Potter Run AMD Watershed Assessment
State Game Lands No. 100 – Clearfield County

Technical Report Provided by Hedin Environmental through the Trout Unlimited AMD Technical Assistance Program

February 9, 2010

Project Description

The Pennsylvania Game Commission (PGC) requested assistance for a rapid watershed assessment of Potter Run in northeastern Clearfield County. The stream is located in State Game Lands (SGL) 100. Mining has occurred on all sides of the drainage basin through much of the stream length. Mine discharges enter the stream in the headwaters area and in small natural drainages in the lower sections of the stream. In order to develop treatment options, sampling under high flow and low flow conditions was requested. This report provides results of two sampling efforts and general recommendations regarding treatment options.

Watershed Characteristics

Potter Run is a mid-sized stream that flows into the West Branch of the Susquehanna River 6.6 miles upstream of Karthaus, 3.1 miles upstream of the inflow of Moshannon Creek, and 4.4 miles downstream of the SR 1011 (Rolling Stone Road) bridge. The stream's headwaters are at 1400 – 1500 ft elevation and the main stem flows 1.8 miles to the its confluence with the West Branch at 880 ft elevation. The total watershed is approximately 1,050 acres.

The watershed has been extensively mined. Almost all land above 1200 ft elevation has been impacted by surface mining activities.

Property Ownership and Access

All AMD discharges in the Potter Creek watershed are within State Game Lands. The PA Game Commission provided access to the SGL and PGC staff were present for most of the sampling events.

AMD Assessment

High flow conditions were evaluated through sampling conducted in May 2009 by Alder Run Engineering (ARE). Low flow conditions were evaluated through sampling conducted in October 2009 by Hedin Environmental (HE). The mouth of Potter Run was sampled in May 2009 and July 2009 as part of the TU and PADEP's West Branch water quality evaluation. All three efforts involved measurement of flow rates and the

collection of water samples that were analyzed by certified laboratories. Sampling results were organized into a single spreadsheet shown in Table 1.

All sampling points were identified by GPS and placed on available aerial and topographic mapping. Map 1 is the aerial photograph that shows all the sampling points. The main stem of the stream is wooded. The extensive surface mining in the higher elevations is apparent from the poor vegetation. Map 2 is taken from the USGS 7.5-minute Frenchville Quadrangle topographic map. The map was divided into lower (Map 2a) and upper (map 2b) portions so that the sampling locations can be more easily viewed.

While the ARE and HE sampling events both characterized conditions in the watershed, the individual efforts varied somewhat. Flow rates were measured in May with a flow velocity meter while flows were measured in October with flumes and pipes. The former method is good for high flows; while the latter method is preferred for low flows. The May effort focused on flows and chemistry for the main stem and tributaries. The October sampling included individual AMD sources. ARE identified Tributary C as an important source of AMD by sampling its inflow to Potter Run (Sample 5 in Table 1 and on Map 2a). In October, the Tributary C watershed was investigated and three sources of AMD were located and sampled (see seeps 1, 2, and 3 in Table 1 and on Map 2a). The October sampling effort did not extend into the headwaters area. The highest point sampled was the discharge from a pond that had formed above a plugged stream culvert at a road crossing below Sample point #10. (The point is labeled the Potter Run Pond on Maps 1 and 2b. The pond is visible on Map 1 immediately west of the blue marker.)

The goal of capturing high and low flow conditions was realized. Table 2 shows flow rates, acidity concentrations, and acidity loadings for Potter Run and its tributaries during the high and low flow periods. Stream flow rates were 2-4 times higher during the May sampling event than the October sampling event. Water samples were generally less acidic during low flow. The slight moderation in contamination was <u>not</u> sufficient to cause environmentally significant improvement in water chemistry during high flow. Acidity loadings were 2-3 times higher during high flow than low flow. Potter Run was severely polluted with AMD during all flow conditions.

The goal of the technical assistance was to provide measurements of Potter Run contamination so that a restoration plan could be considered. The sampling indicates that Potter Run is polluted under all flow conditions. A restoration plan that focuses on low flow conditions will not provide stream restoration. The restoration plan must focus on high flow conditions.

Table 1. Results of samples collected from Potter Run in 2009.

Sample*		Sample	Taken	Flow	pH	Alk	Acid	Fe	Mn	Al	SO4
#	ID	Date	by	gpm	lab	mg/L					
1	Mouth PR	5/6/2009	ARE	1036	3.1	0	171	11.0	9.4	11.2	1042
	Mouth PR	5/19/2009	TU	1026	3.1	0	180	16.5	11.3	14.5	1178
	Mouth PR	7/21/2009	TU	654	3.0	0	211	14.9	13.0	13.6	1296
	Mouth PR	10/1/2009	HE		3.2	0	180	15.8	14.4	13.5	1751
2	Trib A	5/6/2009	ARE	282	2.8	0	339	31.6	10.9	19.6	1087
	Trib A 1st 24"	10/1/2009	HE	150	2.9		386	58.2	20.8	24.8	2242
3	Trib B	5/6/2009	ARE	11	3.5	0	120	0.5	9.6	11.5	858
	Trib B 2nd 24"	10/1/2009	HE	3	3.1	0	199	20.8	13.1	17.7	2166
4	PR above Tribs	5/6/2009	ARE	637	3.3	0	109	3.7	8.9	7.4	1091
	PR 2 @ big culv	10/1/2009	HE		3.2	0	180	16.9	15.2	12.3	1618
5	Trib C	5/6/2009	ARE	484	3.4	0	79	2.0	9.3	4.4	976
	PR Seep 1 @ 5	10/1/2009	HE	60	3.2	0	230	13.0	11.2	0.1	1854
	PR Seep 2 @ 5	10/1/2009	HE	55	3.2	0	178	14.2	11.9	14.1	2115
	PR Seep 3 @ 5	10/1/2009	HE	4	3.3	0	143	1.7	5.7	17.6	2210
6	PR Above C	5/6/2009	ARE	239	3.1	0	180	9.8	9.3	15.5	1480
7	Seep A	5/6/2009	ARE	21	3.4	0	187	2.3	15.3	20.4	1489
	PR Seep A	10/1/2009	HE	2	3.4	0	198	2.2	22.9	29.0	1994
8	Seep B	5/6/2009	ARE	4	3.7	0	111	1.1	14.9	10.3	1193
9	Seep C	5/6/2009	ARE	66	4.2	2	44	2.7	4.8	3.2	579
	Seep C	10/1/2009	HE	6	4.3	0	33	0.0	15.8	2.8	312
10	Trib D	5/6/2009	ARE	39	5.8	8	18	0.2	1.7	0.4	504
	Trib D	10/1/2009	HE	12	5.7	12	5	0.7	1.3	0.2	551
	PR Pond Effluent	10/1/2009	HE	75	3.4	0	58	6.0	17.3	1.0	1243
11	Trib E	5/6/2009	ARE	13	4.6	5	25	1.0	3.6	0.9	399
12	Trib F	5/6/2009	ARE	33	3.6	0	70	0.7	12.8	3.5	1398
13	PR above F	5/6/2009	ARE	159	3.4	0	63	7.1	10.7	1.3	982
14	Mine Disc	5/6/2009	ARE	19	4.2	3	21	0.5	0.4	0.7	204
15	PR Headwaters	5/6/2009	ARE	18	4.8	7	21	0.4	2.4	1.0	785

** Sample # refers to location shown on maps 1, 2a, and 2b.*

Table 2. Flows, chemistry, and loading for Potter Run and its major tributaries during high flow (May 2009) and low flow (October 2009)

	Flow, gpm		Acidity, mg/L		Acidity, lb/day	
	High	**Low**	**High**	**Low**	**High**	**Low**
PR mouth	1,036	366	171	180	2,125	789
Trib A	282	150	339	386	1,149	694
Trib B	11	3	120	190	16	7
Trib C	484	119	67	203	459	289
Trib D	39	12	18	5	8	1
Above PR Pond	204	75	62	58	151	52

Treatment Options and Recommendations

All of the AMD discharges sampled in the Potter Run watershed had low pH and contained elevated concentrations of Al, Mn, and Fe. The treatment of these waters requires the generation of alkalinity and the removal of metals. A common approach on permitted sites with AMD like that in Potter Run is the addition of sodium hydroxide, NaOH. General design and cost information for chemical treatment can be obtained with the Office of Surface Mine's computer program, AMDTreat (www.osmre.gov). The high annual costs of NaOH treatment make it unattractive to most watershed associations. TU's experience with the PGC is that it is similarly sensitive to long-term costs and would not accept a chemical solution unless a long-term revenue source was also available.

A second chemical treatment option is to install a lime doser. PADEP Bureau of Abandoned Mine Reclamation operates several lime dosers where hydrated lime is added directly to acidic streams. No attempt is made to manage the metals that form with neutralization. This approach is inexpensive, but it is only ecologically effective when the treated stream is large enough to allow biological benefits to develop downstream of the portion of the stream degraded by the chemical addition. Potter Run is not recommended for lime dosing because AMD enters the stream throughout its length. A doser would need to be placed below the inflow of Tributary A (highly acidic, see Table 2), which is only 1,600 ft upstream of the mouth. It is unlikely that a valuable fishery could be developed in the short stream stretch below a doser.

Passive treatment is generally the preferred approach for AMD on abandoned mine sites. The PGC has been involved in the construction of passive systems on SGL. TU is aware of successful passive treatment systems that have been constructed in the Slippery Rock Creek watershed on SGL 95 and in the Coon Run watershed on SGL 24. These passive systems treat acid mine drainage contaminated primarily with Fe. The systems use passive technologies (anoxic limestone drains, aerobic settling ponds, constructed aerobic wetlands) that are not appropriate for Potter Run AMD because of the presence of high concentrations of aluminum (Al). The most common passive technology used for Al-contaminated waters is the vertical flow pond or VFP (also called SAPS, RAPS,

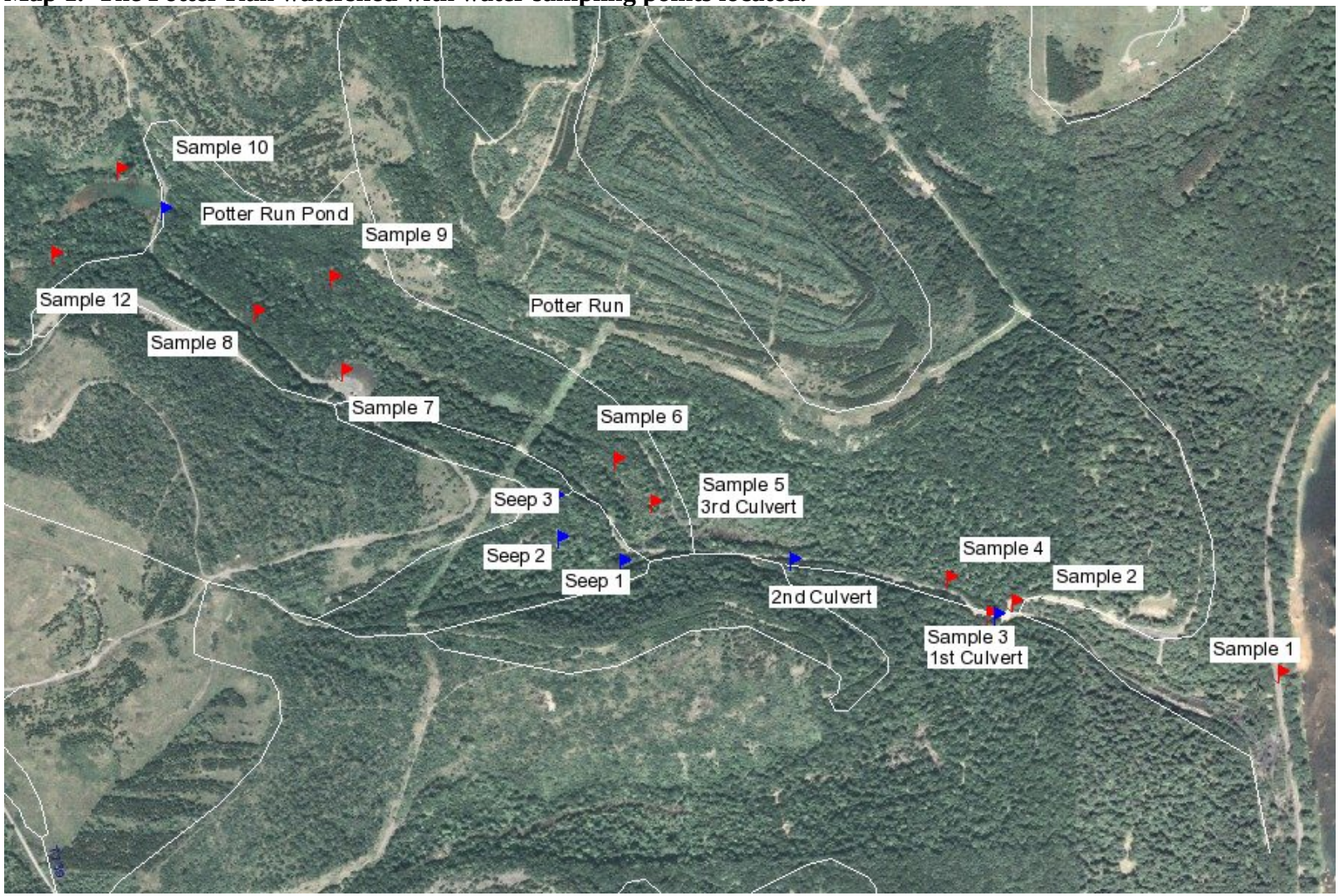
anaerobic wetland). A VFP is a pond that contains 2-4 ft of limestone aggregate overlain with 1-2 ft of organic substrate. The pond contains an underdrain system so that water flows downward through the substrates, while maintaining a water surface in the pond 1-3 feet above the substrates. VFPs neutralize acidity and remove Al and Fe. The VFP discharge typically contains biological oxygen demand (BOD), residual Fe, and Mn, which can all be removed with subsequent flow through aerobic ponds and wetlands.

The VFP approach has been successfully used for waters with chemistry similar to the Potter Run discharges in the Twomile Run watershed (Kettle Creek) and Babb Creek watershed. These systems were designed assuming that 125 ft^2 of VFP is required to remove each pound per day of acidity. Under high flow conditions, the acidity loading at the mouth of Potter Run was 2,125 lb/day. This acidity loading would require a total of about 6 acres of vertical flow ponds and total treatment area of about 12 acres. (The acreage would be divided among multiple treatment systems in the watershed.) The Babb Creek passive systems cost about $100,000 per acre (in 2003). As a first approximation, restoration of Potter Run through the installation of passive VFP systems will likely cost between $1,000,000 and $1,500,000.

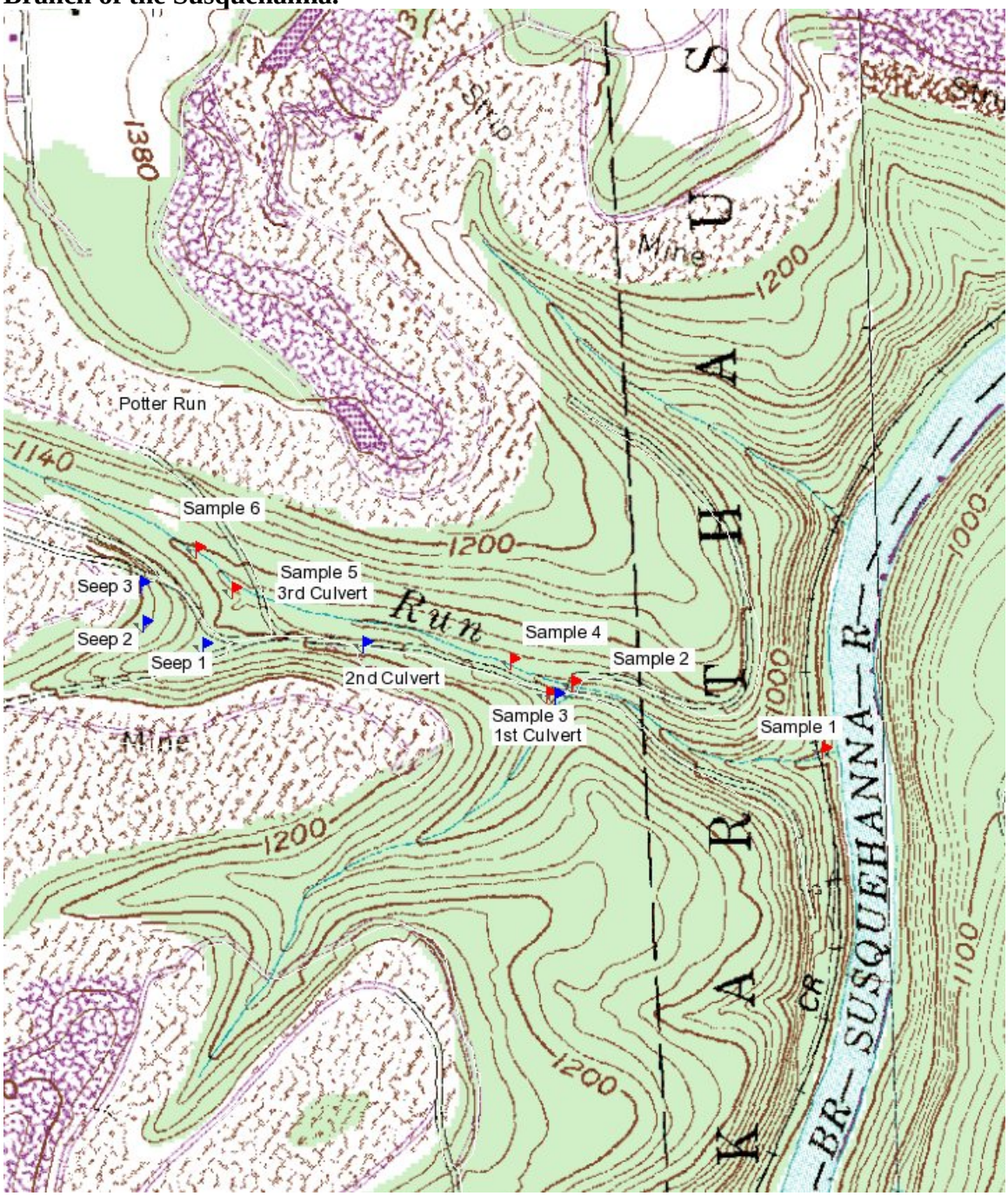
All treatment systems require operation and maintenance (O&M) activities. For passive systems containing VFPs, routine O&M activities include: bi-monthly inspections; manual cleanout of pipes, channels and ditches; removal of muskrats and beavers; adjustments to water level control structures; operation of flushing systems; and water sampling. Eventually, all treatment systems require major maintenance to maintain acidity neutralization and metal removal. VFPs require substrate mixing and eventually substrate replacement. The periodicity of major maintenance varies with AMD severity. VFPs constructed for the Potter Run AMD would likely require substrate mixing after 5-7 years and substrate replacement after 10 years. PADEP recently began to support an O&M fund that is intended to assist watershed groups with planned major maintenance activities.

If the PGC decides to advance restoration plans for Potter Run, a long-term monitoring program should be initiated. The high and low flow conditions described in this report should be verified by measuring flows and collecting water samples over a 12-18 month period. Flow measurement devices should be installed on all significant AMD sources. Flows should be measured monthly and water samples should be collect at least every other month. The water samples should be analyzed for standard AMD parameters. In the past, the PADEP Growing Greener program has funded these assessment studies as a first step in overall stream restoration.

Map 1. The Potter Run watershed with water sampling points located.



Map 2a. The lower portion of Potter Run showing its confluence with the West Branch of the Susquehanna.



Points in red from ARE sampling blue points added by Hedin Environmental

Map 2b. The upper portion of the Potter Run watershed showing the headwaters.

Points in red from ARE sampling blue points added by Hedin Environmental

Benthic Macroinvertebrate Assessment Addendum by Trout Unlimited

Trout Unlimited (TU) staff collected benthic macroinvertebrate data to provide baseline conditions and to complement water quality and quantity data collected by Hedin Environmental as part of the rapid watershed assessment for Potter Run.

Benthic macroinvertebrate collections were made at five locations (Table 3, Figure 1) in the Potter Run watershed on June 5, 2009 by TU personnel. These collections were made according to Pennsylvania Department of Environmental Protection's (DEP) 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 so as to select the best riffle habitat areas with varying depths. Each effort consisted of an area of 1 m^2 to a depth of at least 4 inches as substrate allowed and was conducted with a 500 micron mesh 12-inch diameter D-frame kick net. The six individual efforts were composited and preserved with ethanol for processing in the lab.

No sub-sampling was required for these samples as the individual counts were very low. Individuals were identified to the lowest possible taxonomic level which in most cases was to genus. The samples were evaluated according to the six metrics comprising the DEP's Index of Biological Integrity (Total Taxa Richness, EPT Taxa Richness, Beck's Index V.3, Shannon Diversity, Hillsenhoff Biotic Index, and Percent Sensitive Individuals). These metrics were standardized and used to determine if the stream is meeting its Aquatic Life Use (ALU) as designated by the DEP.

Table 3. Site Locations

Sample Point ID	Description	Latitude	Longitude
1	Potter Run 2	41.09327778	78.13205556
2	Potter Run 5	41.0949208	78.139068
3	Potter Run below 5	41.0950414	78.1375494
4	Potter Run 10	41.10069444	78.14877778
5	Potter Run below 10	41.09977778	78.14775

Potter Run Site 2

A total of 13 individuals from one taxa (Diptera: Chironomidae) were collected from this site. The average of adjusted standardized core metric scores (8.7) included in the ICE calculations indicate that this site is impaired and does not meet the threshold required for aquatic life use.

Table 4. Potter Run Site 2 ICE Metrics

DEP ICE METRICS	*Observed Value*	*Standardized Metric Score*	*Adjusted Standardized Metric Score*
TOTAL TAXA RICHNESS	1	0.030	0.030
EPT TAXA RICHNESS	0	0.000	0.000
BECK'S INDEX (V. 3)	0	0.000	0.000
SHANNON DIVERSITY	0.00	0.000	0.000
HILSENHOFF BIOTIC INDEX	6	0.493	0.493
% SENSITIVE (PTV0-3) INDIVIDUALS	0	0.000	0.000
			8.7
			Impaired

Potter Run Site 5

A total of 4 individuals from one taxa (Diptera: Chironomidae) were collected from this site. The average of adjusted standardized core metric scores (8.7) included in the ICE calculations indicate that this site is impaired and does not meet the threshold required for aquatic life use.

Table 5. Potter Run Site 5 ICE Metrics

DEP ICE METRICS	*Observed Value*	*Standardized Metric Score*	*Adjusted Standardized Metric Score*
TOTAL TAXA RICHNESS	1	0.030	0.030
EPT TAXA RICHNESS	0	0.000	0.000
BECK'S INDEX (V. 3)	0	0.000	0.000
SHANNON DIVERSITY	0.00	0.000	0.000
HILSENHOFF BIOTIC INDEX	6	0.493	0.493
% SENSITIVE (PTV0-3) INDIVIDUALS	0	0.000	0.000
			8.7
			Impaired

Potter Run Below Site 5

A total of 8 individuals from one taxa (Diptera: Chironomidae) were collected from this site. The average of adjusted standardized core metric scores (8.7) included in the ICE calculations indicate that this site is impaired and does not meet the threshold required for aquatic life use.

Table 6. Potter Run Below Site 5 ICE Metrics

DEP ICE METRICS	*Observed Value*	*Standardized Metric Score*	*Adjusted Standardized Metric Score*
TOTAL TAXA RICHNESS	1	0.030	0.030
EPT TAXA RICHNESS	0	0.000	0.000
BECK'S INDEX (V. 3)	0	0.000	0.000
SHANNON DIVERSITY	0.00	0.000	0.000
HILSENHOFF BIOTIC INDEX	6	0.493	0.493
% SENSITIVE (PTV0-3) INDIVIDUALS	0	0.000	0.000
			8.7
			Impaired

Potter Run Site 10

A total of 8 individuals from two taxa (Diptera: Chironomidae, Trichoptera: Polycentropidae) were collected from this site. The average of adjusted standardized core metric scores (9.2) included in the ICE calculations indicate that this site is impaired and does not meet the threshold required for aquatic life use.

Table 7. Potter Site 10 ICE Metrics

DEP ICE METRICS	*Observed Value*	*Standardized Metric Score*	*Adjusted Standardized Metric Score*
TOTAL TAXA RICHNESS	2	0.061	0.061
EPT TAXA RICHNESS	0	0.000	0.000
BECK'S INDEX (V. 3)	0	0.000	0.000
SHANNON DIVERSITY	0.00	0.000	0.000
HILSENHOFF BIOTIC INDEX	6	0.493	0.493
% SENSITIVE (PTV0-3) INDIVIDUALS	0	0.000	0.000
			9.2
			Impaired

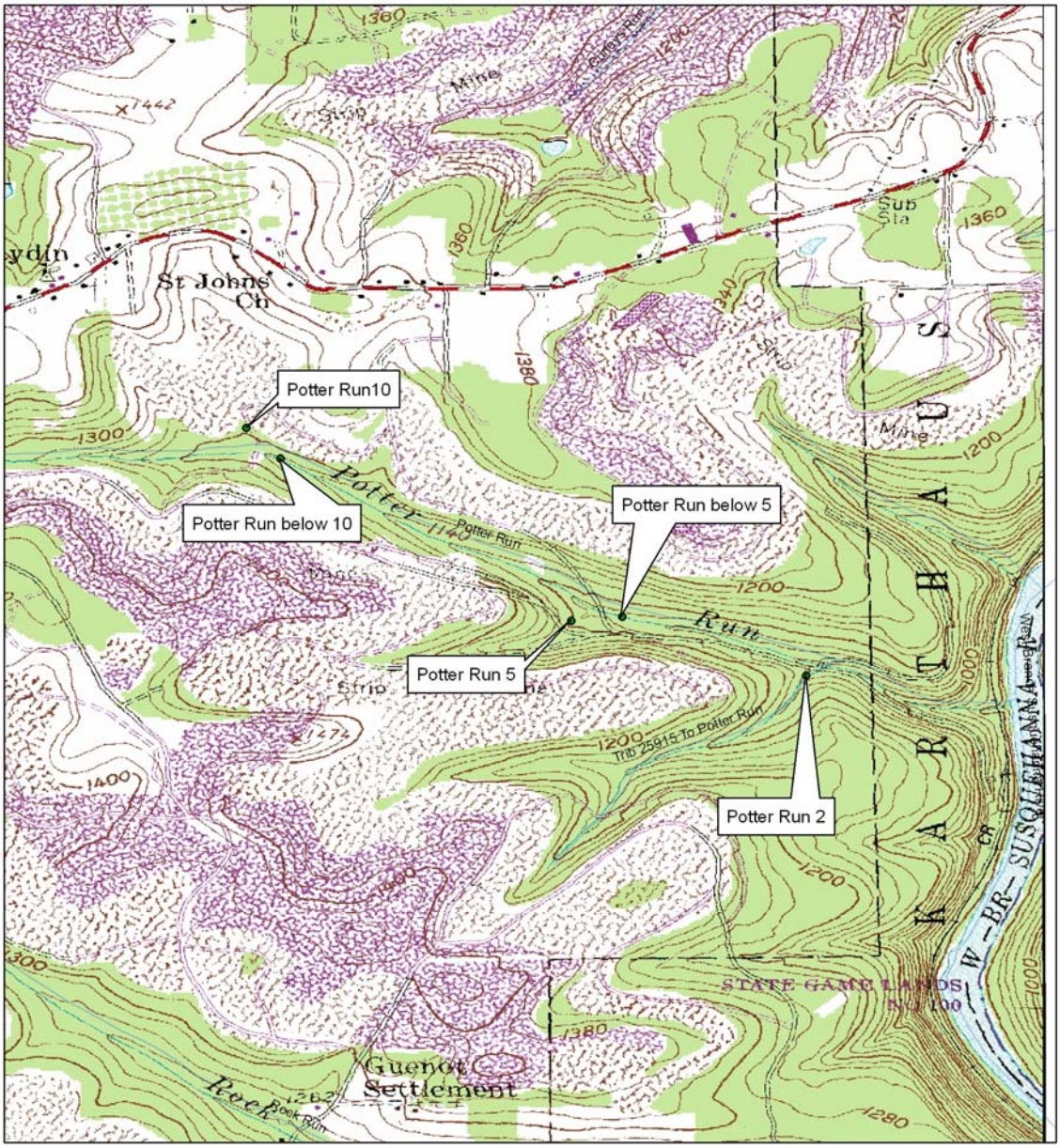
Potter Run Below Site 10

A total of 10 individuals from two taxa (Diptera: Chironomidae, Tipulidae) were collected from this site. The average of adjusted standardized core metric scores (11.8) included in the ICE calculations indicate that this site is impaired and does not meet the threshold required for aquatic life use.

Table 8. Potter Site 10 ICE Metrics

DEP ICE METRICS	*Observed Value*	*Standardized Metric Score*	*Adjusted Standardized Metric Score*
TOTAL TAXA RICHNESS	2	0.061	0.061
EPT TAXA RICHNESS	0	0.000	0.000
BECK'S INDEX (V. 3)	0	0.000	0.000
SHANNON DIVERSITY	0.00	0.000	0.000
HILSENHOFF BIOTIC INDEX	5.7	0.530	0.530
% SENSITIVE (PTV0-3) INDIVIDUALS	10	0.118	0.118
			11.8
			Impaired

Map 3. Benthic macroinvertebrate sampling locations.



Appendix I
Benthic Macroinvertebrate Taxa

Site ID	Potter Run 2
Site name/description	
Collected date	6/5/2009
Collected by	Kester, Bassett, Smith
Identified by	Furguiele, Dunlap
Total Taxa	1
Total Individuals	13

TAXA	**Count**
Diptera (Midges, Flies)	
Chironomidae	13

Site ID	Potter Run 5
Site name/description	
Collected date	6/5/20090
Collected by	Kester, Bassett, Smith
Identified by	Furguiele, Dunlap
Total Taxa	1
Total Individuals	4

TAXA	**Count**
Diptera (Midges, Flies)	
Chironomidae	4

Site ID	Potter Run Below 5
Site name/description	
Collected date	5/5/2009
Collected by	Kester, Bassett, Smith
Identified by	Furgiuele, Dunlap
Total Taxa	1
Total Individuals	8

TAXA	**Count**
Diptera (Midges, Flies)	
Chironomidae	8

Site ID	Potter Run 10
Site name/description	
Collected date	6/5/2009
Collected by	Kester, Bassett, Smith
Identified by	Furguiele, Dunlap
Total Taxa	2
Total Individuals	8

TAXA	**Count**
Trichoptera (Caddisflies)	
Polycentropidae	
Polycentropus	1
Diptera (Midges, Flies)	
Chironomidae	7

Site ID	Potter Run below 10
Site name/description	
Collected date	6/5/2009
Collected by	Kester, Bassett, Smith
Identified by	Furguiele, Dunlap
Total Taxa	2
Total Individuals	10

TAXA	**Count**
Diptera (Midges, Flies)	
Chironomidae	9
Tipulidae	
Dicranota	1