

Upper Two Lick Creek Watershed (Indiana County) Assessment and Restoration Plan

June 2025

Report prepared by Hedin Environmental for the Indiana County Conservation District and Blacklick Creek Watershed Association



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Cover photo was taken downstream of the Richards area on Upper Two Lick Creek.

Photo credit: Olivia Weaver

Summary

This report is intended to be used as a watershed restoration plan for the Upper Two Lick Creek (upstream of Two Lick Reservoir) Watershed in Indiana County, PA. This report details the mine drainage pollution sources in the watershed, but it does not discuss aquatic habitat or other potential sources of pollution (e.g. nutrients, petroleum, etc.). It includes data from six bi-monthly watershed snapshots and 12 monthly discharge sampling events.

The report finds that Upper Two Lick Creek (UTLC) generally had good water quality from the headwaters to the Two Lick Reservoir. Instream metal concentrations were below instream limits until downstream of Dixon Run where aluminum concentrations increased to 0.85 mg/L. Major tributaries were generally good quality and AMD discharges were generally assimilated by UTLC.

Biology assessments by Conemaugh Valley Conservancy (CVC) and PADEP Bureau of Abandoned Mine Reclamation (BAMR) reported that biological conditions were good in the headwaters but progressively worsened downstream until UTLC's confluence with Dixon Run where conditions were poor. The biological conditions of major downstream tributaries were generally poor. Habitat was optimal to marginal in UTLC.

This report details and contextualizes the results of the watershed and discharge sampling and offers recommendations to improve water quality. A summary project priority list is presented below:

1. Improve the lower reaches of Dixon Run by treating Dixon AMD 2 and Dixon AMD 1 discharges
 - a. Near the mouth of Dixon Run, two low pH, high Fe and Al discharges originate from abandoned deep mines. Dixon AMD 2 had the larger pollution loading and should be prioritized.
2. Improve the middle section of Dixon Run by reclaiming the refuse responsible for Dixon 3
 - a. A mine dump on USGS maps has been physically, but not chemically, reclaimed.
3. Improve Two Lick Creek around the Richards Treatment System by treating discharges
 - a. Treating the Diamondville borehole would give the Richards area enough capacity to assimilate the smaller discharges there.
 - b. If treating the Diamondville borehole is not possible, then the T1 discharge should be the second priority for treatment.
4. Improve Sample Run by reclamation to reduce refuse seepage
 - a. AML areas PA 2439-01 and PA 2439-02 should be reclaimed.
5. Improve the lower reaches of Penn Run by treating discharges
 - a. In the middle of Penn Run, five AMD discharges enter the stream. By treating three discharges, the lower reaches of Penn Run would be much improved.
6. After the above is completed, water quality in UTLC Creek should be reassessed to determine if water quality and aquatic life/biological goals are met.

Introduction

Two Lick Creek is a major tributary to Blacklick Creek. Upper Two Lick Creek (UTLC) is defined here as the watershed upstream of Two Lick Reservoir. The UTLC Watershed is approximately 56 square miles and is located in Indiana County, Pennsylvania. Major tributaries are North Branch Two Lick Creek and South Branch Two Lick Creek which combine 2.5 miles east of Clymer to form Two Lick Creek. The headwaters of the North Branch are near the towns of Starford and Commodore. The headwaters of the South Branch are in Green Township near the border of Cambria County. These watersheds have a variety of uses designated under Chapter 93 including cold-water fishes, high quality cold-water fishes, and trout-stocked fishes. The watersheds also have listed impairments including AMD, sediment, and agricultural related.

The Operation Scarlift Report “Two Lick Creek, Mine Drainage Pollution Abatement Project, SL-109” investigated the watershed in 1971. The major sources of AMD were determined to be abandoned deep mines, coal refuse piles, and unreclaimed strip mines. That study found the best approach to abate the mine drainage pollution would be to focus efforts on individual watersheds within the Two Lick Creek Watershed.

Mining and Reclamation History

The Two Lick Creek Watershed was the subject of intensive mineral resource recovery operations for the past 150 years. There were extensive mining activities before the 1977 Surface Mining Control and Reclamation Act (SMCRA). Since SMCRA, there are four active underground mine permits in the watershed mining the Lower Kittanning, Middle Kittanning, and Upper Freeport coal seams, and two active permitted coal refuse disposal areas (CRDAs) named Rock Refuse Disposal Area and Clymer Refuse Disposal Area are in the watershed.

The 1971 Operation Scarlift Report on the Two Lick Creek Watershed recommended sealing deep mines whose drainage was contributing to the acidity and metals loadings in UTLC. When sealing the mine was not feasible, it was suggested to divert the mine drainage away from refuse piles or to treat the mine drainage with hydrated lime treatment plants. Reclamation of strip mines and abandoned mine spoil/refuse piles was also recommended.

Previous reclamation projects in the watershed include one passive treatment system (the Richards System) and many reclamation projects (presumably Rural Abandoned Mine Program (RAMP) Projects in the 1980s and 1990s).

Geology Background

Map 2 shows the bedrock geology, anticlinal and synclinal axes, and coal outcrops in this watershed. The UTLC Watershed is in the Pittsburgh Low Plateau section of the Appalachian Plateau physiographic province, and the topography is characterized by steep, narrow valleys and broad, flat hilltops. Approx. 2.5% of the watershed is in the Appalachian Mountain section of the Appalachian Plateau physiographic province. The drainage pattern of the watershed is dendritic. The bedrock consists of nearly flat-lying stratigraphic units of interbedded sandstone, siltstone, limestone, shale, and coal. The structure of these units is occasional low-amplitude, open to

gentle folds striking northeast. The Chestnut Ridge anticlinal axis runs northeast to southwest through the near center of the watershed and directs drainage toward the Dixonville and Brush Valley synclines on the northwestern and southeastern edges of the watershed boundaries, respectively.

The stratigraphic units exposed in this watershed are the Pottsville Group, Allegheny Group, and Conemaugh Group. The Pottsville Group underlies the main stem of UTLC's valley floor and consists of interbedded sandstones, shales, and minor coal seams. The Allegheny Group outcrops along the Chestnut Ridge Anticlinal axis and in the incised valleys of Dixon Run. The main source of economical bituminous coals, including the Upper Kittanning and Lower Freeport coal seams, are in the Allegheny Group. The Conemaugh Group consists of the Glenshaw and Casselman Formations, outcrops on the edges of the watershed boundary and along the synclinal axes. This group is characterized by reddish shales, thick sandstones, and minor occurrences of limestones and coals.

Coal structure contours and crop lines were obtained from "Coal Resources of Indiana County, Pennsylvania. Part 1. Coal Crop Lines, Mined-out Areas, and Structure Contours" published by the Commonwealth of Pennsylvania Department of Conservation and Natural Resources, Office of Conservation and Engineering Services, Bureau of Topographic and Geologic Survey and written by Bragonier and Glover in 1996. Geologic units and physiographic province data were obtained from the Pennsylvania Department of Conservation and Natural Resources.

Previous Studies

The UTLC Watershed has been studied previously, but this project conducted a more thorough and comprehensive analysis of the watershed which was used to develop a plan to remediate the impairments.

Due to the size of the watershed, extent of AMD impacts, and importance to the Kiski-Conemaugh River Basin, several studies and plans related to the Two Lick Creek Watershed have been completed over the last 50 years including:

- Technical Assistance to Blacklick Creek Watershed Association: Macroinvertebrate Surveys of Blacklick Creek and Two Lick Creek, prepared by John W. Wenzel of Conemaugh Valley Conservancy (CVC), December 2023
- Kiski-Conemaugh Basin Treatment System O&M Assessment Report, Stream Restoration Incorporated & BioMost, Inc, December 2017
- State of the Kiski-Conemaugh River Watershed: Community Shift, prepared by Conemaugh Valley Conservancy, 2017
- A Comprehensive Plan for Indiana County, Pennsylvania: Connecting people with each other, with communities and with the countryside, 2012
- Kiskiminetas-Conemaugh River Watersheds TMDL, prepared by U.S. Environmental Protection Agency (EPA), approved January 2010

- South Branch Blacklick Creek Watershed TMDL, Cambria and Indiana Counties prepared by PA DEP, approved April 2005
- Blacklick Creek Watershed Assessment / Restoration Plan, prepared for Blacklick Creek Watershed Association by L. Robert Kimball Consulting Engineers, January 2005
- South Branch Blacklick Creek Watershed Restoration Plan, prepared by PADEP Bureau of Abandoned Mine Reclamation, April 28, 2000
- The Kiski-Conemaugh River Basin Conservation Plan, prepared by the Kiski-Conemaugh River Basin Alliance, July 1999
- Aquatic Survey of the North and South Branches of Blacklick Creek, prepared by PADEP Bureau of Abandoned Mine Reclamation, March 21, 1997
- Abandoned Mined Lands Survey Demonstration, Indiana and Cambria Counties, Pennsylvania, Boone County, West Virginia, prepared for U.S. Department of the Interior, Bureau of Mines, prepared by Skelly and Loy, October, 1978
- Blacklick Creek Mine Drainage Pollution Abatement Project: Scarlift Report No. 185, prepared for Pennsylvania Department of Mines and Mineral Industries by Michael Baker Jr., Inc., March 1978
- Two Lick Creek Mine Drainage Pollution Abatement Project: Scarlift Report No. 109, prepared for Pennsylvania Department of Mines and Mineral Industries by L. Robert Kimball Consulting Engineers, March 1971

Methods

Biology and Habitat Survey

Biology and habitat data were obtained from two reports: a 2023 Conemaugh Valley Conservancy (CVC) report titled “Technical Assistance to Blacklick Creek Watershed Association: Macroinvertebrate Surveys of Blacklick Creek & Two Lick Creek” which evaluated macroinvertebrate populations in the watershed and a draft PADEP BAMR report on macroinvertebrate, fish, and habitat surveys in the watershed. CVC collected macroinvertebrate data in March and April 2023, and BAMR collected macroinvertebrate, fish, and habitat data in 2022 and 2023. Detailed methods for each can be found in the reports.

Precipitation Data

Precipitation data was obtained for the Indiana 3 SE station located 0.92 miles from the Two Lick Reservoir Dam. Data from this station is collected as a part of the National Weather Service’s Cooperative Observer Program and was retrieved from the Pennsylvania State Climatologist’s website.

AMD Survey

Two types of sampling efforts were undertaken: bi-monthly sampling and monthly discharge sampling. Bi-monthly sampling was conducted approximately every other month in October 2022, December 2022, February 2023, March 2023, June 2023, and August 2023. Sampling involved collecting flows and chemistry at about 30 instream, tributary, discharge, and treatment system locations in a single day. Map 1 gives an overview of the watershed with sampling locations, attaining and non-attaining streams, and watershed boundaries. See Appendix 1 for the names, descriptions, and latitude/longitude coordinates of sampling locations and all water quality data collected during this study. Bi-monthly sampling was completed by the Blacklick Creek Watershed Association (BCWA) members and volunteers, Hedin Environmental staff, Indiana County Conservation District staff, and St. Francis University staff and students.

Monthly discharge sampling was conducted from February 2024 to January 2025. Sampling involved collected flows and chemistry from important AMD discharges. Monthly discharge sampling was completed by Hedin Environmental staff and Indiana County Conservation District staff.

Flow rates, pH, conductivity, temperature, and alkalinity were measured in the field. Water samples were collected for analyses of pH, conductivity, alkalinity, hot acidity, total metal concentrations, and Fe(II) at the PADEP state laboratory. Average flows include zero where no flows were observed. Low flow rates were measured by an installed pipe and the timed volume method. High flow rates were measured using a flow meter. Briefly, a stream cross section absent of riffles or rocks was identified and velocity and depth was measured at approximately ten equally spaced intervals via an impeller flow meter at 60% of the water depth (e.g. a 1 ft depth, velocity was measured at 0.6 ft depth). Flow rate is calculated from the velocity, depth, and distance between the two intervals. More detailed stream flow measurement methods are provided by the USGS: <https://pubs.usgs.gov/tm/tm3-a8/tm3a8.pdf>

Data were aggregated and analyzed in Excel spreadsheets. Net acidity was calculated from field and lab data using equations below (Hedin, 2006). A comparison of measured and calculated net acidity values is presented in Appendix 4.

If pH <5, net acidity (calc) = $Al * 5.56 + Fe(II) * 1.78 + Fe(III) * 2.67 + Mn * 1.81 + 50000 * 10^{-pH - alkalinity}$

If pH >5, net acidity (calc) = $Fe(II) * 1.78 + Fe(III) * 2.67 + Mn * 1.81 + 50000 * 10^{-pH - alkalinity}$

A pH of 5 was used for the inclusions/exclusion of dissolved Al acidity because the solubility of dissolved Al decreases substantially above pH 5. Metal concentrations are in mg/L. When available, field pH and alkalinity were preferentially used over lab pH and alkalinity. Laboratory measured hot acidity (also called “net acidity” in this report) is used in this report unless otherwise noted.

Pollution loadings were calculated from concentration and flow rate data using the equation below. The 0.012 term converts mg to lb and minutes to days.

$$\text{Loading (lb/day)} = \text{Flow rate (gal/min)} * \text{Concentration (mg/L)} * 0.012$$

Mass balances were used to determine how much of the total pollution entering the stream was sampled. A detailed example of the calculations used in the mass balances is presented in Appendix 4.

Chapter 93 instream water quality standards from the Environmental Protection Agency (EPA) are shown in Table 1. These standards were referenced throughout this study for water quality determinations.

Table 1: EPA instream standards for common AMD pollutants.

Analyte	EPA Standard
Alkalinity	> 20 mg/L
Total Fe	< 1.5 mg/L
Total Al	< 0.75 mg/L
Total Mn	< 1.0 mg/L
SO ₄	< 250 mg/L

Results and Discussion

Biology and Habitat Survey

Table 2 shows the results of the CVC macroinvertebrate and habitat survey and whether the sampling location had good (IBI > 70), moderate (50 < IBI < 70), or poor (IBI < 50) biological conditions. At instream locations, the headwaters of TLC (North Branch and South Branch) had good and moderate biological conditions, respectively. The middle part of the watershed (TLC at Diamondville and Brown Run) had moderate biological quality. The downstream part of the watershed (TLC at Dixon Run and Sample Run) had poor biological conditions.

At tributary locations, poor biologic conditions were found at the mouth of Buck Run, the headwaters of Penn Run, the mouth of Penn Run, the middle of Dixon Run, and the mouth of Dixon Run. The headwaters of Dixon Run had moderate biologic conditions.

Table 2: Biological data collected by Conemaugh Valley Conservancy (CVC) in spring 2023 at instream and tributary locations on Two Lick Creek (TLC).

Location	Date	Latitude	Longitude	Temp. (C)	pH	Individuals	Genera	IBI Score	Condition
<i>Instream</i>									
N. Branch TLC at Starford	3/27/2023	40.6977	-78.9583	7.6	8.06	245	27	72	good
Mouth of S. Branch TLC	3/27/2023	40.6747	-78.9622	7.4	7.71	157	27	65	moderate
TLC at Diamondville	3/27/2023	40.6577	-78.9752	7.5	7.68	159	25	58	moderate
TLC US of Brown Run	3/27/2023	40.6578	-78.9751	8.0	7.70	267	31	66	moderate
TLC US of Dixon Run	4/7/2023	40.6716	-79.0121	8.1	7.92	22	7	31	poor
TLC US of Sample Run	4/12/2023	40.6575	-79.0298	11.3	4.84	61	10	24	poor
<i>Tributaries</i>									
Buck Run mouth	4/7/2023	40.6730	-79.0029	7	7.47	31	9	33.9	poor
Dixon Run at Pear Rd	3/30/2023	40.7286	-79.0041	8	8.05	239	25	72.8	good
Dixon Run at Dixonville	3/30/2023	40.7164	-79.0064	6	7.62	313	22	60.5	moderate
Dixon Run at Rd 24	3/30/2023	40.6855	-79.0118	5	7.27	4	4	24.6	poor
Dixon Run mouth	4/7/2023	40.6683	-79.0140	8	7.58	15	10	34.9	poor
Penn Run headwaters	4/12/2023	40.6286	-79.0016	16	8.00	172	13	25.1	poor
Penn Run mouth	4/12/2023	40.6375	-79.0354	13	7.20	15	8	31.6	poor

Table 3 shows the preliminary results of the BAMR macroinvertebrate surveys. Surveys were only conducted upstream of Buck Run. The surveys showed a mix of attaining and nonattaining.

Table 3: Macroinvertebrate data from surveys conducted by BAMR. NBSR240 = North Branch State Rt 240, NBTLM = North Branch Two Lick Mouth, SBTLHW = South Branch Two Lick Headwaters, SBTLM = South Branch Two Lick Mouth, TLCDSB = TLC downstream of the confluence of the N and S branches, TLCDSBH = TLC downstream of Diamondville borehole.

	NBSR240		NBTLM		SBTLHW		SBTLM		TLCDSB		TLCDSBH	
IBI Standardization and Aquatic Life Use Benchmark	SFS	LFS	SFS	LFS	SFS	LFS	SFS	LFS	SFS	LFS	SFS	LFS
Taxa Richness	0.67	0.71	0.48	0.52	0.73	0.77	0.7	0.74	0.58	0.61	0.55	0.58
EPT Taxa Richness PVT 0-4	0.53	0.63	0.32	0.38	0.53	0.63	0.53	0.63	0.21	0.25	0.42	0.50
Becks Index	0.39	0.68	0.29	0.50	0.32	0.55	0.24	0.41	0.24	0.41	0.24	0.41
Hilsenhoff Biotic Index	0.71	0.83	0.62	0.72	0.74	0.87	0.78	0.91	0.76	0.88	0.79	0.92
Shannon Diversity	0.88	0.88	0.53	0.53	0.97	0.97	0.85	0.85	0.84	0.84	0.82	0.82
Percent Sensitive PTV 0-3 Individuals (PSI)	0.42	0.54	0.26	0.33	0.58	0.73	0.60	0.76	0.66	0.84	0.67	0.85
ALU Benchmark	60.04	71.06	41.62	49.52	64.35	75.24	61.42	71.50	54.63	63.81	58.02	67.97
Attaining?	No	Yes	No	No	Yes	Yes	No	Yes	No	Yes	No	Yes

The habitat surveys conducted by BAMR showed habitat conditions ranging from optimal to marginal throughout the survey locations. When considering the biological conditions in the UTLC Watershed in the future, the completed biological assessment report from BAMR discussing these surveys in detail should be requested for reference.

Biological conditions in the headwaters of the North and South branches of UTLC had the best biologic conditions of the watershed with numerous fish species (including trout) and elevated ALU and IBI scores in both BAMR and CVC surveys. Downstream of the confluence of the north and south branches, biological conditions worsened to moderately attaining. Finally, downstream of the confluence of UTLC and Dixon Run, biologic conditions decreased to poor levels and remained poor downstream to the reservoir. The biological conditions of major tributaries to UTLC, Buck Run, Dixon Run, and Penn Run, were generally poor.

Habitat was optimal to marginal in UTLC, so as water quality improvements are made, the habitat conditions in UTLC should be reviewed to determine if this is a deterrent to the development of biological life.

Precipitation

Figure 1 compares historic precipitation to the precipitation during the study period. Historic precipitation was determined as the average total monthly precipitation from 2012 through January 2025. Total historic precipitation over these months was 96 inches. Total actual precipitation over this study was 92 inches. The study period was, on average, slightly drier than the past decade.

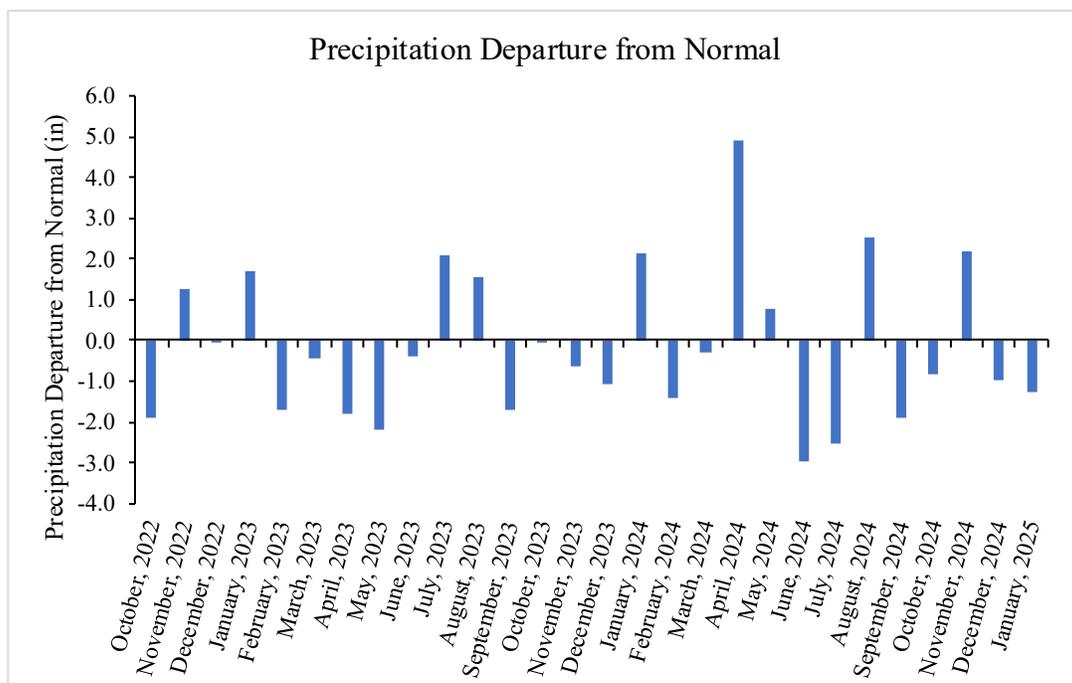


Figure 1: Total monthly precipitation during the study period minus historic precipitation.

Water Quality

UTLC Instream

To determine the water quality changes in the main stem of ULTC, water samples were collected for laboratory analyses above and below the major tributaries and known discharges. In this study, the North Branch is considered the headwaters of UTLC while the South Branch is considered a major tributary.

Figures 2 through 6 show a variety of instream water quality data at the instream locations. These figures illustrate that the entire length of UTLC was generally good quality. Figure 2 shows UTLC was net alkaline from the headwaters to the reservoir with average alkalinity concentrations ranging from 91 to 54 mg/L. For the entire length of UTLC, Fe concentrations were less than 1.2 mg/L (Figure 3), and Mn concentrations were less than 0.3 mg/L (Figure 5). On average, pH was around 7 for the length of UTLC (Figure 6). Aluminum concentrations varied from less than 0.5 mg/L in the headwaters to 0.9 mg/L near the mouth (Figure 4). Table 4 presents the average instream water quality for instream sampling locations from the headwaters to the reservoir.

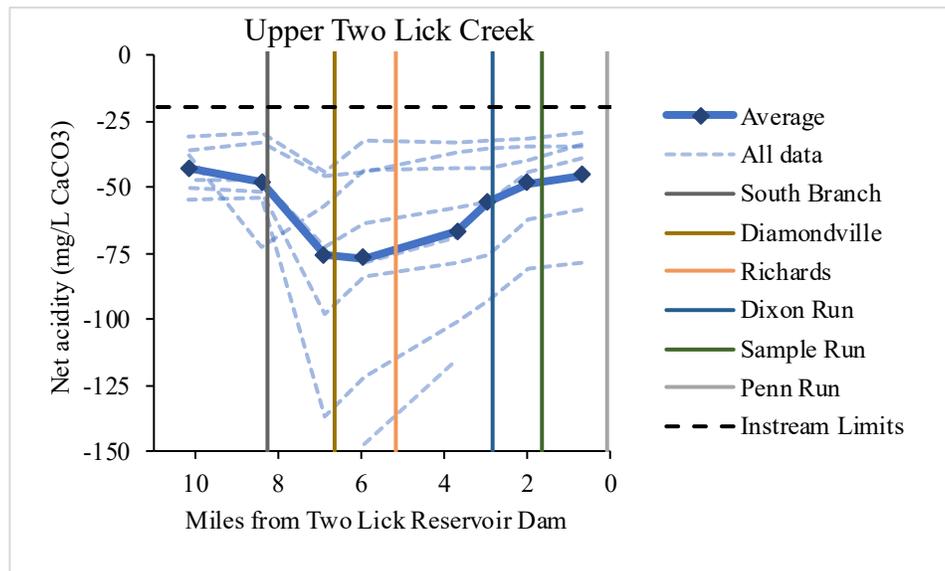


Figure 2: Instream samples graphed showing all sampling events and the average net acidity.

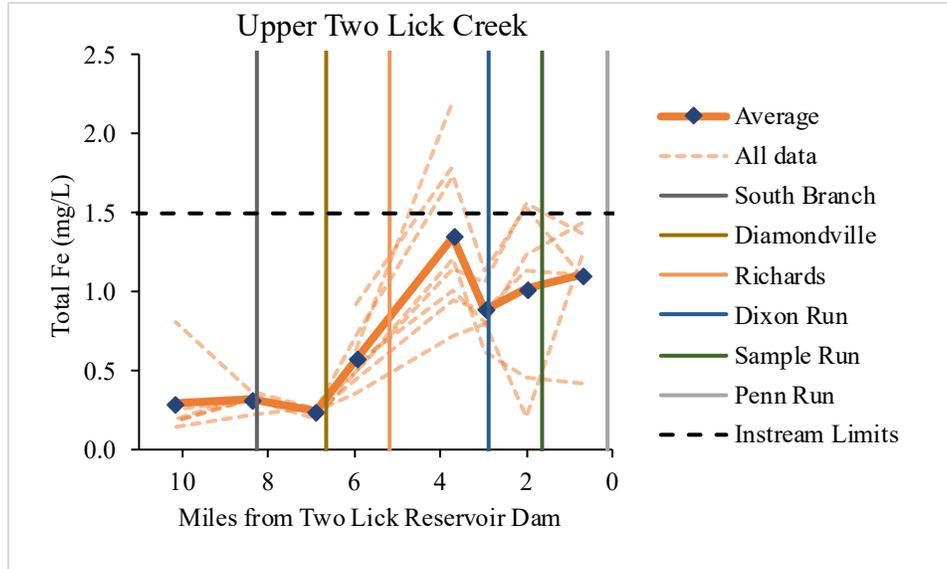


Figure 3: Instream samples graphed showing all sampling events and the average total iron concentrations.

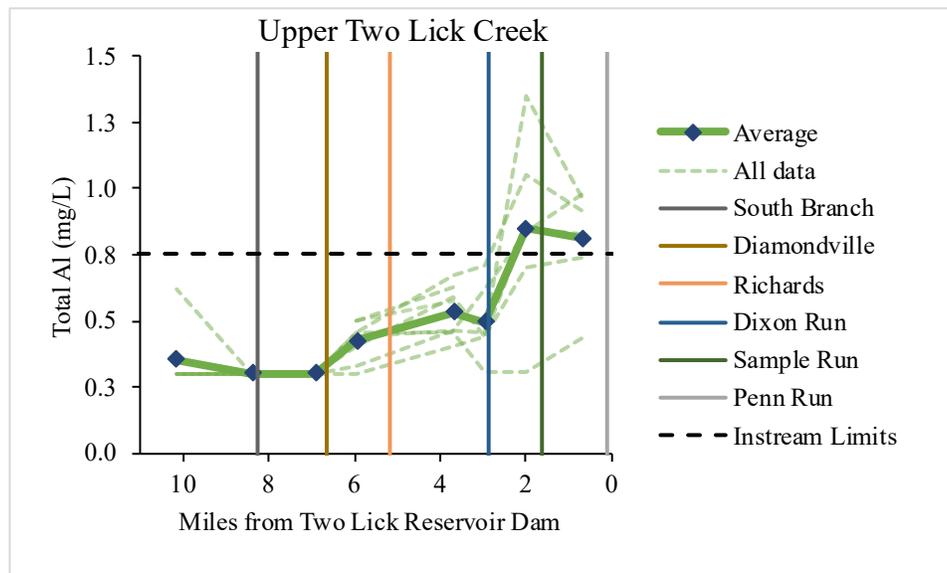


Figure 4: Instream sampling graphed showing all sampling events and the average total aluminum concentrations.

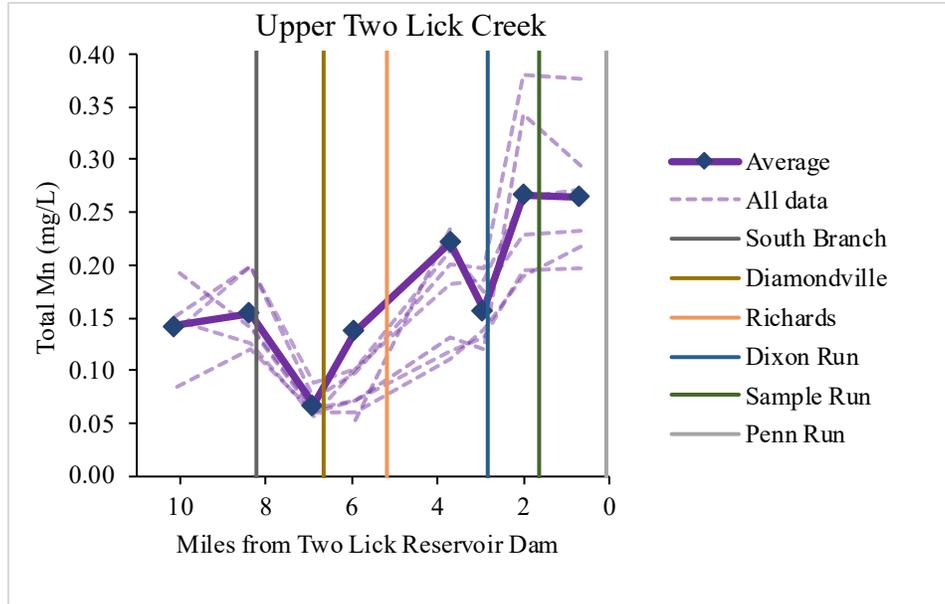


Figure 5: Instream samples graphed showing all sampling events and the average total manganese concentrations.

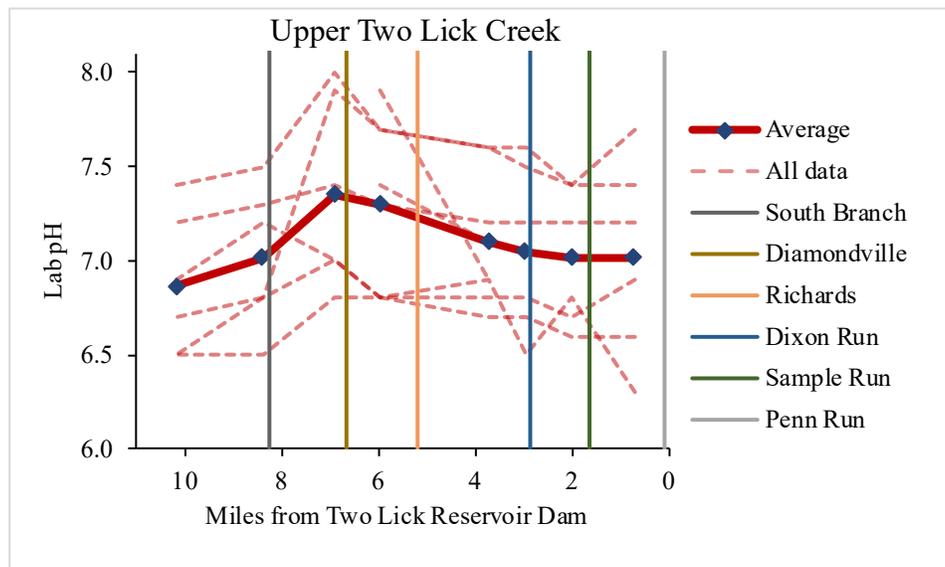


Figure 6: Instream samples graphed showing all sampling events and the average lab pH values.

Table 4: Average instream chemistry for UTLC. (#) = number of samples. The 'Into reservoir' sampling location was calculated from the upstream data.

Stream mile from reservoir	Location	Field pH	Field alkalinity	Net acidity	Fe	Al	Mn
			mg/L				
12.89	Two Lick headwaters (2)	7.67	35	-30	0.2	0.3	0.1
11.60	Two Lick upstream T12 (2)	7.28	38	-55	0.2	0.3	0.1
10.90	Two Lick upstream T11 (2)	7.62	48	-54	0.5	0.3	0.1
10.16	Two Lick south of Starford (6)	7.49	50	-43	0.3	0.4	0.1
8.39	Two Lick upstream of South Branch (6)	7.60	59	-48	0.3	0.3	0.2
6.90	Two Lick upstream of Diamondville (6)	7.83	83	-76	0.2	0.3	0.1
5.95	Two Lick downstream of Diamondville (8)	7.52	90	-77	0.6	0.4	0.1
3.70	Two Lick above Buck Run (8)	7.46	80	-67	1.3	0.5	0.2
2.95	Two Lick above Dixon Run (6)	7.76	72	-56	0.9	0.5	0.2
2.00	Two Lick above Sample Run (6)	7.46	63	-49	1.0	0.8	0.3
0.70	Two Lick above Penn Run (6)	7.51	53	-46	1.1	0.8	0.3
0.00	Into reservoir (2)	7.42	56	-42	1.1	0.7	0.4

Overall, water quality in the main stem of UTLC was good. Fe concentrations increased the most around the Richards area, at times reaching 2 mg/L. Al concentrations increased most from Dixon Run, at times reaching 1 mg/L.

This report is divided into sections from upstream to downstream based on the impactful AMD inputs. The sections are as follows: UTLC Headwaters, Diamondville Borehole discharge, Richards Area, Dixon Run, Sample Run, and Penn Run. The sections about the tributaries Dixon Run, Sample Run, and Penn Run focus on each tributary's impact on UTLC as well as the tributary's own water quality and AMD pollution sources.

UTLC Headwaters

The headwaters of UTLC are considered everything above the Diamondville Borehole discharge and include the North and South branches. The headwaters had the best water quality in the watershed.

Instream

Table 5 shows the average chemistry for the instream sampling locations in the headwaters. Map 3 shows sampling locations in this section. On average, the headwaters had all metals below instream limits and were net alkaline.

Table 5: Average instream water quality data from the sampling locations in the headwaters of UTLC. (#) = map ID.

Location	Flow	Field pH	Field alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al	Mn
	gpm		mg/L						ppd			
Two Lick headwaters (S11)	448	7.67	35	-30	0.2	< 0.3	0.1	17	-140	1	N/A	0
Two Lick upstream of T12 (S10)	1,109	7.28	38	-55	0.2	< 0.3	0.1	137	-641	3	N/A	1
Two Lick upstream of T11 (S9)	1,594	7.62	48	-54	0.5	< 0.3	0.1	137	-641	3	N/A	1
Two Lick south of Starford (S8)	3,989	7.49	50	-43	0.3	0.4	0.1	108	-1,852	9	14	1
Two Lick upstream of South Branch (S7)	4,279	7.60	59	-48	0.3	< 0.3	0.2	116	-1,922	18	N/A	8
Two Lick upstream of Diamondville (S6)	11,941	7.83	83	-76	0.2	< 0.3	0.1	57	-8,324	34	N/A	10

Tributaries

Table 6 shows the average chemistry for major tributaries to UTLC. The South Branch had the highest flow of these and was consistently clean with metals below instream limits, pH > 7, and was net alkaline. Many of the tributaries were net alkaline with extremely low metals concentrations similar to the South Branch. T7, T8, and T9 were minorly polluted by AMD with low metal loadings and were not investigated or monitored further.

Table 6: Average chemistry of the tributaries in the headwaters of UTLC. (#) = map ID.

Location	Flow	Field pH	Lab alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L						ppd		
T14	33	7.06	23	-9	0.1	< 0.3	0.0	10	-3	0	N/A
T13	52	7.04	32	-25	0.1	< 0.3	0.0	10	-18	0	N/A
T12	109	7.45	28	-13	0.1	< 0.3	0.1	252	-15	0	N/A
T11	374	7.94	43	-31	0.1	< 0.3	0.0	42	-186	0	N/A
Pompey Run Mouth (T10)	80	7.56	40	-28	0.1	< 0.3	0.0	17	-25	0	N/A
T9	8	4.40	0	22	0.2	1.6	0.8	283	2	0	N/A
T8	80	4.32	0	19	1.0	1.3	0.4	133	18	1	1
T7	15	5.56	7	-1	0.9	< 0.3	0.0	N/A	0	0	N/A
South Branch Mouth (T6)	7,155	7.83	111	-97	0.2	< 0.3	0.0	17	-6,244	19	26

Diamondville Borehole Discharge

The Diamondville borehole (D2) is a discharge located 6.7 miles upstream of the reservoir near the town of Diamondville. As displayed in Photo 1, this is a point source discharge from an abandoned borehole into the Mack #2 mine that then flows about 100 feet into UTLC. It is not listed in PADEP's AML inventory.



Photo 1: Diamondville borehole upwelling from the mine (left) and entering UTLC (right).

Instream

Table 7 shows the instream water quality data from UTLC upstream and downstream of the Diamondville borehole. Map 4 shows sampling locations in this section. Fe concentrations increased by 0.4 mg/L and loadings increased by 32 ppd. Figures 3 through 5 show that Diamondville borehole did not substantially increase instream metal concentrations.

Table 7: Instream chemistry above and below the Diamondville borehole and the Richards area. Loadings on Two Lick Creek were calculated from 2 samples averages. (#) = map ID.

Location	Flow	Field pH	Field alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L						ppd		
Two Lick US of Diamondville (6S)	11,941	7.83	83	-76	0.2	< 0.3	0.1	57	-8,324	34	N/A
Two Lick DS of Diamondville (S5)	9,103	7.52	90	-77	0.6	0.4	0.1	79	-7,169	66	41

Discharge

Table 8 shows the average, minimum, and maximum flows and pollution concentrations for the Diamondville borehole. This discharge was low pH and polluted with Fe and Al. Despite the high flows and net acidity loadings (798 ppd), the discharge was neutralized and diluted by UTLC (-8,324 ppd net acidity).

Table 8: Average, minimum, and maximum chemistry of the Diamondville borehole discharge. (#) = map ID.

Location		Flow	pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
		gpm		mg/L					ppd		
Diamondville borehole (D2)	Avg	256	2.70	333	31.5	28.6	1.4	674	798	75	68
	Min	112	2.96	297	22.1	25.8	1.3	626	453	33	40
	Max	539	2.17	377	46.3	31.5	1.6	773	1,948	182	177

Richards Area of UTLC

The Richards area is the 1.5-mile-long section of UTLC downstream of the Diamondville borehole and extends from the Diamondville borehole to Buck Run. It is named the Richards area because of the Richards passive treatment system in this reach. This stream section gained acidity and metals from numerous sources. AMD sources here include seepage from abandoned refuse piles, several low flow acidic, high Al unnamed tributaries, the Richards treatment system, and seepage from the Lower Kittanning coal crop line. Map 4 shows the sampling locations in this section of UTLC.

Instream

On average, UTLC above the Richards area had good water quality with all metals below instream limits and net alkalinity. AMD sources in the Richards area increased Fe concentrations to just below instream standards. Occasionally, instream Fe concentrations exceeded 1.5 mg/L (Figure 3).

Table 9 shows instream water quality data from UTLC upstream of the Richards area (DS of Diamondville) and downstream of the Richards area (US of Buck Run). Fe concentrations increased by 0.7 mg/L, and Fe loadings increased by 96 ppd.

Table 9: Instream chemistry above and below the Diamondville borehole and the Richards area. Loadings and flows were calculated from 4 samples averages. (#) = map ID.

Location	Flow	Field pH	Field alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L						ppd		
Two Lick DS of Diamondville (S5)	9,103	7.52	90	-77	0.6	0.4	0.1	79	-7,169	66	41
Two Lick US of Buck Run (S4)	10,010	7.46	80	-67	1.3	0.5	0.2	105	-6,825	162	58

Photo 2 shows UTLC upstream of Buck Run with turbidity, a blue coloration from metals, and Fe solids coating the bottom of the stream channel.



Photo 2: UTLC downstream of the Richards area on 10/11/22 (left) and 8/23/24 (right).

Tributaries and Discharges

There were numerous polluted tributaries and AMD discharges in the Richards Area of UTLC. One discharge is treated at the Richards passive treatment system in this section. Map 5 shows some of the key discharge locations in relation to mine maps.

The Richards System was built in 1999 to treat a discharge from the abandoned Victor No 45 deep mine. The passive system was expanded in 2003 and rehabilitated in 2021. BCWA manages the system. The system was built in AML inventory site PA 2436, and the Operation Scarlift report shows an old refuse pile in the location of the current treatment system. The flow is split between three vertical flow ponds (VFP) which are followed by settling ponds or wetlands. VFP #1 has a separate settling pond and effluent from VFPs #2 and #3 which discharge into the same wetland and have a combined effluent. Table 10 shows the chemistry of the influent and effluents post-2021 modifications. The system reduced acidity and metal concentrations but was discharging on average 5 mg/L and 8 ppd of Fe from the #2 and #3 effluent of the system. The effluent of the settling pond for VFP#1 had Fe and Al below detections limits but was missing an average of 30gpm of flow when compared to the outfall of VFP#1 into the settling pond, suggesting the pond was leaking.

Table 10: Average chemistry data on the influent and final effluents of the Richards System. Some data was collected as part of this study, and some was provided by BCWA.

	Flow	Field pH	Lab alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L						ppd		
Influent KBLRS1	130	2.99	0	185	18.0	15.3	1.5	423	272	25	21
Effluent of #1 KBLRS5	15	7.30	197	-164	<0.3	<0.5	2.0	383	-41	N/A	N/A
Effluent of #2 and #3 KBLRS6	123	6.69	115	-91	5.2	0.4	1.9	414	-133	8	1

Buck Run is the only major tributary in this section of UTLC and joins it downstream of the treatment system. Table 11 shows average chemistry at the mouth of Buck Run. In previous reports, Buck Run was a noteworthy acidity and metal loader in the watershed. During this study, this tributary was net alkaline with negligible metals loadings, and as such, it was not a priority in this study. Even so, biological conditions in it were determined to be poor in CVC's 2023 report.

Table 11: Average chemistry of the tributaries upstream of Dixon Run. (#) = map ID.

Location	Flow	Field pH	Lab alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L						ppd		
Buck Run Mouth (KBLBUC)	848	7.43	21	-9	0.5	1.6	0.3	151	-144	4	15

Table 12 presents the average chemistry of the AMD sources sampled in this section. Of the AMD sources identified in this section of UTLC, T1 was the largest. The T1 discharge originates

from an abandoned mine opening in the Swank #6 mine in the Lower Kittanning coal seam (Photo 3). There is a kill zone from where it exits the mine down a steep hill where it spreads out, until it is channeled into a drainage pipe under Route 403 and continues downhill until it enters UTLC. This discharge is referenced in the Operation Scarlift Report, is in AML inventory site PA 2438, and is near AML inventory point PA 2438-01.



Photo 3: Source of T1 discharge (left) and kill zone before it reaches Rt 403 (right).

T5.5 and T5.25 discharges are from drainage culverts piped under Route 403. They convey drainage off an abandoned refuse pile in PA 2438-05 AML polygon which is listed as reclamation complete, but the drainage from it was high in Al and Fe. This refuse dump is referenced in the Operation Scarlift report, but there is no mention of acidic drainage from it.

The Mack mine discharge (D1) originates from an abandoned mine opening into the Mack #2 mine in the Lower Kittanning coal seam and is listed in the Operation Scarlift report. A small UNT, T5, is also present in this section.

Finally, Seep 1 originates from underneath the Richards System and enters UTLC as diffuse seepage from the stream bank. It is not possible to measure flow rates of this seepage. Presumably, the seep originates from abandoned refuse shown in the Operation Scarlift report. The Richards System is built on this refuse pile, and therefore, reclamation is not possible.

Table 12 shows the average chemistry of the AMD sources identified in the Richards Area. Seep 1 was low pH with high concentrations of Fe and Al. T1 had low flow averaging 14 gpm with high concentrations of Fe (86 mg/L) and Al (43 mg/L). As a result of the high metals concentrations, this discharge was low pH with an average acidity of 572 mg/L.

D1 had low flow with Fe concentrations at 21.8 mg/L and Al concentrations at 15.6 mg/L. T5 had low flow and negligible metals loadings. T5.5 and T5.25 discharges had a seasonal variation in flow, drying up completely during months when there was little to no precipitation. Their flow

probably increases during high precipitation events as rain infiltrates into the refuse pile. They each have high concentrations of Al (20-35 mg/L), with low pH, and high acidity.

Table 12: Average chemistry of discharges entering Two Lick Creek in the Richards area. (#) = map ID.

Location		Flow	pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al	
		gpm		mg/L					ppd			
Seep 1	Avg	N/A	3.46	191	43.4	13.2	2.5	564	N/A	N/A	N/A	
	Min	N/A	4.11	143	10.4	9.7	2.3	507	N/A	N/A	N/A	
	Max	N/A	2.44	350	84.9	25.5	2.7	734	N/A	N/A	N/A	
T1	Avg	14	2.96	572	86.0	42.9	1.5	899	93	15	7	
	Min	6	5.18	294	16.3	26.5	1.2	464	44	5	3	
	Max	26	2.15	695	225.6	48.9	1.7	1,114	161	51	11	
Mack mine discharge, D1	Avg	10	3.12	233	21.8	15.6	1.5	538	29	2	2	
	T5	Avg	35	4.10	36	0.6	3.2	2.6	264	15	0	1
	T5.5	Avg	6	3.32	144	8.9	20.0	1.2	269	10	1	1
T5.25	Avg	2	3.65	237	3.8	35.4	1.7	536	4	0	1	

Ultimately, T1 was the most significant discharge in the Richards Area due to its elevated acidity and Fe loadings.

Mass balances

A detailed discharge sampling effort was conducted on 2/23/2024 to prioritize AMD sources in the Richards area and determine how much AMD pollution was from non-point sources. Table 13 shows the mass balances done in this section.

Table 13: Loadings and percent contribution at UTLC upstream of Buck Run of acidity and metals in the Richards area.

Location	Net acidity	Fe	Mn	SO ₄	Net acidity	Fe	Mn	SO ₄
	ppd				%			
Two Lick downstream of Diamondville	-7,169	66	9	4,556	105%	38%	41%	69%
Richards system out	-114	4	2	326	2%	2%	13%	5%
Mack mine discharge	14	2	0	13	0%	1%	0%	0%
T5	15	0	1	32	0%	0%	4%	1%
T1	154	37	0	235	-3%	28%	3%	3%
T5.5	0	0	0	0	0%	0%	0%	0%
T5.25	1	0	0	4	0%	0%	0%	0%
<i>Upstream Sum</i>	<i>-7,098</i>	<i>108</i>	<i>12</i>	<i>5,166</i>				
Two Lick above Buck Run	-6,825	162	19	6,602				
Accounted for					103%	70%	62%	62%
<i>Unaccounted for</i>	<i>273</i>	<i>54</i>	<i>6</i>	<i>1,435</i>	<i>-3%</i>	<i>30%</i>	<i>38%</i>	<i>38%</i>

The major sources of Fe to TLC are from upstream, T1, and unaccounted for sources. Treating T1 is the only realistic source reduction strategy and removing this loading would help to decrease the elevated Fe concentrations present downstream.

However, 30% to 38% of the Fe, Mn, and SO₄ loadings were unaccounted for. Unaccounted for sources include Seep 1, polluted baseflow from the Lower Kittanning coal seam which outcrops in the stream near the Richards system, and unidentified sources. Unfortunately, there are few practical solutions to eliminate either of these non-point source pollution sources, so no further characterization of this seepage was done in this study.

Dixon Run

Dixon Run is an 11 square mile tributary to UTLC whose confluence with UTLC is in Clymer, PA, 2.9 miles upstream of the reservoir. This tributary gained acidity and metals from numerous AMD sources and was impaired from Dixonville to its mouth. AMD sources here include seepage from abandoned refuse piles and two high flow acidic, high Fe and Al discharges. Map 6 shows the sampling locations, AML areas, and coal outcrops in Dixon Run.

Instream

Dixon Run was a significant metal loader to UTLC. Table 14 shows the average instream chemistry on UTLC above and below Dixon Run. Downstream of Dixon Run, Al concentrations in UTLC increased by 0.4 mg/L. Other minor chemical changes occurred, but the increase in Al was the most significant as this was the first instream location where it exceeded the instream Al limit.

Table 14: Average instream chemistry in this section above and below the Dixon Run. Loadings were calculated from two samples averages. (#) = map ID.

Location	Field pH	Field alkalinity	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
		mg/L						ppd		
Two Lick above Dixon Run (S3)	7.76	72	-56	0.9	0.5	0.2	88	-8,079	159	95
Dixon Run mouth (KBLDIX)	6.85	37	-22	3.4	2.5	0.7	226	-1,533	187	130
Two Lick above Sample Run (S2)	7.46	63	-49	1.0	0.9	0.3	121	-9,789	295	178

Table 15 shows the instream chemistry in Dixon Run. All four sample locations in the main stem of Dixon Run had a pH in the mid-6 to low 7 range and were net alkaline. Fe and Al concentrations fluctuated throughout the length of Dixon Run due to mine drainage entering the stream at different locations. Dixon Run from its headwaters to Dixonville was good quality. Instream metal concentrations increased between Dixonville and just north of the Dixonville Loyal Order of Moose (Moose Lodge) because of refuse seepage in this section.

Rosebud Mining Company has a coal preparation plant and refuse disposal areas located ~1.2 miles upstream from the mouth of Dixon Run. They have two NPDES discharge points, numerous coal-storage areas, and treatment ponds. All their facilities are active and in

compliance as of April 2025. Rosebud Mining Company monitors Dixon AMD 2 and Dixon AMD 1 discharges but does not treat these abandoned discharges. Metal concentrations were generally consistent from the Moose Lodge to upstream of Rosebud’s Clymer Prep Plant after which they increase due to two AMD discharges.

Table 15: Average instream chemistry on Dixon Run. (#) = map ID.

Location	Field pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
		mg/L				ppd			
Dixon Run at Dixonville (T15)	6.53	-69	0.1	0.3	0.0	113	-2,081	5	10
Dixon Run at Moose Lodge (Dixon Moose)	7.11	-59	2.0	0.7	0.2	134	-2,375	88	27
Dixon Run upstream of Prep Plant (Dixon Mid)	6.83	-54	1.3	0.8	0.4	173	-2,532	84	57
Dixon Run Mouth (KBLDIX)	6.85	-22	3.4	2.5	0.7	226	-1,533	187	130

Tributaries and Discharges

There were two areas of AMD sources in Dixon Run. One area is just north of the Dixonville Loyal Order of Moose and the other area is just south of Rosebud’s Clymer prep plant. Table 16 shows the AMD sources. Map 7 shows the main discharges in relation to historic mine maps.

The Barr slope tributary enters Dixon Run about 1,200 feet upstream of the Moose lodge. The tributary is net alkaline with low concentrations of metals. The headwaters of the Barr Slope tributary have extensive mine workings. This tributary was not further investigated as it was not significantly polluted and much of the headwaters of the Barr Slope tributary are on private property.

The Dixon 3 discharge enters Dixon Run about 750 feet upstream of the Moose lodge. The discharge is a diffuse seep zone at the streambank. The chemistry is severe, suggesting it is refuse seepage. It is identified as a “Mine Dump” on USGS maps, and it is in AML inventory site PA 4027 but is not listed as an AML polygon. There is a coal refuse area marked on the mapping in the Operation Scarlift report in the location of the “Mine Dump”. It is now a revegetated and farmed field. Reclamation may have been completed as a RAMP project that regraded and revegetated spoil/refuse piles but did not amend them with alkaline material.

There were no AMD inputs between the Moose Lodge and Rosebud’s Clymer prep plant, so the instream metals decreased slightly as clean tributaries entered Dixon Run.

Downstream of Rosebud’s Clymer Prep Plant and near the mouth of Dixon Run, two significant discharges were Dixon AMD 2 and Dixon AMD 1 seen in Photo 4. Both discharges were high flow and polluted with acidity and high concentrations of Fe and Al. Both are referenced in the Operation Scarlift report, and they likely originate from the Victor #29 mine that is approximately 276 acres in the Lower Kittanning coal seam. Dixon AMD 2 originates from an abandoned mine opening and is in the Operation Scarlift report as a dry mine opening. It is not listed in PADEP’s AML database but is adjacent to AML inventory site PA 2432. Rosebud’s Clymer Prep Plant is just upstream of Dixon AMD 2’s source. Dixon AMD 1 is in AML

inventory site PA 2432 and near the location of AML point 2432-04 which is described as an abandoned untreated discharge.

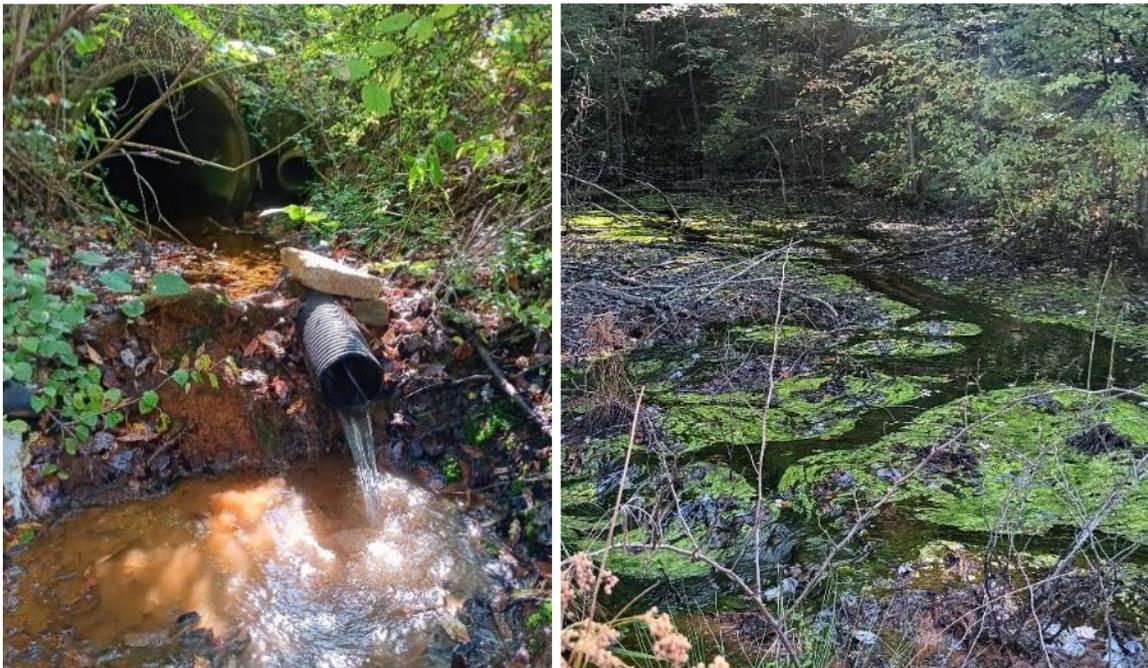


Photo 4: Dixon AMD 1 before it reaches the railroad (left) and Dixon AMD 2 near its source (right).

Table 16 shows the average, minimum, and maximum chemistry for these discharges and for the Barr Slope tributary. The Barr Slope tributary was net alkaline with 6.5 mg/L of Fe and 3.6 mg/L of Al. It accounted for the majority of the Al loadings in the headwaters of Dixon Run. The refuse seepage upstream of the Moose Lodge (Dixon 3) accounted for the additional metal loadings found downstream of the lodge. Dixon 3 flow rates were calculated from mass balances upstream and downstream of the seepage and chemistry of the seepage.

Dixon AMD 2 and Dixon AMD 1 discharges were similar in chemistry. Dixon AMD 2 had a higher flow with an average of 163 gpm versus Dixon AMD 1 which had an average of 43 gpm. These two discharges had significant seasonal changes in flow. Figure 7 shows total monthly precipitation and discharge flow rates. In April 2024, which received an unusually large amount of precipitation, Dixon AMD 2 discharged 456 gpm, and Dixon AMD 1 discharged 159 gpm. Fe and Al concentrations increased 10 to 20mg/L above the average metal concentrations. This is characteristic of up dip draining mines like the Victor #29 mine. When precipitation increases, the mine pool elevation increases into areas of the mine with more acidic/reactive material due to its limited exposure to water in dry weather. This results in an increase in flow with more acidity and higher concentrations of metals than under normal flow conditions.

Conversely, the fall of 2024 received an unusually low amount of rain, and the discharges decreased in flow to their minimum recorded flow rates, and metal concentrations returned to average values. These discharges' flow rates were influenced by precipitation events and as such had variable flow rates and an increase in metals loadings during high flow events.

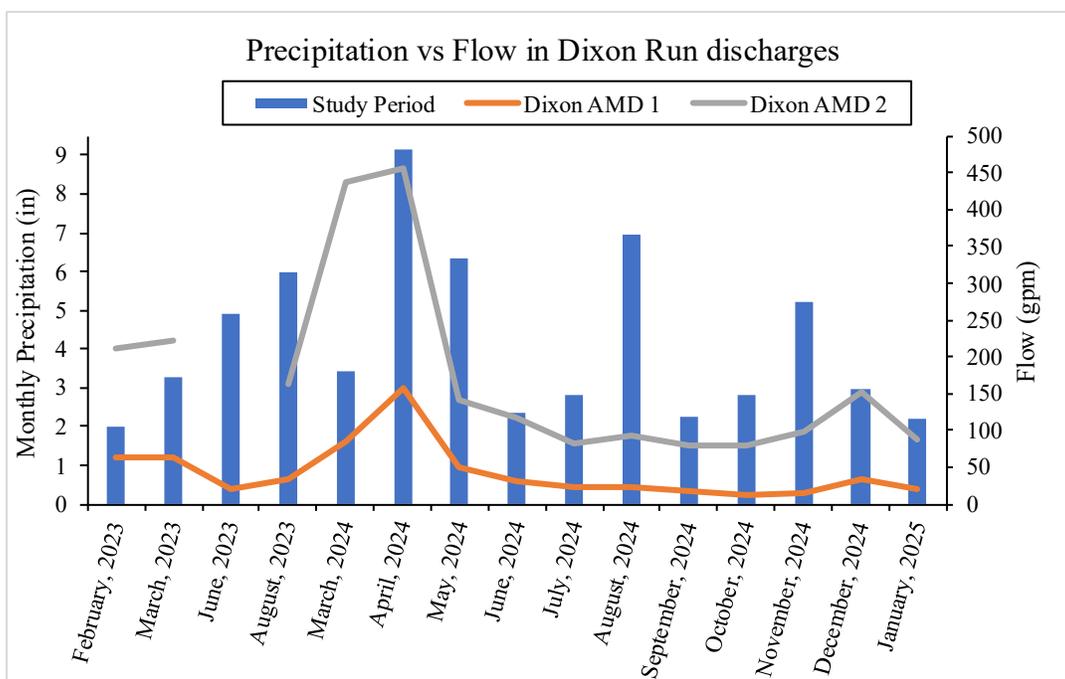


Figure 7: Monthly precipitation vs flow of the Dixon AMD 2 and Dixon AMD 1 discharges.

Table 16: Average, minimum, and maximum chemistry of discharges and tributaries on Dixon Run. (#) = map ID.

Location		Flow	Field pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
		gpm		mg/L					ppd		
Barr Slope trib (Dixon Barr)	Avg	492	6.98	-60	6.5	3.6	0.4	80	-447	66	35
Dixon 3	Avg	19	2.38	7,366	1,854.5	500.5	24	8,628	577	45	10
Dixon AMD 2	Avg	163	2.91	396	29.4	34.7	4.9	1,520	788	64	72
	Min	22	3.94	274	20.6	24.5	3.8	919	389	22	32
	Max	456	2.36	563	45.1	46.2	6.1	5,075	2,488	230	253
Dixon AMD 1	Avg	43	2.90	293	10.2	32.4	2.0	630	140	8	14
	Min	13	3.30	149	5.5	14.6	1.1	298	60	2	6
	Max	159	2.47	485	35.8	54.7	2.9	1,009	694	68	64

The combined impact of the Dixon AMD 2 and Dixon AMD 1 discharges made them the most significant discharges in the Dixon Run watershed and in the UTLC watershed, due to the impact of Dixon Run on Two Lick Creek. Dixon 3 contributes a notable amount of acidity and metals to the upper section of Dixon Run as well.

Mass balances

Mass balances completed in Dixon Run accounted for 79% of the flow, 118% of Mn, and 120% of SO₄. Table 17 shows the percentage of loadings that the AMD inputs and Barr Slope tributary accounted for at the mouth. The Dixon AMD 2 discharge had the highest acidity loadings and

had the largest percentage of the Al loadings of the discharges making it the most significant discharge in Dixon Run.

Table 17: Loadings and percent contribution at Dixon Run's Mouth of acidity and metals in Dixon Run.

Locations	Net acidity	Al	Mn	SO ₄	Net acidity	Al	Mn	SO ₄
	ppd				%			
Dixon Run at Dixonville	-1812	9	1	2,903	201%	9%	4%	31%
Barr Slope trib	-971	28	4	1,459	188%	123%	27%	23%
Dixon 3	355	29	15	1,992	36%	21%	42%	23%
Dixon AMD 2	501	55	11	3,006	4%	50%	43%	41%
Dixon AMD 1	108	11	1	253	-13%	14%	3%	3%
<i>Upstream Sum</i>	<i>-1,819</i>	<i>132</i>	<i>32</i>	<i>9,612</i>	<i>416%</i>	<i>217%</i>	<i>118%</i>	<i>120%</i>
Dixon Run Mouth	-1,513	122	35	10,186				

Sample Run

Sample Run enters UTLC 1.6 miles upstream from the reservoir and approx. 1.3 miles downstream of Dixon Run. It is a relatively small tributary and had minimal impact on the stream. Map 8 shows the sampling locations and AML inventory sites in Sample Run.

Instream

Table 18 shows the instream chemistry of UTLC above and below its' confluence with Sample Run. Iron concentrations increase by 0.1 mg/L and alkalinity decreases by 10 mg/L below Sample Run on UTLC. The impact of Sample Run on UTLC is negligible, and the creek is able to assimilate the loadings of the tributary.

Table 18: Average instream chemistry in this section above and below the Sample Run. Loadings were calculated from two samples averages. (#) = map ID.

Location	Field pH	Field alkalinity	Net acidity	Fe	Al	SO ₄	Net acidity	Fe	Al
			mg/L				ppd		
Two Lick above Sample Run (S2)	7.46	63	-49	1.0	0.9	121	-9,789	295	178
Two Lick above Penn Run (S1)	7.51	53	-46	1.1	0.8	121	-9,040	229	168

Table 19 shows water quality in Sample Run. The stream follows an old railroad grade which separates the stream into two tributaries. The east tributary of Sample Run (considered the headwaters in this project) was called "Sample Run upstream of refuse pile trib". This tributary was severely degraded by AMD and was low pH with high concentration of metals. When this tributary of Sample Run was walked, no point sources of AMD were identified, but it slowly gained polluted water likely from the coal waste on the hill above. The mouth of Sample Run, just upstream of the culvert under Route 286, contains piles of coal waste and dangerous mine features and is severely impacted by AMD with a pH of 3 and net acidity of 450 mg/L.

Table 19: Average instream chemistry in Sample Run. (#) = map ID.

Location	Field pH	Field alkalinity	Net acidity	Fe	Al	SO ₄	Net acidity	Fe	Al
		mg/L				ppd			
Sample Run upstream of refuse pile trib (Sam3)	3.57	0	859	63.4	113.2	1,406	255	21	34
Sample Run Mouth (KBLSAM)	3.25	0	450	53.5	37.8	880	534	78	59

Tributaries and Discharges

Sample Run contains two abandoned refuse piles in AML area PA 2439. PA 2439-01, eastern refuse pile, and PA 2439-02, western refuse pile, are listed as abandoned. These piles are located approximately 0.5 miles from the mouth of the stream. There are also abandoned deep mine workings in the headwaters of Sample Run, but investigation did not find any discharge from these workings.

The tributary on the western side of the railroad grade which separates Sample Run into two tributaries is clean (clean trib). The refuse pile trib originates from the AML feature on the hill to the east of the Sample Run.

Photo 5 shows the refuse pile tributary under low flow conditions. As of February 2025, BAMR was in the process of investigating the composition of the refuse piles in Sample Run to determine if/how these can be reclaimed to remove their drainage as a pollution source for the stream.

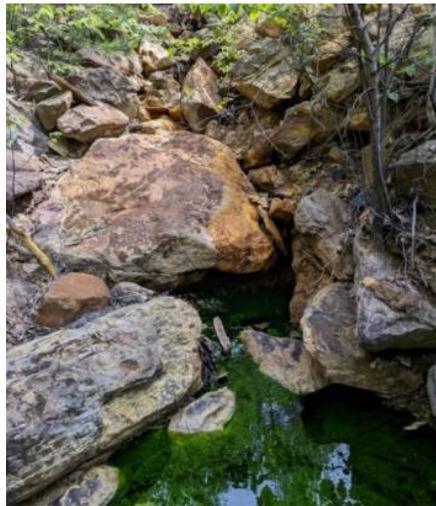


Photo 5: Refuse pile tributary of Sample Run taken on 8/31/2023.

Table 20 shows the chemistry for the tributaries in Sample Run. The refuse pile trib contains severe AMD with 4,183 mg/L net acidity. The clean tributary was net alkaline and minorly diluted the effects of the refuse pile drainages.

Table 20: Average of tributaries to Sample Run. (#) = map ID.

Location	Flow	Field pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L				ppd			
Refuse pile trib (Sam2)	31	2.47	4,183	860.2	318.1	0.0	4,811	390	74	36
Clean trib (Sam4)	18	6.76	-53	0.5	0.5	5.3	54	-12	0	0

Mass balances

Table 21 shows the percentage of loadings that upstream of the refuse pile and tributaries accounted for at the mouth. The upstream location and the refuse pile tributary each contributed similar metal loadings to the mouth, but the refuse pile tributary contributed a larger percentage of Fe loadings to the mouth at 79%.

Table 21: Loadings and percent contribution at Sample Run's Mouth of acidity and metals in Sample Run.

Locations	Net acidity	Fe	Mn	SO ₄	Net acidity	Fe	Mn	SO ₄
	ppd				%			
Sample Run upstream of Refuse pile trib	255	21	2	433	76%	49%	85%	74%
Refuse pile trib	390	74	1	498	68%	79%	62%	63%
Clean trib	-12	0	0	13	-3%	0%	0%	2%
<i>Upstream Sum</i>	<i>633</i>	<i>95</i>	<i>3</i>	<i>943</i>	<i>141%</i>	<i>128%</i>	<i>147%</i>	<i>139%</i>
Sample Run Mouth	533	80	3	902				

While Sample Run did not degrade UTLC, AMD sources and dangerous abandoned mine infrastructure should be reclaimed to restore Sample Run.

Penn Run

Penn Run is the final tributary on ULTC, 0.2 miles before UTLC enters the Two Lick reservoir. Its drainage area is approx. 8 square miles. Map 9 shows the sampling locations in Penn Run.

A Total Maximum Daily Loads (TMDL) assessment was completed in the Penn Run watershed in 2006 by PA DEP. The results of that study are in Appendix 5. The TMDL report found AMD to be the main pollutant source in the lower 2.2 miles of stream. Sampling locations from the TMDL were replicated for this study.

Instream

Table 22 shows the instream chemistry from Penn Run. The headwaters of Penn Run (MP1) were unpolluted from AMD. MP1.5 was located downstream of the first AMD seepage entering Penn Run and upstream of four AMD discharges approx. 2 miles from the mouth. These AMD inputs increased Fe concentrations from 0.3 mg/L to 4.7 mg/L and added 78 ppd of Fe at Penn Run US of MP7.

After the confluence with the MP7 tributary (US of MP13), there was an 86 ppd increase in Fe loadings, and Al concentrations exceeded instream limits at 0.9 mg/L. These increases were

partially due to MP7 which had high Fe and Al loadings. There were also numerous AMD discharges and seeps entering Penn Run downstream of MP7.

Penn Run improved in water quality downstream of the MP13 tributary with metals decreasing and pH increasing. The mouth of Penn Run was net alkaline with Fe concentrations just under instream limits (1.4 mg/L).

Table 22: Average instream chemistry of Penn Run. (#) = map ID.

Location	Flow	pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L				ppd			
Penn Run upstream (MP1)	1,913	7.55	-51	0.3	0.4	0.0	36	-890	8	11
MP1.5	410	7.20	-90	2.0	0.5	0.2	83	-456	11	2
Penn Run upstream of MP7	2,371	6.76	-32	4.7	0.5	0.3	63	-689	86	14
Penn Run upstream of MP13	6,276	6.58	-12	2.3	0.9	0.5	72	-853	172	73
Penn Run Mouth (KBLPEN)	3,533	7.17	-11	1.4	0.4	0.7	127	-456	63	24

Tributaries and Discharges

Of the tributaries in Penn Run, MP7 and MP13 were the most polluted with Fe concentrations above or near instream limits and Al above 0.8 mg/L. Table 23 shows the average chemistry of the major tributaries to Penn Run.

MP7 added a significant amount of acidity and Fe loadings to Penn Run. The Al loadings from MP7 were the highest of any tributary or discharge in the Penn Run watershed. MP7 was investigated, and no point source discharges were identified. A seepage area ~450ft upstream from the mouth of MP7 was the source of the Fe and Al at the mouth. Above this seepage, pH increased, and conductivity and turbidity decreased. This seepage could be from the coal crop line or defuse flow from the small abandoned deep mine on the hill above it.

All other tributaries were relatively clean with minimal metals loadings. MP13 and MP14 had elevated Al concentrations at 0.9 mg/L each, but the loadings were small.

Table 23: Average chemistry of Penn Run's tributary mouth.

Location	Flow	pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
	gpm		mg/L				ppd			
MP7	1,126	6.21	1	1.9	1.4	0.8	153	28	20	23
MP13	236	6.12	-3	1.2	0.9	0.8	62	22	4	3
MP 14	105	4.76	7	0.3	0.9	1.1	136	9	0.4	1
MP 14.5	145	7.08	0	0.4	0.4	0.0	53	6	1	1

Downstream of the MP1 instream sampling location, there were numerous AMD inputs from point source discharges and seepage at the Lower Kittanning coal crop line. Eleven AMD sources were identified and the five largest metals loaders, PD 1-5, were monitored during the monthly discharge sampling portion of the study. Map 10 shows the main discharges in relation to historic mine maps.

PR 1 was the first AMD input in Penn Run. Since it was a non-point source, approximate chemistry of the seepage was calculated by subtracting a downstream sample from an upstream sample on Penn Run. Photo 6 shows this seepage which seemed to originate from a point under large rocks near the bank of the stream.



Photo 6: Instream AMD seepage in Penn Run (left) and seepage under rocks where it originates (right).

PD 1-3 are located within 130 feet of each other on the northern bank of the stream. These originated from seeps near the coal crop line of the Lower Kittanning coal, but it is possible they are draining from the abandoned Cherry Hill #2 surface mines (permits issued in 1960s). The discharges are adjacent to AML inventory site PA 0711. Photo 7 shows PD 1-3 discharges where they join Penn Run.



Photo 7: PD 2 and PD 3 joining before they enter Penn Run (left). PD 1 at its' confluence with Penn Run (right).

PD 4 is on the southern bank of the stream. It differed in chemistry from PD 1-3 and possibly originates from the Cherry Hill #2 surface mine in the Lower Kittanning coal seam (permit issued in 1960s). It is also adjacent to AML inventory site PA 0711.

PD 5 was a point source located on the side of the berm of a pond. It was in AML inventory site PA 0711 and most likely drains from the Waterman #4-B mine in the Upper Freeport coal seam. While this discharge was not in the Operation Scarlift Report, the location of the pond was in the report as an old refuse pile in a strip mine area. Photo 8 shows PD 5 at its source and the Fe terracing it formed as it descended the steep hill to join Penn Run.



Photo 8: PD 5 source (left) and Fe terracing from the source to where it joins Penn Run (right).

Other discharges in the watershed were small seeps originating from the numerous surface mines on the hilltops surrounding Penn Run. These had elevated concentrations of Fe and Al with low flow and small loadings.

Table 24 shows the average, minimum, and maximum chemistry for the discharges in the Penn Run watershed. PD 1-3 were similar in chemistry with high Fe and low Al concentrations. PD 2 and PD 3 had the highest flow, acidity loadings, and Fe loadings. While PD 1 had 40 mg/L of Fe, it had low flow (2 gpm) making it not as significant as PD 2 and PD 3. PD 4 differed in chemistry with 6 mg/L of Al and only 1 mg/L of Fe.

PD 5 had higher flow with 41 gpm but was net alkaline with low Fe loadings when compared to PD 2 and PD 3. It had an average of 0.2 ppd of Al and 3 ppd of Fe.

The remaining discharges (MP13.1, MP14.3, MP14.2, MP14.1) had low flow and loadings, resulting in a negligible impact on Penn Run, and constituting no further investigation during this study.

Table 24: Average, minimum, and maximum chemistry of seeps and discharges in Penn Run. PR1 includes two samples calculated from upstream and downstream loadings.

Location		Flow	Field pH	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al
		gpm		mg/L					ppd		
PD4	Avg	16	3.49	61	1.0	5.7	1.5	225	12	0	1
	Min	7	4.05	51	0.3	4.1	1.2	130	5	0	0
	Max	29	3.21	77	2.6	8.7	2.0	1003	26	1	3
PD3	Avg	31	5.84	61	42.8	< 0.5	3.4	396	22	16	N/A
	Min	22	6.14	45	38.1	< 0.3	3.2	308	15	12	N/A
	Max	46	5.58	85	50.0	< 0.5	3.6	1005	36	21	N/A
PD2	Avg	65	5.99	55	43.4	< 0.5	3.1	390	43	34	N/A
	Min	46	6.19	40	40.1	< 0.3	2.8	301	26	24	N/A
	Max	93	5.72	78	48.2	< 0.5	3.3	1006	67	46	N/A
PD1	Avg	2	6.01	37	39.4	< 0.5	2.8	364	1	1	0
	Min	1	6.38	24	35.1	< 0.3	2.4	269	0.3	0	0
	Max	3	5.05	52	46.3	< 0.5	3.3	1003	2	2	0
PR1	Avg	170	7.30	-69	6.2	0.4	0.4	185	-179	10	1
PD5	Avg	41	6.02	-67	5.7	< 0.5	2.4	231	-33	3	0
	Min	38	6.26	-93	1.3	< 0.5	2.1	143	-52	1	0
	Max	47	5.79	31	12.2	< 0.5	2.8	1014	16	6	0
MP13.1	Avg	5	5.01	11	0.5	0.8	2.5	144	1	0	0
MP14.3	Avg	6	2.86	113	5.8	4.6	10.8	389	8	0	0
MP14.2	Avg	6	3.74	31	0.7	2.7	4.5	136	2	0	0
MP14.1	Avg	6	3.46	20	0.5	< 0.5	2.0	100	1	0	0

PD 2 and PD 3 discharges had the largest Fe loadings of the AMD sources in Penn Run and as such were the most significant contributors of AMD to the tributary to UTLC.

Mass balances

Table 25 shows the average pollution loadings of major tributaries and discharges and their contribution to loadings at the mouth of Penn Run. PD 2 and PD 3 contributed the highest percentage of Fe loadings to the mouth. MP7 had the highest percentages of Al, Mn, and SO₄ loadings at the mouth. Overall, 71% of Mn and 62% of SO₄ loadings were accounted for.

Table 25: Average loadings and percentages accounted for at Penn Run's mouth by AMD sources and tributaries.

Locations	Net acidity	Fe	Al	Mn	SO ₄	Net acidity	Fe	Al	Mn	SO ₄
	ppd					%				
MP1	-723	5	8	1	597	213%	9%	30%	2%	12%
PD1	1	1	0	0	5	0%	8%	0%	1%	0%
PD2	48	32	0	2	145	-25%	241%	4%	17%	4%
PD3	20	12	0	1	46	-10%	109%	2%	8%	1%
PD4	11	0	1	0	23	-4%	1%	11%	1%	0%
MP7	-1	17	14	8	1,561	-5%	70%	64%	29%	36%
PD5	-42	1	0	1	73	4%	1%	0%	2%	1%
MP13	22	4	3	3	158	-3%	5%	8%	6%	3%
MP14	9	0	1	1	160	-3%	1%	6%	4%	3%
MP14.5	6	1	1	0	67	-1%	1%	2%	0%	1%
<i>Upstream Sum</i>	<i>-648</i>	<i>73</i>	<i>28</i>	<i>17</i>	<i>2,835</i>	<i>167%</i>	<i>445%</i>	<i>128%</i>	<i>71%</i>	<i>62%</i>
Penn Run Mouth	-429	67	24	28	4,462					

As a result, PD 2 and PD 3 were the most impactful discharges in the Penn Run watershed contributing a combined 44 ppd of Fe. MP7 added a significant amount of Fe and Al, but no point sources of these metals were found making it difficult to define and remediate.

Recommendations

ULTC had generally good instream water quality and biological assessments showed that the headwaters had good biological attainment, the middle part had moderate biological attainment, and the lower part had poor biological attainment. Additionally, many major tributaries had poor biological attainment. While there are other stream stressors in the lower portions of UTLC (e.g. the town of Clymer), removing AMD pollution would have positive biological impacts.

The following treatment and/or reclamation work is recommended to maximize water quality benefits:

- Treat Dixon AMD 1 and Dixon AMD 2 discharges
- Reclaim the refuse area responsible for the Dixon 3 discharge
- Reduce pollution loadings around the Richards treatment system
- Reclaim the Sample Run refuse area
- Treat the Penn Run PD 1, 2, and 3 discharges.

An overview of AMD treatment technologies is found in Appendix 3. Highest priority to lowest priority recommendations are listed below.

1. Additions to PADEP's AML database

While most of the AML features in UTLC are a part of PADEP's AML inventory, a few are not, but historic mapping and reports indicate that the missing features originate from pre-SMCRA mining and are recommended to be included in the database. A summary of pertinent mine features' inclusion or exclusion in the AML inventory is discussed below.

The Diamondville borehole is not in the AML inventory. T1 is in AML inventory site PA 2438 and near AML points PA 2438-01 and 2438-02. T5.5 and T5.25 originate from AML polygon PA 2438-05 which is listed as reclamation complete but continues to seep acidic water with metals.

Dixon 3 is in AML inventory site PA 4027 but is not recorded as an AML polygon or point. Dixon AMD 2 is not in the AML database but is adjacent to AML inventory site PA 2432 which includes the Dixon AMD 1 discharge. Dixon AMD 1 and Dixon AMD 2 originate from the same mine workings, so Dixon AMD 2 is recommended to be added to PA 2432 as an AML point.

Sample Run's refuse piles are in AML inventory site PA 2439.

Penn Run's discharges PD 1 through 4 are not in an AML inventory site but are adjacent to PA 0711. Their source is uncertain but could be the Cherryhill #2 surface mines with permits issued in the 1960s.

Overall, Diamondville borehole, Dixon AMD 2, and PD 1-4 discharges are recommended to be considered for addition to PADEP's AML database.

2. Dixon Run

Dixon AMD 2 and Dixon AMD 1 discharges are the highest priority for treatment in the UTLC watershed as their treatment would remove the highest Fe loadings at 71 ppd and Al loadings at 86 ppd when combined. Treatment of both discharges would restore 1.1 miles of lower Dixon Run as it flows through the town of Clymer and would positively impact UTLC. While Dixon Run doesn't kill UTLC, it does cause Al to exceed instream standards. Therefore, approximately 2.1 miles of UTLC would also be improved by treating Dixon AMD 2 and Dixon AMD 1.

Dixon AMD 2 would have the largest positive impact of the two discharges if treated. The discharge is low pH and could be treated actively (NaOH or lime) or passively (limestone). Limestone incubation experiments suggest the discharge can generate about 235 mg/L of alkalinity. If the average flow was treated to -50 mg/L net acidity, 1 mg/L of Fe, and 0 mg/L of Al, the impact of removing these metals and acidity on Dixon Run and UTLC is shown in Table 26. If Dixon AMD 2 was treated, it would reduce Fe concentrations at the mouth of Dixon Run by 1.0 mg/L and reduce Al concentrations by 1.2 mg/L. This would bring the Al concentrations at the downstream point on UTLC to below instream limits. It would also reduce the Fe and Al concentrations at UTLC upstream of Penn Run.

Dixon AMD 1 discharge has a lower flow than Dixon AMD 2. Limestone incubation experiments suggest the discharge can generate ~222 mg/L alkalinity. If the average flow was

treated to -50 mg/L net acidity, 1 mg/L of Fe, and 0 mg/L of Al, the impact of treating it is shown in Table 26. It would reduce Fe and Al concentrations at the mouth of Dixon Run by 0.1 mg/L and 0.2 mg/L respectively. Fe and Al loadings would also decrease on UTLC.

Due to the similar chemistry and geographic proximity to each other, treating both discharges together is an option. This would considerably reduce Fe and Al concentrations on Dixon Run and UTLC and treating the discharges together would reduce project planning efforts to one project instead of two separate projects.

The second priority in Dixon Run would be to reclaim the refuse pile upstream of the Moose Lodge which causes the seepage at Dixon 3. Reclaiming the source of Dixon 3 would give Dixon Run upstream of the Prep Plant enough buffering capacity to absorb the impact of the polluted Barr Slope tributary and reduce Fe and Al to below instream limits. This would restore about 1.8 miles of Dixon Run and improve the chemistry at the mouth of Dixon Run as well.

If Dixon AMD 1 and Dixon AMD 2 were treated and Dixon 3 was reclaimed, Dixon Run's Mouth would have all metals below instream limits and, potentially, 2.9 miles in Dixon Run and 2.1 miles in UTLC (totaling 5 stream miles) would be restored.

Table 26: Average Dixon Run and UTLC chemistry under current conditions (untreated) and with the Dixon Run discharges treated to -50 mg/L net acidity.

Locations	Net acidity	Fe	Al	Net acidity	Fe	Al
	mg/L			ppd		
Dixon Run US of Prep Plant untreated	-42	1.4	0.9	-2,532	84	57
Dixon Run US of Prep Plant w/ Dixon 3 reclaimed	-48	0.3	0.5	-2,888	19	28
Dixon Run mouth avg untreated	-25	3.0	2.1	-1,533	187	130
Dixon Run w/ Dixon AMD 2 treated	-39	2.0	0.9	-2,419	125	58
Dixon Run w/ Dixon AMD 1 treated	-28	2.9	1.9	-1,699	180	115
Dixon Run w/ both treated	-42	1.9	0.7	-2,585	118	44
Dixon Run w/ Dixon 3 reclaimed	-31	2.0	1.6	-1,888	122	101
Dixon Run w/ both treated and Dixon 3 reclaimed	-48	0.9	0.2	-2,940	53	14
Two Lick US of Sample Run avg untreated	-40	1.2	0.7	-9,789	295	178
Two Lick US of Sample Run w/ Dixon AMD 2 treated	-44	1.0	0.4	-10,675	233	106
Two Lick US of Sample Run w/ Dixon AMD 1 treated	-41	1.2	0.7	-9,955	287	163
Two Lick US of Sample Run w/ both treated	-45	0.9	0.4	-10,841	226	91
Two Lick US of Penn Run avg untreated	-43	1.1	0.8	-9,040	229	168
Two Lick US of Penn Run w/ Dixon AMD 2 treated	-47	0.8	0.5	-9,926	167	96

The most appropriate method of passive treatment for the Dixon AMD 1 and 2 discharges would be a vertical flow pond (VFP) followed by settling ponds, wetlands, and an oxic limestone bed (OLB) for Mn removal. Dixon AMD 2 would require a footprint of approximately 13 acres and

Dixon AMD 1 would require a footprint of approximately 3 acres. The difference in the footprint required to treat these discharges is mainly due to the significantly higher flow of Dixon AMD 2.

Treating these discharges would be challenging due to their location. They both discharge from the sides of steep hills and cross railroad tracks before they enter the stream. Dixon AMD 2 originates about 292 ft from Dixon Run, and Dixon AMD 1 originates about 490 ft from Dixon Run. Between the discharges and Dixon Run are wetlands, so finding the space to treat them near their source will be difficult.

A mine hydrology study, gravity pipeline, and/or pumping plan would have to be developed to convey the water to a location where there is enough area for treatment. One potential treatment area is identified in Map 12. This is the nearest flat land with 21 acres to build a passive treatment system for the two discharges. The discharges would need to be captured near their sources, and a gravity pipeline would convey the discharges approximately 2 miles downstream to the potential treatment area. This pipeline would cross TLC near Clymer.

Another option would be to treat the discharges separately. There is approximately 5 acres of land just downstream of Dixon AMD 1 along Dixon Run. This would be enough room to treat this discharge independent of Dixon AMD 2 and would not require an extensive pipeline.

The owners of these potential treatment areas are listed in Appendix 1.

3. Diamondville borehole and Richards Area

The water quality in this area of UTLC was complex. While the Diamondville borehole was a high flow and a high Fe and Al discharge, the creek could assimilate it without exceeding instream limits of Fe and Al. However, this left UTLC with little capacity to assimilate the numerous small, acidic discharges and seepages in the Richards area. Also, as seen in the biological assessments conducted by CVC and BAMR, biologic life was negatively impacted in and below this section of UTLC. The source of biological impairment is assumed to be AMD, and the priority of aquatic health should be assessed before decisions are made about treatment in this area.

There are a few different approaches to reducing the AMD impacts in this area. Table 27 shows the resulting instream chemistry at Two Lick above Buck Run if various discharges were treated. One option is to treat the Diamondville borehole so UTLC can assimilate the small discharges and seepages around the Richards area. Treating the Diamondville discharge to -50 mg/L net acidity and 1 mg/L of Fe and Al would decrease Fe concentrations at Two Lick above Buck Run to 0.8 mg/L and would improve about 3 miles of ULTC. The second option is to only treat T1 which would decrease the instream Fe concentrations by 0.2 mg/L and would improve about 0.8 miles of UTLC.

Decreasing the amount of Fe leaving the Richards treatment system would help improve the biological conditions in this section of UTLC. Because of the elevated Fe concentrations in the #2 and #3 final effluent of the treatment system, there is a noteworthy amount of Fe precipitation in UTLC as the effluent from the treatment system mixes with it. While dissolved metals are

generally considered more toxic to fish than precipitating ones, the indirect effects of Fe precipitates on fish and macroinvertebrate health are significant (Vuori, 1995). Accommodating the precipitation of Fe in the system, and not in the creek, would reduce the metals solids present instream and would improve about 1.6 miles of UTLC.

Table 27: Average UTLC chemistry under current conditions (untreated) and with the Diamondville and T1 treated to -50 mg/L net acidity.

Locations	Net acidity	Fe	Al	Net acidity	Fe	Al
	mg/L			ppd		
Two Lick above Buck Run (current conditions)	-57	1.4	0.5	-6,825	162	58
Two Lick above Buck Run with Diamondville borehole discharge treated	-65	0.8	0.0	-7,777	91	0
Two Lick above Buck Run with T1 treated	-58	1.2	0.4	-6,926	148	51
Two Lick above Buck Run with Richards System #2 and #3 effluent Fe=1mg/L	-57	1.3	0.5	-6,826	156	58

The most appropriate method of treatment for the Diamondville borehole would be a VFP followed by settling ponds and wetlands and would require a footprint of approximately 14 acres. The forested land that the discharge is currently on is bounded by a railroad to the south and a bend in TLC to the east, north, and west and is only about 4 acres. Even if the discharge could be raised to make all this land available for treatment, the existing discharge area is not large enough to reliably treat 90th percentile flows.

A mine hydrology study, gravity pipeline, and/or pumping plan would have to be developed to convey the water to a different location where there would be enough area for treatment. One potential treatment area is shown in Map 11. This is the closest flat land with approximately 14 acres. The discharge would need to be collected and piped 0.4 miles to the treatment area. This pipeline would have to cross a railroad and TLC. Property owners pertaining to this potential treatment area are located in Appendix 1.

The most appropriate method of treatment for the T1 discharge would be VFP followed by settling ponds and wetlands and would require a footprint of approximately 1 acre.

Due to the high elevation of T1 there are a few potential treatment areas, but all would require a pipeline from the discharge’s source to the treatment area because of the steep ridge the discharge is located on.

Map 11 shows the potential treatment area locations for T1. One location would require collecting the discharge at its source, installing a 0.5-mile pipeline, and utilizing the existing ponds upstream of T1 (North and South pond on mapping). Another potential treatment area is 1 acre of flat land downstream of the discharge and bordering TLC. This would require a 0.2-mile pipeline from the discharge to the treatment location. More investigation needs to be done into these potential treatment locations before one is decided on, but utilizing the existing ponds seems the better option since they are well above the floodplain of TLC, but it does require an

extensive pipeline from the discharge to reach it. Property owners pertaining to these potential treatment areas are in Appendix 1.

Finally, lowering Fe concentrations out of the Richards treatment system would provide little net benefit to the stream.

4. Sample Run

Reclamation of PA 2439 is the priority in Sample Run and would restore about 1 stream mile in Sample Run. Table 28 shows the chemistry at the mouth of Sample Run if the concentrations of net acidity in the headwaters and tributaries were lowered to 0 mg/L. Based on these data, the reclamation of PA 2439 should restore Sample Run to an alkaline tributary with low concentrations of metals. At the time of this report, BAMR is in the process of characterizing the material in the AML inventory sites of Sample Run and determining if reclamation is possible.

Table 28: Chemistry at the mouth of Sample Run if no reclamation was done and if the acidity in the tributary and headwaters was removed through reclamation of the AML areas.

Location	Net acidity	Fe	Al	Net acidity	Fe	Al
	mg/L			ppd		
Mouth Sample Run untreated	249	37	28	492	72	55
Mouth Sample Run with refuse pile trib to 0 acidity	52	0	10	103	0	19
Mouth Sample Run with upstream to 0 acidity	120	26	11	237	51	21
Mouth Sample Run with both to 0 acidity	-77	0	0	-152	0	0

5. Penn Run

PD 1-3 discharges are the highest priority for treatment in the Penn Run watershed and would improve 2 miles of Penn Run. Due to the location of Penn Run in the UTLC watershed, any treatment/reclamation work done in Penn Run will have little to no impact on UTLC.

Various treatment scenarios for Penn Run and its discharges are presented in Table 29. Limestone incubation experiments suggest the PD1 can generate about 112 mg/L alkalinity. It contains 39 mg/L Fe and 3 mg/L Mn (Table 24) which will generate 76 mg/L net acidity. This results in a final alkalinity generation of 36 mg/L for PD1. Similar calculations and testing resulted in PD2 and PD3 having final alkalinity generation values of 64 mg/L and 58 mg/L, respectively. Treating PD 1-3 to would decrease Fe concentrations at the mouth of Penn Run from 1.5 mg/L to 0.3 mg/L. UTLC downstream of Penn Run would be reduced by 0.2 mg/L. Treating PD 4 or PD 5 would result in minimal to no change in chemistry in Penn Run.

Table 29: Average Penn Run and UTLC chemistry under current conditions (untreated) and with the Penn Run discharges treated to a net acidity as described in the above text.

Locations	Net acidity	Fe	Al	Net acidity	Fe	Al
	mg/L			ppd		
Penn Run Mouth avg untreated	-11	1.5	0.6	-456	63	24
Penn Run Mouth PD 1-3 treated	-14	0.3	0.6	-594	12	24
UTLC Into Reservoir avg untreated	-37	1.1	0.7	-10,429	318	201
UTLC Into Reservoir with PD 1-3 treated	-37	0.9	0.7	-10,567	268	201

The most appropriate method of treatment for PD 1-3 would be anoxic limestone drain (ALD) followed by settling ponds, wetlands, and an oxic limestone bed (OLB) for Mn removal. Due to their proximity and similar chemistry, it is possible that they could be treated in the same system. Combined treatment of the three discharges would require a footprint of about 3 acres.

Map 13 shows two potential treatment areas for PD1-3. One area is about 300ft downstream on the south side of Penn Run. This would require the discharges to be collected and a gravity pipeline to be installed from the discharges, across Penn Run, and to the treatment area. Another potential treatment area is about 500ft downstream on the northern bank of Penn Run and would require the discharges to be collected and a gravity pipeline to be installed from the discharges, across MP7, and to the treatment area. Property owners pertaining to these potential treatment areas are in Appendix 1.

Conclusions

UTLC had generally good water quality from its headwaters to the reservoir. Metals were below instream limits until around the Richards passive treatment system where Fe approached and occasionally exceeded instream limits and after Dixon Run where Al concentrations exceeded instream limits. Table 30 summarizes the recommendations in order of priority to improve water quality in UTLC and its tributaries.

The highest priority is to treat the Dixon AMD 2 and Dixon AMD 1 discharges and reclaim a refuse pile in Dixon Run. The second priority is to decrease pollution loads from around the Richards area. The third and fourth priorities are reclamation in Sample Run and AMD treatment in Penn Run.

Table 30: Summary of priority recommendations to improve water quality in UTLC and its tributaries.

Priority	Tributary/ Section of UTLC	Discharge(s)/ AML	Basic Chemistry	Recommended treatment/reclamation type	Stream miles improved
1.1	Dixon Run	Dixon AMD 2 and Dixon AMD 1	Low pH, high acidity and metals	VFP, settling ponds, wetlands, Mn OLB	3
1.2	Dixon Run	Dixon 3 Refuse	Low pH, high acidity and metals	Reclamation with alkaline amendment	2
2.1	Richards Area	Diamondville borehole	Low pH, high acidity and metals	VFP, settling ponds, wetlands	3
2.2	Richards Area	T1	Low pH, high acidity and metals	VFP, settling ponds, wetlands	1
3	Sample Run	PA 2439	Low pH, high acidity and metals	Reclamation with alkaline amendment	1
4	Penn Run	PD 1-3	Alkaline, high Fe	ALD, settling ponds, wetlands, Mn OLB	2

Improving Dixon Run requires treating Dixon AMD 2. This would decrease Fe and Al concentrations at the mouth of Dixon Run and, ultimately, reduce the Al concentrations in UTLC to below instream limits. The treatment of Dixon AMD 1, which is adjacent to Dixon AMD 2, would further decrease metals in Dixon Run and have a minor positive impact on UTLC. Finally, reclaiming the refuse causing the Dixon 3 seepage would improve the middle section of Dixon Run down to Dixon AMD 2.

The Richards area will be challenging to improve. Although the average metal concentrations were below instream limits, biological assessments in this area resulted in moderate to poor biologic conditions. If there is interest in reducing the AMD impacts to improve biologic conditions one option is to treat the Diamondville borehole so UTLC assimilate the remaining untreated small discharges and seepages downstream. A second option is to treat the largest discharge (T1) and improve refuse areas and seeps where possible.

Sample Run should be restored by the reclamation of two refuse/AML piles. As of February 2025, BAMR was investigating the AML inventory sites in the Sample Run watershed to determine if/ how reclamation could be completed on them. Reclamation would greatly improve the water quality of this tributary.

Penn Run water quality could be improved with the treatment of PD 1, PD 2, and PD 3 discharges. If these were treated, Fe concentrations at the mouth of Penn Run would decrease from 1.4 mg/L to 0.3 mg/L. Additional sources of AMD in this watershed are small seeps which will be challenging to collect and treat.

Overall, while UTLC has generally good water quality, more improvements can be made to further and promote complete restoration of the watershed.

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GIS Data Sources:

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- Abandoned Mine Land Inventory Sites: PADEP via PASDA.
<https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=460>
- Abandoned Mine Land Inventory Polygons: PADEP via PASDA.
<https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=459>
- Abandoned Mine Land Inventory Points: PADEP via PASDA.
<https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=458>
- Non attaining streams: PADEP via PASDA.
<https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=888>
- Bituminous Surface Mine Permits: PADEP via PASDA.
<https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=371>