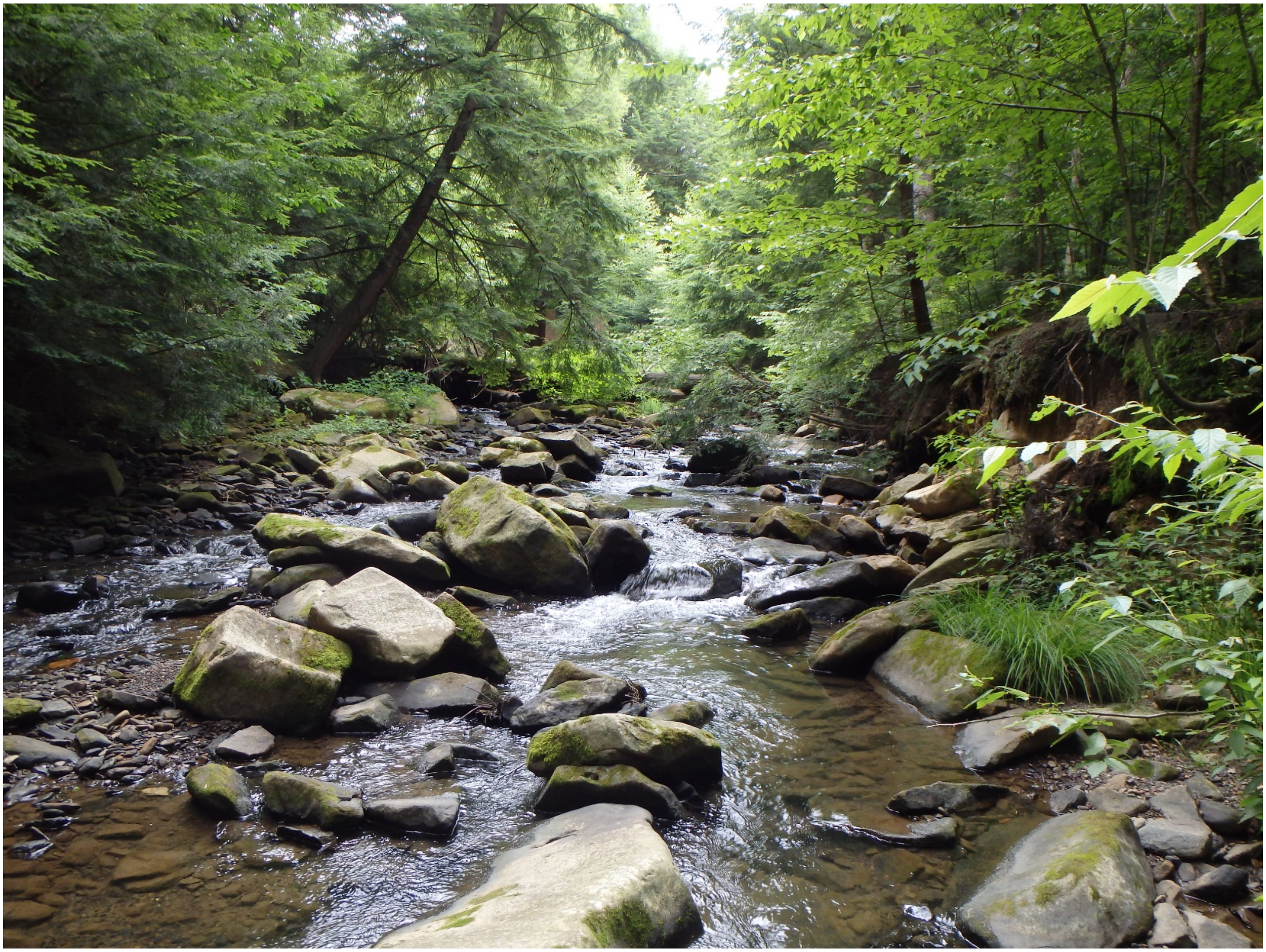
Brubaker Run Assessment and Coldwater Conservation Plan



February 2018

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Funded through a 2016 Coldwater Heritage Partnership Grant
with additional funding from the Community Foundation for the Alleghenies and Foundation for Pennsylvania Watersheds

ACKNOWLEDGEMENTS
Trout Unlimited (TU) would like to thank the following organizations and agencies for providing funding, data, expertise and assistance with the development of this Coldwater Conservation Plan: Chest Creek Watershed Alliance (CCWA), Cambria County Conservation District (CCCD), Coldwater Heritage Partnership (CHP), Community Foundation for the Alleghenies, Foundation for Pennsylvania Watersheds, the Pennsylvania Department of Environmental Protection (DEP), the Pennsylvania Fish and Boat Commission (PFBC), and the Western Pennsylvania Conservancy.

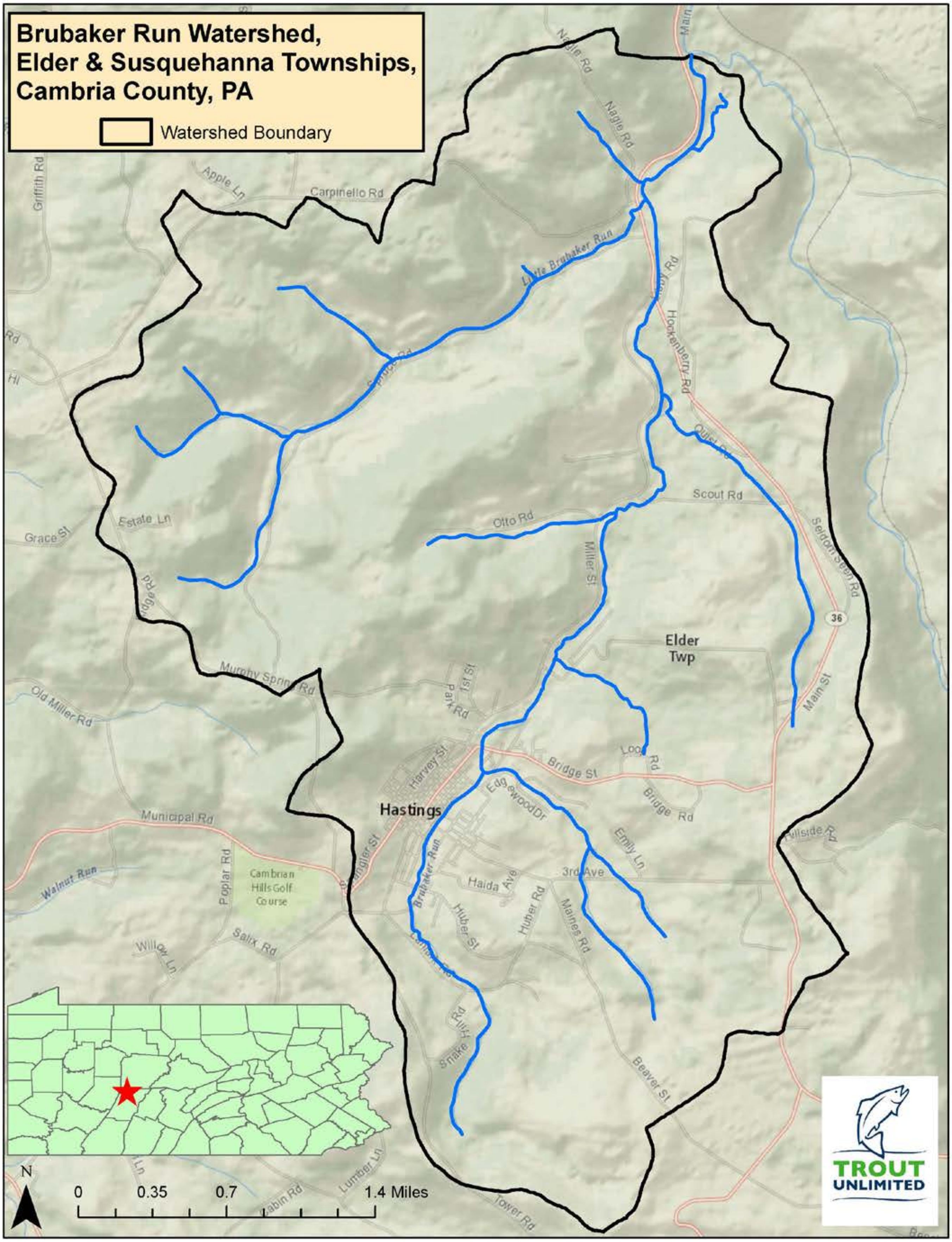
SECTION 1. PURPOSE OF STUDY/WATERSHED BACKGROUND
The purpose of this study was to utilize existing information, as well as information collected as part of this assessment to develop a coldwater conservation plan for the Brubaker Run watershed. Funding from the Coldwater Heritage Partnership Program, Community Foundation for the Alleghenies, Foundation for Pennsylvania Watersheds, and Western Pennsylvania Conservancy Watershed Mini-Grant Program was used to perform chemical and biological monitoring in the Brubaker Run watershed including high and low flow water quality monitoring, habitat assessments, fishery surveys, macroinvertebrates surveys, and culvert assessments. Project partners also considered current and potential recreation and tourism opportunities within the watershed. These components were evaluated and used to identify threats and opportunities within the watershed, as well as create a list of conservation and protection strategies that can be used to help restore, protect, and enhance Brubaker Run and its tributaries, and inform local citizens and government officials as they navigate future development and land use decisions.

Brubaker Run is a tributary to Chest Creek, located in Elder and Susquehanna Townships, Cambria County, Pennsylvania (Figure 1). The Brubaker Run watershed encompasses approximately 12.8 square miles of mostly forests (52%) and farmlands (40%), but also contains the Borough of Hastings, a few other small villages, and some areas of historic and active coal mining. Brubaker Run and its tributaries are designated as Cold Water Fisheries (CWF) according to Pa. Code 25 Chapter 93 Water Quality Standards; however, Brubaker Run and all but one of its tributaries are currently listed as being impaired due to abandoned mine drainage (AMD) – sedimentation by the PA Department of Environmental Protection (DEP).

Recent sampling has suggested that the main stem of Brubaker Run has relatively good water quality but the aquatic life (primarily macroinvertebrates) isn't what would be expected in a healthy stream. This study aimed to look at existing information for the stream and collect additional biological and chemical data to determine what can be done to improve stream quality and remove it from the DEP's Impaired Waters list. In addition, fishery surveys completed by Trout Unlimited in 2016 revealed the presence of wild brook trout (*Salvelinus fontinalis*) and wild brown trout (*Salmo trutta*) in Brubaker Run, prompting the project partners to develop this report and make recommendations on how to protect and improve the coldwater habitat and fishery in Brubaker Run. Additional information regarding fishery surveys can be found in the fishery section of this report.

Although sedimentation from abandoned mine lands and removal of vegetation is listed as the primary source of impairment by the DEP, there are several AMD discharges located in the watershed that are having negative impacts on Brubaker Run and its tributaries. These will also be examined in this report and recommendations will be made as to the best way to mitigate effects on the stream.

Figure 1. Watershed location map



SECTION 2. EXISTING DATA AND PROJECTS

The earliest mention of pollution impacts to the Brubaker Run watershed was in 1968 by the EPA's Federal Water Pollution Control Administration. They produced a report outlining the extent of AMD pollution in the Susquehanna River basin organized by sub-basin. The authors note that at the time of the study, Brubaker Run had 42 AMD discharges that contributed 75% of the acid load to Chest Creek. This led to degradation of Chest Creek from the mouth of Brubaker Run downstream to Westover.

In 2008, the Cambria County Conservation District in partnership with the Chest Creek Watershed Alliance completed an AMD assessment and restoration plan for Chest Creek. In the report, it is noted that Brubaker Run is a priority for restoration in the middle section of Chest Creek. Two discharges attributed to drainage from the Seldom Seen Mine along State Route 36 were sampled during the CCCD's assessment. The report also notes that Little Brubaker Run was AMD impaired at the time, but could not be accessed to sample individual AMD discharges due to landowner issues. The study notes that additional AMD sampling should be completed in the Little Brubaker Run sub-watershed.

In 2011, the DEP completed a Total Maximum Daily Load (TMDL) study for the Chest Creek watershed to address sediment pollution. It was noted in the TMDL that Brubaker Run is impaired due to excessive sedimentation from abandoned mine lands (6.38 miles) and vegetation removal (11.03 miles). The report notes that there are AML areas on the surrounding slopes of the streams that produce turbid waters in-stream, sediment buildup is occurring along banks and near bridges/culverts, and that AMD precipitation, particulate settling, and accretion of stream substrate are all issues. The TMDL calls for a 46% reduction in sediment pollution for Brubaker Run in order to meet the TMDL goals for Chest Creek. The report recommends a variety of agricultural best management practices (BMPs), streambank stabilization projects, and planting of forested buffers as solutions to sedimentation issues in Chest Creek. These will be discussed in greater length in Section 5, below.

SECTION 3. WATERSHED ASSESSMENT

<u>Methods</u>

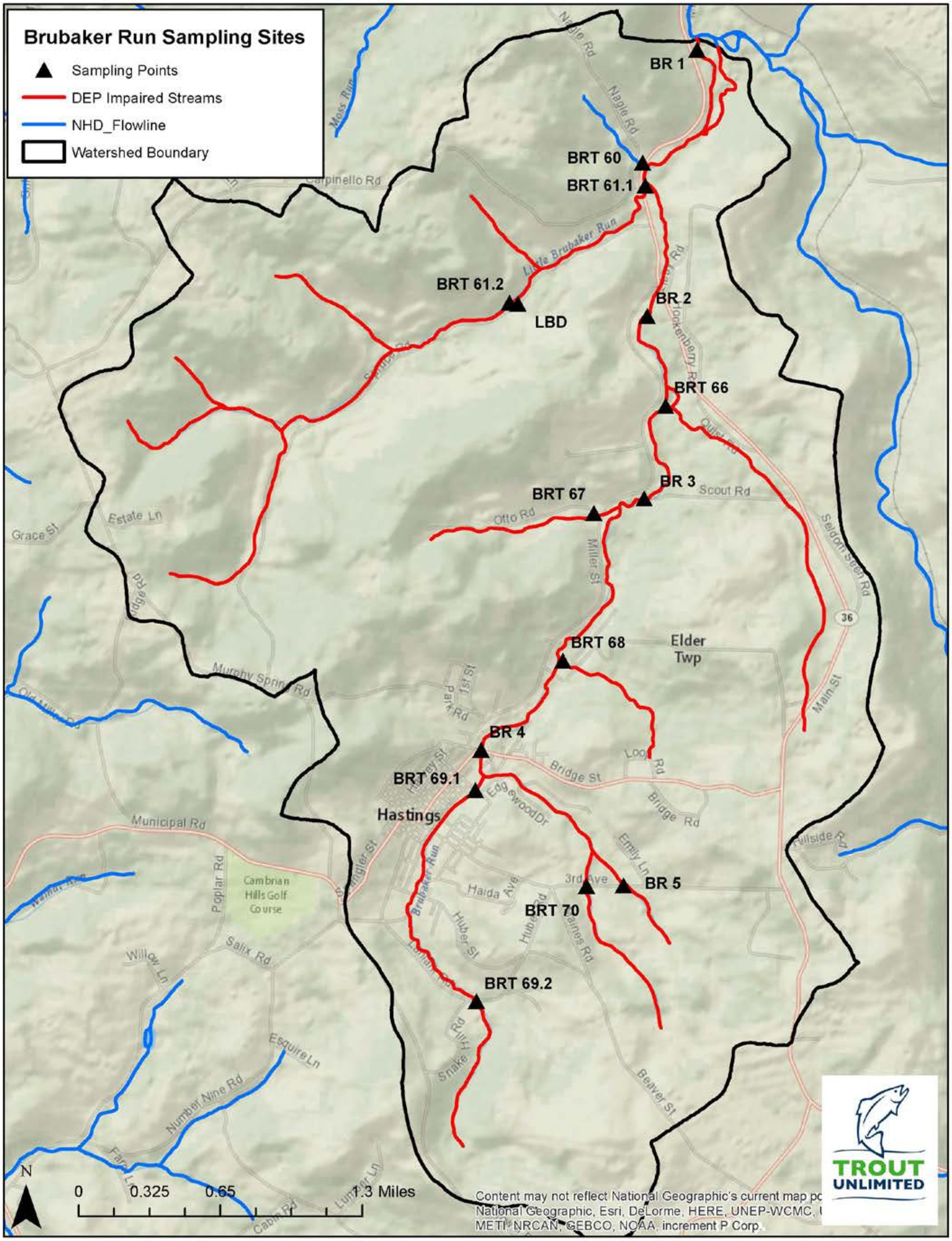
Water Quality

Instream water quality samples were collected once each during high and low flow conditions following standard DEP sampling methodology at the mouth of each tributary to Brubaker Run, as well as, select sites on the main stems of Brubaker Run (Table 1). Field parameters collected at each site included pH, specific conductance, and water temperature. These were measured using various field meters that were calibrated each day according to manufacturer specifications. Water samples were sent to DEP-certified laboratories and analyzed for pH, specific conductance, acidity, alkalinity, iron, aluminum, manganese, sulfates, total dissolved solids and total suspended solids. Flow measurements were taken using a velocity meter. AMD discharges (Table 1) were sampled similarly to instream sites, but the timed-volume method (bucket and stop-watch) was used when a velocity meter could not be used. A map of all sampling locations can be found in Figure 2.

Table 1. Brubaker Run sampling locations

SITE ID	DESCRIPTION	LAT	LONG	CHEM	FISH	BUGS	HABITAT
BR 1	Brubaker Run mouth	40.715813	-78.690327	X	X	X	X
BRT 60	UNT 26860	40.707734	-78.694792	X	X	X	X
BRT61.1	Little Brubaker Run mouth	40.706720	-78.694634	X		X	X
LBD	AMD Discharge to Little Brubaker Run	40.698702	-78.705555	X			
BRT61.2	Little Brubaker Run above LBD	40.698765	-78.706292	X	X		X
BR 2	Brubaker Run upstream of SR36	40.698047	-78.694222	X		X	X
BRT 66	UNT 26866 (Miller Run) mouth	40.692125	-78.692458	X	X	X	X
BR 3	Brubaker Run at Scout Road	40.685895	-78.693552	X		X	X
BRT 67	UNT 26867 at Otto Road	40.684907	-78.698562	X	X	DRY	X
BRT 68	UNT 26868 at Swedetown	40.675055	-78.701004	X	X	X	X
BR 4	Brubaker Run at Bridge Street	40.669023	-78.708005	X	X	X	X
BRT 69.1	Brubaker Run at 7th Avenue	40.666357	-78.708435	X	X	X	X
BRT 69.2	Brubaker Run at Beaver Street (SR4008)	40.652316	-78.707983	X			X
BRT 70	UNT 26870 at 3rd Ave	40.660115	-78.698584	X	X		X
BR 5	UNT at 3rd Ave	40.660223	-78.695329	X	X	X	X

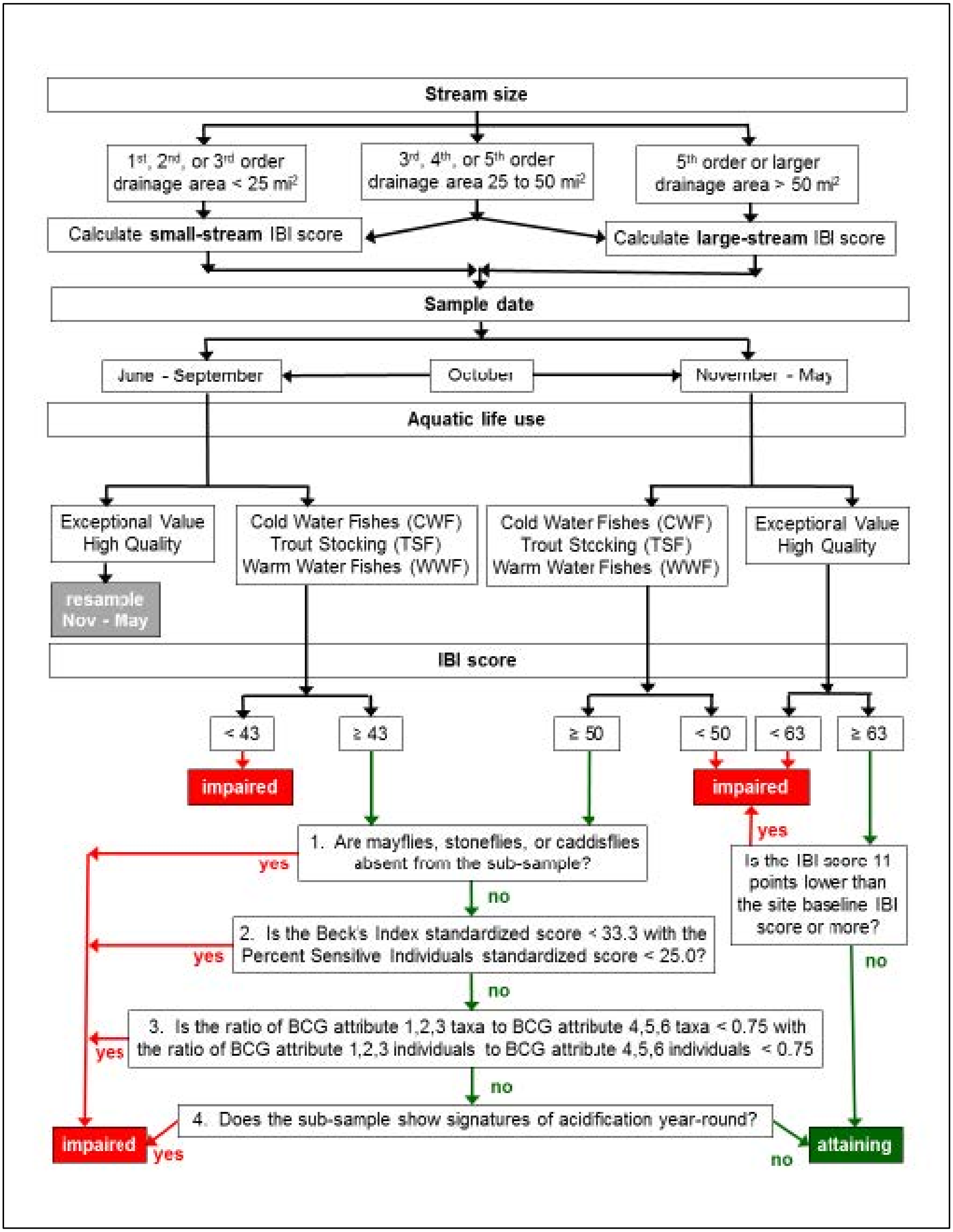
Figure 2. Sampling location map



Macroinvertebrates

Benthic macroinvertebrate collections were made according to DEP's Instream Comprehensive Evaluation (ICE) protocol (specifically section *C.1.b. Antidegradation Surveys*). In short, benthic macroinvertebrate samples consisted of a combination of six D-frame efforts in a 100-meter stream section. These efforts were spread out to select the best riffle habitat with varying depths. Each effort consisted of an area of one square meter to a depth of at least four inches as substrate allowed and was conducted with a 500-micron mesh, 12-inch D-frame kick net. The six individual efforts were composited and preserved with ethanol for processing in the laboratory. Individuals were identified by taxonomists certified by the North American Benthological Society to genus or the next highest taxonomic level. Samples containing 160 to 240 individuals were evaluated according to the six metrics comprising the DEP's Index of Biological Integrity (IBI) (Total Taxa Richness, EPT Taxa Richness, Beck's Index V.3, Shannon Diversity, Hilsenhoff Biotic Index, and Percent Sensitive Individuals). Appendix A contains a description of each of these six metrics. These metrics were standardized and used to determine if the stream met the Aquatic Life Use (ALU) threshold for coldwater fishes, warmwater fishes, and trout stocked fishes (Figure 3).

Figure 3: The aquatic life use assessment process for wadeable, freestone, riffle-run streams in Pennsylvania based on benthic macroinvertebrate sampling (PADEP, 2015).



Habitat

Habitat was evaluated for 100 meters at each macroinvertebrate sampling site using DEP's Water Quality Network Habitat Assessment form, which considers the following twelve parameters: instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alteration, sediment deposition, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, grazing or other disruptive pressure, and riparian vegetation zone width. These parameters are explained in Appendix A. Each parameter is given a score based on a visual survey of the sample sites.

Fishery Surveys

Fishery surveys were completed in the watershed 2016 and 2017 by the TU utilizing the sampling procedures for unassessed trout waters developed by the PFBC in 2010. Surveys were completed during summer low-flow conditions to minimize sampling bias and allow for the capture of young-of-year-fish. A sampling site approximately 100 meters in length was selected that included the benthic macroinvertebrate collection site and contained habitat that was representative of the stream. Each sample site ended at a natural impediment to upstream movement to minimize sampling bias. Sampling was conducted with battery-powered backpack electrofishing units. Proper current and voltage settings were determined on-site following an evaluation of conductivity. All fish captured during the electrofishing surveys were identified to species. Each species present for the sample site was given an abundance rating according to the PFBC (< 3 individuals = rare; 3 – 25 individuals = present; 26 – 100 individuals = common; > 100 individuals = abundant). All salmonid (trout) species collected were held until the survey was complete and then measured to the nearest millimeter (total length).

Culverts

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across a thirteen-state region, from Maine to Virginia. The NAACC has developed common protocols for assessing road-stream crossings (culverts and bridges) and developed a regional database for these field data. The information collected will identify high priority bridges and culverts for upgrade and replacement. Assessments are overseen by NAACC-certified Lead Observers. General information is collected at each site including site coordinates, road name, township name, date, name of certified field staff, stream name, road type, crossing type, crossing material, and number of cells. Road stream crossing assessments consist of physical measurements of crossing dimensions, photos of each crossing as well as the stream channel up and downstream of the crossing, and observations of crossing and stream conditions. Assessments are completed using either paper field forms or digital PDF forms completed on electronic devices. Measurements are taken using stadia rods and a surveyor's tape and are recorded in tenths of feet.

Measurements consist of inlet/outlet dimensions, length of crossing, water depth at the inlet/outlet, and roadfill height where appropriate. Additional observations include a visual assessment of the alignment of the structure relative to the stream channel, general crossing condition, type of inlet/outlet grade (i.e. perched, inlet drop, outlet freefall, at stream grade, etc.), flow condition (i.e. dry, typical low-flow, moderate flow, etc.), size of tail water scour pool, structure substrate type and % coverage, and comparison of water depth and velocity relative to natural stream conditions. Other information that can be collected but is not required to calculate aquatic passability includes slope of structure using a clinometer and bankfull measurements. Bankfull measurements are taken in undisturbed stream reaches out of the range of influence of the structure. Assessment forms are uploaded to the NAACC database and Global Positioning System (GPS) locations are matched to existing crossings identified by Global Information System (GIS) analysis or assigned to a new crossing if one was not recognized by the GIS analysis. Once forms are uploaded they must be approved by an L1 or higher certified staff to be finalized. Once assessments are uploaded and approved, passability scores (Appendix B) are calculated and posted to the online database. Survey information and calculated passability scores can be viewed at www.streamcontinuity.org/cbd2.

Recreation & Tourism

Recreation and tourism opportunities in the watershed were determined by researching the available public spaces and amenities in the watershed, visiting public spaces and other areas of the watershed to see how they are being used, and by talking with CCWA volunteers and local community members to determine if there are other opportunities to enhance recreation and tourism in the watershed.

<u>Results/Discussion</u>

Water Quality

Water quality and flow data were collected at main stem and tributary sites in the Brubaker Run watershed during September 2016 and June 2017 (Tables 2 & 3). These samples were then compared to Chapter 93 water quality standards (Table 4). Of the 15 sites that were evaluated, the majority met water quality standards during both high and low flow water sampling events. During the low flow sampling event, sites BRT60, LBD, and BRT66 fell outside of the Chapter 93 range for pH of 6.0 to 9.0. Sites BRT60, BRT61.1, LBD, BRT66, and BR3 all exceeded the Chapter 93 standard of 1.50 mg/L for iron (Fe) and BRT60, BRT61.1, LBD, and BRT66 exceeded the limit of 1.00 mg/L for manganese (Mn). BRT61.1 and LBD exceeded the limit of 0.75 mg/L for aluminum (Al). BR1, BRT60, BRT61.1, LBD, BRT61.2, BRT66, BR4, and BR5 all exceeded the limit of 250 mg/L for sulfate during low flow conditions. BR1, BRT60, BRT61.1, LBD, BRT61.2, BR2, BR3, BR4, and BR5 all exceeded the limit of 500 mg/L for total dissolved solids during low flow conditions. In addition, all the sampling sites were net alkaline during the low flow event except for sites BRT60, LBD, and BRT66. During the high flow sampling event, all the sites met Chapter 93 standards for all parameters except for sites LBD, which was outside the limits for pH, iron, aluminum, and manganese; BRT60 which exceeded the limit for iron; BRT61.1 which exceeded the limits for iron and aluminum; and BRT69.2 and BR5 which both exceeded the limit for aluminum. Overall, water quality throughout the watershed is relatively good. The low pH values and elevated metal concentrations found at several sites are due to AMD discharges and/or drainage from AML areas within the watershed.

Loading values in pounds per day (lb/day) were calculated for iron, manganese, aluminum, and acidity for each site. This method considers not only the concentrations of water pollutants, but the amount of each pollutant at the sites based on stream flows. The LBD discharge located along Little Brubaker Run in Driscoll Hollow is the main contributor of acidity and metals pollution to Little Brubaker Run and Brubaker Run based on loading data. Site BRT 61.1 is located at the mouth of Little Brubaker Run below the LBD discharge, while BRT 61.2 is located on Little Brubaker above the LBD discharge. During both high and low flow sampling, BRT 61.2 met water quality standards for acidity and metals, while BRT 61.1 did not, due to the influence of the LBD discharge. Other tributaries showed signs of AMD influence, particularly in low flow conditions. These include BRT 60 and BRT 66. BRT 60 is currently not on the DEP's list of impaired waters although multiple iron seeps were encountered during field work and it appeared that they were being monitored by the DEP or another entity. BRT 66 receives two discharges from the Seldom Seen deep mine as described in the Chest Creek watershed assessment and restoration plan. These discharges were not monitored during this study due to limited funding; however, water quality data is available in the assessment/restoration plan. In addition, iron staining on the stream bottom was apparent in the main stem of Brubaker Run at BR3; however, this appears to be due to base flow to the stream as no AMD discharges were found in the area.

Table 2. Low flow water quality results

Low Flows																			
Date Sampled	Site ID	Flow GPM	Field pH	Lab pH	Cond Umhos	Temp C	Alk mg/l	Alk lbs/day	Acid mg/l	Acid lbs/day	Iron mg/l	Iron lbs/day	Mn mg/l	Mn lbs/day	Al mg/l	Al lbs/day	SO4 mg/l	TSS mg/l	TDS mg/l
9/15/2016	BR1	2370	7.9	7.5	941	15	69	1961	-47	-1336	0.94	26.72	0.72	20.46	0.22	6.25	368	<5	636
9/15/2016	BRT60	30	4.05	3.6	958	14.9	0	0	26	9	6.97	2.51	4.59	1.65	0.07	0.03	415	11	672
9/15/2016	BRT61.1	1965	7.03	7.2	940	13.9	63	1485	-42	-990	5.82	137.17	1.78	41.95	2.03	47.84	398	19	710
9/15/2016	LBD	702	3.19	3.2	1140	11.3	0	0	115	968	4.32	36.36	2.45	20.62	9.93	83.58	598	<5	938
9/15/2016	BRT 61.2	1128	8.04	8.1	949	15.3	191	2583	-169	-2286	0.39	5.27	0.12	1.62	<0.05	-	320	<5	697
9/15/2016	BRT 66	30	7.42	5.7	654	16	7	3	14	5	1.52	0.55	3.78	1.36	0.29	0.10	260	6	440
9/15/2016	BR2	1438	8.1	7.8	875	15.6	88	1518	-68	-1173	0.11	1.90	0.04	0.69	0.07	1.21	244	<5	576
9/15/2016	BR3	1399	7.69	7.7	901	15.6	106	1778	-85	-1425	1.94	32.53	0.13	2.18	0.07	1.17	219	5	631
9/16/2016	BRT 67	Dry																	
9/16/2016	BRT 68	35	7.3	6.3	465	14.3	10	4	8	3	0.19	0.08	0.08	0.03	0.1	0.04	156	<5	309
9/16/2016	BR4	874	8.32	8.2	961	15.3	129	1351	-111	-1163	0.08	0.84	0.03	0.31	<0.05	-	252	<5	719
9/16/2016	BRT 69.1	76	8.8	8.5	596	16.5	90	82	-71	-65	<0.05	-	0.02	0.02	<0.05	-	117	<5	359
9/16/2016	BRT 69.2	30	7.48	6.7	349	15.8	22	8	-4	-1	0.12	0.04	0.12	0.04	0.07	0.03	94	<5	202
9/16/2016	BRT 70	Not Sampled																	
9/16/2016	BR5	493	8.33	8.2	905	13.3	178	1053	-157	-929	0.19	1.12	0.16	0.95	0.27	1.60	260	<5	727

Note: Parameters highlighted in yellow exceeded the Chapter 93 Water Quality Standards listed in Table 4.

Table 3. High flow water quality results

High Flows																				
Date Sampled	Site ID	Flow GPM	Field pH	Lab pH	Cond Umhos	Temp C	Alk mg/l	Alk lbs/day	Acid mg/l	Acid lbs/day	Iron mg/l	Iron lbs/day	Mn mg/l	Mn lbs/day	Al mg/l	Al lbs/day	SO4 mg/l	TSS mg/l	TDS mg/l
6/21/2017	BR1	3983	7.64	7.7	538	15.0	69	3295	-44	-21013	0.87	41.55	0.31	14.80	0.36	17.19	162	9	337
6/21/2017	BRT60	118	6.92	6.5	181	15.6	14	20	6	85	1.93	2.74	0.44	0.62	0.10	0.14	50	12	115
6/21/2017	BRT61.1	2006	7.46	7.2	624	14.3	90	2165	-66	-15879	3.03	72.90	0.85	20.45	1.21	29.11	211	17	409
6/21/2017	LBD	311	3.21	3.2	1130	11.5	0	0	116	4323	5.52	20.57	2.16	8.05	10.1	37.71	480	4	753
6/21/2017	BRT 61.2	1186	7.69	7.5	618	15.4	143	2034	-120	-17067	0.31	4.41	0.12	1.71	0.06	0.85	161	7	382
6/21/2017	BRT 66	282	6.98	6.5	443	16.1	24	81	-3	-101	0.52	1.76	0.66	2.23	0.19	0.64	109	8	259
6/21/2017	BR2	1863	7.71	7.1	529	15.3	63	1407	-43	-9606	0.38	8.49	0.21	4.69	0.22	4.91	142	7	328
6/21/2017	BR3	2462	7.56	7.1	532	15.3	70	2067	-46	-13581	0.50	14.76	0.1	2.95	0.24	7.09	138	8	340
6/21/2017	BRT 67	Dry																	
6/21/2017	BRT 68	90	7.19	6.3	275	15.8	14	15	6	65	0.32	0.34	0.05	0.05	0.25	0.27	56	10	153
6/21/2017	BR4	1617	7.86	7.3	595	17.6	88	1706	-65	-12604	0.22	4.27	0.08	1.55	0.16	3.10	162	6	381
6/21/2017	BRT 69.2	588	7.12	6.6	237	15.7	26	183	-4	-282	1.13	7.97	0.08	0.56	0.79	5.57	47	29	131
6/21/2017	BRT 69.1	850	7.43	6.9	380	17.4	52	530	-33	-3365	0.23	2.35	0.05	0.51	0.21	2.14	73	9	210
6/21/2017	BRT 70	Not Sampled																	
6/21/2017	BR5	508	8.12	8.0	855	14.2	174	1059	-153	-9312	0.31	1.89	0.29	1.76	0.54	3.29	234	17	554

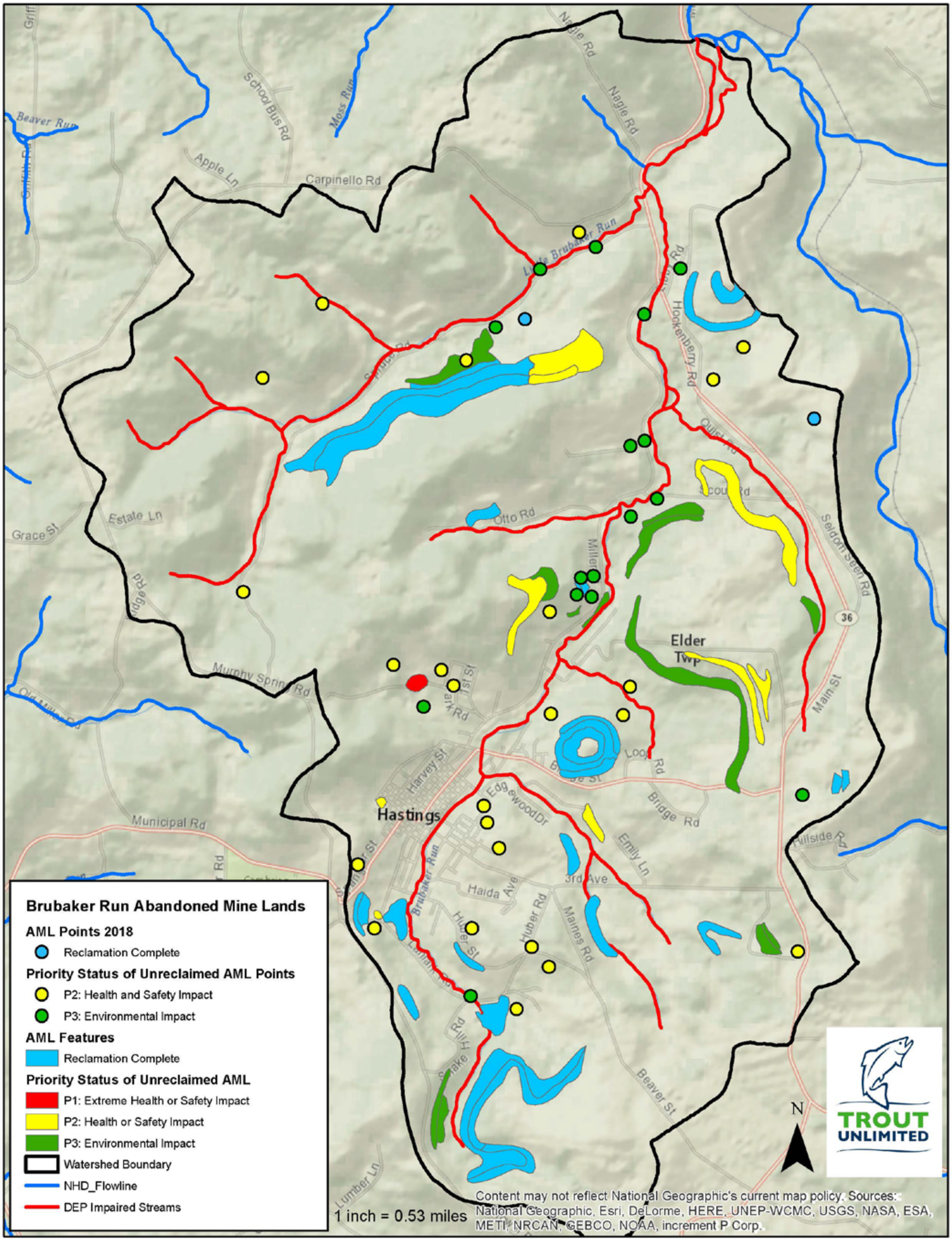
Note: Parameters highlighted in yellow exceeded the Chapter 93 Water Quality Standards listed in Table 4.

Table 4. Chapter 93 water quality standards

Parameter	Criteria Value (mg/L)	Total Recoverable/Dissolved
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50	Total Recoverable
Manganese (Mn)	1.00	Total Recoverable
pH	6.0 - 9.0	NA
Sulfate (SO4)	250	NA
Total Dissolved Solids (TDS)	500	NA

The Bureau of Abandoned Mine Reclamation has identified numerous abandoned mine land (AML) features in the watershed that have not yet been reclaimed. These features are ranked by their priority for restoration. Priority 1 (P1) and Priority 2 (P2) sites are considered human health and safety hazards and are thus prioritized over Priority 3 (P3) sites, which are considered environmental hazards. A map of priority AML areas in the watershed can be found in Figure 4. Reclamation of these sites would benefit water quality in the stream by removing sources of sediment and AMD pollution, along with removing safety hazards to watershed residents and visitors.

Figure 4: Priority AML areas in the Brubaker Run watershed



Macroinvertebrates

Macroinvertebrate surveys were completed at ten sites in the Brubaker Run watershed. Site BRT 67 was not included as the stream was dry during both low and high flow sampling. Of the ten sites where macroinvertebrate data were collected, only seven met the criteria for calculating an IBI score (Table 5). The other samples did not contain enough individual organisms (160-240) to complete the calculations. Of the seven that were scored, only two, BRT 66 and BRT 68, were found to be attaining their aquatic life use (ALU) for coldwater fisheries with scores of 59.3 and 66.7, respectively. Not surprisingly, these two streams had high taxa richness scores and included the highest number of EPT (sensitive) taxa. BRT 68 had a score that should qualify it for high quality or exceptional value (anti-degradation) designation. Some of the sites with marginal IBI scores such as BR1 and BR2 should be resurveyed, perhaps at a different time of year, to see if their scores change; however, research conducted on abandoned mine impacted streams in West Virginia (Freund & Petty, 2007) have indicated that mine impacted watersheds may never biologically recover to pre-mining conditions. The study showed that even though water quality is relatively good within the watershed, elevated parameters such as metals and sulfate may prevent biota, including macroinvertebrates, from reaching population levels found in reference streams. Almost all the Brubaker Run sampling locations had elevated levels of sulfate during the low flow sampling event. Additional research should be conducted to determine if sulfate levels are having an impact on aquatic life, and if so, what level of biological recovery can reasonably be expected in the watershed.

Table 5. Index of Biological Integrity (IBI) scores for the Brubaker Run sampling locations

METRIC	BR1	BRT60	BRT61	BR2	BRT66	BR3	BRT68	BR4	BRT69.1	BR5
Total # of Individuals	216	64	49	205	160	232	218	197	219	153
Total Taxa Richness	23	18	8	24	24	24	27	22	17	18
EPT Taxa Richness (PTV 0 – 4)	4	7	2	7	7	5	12	6	2	6
Beck's Index, version 3	9	11	1	14	16	8	16	6	1	6
Hilsenhoff Biotic Index	4.58	6.25	6.41	4.98	4.10	5.86	4.15	5.68	6.74	2.67
Shannon Diversity	2.19	2.20	1.13	2.44	2.38	2.54	2.53	2.45	2.17	1.99
Percent Sensitive Individuals (PTV 0 – 3)	34.3	17.2	2.0	17.1	40.6	3.0	44.5	11.2	0.9	66.0
IBI Score	**49.7**	**NA**	**NA**	**52.3**	**59.3**	**43.9**	**66.7**	**44.4**	**30.3**	**NA**

Habitat

Habitat scores were calculated for each of the sampling locations (Table 6). Despite many of the sites being located near roadways and more urbanized areas, total habitat scores within the watershed were all within the optimal and suboptimal range. BRT 66 had the best habitat score in the watershed, which is not surprising given that it is also the most remote sampling site. Eight out the eleven sites that were surveyed had poor or marginal scores for riparian vegetative zone width due to being in town or next to major roadways. There are also multiple sites which received marginal or poor scores for instream cover, embeddedness, and sediment deposition, which are of greater concern because they directly affect macroinvertebrate habitat. Some of the sites (BRT 60, BRT 61.1, BR3, and BRT 66) contained iron precipitate coating the stream bottom that affects macroinvertebrate populations in the stream, but is not necessarily captured on the habitat assessment form.

Table 6. Habitat assessment scores for the Brubaker Run watershed

Site ID	BR1	BRT60	BRT61	BR2	BRT66	BR3	BRT67	BRT68	BR4	BRT69.1	BR5
Instream Cover (Fish)*	19	6	13	17	19	16	16	16	15	5	19
Epifaunal Substrate*	19	15	16	17	17	14	17	18	15	16	16
Embeddedness*	13	5	10	15	15	11	16	16	19	16	15
Velocity/Depth Regimes	19	19	19	17	19	19	16	16	19	15	17
Channel Alteration	19	14	15	18	11	15	15	13	13	5	12
Sediment Deposition*	18	8	19	10	17	17	19	19	19	16	17
Frequency of Riffles	18	16	15	19	17	11	16	18	17	17	19
Channel Flow Status	16	19	17	14	19	18	17	19	19	19	18
Condition of Banks	12	18	18	5	18	11	19	19	15	15	14
Bank Vegetative Protection	15	19	19	6	19	12	17	19	19	16	17
Grazing or Other Disruptive Pressure	18	19	19	18	19	19	19	11	17	18	15
Riparian Vegetative Zone Width	12	5	10	15	16	10	10	5	5	6	6
Total Score	**198**	**163**	**190**	**171**	**206**	**173**	**197**	**189**	**192**	**164**	**185**

Optimal
Suboptimal
Marginal
Poor

*Scores in the "marginal" (6 -10) or "poor" (0- 5) categories for these parameters are of greater concern than for those of the other parameters due to their ability to influence instream benthic macroinvertebrate habitat.

Fishery Surveys

Beginning in 2014, Trout Unlimited completed fishery surveys in the Brubaker Run watershed following the PFBC's Unassessed Waters protocol. The fishery survey completed at BR1 in September 2016 yielded sufficient numbers of brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*), including young-of-year of both species, to qualify Brubaker Run as a naturally reproducing wild trout fishery. The stream is on the PFBC's list of proposed wild trout streams and will be voted on at a future commissioner's meeting after advertisement in the *Pennsylvania Bulletin*. Other species of fish encountered during fishery surveys include: Blacknose Dace (*Rhinichthys atratulus*), Creek Chub (*Semotilus atromaculatus*), Green Sunfish (*Lepomis cyanellus*), Mottled Sculpin (*Cottus bairdii*), Northern Hogsucker (*Hypentelium nigricans*), Rainbow Trout (*Oncorhynchus mykiss*), Tessellated Darter (*Etheostoma olmstedi*), and White Sucker (*Catostomus commersonii*) (Table 7).

Table 7. Results of Brubaker Run fishery surveys (trout species highlighted in yellow)

	Number of Individual Trout and Relative Abundance of Other Species at Survey Sites										
Common/Scientific Name	**BR 1**	**BRT 60**	**BRT 61.2**	**BR2**	**BRT 66**	**BRT 67**	**BRT 68**	**BRT 69.1**	**BRT 70**	**BR 4**	**BR 5**
Blacknose Dace/*Rhinichthys atratulus*	Abundant		Abundant	Abundant	Present		Common	Abundant		Abundant	Common
Brook Trout/*Salvelinus fontinalis*	3			5							3
Brown Trout/*Salmo trutta*	6			5						4	2
Creek Chub/*Semotilus atromaculatus*	Abundant		Abundant	Common	Common		Common	Abundant		Abundant	Rare
Green Sunfish/*Lepomis cyanellus*	Present										
Mottled Sculpin/*Cottus bairdii*				2							
Northern Hogsucker/*Hypentelium nigricans*	Present										
Tessellated Darter/*Etheostoma olmstedi*	Rare										
Rainbow Trout/*Oncoryhnchus mykiss*				1							
White Sucker/*Catostomus commersonii*			Common	3				Present			

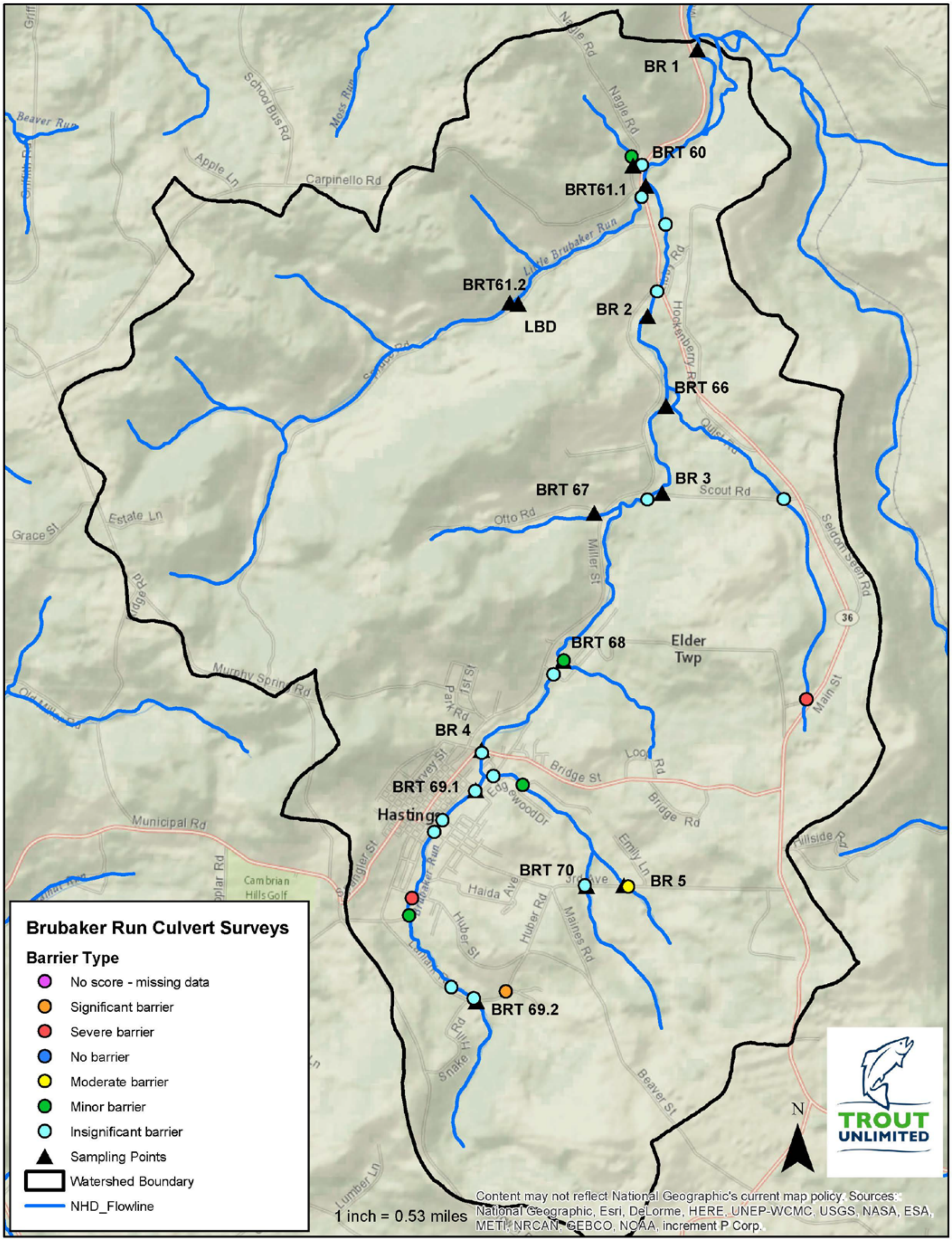
RELATIVE ABUNDANCE
<2 = RARE
2-8 = PRESENT
9-33 = COMMON
>33 = ABUNDANT

Site	**Survey Date**
BR1	9/14/2016
BRT60	9/14/2016 No fish
BRT61.2	9/14/2016
BR2	7/21/2014
BRT66	9/14/2016
BRT67	9/14/2016 Dry
BRT68	9/14/2016
BRT69.1	9/14/2016
BRT70	9/14/2016 No fish
BR5	7/28/2017
BR4	7/28/2017

Culverts

Figure 5 shows the location and aquatic organism passage (AOP) status of all the accessible culverts in the Brubaker Run watershed. Due to the location of this stream near towns and major roadways, there are multiple culverts and bridges in the watershed, particularly along the main stem of Brubaker Run. Fortunately, most of the stream crossings in the watershed are bridges which do not impede the movement of fish or other aquatic organisms. However, as can be seen on the map, there are two severe (red) barriers to the movement of fish and other aquatic organisms. There are also one significant (orange) and one moderate (yellow) barriers in the watershed. These culverts make it difficult or impossible for trout and other aquatic species to move freely around the watershed and should be addressed so that as the stream continues to recover, fish and other species can utilize all available habitat.

Figure 5. Aquatic organism passage barriers in the Brubaker Run watershed



Recreation, Tourism, and Access

The Brubaker Run watershed is important to the local economy because it helps to support recreation and tourism in Hastings, Westover, and surrounding townships in Clearfield and Cambria County. Water quality in Brubaker Run has improved significantly over the last few decades due to a number of factors including remining and reclamation of AML sites. It has become a destination for local anglers and has garnered attention from local sportsman's organizations who have taken to stocking sections of the main stem with trout. Better water quality in Brubaker Run has also led to better water in Chest Creek, which is an important economic driver in the region due to the many outdoor recreation opportunities it provides, including angling and paddling. With some additional work, Brubaker Run could become a top notch wild trout fishery and mecca for anglers, bringing even more money into the local economy. Gas stations, bait and tackle shops, hotels and other lodging, restaurants, and outfitters all stand to benefit from the conservation and enhancement of Brubaker Run.

While most of the Brubaker Run watershed is privately owned, there are a few stream access points including the Hastings Park, walk-in fishing along Brubaker Run near Libby Road, and Little Brubaker Run (Driscoll Hollow). While access at the park is a wonderful thing, there are a number of opportunities to improve the habitat there and make fishing access easier. The 2,031-acre Driscoll Hollow tract is currently under the ownership of Laurel Sand and Stone, Inc. who has worked out a deal to re-mine the area and then turn it over to the PA Game Commission to form the new State Game Land 334. Re-mining activities have not taken place in the watershed, but the area has been clear cut in preparation for mining. The tract has also been made open to the public for hunting. Once re-mining activities are complete, the project partners should work with the PGC to improve habitat for fish and other aquatic life in Little Brubaker Run. Efforts should also be made to obtain formal fishing access easements along the main stem of Brubaker Run. The section from Libby Road/SR 36 that parallels Miller Street, also has an abandoned rail line that runs the length of the stream and could provide access for anglers, hikers, and bikers, so efforts to gain formal access should be focused in this area.

SECTION 4. THREATS AND OPPORTUNITIES

There are numerous threats to the Brubaker Run watershed, but an equal or greater number of opportunities that will be discussed in this section. Please see Appendix C for photographs of threats and opportunities within the watershed. This list should be reexamined and updated periodically as coldwater conservation practices are implemented.

<u>Threats</u>

Because land use in the watershed is mainly forest, agriculture, residential, and abandoned mine lands, human activities are the greatest threat to the stream. Human activities such as logging, mining, farming, and development have been and continue to be threats to water quality in Brubaker Run. As discussed above, the most significant of the AMD impacts are in the Little Brubaker Run sub-watershed, also known as Driscoll Hollow. It is hoped that re-mining will help to improve water quality in Little Brubaker Run; however, the CCWA and other conservation partners should be diligent in monitoring water quality once re-mining operations begin. Given the scope of the permit area and the proximity to the stream, the potential exists for AMD and sediment pollution to enter the stream if all permit requirements are not met. Existing AMD discharges and AML areas in other parts of the watershed also pose a threat to water quality in the form of sediment, acidity, and metals pollution to Brubaker Run and its tributaries. Reclamation of these AMD/AML sites will further help to improve water quality in the watershed.

Another threat to the Brubaker Run watershed is development and stream encroachment. There are many homes and businesses located within the watershed, particularly around Hastings Borough. As humans continue to build houses, sheds, garages, parking areas, etc. along the stream corridor, natural habitat and vegetative buffers along the stream are lost. Parking lots and driveways create impermeable surfaces that produce more polluted runoff and higher stream flows leading to erosion. Clearing and mowing along the stream increases exposure to sunlight, warming the water and making it harder for trout and other coldwater species to survive. It also creates more erosion as the roots of streamside vegetation are important for holding soil in place. Development in the floodplain of streams also leads to increased flooding and property damage. Undersized and improperly installed culverts create additional threats to the Brubaker Run watershed. Failing and undersized culverts can create flooding hazards, especially in areas of the watershed where homes and businesses are located in the floodplain. Another threat posed by these culverts is to aquatic ecosystems. Undersized or improperly installed culverts can create physical barriers that prevent fish and other organisms from moving freely throughout the watershed to feed, reproduce, and escape warm temperatures, pollution, and other threats.

There are a few active farms in the watershed. For the most part, they seem to be following good farming practices; however, there is always room for improvement. The CCWA and partners should work with local farmers, the county conservation district, and state and federal agricultural entities to ensure that farmers are educated on the latest farming best management practices (BMPs) so that they can continue to be good stewards of the watershed.

<u>Opportunities</u>

Many restoration and conservation opportunities exist in the Brubaker Run watershed. One of the easiest things that can be done to help protect and preserve the coldwater resources of the Brubaker Run watershed is to collect additional data where necessary and petition the state to remove those stream segments that meet water quality and biological standards from the impaired waters list. As mentioned above, a wild trout fishery has recently been documented in Brubaker Run and at least one tributary. The stream is on the PFBC's list of proposed wild trout waters. The CCWA and partners should advocate for the addition of Brubaker Run to the wild trout list as this designation automatically help protect any wetlands surrounding the stream by designating them as exceptional value (EV). As noted in the macroinvertebrate section of this report, two streams Miller Run (UNT 26866) and Unnamed Tributary 26868 were found to be meeting their designated aquatic life use for coldwater fisheries and should be removed from the impaired waters list. In addition, UNT 26668 should be looked at closer by the DEP for possible listing as a high quality stream, which would garner additional antidegradation protections. As restoration efforts continue and additional water quality improvements are made throughout the watershed, attempts should be made to continue monitoring biological recovery, especially macroinvertebrates, and petition DEP to remove additional stream segments from the impaired waters list as they qualify.

One of the most visible problems facing the watershed is abandoned mine drainage. Restoration of the remaining AMD discharges in the watershed will lead to water quality improvements and the further recovery of stream biota. Efforts should be made to work with local, state, and federal partners and funding sources to address the remaining AMD and AML issues in the watershed. In addition, the opportunity exists to conduct research into whether sulfate levels, which remain high in the watershed post-mining, are having a detrimental effect on aquatic life, in particularly macroinvertebrates, and what level of biological recovery can be expected in the watershed.

Culvert replacement projects provide another opportunity in the watershed to increase flood resiliency, reduce maintenance costs, and open additional habitat for trout and other aquatic species. Properly sized and installed culverts have been shown to reduce flooding impacts while reducing long-term maintenance costs as they allow flood waters and accompanying debris to pass under roadways rather than creating areas where debris jams can exacerbate flooding issues. This also means that municipal and state road crews will spend less time and money maintaining and repairing clogged and/or damaged culverts. In recent years, there has been increased interest federally and statewide in projects that provide for aquatic organism passage while also helping to increase flood resiliency.

While overall stream habitat within the Brubaker Run watershed is mostly intact, there are areas of the watershed where the opportunity exists to complete habitat and/or streambank stabilization projects, particularly in residential areas near Hastings. Instream habitat restoration projects not only provide cover and habitat for fish and other aquatic species, but can also reduce erosion. Habitat restoration is accomplished by constructing PFBC-approved structures in the stream that are designed to work with the stream hydrology to protect banks and provide pools and overhanging cover for trout and other species. Examples of these structures can be found on the PFBC website at: http://www.fishandboat.com/Resource/Habitat/Pages/default.aspx. Streamside (riparian) restoration can be accomplished by limiting mowing and grazing, and planting trees and other vegetation along the stream corridor to create a natural buffer that cools water temperatures, stabilizes streambanks, filters pollution, and provides food and habitat for aquatic and terrestrial species. These buffer zones can be designed to meet the needs of the landowner and can include native trees, shrubs, and grasses, fruiting trees and bushes, or other suitable vegetation. A good place to start when looking for additional information on streamside buffers is the DCNR's website: http://www.dcnr.pa.gov/Conservation/Water/RiparianBuffers/Pages/default.aspx. In addition, conservation easements are another potential tool for the protection of forested habitat that contributes to the coldwater resources in the watershed. There are numerous land conservancies in the area that could be contacted to assist in identifying critical habitat and engaging landowners to enhance and protect those areas.

Another way to help prevent stormwater runoff, decrease erosion and sedimentation issues, and protect water quality is by working with municipal and state officials to ensure they are using best management practices for transportation projects and maintenance. One way they can do this is through the Dirt, Gravel and Low Volume Road Program administered by the county conservation district. This program helps municipalities to receive the training and funding they need to complete projects that will improve travel conditions while also protecting local waterways. More information about this program can be found at: https://www.dirtandgravel.psu.edu/.

As mentioned above, there are numerous recreation opportunities within the Brubaker Run watershed. One of the factors limiting recreation is the lack of public access. Efforts should be made to reach out to the various municipalities and streamside landowners to identify areas where public access would be desirable and procure the necessary easements to allow a greater number of people to be able to access the stream for fishing and other outdoor activities. An effort should also be made to engage Hastings Borough and the PGC to promote available stream access in Hastings Borough and Driscoll Hollow.

Finally, community planning provides another opportunity for protecting coldwater resources in the Brubaker Run watershed. Municipalities within the watershed can assist with stream conservation by forming watershed committees; passing ordinances that reduce stream encroachment, stormwater runoff, and flooding; adopting environmentally sensitive maintenance practices for roadways and stream crossings; and working with community members to seek funding for and implement projects that will benefit stream health.

SECTION 5. CONSERVATION & PROTECTION STRATEGIES

Based on the threats and opportunities in Section 4 above, there are numerous conservation and protection strategies that can be taken by watershed stakeholders within the Brubaker Run watershed. This is not an exhaustive list, but should serve as a starting point. This section should be periodically updated as projects are implemented and stream conditions change.

Strategy 1: Community Planning – Many of the issues facing the Brubaker Run watershed were created because development occurred in the watershed before community planning became the norm. Watershed stakeholders should work with the Cambria County Planning Department, local municipalities, businesses, and landowners to make sure that future development will not have detrimental effects on the stream. Activities may include developing planning documents such as master site plans, revitalization plans, and ordinances related to flooding and stream conservation, and limiting future development that would encroach on the stream corridor.

Strategy 2: AMD/AML Restoration and Monitoring – Efforts should be made to address the remaining AMD and AML issues throughout the watershed through reclamation, re-mining, water treatment, and reforestation. Water quality and biological monitoring should continue to gage the success of restoration projects and provide data aimed at removing streams from the DEP impaired waters list and upgrading stream status where possible. Along those lines, research should be conducted to determine if sulfate and/or other pollutants are thwarting biological recovery in the watershed, and if so, what is the appropriate way to measure stream recovery on a biological level post mining and reclamation. Additionally, there are un-reclaimed priority AML areas throughout the watershed (Figure 4, above) that should be remediated not only because they pose human health and safety hazards, but also because they would help reduce AMD and sediment pollution. In addition, there are efforts underway in the mining reclamation community to convert sites that were previously restored as grasslands/meadows to productive forestlands. There are several sites in the watershed that could benefit from this approach.

Strategy 3: Habitat and Bank Stabilization Projects – Efforts should continue to identify areas in need of bank stabilization and/or instream habitat projects that would reduce sediment pollution and provide habitat for fish and other aquatic species. There are many areas in Hastings Borough that are eroding and in need of stabilization. Brubaker Run near Site BR2 has some areas of bank erosion that should be addressed as well. Regarding streamside habitat, there are several areas of the watershed that could benefit from riparian buffer plantings and reforestation, mainly in Hastings (residential) and Driscoll Hollow (AML reclamation). The project partners should work with municipalities and private landowners along Brubaker Run to encourage implementation of riparian buffers.

Strategy 4: Agriculture Outreach and BMPs – Although the farms operating in the watershed seem to be doing a fairly good job implementing sound farming practices, efforts should be made to do outreach to farmers and ensure that they have the tools an resources necessary to prevent soil erosion and nutrient and sediment pollution. BMPs such as no-till, contour strip-cropping, crop rotation, streambank fencing, riparian buffers, stabilized stream crossings, nutrient management plans, etc. should be encouraged where possible. The CCWA should work with the county conservation district and state and federal agencies to ensure that farmers have the tools and funding they need to implement BMPs throughout the watershed.

Strategy 5: Stormwater Management Activities – Polluted runoff is an issue in the Brubaker Run watershed due to the numerous impermeable surfaces (roads, driveways, parking lots, etc.) that are present in the watershed and the lack of stormwater runoff controls. Efforts should be made to work with municipal officials, business owners, residents, and the PA Department of Transportation to put stormwater control measures in place for new development, retrofit older structures, and assist landowners with stormwater management. These measures will help reduce flash flooding and prevent streambank erosion.

Strategy 6: Culvert Replacement Projects – Four culverts in the Brubaker Run watershed have been identified as being partial or complete barriers to aquatic organism passage. The project partners should seek funding to replace these culverts, which will reconnect important coldwater habitat while also increasing flood resiliency for the local community. See Appendix B for a list of the assessed culverts.

Strategy 7: Dirt, Gravel, and Low Volume Road Projects – There are several dirt and gravel and/or low volume roads within the Brubaker Run watershed that are contributing polluted runoff to the stream. The project partners should work with the CCCD to identify projects that could be funded through the Dirt, Gravel, and Low Volume Road Program that would benefit water quality and coldwater habitat in the watershed. Two roads that were identified during this study are Carpinello Road and Spruce Road Extension, which flank either side of Little Brubaker Run, and Libby Road; however, there are likely other roads in the watershed that could be improved through this program.

Strategy 8: Fishing Access and Conservation Easements – The project partners should work with the PFBC and other interested parties to identify additional areas for fishing access along Brubaker Run and its tributaries. The main stem of Brubaker Run near the SR 36/Libby Road area are accessible for walk in fishing by permission of the landowners, but formal fishing easements or land acquisitions should be procured where possible ensuring that public access to the stream is maintained into the future. An effort should be made to reach out to land conservancies that service Cambria County to identify important properties for coldwater resource protection and engage landowners in conservation practices.

Strategy 9: Recreation and Tourism Promotion – Part of getting people to care about local waterways is to get them out in the watersheds enjoying them. This can be accomplished by promoting all the great outdoor recreation opportunities that have been identified in the watershed. Efforts should be made to work with recreation and tourism promotion agencies such as the Cambria County Recreation and Tourism Authority, the Department of Conservation and Recreation, the Lumber Heritage Region, and others to promote area attractions, fishing opportunities, trails, geocaches and other activities available in the watershed.

Strategy 10: Outreach and Stewardship – Another strategy for conserving the coldwater resources in Brubaker Run is through public outreach and stewardship activities. Community members agree that clean water is an important natural resource, but they sometimes struggle to identify actions and activities that they can do to help protect local streams. Efforts should be made to develop education and outreach materials, events, and activities that will empower residents to become watershed stewards. This could include things like litter cleanups, stream monitoring, citizen science projects, tree plantings, brochures, rain barrel workshops, buffer trainings, social media outreach, activities at local fairs and festivals, field trips for local students, and many other projects and activities depending on the need.

SECTION 6. BUILDING COMMUNITY AWARENESS

There are many ways in which the project partners can build community awareness. These include: promotion of Chest Creek Watershed Alliance meetings; community outreach projects such as those mentioned in Strategy 10 above; press releases to local media outlets regarding conservation projects; a state of the watershed report to be distributed periodically as an update on restoration and conservation efforts; an increased social media presence for the CCWA; engagement of local students in research and monitoring projects; and engagement of local schools, libraries, etc. in the Trout in the Classroom Program. It may be helpful to develop a communication/strategic plan for the CCWA to help formalize community outreach and activities.

REFERENCES

An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania's Wadeable, Freestone, Riffle-Run Streams. 2015. Pennsylvania Department of Environmental Protection - Bureau of Clean Water. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Methodology/2015%20Methodology/freestoneIBI.pdf.

Chest Creek Watershed Assessment and Restoration Plan. 2007. Cambria County Conservation District. http://www.wbsrc.org/uploads/2/5/6/0/25607137/chest_creek_assessment_restoration_plan.pdf.

Chest Creek Watershed Sediment TMDL, West Branch Susquehanna River, Cambria County, Pennsylvania. 2011. Pennsylvania Department of Environmental Protection. http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/TMDL/Chest_Creek_Sediment_TMDL.pdf.

Mine Drainage in the Susquehanna River Basin. 1968. Environmental Protection Agency – Federal Water Pollution Control Administration. https://nepis.epa.gov.

PA Code 25 Chapter 93 Water Quality Standards. https://www.pacode.com/secure/data/025/chapter93/chap93toc.html.

PA Fish and Boat Commission Trout Webpage http://www.fishandboat.com/Fish/PennsylvaniaFishes/Trout/Pages/default.aspx.

Response of Fish and Macroinvertebrate Bioassessment Indices to Water Chemistry in a Mined Appalachian Watershed. 2007. Freund, J.G. and J. Todd Petty. Environmental Management.

2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. 2016. http://www.dep.pa.gov/Business/Water/CleanWater/WaterQuality/Integrated%20Water%20Quality%20Report-2016/Pages/default.aspx.

APPENDICES

Appendix A: Description of biological metrics that were used in this project

Total Abundance
The total abundance is the total number of organisms collected in a sample or sub-sample.

Dominant Taxa Abundance
This metric is the total number of individual organisms collected in a sample or sub-subsample that belong to the taxa containing the greatest numbers of individuals.

Taxa Richness
This is a count of the total number of taxa in a sample or sub-sample. This metric is expected to decrease with increasing anthropogenic stress to a stream ecosystem, reflecting loss of taxa and increasing dominance of a few pollution-tolerant taxa.

% EPT Taxa
This metric is the percentage of the sample that is comprised of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). Common names for these orders are mayflies, stoneflies, and caddisflies, respectively. The aquatic life stages of these three insect orders are generally considered sensitive to, or intolerant of, pollution (Lenat and Penrose 1996). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution-sensitive orders.

Shannon Diversity Index
The Shannon Diversity Index is a community composition metric that takes into account both taxonomic richness and evenness of individuals across taxa of a sample or sub-sample. In general, this metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and increasing dominance of a few pollution-tolerant taxa.

Hilsenhoff Biotic Index
This community composition and tolerance metric is calculated as an average of the number of individuals in a sample or sub-sample, weighted by pollution tolerance values. The Hilsenhoff Biotic Index was developed by William Hilsenhoff (Hilsenhoff 1977, 1987; Klemm et al. 1990) and generally increases with increasing ecosystem stress, reflecting dominance of pollution-tolerant organisms. Pollution tolerance values used to calculate this metric are largely based on organic nutrient pollution. Therefore, care should be given when interpreting this metric for stream ecosystems that are largely impacted by acidic pollution from abandoned mine drainage or acid deposition.

Beck's Biotic Index
This metric combines taxonomic richness and pollution tolerance. It is a weighted count of taxa with PTVs of 0, 1, or 2. It is based on the work of William H. Beck in 1955. The metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive taxa.

Percent (%) Sensitive Individuals
This community composition and tolerance metric is the percentage of individuals with PTVs of 0 to 3 in a sample or sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive organisms.

Appendix B: Aquatic Organism Passage scores

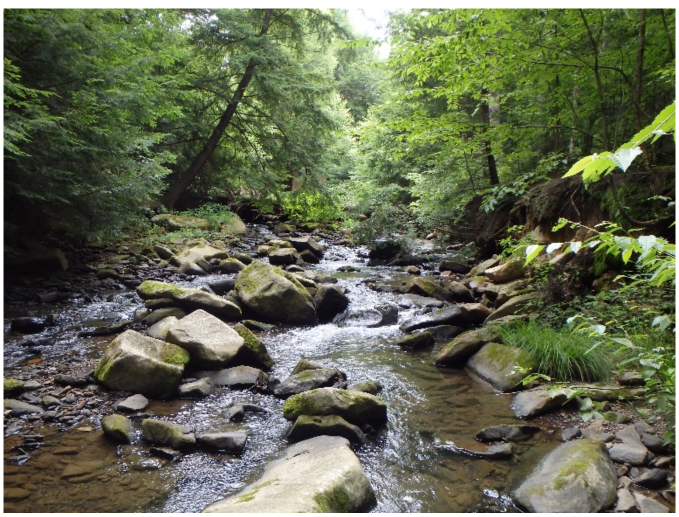
Survey ID	Aquatic Passability Score	NAACC Coarse Screening	Latitude	Longitude
52021	0.990541386	Full AOP	40.705932	-78.694924
52022	0.891560579	Reduced AOP	40.708059	-78.694953
52025	0.714076893	Reduced AOP	40.708609	-78.695862
52026	0.985420413	Full AOP	40.704147	-78.692806
52028	0.991	Full AOP	40.699674	-78.693433
52029	0.844007133	Reduced AOP	40.686034	-78.682028
55800	0.842072805	Full AOP	40.68583	-78.693929
55801	0.853827459	Full AOP	40.674114	-78.701837
55802	0.791651063	Reduced AOP	40.675048	-78.700944
55803	0.991	Full AOP	40.668798	-78.70795
55804	0.940586093	Full AOP	40.667291	-78.706914
55805	0.985948486	Reduced AOP	40.666271	-78.70844
55806	0.781818794	Reduced AOP	40.666731	-78.704318
55806	0.781818794	Reduced AOP	40.666731	-78.704318
55807	0.95195252	Reduced AOP	40.664282	-78.711248
55808	0.932630659	Reduced AOP	40.6635	-78.711983
55809	0.130434581	No AOP	40.659078	-78.713784
55810	0.640071479	No AOP	40.657933	-78.71399
55811	0.946566292	Reduced AOP	40.653215	-78.710181
55812	0.958572262	Reduced AOP	40.652491	-78.708243
55822	0.353685934	No AOP	40.652996	-78.705439
55823	0.906182575	Reduced AOP	40.66013	-78.698728
55824	0.501824827	No AOP	40.660121	-78.694928
55825	0.130434581	No AOP	40.672795	-78.679722

Note: Those crossings highlighted in yellow are complete barriers to aquatic organism passage.

Appendix C: Photographs


Abandoned Mine Drainage at Site BRT 60


Bank erosion along Little Brubaker Run


Example of forested habitat along Brubaker Run


Large wild brown trout captured during electrofishing surveys on Brubaker Run


Channelization, sedimentation, and lack of buffers in Hastings Borough