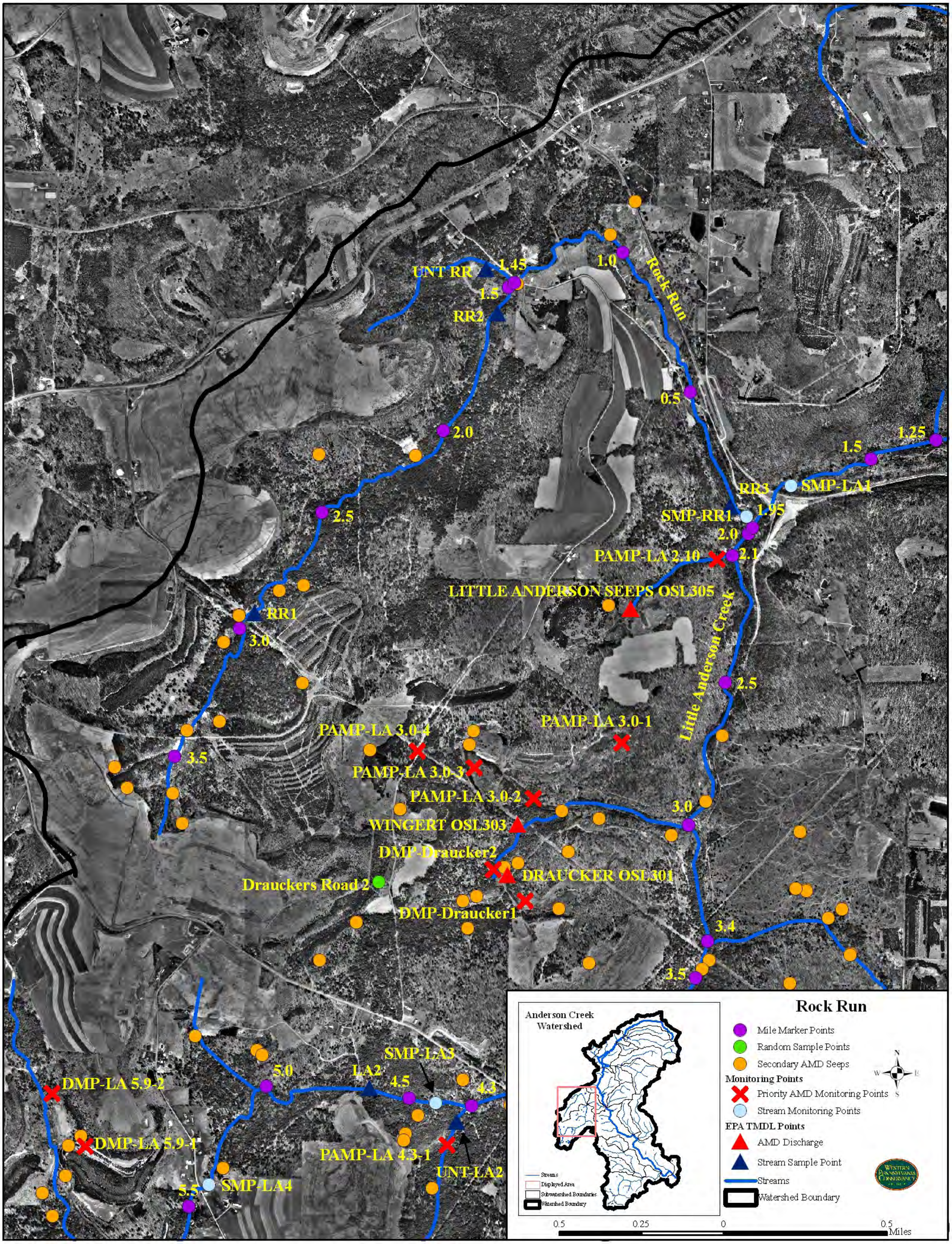
Recommendations for TMDL Rock Run above RR1

As mentioned above, a large reclaimed surface mine is associated with numerous seeps discharging from the toe of the spoil. Because the toe of the spoil is not at the original contour, but is much higher in elevation, it will be extremely difficult to address the discharges on the mine site. A large wetland exists immediately below the surface mine and all of the discharges above RR1 eventually flow into the wetland. By creating a series of low dikes that control the flow of the discharges, it may be possible to gain additional detention time in order to remove some of the metals before they enter the wetland. It should be noted that it will likely be difficult to obtain permits for working within the wetland area to treat the discharges. As was indicated for the headwaters area of Little Anderson Creek, a simple solution could be the installation of a low-impact dike system throughout the wetland area, similar to silt fencing constructed for erosion and sediment control. Again, because there is a large drainage area above the wetlands, surface runoff during heavy storms could be a problem with a lightweight dike system.

There is one discharge, which enters the wetland from the north, on what may be a pipeline right-of-way. This discharge could be a priority for remediation efforts in this segment. It was not considered as an overall priority in the context of assessing the entire Anderson Creek watershed. The discharge emanates from the toe of spoil below the surface mine, and is one of the more significant discharges on the headwaters of Rock Run. Sufficient area exists for creating settling ponds and treatment wetlands. Once



UNT-RR
1.45
1.5
1.0
RR2
2.0
2.5
3.0
RR1
3.5
0.5
Anderson
RR3
SMP-RR1
SMP-LA1
1.5
1.95
2.0
2.1
PAMP-LA-2.10
LITTLE ANDERSON SEEPS OSL305
2.5
PAMP-LA 3.0-1
PAMP-LA 3.0-4
PAMP-LA 3.0-3
PAMP-LA 3.0-2
WINGERT-OSL303
3.0
DMP-Drauker2
DRAUCKER OSL301
Draukers Road 2
DMP-Drauker1
3.4
3.5
UNT LA2
LA2
5.0
4.5
SMP-LA3
PAMP-LA 4.3-1
DMP-LA 5.9-2
DMP-LA 5.9-1
SMP-LA4
5.5
UNT AC-12.35
Rockton Sta
Anderson Creek Watershed
Rock Run
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5 0.25 0 0.5 Miles


Rock Run
UNT RR
1.45
1.5
RR2
1.0
Rock Run
0.5
2.0
1.25
1.5
RR3
SMP-LA1
SMP-RR1
1.95
2.0
2.5
PAMP-LA 2.10
2.1
LITTLE ANDERSON SEEPS OSL305
RR1
3.0
Little Anderson Creek
2.5
PAMP-LA 3.0-1
PAMP-LA 3.0-4
PAMP-LA 3.0-3
3.5
PAMP-LA 3.0-2
WINGERT OSL303
3.0
DMP-Draucker2
DRAUCKER OSL301
Drauckers Road 2
DMP-Draucker1
3.4
3.5
SMP-LA3
LA2
5.0
4.5
4.3
DMP-LA 5.9-2
DMP-LA 5.9-1
PAMP-LA 4.3-1
UNT-LA2
SMP-LA4
5.5
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
N
W
E
S
0.5
0.25
0
0.5
Miles

again, wetland-permitting issues will be a concern because the discharge flows through wetlands before entering Rock Run.

TMDL for Rock Run at RR2 (RR1 to RR2)

TMDL point RR2 is located at a bridge crossing on Rock Run Road, approximately .3 miles south of Route 322 and just upstream of UNT-RR 1.45. Reductions at point RR2 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point RR2 are shown in Table G15. Necessary reductions at point RR2 are shown in Table G16 [both tables are taken from the TMDL report] (SRBC 2004).

Table G15. Summary of Loads Affecting Point RR2

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
RR1				
Existing Load	15.02	130.55	18.69	571.36
Allowable Load	3.74	2.63	2.22	1.73
Load Reduction	11.28	127.92	16.47	569.63

Table G16. Reductions Necessary at Point RR2

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at RR2	17.70	191.09	30.15	686.99
Total Load Reduction (RR1)	11.28	127.92	16.47	569.63
Remaining Load	6.42	63.17	13.68	117.36
Allowable Loads at RR2	3.39	1.86	3.06	41.19
Percent Reduction	47	97	78	65

The TMDL for Rock Run at point RR2 requires that a load allocation be made for total iron, total manganese, total aluminum, and acidity (SRBC 2004).

Recommendations for TMDL RR1 to RR2

This segment of Rock Run is rather secluded, flowing through an undeveloped, mostly forested area. Several previously mined areas discharge AMD into the stream along this segment.

A few hundred feet downstream of the bridge, a series of acid seeps enter from the right and are associated with an old, poorly reclaimed surface mine located immediately to the east. Field testing noted a drop in the pH of the stream after the discharges entered, and thus the seeps are considered a significant source of impairment to this segment. The seeps are located in the woods, downslope from the poorly reclaimed spoil piles of the mine.

Reclamation of the poorly reclaimed surface mine will be necessary to reduce the impacts from the discharges. It is likely that substantial alkaline addition will be necessary during reclamation of the area in order to reduce or eliminate the acidic conditions of the discharges. Based on discharges associated with other reclaimed surface mine areas in the watershed, it may be possible to eliminate the acidity, but it is unlikely that the metal loadings associated with the discharges will be eliminated once the surface mine is reclaimed. Metal loadings will likely be reduced. Once the area is reclaimed, or remined, if possible, further testing of the discharges should be performed. Only then will it be possible to determine the proper method of remediation. In any case, wetlands permitting will again be an issue. This is especially true for this site, since some of the seeps appear in wooded bogs, and wooded bogs or wetlands are usually accorded a heightened status for protection by the regulatory agencies.

Additionally, the higher elevations of the entire left side of this stream segment were surface mined. AMD enters the stream from numerous points but most appear to be net alkaline. There is one area about midway along the segment that had seeps with pH readings in the mid-three range. Flow volume was low and access to the site would be very difficult due to its remote location, so the seeps were given a low priority for restoration.

Unnamed Tributary to Rock Run - UNT RR (UNT-RR 1.45)

TMDL point UNT RR is located at the mouth of a tributary entering Rock Run from river-left, just downstream from TMDL point RR2. This tributary is impaired by AMD from several seeps in its headwaters. The seeps emanate from reclaimed surface mines just south of Route 322.

Necessary reductions at TMDL point UNT RR are shown in Table G17 [taken from the TMDL report]. The TMDL for the unnamed tributary to Rock Run at point UNT RR requires that a load allocation be made for all areas above UNT RR for total iron, total manganese, and acidity (SRBC 2004).

Table G17. Reductions for the Unnamed Tributary to Rock Run above UNT RR

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
UNT RR	Fe	0.62	0.62	0.30	0.30	52
	Mn	22.03	22.05	0.20	0.20	99.1
	Al	0.80	0.80	-	-	-
	Acidity	59.38	59.43	1.19	1.19	98
	Alkalinity	5.99	5.99			

All values shown in this table are long-term average daily values.

There was not enough data to properly develop a TMDL for aluminum at point UNT RR so a reduction percentage was not identified. The observations for aluminum in the downstream segments of Rock Run indicate that it also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of aluminum (SRBC 2004).

Recommendations for TMDL point UNT RR

Similar to TMDL point RR1, the AMD entering this tributary appears in a wooded area, downslope of a large reclaimed surface mine located at the very headwaters of the tributary. Again, the reclaimed site has a very high and steep embankment at the toe of the spoil and does not follow the approximate original contour of the undisturbed land below it. These conditions would make it very difficult to address the discharges on the reclaimed mine site.

Field testing indicated that most of the AMD discharges are not very acidic, with pH readings ranging from 5.4 to 6.1. Based on the field testing, it may be possible to remove some of the polluting metals by capturing the discharges and directing them through a passive settling pond and wetland treatment system to improve retention time and promote precipitation of the metals. Most of the discharges flow into a large wetland area located west of Rock Run Road, which is likely removing some of the metals. It is difficult to determine whether additional AMD enters the wetland through polluted groundwater. A more detailed study of the wetland area would be necessary to make that determination. Such a study was beyond the scope of this assessment but is recommended as a future activity.

The wooded area below the surface mine where the discharges are located is apparently being used for hunting purposes, as there were several tree stands located in the area. It is unknown whether the property owner would be willing to use the wooded area for the construction of a treatment system. Communication with the property owner has not occurred and would be necessary to determine if the area would be available for treatment.

TMDL point Rock Run 3 (RR3) [SMP RR1]

The TMDL point for RR3 is located near the mouth of Rock Run and includes all of the pollution sources on Rock Run, including UNT RR. Necessary reductions at TMDL point UNT RR are shown in Table G20 [taken from the TMDL report]. The TMDL for Rock Run at point RR3 requires that a load allocation be made for total iron, total manganese, and acidity. The TMDL for Rock Run at point RR3 does not require a load allocation to be made for total aluminum. [It assumes] all necessary reductions have been made upstream from this point (SRBC 2004).

Table G20. Reductions Necessary at Point RR3

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at RR3	65.74	508.77	23.17	1,935.61
Total Load Reduction (RR1, RR2, and UNT RR)	25.91	339.00	43.56	1,273.67
Remaining Load	39.83	169.77	0	661.94
Allowable Loads at RR3	6.71	4.34	4.09	116.11
Percent Reduction	83	97	0	82

TMDL monitoring point RR3 is also represented by this assessment as monitoring point SMP-RR1, which was located slightly upstream from Rock Run's confluence with Little Anderson Creek. The following averages were developed using the data collected during this assessment and represents the average pollution load in all of Rock Run during that time period

Average water quality measured at SMP-RR1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-RR1	2.15	20.9	7.19	96.0	0.91	19.4	15.44	217.7	5	96.5

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for TMDL RR 3

One area of significance was identified downstream of UNT RR (UNT RR 1.45) that adds to the metals pollution load entering Rock Run. The site is an abandoned coal tipple adjacent to the abandoned Baltimore and Ohio rail line approximately .75 miles south of Rockton Station. The site contains a large area of mine spoil that is un-vegetated and has an erosion problem. Based on field tests and visual observations during the assessment, rain and surface water runoff become polluted when they come in contact with the mine spoil. It is unknown whether the site pollutes the groundwater in the area, although it is likely to have some negative effect. One small discharge was identified near Rock Run below the site and is assumed to be hydrologically connected. A definitive determination was beyond the scope of this assessment.

Reclamation of the abandoned tipple site is recommended. Removal of the spoil or re-grading and re-vegetation of the site, along with some type of alkaline addition would likely improve the quality of the water associated with the site. Because restoration of Rock Run is not considered a high priority in the overall restoration of Anderson Creek at this time, it is recommended that this site be included in a more detailed study of Rock Run sometime in the future.

TMDL for Little Anderson at LA3 (SMP-LA1)

The TMDL point for LA3 is identified as the mouth of Little Anderson Creek near the confluence with Anderson Creek. Basically, LA3 captures the entire pollution load entering Little Anderson Creek. The TMDL for LA3 was developed by subtracting the required TMDL load reductions for all of the discharges above LA3, assuming they will be addressed at those points, from the existing loads at LA3. The results show a required load reduction only for aluminum at LA3. Table G23, taken from the TMDL study, shows the required load reductions at LA3.

Table G23. Reductions Necessary at Point LA3				
	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at LA3	439.73	411.92	475.36	6,778.42
Total Load Reduction (Sum of OSL Discharges, La1, UNT LA1, LA2, UNT LA2, RR1, RR2, UNT RR, and RR3)	634.20	898.18	65.18	7,017.02
Remaining Load	0	0	410.18	0
Allowable Loads at LA3	47.57	44.49	32.32	0
Percent Reduction	0	0	92	0

The TMDL for point LA3 requires that a load allocation be made for all areas above LA3 for total aluminum. The TMDL for Little Anderson Creek at point LA3 does not require a load allocation to be made for total iron, total manganese, and acidity. All necessary reductions have been made upstream from this point (SRBC 2004).

TMDL point LA3 is also represented by this assessment by SMP-LA1, which is located slightly upstream from the TMDL monitoring point. The following averages were developed using the data collected during this assessment and represents the average pollution load in all of Little Anderson Creek during that period.

Average water quality measured at SMP-LA1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-LA1	**6.2**	**140.1**	**5.2**	**192.6**	**3.6**	**134.7**	**49.9**	**1559.6**	**0.8**	**87.3**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for TMDL LA3

Below Rock Run, no identifiably significant AMD source enters Little Anderson Creek. Some minor seeps were observed at the base of the viaduct below the railroad, but none were significant enough to warrant a priority status. The first unnamed tributaries entering Little Anderson Creek below the viaduct from river-left, UNT-LA 1.25, was influenced by lower pH seeps but none were significant enough to cause concern. It is clear that the previously identified AMD discharges to Little Anderson Creek above Rock Run are the major contributors of metals and acid pollution to the subwatershed. It is recommended to focus efforts to reduce pollution loads on those discharges.

The Main Stem of Anderson Creek

The main stem of Anderson Creek flows for approximately 23.5 miles, from its headwaters above Interstate 80 to its confluence with the West Branch of the Susquehanna River in Curwensville. This study only covered the portion of Anderson Creek from the outflow of the Dubois Reservoir to the confluence with the West Branch, a distance of 14 miles. Between the Dubois Reservoir and Little Anderson Creek, Anderson Creek supports a trout-stocked fishery and is relatively unimpaired by AMD. It is influenced by acid rain, which is compounded by a general lack of buffering capabilities, as is the case throughout most of the watershed. Although the acidic conditions in the upper watershed affect its quality, the stream remains net alkaline and has the lowest levels of metals for all sampling points.

For this assessment, the main stem was monitored at four points. Stream Monitoring Point AC1 (SMP-AC1) is located just upstream of the State Route 153 Bridge in Curwensville. Stream Monitoring Point AC2 (SMP-AC2) is located just above the old State Route 879 Bridge (now abandoned), which is located approximately two miles upstream from the mouth. Stream Monitoring Point AC3 is located about .5 miles below the Pike Township Municipal Authority dam on Anderson Creek and approximately 5.25 miles upstream from the mouth. The uppermost monitoring point, Stream Monitoring Point AC4 (SMP-AC4) is located just downstream from the State Route 322 Bridge, west of Rockton. It is approximately 12.25 miles upstream from the mouth.

The water quality of Anderson Creek becomes severely degraded at the confluence with Little Anderson Creek. The pollution load from Little Anderson Creek essentially kills the stream when it enters. Although Little Anderson Creek is the main source of metals and acid pollution to Anderson Creek, other unnamed tributaries and AMD discharges also degrade the stream. In addition, discharges entering Kratzer Run, and its subwatershed Bilger Run, also add to the metals and acid pollution load of Anderson Creek.

Anderson Creek also receives relatively good water, which is sometimes net acidic but low in metals, from several named tributaries which enter from the eastern side of the watershed. Panther Run, Irvin Branch, and Bear Run all provide water that helps Anderson Creek hold its pH in the mid to upper four range for most of year. During base flow conditions, Anderson Creek below Kratzer Run actually increases its level of alkalinity and receives lower levels of metals because several of the more severe AMD discharges on Little Anderson Creek, Bilger Run, and Kratzer Run cease to flow. During the August 2005 monitoring event, minnows were observed for the first time at SMP-AC1 and at SMP-BR2 on Bilger Run. It is assumed the fish migrated into these sites from refuges on the West Branch of the Susquehanna River and other tributaries in the lower watershed with water quality good enough to support fish. These positive indicators point to the significance of addressing the worst discharges on Little Anderson Creek, Bilger Run, and Kratzer Run and give hope for the restoration of Anderson Creek.

TMDL for Main Stem of Anderson Creek - A1

The reach of Anderson Creek above TMDL point A1 is the area of Anderson Creek located above and just below the DuBois Reservoir. Anderson Creek above point A1 is not listed on the Section 303(d) list as being impaired by AMD, and a TMDL will not be developed for this point. The DuBois Reservoir is used by the City of DuBois as a public water supply. Up to 3.00 mgd is allocated to DuBois from the reservoir (Runkle 2000). A conservation release of 1.52 mgd must be maintained at all times over the reservoir to sustain downstream uses (Runkle 2000). This release becomes especially important in times of low flow, as a backup public water supply intake for the Pike Township Municipal Authority, which is located a few miles downstream on Anderson Creek.

Other potential problems exist in areas of the watershed above point A1, which is not degraded by AMD. Interstate 80 transects the watershed in its upper reaches less than one mile upstream of the DuBois Reservoir. The City of DuBois applied for and received a Growing Greener Grant through the Commonwealth of Pennsylvania to investigate sources of pollution to the upper reaches of the watershed. The City of DuBois Watershed Commission is concerned that a spill on Interstate 80, the spraying of overpasses during the winter months by the Pennsylvania Department of Transportation (PennDOT), and the possibility of malfunctioning gas wells present risks to the water supply. The EADS Group of Clarion, Pa., completed the study in July 2001. It concluded that the pollution is from natural sources, such as acid rain leaching metals from the bedrock (DuBois Reservoir Watershed Water Quality Assessment Project 2001; SRBC 2004).

Monitoring point SMP-AC4 coincides with the TMDL sampling point A1. The following averages were developed using the data collected during this assessment.

Average water quality measured at SMP-AC4

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-AC4	**0.14**	**25.0**	**0.06**	**13.3**	**0.09**	**19.7**	**1.40**	**480.7**	**10.2**	**1201.2**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

TMDL for Main Stem of Anderson Creek - A1 to A2 (SMP-AC3)

Anderson Creek between A1 and A2 represents Anderson Creek and its unnamed tributaries from just above Route 322 to the mouth of Anderson Creek. This includes the main-stem segment and its named and unnamed tributaries from below the DuBois Reservoir to the West Branch of the Susquehanna River in Curwensville.

The TMDL for Anderson Creek at point A2 consists of a wasteload allocation to one future mining operation and a load allocation to all of the watershed area between A1 and A2. Addressing the mining impacts above this point addresses the pH and metal impairment for the segment. An in-stream flow measurement was not available for A2; therefore, the flow was determined using the AVGWLF model (74.19 mgd) (SRBC 2004).

The water quality standard for acidity (17.85 mg/l) at point A2 was determined by adding the net alkalinity at A1 (A1 alkalinity - A1 acidity) to the acidity at A2 (9.97 -4.70

= 5.27; 5.27 + 12.58 = 17.85). Load reductions for acidity were calculated using this value as the water quality standard for acidity at point A2 (SRBC 2004).

There were fewer manganese and aluminum data than necessary for this discharge to conduct Monte Carlo analysis; therefore, they were not evaluated for this TMDL. However, the observations for manganese and aluminum in these segments of Anderson Creek indicate that they also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of manganese and aluminum (SRBC 2004).

Tables G38 and G40, taken from the TMDL report, show the long-term concentrations and the load reductions established for Anderson Creek at TMDL point A2.

Table G38. Long-Term Average (LTA) Concentrations for Anderson Creek Between A1 and A2

Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
A2	Fe	0.28	173.25	0.28	172.15
	Mn	0.92	569.25	-	-
	Al	0.79	488.81	-	-
	Acidity	12.58	7,783.81	8.55	5,290.27
	Alkalinity	1.63 (17.85)*	1,008.55 (11,044.59)*		

All values shown in this table are long-term average daily values.
*Alkalinity value used as water quality standard.

Table G40. Reductions Necessary at Point A2

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at A2	173.25	569.25	488.81	7,783.81
Total Load Reduction (LA1, UNT LA1, LA2, UNT LA2; OSL 352, 329, 330, 301, 303, 305; RR1, RR2, UNTRR, RR3, LA3, OSL 350, OSL 351, HR1, OSL 211-214, BR1, BR2, FR1, KR1, OSL 220)	1,263.25	1,572.95	598.95	18,282.89
Remaining Load	0	0	0	0
Allowable Loads at A2	172.15	-	-	5,290.27
Percent Reduction	0	0	0	0

The TMDL for Anderson Creek at point A2 does not require a load allocation to be made for total iron, total manganese, total aluminum, and acidity. All necessary reductions have been made upstream from this point (SRBC 2004).

Monitoring point SMP-AC1 coincides with the TMDL sampling point A2. The following averages were developed using the data collected during this assessment.

Average water quality measured at SMP-AC1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-AC1	0.31	138.2	0.82	260.5	0.46	206.4	5	2000.2	9	2060.4

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Problem Areas on the Main Stem of Anderson Creek

Dubois Reservoir to Little Anderson Creek

The study area of this assessment begins at the outflow of the Dubois Reservoir. Between the outflow of the reservoir and Little Anderson Creek, Anderson Creek is relatively unimpaired by non-point source pollution. Tributaries entering the main stem are generally affected by acid deposition and are afflicted with depressed pH readings. Although some surface mining has taken place in this area of the watershed, AMD is not a problem in this 3.75-mile long section of Anderson Creek. The Pennsylvania Fish and Boat Commission manages this stream segment as a trout-stocked fishery. It is likely that Anderson Creek occasionally receives a significant amount of salt runoff from Route 322 during winter weather. The stream flows at higher volume during that time and likely is able to assimilate such conditions without significant impacts. The stream is also susceptible to toxic spills from vehicles traveling Route 322, which is a concern but beyond the scope of this study.

Panther Run

Panther Run is the largest tributary entering Anderson Creek between the DuBois Reservoir and the confluence with Little Anderson Creek, which enters just downstream of Panther Run. The headwaters of Panther Run are located south of Route 322 and east of the Anderson Creek main stem. The area is forested and contains a very dense and nearly impenetrable population of rhododendron along the stream. The upper reaches along Route 322 are receiving some development pressure as several new residences have been built in recent years. No specific problems were noted related to the development. A gas line traverses the subwatershed in a northeast/southwest orientation. Some erosion problems, caused by ATV use, were identified along the pipeline.

When field sampled during the assessment, Panther Run exhibited symptoms of an acidified stream, with depressed pH (4.7) and depressed macroinvertebrate life observed in the stream. A lab sample showed that Panther Run was net acidic with low metal content and contained aluminum levels identified as being toxic to some fish species. Panther Run is similar, in such respects, to many of the other streams draining the eastern part of Anderson Creek. The acidic geology of Panther Run, combined with chronic acid deposition, causes the stream to mainly support acid-tolerant aquatic insects. In the 1999 assessment performed by Headwaters Charitable Trust, a good population of brook trout was noted at the sample site. Brook trout are the most acid-tolerant species of trout in Pennsylvania.

Unnamed Tributaries below Little Anderson Creek

Below the confluence of Anderson Creek and Little Anderson Creek, several impaired tributaries enter the main stem of the stream. The first three tributaries entering from river-right, UNT-AC 9.20, UNT-AC 8.80, and UNT-AC 8.20 are impaired by AMD to varying degrees. Each is affected by abandoned surface mines and underground mines located in the higher elevations of the sub-basins on the western side of Anderson Creek.

Immediately below these impaired tributaries, two very large net acidic tributaries enter Anderson Creek from river-left, Irvin Branch (AC-6.45) and Bear Run (AC- 6.05). Although neither is heavily impacted with AMD, each suffers from acid deposition and had depressed pH and slightly elevated levels of aluminum. Both Bear Run and Irvin Branch were identified by the Headwaters Charitable Trust study as containing good populations of brook trout. Data for the macroinvertebrate sampling was not available at the time of the assessment. Based on empirical observations taken during the assessment and the water quality of the streams, it is likely macroinvertebrates will tend to be of the acid-tolerant type.

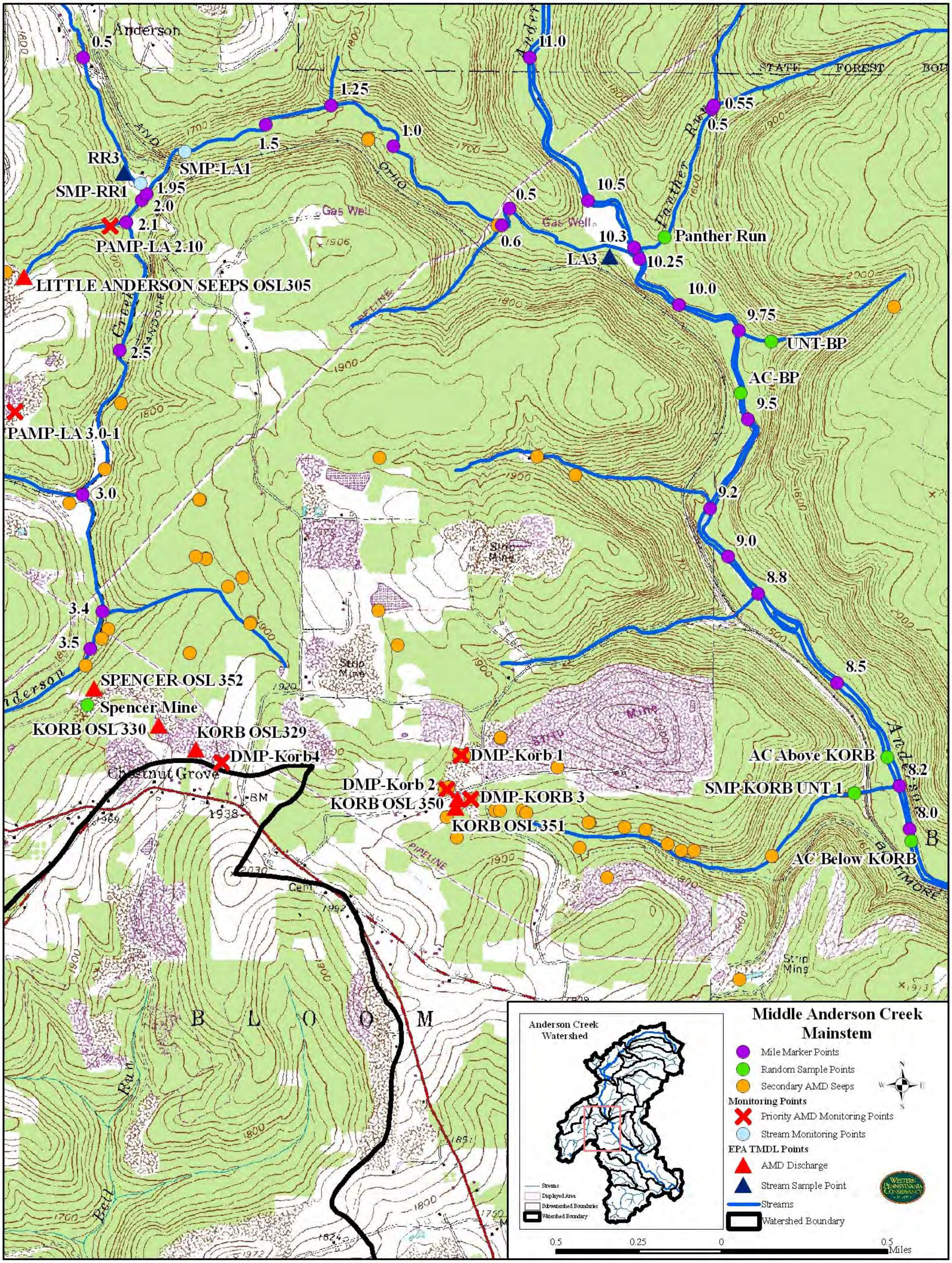
The combined flows of Bear Run and Irvin Branch are large enough to add significant amounts of alkalinity and acidity to Anderson Creek. Some AMD does enter the streams from abandoned surface and deep mines, but the main source of their acidity appears to be from atmospheric deposition or acid rain and the geology of the area. The geology of the eastern side of the Anderson Creek watershed provides little or no buffering capacity for acid rain and most of the streams draining the eastern side are often net acidic with low metals.

Just below Bear Run, a small, unnamed tributary enters from river-left (UNT-AC 5.8). For most of its length, the stream quality is decent, but as it approaches Anderson Creek several low-pH AMD seeps enter the stream almost unnoticed. The seeps are likely springs, which have been polluted from an abandoned mine located in higher elevations. Known locally as Laurel Swamp, the site was apparently deep mined and then surface mined for the Mercer clay. An area of unreclaimed mine spoil remains at the site. No restoration recommendations were identified within the Scarlift study, but the site was identified on mining maps. Perhaps it was an oversight. The pH of the stream steadily drops as additional low-pH seeps enter, very near to the streambed, and reduce the pH of the tributary considerably. This low-pH condition was noted by an ACWA volunteer who monitored the mouths of many of the small tributaries entering Anderson Creek for pH several years prior to this assessment.

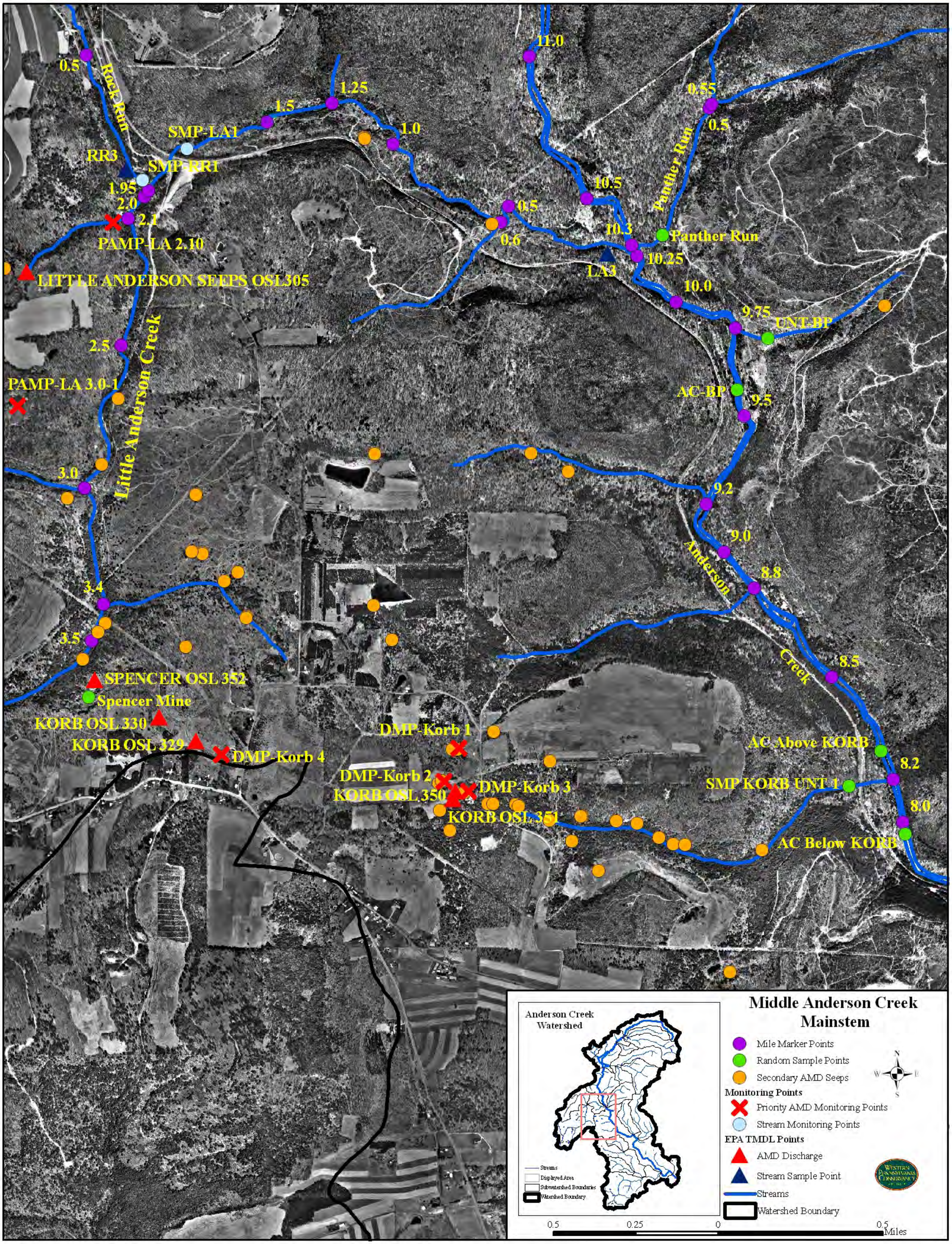
Approximately two miles further downstream, Anderson Creek receives additional AMD from an abandoned clay mine located several hundred feet above the stream on the eastern flank of the gorge. Similar to the situation on UNT-AC 5.8 at Laurel Swamp, the clay mine, known locally as Bloom mine, was deep mined and later surface mined. This site is much larger and produces AMD from two distinct areas located on either side of UNT-AC 3.75. Both areas were monitored as part of this assessment and are identified as DMP-AC 3.75-1 and DMP-AC 3.75-2. DMP-AC 3.75-1 flows from a collapsed mine tunnel at an elevation of about 1,700 feet above the gorge. DMP-AC 3.75-2 once again, does not appear at the abandoned mine site but hundreds of feet below the mine on the very steep hillside within the gorge. This discharge is being sampled along the Pike Township Water Authority access road, located along the eastern side of the Anderson Creek gorge. Another drainage site associated with this tributary was also sampled for a short time during this assessment, DMP-AC 3.75-3. It is located near DMP-AC 3.75-1. It was determined that the drainage was likely more associated with acidic mine spoil runoff and was dropped from the sampling schedule.

From UNT-AC 3.75 to the confluence with Kratzer Run, no significant discharges were identified. Downstream of Kratzer Run, two additional sources of AMD were identified. The first enters Anderson Creek just above the North American Refractory from the river-right side of the stream. This discharge actually emanates from an abandoned underground mine located just outside of Curwensville along Windy Hill Road. The discharge emerges in a very steep ravine north of Windy Hill Road and drops approximately 200 feet in elevation before entering a wetland located upstream and on the opposite side of Anderson Creek from the refractory (AC-1.5). The discharge apparently encounters alkaline material near the refractory as the pH rises before it enters Anderson Creek. The discharge was not monitored as part of the assessment. A single water sample was gathered at the discharge site to determine the water quality as it discharges from the mine.

One additional area of AMD was noted entering the main stem of Anderson Creek, which emanates from an area along an unnamed tributary flowing through Curwensville, UNT-AC 0.3, which enters Anderson Creek in a concrete flood-control channel from the river-left side near the confluence with the West Branch of the Susquehanna River. Iron-stained seeps were located along the tributary prior to it entering buried pipe just east of Oak Hill Cemetery, which carries the stream underground through most of Curwensville. It re-emerges from underground in the above-mentioned concrete channel once past Route 879 and before entering Anderson Creek. Because field sampling did not indicate the seeps were of very poor water quality or of high flow and did not have a significant impact to Anderson Creek, they were not sampled as part of the assessment. There may be a possibility of improving the water quality of this unnamed tributary by removing some of the metals through passive treatment or other methods. Finding ample room to construct a passive treatment system might be difficult because of the location of the seeps near the stream or residences.



Middle Anderson Creek Mainstem
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5
0.25
0
0.5
Miles
Anderson
0.5
1.25
1.0
1.5
RR3
SMP-LA1
SMP-RR1
1.95
2.0
2.1
PAMP-LA 2.10
LITTLE ANDERSON SEEPS OSL305
2.5
PAMP-LA 3.0-1
3.0
3.4
3.5
SPENCER OSL 352
Spencer Mine
KORB OSL 330
KORB OSL329
DMP-Korb4
Chestnut Grove
11.0
0.55
0.5
Panther Run
10.5
0.5
0.6
10.3
LA3
10.25
10.0
9.75
UNT-BP
AC-BP
9.5
9.2
9.0
8.8
8.5
DMP-Korb 1
DMP-Korb 2
DMP-KORB 3
KORB OSL 350
KORB OSL 351
AC Above KORB
8.2
SMP-KORB UNT 1
8.0
AC Below KORB
Gas Well
Strip Mine
B L O O M
STATE FOREST



Middle Anderson Creek Mainstem
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
0.5 0.25 0 0.5 Miles
Rock Run
Little Anderson Creek
Panther Run
Anderson Creek
SMP-LA1
SMP-RR1
RR3
PAMP-LA 2.10
LITTLE ANDERSON SEEPS OSL305
PAMP-LA 3.0-1
SPENCER OSL 352
Spencer Mine
KORB OSL 330
KORB OSL 329
DMP-Korb 4
DMP-Korb 1
DMP-Korb 2
KORB OSL 350
DMP-Korb 3
KORB OSL 351
LA3
Panther Run
UNT-BP
AC-BP
AC Above KORB
SMP KORB UNT 1
AC Below KORB
0.5
1.25
1.5
1.0
1.95
2.0
2.1
2.5
3.0
3.4
3.5
0.5
0.6
11.0
0.55
0.5
10.5
10.3
10.25
10.0
9.75
9.5
9.2
9.0
8.8
8.5
8.2
8.0

Recommendations for the Problem Areas on the Main Stem of Anderson Creek

Recommendations for Panther Run

Panther Run is essentially unimpaired by AMD. As is the case with all of the streams draining the northeasterly portion of the watershed, the lack of alkaline material, acidic rock formations, and acid precipitation cause its waters to be pH depressed and likely to have populations of acid-tolerant aquatic macroinvertebrates. No fish were observed in the stream during this assessment, although no electro-fishing study was performed. The 1999 Headwaters Charitable Trust study did find the stream contained a population of reproducing brook trout. Because AMD was not an issue with Panther Run it was not sampled as part of this assessment. Panther Run would be a prime candidate for some type of alkaline addition treatment, such as limestone sand addition, which performs well on high-gradient streams such as Panther Run. Its inaccessibility and remoteness would make such treatment very difficult. Another option would be the use of automated lime dosers to raise the pH of the stream and neutralize episodic acidic events. Such treatments are costly and require regular operation and maintenance. It is likely that only a reduction of atmospheric acid deposition would be of the most long-term benefit to the depressed pH conditions of Panther Run.

UNT-AC 9.20

Surface mines located along Viaduct Road, on property owned by Anderson Creek Sportsmen, affect the first tributary, UNT-AC 9.20. A portion of the headwaters area of the tributary was surface mined and reclaimed, but present vegetation is sparse, consisting mostly of a pine tree forest with very little groundcover vegetation. The area likely serves as a groundwater recharge area. Several minor seeps appear adjacent to the stream at elevations that appear to be about 200 feet lower in elevation than the reclaimed surface mine area. None of the seeps had significant flow at the time of assessment. Field tests showed that some had depressed pH and obviously contained elevated concentrations of metals. None were identified as a single significant source. Collectively they reduce the quality of the stream significantly. A large pond, located on Anderson Creek Sportsmen property also field-tested as having a depressed pH. Although the stream is impaired, it was considered a low priority for remediation at this time.

Recommendation for UNT-AC 9.20

UNT-AC 9.20 is AMD impaired and its water quality could likely be improved though a combination of land reclamation and passive AMD remediation techniques. The headwaters area, which is sparsely vegetated with pine trees and contains poor soil conditions, could be improved by the addition of alkalinity and nutrients into the soil. Replacing the pine trees with either a thick vegetative mat, which would reduce rain infiltration into the mine spoil, or replanting with high-value deciduous trees after proper soil and subsoil enhancements would be beneficial as well.

The water quality of the large pond on the sportsmen's property appeared to contain low concentrations of metals and might be improved though methods used in passive AMD treatment, such as anoxic limestone drains, Upflow Limestone Ponds, or self-flushing limestone ponds. Because the stream is very steep, limestone sand dosing would likely be very successful in neutralizing acidic water. Any neutralization of acidic conditions and additional alkalinity would have a positive effect not only on the tributary, but on Anderson Creek as well.

UNT-AC 8.80

The second AMD-impaired unnamed tributary entering Anderson Creek below Little Anderson Creek again flows from the west, or river-right, side. Because field sampling indicated this tributary was not severely degraded, it was not regularly monitored under this assessment. Mostly old, poorly reclaimed surface mines in its headwaters affect UNT-AC 8.80. These poorly reclaimed mines surround the headwaters area.

A large pond exists on the main flow of the tributary on private property in its very headwaters. The pond is impaired by AMD, mainly by acid and aluminum. Sampling measured acidity at 27mg/L of acidity and 1.87 mg/L aluminum and very little iron (Franke sample). The property owner indicated that a discharge upwelling occurs at the northeastern side of the pond, under water. No visible areas of discharge were identified surrounding the pond. Immediately below the pond is a large wetland area where additional AMD with higher levels of iron enter the tributary, indicated by a change in the color of water. Field testing indicated pH increased below the pond area. Communication with the landowner indicated a willingness to address the polluted water leaving the pond. The landowner was uncertain whether he would be willing to address the pollution within the pond.

Recommendations for UNT-AC 8.80

A passive treatment system, which would address the outflow of the pond, would likely make significant improvements to UNT-AC 8.80. Because of low iron concentrations, it may be possible to treat the pond discharge using a self-flushing, open limestone pond-type system. Such a system is basically a large basin filled with limestone, which is used to neutralize acidity, combined with a self-flushing device that allows the pond to fill and then drain out at a rapid rate. The system is designed to minimize plugging problems associated with aluminum. As described above, the area below the pond contains wetlands, so permitting would be an issue.

In addition, significant benefits could be achieved by a much more dense blanket of vegetation over the entire area now covered by pine trees. Dense vegetation along with the addition of alkaline material would likely further improve any water draining through the mine spoil on the abandoned mine sites. This would likely be very costly unless it was part of another mitigation project.

UNT-AC 8.20

The third AMD-impaired unnamed tributary to enter the main stem downstream of Little Anderson Creek also flows in from the west, or the river-right, side. UNT-AC 8.20 appears to be the most impaired of the three streams entering the gorge below Little Anderson Creek from the west. Like its two other adjacent streams, its problems stem from abandoned mines in its headwaters. This tributary also receives significant discharges from the abandoned Korb underground clay mine located in Chestnut Grove.

Three areas of discharges drain from the Korb mine into UNT-AC 8.20 and account for one of the top three acid, iron, and pollution loads in Anderson Creek. Addressing the Korb mine discharges would, as discussed previously, make significant improvements to this tributary. It would not address all of the pollution sources.

Several seeps appear on either side of the stream lower in elevation. Those seeps appear to be directly associated with two large surface mines located on the hills, on either side, above the stream. Combined, these discharges account for a significant amount of pollution entering UNT-AC 8.20. During dry periods, when the Korb discharges were flowing little water, over 50 gpm of AMD-impaired water was observed still flowing at the mouth of the stream. Therefore, other measures should be taken to address the pollution generated at those mines.

Recommendations for UNT-AC 8.20

UNT-AC 8.20 is associated with two of the highest priority discharges for remediation identified by this assessment. Those discharges drain from the abandoned Korb underground clay mine located in the headwaters area of tributary near Chestnut Grove. A recommendation for addressing those discharges involved remining of the Korb mine in combination with the addition of alkaline material and was discussed previously.

In addition to the Korb mine discharges, there are several AMD seeps that impact UNT-AC 8.20 lower in elevation along the stream. These discharges are associated with surface mines located on either side of the stream at higher elevations. Consistent with other areas of the watershed, the seeps appear well below the actual area that was mined. Some were also located nearer to the surface mine.

Because the seeps are located very near the stream, and the stream is in a remote, steep valley, it will be very difficult to address them where they appear. A better approach would be to determine whether remining and enhanced reclamation techniques, using significant alkaline addition, could be utilized on the abandoned mine site to improve the quality of the seeps. The abandoned mine located on the southern side of the tributary contains areas with un-vegetated or poorly vegetated spoil and a pond of water in one area. This site is the most likely to have some possibility of remining. The surface mine to the north is reclaimed and covers the entire hilltop. It is probably less likely to have any possibility of remining.

The surface-mined headwater areas of Anderson Creek unnamed tributaries 9.20, 8.80, and 8.20 may also be responsible for several low-pH seeps entering Little Anderson Creek from the area west of Viaduct Road. The seeps appear 60 to 100 feet lower in elevation than the surface mines. A hydrologic study making a connection to the seeps was beyond the scope of this study, but would be useful in making a definitive determination.

Irvin Branch (AC-6.45)

Irvin Branch is a remote, forested stream draining from the eastern side of the Anderson Creek watershed. Access to the stream is very limited. It flows in a southeasterly direction and is situated between the main stem of Anderson Creek and Bear Run, which enters .4 miles downstream. Irvin Branch is essentially unimpaired by AMD, although some surface mining was done in the headwaters area. As is the case with all of the streams draining the northeasterly portion of the watershed, the lack of alkaline material, naturally occurring acidic rock formations, and acid precipitation cause its waters to be pH depressed and likely have low populations of acid-tolerant aquatic macroinvertebrates. No fish were observed in the stream during the assessment. The 1999 Headwaters Charitable Trust study did find the stream contained a population of reproducing brook trout. Because AMD was not an issue with Irvin Branch, it was not sampled regularly as part of this assessment

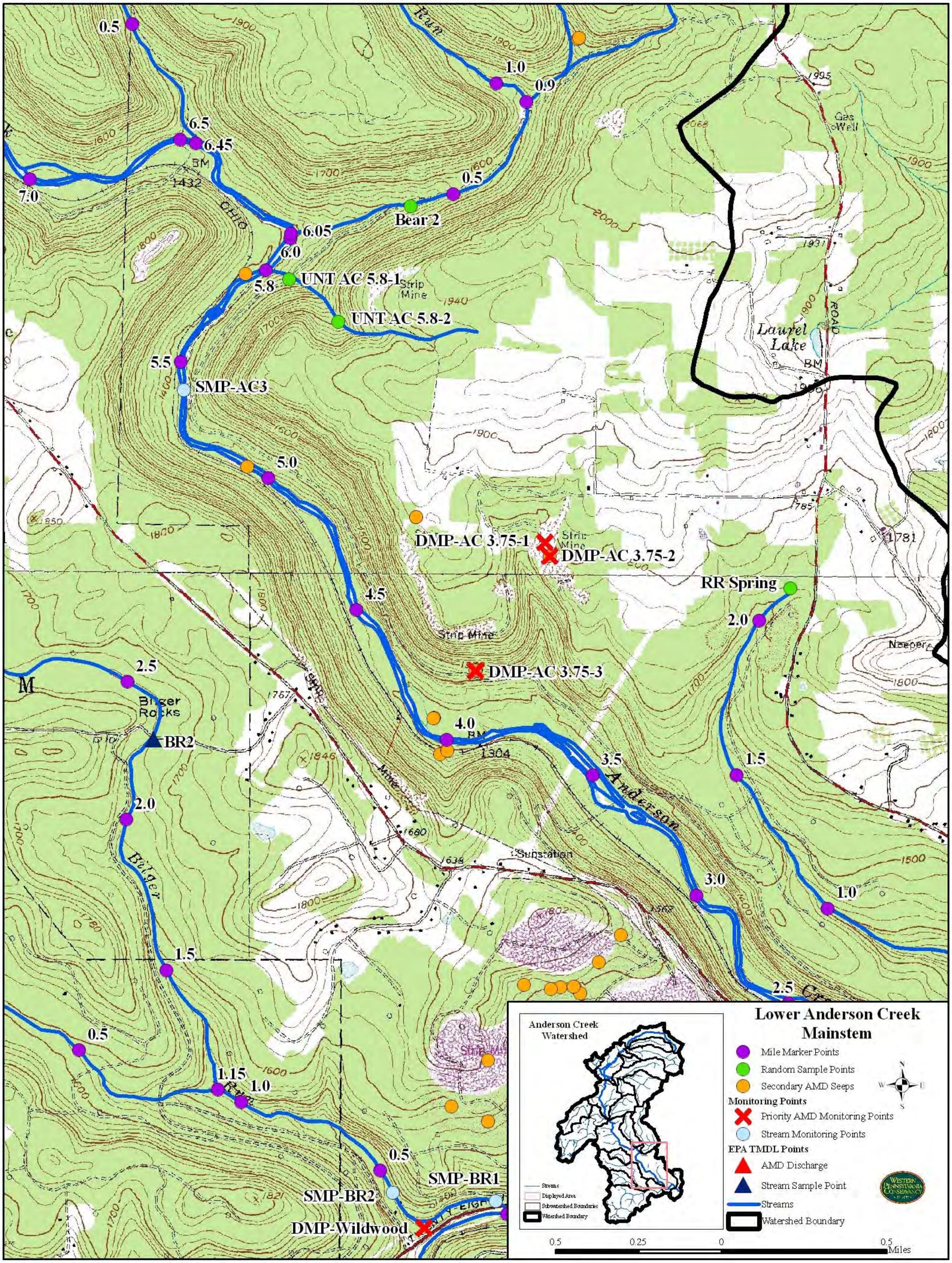
Recommendations for Irvin Branch (AC-6.45)

The water quality problems of Irvin Branch are mainly acidification primarily due to acid precipitation. Irvin Branch would be a prime candidate for some type of alkaline addition treatment, such as limestone sand addition, which performs well on high-gradient streams such as Irvin Branch, strategically placed anoxic or open limestone drains or limestone ponds, diversion wells, or other passive types of alkaline addition. Its inaccessibility and remoteness would make such treatment very difficult. It is likely that a reduction of atmospheric acid deposition would be very beneficial and the most long-term benefit to the depressed pH conditions of Irvin Branch.

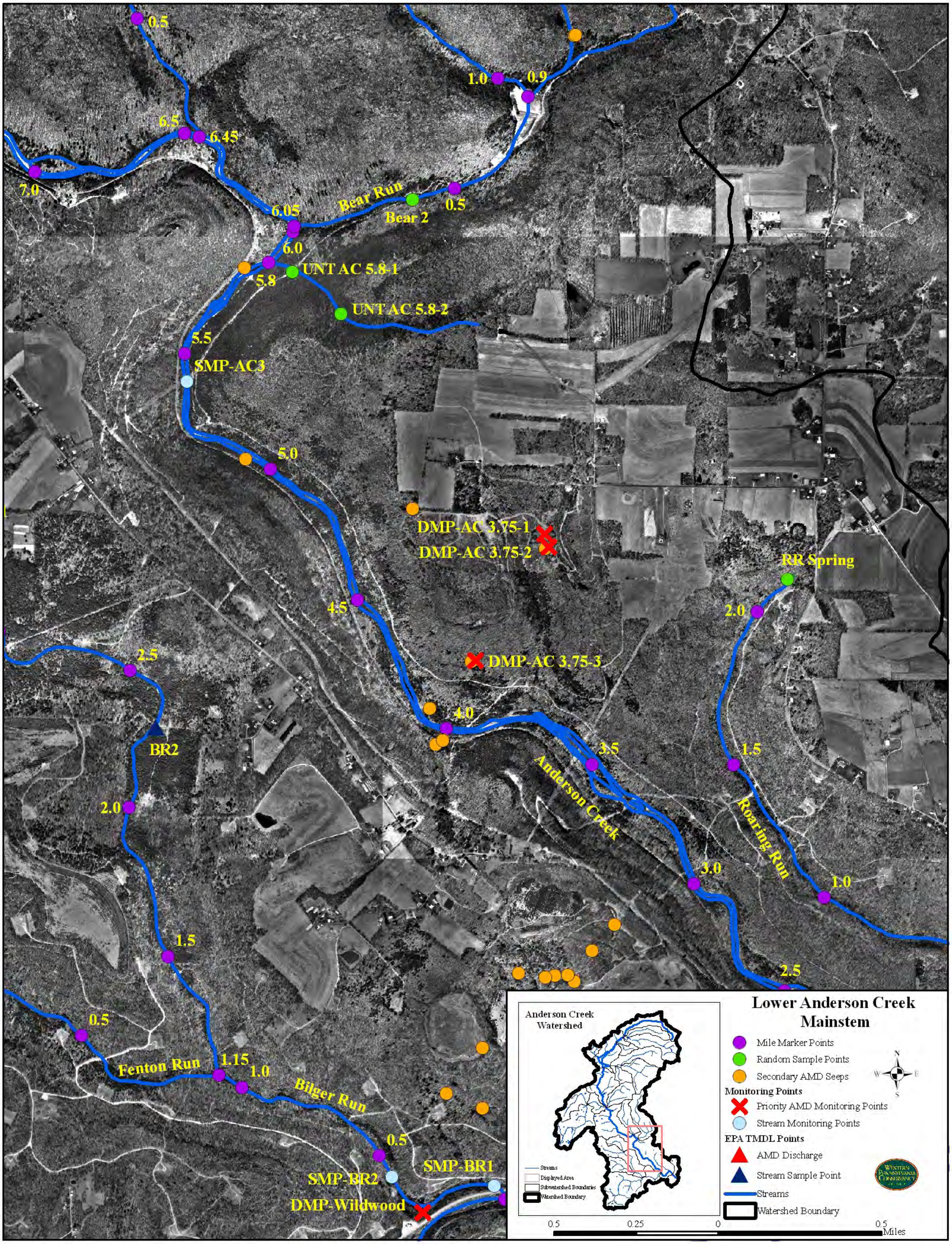
Bear Run (AC- 6.05)

Bear Run is the largest subwatershed draining the eastern portion of Anderson Creek within the gorge. Three first order headwater tributaries flow in a southeasterly direction and meet a fourth tributary that flows in a westerly direction. The four tributaries are impounded in a reservoir approximately .9 miles upstream from the confluence of Bear Run with Anderson Creek. Exiting the reservoir, Bear Run flows in a westerly direction to its junction with Anderson Creek.

It is very remote but accessible via a road maintained by the Pike Township Municipal Authority. The road follows the eastern side of Anderson Creek in a northwesterly direction through the gorge to Bear Run. There it turns east to follow Bear



Lower Anderson Creek Mainstem
Anderson Creek Watershed
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5
0.25
0
0.5
Miles
Bear 2
UNT AC 5.8-1
UNT AC 5.8-2
SMP-AC3
DMP-AC 3.75-1
DMP-AC 3.75-2
DMP-AC 3.75-3
RR Spring
BR2
SMP-BR2
SMP-BR1
DMP-Wildwood
Anderson
Bilger
Bilger Rocks
Laurel Lake
Strip Mine
Substation


Lower Anderson Creek Mainstem
Mile Marker Points
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Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
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AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
Anderson Creek Watershed
0.5
0.25
0
0.5
Miles
Bear Run
Bear 2
UNT AC 5.8-1
UNT AC 5.8-2
SMP-AC3
DMP-AC 3.75-1
DMP-AC 3.75-2
DMP-AC 3.75-3
RR Spring
BR2
Anderson Creek
Roaring Run
Fenton Run
Bilger Run
SMP-BR1
SMP-BR2
DMP-Wildwood
7.0
6.5
6.45
6.05
6.0
5.8
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.15
1.0
0.9
0.5

Run to the reservoir previously mentions, which is maintained by the Pike Township Water Authority.

The headwaters of Bear Run lie just west of Greenwood Road, which connects State Route 322, east of the Dubois Reservoir, to State Route 879 in Curwensville, and is roughly the eastern boundary of the Anderson Creek watershed. Bear Run, like the adjacent Irvin Branch, is partially impaired due to atmospheric acid deposition. Its geology consists of acidic rock formation and little alkaline material so it is very susceptible to acid rain. Like Irvin Branch, it suffers from depressed pH and likely contains acid-tolerant macroinvertebrates. Very few macroinvertebrates and no fish were observed in the stream. Again, no electro-fishing survey was performed as part of this study. The 1999 Headwaters Charitable Trust study did find the stream contained a good population of reproducing brook trout.

Bear Run near its confluence with Anderson Creek.

Bear Run is a steep, mostly wooded watershed. Some underground and surface mining for clay has occurred south of the reservoir, at the higher elevations. This same area also contains some farming activity. Both recent and past logging activity is apparent.

Two abandoned mines are located southeast of the Bear Run's confluence with Anderson Creek. A third is located south and east of Bear Run Reservoir. The pH of Bear Run is depressed (field measured pH 5.3), but the previously mentioned small, unnamed tributary south of Bear Run, AC UNT 5.8, is more impaired. Several AMD seeps were identified draining from the slope west of the abandoned mine at an elevation of approximately 1,500 feet. The drainage caused the pH of the stream to dip from 5.3 to 4.1 near its mouth at high flow, and even lower at low flow. The area is also indicated as the site of a Mercer coal seam. References indicate an underseam of medium hard clay. No apparent AMD discharges were identified during the initial investigation of the site, but the abandoned pit did contain a pool of water.

Large erosion site on Bear Run, immediately below the water-supply reservoir.

Inspection of the most easterly and smaller unreclaimed surface mine, known locally as the Stadtmiller mine, revealed an AMD problem along with the unreclaimed land issues. The lack of surface water controls above the site allows water runoff to enter the abandoned pit. Water is captured in the pit in two areas. Additional water is entering the pit through a groundwater source, and is indicated by a larger volume of water exiting the southwestern end of the pit than the amount entering from the runoff above the site. After exiting the pit, the AMD travels several yards before disappearing into the ground. Field testing indicated an influx of acidic groundwater flow entering into the stream several hundred feet below the mine, but no distinct discharge could be located. It is assumed that the AMD, like in many other areas in the watershed, percolates through the ground until hitting an impervious layer which prevents it from flowing deeper underground and forces it out, in this case as stream base flow in Bear Run, far below the actual mine site.

The main stem of Bear Run is relatively unimpaired by non-point source pollution from visible sources. Immediately below the Bear Run Reservoir outflow, the stream appears channelized against a steep hillside where moderate erosion is occurring.

The streambed itself appears scoured from that point downstream to the mouth. Also, at the time of the assessment there was a considerable amount of earth disturbance along the road, which parallels Bear Run in its local reaches. It appears that it was part of an effort to widen and re-grade the road. Numerous trees were pushed over and into the stream channel, sometimes blocking it.

Recommendations for Bear Run (AC-6.05)

Similar to the adjacent Irvin Branch, much of Bear Run’s non-point source pollution problems stem mostly from acid precipitation/deposition. Little alkaline material occurs naturally in the subwatershed and, therefore, is unavailable to neutralize inputs of acidity. Reducing acid deposition is the best long-term solution to the acidification of the stream. A very good rate of success has been achieved by artificially introducing limestone into a watershed, mainly through direct application to the stream. Significant improvements have been achieved in other watersheds by using limestone sand dosing, which places sand-sized (and slightly larger) limestone in the stream and on the streambank in such a way that it will wash into the stream during high-flow events. The technique adds more limestone when it is most necessary, at high stream flows, which are times of high acid conditions. Other watersheds using this technique have returned naturally reproducing brook trout to streams that were essentially devoid of fish life.

As describe above, Bear Run is also impacted by a small surface mine located in its southeastern headwaters area. The abandoned, unreclaimed mine produces AMD, which pools at the highwall area and flows away from the site into the nearby forest and disappears into the ground. Eventually this water reappears in Bear Run as base flow, depressing its pH and likely adding some aluminum.

Reclaiming the mine site and incorporating excess alkaline material during reclamation would very likely be beneficial to Bear Run by reducing the acid presently being produced at the mine site. It is extremely difficult to determine just how much improvement could be achieved. The mine is relatively small and it is likely the overall benefits would be as well.

UNT-AC 5.8

UNT-AC 5.8 drains a small area of Anderson Creek just south of Bear Run. The tributary begins high on the plateau above the eastern side of the gorge and flows in a westerly direction into Anderson Creek. The water quality of the tributary is relatively unimpaired for much of its length, but does become impaired by AMD as it nears Anderson Creek. As with several other areas in the watershed, it appears that the discharges are associated with an abandoned mine, in this case, a clay mine, known locally as Laurel Swamp, located several hundred feet higher on the slope above the stream. The clay mine was first deep mined and then surface mined. Presently, unreclaimed mine spoil and a highwall remain at the site. No AMD was identified at the abandoned mine site itself. As is apparent elsewhere in the watershed, the AMD percolates through the subsurface material below the mine until reaching an impermeable layer which forces it to the surface at what appear to be springs. It is likely that prior to mining the springs were unpolluted, although no historic data exists that would confirm this assumption. Once this series of seeps, which field tested 3.2 pH, enters the tributary, its pH quickly drops. At the time of the sampling in April, in-stream pH was 3.9 and the aluminum concentration spiked to over 2 mg/L.

In addition to the seeps located along UNT-AC 5.8 an additional discharge was located very near the pumping station located at the emergency water intake dam on Anderson Creek located just downstream of the mouth of UNT-AC 5.8. The discharge had an estimated flow of less than 5gpm when field-tested and the pH of 3.3 was worth noting. In relative comparison to other discharges impacting Anderson Creek, the site was not recommended for inclusion as a monitoring point. Further investigation and analysis of UNT-AC 5.8 should be performed once other more significant sources of AMD are addressed within the watershed.

Recommendation for UNT-AC 5.8

UNT-AC 5.8 was not identified as a priority for restoration and was not regularly sampled as part of this assessment. The stream is impaired by the abandoned mine on the north side above the stream. This was an underground clay mine that was later surface mined. Acidic water from the mined area percolates through the ground and appears as acid seeps or springs along the tributary just above the municipal authority road in the Anderson Creek gorge below Bear Run. Due to their location, the seeps will be difficult to treat where they appear. Also, no discharge was identified at the actual mine site. Presently, it is unlikely that there is a possibility to remine the abandoned mine site and reclaim the area using additional alkaline material to improve the quality of the seeps. The most practical way to address the polluted stream is to neutralize the acidity in the stream near the municipal authority road. The distance from that point to Anderson Creek is too short to allow for alkaline sand treatment because there would not be sufficient time for the limestone to react. Either an automated lime doser or a limestone diversion well could be used to increase the alkalinity of the stream. Either of these treatment technologies would require significant operation and maintenance commitments. The small discharge located adjacent to the municipal authority pumping station may be able to be treated with a small self-flushing open limestone system. No water samples were taken because UNT-AC 5.8 was not considered a priority under this assessment. The tributary definitely should be further investigated once other higher priority sites are addressed.

UNT-AC 3.75

UNT-AC 3.75 is a small tributary that flows into the lower Anderson Creek gorge from the east, or river-left. This unnamed tributary is impacted by AMD from a large abandoned clay mine site, known locally as the Bloom mine, located in the headwaters area of the stream. The mined area surrounds the upper reaches of the stream. The mining consisted of both underground mines and surface mines. A large area of disturbed land is present, including un-vegetated spoil piles, abandoned highwalls, water-filled pits, and subsidence areas.

Polluted water flows from an open mine tunnel, mine spoil areas, and from the hillside in the Anderson Creek gorge below the mine site. Three locations were monitored as part of this assessment and given the designations DMP-AC 3.75-1, DMP-AC 3.75-2, and DMP-AC 3.75-3. One monitoring site, DMP-AC 3.75-1, was discontinued because it was determined that the water quality at that point was not impaired sufficiently to warrant continued monitoring. Some additional seeps were identified near the mouth of the tributary but were not considered significant.

Recommendation for DMP-AC 3.75-2

Discharge monitoring point DMP-AC 3.75-2 emanates from an underground abandoned clay mine opening just east of the headwaters of the tributary. The discharge flows through the site and into the tributary. A highwall also exists at the site and surface water collects and forms a pond at the site. The water quality in the pond was not impaired, as small fish were observed in the pond.

This discharge contains less than one part iron and low levels of aluminum so it should be very easily treated using passive treatment technology. A vertical flow system would likely be very successful at treating the discharge. With the low levels of iron, it may also be possible to treat the water using a self-flushing limestone pond system. Using these types of systems should remove all the acidity and provide additional alkalinity to the stream, which would be beneficial to Anderson Creek. The aluminum can be easily collected in a small settling basin/wetland.

Average water quality measured at DMP-AC 3.75-2

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-AC3.75-2	**0.9**	**0.4**	**0.4**	**0.2**	**2.8**	**1.2**	**42.8**	**17.91**	**0.0**	**0.0**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendation for DMP-AC 3.75-3

Discharge Monitoring Point-AC 3.75-3 is located along the Pike Township Municipal Authority road adjacent to Anderson Creek. The discharge actually flows from the hillside high above the road to the east. The monitoring point was chosen as the most practical point to monitor the discharge. As with many other discharges in the watershed, the discharge appears well below the mine site that produces the AMD. As previously mentioned, this discharge is associated with the Bloom mine. This discharge drains from the large surface-mined and subsidence area west of UNT-AC 3.75, and its water quality is significantly worse than DMP-AC 3.75-2.

Remining the abandoned mine area associated with this site is likely impractical. The area causing the AMD is a former clay mine that was deep mined and then surface mined. Because there is little demand for clay, there are no significant coal seams at the site and it does not qualify for federal reclamation funding, it is likely it will remain unreclaimed. It is beyond the scope of this study to determine if other techniques could be employed at the mine site in order to lessen or eliminate the severity of the AMD at its source.

This discharge will require the construction of a passive treatment system capable of treating high levels of aluminum or active treatment. Area does appear to exist below the monitoring point along Anderson Creek to install a treatment system. The discharge actually appears quite a distance higher in elevation than the monitoring point along the road, which means it could be taken even further upstream along Anderson Creek, possibly allowing for more treatment area. It will be impossible to treat the discharge at the point where it first appears high on the hillside.

Average water quality measured at DMP-AC 3.75-3

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-AC3.75-3	3.1	0.3	3.2	0.5	23.4	4.8	195.3	38.84	0.0	0.0

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Windy Hill Discharge

The Windy Hill discharge emanates from an abandoned underground mine located just outside of Curwensville along Windy Hill Road. The discharge emerges in a very steep ravine north of Windy Hill Road and drops approximately 200 feet in elevation before entering a wetland located upstream and on the opposite side of Anderson Creek from the North American Refractory Company operation located along State Route 879, at stream mile point AC-1.5. The discharge apparently encounters alkaline material near the refractory because the pH rises before it enters Anderson Creek. The discharge was not monitored as part of the assessment. A single water sample was gathered at the discharge site to determine the water quality as it discharges from the mine. Acidity measured 96mg/L, iron and manganese, less than one mg/L, and aluminum 13.4 mg/L.

Recommendation for the Windy Hill Discharge

Because this discharge picks up alkalinity near the North American Refractory, its impacts to Anderson Creek are minor. It contains high levels of aluminum and acidity and essentially no iron so it could very well be treated passively, using a self-flushing limestone pond. Such a treatment system could produce excess alkalinity and remove all the aluminum in the discharge. Further investigation of property ownership, their willingness to cooperate, water quality and flows, and site conditions will be necessary in order to properly determine how to best address the discharge.

UNT-AC 0.30

UNT-AC 0.30, or Tanner Run, as it is known locally, drains the area directly north of Curwensville along Naulton Road and essentially flows through, and for the most part, beneath the town, entering Anderson Creek in a concrete flood-control channel from river-left very near the confluence with the West Branch of the Susquehanna River. AMD was identified draining from an area along the stream just outside of Curwensville. Iron-stained seeps were located along the tributary prior to entering a buried pipe just east of Oak Hill Cemetery, which carries the stream underground through most of Curwensville. It re-emerges from underground in the above-mentioned concrete channel once past Route 879 and before entering Anderson Creek. It appears the discharges may be associated with some surface mining that was done in the headwaters.

Recommendations for UNT-AC 0.30

Because field sampling did not indicate the seeps were of very poor water quality or of high flow and they did not have a significant impact to Anderson Creek, they were not considered a priority or sampled as part of this assessment. There may be a possibility of improving the water quality of this unnamed tributary by removing some of the metals through passive treatment or other methods. Further study of the area should be conducted to determine the exact source(s) of the discharges. Finding ample room to construct a passive treatment system might be difficult because of the location of the seeps near the stream and several residences located in the area. Landowner cooperation will be essential.

Kratzer Run

Kratzer Run is the largest tributary to Anderson Creek, consisting of 15.4 square miles. Beginning in its headwaters just west of Hepburnia, Kratzer Run flows in a northeasterly direction for approximately four miles before its largest tributary, Bilger Run, joins it. Kratzer Run then flows approximately 1.5 additional miles to its confluence with Anderson Creek near the Pike Township municipal building in Bridgeport.

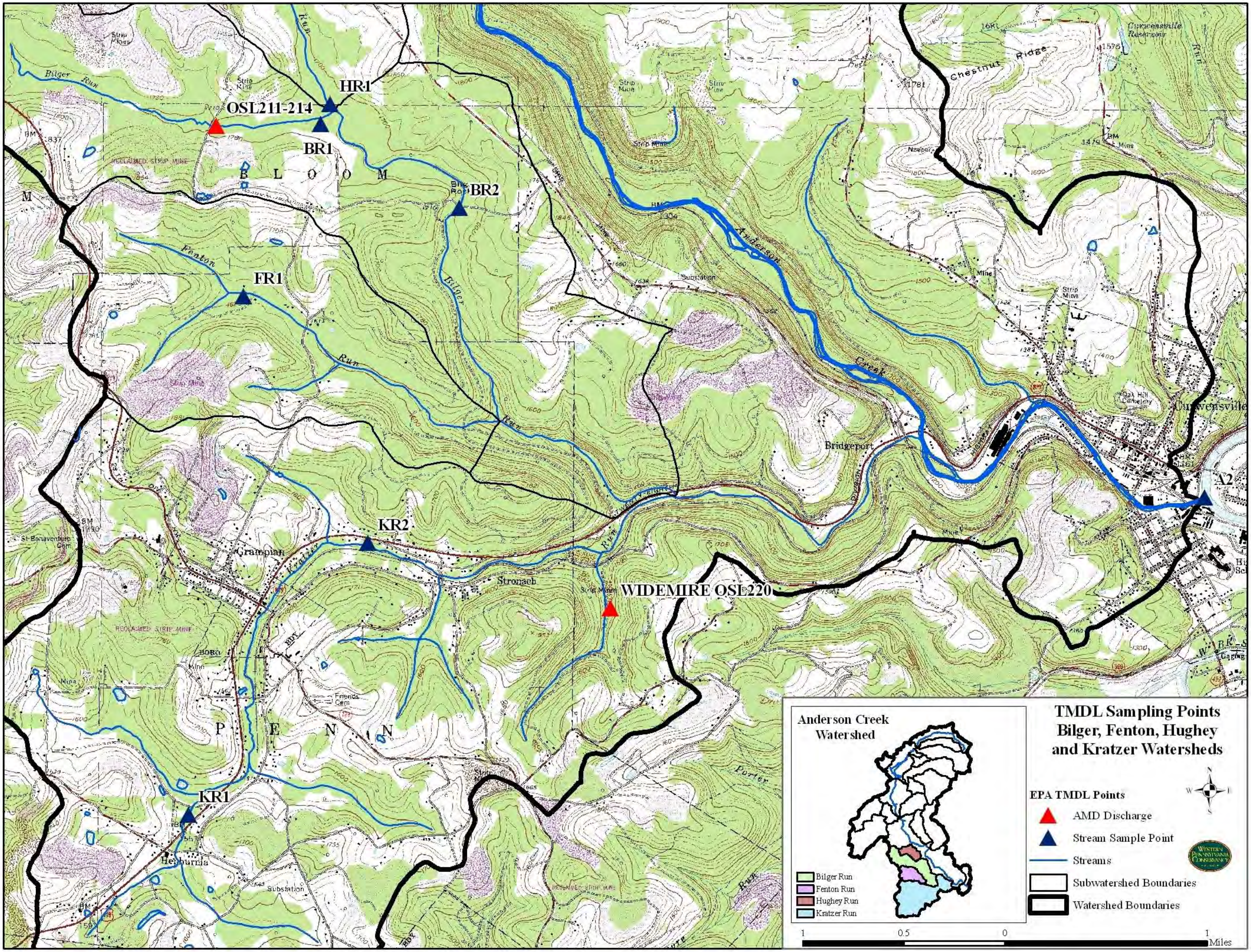
The headwaters of Kratzer Run are comprised mostly of farmland of moderately steep, rolling hills, previously farmed areas that have now been surfaced mined for coal, and wooded stream corridors. Some unreclaimed mines remain, but most have been reclaimed and are classified as pastureland, although little of it appears used for that purpose. The stream valleys mostly contain wooded riparian areas with good vegetative cover, even near surface-mined areas.

Flowing from west to east, the Kratzer Run headwaters closely follows Route 219 past Hepburnia until reaching the town of Grampian. In Grampian, it begins to parallel State Route 879, following it past the nearby community of Stronach and on to its confluence with Anderson Creek.

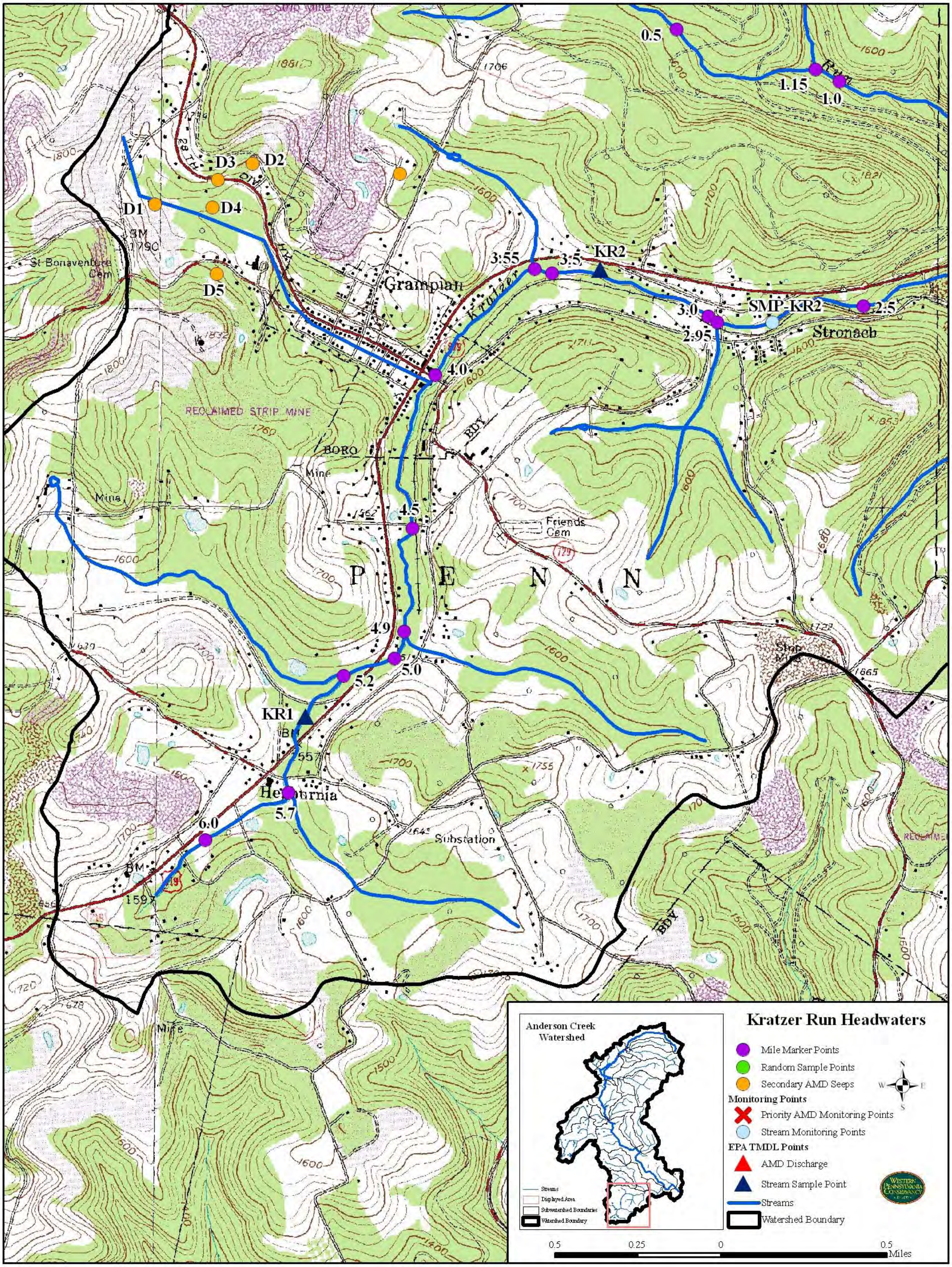
From the headwaters above Hepburnia and to just downstream of the town of Stronach, the stream has a low gradient and many homes and business are located adjacent to Kratzer Run or its unnamed tributaries. As expected, the stream has been affected by the development that occurred along this segment. Some channelization has occurred. In addition, farming in the headwaters area is having some impacts, as sediment was noted in the stream. On the headwaters of Kratzer Run, unnamed tributary KR-5.2, a farm operation was noted as a problem area. Cattle had direct access to the stream and little vegetation was present in the riparian corridor. The site was noted in the visual assessment. Just downstream of that area, on the river-right side of the stream, an unreclaimed surface mine was causing erosion problems. Most of the drainage from the site ended in a sediment pond. During the assessment, some measures were taken to help stabilize the slopes below the open pit. As of this writing, the open pit remained but the sediment problem was under control. An unreclaimed surface mine along TR 463 also drains to this stream segment. No significant pollution was noted coming from the site. An open pit and vegetated spoil piles remain.

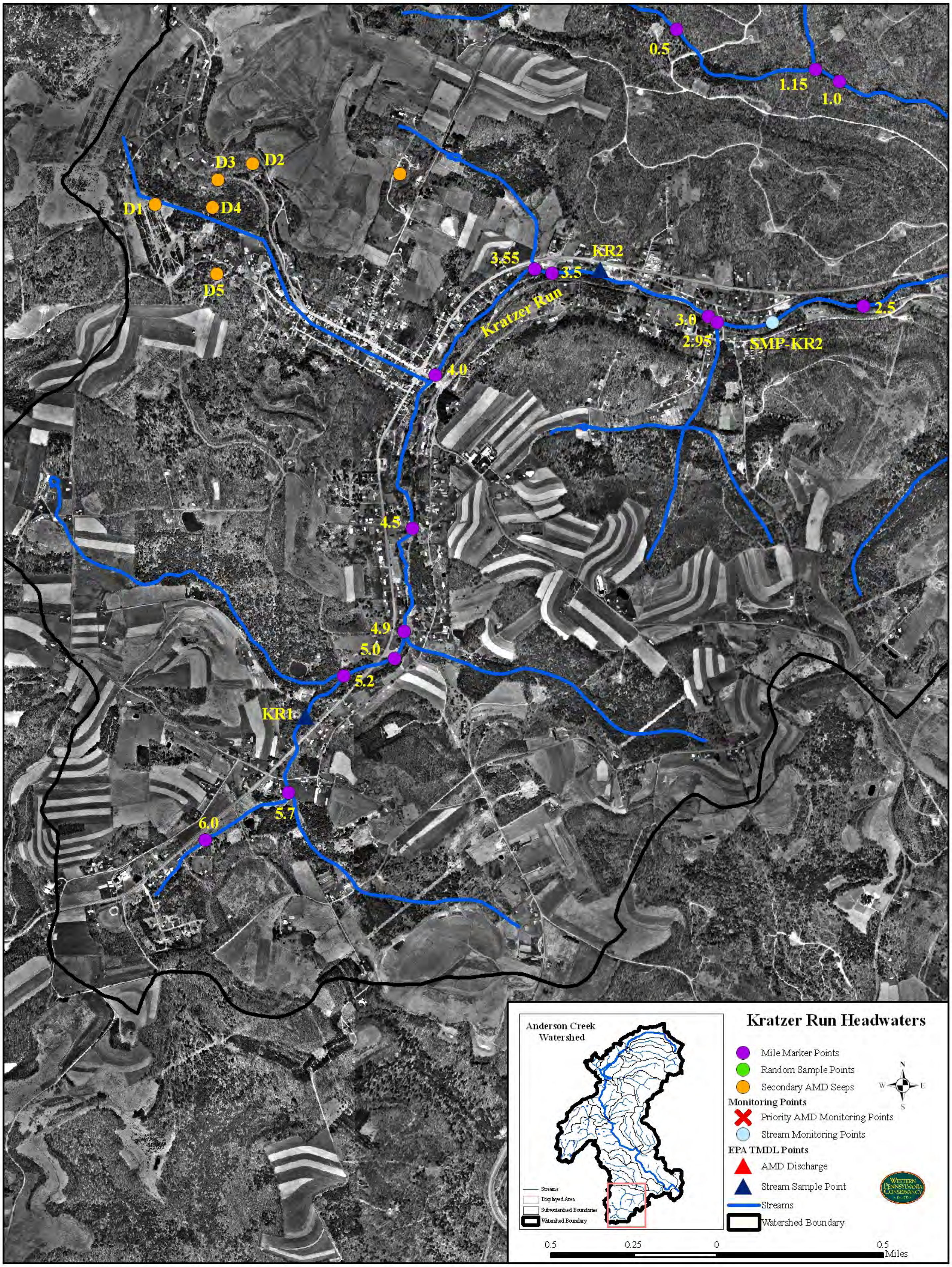
The most heavily impaired stream in Kratzer Run's headwaters (above Stream Monitoring Point KR2) is UNT-KR-4.0, which enters the main stem in Grampian and flows from the north, roughly following Route 219 South. The stream is not identified on the USGS topography map. It flowed even during the driest period of the year. Five main sources of mine drainage enter the stream. It appears that four of the five are net alkaline. All of the net alkaline discharges enter the tributary upstream of the community park located along the stream in Grampian. Iron stained the water, but small fish were observed living in the stream segment above the park.

The uppermost discharge flows from below the toe of a reclaimed surface mine, located east of TR 462 and west of Route 219, and appears to be net alkaline. The next discharge flows from a gully below a reclaimed surface mine north of Grampian and east of Route 219. It appears to be associated with the surface mine. Two seep areas discharging AMD to the stream were located downslope of this area closer to the stream and west of Route 219. All these areas are located on the river-left of the tributary. The worst of the five discharges, water quality wise, flows from an abandoned mine site located west of Grampian. It is unclear whether this discharge is associated with an underground mine, a surface mine, or both. The Scarlift Report identifies it as surface



TMDL Sampling Points
Bilger, Fenton, Hughey
and Kratzer Watersheds
Anderson Creek
Watershed
Bilger Run
Fenton Run
Hughey Run
Kratzer Run
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Subwatershed Boundaries
Watershed Boundaries
1
0.5
0
1
Miles
HR1
OSL211-214
BR1
BR2
FR1
KR2
KR1
A2
WIDEMIRE OSL220
Bilger Run
Fenton
Run
Anderson
Creek
Curwensville
Bridgeport
Grampian
Stronach
Hepburnia
Chestnut Ridge
B L O O M
P E N N
Porter


Kratzer Run Headwaters
Anderson Creek Watershed
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5 0.25 0 0.5 Miles
Grampian
Stronach
Helvetia
St Bonaventure Cem
Friends Cem
RECLAIMED STRIP MINE
Substation
P E N N
KR1
KR2
SMP-KR2
D1
D2
D3
D4
D5
0.5
1.0
1.15
2.5
2.95
3.0
3.5
3.55
4.0
4.5
4.9
5.0
5.2
5.7
6.0


0.5
1.15
1.0
D3
D2
D1
D4
D5
3.55
3.5
KR2
Kratzer Run
3.0
2.95
2.5
SMP-KR2
4.0
4.5
4.9
5.0
5.2
KR1
5.7
6.0
Anderson Creek Watershed
Kratzer Run Headwaters
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
Displayed Area
Subwatershed Boundaries
0.5
0.25
0
0.5
Miles

mine related. Belfast Number 2 Mine (underground) was located nearby and may also be associated with the discharge. The discharge is acidic and contains aluminum (white precipitate observed). It flows from a hillside on the left side of the road and is located just past the school heading west on SR 3011. This discharge was not sampled during this assessment because of its low flow and relatively minor impacts in relation to Kratzer Run. This discharge enters UNT-KR 4.0 within the community of Grampian, below the community park. At that point, the stream is channelized, moved, and degraded by the urban setting. Below the park, the stream habitat and riparian zone is poor.

Although UNT-KR 4.0 is impaired, it does not have a significant impact on Kratzer Run. Remediation of the discharges is classified as low priority. Any reductions in pollution loading to the tributary through remediation would be beneficial.

From UNT-KR 4.0 downstream to TMDL monitoring points KR2, and SMP-KR2, no significant sources of AMD enter the stream. Minor sources of impairments were observed on some of the unnamed tributaries, but none were significant enough to warrant concern.

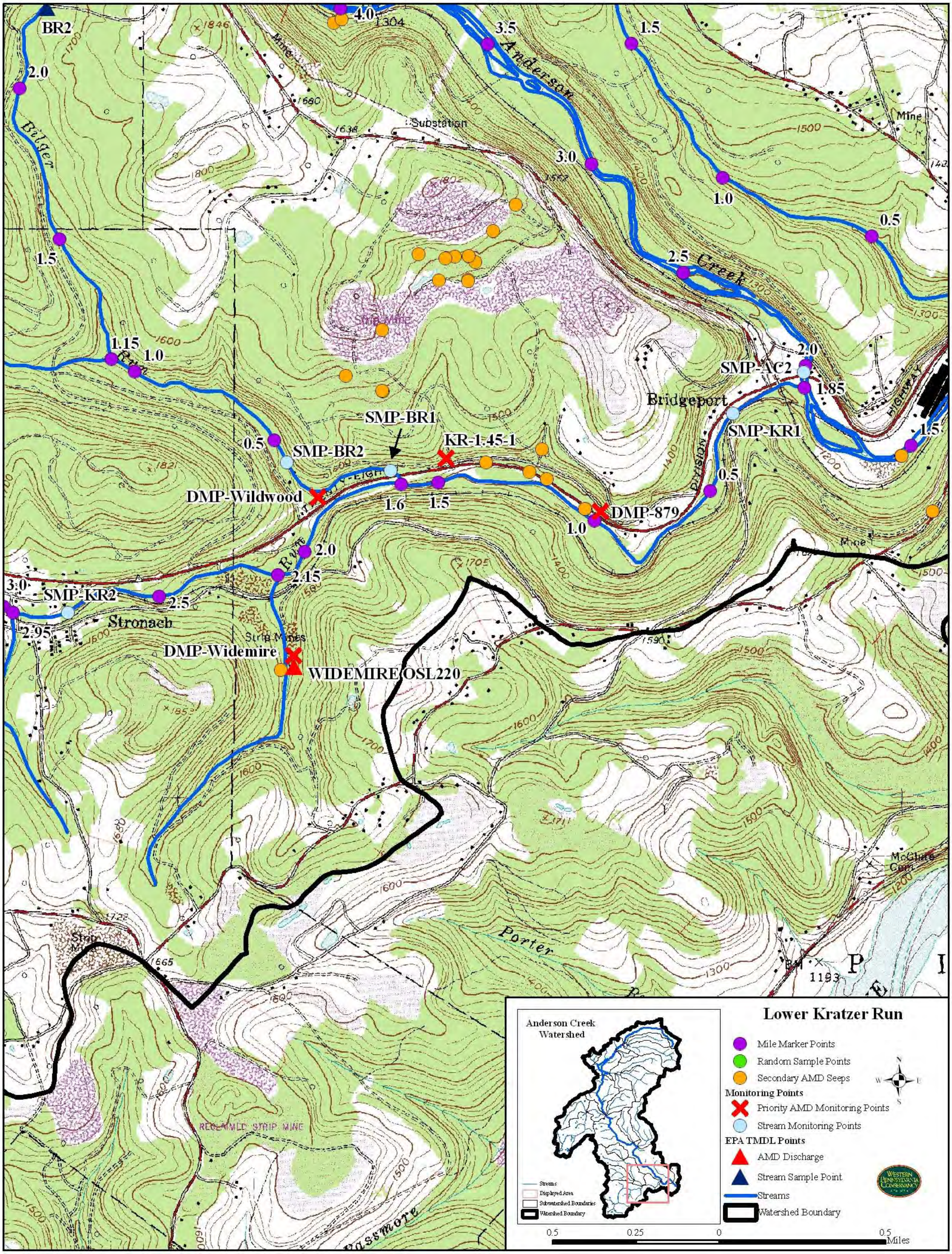
Lower Kratzer Run

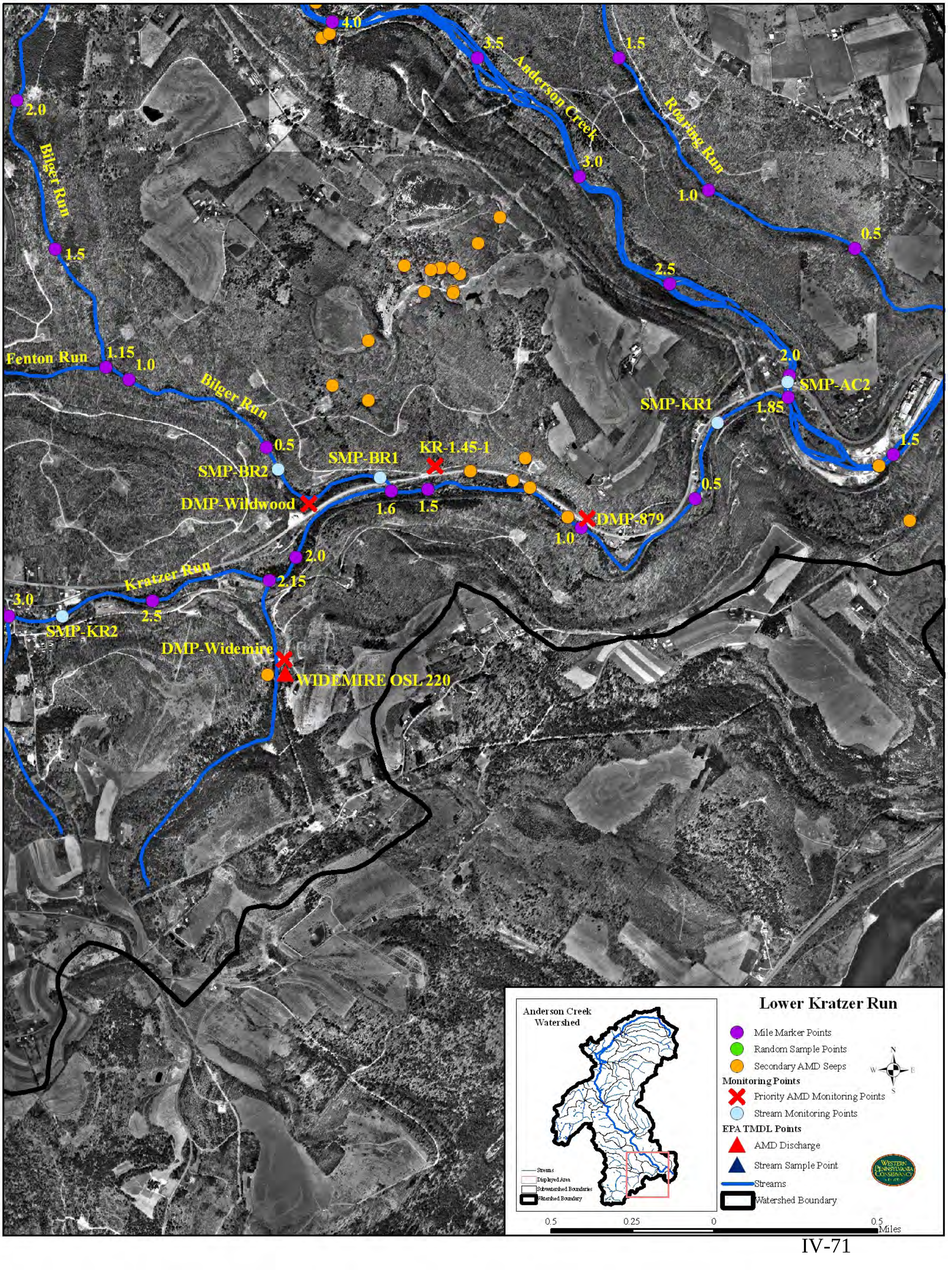
For this assessment, Kratzer Run below Stronach is being designated as lower Kratzer Run. Not only does the character of the stream change significantly, but the amount of AMD pollution changes significantly as well. Just below the sewage treatment plant in Stronach, the stream gradient becomes much steeper, increasing stream velocity significantly. Many boulders in the channel create numerous rapids and small waterfalls. It is in this section of the stream that numerous AMD sources enter and degrade Kratzer Run's water quality. As more AMD sources enter Kratzer Run as it flows along Route 879 to its confluence with Anderson Creek, the effects become more apparent as the streambed is stained orange.

Widemire Discharge

Below SMP-KR2 significant degradation of Kratzer Run water quality from AMD occurs. Just east of Stronach, two underground mines (Widemire and Irvin) and associated surface mines severely impact the stream. The worst impacts from the two mines come from the Widemire mine located south of State Route 879 along UNT-KR 2.15. Two significant sources discharge from the mine. Only one was sampled because of its significantly higher volume and lower water quality, DMP-Widemire. This source discharges net acid water with relatively low iron, aluminum, and manganese levels.

The Widemire Discharge pollutes an unnamed tributary to Kratzer Run (UNT-KR2.15) with acid and aluminum.


Lower Kratzer Run
Anderson Creek Watershed
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
0.5
0.25
0
0.5
Miles
BR2
SMP-BR1
SMP-BR2
KR-1.45-1
DMP-Wildwood
DMP-879
SMP-AC2
SMP-KR1
SMP-KR2
DMP-Widemire
WIDEMIRE OSL220
Bridgeport
Stronach
Anderson
Creek
Bilger
Run
Porter
Substation
Strip Mine
Strip Mines
RECLAIMED STRIP MINE
Passmore



4.0
3.5
Anderson Creek
1.5
Roaring Run
2.0
Bilger Run
3.0
1.0
0.5
1.5
2.5
Fenton Run
1.15
1.0
Bilger Run
2.0
SMP-AC2
SMP-KR1
1.85
1.5
0.5
SMP-BR2
SMP-BR1
KR-1.45-1
DMP-Wildwood
1.6
1.5
0.5
DMP-879
1.0
2.0
Kratzer Run
2.15
3.0
2.5
SMP-KR2
DMP-Widemire
WIDEMIRE OSL 220
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
Lower Kratzer Run
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
N
W
E
S
0.5
0.25
0
0.5
Miles

Aluminum and acidity levels are of most concern. During the study period, its flows fluctuated between 50 and 250 gpm. The TMDL for Widemire Discharge requires that a load allocation be made for OSL 220 [DMP-Widemire] for total iron and acidity (SRBC 2004).

There were fewer manganese and aluminum data than necessary for this discharge to conduct Monte Carlo analysis; therefore, they were not evaluated for this TMDL. However, the observations for manganese and aluminum in the downstream segments of an unnamed tributary to Kratzer Run indicate that they also may be violating water quality standards. It is assumed that BMPs used to reduce iron loads in this reach also would reduce the amount of manganese and aluminum (SRBC 2004).

Table G37, taken from the TMDL report, identifies the load reductions required for the Widemire Discharge (OSL 220).

Table G37. Reductions for the Widemire Discharge (OSL 220)

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
OSL 220	Fe	10.17	129.77	0.51	6.51	95
	Acidity	86.83	1,107.97	0	0	100
	Alkalinity	0	0			

The Widemire Discharge was also sampled as a priority during this assessment and is identified as DMP-Widemire. The discharge is the second highest priority for restoration in Kratzer Run. The following averages were developed using the data collected during this assessment.

Average water quality measured at DMP-Widemire

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-Widemire	**5.84**	**6.30**	**2.24**	**2.57**	**4.94**	**6.21**	**48**	**55.06**	**0**	**0.12**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendation for Widemire Discharge

The discharge is very close to the stream and in a steep stream valley, making passive treatment difficult. Because of its location, this discharge may necessitate using active treatment or alternative passive treatment. A slight boost in alkalinity should allow the aluminum to precipitate quickly. Perhaps a self-flushing limestone pond would be sufficient to reduce or remove the acid and aluminum levels. Little room exists for settling ponds, so it may only be possible to treat for acidity and allow the metals to settle in the streambed, with those metals being flushed at periods of very high flows when they should have less effect on the stream. Otherwise, it will be extremely difficult to collect the metals. Fish were observed in Kratzer Run at assessment monitoring point SMP-KR1 and the watershed group reported trout surviving in Kratzer Run above SMP-KR1. Because the Widemire Discharge does not appear to degrade the stream enough to kill fish near SMP-KR1, it is being given a moderate rating for restoration. It does add acidity and metals to the stream, increasing its pollution load, and any effort to reduce or eliminate the pollution would be beneficial.

Kratzer Run Below Stronach

Immediately below UNT-KR 2.15, on which the Widemire Discharge is located, the water quality of Kratzer Run changes. It is in this area that the first iron staining begins to appear in the stream. Several discharge areas are located along Kratzer Run, from this point to the confluence with Anderson Creek, including a major discharge near the mouth of Bilger Run, the largest tributary of Kratzer Run. Bilger Run will be addressed later in this report.

Field investigations and monitoring indicate that most of the discharges are net alkaline in this section, which means there is enough alkalinity in the discharge to neutralize the acidity produced. It is assumed that the alkaline discharges are associated with the surface mines located on the hilltops just north of Route 879. A more detailed study would be required to determine the exact source, but the geology dips to the south and discharges have been noted at lower elevations beneath hilltop surface mines in other areas of the watershed. Another possibility might be an association with a clay mine identified in the Scarlift Report as being west and north of the area along Route 879. Usually, clay mines are associated with acid discharges and these are net alkaline, so they likely come from another source.

Kratzer Run does support fish and other aquatic life below Stronach because most of the discharges are net alkaline or nearly net alkaline. The diversity and numbers of aquatic organisms living in the stream are usually reduced because of the degraded stream habitat, due to iron deposition. In addition, there are other discharges entering the stream that are net acidic and further degrade the stream.

Problem Area KR 1.45

The next major pollution source entering Kratzer Run actually comes from Bilger Run. The discharges associated with Bilger Run will be described separately. Just below the mouth of Bilger Run, a significant source of AMD enters from river-left at mile KR 1.45. It can be easily identified because it flows from a concrete pipe, high on the northern roadside bank and is visible from Route 879. At periods of high flow it looks like a waterfall. The monitoring point, which is actually located upslope of the pipe, was given the name “falls” by the watershed group for obvious reasons.

The discharge actually emanates from a large abandoned mine site north of the monitoring point, at the top of the hill. The Scarlift Report identified the site as Project

Area XI. The description given in the report does not accurately match existing conditions.

Because the site contains numerous unreclaimed areas and numerous sources of polluted water, the monitoring point was chosen to collectively account for all of the polluted surface water draining from the site. The monitoring point was given the designation PAMP-KR 1.45 by WPC to indicate it is a collection of sources. ACWA and Mahaffey Labs identified the monitoring point as “Falls.”

Reclamation of the abandoned mine site responsible for PAMP-KR 1.45 discharge is the highest priority for restoration in Kratzer Run. The following averages were developed using the data collected during the time of this assessment.

Average water quality measured at PAMP-KR 1.45

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
PAMP-KR 1.45-1	**0.26**	**0.30**	**5.50**	**5.82**	**7.95**	**8.61**	**72**	**70.19**	**.33**	**0.98**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

It is assumed that groundwater associated with the site is also likely polluted. Several discharges located along Route 879 below the mouth of Bilger Run may very well be associated with Problem Area KR 1.45, since the rock strata dips in that direction. One of the more significant discharges in that area (DMP-879) is being monitored under this assessment and will be addressed separately.

Recommendations for PAMP KR-1.45

This Problem Area is a very large site with numerous abandoned mine problems. In order to remediate the water problems associated with the site, significant land reclamation is recommended. All of the previously mentioned recommendations associated with land reclamation apply to this site as well. It is unknown at this time whether remining of the site is possible, but that option should be investigated and is highly recommended. Most of the large hilltop at the western end of the site has been remined and reclaimed. There are several remaining areas with dangerous highwalls, open pits, un-vegetated mine spoil, standing water, and poor surface drainage. As recommended for other areas, remining combined with traditional and innovative reclamation techniques would likely be a good option. Some recommendations include:

- Negotiations with the landowner about reclamation and remining should be initiated.
- Land reclamation to remove the highwalls, eliminate the unreclaimed spoil piles, limit or eliminate contact of acid materials with water, and promote positive surface drainage. Adding high amounts of alkaline material when reclaiming the site would very likely improve groundwater quality.

- Installation of an impermeable alkaline barrier on the pit floor to prevent acid water from infiltrating into the groundwater.
- Re-grading other areas upslope of the mine to improve surface runoff and addition of high alkaline materials to buffer acidity in this area as well.
- Installation of open limestone trenches to impart alkalinity to surface runoff.
- Re-vegetate areas above the mine to develop a thick groundcover and reduce groundwater infiltration. Incorporate high-alkaline material or biosolids to enhance growth, improve water quality, and reduce surface water infiltration.
- Reduce the production of AMD at the source. In addition to incorporating high-alkaline material into the backfill, subsurface limestone drains should be incorporated into the highwall area to capture groundwater, increase alkalinity, and perhaps redirect it to a specific area for passive treatment if necessary.
- Install high-alkaline surface trenches to intercept surface water and redirect into the groundwater.
- Monitoring of remaining AMD after reclamation and development of appropriate passive treatment system based on final chemistry and flow data.
- Close monitoring of AMD s

Abandoned mine located above monitoring point PAMP-KR 1.45.

Perhaps the best option for the Problem Area Monitoring Point KR 1.45 site is to explore the feasibility of remining the site and incorporating the reclamation of the land area during the remining. Conditions at this site are not likely conducive to remining, otherwise it would have already been remined. Implementing remining and reclamation by cooperatively developing a reclamation plan between DEP and the mining company, using the best available techniques to reduce the possibility of creating additional pollution sources, would be the best option. Remining would strictly follow the agreed-upon plan and the mining company would not be liable for any unforeseen circumstances should the pollution become worse. DEP would then assume responsibility for treating the water.

Again, barring remining of the site, several reclamation techniques could be considered. Land reclamation is an absolute necessity, considering the extent of the conditions on the site. The site is dangerous with its water-filled pits, vertical highwalls, and steep spoil piles. The addition of alkaline materials during reclamation is highly recommended.

With the construction of the new waste-coal-fired cogeneration plant being planned for the Karthus area, a ready supply of high-alkaline ash should be available for use on the site. Mine spoils containing highly acidic materials could be encapsulated in alkaline ash mixed with cement or bottom ash, which can harden and prevent infiltration of water into the acidic material.

Reclaiming and re-grading the site to promote surface water runoff rather than allowing the water to infiltrate into the mine spoil would also greatly reduce AMD production. The combination of encapsulation of acidic mine spoil combined with proper control of surface and subsurface waters would greatly reduce the metals and acidity load presently produced at the site. Any remaining discharges would likely contain much less metals and acidity.

There appears to be ample area for passive treatment, should that option be viable. Because of the high acidity and high levels of aluminum in the present discharges, passive treatment would likely necessitate the use of treatment systems able to handle that type of water. SAPS, Vertical Flow Systems, Sulfate Reducing Bioreactors, and Upflow Limestone Ponds are again some possibilities.

Active treatment of the entire amount of water draining from the site using chemicals might also be an option, especially if remining is not viable. Excess alkalinity could be generated from active treatment, which would provide additional benefits downstream. Operation and maintenance would again be a consideration if active treatment was employed and a system that would not use electricity would be very desirable.

Route 879 Discharges

Approximately .5 miles downstream from the inflow of the acidic discharges of Problem Area KR 1.45, an alkaline discharge seeps from a roadside gully located on the north side of Route 879. The monitoring point is identified as DMP-879. The discharge flows in the gully, parallel to Route 879 before crossing underneath the road and entering Kratzer Run. This discharge, along with several other more diffuse discharges located in the floodplain of the stream along Route 879, is barely net acid and does not have a killing effect on the stream. It does add iron loading and stains the stream orange. Because of the chemical makeup, it would be fairly easy to treat and there appears to be some area for settling prior to discharging into the stream.

DMP-879 is located adjacent to Route 879 below the mouth of Bilger Run on the north-side berm of the road.

In addition to DMP-879, there are several other similar discharges impacting Kratzer Run. One of the most intriguing is actually coming from the base of the Route 879 Bridge over Bilger Run, at its confluence with Kratzer Run. The discharge comes from a large crack in the bridge pier. At the time it was assessed, the discharge caused the stream to become noticeably more orange. It appears that PennDOT is monitoring the crack in the bridge pier, which seems to be widening. It can be assumed that eventually the bridge will need to be stabilized or replaced. Every effort should be made to work with PennDOT to address the bridge discharge while they are working in the area. At the time of the assessment, no contact had been made with PennDOT.

Because Route 879 is located adjacent to the stream in a fairly steep valley, room for passive treatment of any of the discharges will be minimal. Many of the discharges are associated with wetland areas adjacent to the stream and treatment options would likely require considerable efforts to acquire wetland permits.

The DMP-879 discharge is the third highest priority site in Kratzer Run. The following monitoring data averages were developed using the samples collected during the time of this assessment.

Average water quality measured at DMP-879

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-879	**17.13**	**1.89**	**2.21**	**0.24**	**0.10**	**0.01**	**5.08**	**.90**	**13.17**	**1.65**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for the Route 879 Discharge

As previously mentioned, because of the chemical makeup of this discharge it would be fairly easy to treat passively, using a wetland treatment system. Because of its location along the road, it would also make an excellent spot for a demonstration and education area for passive treatment. Because its location is confined along Route 879, it may be difficult to treat the discharge enough to remove all of its iron without using area on the opposite side of the road near the stream. This area is an AMD-impacted wetland and would require proper permits in order to use the area. Such sites have often been problematic and may require wetland mitigation even though it is already degraded.

The iron in the discharge is its main problem. There are elevated levels of manganese but they are not high enough to cause concern. Aluminum is not a concern. An anoxic limestone drain (ALD) followed by a wetland/settling basin is recommended for the site. It is doubtful that enough area is available for total treatment at periods of high flow, but the additional alkalinity generated would help settle the iron faster at those levels. At low flows, concentration levels rise significantly, but with the reduced flow, a wetland treatment system should be able to reduce iron loadings significantly. Also, the additional alkalinity generated by an ALD would be beneficial to Kratzer Run and Anderson Creek. As mentioned earlier, another issue associated with this site is the degraded wetland, which the discharge has created. Permitting issues might arise and mitigation be required if the project is not considered for its overall benefit to the watershed.

Additional seeps, with what appears to be similar water chemistry, are located within the floodplain along both sides of Kratzer Run and Route 879 for nearly the remainder of its course to its confluence with Anderson Creek near Bridgeport. Although these seeps also add to the metals pollution load to Kratzer Run, they did not appear as easy to treat as the Route 879 discharge because of their location and more difficult accessibility. They were not sampled as part of this study. It is recommended that the additional seeps along Route 879 be investigated in the future, once the higher priority sites in the watershed are addressed.

Bilger Run

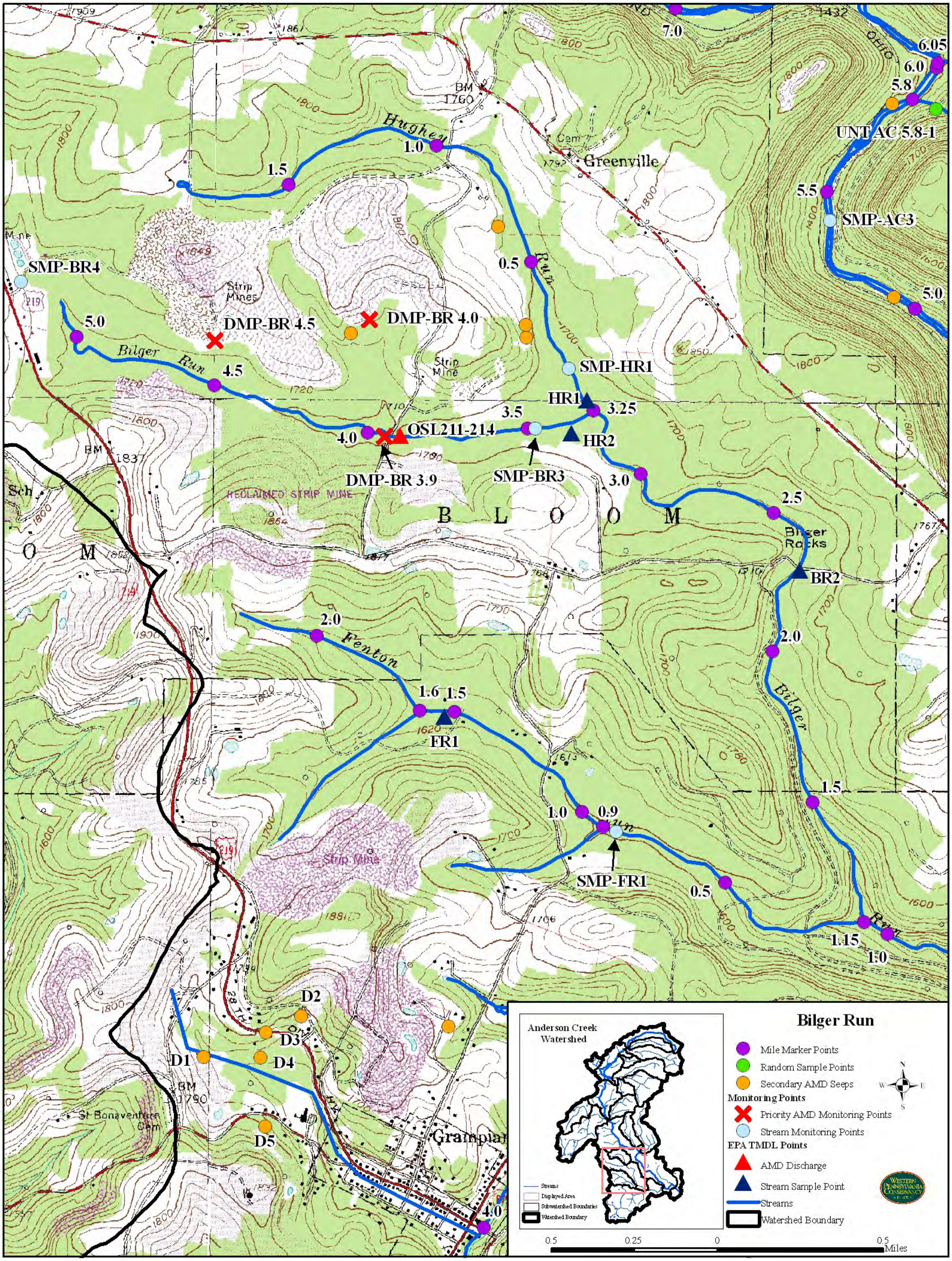
Bilger Run and its two named tributaries, Fenton Run and Hughey Run, account for almost half (47 percent) of the Kratzer Run watershed. Nearly all of the headwaters of Bilger Run are located just east of Route 219, when traveling north out of Grampian. Of the total area of Bilger Run, Fenton Run accounts for 27 percent and Hughey Run 17 percent.

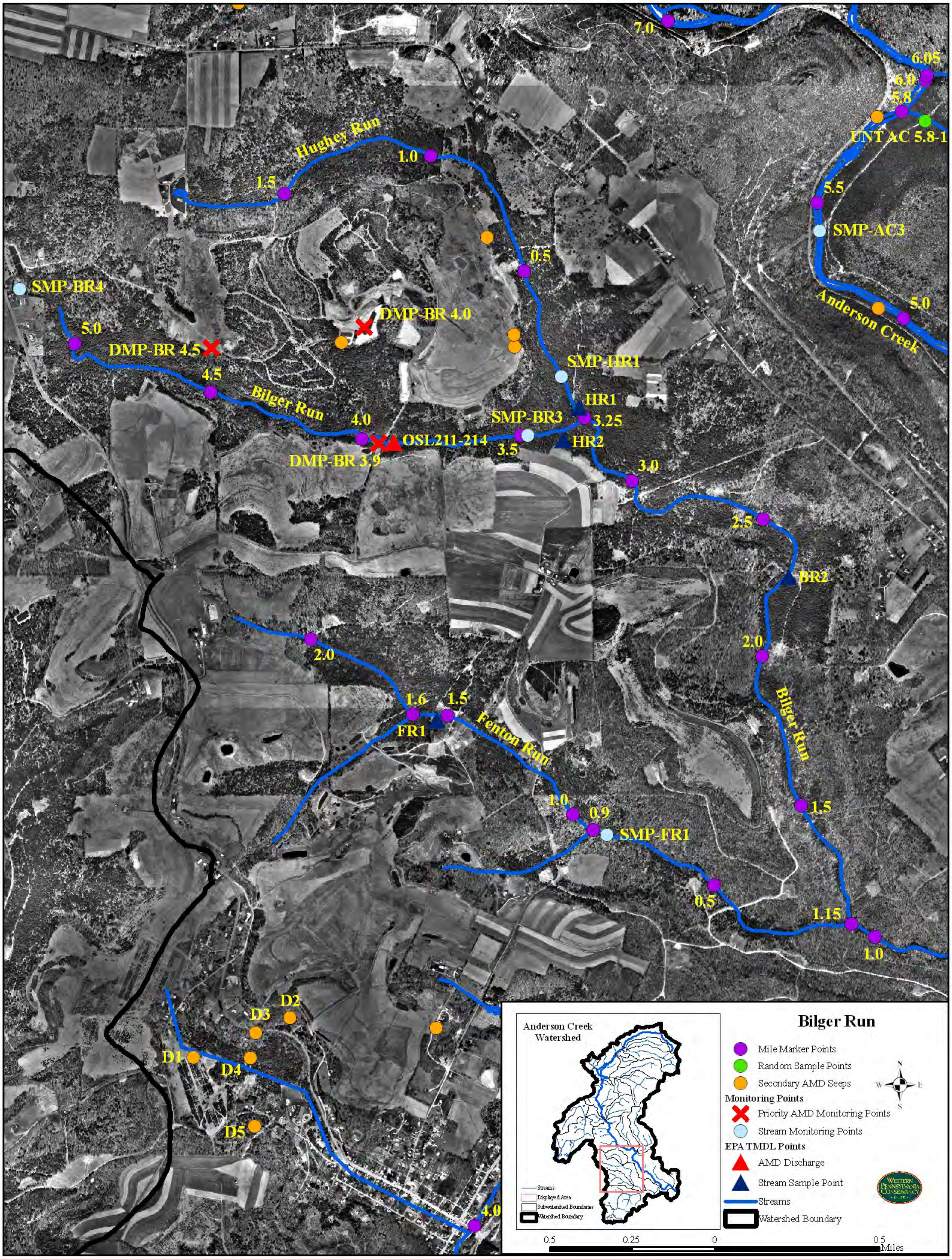
The upper reaches of Bilger Run are low gradient and contain very large wetland areas. Many areas within the headwaters of Bilger Run have been surface mined. Two deep mines were located there as well. As can be expected, impacts from abandoned mines affect Bilger Run and its tributaries. Unreclaimed land, poorly reclaimed land, and AMD degrade each of the streams. However, the main stem of Bilger Run is the most impacted.

Two major tributaries to Bilger Run are Fenton Run and Hughey Run. Over the last thirty years, the water quality in Fenton Run has been vastly improved through remining. Water quality sampling from the early 1970s Scarlift Report indicates Fenton Run having a pH of about 4.5. Today, the pH is often in the low sevens. Most of that change can be attributed to remining and the application of alkaline addition during reclamation of the previously degraded areas. Hughey Run has improved since that time as well, while water in Bilger Run has less acidity but still contains unacceptable levels of acid, iron, and aluminum. Aluminum was not measured during the Scarlift studies.

ACWA decided to focus their efforts on Bilger Run because it had the most potential to recover enough to support trout stocking. In 2000 and 2001, ACWA used alkaline sand addition to help neutralize in-stream acidity in the stream segment below Bilgers Rocks. The project was successful in reducing acidity. The group stocked trout in the stream and the trout survived over the life of the project. In the following years, ACWA was not able to secure funding to continue the in-stream alkaline sand dosing and conditions returned to pre-dosing levels.

Bilger Run has two distinctly different areas of AMD impacts. The upper watershed, located above Bilger Rocks and TMDL monitoring point BR1, is impaired by poorly reclaimed or unreclaimed land areas and high acidity discharges containing low levels of iron and moderate levels of aluminum, which is deadly to aquatic life. Near its mouth in the lower watershed, Bilger Run is polluted by low-acidity discharges that


Bilger Run
Anderson Creek Watershed
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
Miles
SMP-BR4
DMP-BR 4.5
DMP-BR 4.0
OSL211-214
DMP-BR 3.9
SMP-BR3
SMP-HR1
HR1
HR2
BR2
FR1
SMP-FR1
SMP-AC3
UNT AC 5.8-1
D1
D2
D3
D4
D5
Greenville
Hughey Run
Bilger Run
Fenton Run
Bilger Rocks
Strip Mines
Reclaimed Strip Mine
Strip Mine
St Bonaventure Cem
Grampian
BLOOM


Hughey Run
1.5
1.0
0.5
7.0
6.05
6.0
5.8
UNT AC 5.8-1
5.5
SMP-AC3
Anderson Creek
5.0
SMP-BR4
5.0
DMP-BR 4.5
DMP-BR 4.0
4.5
Bilger Run
SMP-HR1
HR1
SMP-BR3
3.25
4.0
OSL211-214
3.5
HR2
DMP-BR 3.9
3.0
2.5
BR2
2.0
2.0
Bilger Run
1.6
1.5
FR1
Fenton Run
1.0
0.9
SMP-FR1
1.5
0.5
1.15
1.0
D2
D3
D1
D4
D5
4.0
Anderson Creek Watershed
Streams
Displayed Area
Subwatershed Boundaries
Watershed Boundary
Bilger Run
Mile Marker Points
Random Sample Points
Secondary AMD Seeps
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
EPA TMDL Points
AMD Discharge
Stream Sample Point
Streams
Watershed Boundary
N
S
W
E
0.5
0.25
0
0.5
Miles

contain low levels of iron and virtually no aluminum. Each area was identified as a priority by this study.

Bilger Run TMDLs

Bilger Run above BR1

This stream segment represents the headwaters of Bilger Run before any major tributaries enter the stream. The stream begins near Route 219 and flows southeast for approximately two miles to its confluence with Hughey Run. Rankin mine, an abandoned underground clay mine is located just west of Route 219 on the headwaters and drains some AMD into Bilger Run. The entry to the mine crosses under Route 219 from the eastern side of the roadway but all of the Rankin mine workings are located on the western side. The entry has subsided numerous times and the location can be easily identified on Route 219 by a road-wide patch located in a dip of the road just before reaching Chestnut Grove when traveling north from Grampian. The discharge from the mine is small and field tests did not indicate severely degraded water quality, although the stream is clearly degraded.

In addition to the deep mine discharge, there are other abandoned mine problems near the site. Reclaimed surface mines lie to the west of Route 219 that may be degrading the groundwater in the area but most of the area appears to drain to the west toward adjacent Bell Run. To the east of Route 219 and just south of the old mine entry and a short distance downstream is an area of unreclaimed, poorly vegetated mine spoil. It is assumed the spoil is associated with the old deep mine workings. Also, there are three ponds located opposite the spoil piles that ACWA members thought were polluted, but that turned out to support fish. The ponds become hypereutrophic in the summer, which may be due to septic systems from nearby residences.

Below the Rankin mine area, Bilger Run flows through a very large wetland area that is very difficult to traverse. Many of the hills surrounding the stream segment were surface mined and reclaimed. Most have been re-designated as pastureland and now contain few trees. Several areas along the wetland were identified as having depressed field pH but only one small discharge entered from river-right that measured in the lower 3-pH range. It was not considered as a priority for restoration.

A large, poorly reclaimed surface mine is located to the north of the stream along the segment between Route 219 and Evergreen Road (Township Road 484). The main sources of acidity and aluminum in upper Bilger Run come from this area. The area has been the site of several previous surface-mining operations and, at the time of this assessment, was being surface mined again. Two main sources of AMD and a few other minor discharges drain off the site. The two main pollution sources associated with the site were monitored under this assessment. Another less severe discharge located just south of the bridge on Evergreen Road was also monitored. This less severe site was chosen because treatment could provide additional alkalinity to Bilger Run. Because it is very likely that addressing the three discharge points on this problem area would likely result in significant improvements to Bilger Run, monitoring of the three discharges was a high priority under this assessment.

TMDL for Bilger Run above BR1

The TMDL for Bilger Run above point BR1 requires that a load allocation be made for total iron, total manganese, and total aluminum. The TMDL does not require a load allocation be made for acidity. All necessary reductions have been upstream from this point. Table G28 below, taken from the TMDL report, establishes the long-term averages for monitoring station BR1. Table G30, also taken from the Anderson Creek TMDL report, identifies the necessary reductions.

Table G28. Long Term Average (LTA) Concentrations for Bilger Run Above BR1

Station	*Parameter*	*Measured Sample Data*		*Allowable*	
		Conc. (mg/l)	*Load (lbs/day)*	*LTA Conc. (mg/l)*	*Load (lbs/day)*
BR1	Fe	1.66	25.47	0.20	2.97
	Mn	6.01	92.23	0.24	3.58
	Al	2.44	37.44	0.15	2.30
	Acidity	43.05	660.63	0.86	13.20
	Alkalinity	4.76	73.05		

All values shown in this table are long-term average daily values.

Table G30. Reductions Necessary at Point BR1

	Iron (lbs/day)	*Manganese (lbs/day)*	*Aluminum (lbs/day)*	*Acidity (lbs/day)*
Existing Loads at BR1	25.47	92.23	37.44	660.63
Total Load Reduction (OSL 211-214)	18.33	-	-	679.39
Remaining Load	7.14	92.23	37.44	0
Allowable Loads at BR1	2.97	3.58	2.30	13.20
Percent Reduction	58	96	94	0

Based on the watershed assessment performed under this study, it appears that a major source of AMD was not identified by the TMDL. The discharge, identified in the Scarlift Report as OSL 215, is very likely the same discharge identified by this study as DMP-BR4.5 or Bilger 3, although the discharge point has likely been moved slightly because of subsequent surface mining. This significant pollution source discharges from a pond located downslope from a reclaimed surface mine and adjacent to the large wetland. The TMDL monitoring point BR1 should still account for its pollution load.

TMDL monitoring point BR1 was also represented by a monitoring point established for this assessment, SMP-BR3. SMP-BR3 was established to measure what was determined to be the worst polluted stream segment of Bilger Run. The three discharges identified on this segment are the highest in priority for restoration on Bilger Run. The following monitoring data averages for SMP-BR3 were developed using the samples collected during the time of this assessment.

Average water quality measured at SMP-BR3

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-BR3	**1.29**	**4.7**	**7.17**	**52.5**	**1.4**	**16.8**	**20.50**	**188.5**	**6.7**	**28.1**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for TMDL above BR1

This section of Bilger Run contains the worst polluting discharges that enter the stream. In its upper reaches, Bilger Run is polluted from water draining from the Rankin mine, which is located west of Route 219. That source does not severely degrade the stream. Several reclaimed surface mines are also located in the area, but no significant discharges appear to be draining from the sites into Bilger Run. Just east of Route 219, several large, poorly vegetated spoil piles are located directly adjacent to the stream. The piles should be reclaimed, but they do not appear to be significantly degrading the stream with AMD. They do, however, provide a significant source of sediment.

Downstream of this area is the large area of poorly reclaimed surface and deep mines discharging AMD into Bilger Run, which was mentioned previously. Three discharges-two containing high levels of acidity and high levels of metals and one with moderate acidity and low levels of metals-are being monitored. All are ranked as priorities for restoration. DMP-BR 4.5 and DMP-BR 4.0 are ranked priority one and two respectively for Bilger Run.

Assessment monitoring point DMP-BR 4.5 is the highest priority discharge for restoration in Bilger Run. The following monitoring data averages for DMP-BR 4.5 were developed using the samples collected during the time of this assessment.

Average water quality measured at DMP-BR 4.5

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-BR4.5	**13.63**	**13.95**	**21.32**	**19.19**	**8.17**	**7.35**	**115**	**103.76**	**0**	**0.18**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Assessment monitoring point DMP-BR 4.0 is the second-highest priority discharge for restoration in Bilger Run. The following monitoring data averages for DMP-BR 4.5 were developed using the samples collected during the time of this assessment.

Average water quality measured at DMP-BR 4.0

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-BR4.0	**8.22**	**2.38**	**18.82**	**6.10**	**10.09**	**3.30**	**101.27**	**33.20**	**0**	**0.00**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

DMP-BR 4.5 and DMP-BR 4.0 are presently part of a restoration effort being directed by the Pennsylvania DEP Moshannon District Mining Office and the DEP Bureau of Abandoned Mine Reclamation. The preliminary plans call for an active treatment plant using chemicals. When completed, the treatment plant should eliminate the metals and acid load of the discharges.

A third discharge, emanating from an area on the opposite side of Bilger Run and to the south, contains low metals and lower acidity. This discharge can be easily treated using passive treatment technology. In March 2005, ACWA applied to Pennsylvania's Growing Greener grant program to design and construct an anoxic limestone drain to treat the discharge. Expected results include eliminating all the present metals and acidity and producing an additional 150 mg/L of alkalinity to be discharged into the stream to help neutralize acidity in Bilgers Run. It is estimated that over 50 lbs/day of alkalinity can be introduced into the stream at average flow.

Assessment monitoring point DMP-BR 3.9 is the third-highest priority discharge for restoration in Bilger Run. The following monitoring data averages for DMP-BR 3.9 were developed using the samples collected during the time of this assessment.

Average water quality measured at DMP-BR 3.9

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-BR3.9	**1.78**	**0.41**	**3.08**	**.86**	**0.64**	**0.29**	**12.86**	**4.61**	**6**	**2.16**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Bilger Run between BR1 and BR2

This stream segment of Bilger Run is identified by the TMDL as being located between the bridge on TR 484 and the confluence with Fenton Run. The TMDL for BR2 consists of a load allocation to all of the watershed area between BR1 and BR2, including that of Hughey Run. The TMDL for Bilger Run at point BR2 requires that a load allocation be made for total manganese, total aluminum, and acidity. The TMDL for Bilger Run at point BR2 does not require a load allocation to be made for total iron. All necessary reductions have been made upstream from this point (SRBC 2004).

A summary of all loads that affect point BR2 are shown in Table G32, taken from the TMDL report. Note: As mentioned above, a significant pollution source on this stream segment, OSL 215 or DMP-BR 4.5 as designated by this study, appears to have been omitted from the TMDL report.

Table G32. Summary of Loads Affecting Point BR2				
	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
HR1				
Existing Load	3.41	1.05	1.16	45.74
Allowable Load	1.38	1.05	1.16	6.39
Load Reduction	2.03	0	0	39.35
OSL 211-214				
Existing Load	18.51	-	-	679.39
Allowable Load	0.18	-	-	0
Load Reduction	18.33	-	-	679.39
BR1				
Existing Load	25.47	92.23	37.44	660.63
Allowable Load	2.97	3.58	2.30	13.20
Load Reduction	22.50	88.65	35.14	647.43

Necessary load reductions at point BR2 are shown in Table G33, taken from the TMDL report.

Table G33. Reductions Necessary at Point BR2				
	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
Existing Loads at BR2	30.04	224.77	59.73	1,574.11
Total Load Reduction (OSL 211-214, BR1, and HR1)	42.86	88.65	35.14	1,366.17
Remaining Load	0	136.12	24.59	207.94
Allowable Loads at BR2	13.81	10.70	4.14	31.42
Percent Reduction	0	92	83	85

Assessment Recommendations for BR1 to BR2

This assessment differed from the TMDL in that it established stream monitoring points near the mouth of Bilger Run rather than at the mid-point where TMDL BR2 is located. The TMDL used the monitoring point at the mouth of Anderson Creek (A2) to measure the remaining pollution sources on Bilger Run. Because AMD sources with a different general chemical makeup (net alkaline rather than net acid) enter Bilgers Run in its lower reaches, two monitoring points (one above the area of the net alkaline AMD discharges and one below) were established as monitoring points. In addition, monitoring point SMP-KR1 on Kratzer Run measures the total pollution loads received from Bilger Run before it joins Anderson Creek. Recommendations for the discharges near the mouth of Bilger Run will be addressed later in the "Lower Bilger Run" section.

Between TMDL point BR2 and the net alkaline discharges on lower Bilger Run, Hughey Run and Fenton Run enter the stream. These subwatersheds of Bilger Run are described separately below. Since no other significant pollution sources enter the Bilger

Run main stem above the net alkaline discharges, no recommendations for restoration are given.

Hughey Run

Hughey Run drains the northernmost area of the Bilger Run watershed. It is a low-gradient stream that joins the main stem of Bilger Run about .75 miles downstream of the TR 484 Bridge that crosses Bilger Run. Several areas draining into Hughey Run have been surface mined. Most have been properly reclaimed. The uppermost reaches are also associated with the previously mentioned problem area containing acidic discharges on Bilger Run. The stream is not severely degraded by those mines, however.

Hughey Run was visually assessed during the period of high groundwater. Water draining from several drainage ditches, located on reclaimed mines and wet areas down gradient of the mine sites, were noted as having depressed field pH readings. The stream itself maintained a field pH reading near 6.0. Small fish were observed in the stream as well. Hughey Run consistently maintained pH readings near 6.0 throughout the assessment monitoring period and is considered a low priority for restoration. Hughey Run would likely benefit from the installation of high calcium carbonate limestone in the surface water diversions draining the reclaimed mine sites, as well as the wet areas below the mine sites. Doing so would likely reduce the acidity in Hughey Run and have beneficial impacts to Bilger Run as well.

Hughey Run TMDL

The TMDL for Hughey Run was included in the reductions required for TMDL point BR2, which included all of the pollution sources in the upper Bilger Run watershed. Table G32, taken from the TMDL report, identifies the load reductions specifically for HR1 and is presented below.

Table G32. Summary of Loads Affecting Point BR2 Repeated Table

	Iron (lbs/day)	***Manganese (lbs/day)***	***Aluminum (lbs/day)***	***Acidity (lbs/day)***
HR1				
Existing Load	3.41	1.05	1.16	45.74
Allowable Load	1.38	1.05	1.16	6.39
Load Reduction	2.03	0	0	39.35
OSL 211-214				
Existing Load	18.51	-	-	679.39
Allowable Load	0.18	-	-	0
Load Reduction	18.33	-	-	679.39
BR1				
Existing Load	25.47	92.23	37.44	660.63
Allowable Load	2.97	3.58	2.30	13.20
Load Reduction	22.50	88.65	35.14	647.43

The TMDL for Hughey Run consists of a load allocation to all of the watershed area above point HR1. Addressing the mining impacts above this point addresses the impairment for the segment (SRBC 2004).

The load reductions required for Hughey Run above HR1 are identified in Table G26, taken from the TMDL report. Reductions of iron and acid are required.

Table G26. Reductions for Hughey Run Above HR1						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
HR1	Fe	0.62	3.41	0.25	1.38	59
	Mn	0.19	1.05	0.19	1.05	0
	Al	0.21	1.16	0.21	1.16	0
	Acid	8.31	45.74	1.16	6.39	86
	Alkalinity	9.58	52.73			

All values shown in this table are long-term average daily values.

The TMDL for Hughey Run at point HR1 requires that a load allocation be made for all areas above HR1 for total iron and acidity. The TMDL for Hughey Run at point HR1 does not require a load allocation to be made for total manganese and total aluminum. This assessment also established a monitoring point representative of TMDL HR1 (SRBC 2004).

TMDL monitoring point HR1 was also represented by a monitoring point established for this assessment, SMP-HR1. The following monitoring data averages for SMP-HR1 were developed using the samples collected during the time of this assessment.

Average water quality measured at SMP-HR1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-HR1	**0.24**	**0.9**	**0.32**	**1.2**	**0.17**	**0.9**	**5.20**	**24.3**	**8.4**	**37.1**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for Hughey Run above TMDL point HR1

The TMDL recommends load reductions of 2.03 lbs/day of iron and 39.35 lbs/day of acidity for the entire Hughey Run watershed. Hughey Run would likely benefit from the installation of high calcium carbonate limestone in the surface water diversions draining the reclaimed mine sites as well as the wet areas below the mine sites, some of which may be impaired springs. It may also be possible to install small anoxic limestone drains in the depressed-pH wet areas to increase alkalinity at these specific points. Doing so would likely reduce the acidity and metals in Hughey Run and have beneficial impacts to Bilger Run as well.

Fenton Run

The Fenton Run headwaters begin just south of Bilger Rocks Road, which is located about two miles north of Grampian along Route 219. Fenton Run is a low-gradient stream that flows southeast for 1.5 miles before it begins its steep decline to its confluence with Bilger Run. In the steep section, Fenton Run becomes boulder-choked and contains several small waterfalls. Once it reaches Bilger Run, the alkalinity in Fenton Run causes Bilger Run to precipitate much of its aluminum load. The stream takes on a milky appearance and the rocks on the substrate become coated with aluminum precipitate.

TMDL for Fenton Run

The TMDL for Fenton Run consists of a load allocation to all of the watershed area above point FR1. The TMDL for Fenton Run at point FR1 requires that a load allocation be made for all areas above FR1 for total iron, total manganese, and acidity (SRBC 2004). Table G34, taken from the TMDL report, identifies the reductions required to meet in-stream TMDL requirements.

Table G34. Reductions for Fenton Run Above FR1

Station	*Parameter*	*Measured Sample Data*		*Allowable*		*Reduction Identified*
		Conc. (mg/l)	*Load (lbs/day)*	*LTA Conc. (mg/l)*	*Load (lbs/day)*	*Percent*
FR1	Fe	0.51	1.32	0.19	0.49	63
	Mn	1.92	4.96	0.13	0.34	93
	Al	1.56	4.03	-	-	-
	Acid	5.50	14.22	3.24	8.38	41
	Alkalinity	22.72	58.74			

All values shown in this table are long-term average daily values.

A monitoring point for this assessment was established on Fenton Run. It was located approximately .5 miles downstream of the TMDL station and below the confluence of an unnamed tributary and identified as SMP-HR1. The following monitoring data averages for SMP-HR1 were developed using the samples collected during the time of this assessment.

Average water quality measured at SMP-FR1

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
SMP-FR1	**0.74**	**2.4**	**0.80**	**6.1**	**0.22**	**1.9**	**-29.00**	**-146.3**	**49**	**272.6**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

Recommendations for Fenton Run

The water quality in Fenton Run is good enough to support fish and aquatic insects. The upper reaches show some signs of iron precipitation, particularly at low flows, but the impacts to Fenton Run are minor. Fenton Run is considered a low priority and is not recommended for restoration activities at this time.

DMP-Wildwood is located just upstream of Route 879 on Bilger Run.

Lower Bilger Run

Near the mouth of Bilger Run at Route 879, the water quality of the stream is again degraded by additional sources of AMD. The AMD in this area is much different from that in the upper watershed. The upper watershed discharges have high acidity and high concentrations of metals. Here discharges have low acidity, lower iron, and are nearly balanced between acidity and alkalinity.

The Wildwood Discharge, named for a nearby local establishment, is located adjacent to the stream and forms a large, degraded wetland before discharging into the stream. There are some additional AMD seeps on the opposite side of the stream from the Wildwood Discharge. The seeps are smaller flows but do appear to have elevated levels of iron. Because the seeps were lower in flow, they were not considered a high priority and were not sampled during the monitoring period. Because of the steep topography on that side of the stream, it does not appear it would be feasible to treat the seeps without relocating them. They were considered a low priority for monitoring.

AMD discharges from crack in Route 879 Bridge pier on Bilger Run.

Located slightly downstream, at the Route 879 Bridge over Bilger Run, are additional AMD discharges. These discharges appear at the base of the Route 879 Bridge piers. One of the piers has a large crack in it and is being monitored by PennDOT. At the base of the crack, AMD can be observed bubbling out. The discharge is substantial enough to stain the stream with iron. It appears that PennDOT will eventually address the bridge pier situation. Coordination with PennDOT will be critical if any possible action can be taken to address these discharges.

Recommendations for Lower Bilger Run - Wildwood Discharge

Although there may be permitting issues with the location of the discharge next to the stream and the wetland area it has created, based on water quality, the Wildwood

Discharge should be easily treated using passive treatment. An anoxic limestone drain (ALD) and pond/wetland treatment system should work well. The discharge is net acidic but does already contain some alkalinity. The biggest issue will be working in or near the stream and wetland, especially with heavy equipment. Access is somewhat difficult. It may also be possible to enhance the present wetland to improve the treatment efficiency without significant impacts to the wetland by using materials other than earthen dikes to improve detention time in the wetland. ACWA made application to the Growing Greener grant program in 2003 to remediate the discharge, but the application was denied. It is recommended that ACWA again make application for funding to address this discharge.

Average water quality measured at DMP-Wildwood

Sample ID	Fe mg/L	Fe Loading lbs/day	Mn mg/L	Mn Loading lbs/day	Al mg/L	Al Loading lbs/day	Acidity mg/L	Acidity Loading lbs/day	Alkalinity mg/L	Alkalinity Loading lbs/day
DMP-Wildwood	**8.91**	**9.28**	**2.71**	**2.55**	**0.05**	**0.06**	**17**	**15.95**	**9**	**10.75**

All values represent short-term averages for samples taken during the monitoring period of the assessment.

As mentioned in the Kratzer Run section, AMD is discharging into Bilger Run from the base of the Route 879 Bridge pier. Because of the location, it will be very difficult to address the discharge. Efforts must be coordinated with PennDOT and treatment system engineers well in advance of any repairs to the bridge piers to determine the best approach to remediation.

Sediment and Nutrient TMDLS

Pollutants and Sources

Nutrients and siltation have been identified as the pollutants causing designated-use impairments in the Anderson Creek watershed. Sub-basin 1 represents the portion of the watershed affected by siltation. The watersheds in Sub-basin 1 are comprised of Little Anderson Creek and Rock Run. Sub-basin 2 represents the portion of the watershed affected by nutrient impairment. Kratzer Run and Bilger Run are the two streams in Sub-basin 2. There are no known permitted wastewater discharges present within the two sub-basins. Based on the assessment data and visual observations, abandoned mine and agricultural lands are the sources of the siltation in Sub-basin 1. Some areas are sparsely vegetated where acid conditions exist, contributing to significant sediment runoff. There also are portions of the watershed where livestock have unlimited access to the stream, and no riparian buffer exists. For Sub-basin 2, the assessment data states the source of the nutrients to be septic systems in the more developed areas, however, there is a significant amount of disturbed and agricultural lands present as well (SRBC 2004).

Reference Watershed Approach

The TMDL developed for Anderson Creek Sub-basins 1 and 2 addresses sediment and phosphorus, respectively. Because neither Pennsylvania nor the EPA has numeric water quality criteria for these pollutants, a method was developed to determine water quality objectives that would result in the impaired stream segments attaining their designated uses. The method employed for these TMDLs is termed the “Reference Watershed Approach” (SRBC 2004).

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. Other features, such as base geologic formation, should be matched to the extent possible; however, most variations can be adjusted for in the model. The objective of the process is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to the loading rate in the non-impaired, reference stream segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments (SRBC 2004).

Curry Creek, stream code 26760, was selected as the reference watershed for developing the Anderson Creek Sub-basin TMDLs. The Curry Creek watershed is located just west of Anderson Creek in Clearfield County, Pennsylvania. The watershed is located in State Water Plan Sub-basin 8B, and protected uses include aquatic life and recreation. The entire basin is currently designated as CWF under §93.9z in Title 25 of the Pa. Code (Commonwealth of Pennsylvania 2001). Based on DEP’s 305(b) report database, Curry Creek is currently attaining its designated uses. The attainment of designated uses is based on sampling done by DEP in 1999 (SRBC 2004).

TMDLs

Targeted TMDL values for the Anderson Creek watershed were established based on current loading rates for sediment and phosphorus in the Curry Creek reference watershed. Biological assessments have determined that Curry Creek is currently attaining its designated uses. Reducing the loading rate of sediment and phosphorus in the Anderson Creek watershed to levels equivalent to those in the Curry Creek watershed will provide conditions favorable for the reversal of current use impairments (SRBC 2004).

Targeted TMDLs

Targeted TMDL values for sediment and phosphorus were determined by multiplying the total area of Sub-basins 1 and 2 of the Anderson Creek watershed (6,626.31 and 9,779.61 acres, respectively) by the appropriate unit-area loading rate for the Curry Creek watershed. The existing mean annual loading of sediment to Sub-basin 1 (1,588,248.60 lbs/yr) will need to be reduced by 57 percent to meet the targeted TMDL of 686,684.51 lbs/yr. Meeting the targeted phosphorus TMDL of 1,564.74 lbs/yr for Sub-basin 2 will require a 29 percent reduction in the current mean annual loading (2,212.10 lbs/yr) (SRBC 2004).

Recommendations for Implementation

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Anderson Creek sediment and phosphorus TMDLs identify the necessary overall load reductions and distribute those reduction goals to the appropriate non-point sources. Reaching the reduction goals established by these TMDLs will only occur through changes in current land-use practices and reclamation of abandoned mine lands, including the incorporation of BMPs. BMPs that would be helpful in lowering the amount of sediment and nutrients reaching Anderson Creek include streambank fencing and riparian buffer strips, among many others (SRBC 2004).

The required level of detail is outside the scope of this TMDL document and is an activity best accomplished at the local level. Successful implementation of the activities necessary to address current use impairments to Anderson Creek will require local citizens taking an active interest in the watershed and the enthusiastic cooperation of local landowners. Some of the work needed is actively being pursued through efforts targeting the abandoned mine lands (SRBC 2004).

Assessment Recommendations for Sub-basin 1

Meeting TMDL sediment reduction goals for Sub-basin 1, as established by the Anderson Creek watershed TMDL, will require significant amounts of land restoration on many of the AMD TMDL sites previously identified for Little Anderson Creek. These sites include areas associated with PAMP-LA2.10, PAMP-LA 3.0-1, PAMP-LA 3.0-2, DMP-Drauckers 1, Spencer mine, and PAMP-LA4.3-1. No agricultural sites were identified as significant sediment sources on Little Anderson Creek. In addition to the identified sites, other poorly vegetated sites within the sub-basin may also be contributing to the sediment load, but to a lesser degree. Also contributing to the problem is the flocculent associated with metals deposition from AMD onto the streambed.

Two sites in the Rock Run subwatershed, one abandoned mine site and one agriculture site, were also noted during the visual assessment as likely sources of sediment. Both sites are located in the lower reaches of Rock Run. An abandoned coal tipple, located east of Rock Run Road, contains large piles of un-vegetated coal waste that are severely eroding. Although it is not located adjacent to the stream, coal waste fines were observed in a drainage way leading to the stream. The agriculture site is also located in the vicinity, approximately .5 miles downstream. At this site, livestock have direct access to the stream and the pasture field is poorly vegetated.

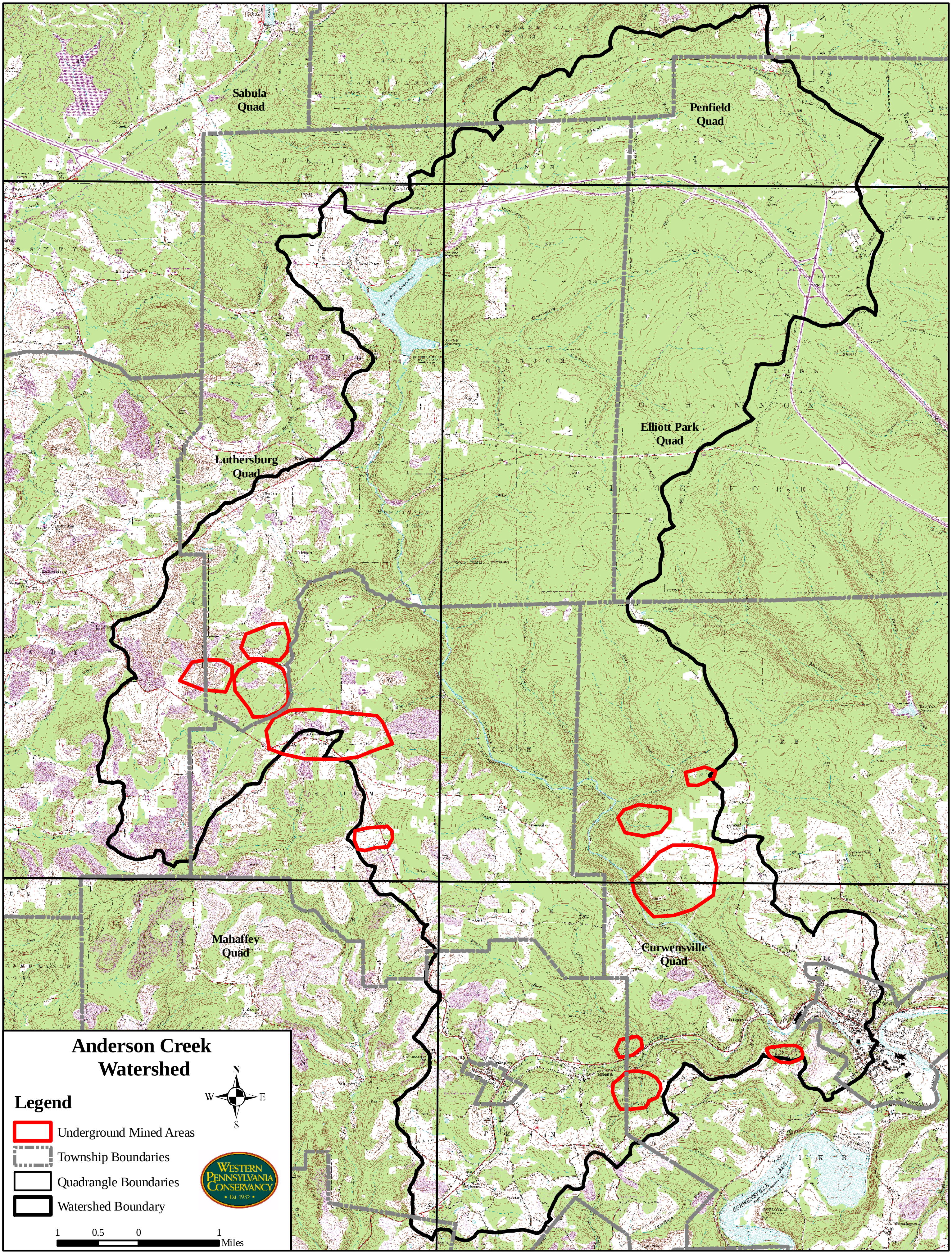
Assessment Recommendations for Sub-basin 2

The TMDL report identified Sub-basin 2, Kratzer Run and Bilger Run, as impaired by nutrients and requiring a 23 percent reduction of phosphorous. The visual assessment conducted during this study appeared to support these findings. Two possible agricultural sources were identified in the headwaters area during the assessment. The worst of the two is located on the headwaters of UNT-KR 5.2, north of Hepburnia, where a barnyard and adjoining pasture permit uncontrolled livestock access to the stream. Streamside vegetation is sparse and streambanks are eroding. It is recommended that contact be made with the landowner and efforts be made to initiate proper agricultural BMPs on the site.

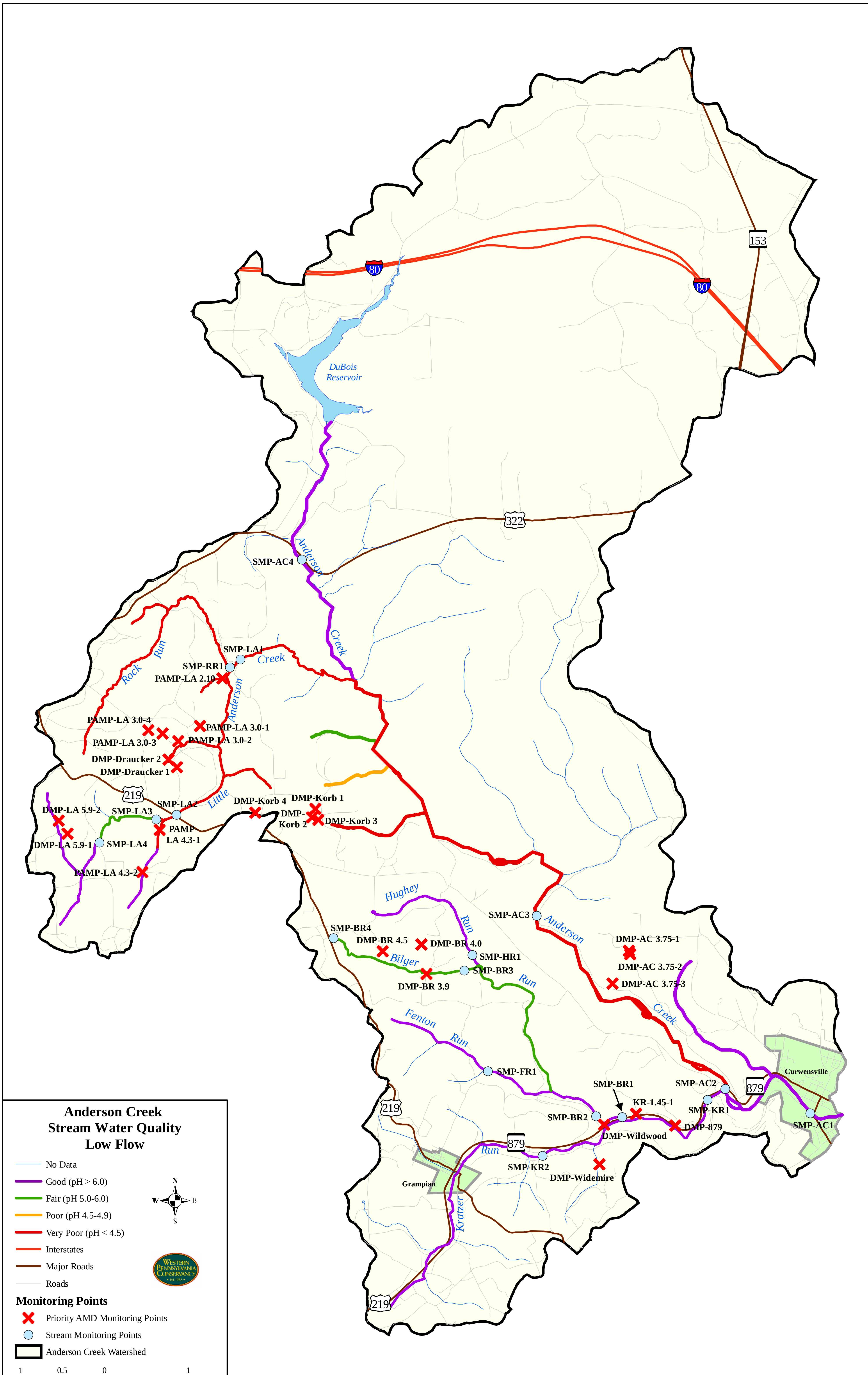
The TMDL study also noted failing septic systems as another source of nutrients in the watershed. Although sewage discharges into Sub-basin 2 were noted, they did not appear to be widespread. Kratzer Run, in particular, visually appeared to be affected by nutrients. However, no tests were performed to confirm these suspicions. The towns of Grampian and Stronach, both located in Sub-basin 2 on Kratzer Run, had a sewage treatment plant installed to serve their residents. The plant was operational prior to the assessment, which indicates agricultural areas and remaining on-lot septic systems are likely still affecting the stream.

Although not identified specifically by the TMDL, Kratzer Run also has a sediment problem. Because the stream flows through the communities of Grampian and Stronach and parallels Route 879, it is clearly affected by human encroachment. It is also affected by many areas in the headwaters that have been surface mined and contain few trees, leading to accelerated rates of precipitation runoff during storm events. The visual assessment identified several areas of moderate to severe streambank erosion along Kratzer Run. Several are associated with poor streamside vegetation, some due to lawns being mowed to the edge of the stream. The area between Grampian and Stronach is particularly notable.

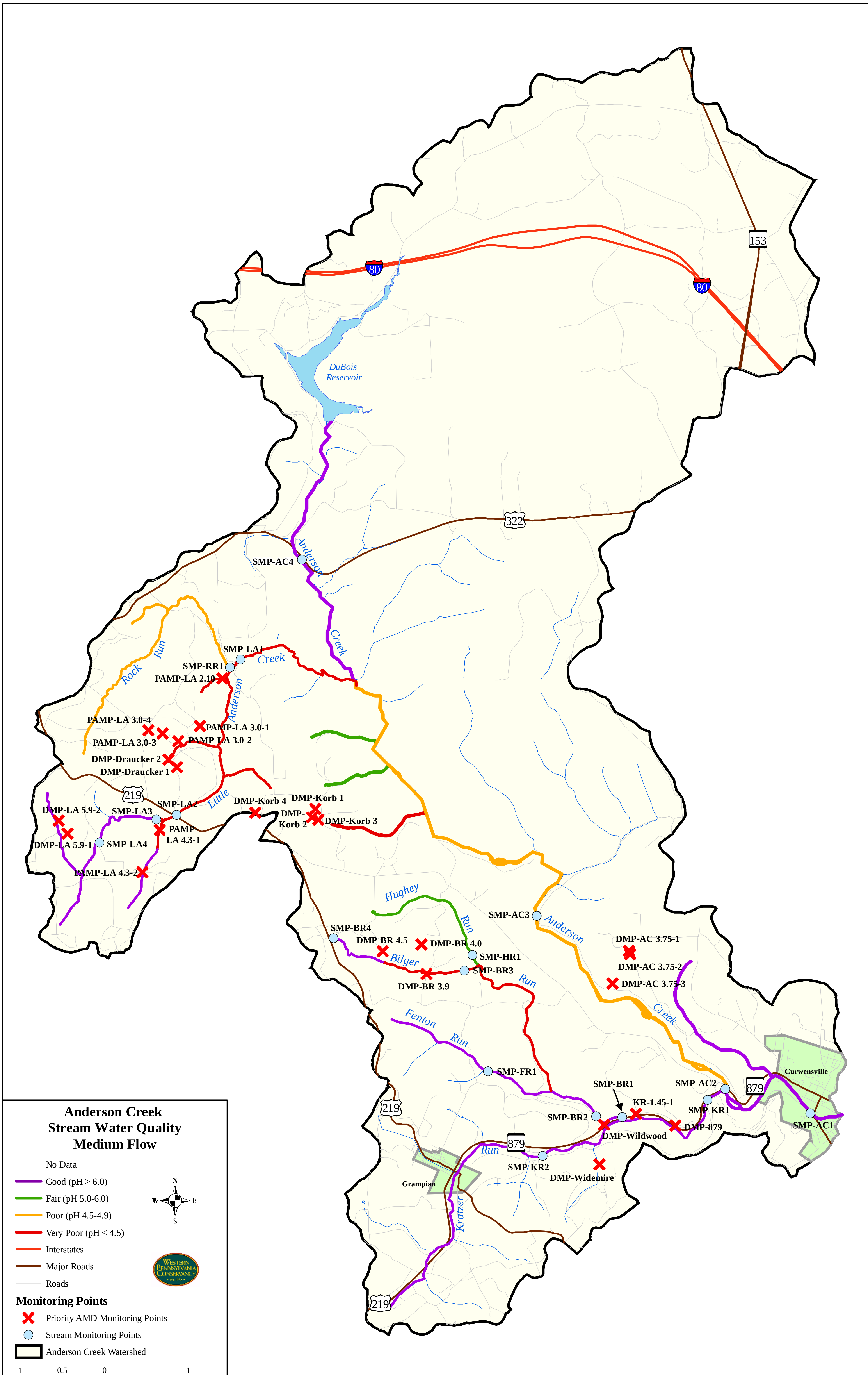
The worst area of streambank instability is below Stronach. The gradient of the stream becomes steeper in this section, which can increase erosion rates when problems occur. Between Stronach and the mouth of Bilger Run, a road crossing the stream has been removed without proper streambank stabilization being employed. At this site, significant siltation is occurring from the downcutting of in-stream sediment remaining above the former road crossing. Additionally, severe bank erosion is taking place at the site of the former road and immediately below it. Heavy sediment deposits were noted in the stream channel below the site for a considerable distance. This area is considered the number one priority for erosion and sedimentation in the entire Anderson Creek watershed. It is recommended that a more detailed study of the entire Kratzer Run area below Stronach be undertaken to determine the proper natural stream channel stabilization techniques to be implemented throughout the stream segment.

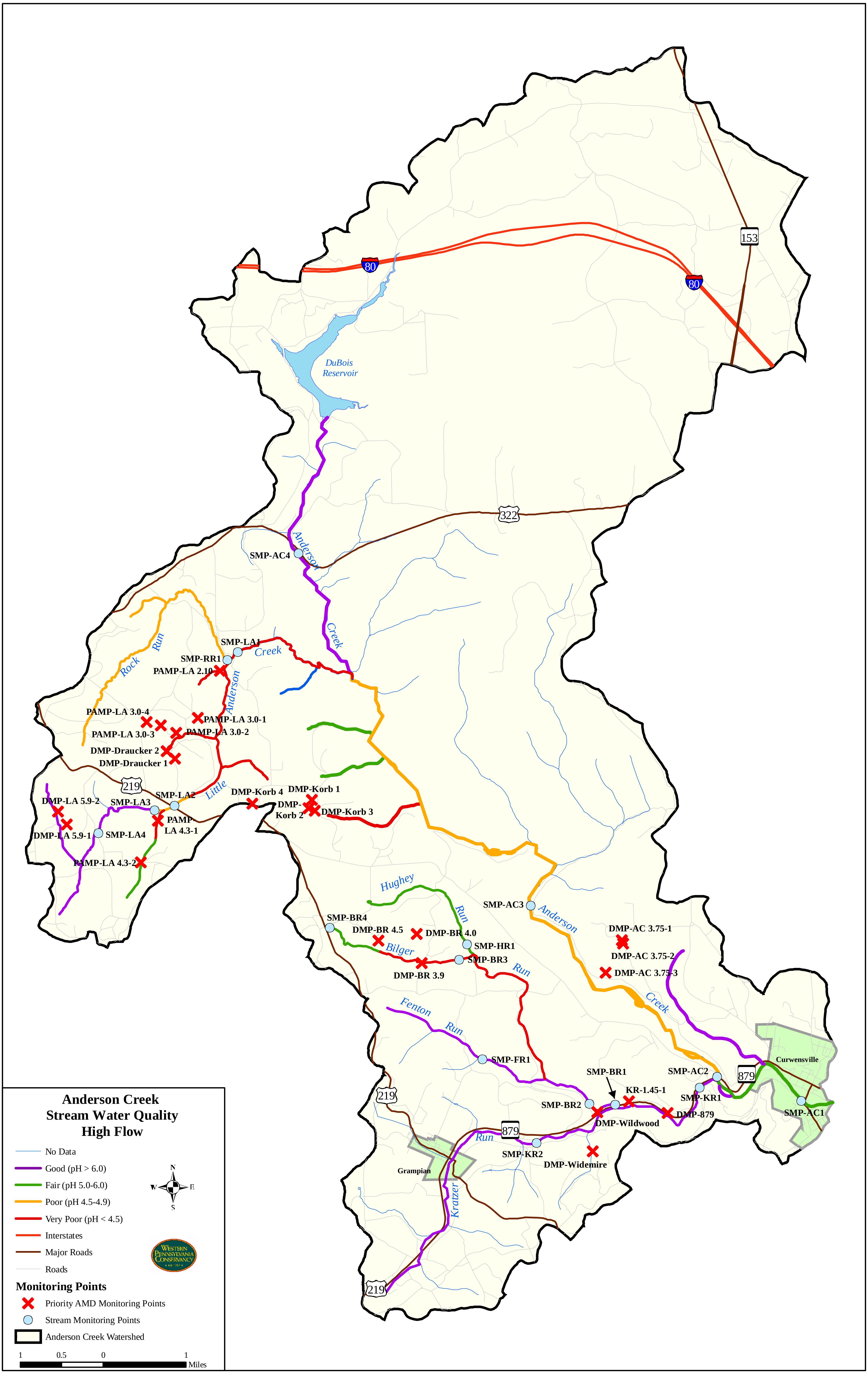


Sabula Quad
Penfield Quad
Elliott Park Quad
Luthersburg Quad
Mahaffey Quad
Curwensville Quad
Anderson Creek Watershed
Legend
Underground Mined Areas
Township Boundaries
Quadrangle Boundaries
Watershed Boundary
N
W
E
S
Western Pennsylvania Conservancy
1
0.5
0
1
Miles



Anderson Creek
Stream Water Quality
Low Flow
No Data
Good (pH > 6.0)
Fair (pH 5.0-6.0)
Poor (pH 4.5-4.9)
Very Poor (pH < 4.5)
Interstates
Major Roads
Roads
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
Anderson Creek Watershed
1 0.5 0 1
Miles
DuBois Reservoir
80
153
322
219
879
Anderson Creek
Little Anderson Creek
Rock Run
Hughey Run
Bilger Run
Fenton Run
Kratzer Run
SMP-AC4
SMP-LA1
SMP-RR1
PAMP-LA 2.10
PAMP-LA 3.0-4
PAMP-LA 3.0-3
PAMP-LA 3.0-1
PAMP-LA 3.0-2
DMP-Draucker 2
DMP-Draucker 1
SMP-LA2
SMP-LA3
SMP-LA4
DMP-LA 5.9-2
DMP-LA 5.9-1
PAMP-LA 4.3-1
PAMP-LA 4.3-2
DMP-Korb 4
DMP-Korb 1
DMP-Korb 2
DMP-Korb 3
SMP-AC3
SMP-BR4
DMP-BR 4.5
DMP-BR 4.0
SMP-HR1
SMP-BR3
DMP-BR 3.9
DMP-AC 3.75-1
DMP-AC 3.75-2
DMP-AC 3.75-3
SMP-FR1
SMP-BR1
KR-1.45-1
SMP-AC2
SMP-KR1
SMP-BR2
DMP-Wildwood
DMP-879
SMP-AC1
Curwensville
SMP-KR2
DMP-Widemire
Grampian
Western Pennsylvania Conservancy


Anderson Creek
Stream Water Quality
Medium Flow
No Data
Good (pH > 6.0)
Fair (pH 5.0-6.0)
Poor (pH 4.5-4.9)
Very Poor (pH < 4.5)
Interstates
Major Roads
Roads
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
Anderson Creek Watershed
1 0.5 0 1
Miles
N
S
E
W
DuBois
Reservoir
80
153
322
219
879
Anderson
Creek
Little
Rock
Run
Hughey
Run
Bilger
Run
Fenton
Run
Kratzer
Run
Curwensville
Grampian
SMP-AC4
SMP-LA1
SMP-RR1
PAMP-LA 2.10
PAMP-LA 3.0-4
PAMP-LA 3.0-1
PAMP-LA 3.0-3
PAMP-LA 3.0-2
DMP-Draucker 2
DMP-Draucker 1
SMP-LA2
DMP-Korb 4
DMP-Korb 1
DMP-Korb 2
DMP-Korb 3
DMP-LA 5.9-2
SMP-LA3
PAMP-LA 4.3-1
DMP-LA 5.9-1
SMP-LA4
PAMP-LA 4.3-2
SMP-AC3
SMP-BR4
DMP-BR 4.5
DMP-BR 4.0
SMP-HR1
SMP-BR3
DMP-BR 3.9
DMP-AC 3.75-1
DMP-AC 3.75-2
DMP-AC 3.75-3
SMP-FR1
SMP-BR1
KR-1.45-1
SMP-AC2
SMP-BR2
SMP-KR1
DMP-879
DMP-Wildwood
SMP-AC1
SMP-KR2
DMP-Widemire



Anderson Creek
Stream Water Quality
High Flow
No Data
Good (pH > 6.0)
Fair (pH 5.0-6.0)
Poor (pH 4.5-4.9)
Very Poor (pH < 4.5)
Interstates
Major Roads
Roads
Monitoring Points
Priority AMD Monitoring Points
Stream Monitoring Points
Anderson Creek Watershed
1 0.5 0 1
Miles
N
E
S
W
DuBois Reservoir
80
153
322
219
879
SMP-AC4
Anderson Creek
SMP-LA1
SMP-RR1
PAMP-LA 2.10
Rock Run
Little Anderson Creek
PAMP-LA 3.0-4
PAMP-LA 3.0-3
PAMP-LA 3.0-1
PAMP-LA 3.0-2
DMP-Draucker 2
DMP-Draucker 1
SMP-LA2
SMP-LA3
DMP-LA 5.9-2
DMP-LA 5.9-1
SMP-LA4
PAMP-LA 4.3-1
PAMP-LA 4.3-2
DMP-Korb 4
DMP-Korb 1
DMP-Korb 2
DMP-Korb 3
Hughey Run
SMP-AC3
SMP-BR4
DMP-BR 4.5
DMP-BR 4.0
SMP-HR1
Bilger Run
SMP-BR3
DMP-BR 3.9
DMP-AC 3.75-1
DMP-AC 3.75-2
DMP-AC 3.75-3
Fenton Run
SMP-FR1
SMP-BR1
KR-1.45-1
SMP-AC2
SMP-BR2
SMP-KR1
DMP-Wildwood
DMP-879
SMP-AC1
Curwensville
Kratzer Run
SMP-KR2
DMP-Widemire
Grampian