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AMD Total Maximum Daily Load for the South Branch Bear Creek Watershed, Pennsylvania

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Draft Report

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1.0 Introduction

1.1 Regulatory Guidance

Section 303(d) of the Clean Water Act and the Environmental Protection Agency (EPA)'s Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are exceeding water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 2001).

The state regulatory agency for Pennsylvania is the Department of Environmental Protection (PADEP). As required by the Clean Water Act, PADEP develops and maintains a listing of all impaired waters in the state that details the pollutant(s) exceeding water quality standards and the potential source(s) of each pollutant. This list is referred to as the 303(d) list. As part of the settlement of a TMDL lawsuit in Pennsylvania[1], EPA agreed to develop or approve TMDLs for waters included on Pennsylvania's 1996 303(d) List of Impaired Waters under a specified timeframe. The TMDLs in this report were developed in partial fulfillment of that lawsuit and address seven segments impaired by acid mine drainage (AMD) on Pennsylvania's 1996, 1998, 2002, and 2004 Section 303(d) lists within the South Branch Bear Creek watershed, located within Butler and Armstrong Counties.

[1] *American Littoral Society and Public Interest Research Group of Pennsylvania v. EPA*

1.2 Impairment Listing

The South Branch Bear Creek watershed is located within Butler and Armstrong Counties in western Pennsylvania. The watershed contains only one major named stream: South Branch Bear Creek. This stream accounts for 27% of the watershed's total stream mileage with the remainder accounted for in small tributaries. The mainstem of South Branch Bear Creek begins in the southwestern tip of the watershed in the township of Fairview and flows northward. In the borough of Bruin, South Branch Bear Creek feeds into Bear Creek. Bear Creek flows northeastwardly and eventually meets the Allegheny River. Smaller headwater streams, i.e. stream order 1 and 2 tributaries, account for nearly 73% of the watershed's stream mileage. (**Figure 1-1**).

Stream segments in the South Branch Bear Creek watershed (located in Pennsylvania State Water Plan 17C) were first reported as impaired on Pennsylvania's 1996 303(d) List of Impaired Waters. Additional segments and impairment sources were subsequently added on Pennsylvania's 1998, 2002, and 2004 303(d) lists. Each stream segment in these watersheds is identified by a unique code, referred to as a stream code. The stream codes for each stream segment in South Branch Bear Creek are presented in Figure 1-1, and will be used to describe the impairment listings for these streams.

The full impairment listings for South Branch Bear Creek are discussed below in Section 1.2.1. Stream segments in the watershed were listed as impaired for nutrients, metals, and unknown causes. However, the analysis and results presented in this report establishes TMDLs for AMD-related causes (i.e., metals) for South Branch Bear Creek. The other impairments will be addressed in a separate TMDL at a later time.

1.2.1 Impaired Segment Listings

Two segments in the South Branch Bear Creek watershed (stream codes 49156 and 49157) were reported on Pennsylvania's 2004 303(d) list as impaired due to priority organics from unknown sources. The reminder of the impaired segments is on the mainstem of the South Branch Bear Creek. Two segments on the mainstem were reported on the 1996 listed as impaired due to priority organics from unknown sources

(assessment ID 20000628-0802-JJM and 20000628-0800-JJM). In addition to being listed in 1996 for priority organics, these segments were also reported as impaired due to metals from abandoned mine drainage. One of the segments (assessment ID 20000628-0800-JJM) had another impairment in the same year due to other inorganics from abandoned mine drainage. An additional segment on the mainstem was listed for priority organics from unknown sources on the 1998 303(d) list (assessment ID 20000628-0803-JJM). In 2002, a segment on the mainstem was reported as impaired due to nutrients from a municipal point source (assessment ID 20000628=0759-JJM). Additionally in 2002, two segment on the mainstem were reported as impaired due to causes unknown from unknown sources (assessment ID 20000628-0800-JJM and 20010628-1130-JJM). **Table 1.1** shows the 303(d) impairment listings for segments within the South Branch Bear Creek watershed.

As stated above, this report addresses only the AMD impairment present in South Branch Bear Creek and establishes an AMD TMDL for these streams.

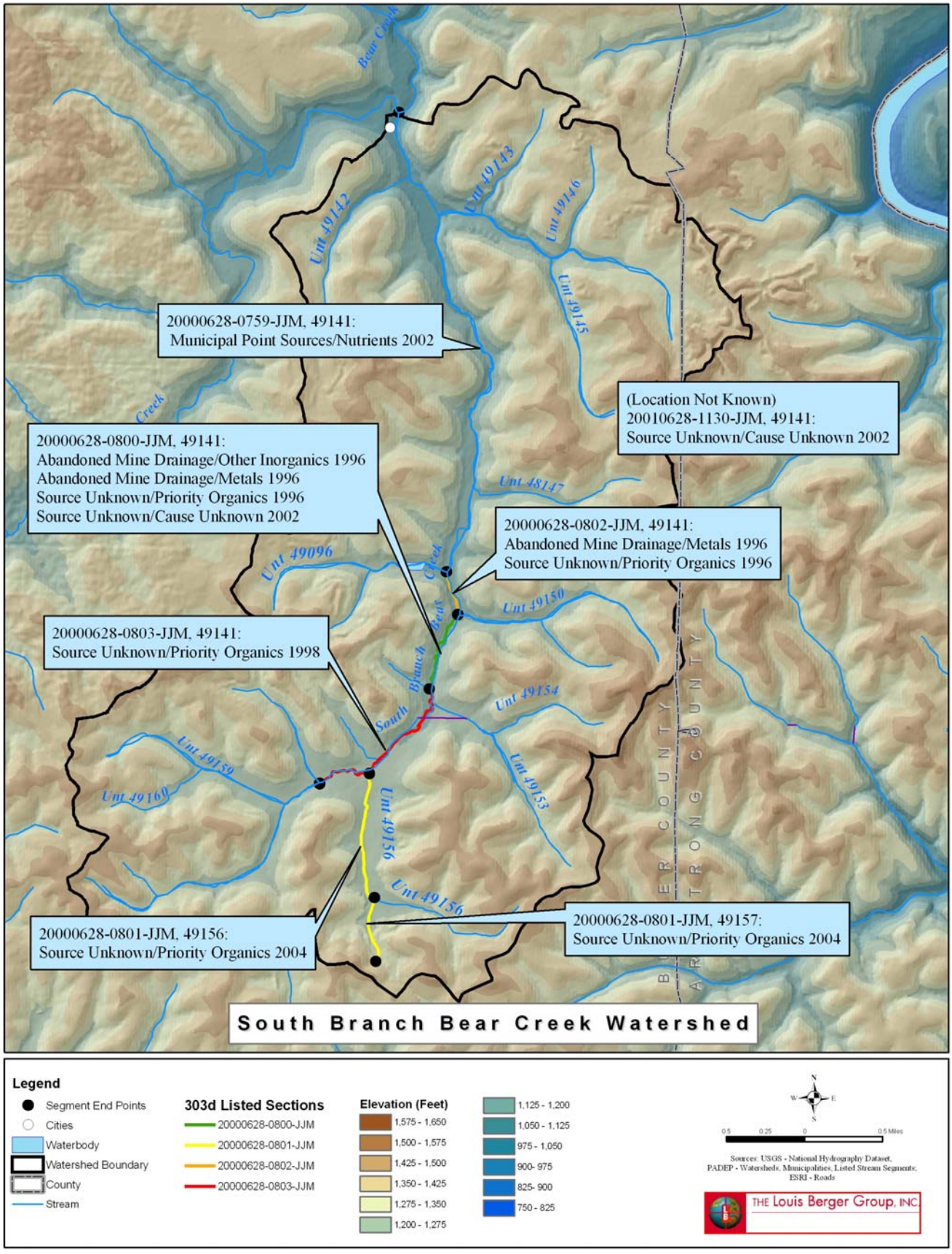

Figure 1-1: Impaired Segments in the South Branch Creek Watershed

1.3 Applicable Water Quality Standard

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses, as well as an antidegradation section. According to Pennsylvania Water Quality Standards, the term *water quality criteria* are defined as "numeric concentrations, levels or surface water conditions that need to be maintained or attained to protect existing and designated uses."

1.3.1 Designated Uses

Pennsylvania Water Quality Standards (§ 93.3 of the Code of Pennsylvania) designate water uses which shall be protected, and upon which the development of water quality criteria shall be based. These include the protection of potable water supplies as defined by the Federal Safe Drinking Water Act (42 U.S.C.A. § 300F), or by other water users that require a permit from the Department under the Pennsylvania Safe Drinking Water Act (35 P. S. § 721.1—721.18), as well as water supply for wildlife, industry, livestock, and irrigation. The maintenance and propagation of aquatic life, including coldwater and warmwater fisheries, and anadromous and catadromous fishes which ascend into flowing waters to complete their life cycle, are also protected as designated uses of Pennsylvania's waters. Pennsylvania Water Quality Standards also serve to designate waters in the state for primary contact recreation, fishing, boating, esthetics, and navigation. **Table 1-1** shows the designated uses for the 303(d) listed segments.

Table 1-1: Designated Water Uses and 303(d) Impairment Listings for South Branch Bear Creek Watershed segments

Original Listing Date	303(d) Listed Segment (Assessment ID, Stream Code)	Stream Name	Designated Water Uses	303(d) Impairment (Source/Cause)
1996	20000628-0800-JJM, 49141	South Branch Bear Creek	WWF	*AMD/ Metals, *AMD/Other Inorganics, Source Unknown/ Priority Organics
2002	20000628-0800-JJM, 49141	South Branch Bear Creek	WWF	Source Unknown/ Cause Unknown
1996	20000628-0802-JJM, 49141	South Branch Bear Creek	WWF	*AMD/Metals, Source Unknown/ Priority Organics
1998	20000628-0803-JJM, 49141	South Branch Bear Creek	WWF	Source Unknown/ Priority Organics
2004	20000628-0801-JJM, 49156	South Branch Bear Creek UNT 49156	WWF	Source Unknown/ Priority Organics
2004	20000628-0801-JJM, 49157	South Branch Bear Creek UNT 49157	WWF	Source Unknown/ Priority Organics

UNT: Unnamed tributary to South Branch Bear Creek
WWF: Warm Water Fishes
Pennsylvania State Water Plan 17C
* denotes impairments listings addressed under this TMDL

1.3.2 Water Quality Criteria

General Criteria

The General Criteria defined in Pennsylvania's Water Quality Standards (§ 93.6 of the Code of Pennsylvania) provides general, narrative criteria for the protection of designated uses from substances that may interfere with attainment of such uses. The general water quality criteria state:

"Water may not contain substances attributable to point or non-point source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life. In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, orders, turbidity or settle to form deposits."

Table 1-2 shows the specific water criteria for each of designated uses in South Branch Bear Creek.

Table 1-2: Pennsylvania "Specific Water Quality Standards" for South Branch Bear Creek*

Parameter	Critical Use	Criteria
Alkalinity	WWF	Minimum of 20 mg/L as $CaCO_3$
Chloride	PWS	Maximum 250 mg/L
Color	PWS	Maximum 75 units on the platinum-cobalt scale; no other colors perceptible to the human eye
DO	WWF	Minimum of 4.0 mg/L
Total Fe	WWF	30 day average 1.5 mg/L
Dissolved Fe	PWS	Maximum 0.3 mg/L
Fluoride	PWS	Daily average 2.0 mg/L
Total Manganese	PWS	Maximum 1.0 mg/L
NO_x-N (NO_3-N+NO_2-N)	PWS	Maximum 10 mg/L
Phenolics	PWS	Maximum 0.005 mg/L
pH	WWF	From 6.0 to 9.0 inclusive
Total Dissolved Solids	PWS	500 mg/L as a monthly average value; maximum 750 mg/L
Sulfate	PWS	Maximum 250 mg/L
Temperature	TSF	Depending on month of sampling
Tot. Res. Chlorine	WWF	1-hour average of 0.019 mg/L

* Department of Environmental Protection (May 14, 2005). Commonwealth of Pennsylvania, Pennsylvania Code, Title 25. Environmental Protection.

Metals Criteria

Pennsylvania had developed a criteria for metals in § 16.24 of the Pennsylvania Code. The aquatic life criteria for metals can be expressed as either dissolved or total recoverable, depending on the available data. The dissolved criteria can be found in Appendix A, Table 1 in Chapter 16 of the Pennsylvania code. The dissolved criteria was developed by Pennsylvania using the most current EPA conversion factors to the total recoverable criteria.

1.4 TMDL Development for South Branch Bear Creek

TMDL development requires a methodology to confirm impairment causes identified in the 303(d) list and to determine pollutant reductions that will allow the streams to attain their designated uses. Priority organics, metals, and sources unknown were identified as the cause of the impairment in South Branch Bear Creek. This report only addresses the AMD impairments and establishes an AMD TMDL for South Branch Bear Creek.

In the subsequent sections of this report, watershed and environmental monitoring data used in TMDL development for South Branch Bear Creek is discussed and analyzed. Sources of metals in the watershed are also described and analyzed. After reviewing the available watershed and environmental monitoring data, a technical approach was developed. For an AMD TMDL, a statistical analysis using Monte Carlo simulation was used to determine the necessary load reductions for AMD.

These approaches and calculations are presented in Section 4.0 of this TMDL report. TMDL allocations for South Branch Bear Creek are presented in Section 5.0. Finally, reasonable assurance and the public participation process for these TMDLs are discussed in Section 6.0.

2.0 Watershed Characterization

The purpose of the watershed characterization is to provide an overview of conditions in the watershed as they relate to the impairment listings. In particular, watershed physical features such as topography, soil types, and land use types are inventoried and assessed. In addition, any permitted discharge facilities or water quality monitoring stations present in the watersheds are documented. Information obtained from the watershed characterization is then used in identifying potential pollutant(s) causing the impairment, as well as for the subsequent TMDL development.

2.1 Physical Characteristics

Important physical characteristics of the South Bear Branch Creek watershed were analyzed using GIS coverages and other ancillary information describing its physical condition. GIS coverages of the watershed boundary, stream network, topography, soils, land use, and ecoregion were compiled and analyzed from the following primary sources:

- BASINS Database - EPA
- National Land Cover Dataset (NLCD) – USGS
- National Hydrography Dataset (NHD) – USGS
- Soil Survey Geographic Database (SSURGO)– NRCS
- Pennsylvania Spatial Data Access (PASDA), PA Bureau of Geospatial Technologies and Penn State Institutes of the Environment

2.1.1 Watershed Location and Boundary

The South Branch Bear Creek watershed is located within Butler and Armstrong Counties in western Pennsylvania (**Figure 2-1**). South Branch Bear Creek begins in the southern tip of the watershed, flows through the boroughs of Karns City, Petrolia, the townships of Parker and Fairview, and the city of Bruin. After flowing through Bruin,

the main stem of South Branch Bear Creek meets Bear Creek, which eventually flows into the Allegheny River. The total size of the watershed is 9,429 acres, or about 15 square miles.

State Route 268, traversing in a north-south direction and roughly dividing the watershed in half, serves as the primary transportation route in the watershed (**Figure 2-1**).

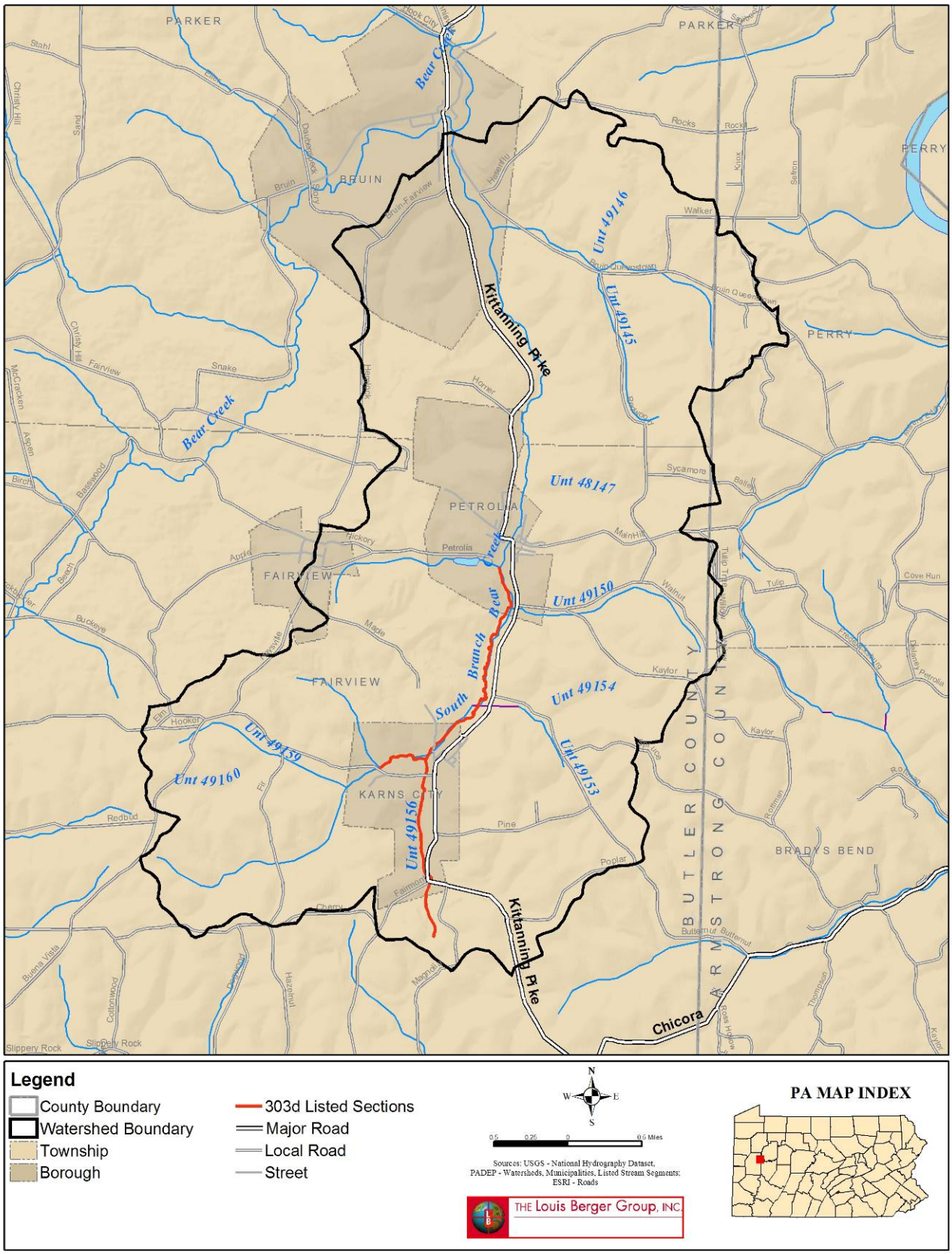

Figure 2-1: South Branch Bear Creek Vicinity Map

2.1.2 Stream Network

The stream network for South Branch Bear Creek was mapped and analyzed using GIS data provided by the PADEP (**Figure 2-2**). Based on this data, there are 26.7 miles of stream in the watershed, approximately 3.3 miles of which were identified on the 303(d) list of impaired waters in 1996, 1998, or 2004. The listed segments consist of the headwaters of South Branch Bear Creek and two unnamed tributaries (UNT 49156 and UNT 49157).

Table 2-1: Major Tributaries in South Branch Bear Creek Watershed

Name	Length (miles)
South Branch Bear Creek	7.4
UNT 49143	2.0
UNT 49156	2.0
UNT 49150	1.6
UNT 49153	1.5
UNT 49148	1.4
UNT 49159	1.3
UNT 49145	1.2
UNT 49147	1.2
UNT 49142	1.2
Other Tributaries	6.1
Total	**26.7**

The South Branch Bear Creek watershed contains only one major named stream: South Branch Bear Creek. This stream accounts for 27% of the watershed's total stream mileage with the remainder accounted for in small tributaries **(Table 2-1)**. The mainstem of South Branch Bear Creek begins in the southwestern tip of the watershed in the township of Fairview and flows northward. In the borough of Bruin, South Branch Bear Creek feeds into Bear Creek. Bear Creek flows northeastwardly and eventually meets the Allegheny River. Smaller headwater streams, i.e. stream order 1 and 2 tributaries, account for nearly 73% of the watershed's stream mileage **(Table 2-2)**.

Table 2-2: Streams Mileage by Stream Order in the South Branch Bear Creek Watershed

Stream Order	Length (miles)
1	15.9
2	5.1
3	5.8
Total	**26.7**

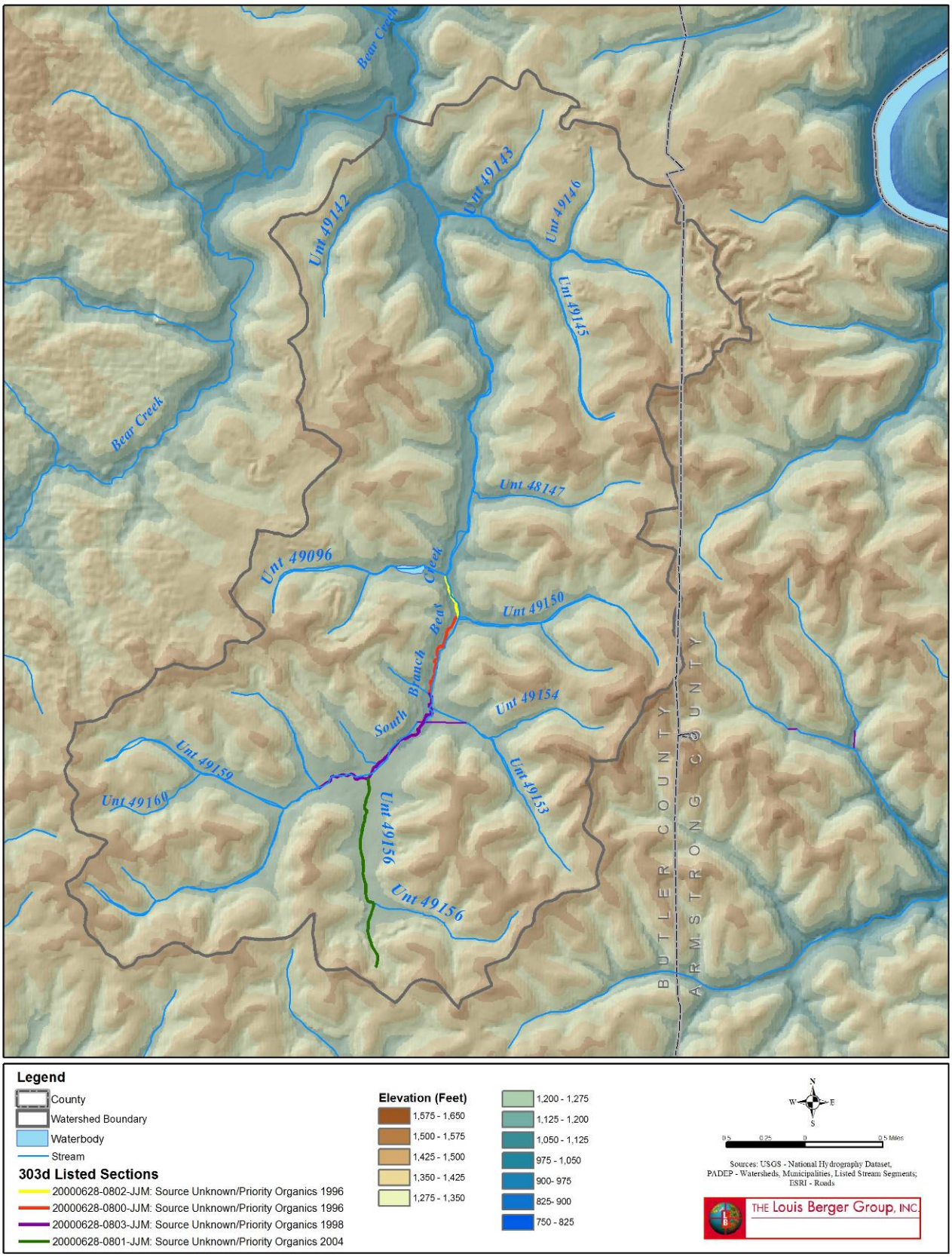

Figure 2-2: Stream Networks and Topography

2.1.3 Topography

A 10-meter digital elevation model (DEM) was used to characterize topography in the watershed. Elevations in the watershed ranged from 1,085 to 1,543 feet above mean sea level with an average elevation of 1,339 feet.

The steepness and distribution of slopes in the watershed has a significant effect on the hydrologic character of a given watershed. In general, in the absence of the effects of urban development, watersheds with a high proportion of their area in low slope classes tend to have a greater proportion of rainfall reabsorbed into the soil before becoming surface runoff. In contrast, watersheds with a significant portion of their area in higher slope classes tend to have more rapid conversion of rainfall to runoff and more flashy flow characteristics. Based on slope calculations modeled from the DEM, slopes in the watershed (calculated as percent slope) ranged from 0% to 81%, with the average slope in the watershed approximately 16%. Slope classes in the watershed are presented below in **Table 2-3**.

Table 2-3: Percent Slope Classes in the South Branch Bear Creek Watershed by Proportion

Slope Classes	Acres	Proportion of Watershed
0-2%	208	2.2%
2-5%	605	6.4%
5-10%	1,617	17.2%
10-25%	5,786	61.4%
25-50%	1,199	12.7%
>50%	14	0.1%
TOTAL	9,429	100.0%

2.1.4 Soils

Soil Survey Geographic Database (SSURGO) data with both spatial and tabular components was obtained for Butler and Armstrong counties and used to characterize soils in the watershed (NRCS, 2004). Based on this data, twenty soil series exist in the South Branch Bear Creek Watershed. Of these soil series, only three, the Gilpin (27%), Hazleton (22%), and Buchanan (10%) soil series, comprise significant portions of the watershed (**Table 2-4**). The Gilpin soil series consists of moderately deep, well drained soils formed in residuum of nearly horizontal interbedded shale, siltstone, and some sandstone of the Allegheny Plateau. The Hazelton soil series consists of deep and very deep, well drained soils formed in residuum of acid gray, brown or red sandstone on uplands. The soils of the Buchanan series are very deep, somewhat poorly and

moderately well drained, and slowly permeable. These soils formed in colluvium on mountain footslopes, sideslopes and in valleys, and are derived from acid sandstone, quartzite, siltstone, and shale.

Table 2-4: Major Soil Series Mapped in the South Branch Bear Creek Watershed

Series	Acres	Proportion of Watershed
Gilpin	2,503	27%
Hazleton	2,113	22%
Buchanan	938	10%
Udorthents	683	7%
Cookport	588	6%
Ernest	582	6%
Atkins	546	6%
Cavode	513	5%
Series that comprise less than 5% of the watershed (13 total)	963	10%

Hydrologic soil groups describe the different levels of infiltration capacity for any given soil type. Hydrologic soil group "A" designates soils that are well to excessively well drained, whereas hydrologic soil group "D" designates soils that are poorly drained. Thus, soils in hydrologic group "A" allow a larger portion of the rainfall to infiltrate and become part of the ground water system. Conversely, soils in hydrologic group "D" allow a smaller portion of the rainfall to infiltrate and become part of the ground water. Consequently, more rainfall becomes part of the surface water runoff in hydrologic group D. The majority of the South Branch Bear Creek watershed is dominated by soils of moderate to moderately slow infiltration rates (Hydrogroup C) (**Table 2-5, Figure 2-3**).

Table 2-5: Hydrologic Soil Groups in the South Branch Bear Creek Watershed

Hydrologic Soil Group	Description	Acres	Proportion of Watershed
A	High infiltration rates. Soils are deep, well drained to excessively drained sand and gravels.	0	0%
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well-drained soils with moderately coarse textures.	2,133	23%
C	Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures.	6,167	65%
D	Very slow infiltration rates. Soils are clayey, have high water table, or shallow to an impervious cover	801	8%
C/D	Combination of Soil Group C and D	<1	<1%
---	Not applicable	328	6%
Total		**9,429**	**100%**

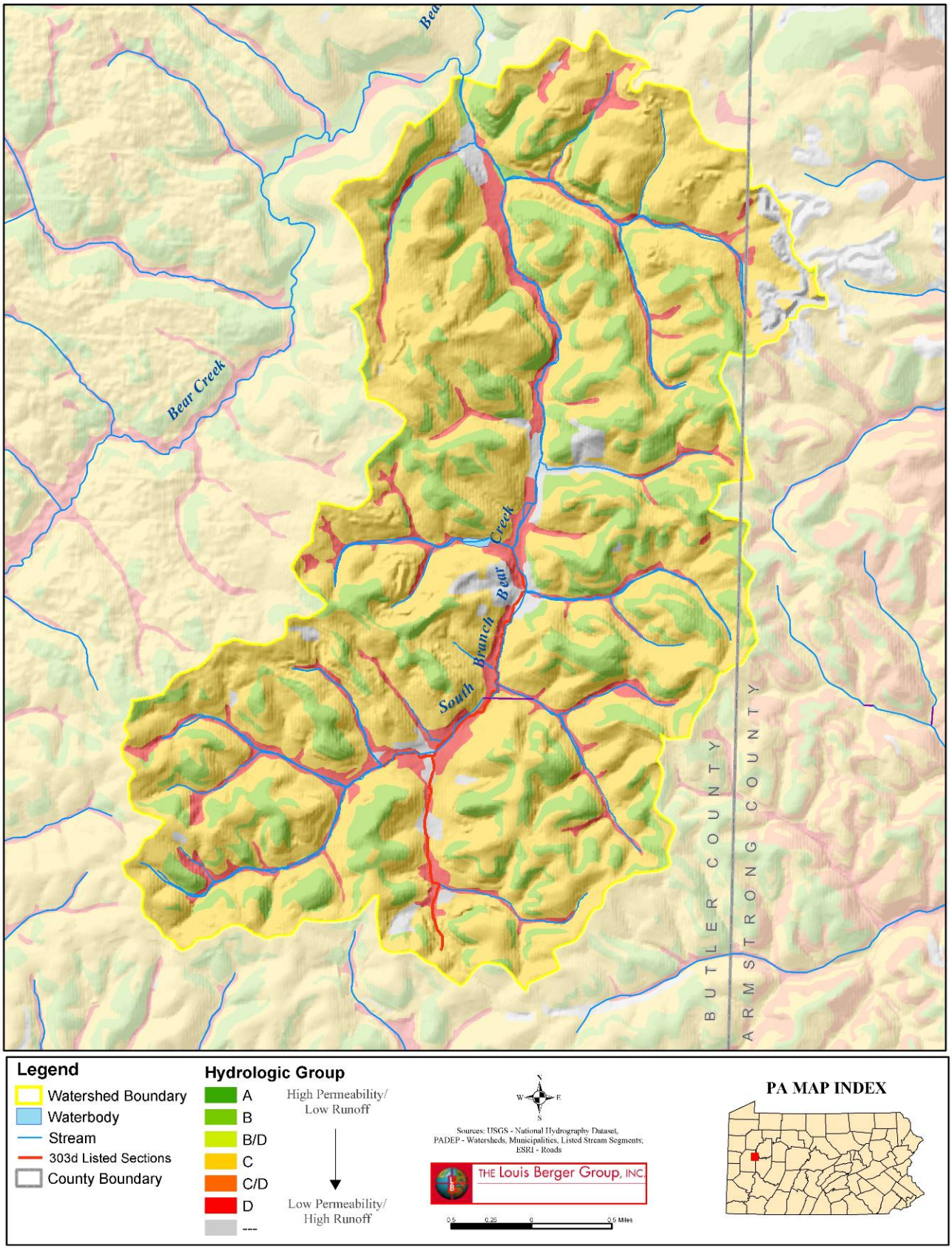

Figure 2-3: Hydrologic Soil Groups in the South Branch Bear Creek Watershed

2.1.5 Land Use

Land use characterization was based on 1992 National Land Cover Data (NLCD) developed by USGS. The distribution of land uses in the South Branch Bear Creek watershed, by land area and percentage, is presented in **Table 2-6**. Forested lands cover the majority of the watershed (83%). The majority of the remaining watershed area is dominated by agricultural land uses (11.7%) with some developed lands (3.6%). **Figure 2-4** displays a map of the land uses within the South Branch Bear Creek watershed. Brief descriptions of land use categories are presented in **Table 2-7.**

Table 2-6: South Branch Bear Creek Watershed Land Use Distribution

General Land Use Category	NLCD Land Use Type	Acres	Percent of Watershed	Total Percent
Water/Wetlands	Open Water	4	< 0.1%	< 0.1%
Developed	Low Intensity Residential	276	2.92%	3.6%
	High Intensity Residential	2	< 0.1%	
	Commercial/Industrial/Transportation	61	0.6%	
Agriculture	Pasture/Hay	882	9.4%	11.7%
	Row Crops	219	2.3%	
Forest	Deciduous Forest	7,364	78.1%	83.0%
	Evergreen Forest	180	1.9%	
	Mixed Forest	279	3.0%	
Other	Quarries/Strip Mines/Gravel Pits	162	1.7%	1.7%
Total		9,429	100.0%	100.0%

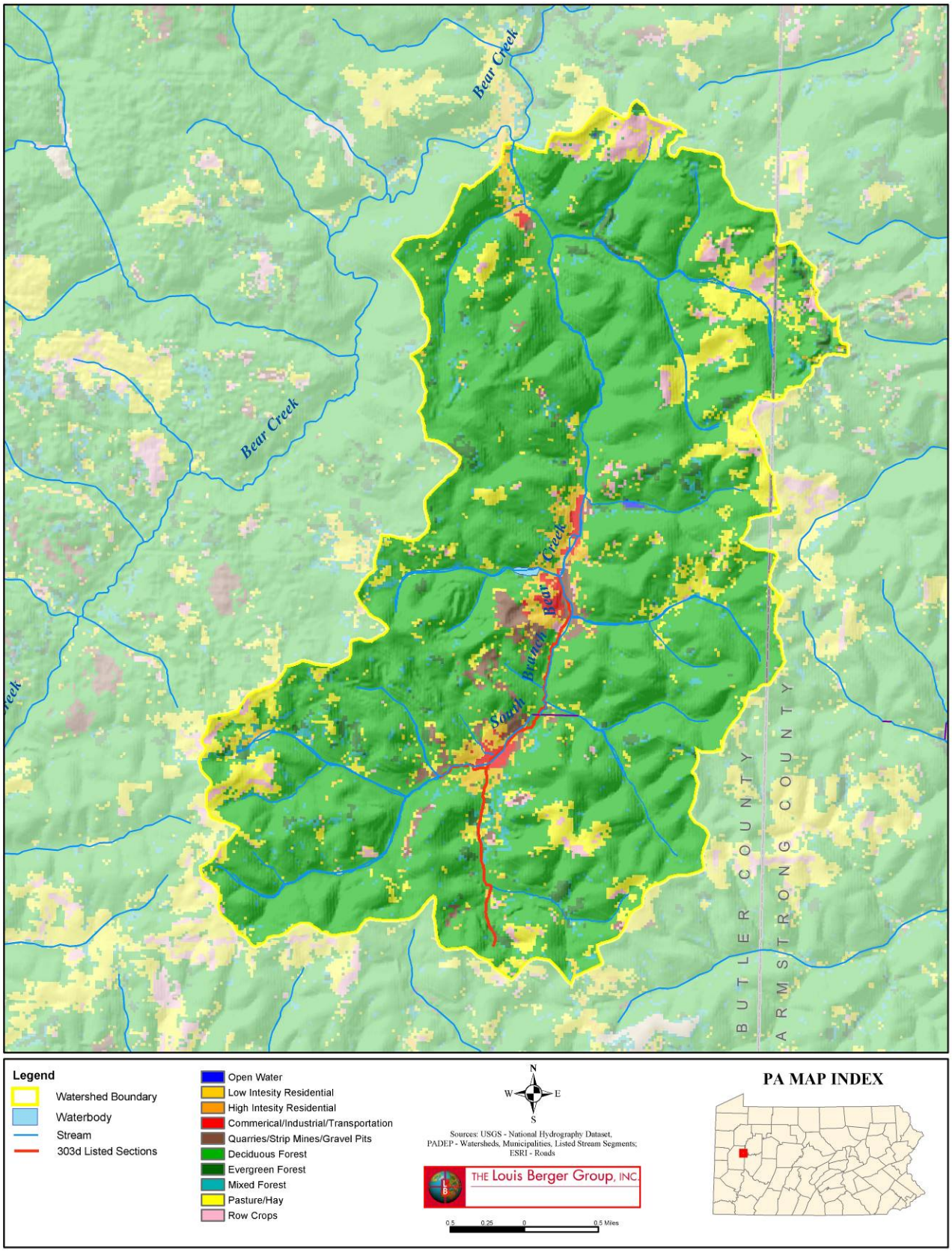

Figure 2-4: Land Use in the South Branch Bear Creek Watershed

Table 2-7: Descriptions of NLCD Land Use Types

Land Use Type	Description
Open Water	All areas of open water, generally with less than 25% cover of vegetation or soil.
Low Intensity Residential	Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
High Intensity Residential	Includes heavily built up urban centers where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80-100 percent of the cover.
Commercial/Industrial /Transportation	Includes infrastructure (e.g. roads, railroads, etc.) and all highways and all developed areas not classified as High Intensity Residential.
Transitional	Areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).
Deciduous Forest	Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest	Areas characterized by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest	Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
Row Crops	Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
Urban/Recreational Grasses	Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
Woody Wetlands	Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

Source: National Land Cover Data (NLCD) (http://www.mrlc.gov/nlcd_definitions.asp)

2.1.6 Ecoregions

The South Branch Bear Creek watershed is located entirely within the Pittsburgh Low Plateau ecoregion (Level IV Ecoregions, classification numbers 70c; Woods et al., 1999). The following ecoregion descriptions are taken from Woods, Omernik, and Brown (1999).

The Pittsburgh Low Plateau ecoregion is unglaciated and has rounded hills, narrow valleys, fluvial terraces, entrenched rivers, general farming, land slides, and bituminous coal mining. Hilltop elevations commonly range from 1,100 to 1,400 feet (366-396 m). Generally, the ecoregion is is both lower and less forested than the Unglaciated Allegheny High Plateau (62d), the Forested Hills and Mountains (69a), or the Uplands and Valleys of Mixed Land Use (69b). The average annual growing season varies inversely with elevation and ranges from about 170 days in the southwest to 120 days in the northeast. Today, farming is more common than woodland. General farming and dairy operations predominate but are often handicapped by sloping terrain, soil wetness, low soil fertility, and a short growing season. There are oil wells in the west and gas fields in the east. Industry and population are concentrated in the Beaver, lower Allegheny, and Ohio valleys. Widespread coal mining has left some land barren or reverting to woodland. Other areas have been reclaimed and releveled but their soils are not always satisfactory for cultivation. Extensive acidic mine drainage and industrial pollution have degraded stream habitat and caused the loss of at least 16 fish species from the Ohio River drainage (Woods et al., 1999).

2.2 Monitoring Data

Ambient and biological water quality monitoring had been conducted at several different sites in the watershed. These sites are distributed throughout the watershed, but are limited in number (**Figure 2-5**). Sampling had been conducted by two agencies, the Pennsylvania Department of Environmental Protection (PADEP) and the United States Geological Survey (USGS). In addition, Michael Baker Jr., Inc. had conducted some sampling at four sites associated with the Bear Creek Chemical Area.

2.2.1 PADEP Monitoring

PADEP conducted sampling within the watershed in 2000, 2001, and 2006. The data collected in 2006 was primarily for the AMD TMDL development.

PADEP Data Collected in 2001 and 2001

On July 10, 2000 and June 28, 2001, PADEP collected biological monitoring data at 11 sites in the watershed (**Figure 2-5**). These sites were identified from handwritten notes on hardcopy maps (Chicora and Parker quad maps) provided by PADEP, and are referenced only by sampling date and time of observation. Macroinvertebrate communities were analyzed at each sample location, and basic ambient water quality measurements (pH, temperature, and conductivity) were taken. Measurements of pH, temperature, and conductivity, as well as qualitative descriptions of stream/aquatic community condition were also noted for an additional 12 sites where no formal benthic sampling was conducted.

AMD DATA Collected in 2006

For the development of this AMD, it was necessary to have recent monitoring data that characterizes the watershed. Based on present and past sampling locations, impaired segments, review of potential pollutant sources, and their spatial reference, five sampling locations were chosen. Five sampling events were conducted at each of these sites under base and non-base flow conditions. For each event, the following AMD-related

parameters were collected: pH, total alkalinity, acidity, total hardness, sulfate, total iron, total manganese, and total aluminum.

In addition to these parameters, field measurements of pH, temperature, specific conductivity, dissolved oxygen, and flow had been taken during each sampling event. Based on the measurements, there were no violations of temperature, pH, or dissolved oxygen standards.

2.2.2 United States Geological Survey (USGS)

The United States Geological Survey (USGS) has collected ambient water quality data at one sampling station in the watershed (**Figure 2-5**, **Table 2-8**). Four samples were taken at this site between 1979 and 1998 with measured parameters including: organics, major inorganics, minor and trace inorganics, physical properties and sediment.

Table 2-8: Summary of USGS Monitoring Program

USGS Station Number	Date Type	Period	Count
USGS – 03031508	Chemical	1979-1998	4

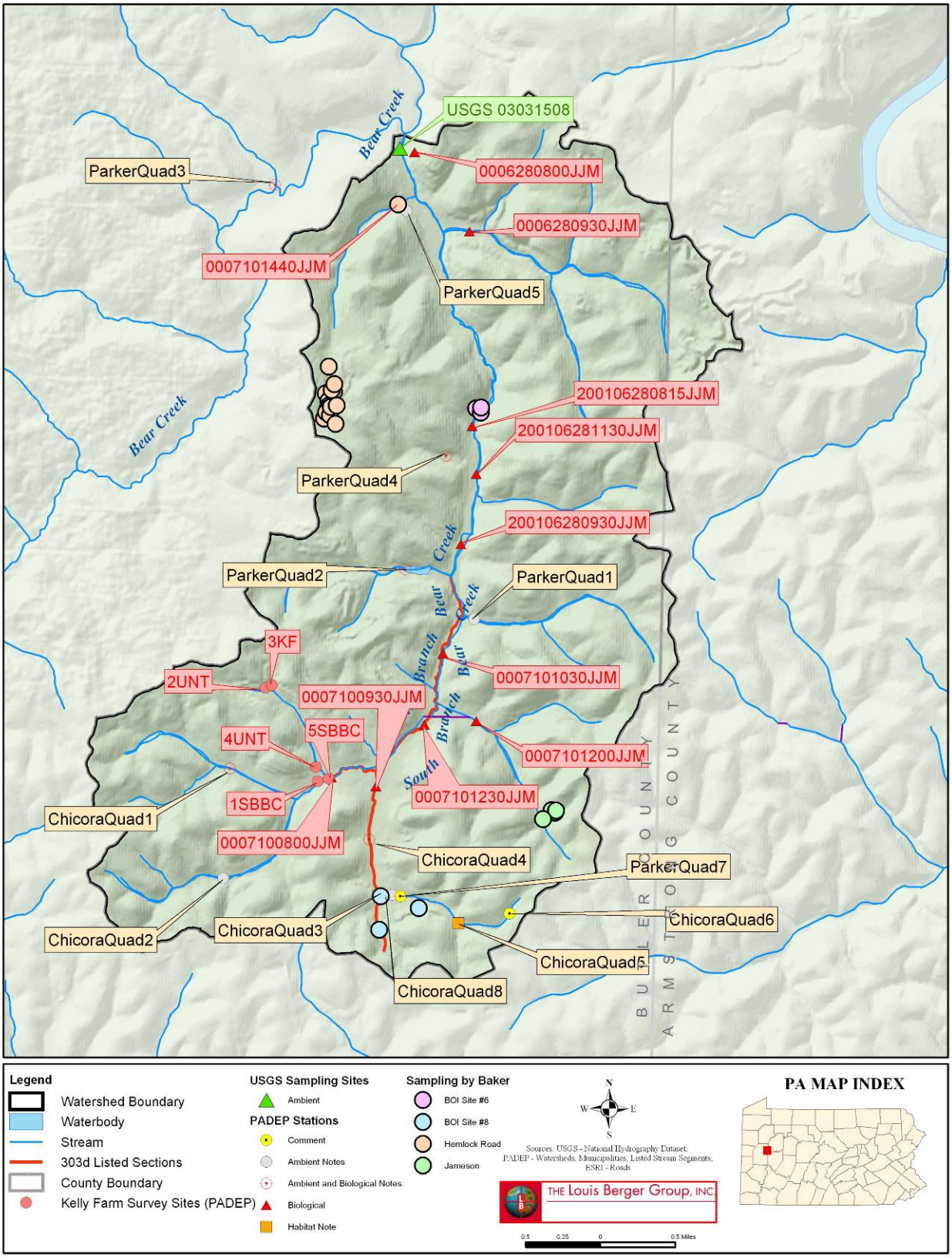

Figure 2-5: Sampling Locations in the South Branch Bear Creek Watershed

Michael Baker Jr., Inc Data (Baker)

As part of a study of the Bear Creek Chemical Area, Baker had conducted surface water for the BOI Site #6, BOI Site #8, Hemlock Road, and Jameson sites. Sediment samples had also been collected at the Hemlock Road site as well. **Table 2-9** summarizes the data collected and **Figure 2-5** shows the location of the sampling sites.

Table 2-9: Data Collection by Michael Baker Jr., Inc.

Site	# of Samples	Date	Data Collected
BOI Site #6	3	June 2004	Water Quality
BOI Site #8	3	June 2004, August 2004	Water Quality
Hemlock Road	26	November 2004	Water Quality, Sediment
Jameson Site	5	July 2004	Water Quality

2.2.3 Permitted Discharge Facilities

Based on data obtained from the EPA's online PCS database and DMR data provided by PADEP, there are currently 11 National Pollutant Discharge Elimination System (NPDES) discharge permits in the South Branch Bear Creek watershed. Four of the permit holders, the Indspec Chemical Corporation, PENRECO, Sonneborn, Inc., and Beazer East Inc. are industrial operations with reported design flows. Discharges from the Indspec Chemical Corporation and Beazer East Inc. are associated with its manufacture of organic chemicals. Discharges from PENRECO are associated with petroleum refining. Discharges from Sonneborn Inc. are associated with its petroleum and coal products operations. The remaining discharge permits in the watershed are associated with stormwater or construction operations. The permit number, type, permitted flow, receiving waterbody, and status of each permit is presented in **Table 2-10**. Permitted discharge locations are presented in **Figure 2-6**.

Table 2-10: Facilities Holding Individual Permits in the South Branch Bear Creek Watershed

Permit Number[1,2]	Discharger Name	Category	Design Flow (gpd)	Receiving Waterbody	Status
PA0001988	Indspec Chemical Corp	Industrial	45,000	S. Branch of Bear Creek	Active
PA0002135	Penreco	Industrial	276,000*	Unt to S. Branch Bear Creek	Active
PA0002666	Sonneborn Inc	-	477,200*	S. Branch Bear Creek	Active
PA0210218	Beazer East Inc.	-	144,000	S. Branch Bear Creek	Active
PA0094200	Bear Creek Watershed Authority - Petrolia	Municipal	41,000	Bear Creek/UNT Bear Creek	Active
PA0239721	Bear Creek Watershed Authority – Fairview STP	Municipal	29,900	UNT to Bear Creek	Active
PA0239739	Bear Creek Watershed Authority – Karns City STP	Municipal	41,100	South Branch Bear Creek	Active
PAG058322	Bruin Service Inc	-		S. Branch Bear Creek	Active
PAG058362	Rottman's Service	-		S. Branch Bear Creek	Active
PAG108306	Indspec Chem Corp	-		S. Branch Bear Creek	Active
PAR808321	Superior Carriers Inc	-		S. Branch Bear Creek	Active

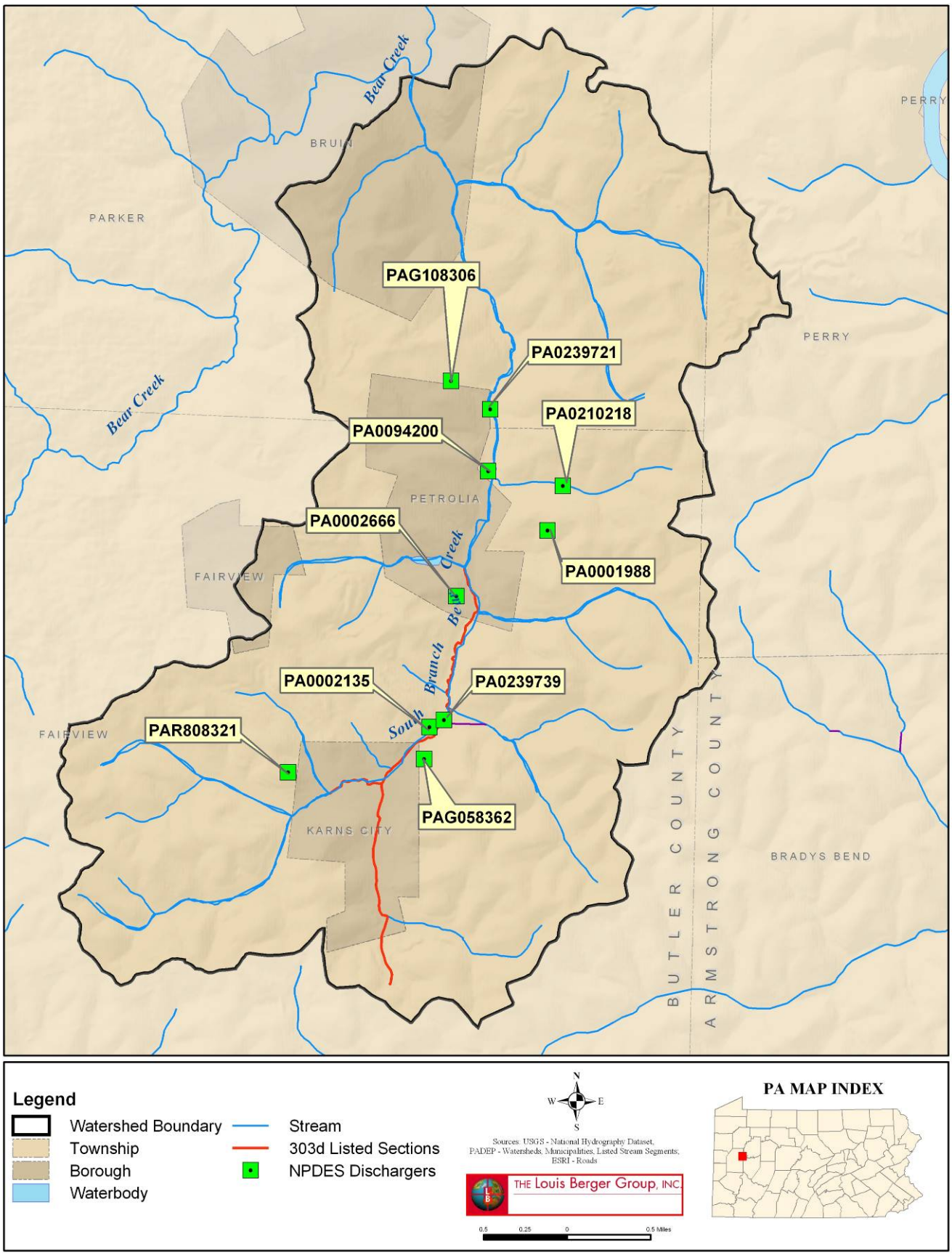

Figure 2-6: Discharge Locations in the South Branch Bear Creek Watershed

2.3 Natural Resource Extraction

Based on data obtained from the Pennsylvania Spatial Data Access (PASDA) database, there are a number of active and inactive mining operations within the South Branch Bear Creek watershed (**Figure 2-7**). There are currently 4 active coal mining operations (Stage 2 approved), including: the McCollough Mine, Kelly Mine, J & S Lands Mine, and the Barrett Mine. There are also several inactive coal mining operations, mineral preparation plants, and abandoned surface mines.

There are currently 122 oil/gas wells in the watershed, 63 of which are considered active. The remainder of the wells are either plugged/inactive wells (13), abandoned (41), or are wells that were proposed but never materialized (5).

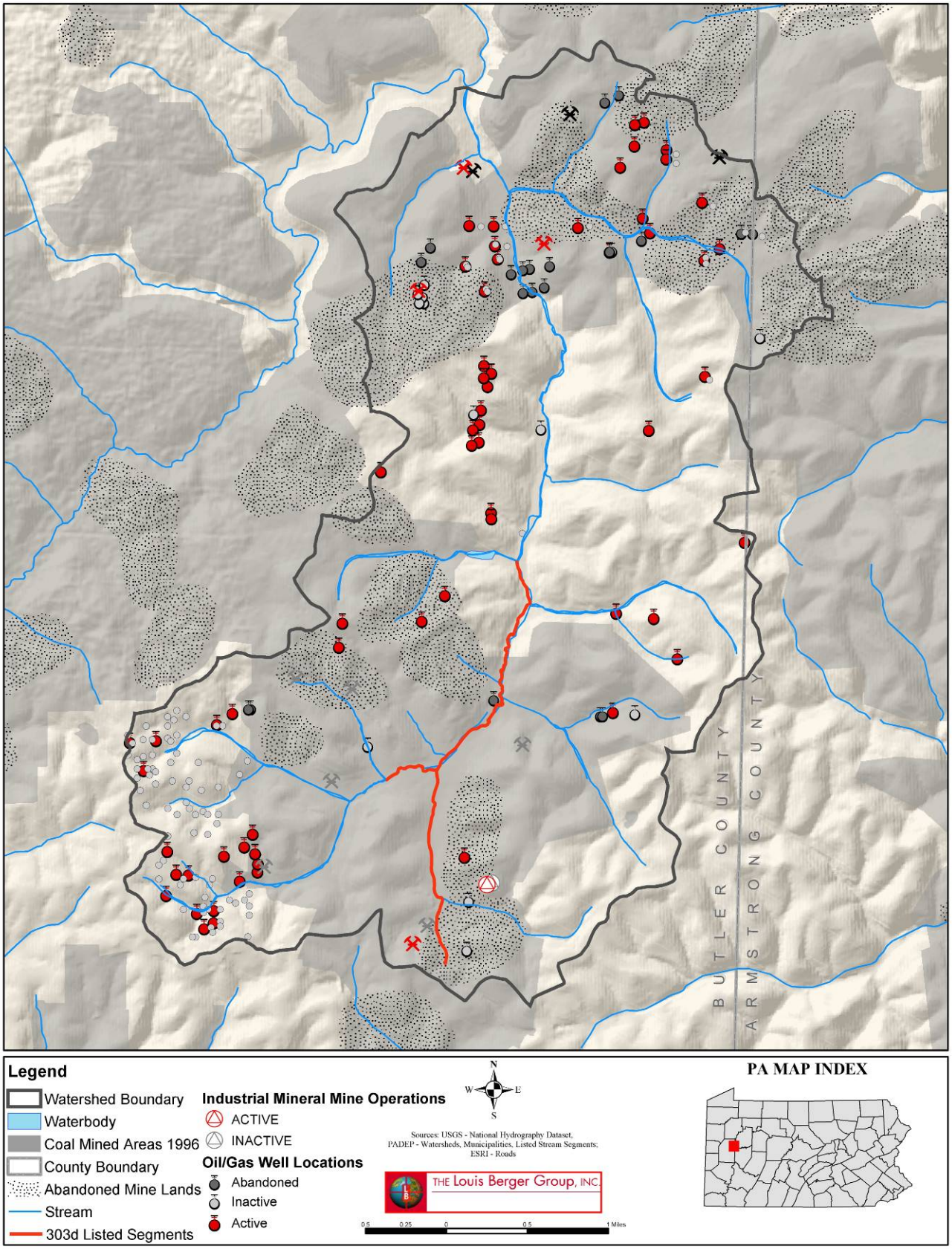

Figure 2-7: Mining/Drilling Activities in the South Branch Bear Creek Watershed

2.4 Hazardous Sites

There a number of sites where industrial waste from nearby industrial facilities was disposed of on private property in northeastern Butler County and northwestern Armstrong County. These activities began in the 1950s and eventually ended in the 1970s and today have resulted in the formal designation of these properties as the Bear Creek Chemical Area. Many of these sites lie within the South Branch Bear Creek watershed (**Figure 2-8**).

The following list includes those sites from the Bear Creek Chemical Area that have been identified as existing within the South Branch Bear watershed (ATSDR, 2005):

- Kelly Farm is located approximately 1 mile northwest of Karns City in Fairview Township, Butler County. Strip mining was conducted on this 3.5 acre property until about 1950. A total volume of 68,000 tons of industrial waste was estimated to have been deposited on the Kelly Farm Site.

- Hemlock Road Site is located approximately 1-mile north of Fairview Borough and east of Township Road 632 (also known as Hemlock Road). It is suspected that waste material was deposited on this site, which was previously strip-mined.

- Bruin Lagoon/Shaler is located along the western bank of the South Branch of Bear Creek in Bruin, Butler County. A mineral oil refinery, which began operations in the 1930s, was located on the Shaler property. Bruin Lagoon was an adjacent disposal area that received refinery waste for approximately 40 years. The Bruin Lagoon was placed on the EPA's NPL and designated a Superfund site in 1993. EPA has conducted investigations and cleanup at Bruin Lagoon. The site was removed from the NPL in September 1997, upon completion of the selected remediation.

- DEP-NO-4 is a large ravine located north of the Bear Creek Cemetery. The area contains several pits suspected of having been used for waste disposal.

- DEP-NO-5 is currently an abandoned baseball field and is located east of Bear Creek Cemetery. Reportedly, drums have been deposited on the site

- DEP-NO-6 is located approximately 1 mile north of Petrolia, on the east side of Route 268. The site contains several old deep mines where drums and liquid waste have reportedly been disposed.

- DEP-NO-8 is also referred to as the Old Rosebud Mine Site and is located along Magnolia Road. Specific information regarding the type, location, and time period for waste disposal at the site is unavailable.

- Indspec Plant - Beazer, formerly known as Koppers, operates a plant in Petrolia, Butler County. Beazer manufactures organic materials, including but not limited to resorcinol. In 1988, Indspec Chemical Corporation bought Beazer's operations and the plant in Petrolia. Beazer has, however, retained ownership of portions of the property.

- Crompton/Witco Plant - Operations began at the plant in the early 1900s when it was operated by Daughtery and Sons. L. Sonneborn Sons, Inc. owned the facility from 1933 through 1962. Witco Corporation took over operation of plant in the early 1960s. Currently, Crompton Corporation, formerly Witco Corporation owns and operates the white oil manufacturing plant in Petrolia.

- Penreco Plant - Penreco Co., formerly Pennsylvania Refining Company, operates a white oil refining and manufacturing complex in Karns City, Butler County, Pennsylvania. The plant has been in operation since 1878.

- Jameson Site, previously referred to as Site #11, is located less than 1 mile southeast of Karns City. The area had been previously strip-mined and was also used as a garbage dump. Industrial waste from the Koppers plant was deposited at the site from 1953 to 1956. The site has since been covered and naturally revegetated.

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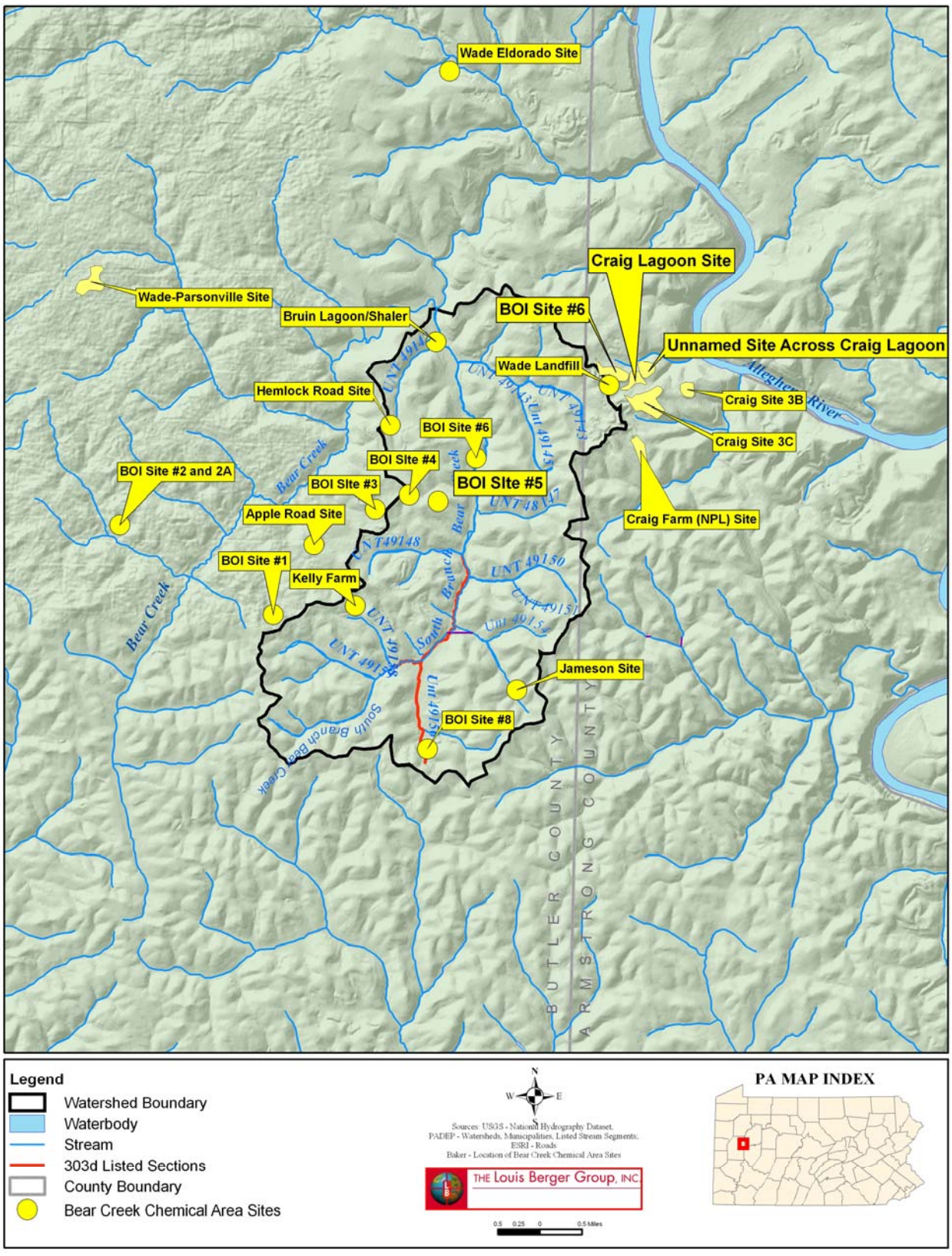


Figure 2-8: Location of Bear Creek Chemical Area Sites

3.0 Environmental Monitoring

Environmental monitoring efforts in the South Branch Bear Creek watershed include benthic community sampling and ambient water quality sampling. Monitoring efforts have been conducted by agencies including Pennsylvania Department of Environmental Protection (PADEP), a PADEP contracted firm (Michael Baker Jr., Inc), and the United States Geological Survey (USGS) (**Figures 3-1** and **3-2**).

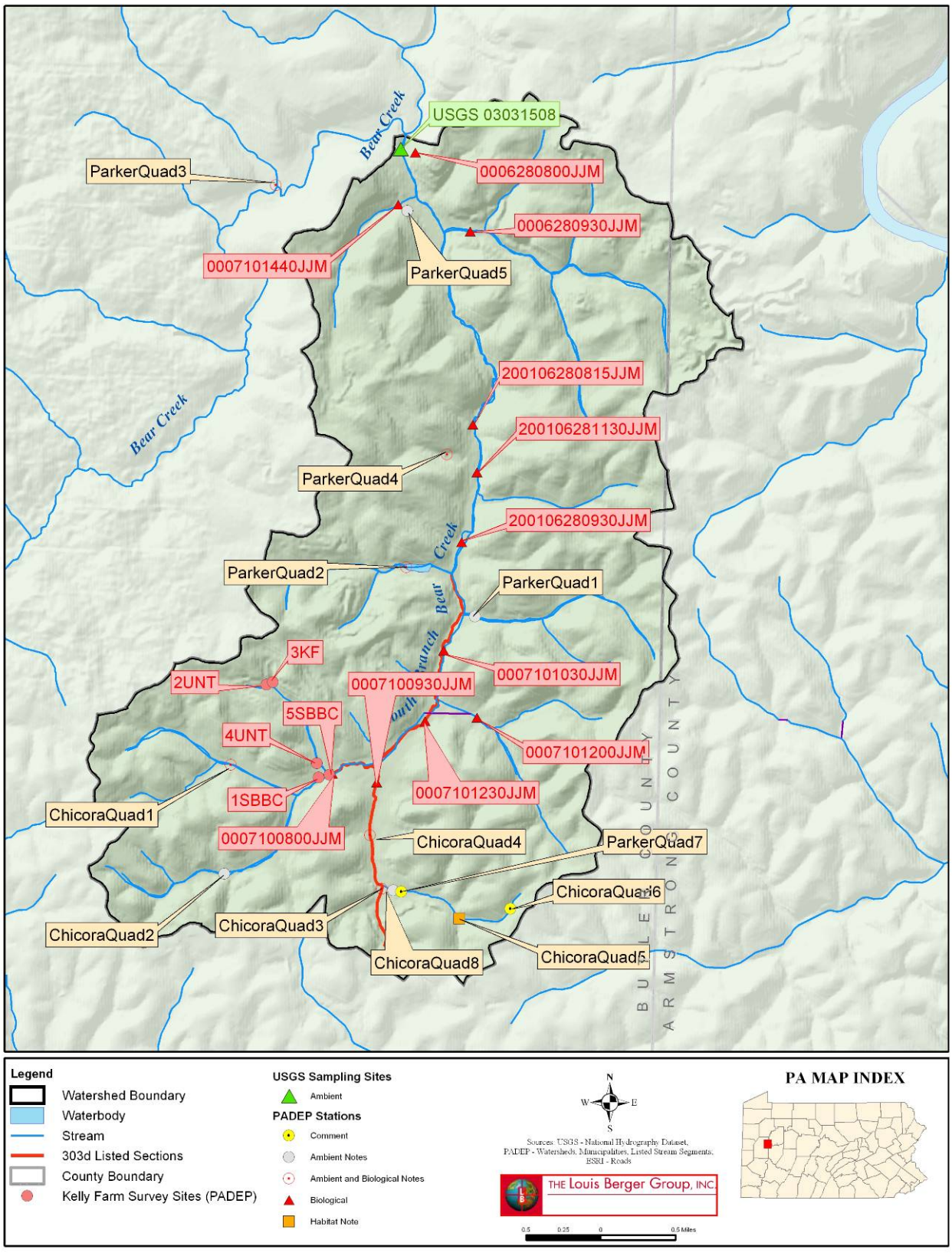


Figure 3-1: Location of PADEP and USGS Sampling Sites in the South Branch Bear Creek Watershed

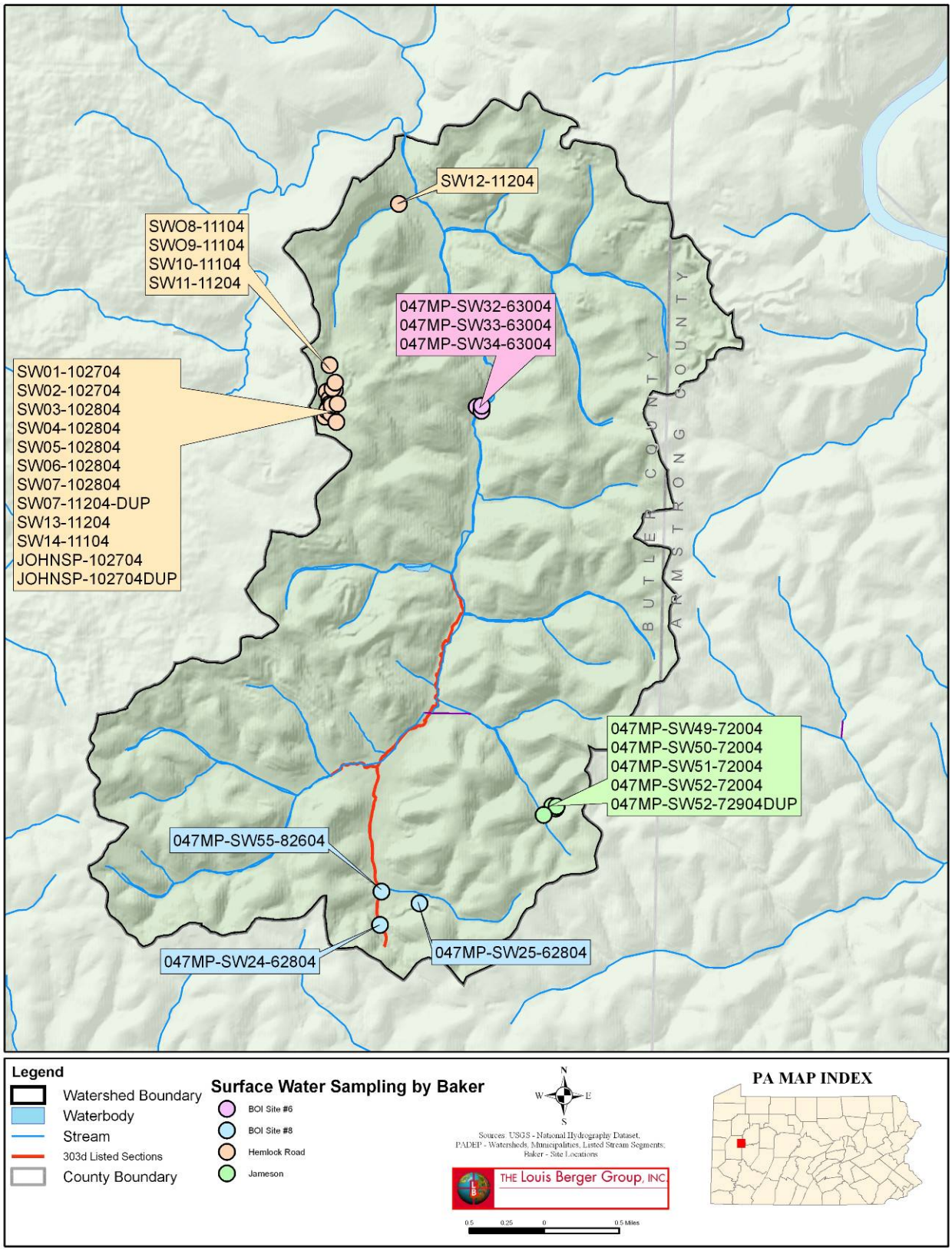


Figure 3-2: Location of Baker Sampling Sites in the South Branch Bear Creek Watershed

3.1 PADEP Monitoring Data

Much of the initial data provided by PADEP was collected between 1998 and 2001 and in 2004. Data collected between 1998 and 2001 included biological and general chemical measurements, while data collected in 2004 included organic chemical measurements at tributaries and ponds located specifically in previous chemical waste disposal sties. Recent data were collected in 2006 for the development of an AMD TMDL in the watershed. The following discussion of the data will be divided into the following three sections:

1. Historic PADEP monitoring data collected before 2005
2. Monitoring data collected by Michael Baker Jr., Inc
3. PADEP monitoring data collected in 2006. This monitoring data was collected specifically for AMD TMDL development.

Included in each of these sections is a description of the data provided by PADEP (data inventory) and the corresponding analysis.

3.1.1 Monitoring Data Inventory and Analysis before 2005

PADEP conducted biological, habitat, and chemical water quality monitoring in the SBBC watershed between 1998 and 2004. In addition, PADEP monitored the impact of the industrial discharge from Beazer East Inc. (PA0210218) on instream water quality in 2003 and 2004.

3.1.1.1. Biological and Habitat Monitoring Data

PADEP conducted macroinvertebrate and habitat samplings in the South Branch Bear Creek watershed in 1998, 2000, and 2001. Data sheets, annotated quad maps, and reports were received from PADEP, digitally entered, and analyzed.

Aquatic Biology Investigation – 1998

An aquatic biology and habitat investigation was conducted by PADEP in late January and early February 1998. Samples were collected on three stations located on UNT49158, which flows east to the lower portion of South Branch Bear Creek, and on two stations along the mainstem South Branch Bear Creek. The reference station for this study, R1UNT, is located about 3.2 miles south of Kelly Farm on an unnamed tributary to Buffalo Creek and in the same ecoregion as South Branch Bear Creek. The area upstream of this station was not mined in the past and is considered by PADEP to be indicative of a relatively unimpaired benthic community. However, instream samples indicated that this reference station did not receive chemical and habitat scores much higher than the sample stations. In fact, station R1UNT, like other stations sampled in this study received habitat scores considered by PADEP to be indicative of suboptimal habitat. The impaired habitat of the reference station was potentially due to stormwater runoff from surrounding commercial and residential areas. Although the surrounding habitat was suboptimal, the instream benthic community received higher scores than the impaired stations with a high percentage of sensitive EPT taxa (74%) and a low HBI score (2.99) indicating that organic pollution is not affecting the benthic community structure. **Table 3-1** shows the biological and habitat scores for each station and **Figure 3-1** shows the location of these stations.

The most upstream station sampled on UNT49158, 2UNT, is located just upstream of the Kelly Farm site. At this station, the pH was below the standard range (4.0), alkalinity was 0.0, and the macroinvertebrate sample was dominated by *Leuctridae plecoptera*, or rolledwing stoneflies, which are generally very tolerant of low pH levels and intolerant to organic pollution. Also, the instream habitat was rated poorly, due to iron precipitate covering the stream bottom, iron staining at seeps, and a lack of flow and a low gradient stream bed. Areas upstream of this site may have been stripped mined, causing the low instream pH values observed.

Station 3KF is located downstream from the Kelly Farm waste site on UNT49158. At this station, the stream gradient is steeper and better instream habitat was identified for macroinvertebrates than at station 2UNT. The biological habitat at this site was potentially impacted by bank erosion, foam on the water surface, and evidence of AMD that include seeps and iron precipitate on rocks. In addition, the effects of AMD were considered to be at a much lesser extent at this site than at station 2UNT. The macroinvertebrate sample collected at this station was primarily comprised of individuals tolerant of organic pollution and received the highest HBI score (modified Hilsenhoff Index) out of all stations sampled. Almost 55% of the sample, which had overall a low abundance of macroinvertebrates, was composed of oligochaetes (aquatic earthworms) which are tolerant of organic pollution but generally sensitive to heavy metals and acids. According to PADEP, the biological composition may indicate an episodic toxicity effect from the Kelly Farm site.

Station 4UNT is located on UNT49158, just above the confluence with South Branch Bear Creek. The instream habitat of this station was affected by a narrow riparian buffer and moderate instream sediment deposition. In comparison to station 3KF upstream, 4UNT received a low HBI score, an indication that organic pollution is not affecting the benthic community. There was a larger abundance of sensitive species and greater species diversity at station 4UNT. One of the sensitive species recorded at this station was *Diplectrona,* which is somewhat tolerant of acidic conditions and relatively intolerant of organic pollution. However, this sample did not capture any mayflies which may be due to the AMD influences upstream and the sensitivity of mayflies to acid mine drainage. According to PADEP, the biological community structure at this station may indicate that this point is the beginning of a recovery zone from upstream conditions.

During this assessment, two stations were sampled along the mainstem South Brach Bear Creek. Station 1SBBC is located directly upstream the confluence with UNT49158. Habitat scores recorded at this station were low for riparian vegetative zone width and instream fish cover. The HBI index was the second highest in the watershed (5.64) and the dominant species was the pollution tolerant *Chironomidae*, which comprised 55% of the sample. Of the sensitive species sampled, mayflies were in the highest abundance at

this station compared to the other stations sampled in this study. PADEP biologists noted that an abandoned oil well was found upstream and large amounts of iron were entering the stream from groundwater.

Station 5SBBC is located directly downstream the confluence with the UNT49158. This sample received an HBI score that was indicative of moderate organic pollution (4.66) mainly due the fact that the dominant species in this sample was *Hydropsyche* a species considered to be an indicator of organic or nutrient pollution. Station 5SBBC also received the highest taxa richness score in the watershed. Therefore, although there may be instream organic enrichment, due to the presence of some sensitive species, this community appears to be recovering from pollution coming from the tributary upstream.

This assessment noted that the effects of the pollutants draining from UNT49158 did not appear to be affecting the South Branch Bear Creek instream biological communities. In addition, PADEP also noted that the destruction of some of the toxic compounds (sulfonic acid) through photolytic oxidation indicated that a portion of the toxicity is not persistent instream. However, whole effluent toxicity testing downstream form the Kelly Farm site would be needed to ascertain the effect of these components on the aquatic community.

Table 3-1: PADEP 1998 Biological and Habitat Monitoring Assessment Scores

Sampling Type	Parameter Sampled	Station					
		1SBBC	2UNT	3KF	4UNT	5SBBC	R1UNT[1]
Biological	Total Number Individuals	107	184	100	114	145	142
	Taxa Richness	14	10	10	13	17	16
	Modified EPT Index	5	2	3	5	8	8
	% Modified EPT Taxa	18	42	7	44	30	74
	Modified Hilsenhoff Index	5.64	3.43	7.92	3.72	4.66	2.99
	%Dominant Taxon	55	46	55	19	30	51
	Dominant Taxon	Chiron-omidae	Chirono-midae	Oligo-chaeta	Chirono-midae	Hydro-psyche	Prostoia
	% Modified Mayfly	13	0	0	0	11	11
	% Stonefly	4	40	0	30	19	59
	% Caddisfly	1	7	7	26	50	4
Habitat[2]	Instream Cover (fish)	8	10	10	13	14	13
	Epifaunal Substrate	11	13	15	14	13	13
	Embeddedness/Pool Substrate Characterization	11	13	17	13	15	14
	Velocity+Depth Regimes/Pool Variability	13	10	16	14	18	16
	Channel Alterations	17	16	15	16	15	17
	Sediment Deposits	10	12	12	9	12	12
	Frequency of Riffles/Channel Sinuosity	16	8	13	16	14	16
	Channel Flow Status	18	17	19	17	18	14
	Condition of Banks	18	19	13	12	17	11
	Bank Vegetation Protection	15	19	13	15	15	15
	Vegetation Disruptive Pressure	15	17	14	13	8	14
	Riparian Vegetative Zone Width	8	15	8	6	5	10
	Total Score	160	169	162	158	164	165
	Rating	Sub-optimal	Sub-optimal	Sub-optimal	Sub-optimal	Sub-optimal	Sub-optimal

[1] R1UNT served at the reference station for this survey
[2] Habitat Score out of a possible 20 points

Aquatic Biology Investigation- 2000 and 2001

In 2000 and 2001, biological and habitat samples were collected by PADEP at a total of 11 separate stations within the watershed at stations which were not previously sampled in the 1998 study. Two stations were sampled in June 2000, six in October 2000 and three in June 2001 along both the mainstem and upstream tributaries to South Branch Bear Creek (**Figure 3.1**). The majority of samples collected were considered to be indicative of impaired biological conditions. Three of the four stations that had sampled considered biologically unimpaired are located on tributaries to South Branch Bear Creek (**Table 3-2**).

The most upstream tributary sampled, UNT49156, flows north into the headwaters of South Branch Bear Creek. The sample collected on this tributary at station 0007100930JJM, located at the Hooker Road Crossing in Fairview Township, was considered biologically impaired due to a low abundance of individuals, low species diversity, few to no mayfly individuals present, and a HBI indicative of organic pollution. The main land uses surrounding this station are forested (50%), abandoned mining (15%), and residential areas (15%). Also, this station is located downstream of abandoned mine lands, active and inactive mineral mine operations, and active and inactive oil wells. In addition, the habitat scores were considered unacceptable for riffle frequency, amount of vegetative bank protection, and the riparian zone width. PADEP biologist notes add that at this station, although the pH values are within the acceptable range (7.31), metal precipitate covers the substrate.

Less than half a mile downstream, tributary UNT149153 drains from the east into South Branch Bear Creek. Station 0007101200JJM is located directly below the confluence of UNT149153 with UNT49154. Biological samples at this station were considered unimpaired due to the presence of sensitive species such as stoneflies and mayflies, a low HBI score, and overall acceptable habitat characteristics. PADEP biologist notes indicated that a gas pipe line flows through the basin.

The next two tributaries sampled were located in the downstream portion of the watershed. Station 0006280930JJM is located on tributary UNT49143 directly below the confluence with UNT59144. The surrounding land uses are primarily abandoned mining (35%) and forest (40%). Biological conditions sampled at this station were considered unimpaired due to the presence of several sensitive species, a low HBI score indicating that the benthic community is not affected by organic pollution. The majority of habitat parameters sampled received optimal scores. In addition, PADEP biologist notes indicate that old strip mines lie in the headwaters, a gas pipeline and oil wells were present in the basin, but no metals precipitate or unusually low pH levels were evident at this station.

The most downstream tributary sampled, UNT49142, drains from the west into South Branch Bear Creek. The station located on this tributary, 0007101440JJM, is located upstream from the Route 268 crossing in Parker Township and is surrounded primarily forest (75%) with the instream habitat scores that were generally acceptable. Due to the presence of sensitive species such as mayflies, stoneflies, and caddisflies and a low HBI score, this station was considered biologically unimpaired. PADEP biologist notes add that although a very good benthic assemblage was recorded at this station, the Rosebud Mining Company is actively mining in the lower portion of the basin and that the stream may potentially be affected by runoff from surrounding dirt roads.

The mainstem of South Branch Bear Creek was also sampled in 2000 and 2001. The most upstream station sampled, 00071008000JJM is located at the crossing with Hooker Road. The biological condition of this stream is considered unimpaired because of the presence of several sensitive species, a relatively high species diversity and a low overall HBI score indicating that the community is not affected by organic pollution. The overall habitat scores taken at this station were considered acceptable. Much of the area surrounding the station is forested with some abandoned mine lands located upstream.

Downstream of 00071008000JJM, station 007101230JJM, is located approximately 50 to 75 feet upstream of the Bear Creek Watershed Authority Outfall. The surrounding land uses at this station are primarily forest (45%) and abandoned mine lands (15%). This station was considered biologically impaired due to few individuals sensitive to pollution

and a HBI score indicative of a community tolerant of heavy organic pollution. Several habitat parameters were scored as unfavorable including the riparian zone width, amount of vegetative bank protection, and the frequency of riffles.

Station 007101030JJM is located directly below the South Branch Bear Creek Watershed Authority and is surrounded primarily by forest and abandoned mines. This station was considered biologically impaired due to the lack of sensitive species present and a high HBI score indicating that the community is affected by organic pollution.

Just below the confluence of South Branch Bear Creek with UNT49096, station 200106280930JJM is situated just upstream of Indespec Inc and surrounded by forest (40%), residential land (20%), and some abandoned mine land (15%). The stream channel was considered channelized as it flows through the industrial area of Petrolia. Biologist notes indicate that a layer of brown silt or precipitate covered the substrate, industrial debris were prevalent, and some iron staining was present on the rocks. The biological condition at this station is considered impaired due the sample being dominated by the highly tolerant *Chironomidae* family. The benthic assembly is poor and is comprised primarily of tolerant taxa.

Station 200106281130JJM, located downstream of Indespec Inc, is surrounded primarily by residential (20%) and forested (40%) land uses. At the time the sample was collected, it was observed that the water was hazy, slightly darkened, brown precipitate was on the substrate, an oily sheen on the service, a chemical odor, foam being produced when the water was agitated, and 3 to 4 inches of anoxic solids were visable in the backwater areas. The biological community at this station was considered impaired due to the dominance of species highly tolerant to pollution. PADEP noted that fish (mainly creek chubs and white suckers) were abundant at this station. In addition, the main sources of pollution identified at this station were metals and nutrients from municipal point sources, abandoned mine drainages, and unknown causes.

Located downstream, station 20016280815JJM is located primarily within forested and residential areas with some abandoned mines in the surrounding area. Although the fish and benthic habitat was considered favorable, the macroinvertebrate sampling conducted

at this station showed that the community is impaired due to a low abundance and the dominance of pollution tolerant organisms. Some small minnows were observed at this station. Fine brown solids were observed on the substrate, the water was hazy, and anoxic substances were present along the stream edge and backwater areas.

The most downstream station on South Branch Bear Creek sampled during this study is station 0006280800JJM which is surrounded primarily by forested land (50%) with some developed areas and abandoned mines nearby. This station was also considered biologically impaired because of the low macroinvertebrate abundance, presence of few sensitive species, and a HBI score greater than 6 which indicated that the impairment may be due to organic enrichment. In addition, no fish were observed at this station. According to the biologist's notes, both metals precipitate and periphyton were observed on rock surfaces. In addition, PADEP stated that at this station, the stream is potentially affected by abandoned mine drainage, industrial, and municipal discharges and follow up monitoring would help determine the exact cause of the impairment.

Table 3-2: PA DEP Biological and Habitat Sampling Data Collected in 2000 and 2001.

Station Code		**0006280930JJM**	**2006280800JJM**	**0007101440JJM**	**0007100930JJM**	**0007101230JJM**	**0007101030JJM**	**0007101200JJM**	**0007100800JJM**	**2001062809 30JJM**	**2001062811 30JJM**	**2001062808 15JJM**
Stream Sampled		UNT to SB Bear Cr	South Br Bear Creek	UNT to SB Bear Cr	UNT to SB Bear Cr	South Br Bear Creek	South Br Bear Creek	UNT to SB Bear Cr	South Br Bear Creek	South Br Bear Creek	South Br Bear Creek	South Br Bear Creek
Date		6/28/00	6/28/00	10/7/00	10/7/00	10/7/00	10/7/00	10/7/00	10/7/00	6/28/01	6/28/01	6/28/01
Surrounding Land Use (%)	Residential	5	15	5	20	10	15	25	10	20	20	20
	Commercial	0	5	0	5	10	15	0	0	10	10	10
	Industrial	0	15	5	5	10	15	0	0	15	15	15
	Cropland	14	0	0	0	0	0	0	0	0	0	0
	Pasture	1	0	0	0	0	0	0	0	0	0	0
	Abandoned Mining	35	15	10	15	15	20	0	20	15	15	15
	Oil Fields	5	0	5	5	5	10	5	10	0	0	0
	Forest	40	50	75	50	45	25	65	45	40	40	40
	Other	0	0	0	0	5	0	5	15	0	0	0
Biological *	Low Abundance		√		√							√

Table 3-2: PA DEP Biological and Habitat Sampling Data Collected in 2000 and 2001.

Station Code		0006280930JJM	2006280800JJM	0007101440JJM	0071009330JJM	0071012300JJM	0071010300JJM	0071012000JJM	0071008000JJM	2001062809300JJM	2001062811300JJM	2001062808150JJM
	Seven or Fewer Macroinvertebrate Families in the collection				√		√			√	√	√
	3 or fewer mayfly individuals		√		√	√	√			√	√	√
	Stoneflies Present	√		√				√	√			
	Mayflies and Caddisfleis are collectively Abundant			√				√				
	At least 4 EPT Families with a HBI of 4 or less	√		√				√	√			
	Overall HBI Score is less than 5	√		√				√	√			
	Overall HBI Score Greater than 6		√		√	√	√					
	Biologically Impaired or Unimpaired	Unimpaired	Impaired	Unimpaired	Impaired	Impaired	Impaired	Unimpaired	Unimpaired	Impaired	Impaired	Impaired
Habitat	pH (S.U.)	6	6.82	7.24	7.31	6.89	7.48			7.6	8	7.5
	Instream Fish Cover	14	7	11	9	13	14	10	12	9	12	14
	Epifaunal Substrate	17	8	13	10	12	15	9	14	11	13	17
	Pool Substrate Composition	16	11	14	14	14	15	16	14	12	13	14
	Pool Variability	15	14	13	9	11	14	9	12	14	14	15
	Channel Alteration	17	14	15	12	11	17	17	11	11	12	15
	Sediment Depostition	16	16	11	14	11	12	15	13	13	13	12
	Riffle Frequency	17	12	16	14	8	16			16	15	18
	Channel Flow Status	18	18	19	17	19	18			18	18	18
	Bank Condition	18	18	17	16	16	14			16	14	15
	Bank Vegetative Condition	19	15	19	15	13	18			14	16	16
	Vegetative Bank Protection	17	13	16	10	9	11			7	14	14
	Riparian Zone	18	10	14	7	6	10			3	14	14
	Total	202	158	178	147	143	174			144		182

* Checked if statement applies

3.1.1.2. Ambient Water Quality Monitoring Data

PADEP also conducted measurements at several sites for ambient water quality sampling (in the water column) in 1998 and between 2000 and 2001. Water quality data were obtained either from a report (PADEP, 1998), from data field sheets, or annotated quad maps.

In January 28, 1998, PADEP conducted a water quality survey of unnamed tributary UNT 49158 to investigate the impact of the Kelly Farm Waste Site on South Branch Bear Creek. Water quality sampling was conducted at four stations and included general water quality parameters (field temperature, field pH, lab pH, conductivity, dissolved oxygen, alkalinity, hardness, total dissolved solids, suspended solids, ammonia, nitrite, nitrate, total phosphorus, and chloride) and total recoverable metals (aluminum, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc). Two stations were located on UNT 49158 (one at the headwater of UNT 49158 before Kelly Farm discharge and the other before the confluence with South Branch Bear Creek) and the other two stations on South Branch Bear Creek (before and after the confluence with UNT49156).

Between 2000 and 2001, PADEP conducted several surveys which included a total of sampling sixteen sites; eight on South Branch Bear Creek and on eight on unnamed tributaries. During these studies, only field parameters such as temperature, pH, and conductivity were sampled.

The ambient water quality data were evaluated to determine whether the examined parameters complied with Pennsylvania's established water quality standards. A bulleted summary of the data derived from all general monitoring data from 1998, 2000, and 2001 including iron and manganese collected on South Branch Bear Creek are provided below (data in the bulleted list is from the1998 study unless otherwise indicated):

- Measured concentrations for dissolved oxygen, chloride, nitrate and nitrite, and ammonia were in compliance with the respective criteria.

- Temperature violated the standard in the stations on UNT 49158 and on South Branch Bear Creek.
- The standard for pH was violated at two stations in the watershed (in 1998 at station 2UNT and in 2000 at station ChicoraQuad3).
- Alkalinity concentrations violated the standard at stations 2UNT (0 mg/L) and 4UNT (11.4 mg/L) on UNT 49158. The lower alkalinity levels at UNT 49158 did not cause violations at the South Branch Bear station. However, alkalinity concentrations in South Branch Bear Creek were low (28 mg/L).
- NO_x-N concentrations (NO_2 + NO_3-N) were low at all stations (range: 0.06 - 0.82 mg/L). Lowest values were recorded at UNT 49158 (0.06 mg/L).
- Although no violations for total iron were recorded, concentrations measured in South Branch Bear Creek were higher than in the unnamed tributary (0.65 mg/L versus 0.12 mg/L at 4UNT). PADEP biologists noted that the stream bottoms of the unnamed tributary and South Branch Bear Creek were stained with iron oxides/hydroxides (PADEP, 1998).
- Total manganese concentrations exceeded the standard at the Kelly Farm site station. The total manganese concentrations were higher in the unnamed tributary than in South Branch Bear Creek (0.65 mg/L at station 4UNT versus 0.39 mg/L in South Branch Bear Creek). This caused a slight increase of total manganese concentrations in South Branch Bear Creek. In a previous study from 1997, the total manganese concentration violated the standard at a station right below the Kelly Farm site discharge (PADEP, 1998).
- Sulfate concentrations measured at the Kelly Farm site discharge station exceeded the state standard. Sulfate concentrations were higher in the unnamed tributary than in South Branch Bear Creek (132 mg/L at station 4UNT versus 51 mg/L at the South Branch Bear Creek station). This high concentration caused only a slight increase of the sulfate level in South Branch Bear Creek (55 mg/L).
- Hardness concentrations were higher in the unnamed tributary than in the South Branch Bear Creek (129 mg/L at station 4UNT versus 74 mg/L at the South Branch Bear Creek station) and caused only a slight increase of the sulfate level in South Branch Bear Creek (75 mg/L).

- It should be noted that the headwater station located on the unnamed tributary (station 2UNT) showed relatively high concentrations of total iron, total manganese, and sulfate. Moreover, vales taken at the tributary headwater station had the lowest pH of 4 and had an alkalinity concentration of 0 mg/L. This strongly suggests that the unnamed tributary headwaters are probably impacted by acid mine drainage located upstream of station 2UNT. Although the discharge from the Kelly Farm site showed exceedances of manganese and sulfate), relatively high levels of iron, and a low concentration of alkalinity, there appeared to be little impact from the Kelly Farm site on the unnamed tributary.

3.1.1.3. Metal Data

Total metals measured included aluminum, cadmium, chromium, copper, lead, nickel, and zinc. All detected metals were analyzed to determine whether the examined parameters complied with Pennsylvania's established water quality standards for CCC (Criteria Continuous Concentration) and CMC (Criteria Maximum Concentration). At station 2UNT (headwater station at the UNT49158) the aluminum standard was violated. No violations of the human health criteria were found.

3.1.1.4. Organic Data

No organic data were sampled in the 1998, 2000, and 2001 studies. However, in a previous study from 1997, site-related constituents such as calcium petronate and sulfonic acid compounds were measured in the water column and in the sediment. Only calcium petronate was detected in the sediment directly downstream of the Kelly Farm site discharge and before the confluence with the South Branch Bear (PADEP, 1998).

3.1.1.5. Assessment of the Potential Impact of an Industrial Discharger

The industrial discharger Beazer East Inc. (PA0210218), is located in the Borough of Petrolia, in the middle section of the South Branch Bear Creek. Beazer East Inc, a manufacturer of cyclic organic crudes, intermediates, dyes, and pigments, commissioned

the Severn Trent Laboratories, Inc, to conduct an assessment of the potential impact of their plant on the South Branch Bear Creek. Between November 2003 and June 2004, the Severn Trent Laboratories sampled three sites located on five occasions upstream and downstream of the facility, and as well as at the facility's outfall. Water quality samples included general parameters (biochemical oxygen demand, chemical oxygen demand, hardness, oil and grease, sulfate, total dissolved solids, total recoverable phenolics, total suspended solids, and total organic carbon) and organics (resorcinol, benzene metadisulfonic acid, benzene sulfonic acid, trihydroxydiphenyl, para-phenolsulfonic acid).

The data collected during these surveys showed that the impact of the Beazer East Inc. on the stream was found to be generally insignificant. The majority of organic measurements were below detection limit except for benzene meta disulfonic acid on two surveys (01.22.04: 0.421 µg/L at the facility's effluent and 0.467 µg/L below the facility's effluent, 01.12.03: 0.236 µg/L below the facility's effluent) and para-phenolsulfonic acid on one survey (01.2204: 0.256 µg/L below the facility's effluent). In addition, all parameters were evaluated to determine whether the examined parameters complied with Pennsylvania's established water quality standards. Only total dissolved solids values violated the standard on 06.10.04 at all sampling sites (above the facility, at the facility's effluent, and below the facility).

3.1.2 Baker Water Quality Data

Michael Baker Jr., Inc established 28 water quality monitoring stations in the South Branch Bear Creek watershed (**Table 3-1 and Figure 3-2**) as an effort to monitor sites within the Bear Creek Chemical Area. The stations were located on the mainstem of South Branch Bear Creek, unnamed tributaries, ponds, and drains. A sampling was conducted at each station between June and November of 2004. In addition, flow estimates were determined on all tributaries. At the Hemlock Road station, sediment samples were collected and analyzed for metals, organics (volatiles, semi-volatiles, and PAHs), and other chemicals of interests (sulfate, acids, etc.).

Table 3-3: Baker Ambient Water Quality Monitoring Stations

Stream/Pond/Drain	Sample ID	Location	Sampling Date
South Branch Bear Creek	047MP-SW32-63004	BOI Site #6	06-30-2004
	047MP-SW33-63004	BOI Site #6	06-30-2004
	047MP-SW34-63004	BOI Site #6	06-30-2004
UNT49157	047MP-SW24-62804	BOI Site #8	06-28-2004
	047MP-SW55-82604	BOI Site #8	08-26-2004
UNT49156	047MP-SW25-62804	BOI Site #8	06-28-2004
UNT49153	047MP-SW49-72004	Jameson	07-20-2004
	047MP-SW50-72004	Jameson	07-20-2004
	047MP-SW51-72904	Jameson	07-29-2004
	047MP-SW52-72904	Jameson	07-29-2004
	047MP-SW52-72904DUP	Jameson	07-29-2004
UNT49142 (Hemlock Road)	SW08-11104	Tributary to the South Branch of Bear Creek (Downstream of Beaver Pond)	11-01-2004
	SW09-11104	Tributary to the South Branch of Bear Creek (Downstream of North Pond)	11-01-2004
	SW10-11104	Tributary to the South Branch of Bear Creek (Downstream of North Pond and Beaver Pond Confluence)	11-01-2004
	SW11-11204	Tributary to the South Branch of Bear Creek (appr. 645 feet downstream of sample location SW10)	11-02-2004
	SW12-11204	Tributary to the South Branch of Bear Creek (appr. 6,187 feet downstream of sample location SW11)	11-02-2004
Pond (Hemlock Road)	SW01-102704	North Pond (Wetland Area)	10-27-2004
	SW02-102704	Middle Pond (Center)	10-27-2004
	SW03-102804	South Pond (North)	10-28-2004
	SW04-102804	South Pond (Center)	10-28-2004
	SW05-102804	South Pond (South)	10-28-2004
	SW06-102804	Johns Spring Pond	10-28-2004
	SW07-11204	Drainage swale located east of the South Pond (Drains in the Beaver Pond)	11-02-2004
	SW07-11204-DUP	Hemlock Road	11-02-2004
Pond (Hemlock Road)	SW13-11204	Beaver Pond (Downstream of Potential Mine Drainage)	11-02-2004
Drain (Hemlock Road)	SW14-11104	Potential Mine Drainage (Upstream of Johns Spring Pond)	11-01-2004
Pipe (Hemlock Road)	JOHNSP-102704	Johns Spring Overflow Pipe	10-27-2004
	JOHNSP-102704DUP	Hemlock Road	10-27-2004

3.1.2.1. Ambient Water Quality Monitoring Data

Of the 28 monitoring stations in the watershed, only six are located on the mainstem of South Branch Bear Creek. Only two of these mainstem stations are located on the impaired section. The remaining four mainstem stations are located outside of the impaired section in the lower section of South Branch Bear Creek. Of the remaining 22 stations:

- 17 stations (within sampling location: "Hemlock Road") are located on the unnamed tributary UNT49142, on spring fed ponds, and drains or pipes emptying into UNT49142
- 4 stations (within sampling location: "Jameson") on UNT 49153
- 1 station (sampling location: "BOI Site #8") on UNT 49156.

Data was analyzed for all parameters such as general water quality parameters (pH, temperature, dissolved oxygen, specific conductance, reduction oxidation potential, turbidity, bicarbonate, total hardness, alkalinity to pH 8.3, total alkalinity, chloride, nitrate, and total suspended solids, sulfate), metals (aluminum, iron, manganese, antimony, arson, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, lead, magnesium, mercury, nickel, potassium, selenium, silver, thallium, vanadium, and zinc), organics (volatiles, semi-volatiles, PAHs, pesticides, and herbicides), and organic "chemicals of interest" (benzene sulfonic acid or BSA, calcium petronate or CP, formaldehyde, KSS, m-benzene disulfonic acid or BDSA, p-phenol sulfonic acid or PSA, and resorcinol). All parameter were evaluated to determine whether the examined parameters complied with Pennsylvania's established water quality standards.

A bulleted summary of the data derived from all general monitoring data including iron and manganese collected on South Branch Bear Creek are provided below (It should be noted that not all general parameters were measured at all stations and parameters sampled in ponds, pipes, and drains were also examined whether they exceed the standards for instream parameters):

- Chloride, nitrate, and sulfate were in compliance with the criteria.

- Temperature violated the standard in the mainstem (two out of three measurements) and tributaries (six out of twelve measurements).
- Dissolved oxygen concentrations frequently violated or exceeded the criterion of 5 mg/L at thirteen stations including pond stations. All sample sites on the mainstem violated the standard for dissolved oxygen (range: 2.0 - 2.92 mg/L). Seven sample sites (out of 12) at tributaries violated the standard for dissolved oxygen (total range of all tributary sites: 1.17 - 8.67 mg/L). Three sample sites (out of eight) at ponds exceeded the standard for dissolved oxygen (total range of all pond sites: 1.55 and 8.75 mg/L).
- Field pH levels violated or exceeded the standard at fourteen stations. Eight violations were found on the tributaries (average: 5.98; min: 5.20; max: 6.90), four exceedances on the ponds (average: 5.93; min: 5.11; max: 6.68), and one exceedance in a drain (pH: 4.93) and pipe (pH: 4.6).
- The criterion for total alkalinity was violated at five stations (only sampled on Hemlock Road) with total alkalinity measurements ranging between 4.8 and 43 mg/L (total average: 24 mg/L). Station SW12-11204 situated before the confluence with South Branch Bear Creek showed no violation of total alkalinity, however, total alkalinity values were close to the standard of 20 mg/L (28.1 mg/L).
- Nitrate concentrations (only sampled on Hemlock Road) were generally low with a concentration of 0.19mg/L at station SW12-11204 (before confluence with South Branch Bear Creek).
- Hardness concentrations (only sampled on Hemlock Road) ranged between 17.6 and 133 mg/L with average of 65.9 mg/L. Hardness concentrations at Station SW12-11204 (before confluence with South Branch Bear Creek) were at 61.3 mg/L and were the total average for Hemlock Road.
- Three sampling sites violated the criterion for total iron with one site located at the Utn49157 and two sites located at the unnamed tributary at Jameson. Also, two sampling sites exceeded the criterion at ponds on Hemlock Road.

- The criterion for dissolved iron was violated at four sample sites; one on the mainstem, one located on UNT 49157, and two located site on the unnamed tributary at Jameson.
- The criterion for manganese was violated at three stations; two located on the Utn49157 and one located on the unnamed tributary at Hemlock.
- It should be noted that the total iron, dissolved iron, and total manganese criteria was violated at station MD-SW55-82604.

3.1.2.2. Toxic Metals Data

Total and dissolved toxic metals measured included aluminum, antimony, arson, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. All detected metals data were analyzed to determine whether the examined parameters complied with Pennsylvania's established water quality standards for CCC (Criteria Continuous Concentration) and CMC (Criteria Maximum Concentration). Hardness concentrations were not measured at three sampling locations (BOI #6, BOI #8, and Jameson) and therefore were estimated based on the averages of stations located at Hemlock Road (see footnotes on **Table 3-5**). Violations were only found at one site at the upstream section of the mainstem for total aluminum and total nickel and exceedances were only found at two stations at the South Pond on Hemlock Road for total aluminum, total copper, total lead, and total zinc. There were no violations or exceedances of the human health criteria.

Table 3-4: Number of Violations/Exceedances for Total Recoverable Metals

Criteria	Aluminum	Copper	Lead	Nickel	Zinc
CCC[1]	-*	**1**/28	**1**/28	**1**/28	**1**/28
CMC[1]	**3**/28	**0**	**0**	**0**	**1**/28

[1] Number of violations to number of observed metals

* No standard is defined

Table 3-5: Total Recoverable Metal Violations/Exceedances for South Branch Bear Creek at PADE{ (Baker) stations

Stream/Pond/ Drain	Sample Station	Tot. Al		Tot. Cu		Tot. Pb		Tot. Ni		Tot. Zn	
		CCC[1]	CMC	CCC	CMC	CCC	CMC	CCC	CMC	CCC	CMC
Mainstem	047MP-SW32-63004										
	047MP-SW33-63004										
	047MP-SW34-63004										
UNT49157	047MP-SW24-62804										
	047MP-SW55-82604		✓					✓			
UNT49156	047MP-SW25-62804										
UNT49153	047MP-SW49-72004										
	047MP-SW50-72004										
	047MP-SW51-72904										
	047MP-SW52-72904										
	047MP-SW52-72904DUP										
UNT49142 (Hemlock Road)	SW08-11104										
	SW09-11104										
	SW10-11104										
	SW11-11204										
	SW12-11204										
Pond (Hemlock Road)	SW01-102704										
	SW02-102704										
	SW03-102804		✓								
	SW04-102804		✓	✓		✓				✓	✓
	SW05-102804										
	SW06-102804										
	SW07-11204										
	SW07-11204-DUP										
Pond (Hemlock Road)	SW13-11204										
Drain (Hemlock Road)	SW14-11104										
Pipe (Hemlock Road)	JOHNSP-102704										
	JOHNSP-102704DUP										

[1] Not defined for CCC

[2] For computing the CCC and CMC for Cu, Pb, Ni, and Zn, an average hardness value of 65.93 were used based on all measurements at Hemlock Road.

3.1.2.3. Organic Data

All organic compounds, such as voltatiles, semi-volatiles, PAHs, pesticides, and herbicides, were analyzed to determine whether the examined parameters complied with Pennsylvania's established water quality standards. No violations of the both the fish and aquatic life criteria and the human health criteria were observed and the majority of dissolved organic parameters measured were not detected.

3.1.2.4. Chemicals of Interest

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment (PHA) for sulfuric acids (BSA, BDSA, and PSA), CP, and resorcinol in the Bear Creek watershed including South Branch Bear Creek. From this PHA, the ATSDR stated that the water in this area "posed an indeterminate public health hazard" for drinking purposes and a "short-term and intermittent exposures to surface water are not likely to result in significant health effects" (ATSDR, 2005). However, for the above chemicals, no limits or applicable comparison values, CVs (value which requires further evaluation) are established because due to the limited number of sites sampled.

The majority of the organic "chemicals of interest" (BSA, CP, formaldehyde, KSS, BDSA, PSA, and resorcinol) were either non-detect or reported as estimates and no standard exist (except for formaldehyde). At the only mainstem sampling area (B01 site # 6), sulfuric acids (BDSA and PSA) were detected (for BDSA: 330 µg/L at 047MP-SW32-63004 and 230 µg/L at 047MP-SW34-63004; for PSA: 410 µg/L at 047MP-SW32-63004). For the Unt49142 at station SW08-112804, BSA (86 µg/L) and BDSA (120 µg/L) were detected. Also, BSA was detected at the center of the South Pond (86 µg/L at SW04-102804). For formaldehyde, all detected measurements were in compliance with the standard (110 µg/L at 047MP-SW55-82604; 110 µg/L at 047MP-SW33-63004; 130 µg/L at 047MP-SW34-63004).

3.1.3 PADEP AMD Monitoring Data, 2006

In 2006, PADEP collected water quality data in the watershed to identify and characterize the impact of acid mine drainage on the stream under different flow regimes. A total of five instream sampling stations were selected in the SBBC watershed. Four of these stations are located on the mainstem of South Branch Bear Creek and one at UNT 49156, an AMD impacted tributary. The stations were selected based on the impaired segments, a review of potential pollutant sources and their spatial distribution. **Figure 3-3** provides the locations of these stations in the watershed.

In order to characterize the impact of AMD, water quality data were collected on five occasions (three times in July 2006 and twice in August 2006) at five stations under low and high flow conditions. **Table 3-6** provides a description of the five stations sampled.

Table 3-6: AMD Sampling Stations for the South Branch Bear Creek Watershed

Sample Station	Waterbody	Location
SBBC00	SBBC	Downstream of confluence with UNT49096
SBBC01	SBBC	Upstream of confluence with UNT49096
SBBC02	SBBC	Downstream of UNT49154
SBBC03	UNT49156	Upstream of confluence with SBBC
SBBC04	SBBC	Upstream of confluence with UNT49156

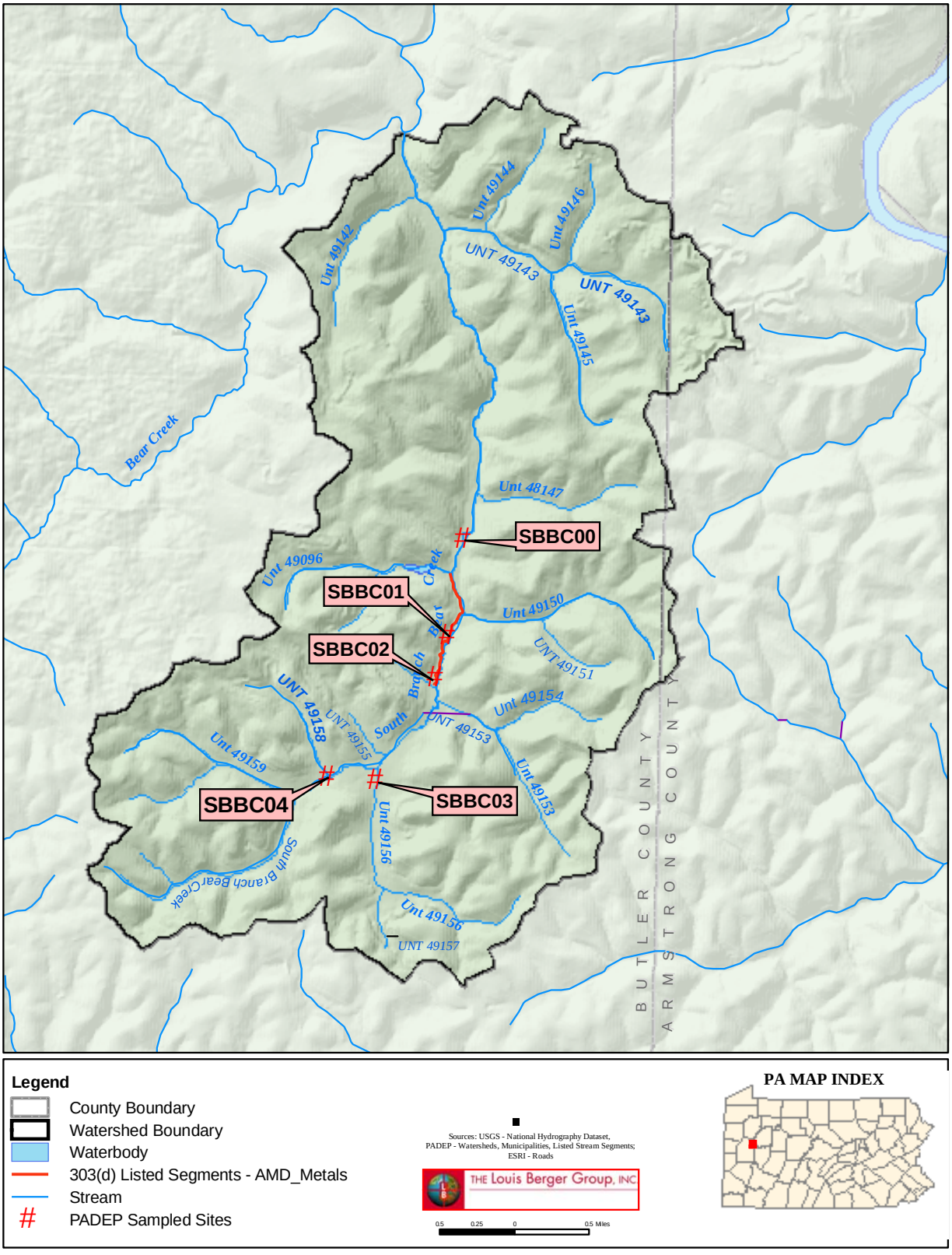


Figure 3-3: PADEP AMD Sampling Stations in the SBBC Watershed

3.1.3.1. Summary of AMD Data

Samples were assessed for the following chemical water quality parameters: pH, total suspended solids (TSS), total hardness, total acidity, sulfate, and alkalinity. In addition, samples were also analyzed for metal parameters: total aluminum, total iron, ferrous iron, total magnesium, total calcium, and total manganese. All sample measurements were assessed based on Pennsylvania's established water quality standards.

In addition to these parameters, field measurements of pH, temperature, specific conductivity, dissolved oxygen, and flow were also recorded during each sampling event. Based on the measurements, there were no violations of temperature, pH, or dissolved oxygen standards.

The following is a bulleted summary of the monitoring data collected by PADEP within the South Branch Bear Creek

- TSS ranged from 4 to 24 mg/L at all stations.
- Total alkalinity was above the minimum standard of 20 mg/L at all stations.

- Sulfate levels measured were below the maximum standard of 250 mg/L at all stations. The maximum, average, and minimum concentrations for sulfate at each AMD station is shown in **Figure 3-4**.

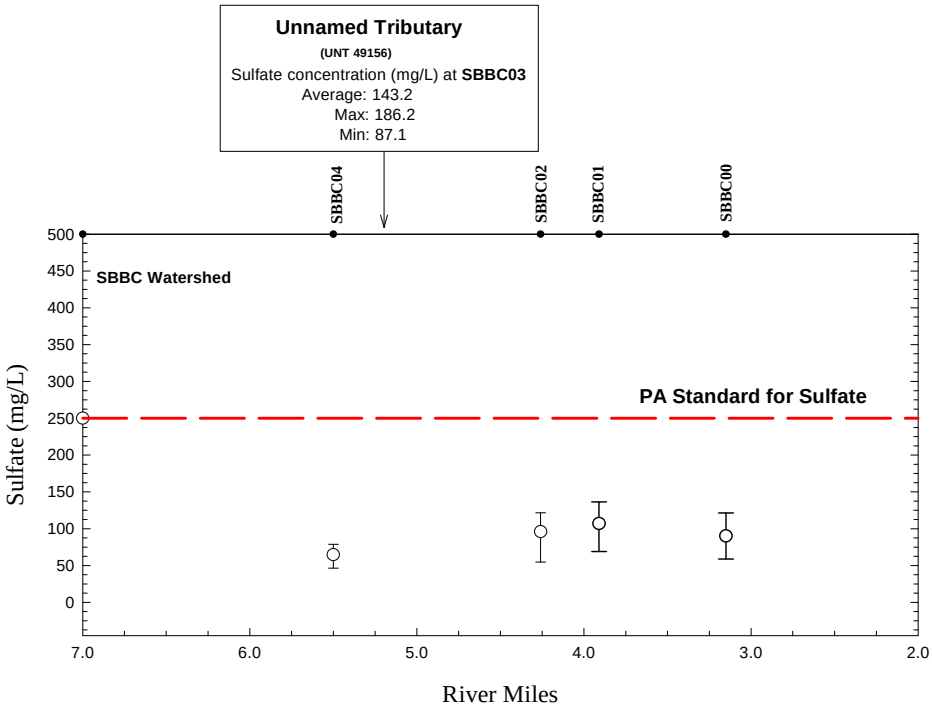


Figure 3-4. Maximum, Average, and Minimum Concentration for Sulfate

- pH and net-alkalinity (total alkalinity minus total acidity) levels at all stations were in compliance with PA standard. The maximum, average, and minimum concentration for net-alkalinty at each AMD station is shown in (**Figure 3-5**).

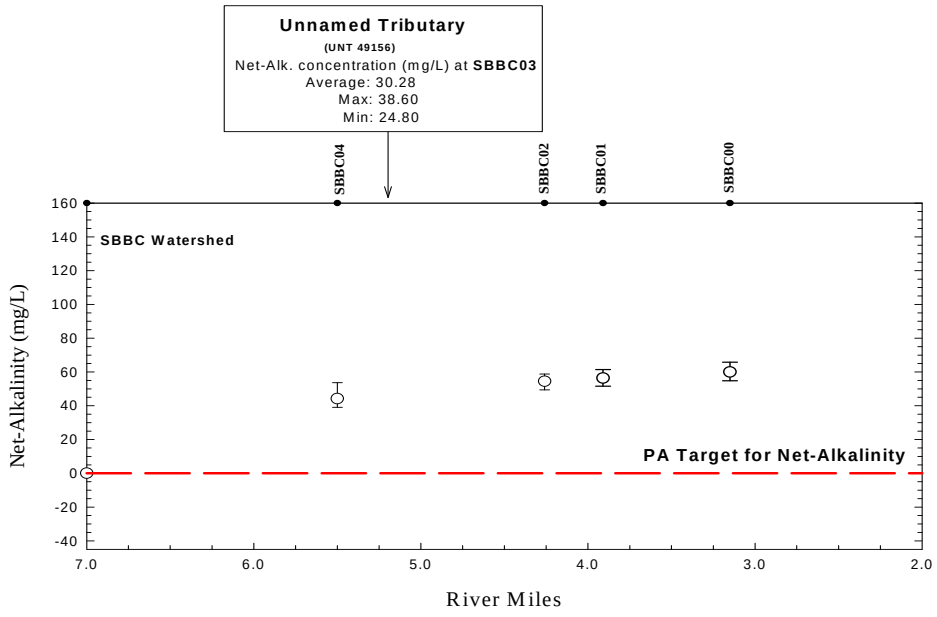


Figure 3-5. Maximum, Average, and Minimum Concentration for Net-Alkalinity

- Total iron levels violated the maximum standard of 1.5 mg/L at SBBC03 on five occasions (ranged from 1.76 to 3.16 mg/L). The maximum, average, and minimum concentration for total iron at each AMD station is shown in **Figure 3-6.**

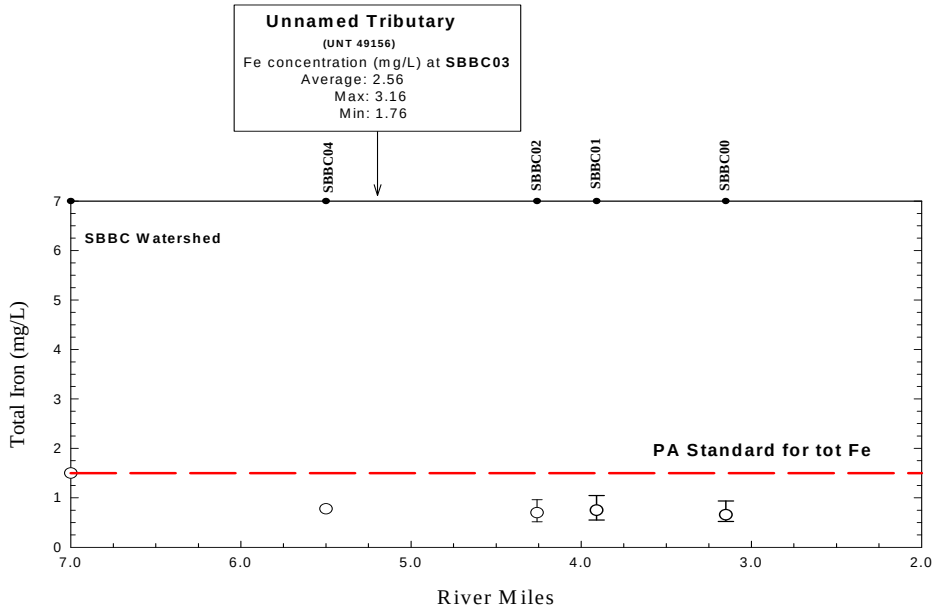


Figure 3-6. Maximum, Average, and Minimum Concentration for Total Iron

- Total recoverable manganese violated the maximum standard of 1 mg/L at SBBC03 on five occasions. Concentrations ranged from 1.134 to 1.537 mg/L. The maximum, average, and minimum concentration for total manganese at each AMD station is shown in **Figure 3-7.**

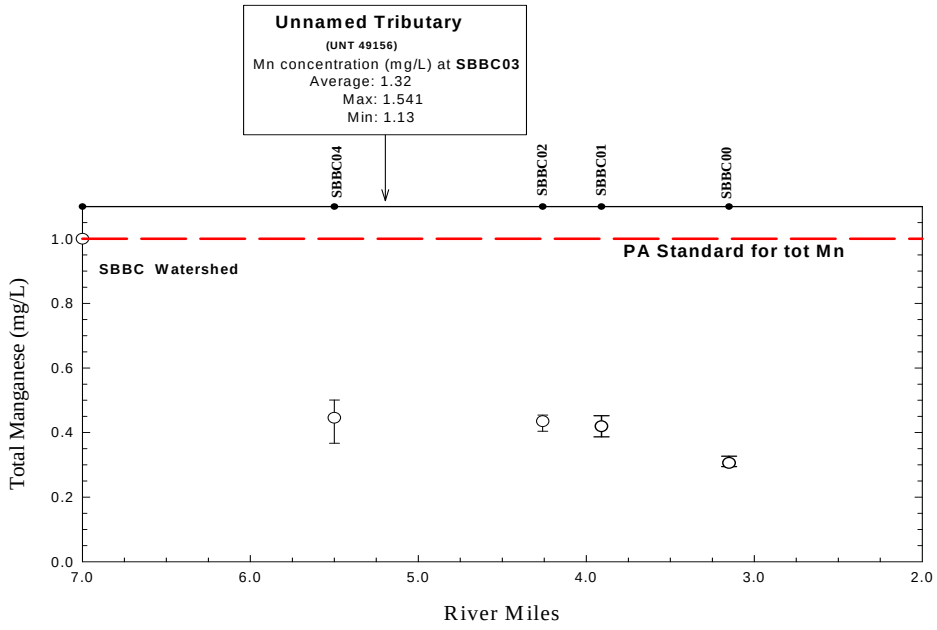


Figure 3-7. Maximum, Average, and Minimum Concentration for Total Manganese

- Total aluminum levels were in compliance with PA standard of 0.75 mg/L at all stations. The maximum, average, and minimum concentration for total aluminum at each AMD station is shown in **Figure 3-8.**

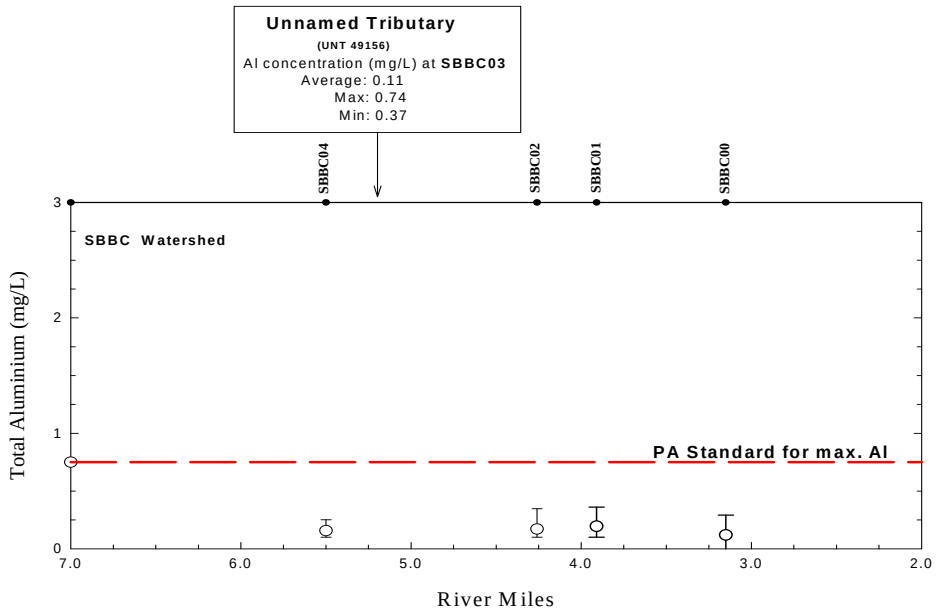


Figure 3-8. Maximum, Average, and Minimum Concentration for Total Aluminum

3.2 Supplemental Water Quality Monitoring Data

3.2.1 United States Geological Survey (USGS)

There is only one ambient water quality station located in the South Branch Bear Creek (**Table 3-7**). The station was sampled four times between 1979 and 1998 (1979, 1980, 1981, and 1998). However, data for water quality analysis were only retrieved for 1998 (last 15 years of sampling). Sampling included flow, temperature, specific conductivity, pH, acid neutralization capacity (ANC), acidity (as CaCO3), acidity (as hydrogen ion), chloride, sulfate, total iron, dissolved iron, total manganese, dissolved manganese, total aluminum, and dissolved aluminum.

Table 3-7: Location of Ambient Water Quality Monitoring Stations

Station	Description
USGS 3031508	Before the confluence with Bear Creek

3.2.1.1. Ambient Water Quality Monitoring Data

A bulleted summary of the general water quality data including iron and manganese derived from USGS is listed below (**Table 3-8**):

- Sulfate concentration was in compliance with the criterion.
- Field pH and chloride violated the criteria.
- Total iron concentration exceeded the criterion of the 30 day average of 1.5 mg/L.
- Dissolved iron concentration violated the maximum standard.
- Specific conductivity level reached a level of 1800 µS/cm.
- ANC level (108 mg/L or 1200 µeq/L) were considerably above the critical ANC value of 10 mg/L (equals 200 µeq/L) for streams not sensitive to acidification (EPA, 2006).

Table 3-8: Measured Water Quality Parameters in South Branch Bear Creek at USGS 3031508 on August 13 1998

Station	Temp	Spec. Conduct.	pH	Acidity, CaCO3	Acidity, Hydrogen Ion	ANC	SO4	Cl	Fe, tot	Fe, diss	Mn, tot	Mn, diss
	°C	µSim/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
USGS 3031508	18.0	1940.0	14.4	5.0	0.1	108.0	213.0	429.0	7.24	1.37	0.62	0.67

3.2.1.2. Toxic Metals Data

Toxic metals measured included only dissolved and total aluminum concentrations. Aluminum data were analyzed to determine whether the examined parameters complied with Pennsylvania's established water quality standards for CCC (Criteria Continuous Concentration) and CMC (Criteria Maximum Concentration). No violations were determined for the fish and aquatic life and human health criteria.

3.2.1.3. Organic Data

No organic data were collected by USGS in the South Branch Bear Creek watershed.

4.0 AMD Modeling Approach

This section describes the modeling approach used in the TMDL development. The primary focus within this section is on the assumptions used and the model set-up.

4.1 TMDL Endpoints

One of the important steps in TMDL development is determining the numeric endpoints, or water quality targets. Water quality targets compare the current stream conditions to the expected restored stream conditions after TMDL load reductions are implemented. The endpoint is based on either the narrative or numeric criteria available in the water quality criteria.

The TMDL endpoints for AMD in the South Branch Bear Creek watershed are based on the water quality criteria, as defined in *the Pennsylvania Code. Title 25 Environmental Protection, Department of Environmental Protection, Chapter 93, Water Quality Standard* for total aluminum, total iron, total manganese, and pH. **Table 4-1** presents the criterion value for each pollutant.

Table 4-1:PA Water Quality Criteria for AMD pollutants in the South Branch Bear Creek Watershed*

Parameter	Criteria
Total Aluminum	0.75 mg/L
Total Iron	30 day average of 1.5 mg/L
Total Manganese	1.0 mg/L
pH	6 - 9

* Department of Environmental Protection (May 14, 2005). Commonwealth of Pennsylvania, Pennsylvania Code, Title 25. Environmental Protection.

Much of the sources of pollution in the watershed are nonpoint sources which are expressed as Load Allocations (LAs) in a TMDL. All allocations are specified as long-term average daily concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time as required in *PA Title 25 Chapter 96.3(c).*

4.2 TMDL Methodology

The South Branch Bear Creek AMD TMDL was developed using a two-step process that is used regularly by PADEP for AMD TMDLs. The first step determines the maximum allowable instream concentrations of the pollutants at each location of interest. The second step performs a load tracking using a mass balance approach for each pollutant (aluminum, iron, manganese, acidity) at each point of interest to compute the TMDL allocations. The mass balance approach tracks the pollutant loads along the stream and ensures that the Pennsylvania water quality standards are attained at all locations.

4.2.1 Statistical Approach

The allowable instream concentration of each pollutant is determined by statistically analyzing instream water quality data and finding a concentration that has a 99 percent probability of meeting the water quality criteria, as defined in the *Pennsylvania Code. Title 25 Environmental Protection, Department of Environmental Protection, Chapter 93, Water Quality Standard*. Since the statistical analysis requires a large number of instream water quality measurements, the Monte Carlo simulation was used to generate 5000 data points at each location. The Monte Carlo simulation was performed using the @RISK software (Palisade Corporation, 2005).

The Monte Carlo simulation randomly generates a larger data set based on the mean and the standard deviation of observed concentrations of the pollutants at each sampling site and a lognormal distribution. The @Risk software also computes the pollutant concentration corresponding to a specified probability of exceedence. Thus the pollutant concentration that will not be exceeded 99 percent of time (Cd) was determined and compared with the water quality criterion (Cc) to compute the required percent reduction (PR). For each iteration, the required percent reduction can be expresses as:

$$PR = \text{maximum } \{0, (1 - Cc/Cd)\}$$

The allowable long-term average concentration (LTA Conc) can be computed using:

$$\text{LTA Conc} = \text{Mean Conc} \bullet (1 - \text{PR})$$

In order to compute the mean and the standard deviation as input to the Monte Carlo simulation, five base flow and non-base flow samples were collected at each specified monitoring site to improve the sample population statistics.

Figure 4-1 provides a graphical representation of the steps needed to develop the maximum allowable instream concentrations.

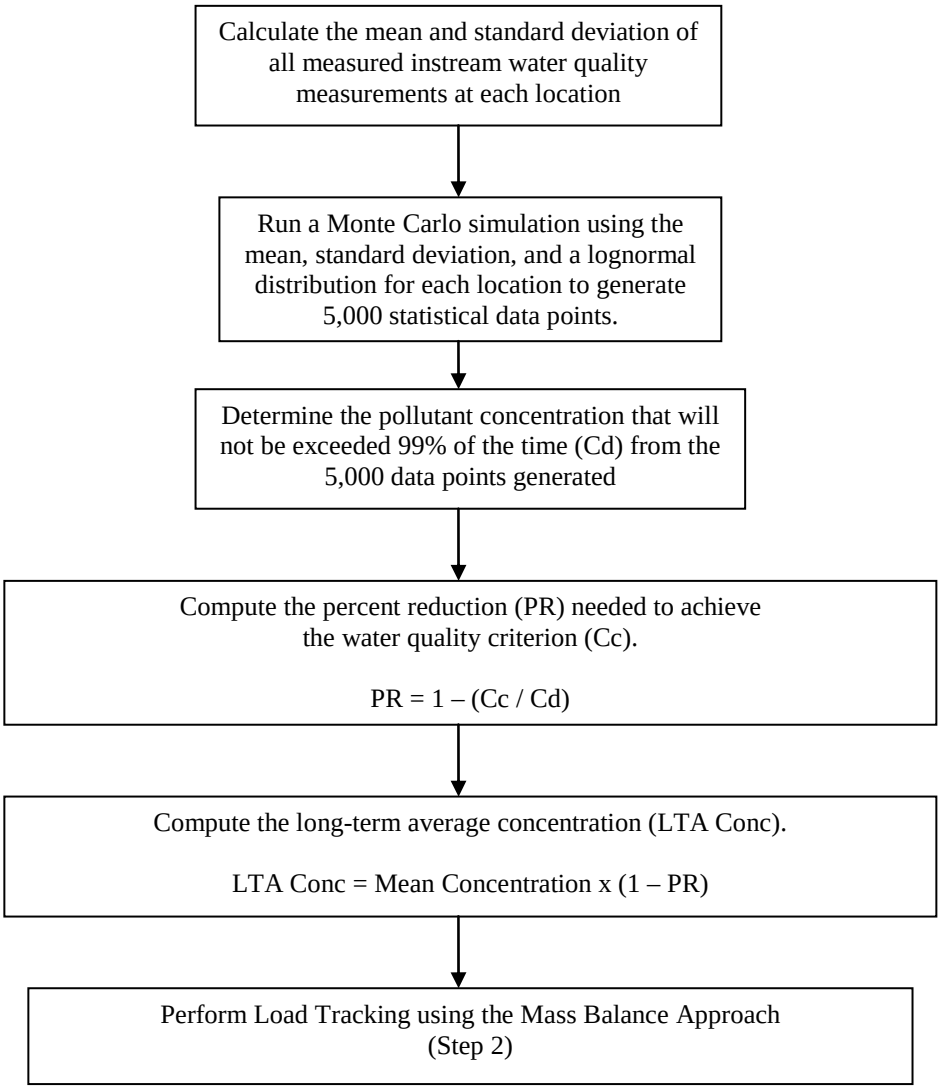


Figure 4-1: Flow Diagram of Step 1 – Calculation of the Maximum Allowable Instream Concentration

4.2.2 Mass Balance Analysis

Using the change in measured loads between sampling locations and the calculated allowable load, the mass balance analysis provides a picture of how AMD is impacting each sampling location. This analysis is conducted in order to ensure that all water quality standards will be met at all points within the impaired stream.

For each sample site, mass balances were computed based on upstream and downstream loads and the allowable LTA load determined from the Monte Carlo simulation. The loads were calculated using the allowable LTA concentration and the average stream flow. The mass balance was computed following two basic rules to establish TMDL load:

1. If the sum of the load received from upstream is less than the load at the downstream site, the difference between the downstream and upstream loads will be added to the allowable LTA load as a contribution from groundwater/diffuse sources.

2. If the sum of the load received from upstream is greater than the load at the downstream site, the ratio of the decrease will be applied to the allowable LTA load at the upstream site. This will account for any in-stream processes, such as settling, taking place within the stream segment.

Figures 4-2 provides a graphical representation of the mass balance approach used to track the pollutant loads.

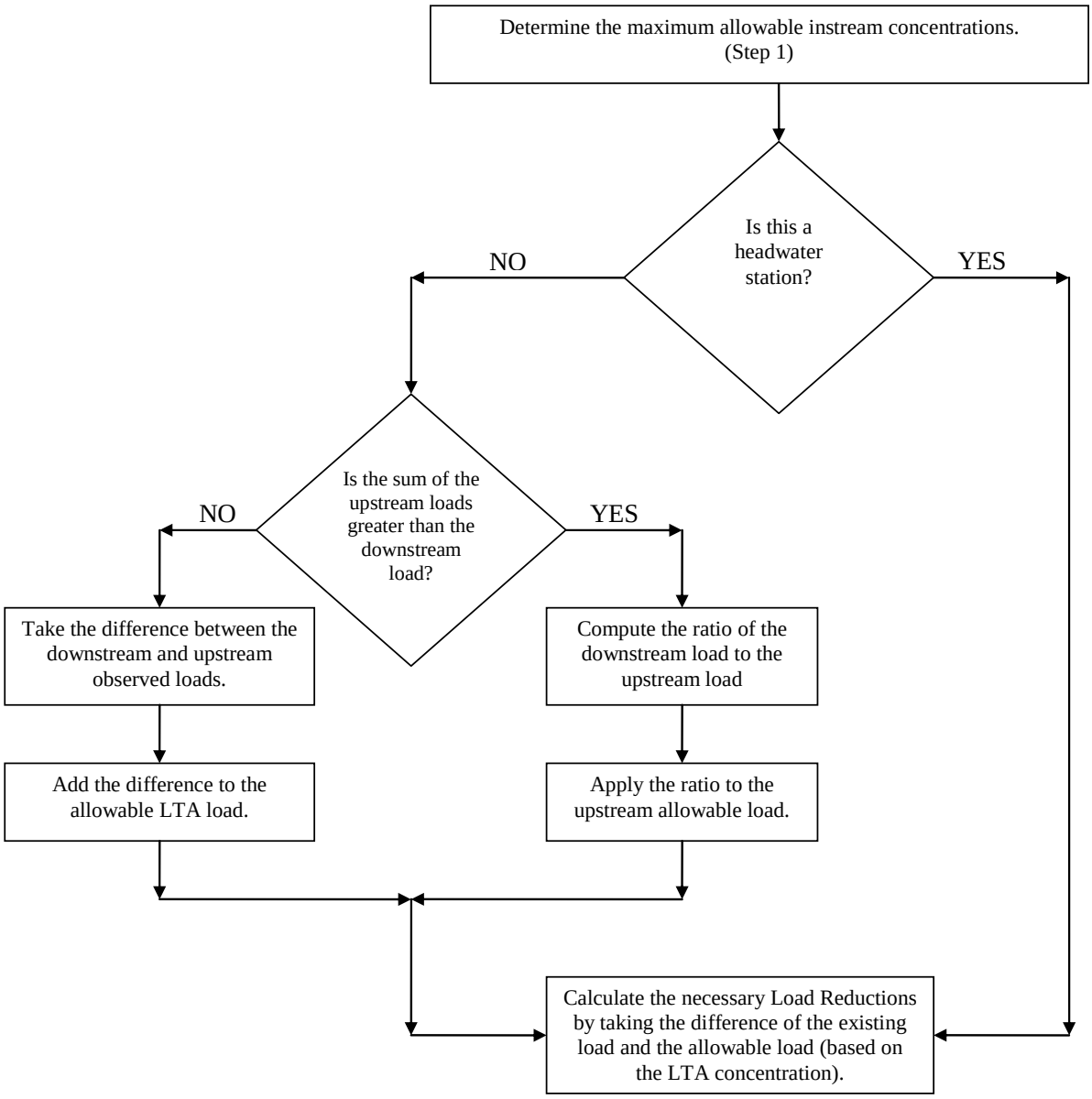


Figure 4-2. Flow Diagram of Step 2 –Mass Balance Analysis

The development of the allocations for point sources and nonpoint sources was based on the allocation approach performed in previously EPA-approved TMDLs for AMD such as for the Brubaker Run watershed (PADEP, 2004) and Raccoon Creek watershed (PADEP, 2005).

The TMDL load is allocated to point sources (waste load allocation) and to non-point sources (load allocation) at each sample site. The waste load allocations (WLA) are applied to permitted discharges. The load allocations (LAs) were calculated as the difference between the TMDLs (allowable LTA) and the WLAs. The LAs at each sample site incorporated the allowable loads from upstream and loads from tributaries. The percent reductions were computed for each sample site.

4.2.3 Load Tracking using Mass Balance

Extensive research on geochemistry of acid mine drainage provided the basis for development of pH TMDLs in Pennsylvania and established the relationship between alkalinity, acidity and pH under the special circumstances. Research by Department of Environmental Protection revealed that for positive (greater than or equal to zero) net alkalinity, alkalinity minus acidity (both in units of milligrams per liter (mg/l) CaCO3), the pH is commonly between six to eight, which also lies within the acceptable pH criteria range specified in PA Title 25 Chapter 96.3(c). The pH, a measurement of hydrogen ion acidity presented as a negative logarithm, is not conducive to standard statistics and pH does not measure latent acidity. Since acidity in a stream is partially chemically dependent upon dissolved metals and it is extremely difficult to predict the exact pH in water in acid mine drainage areas, Pennsylvania uses net alkalinity (= – net acidity) allocations to address the pH impairments included in the Section 303(d) list. This methodology assures that the standard for pH will be met when acidity in a stream is neutralized or a net alkaline stream is maintained. This method eliminates the need to specifically compute the pH value, which for mine drainage effected waters is not a true reflection of acidity.

The procedure for development of the acidity allocations at the sampling sites involves the following steps.

1. Compute acidity from measured hot acidity and alkalinity of each sample at a sampling site

2. Perform Monte Carlo simulation to generate 5,000 data points using the mean and the standard deviation of all acidity values, and based on a log-normal distribution as described in Section 4.2.1
3. Determine the percent reduction needed to make the 99th percentile acidity equivalent to the mean alkalinity as described in Section 4.2.1
4. Apply the percent reduction to determine long-term average (LTA) acidity (i.e. desired target for mean acidity) at the sampling site as described in Section 4.2.1
5. Perform a mass-balance analysis to determine TMDL allocations for acidity at each site as described in Section 4.2.2

4.2.4 Existing AMD Loads

In summary, average AMD loads for the South Branch Bear Creek watershed were determined as follows:

- Existing loads were calculated using the average stream flow and average concentration measured at each sampling site.
- Allowable LTA concentrations were determined by Monte Carlo simulation using a lognormal distribution, mean, and standard deviation.
- The allowable load was calculated using LTA concentration and the average stream flow measured at each sampling site.

Table 4-2: AMD Concentrations and Loads in the South Branch Bear Creek watershed

Station	Average Stream Flow (cfs)	Parameter	Existing		Allowable	
			Concentration (mg/L)	Load (lb/day)	Concentration (mg/L)	Load (lb/day)
SBBC04	1.40	Iron	0.78	5.87	1.25	9.46
		Manganese	0.45	3.36	0.74	5.59
		Aluminum	0.16	1.18	0.28	2.10
		Acidity	8.08	60.97	53.30	402.19
SBBC03	1.20	Iron	2.59	16.69	0.97	6.27
		Manganese	1.32	8.51	0.79	5.08
		Aluminum	0.51	3.31	0.42	2.72
		Acidity	8.60	55.44	21.50	138.62
SBBC02	7.17	Iron	0.70	27.04	0.82	31.53
		Manganese	0.44	16.82	0.91	35.01
		Aluminum	0.17	6.59	0.23	9.03
		Acidity	7.08	273.69	47.87	1,850.51
SBBC01	6.75	Iron	0.75	27.25	0.70	25.45
		Manganese	0.42	15.25	0.88	31.98
		Aluminum	0.02	7.06	0.21	7.74
		Acidity	7.76	282.24	69.69	2,534.63
SBBC00	10.01	Iron	0.66	35.43	0.80	43.11
		Manganese	0.31	16.51	0.89	48.25
		Aluminum	0.15	7.98	0.23	12.44
		Acidity	7.30	393.77	62.13	3,351.06

5.0 AMD TMDL Allocation

The purpose of TMDL allocation is to identify the pollutant load reductions required from each source to achieve water quality standards. Reduction of AMD loads from each non-point source in the impaired watershed to cumulatively meet the TMDL endpoint load is expected to ensure that South Branch Bear Creek meets water quality standards and restore its designated uses.

5.1 Basis for TMDL Allocations

AMD TMDL allocations for South Branch Bear Creek were based on the following equation:

$$TMDL = WLA + LA + MOS$$

Where:
TMDL= Endpoint AMD Load
WLA = Wasteload Allocation
LA = Load Allocation
MOS = Margin of Safety

The wasteload allocation (WLA) represents the total AMD loading allocated to point sources. Since there are two point sources located within the South Branch Bear Creek watershed, wasteload allocations were assigned accordingly. The load allocation (LA) represents the total AMD loading allocated to non-point sources. The margin of safety (MOS) is a required TMDL element designed to account for uncertainties in the calculation of the TMDL.

5.1.1 Margin of Safety

For this TMDL, the margin of safety was applied implicitly by simulating concentrations and loadings with a Monte Carlo simulation. Another margin of safety used for this TMDL analysis included the consideration of effluent variability. The standard deviation of the dataset was the value that best provides this variability for this analysis. The simulation results are based on this variability and the existing stream conditions, an

uncontrolled system. The general assumption can be made that a controlled system, one that is controlling and stabilizing the pollution load, would be less variable than an uncontrolled system. This implicitly builds in a margin of safety.

5.1.2 Wasteload Allocation

The wasteload allocated to a point source was determined based on a facility's permitted limit and its reported design flow. There are two dischargers in the South Branch Bear Creek watershed that have permitted limits for iron, manganese and aluminum – Penreco (PA0002135) and Sonneborn (PA0002666). **Table 5-1** shows the permitted loads for iron, manganese, and aluminum for these two facilities.

Table 5-1. Wasteload Allocations for Permitted Facilities in the South Branch Bear Creek watershed

Permit Number	Facility	Flow (gpd)	Parameter	Permitted Limits	
				Concentration (mg/L)	Load (lb/day)
PA0002135	Penreco	276,000	Iron	2.00	4.61
			Manganese	1.00	2.30
			Aluminum	0.62	1.43
PA0002666	Sonneborn	477,200	Iron	1.30	5.20
			Manganese	1.00	4.00
			Aluminum	0.58	2.30

5.1.3 Load Allocation

The TMDL for South Branch Bear Creek consists of load allocations to all of the areas upstream of and between each of the sampling sites used. The load allocation for each stream segment was computed using the data collected at each sampling station. In addition, flow measurements gathered with each sampling event had been used.

The TMDL for SBBC04 consists of a load allocation to all the area upstream of the sampling site. Upstream of confluence with UNT 49156, SBBC04 is located on the mainstem of South Branch Bear Creek. **Table 5.2** provides the calculation for the SBBC04.

Table 5-2: TMDL Calculations for SBBC04

	Iron (Ib/day)	Manganese (Ib/day)	Aluminum (Ib/day)	Acidity (lb/day)
Existing Load	5.87	3.36	1.18	60.97
Allocated Load	9.46	5.59	2.10	402.19
Load Reduction	0.00	0.00	0.00	0.00
Percent Reduction	0.00	0.00	0.00	0.00

The TMDL for SBBC03 consists of a load allocation to the area that drains into UNT 49156. This station is located upstream of the confluence with South Branch Bear Creek. **Table 5.3** provides the calculation for the SBBC03

Table 5-3: TMDL Calculations for SBBC03

	Iron (Ib/day)	Manganese (Ib/day)	Aluminum (Ib/day)	Acidity (lb/day)
Existing Load	16.69	8.51	3.31	55.44
Allocated Load	6.27	5.08	2.72	138.62
Load Reduction	10.42	3.43	0.59	0.00
Percent Reduction	62.41	40.34	17.79	0.00

The TMDL for SBBC02 consists of a load allocation includes the area between SBBC04 and this station. Downstream of UNT 49154 and Penreco, SBBC02 is located on South Branch Bear Creek. **Table 5.4** provides the calculation for the SBBC02.

Table 5-4: TMDL Calculations for SBBC02

	Iron (Ib/day)	Manganese (Ib/day)	Aluminum (Ib/day)	Acidity (lb/day)
Existing Load	27.04	16.82	6.59	273.69
Existing Load From Upstream	22.56	10.67	4.49	116.41
Upstream Point Source Load (Penreco)	4.61	2.30	1.43	-
Difference with Upstream Existing Load	-0.12	2.65	0.67	157.28
Ratio of difference	0.996	-	-	-
Allowable load from Upstream	20.34	10.67	2.41	540.82
Total Upstream Load Tracked	20.25	15.62	6.92	698.10
Allocated Load	26.92	32.71	7.60	1,850.51
Load Reduction	0.00	0.00	0.00	0.00
Percent Reduction	0.00	0.00	0.00	0.00

The TMDL for SBBC01 consists of the load allocation of the area between SBBC02 and this station. SBBC01 is located upstream of confluence with UNT 49096. **Table 5.5** provides the calculation for SBBC01.

Table 5-5: TMDL Calculations for SBBC01

	Iron (Ib/day)	Manganese (Ib/day)	Aluminum (Ib/day)	Acidity (lb/day)
Existing Load	27.25	15.25	7.06	282.24
Existing Load From Upstream	27.04	16.82	6.59	273.69
Difference with Upstream Existing Load	0.21	-1.57	0.47	8.55
Ratio of difference	-	0.91	-	-
Alllowable load from Upstream	31.53	35.01	9.03	1,850.51
Total Upstream Load Tracked	31.75	31.74	9.50	1,859.06
Allocated Load	20.84	29.68	6.31	2,534.63
Load Reduction	10.89	2.03	3.19	0.00
Percent Reduction	34.32	6.48	33.60	0.00

The TMDL for SBBC00 consists of the load allocation of the area between SBBC01 and this station. Located downstream of UNT 49096, this station is the most downstream station on South Branch Bear Creek. **Table 5.6** provides the calculation for SBBC00.

Table 5-6: TMDL Calculations for SBBC00

	Iron (Ibs/day)	Manganese (Ibs/day)	Aluminum (Ibs/day)	Acidity (lbs/day)
Existing Load	35.43	16.51	7.98	393.77
Existing Load From Upstream	32.45	15.25	7.06	282.24
Upstream Point Source Load (Sonneborn)	5.2	4.00	2.30	-
Difference with Upstream Existing Load	2.98	-2.75	-1.37	111.52
Ratio of difference	-	0.86	0.85	-
Allowable load from Upstream	25.45	31.98	7.74	2,534.63
Total Upstream Load Tracked	33.63	30.85	8.56	2,646.15
Allocated Load	33.30	41.95	8.71	3,351.06
Load Reduction	0.33	0.00	0.00	0.00
Percent Reduction	1.00	0.00	0.00	0.00

Table 5.7 provides load reductions needed for water quality criteria to be met in the South Branch Bear Creek watershed.

Table 5-7. Allowable Loads and Necessary Load Reductions for the South Branch Bear Creek watershed

Station	Parameter	Existing Load (Ib/day)	Allocated Load (Ib/day)	Load Reduction (Ib/day)	Reduction (%)
SBBC04	Iron	5.87	9.46	0.00	0.00
	Manganese	3.36	5.59	0.00	0.00
	Aluminum	1.18	2.10	0.00	0.00
	Acidity	60.97	402.19	0.00	0.00
SBBC03	Iron	16.69	6.27	10.42	62.41
	Manganese	8.51	5.08	3.43	40.34
	Aluminum	3.31	2.72	0.59	17.79
	Acidity	55.44	138.62	0.00	0.00
SBBC02	Iron	27.04	26.92	0.00	0.00
	Manganese	16.82	32.71	0.00	0.00
	Aluminum	6.59	7.60	0.00	0.00
	Acidity	273.69	1,850.51	0.00	0.00
SBBC01	Iron	27.25	20.84	10.89	34.32
	Manganese	15.25	29.68	2.03	6.48
	Aluminum	7.06	6.31	3.19	33.60
	Acidity	282.24	2,534.63	0.00	0.00
SBBC00	Iron	35.43	33.30	0.33	1.00
	Manganese	16.51	41.95	0.00	0.00
	Aluminum	7.98	8.71	0.00	0.00
	Acidity	393.77	3,351.06	0.00	0.00

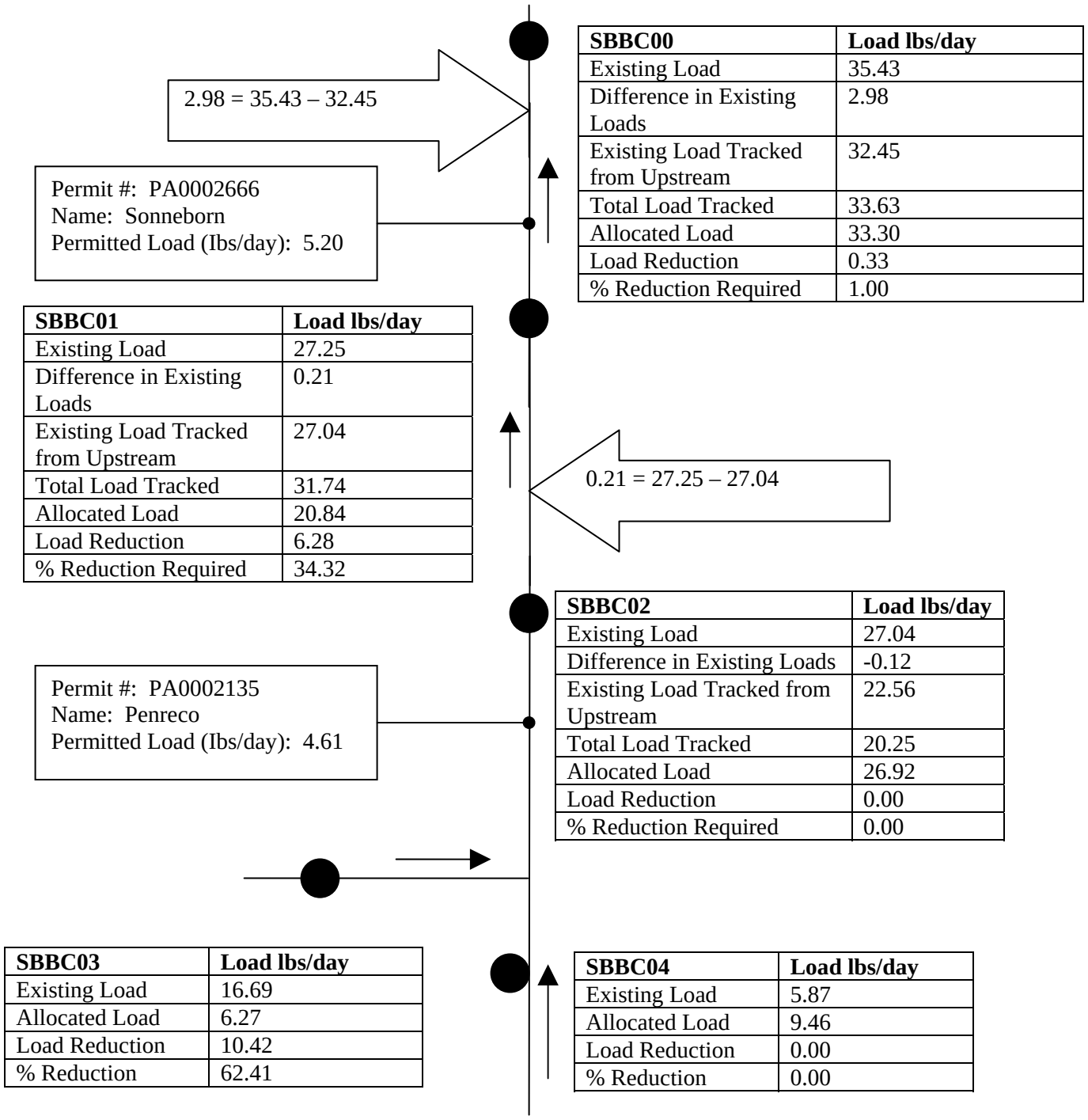
5.2 Overall Recommended TMDL Allocations

The load allocations for the South Branch Bear Creek AMD TMDL are summarized in **Table 5-8**.

Figures 5.1, 5.2, 5.3, and **5.4** provide a graphical representation of the allocations required for the South Branch Bear Creek watershed to meet water quality criteria.

Table 5-8. AMD TMDL for South Branch Bear Creek watershed

Station	Parameter	Existing Load (lb/day)	Reduction (%)	TMDL (lb/day)	WLA (lb/day)	LA (lb/day)
SBBC04	Iron	5.87	0.00	9.46	0.00	9.46
	Manganese	3.36	0.00	5.59	0.00	5.59
	Aluminum	1.18	0.00	2.10	0.00	2.10
	Acidity	60.97	0.00	402.19	0.00	402.19
SBBC03	Iron	16.69	62.41	6.27	0.00	6.27
	Manganese	8.51	40.34	5.08	0.00	5.08
	Aluminum	3.31	17.79	2.72	0.00	2.72
	Acidity	55.44	0.00	138.62	0.00	138.62
SBBC02	Iron	27.04	0.00	31.53	4.61	26.92
	Manganese	16.82	0.00	35.01	2.30	32.71
	Aluminum	6.59	0.00	9.03	1.43	7.60
	Acidity	273.69	0.00	1,850.51	0.00	1,850.51
SBBC01	Iron	27.25	34.32	25.45	4.61	20.84
	Manganese	15.25	6.48	31.98	2.30	29.68
	Aluminum	7.06	33.60	7.74	1.43	6.31
	Acidity	282.24	0.00	2,534.63	0.00	2,534.63
SBBC01	Iron	35.43	1.00	43.11	9.81	33.30
	Manganese	16.51	0.00	48.25	6.30	41.95
	Aluminum	7.98	0.00	12.44	3.73	8.71
	Acidity	393.77	0.00	3,351.06	0.00	3,351.06



SBBC00	Load lbs/day
Existing Load	35.43
Difference in Existing Loads	2.98
Existing Load Tracked from Upstream	32.45
Total Load Tracked	33.63
Allocated Load	33.30
Load Reduction	0.33
% Reduction Required	1.00

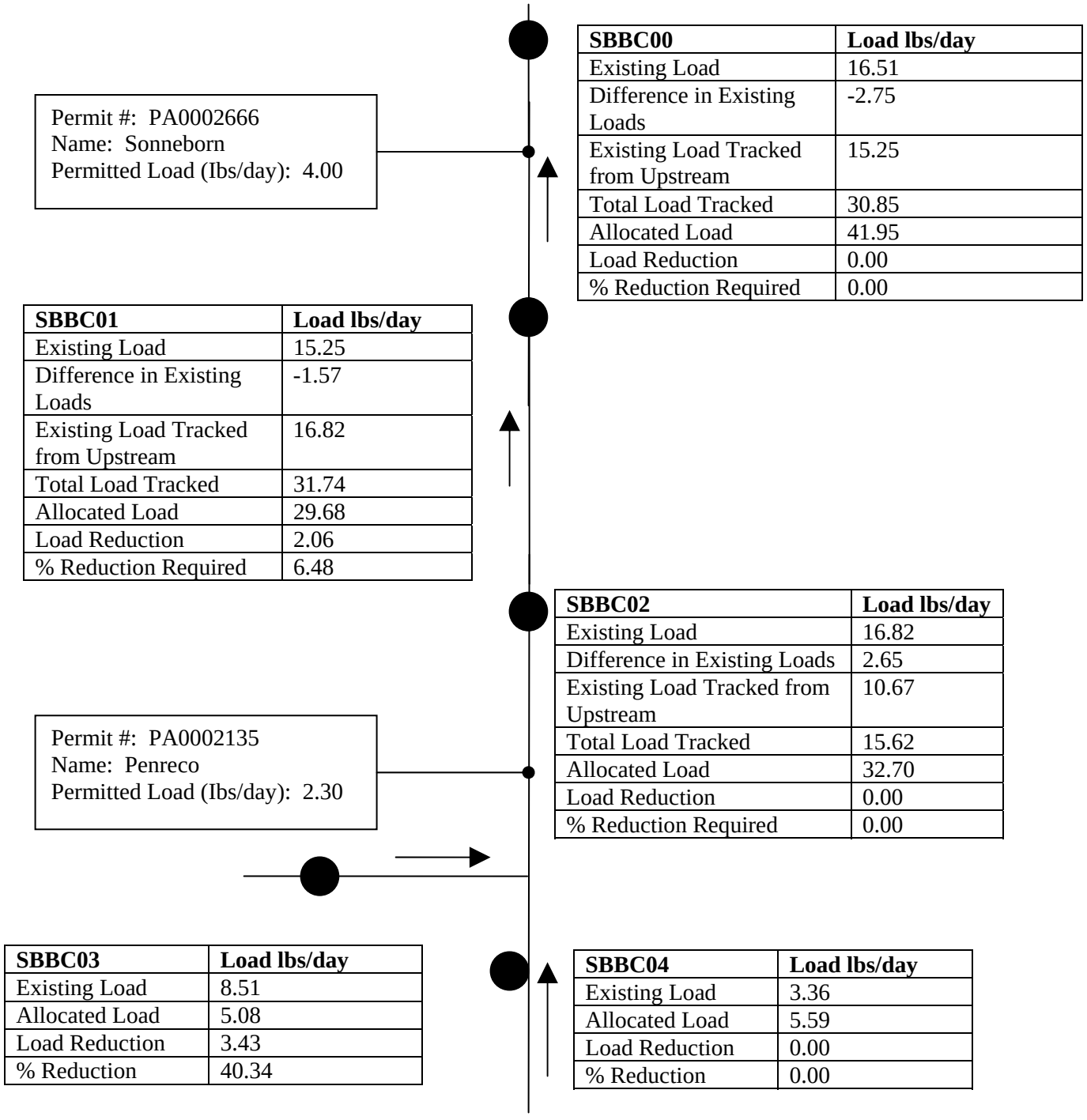
SBBC01	Load lbs/day
Existing Load	27.25
Difference in Existing Loads	0.21
Existing Load Tracked from Upstream	27.04
Total Load Tracked	31.74
Allocated Load	20.84
Load Reduction	6.28
% Reduction Required	34.32

SBBC02	Load lbs/day
Existing Load	27.04
Difference in Existing Loads	-0.12
Existing Load Tracked from Upstream	22.56
Total Load Tracked	20.25
Allocated Load	26.92
Load Reduction	0.00
% Reduction Required	0.00

SBBC03	Load lbs/day
Existing Load	16.69
Allocated Load	6.27
Load Reduction	10.42
% Reduction	62.41

SBBC04	Load lbs/day
Existing Load	5.87
Allocated Load	9.46
Load Reduction	0.00
% Reduction	0.00

Figure 5-1: Allowable and Existing Iron Loads



SBBC00	Load lbs/day
Existing Load	16.51
Difference in Existing Loads	-2.75
Existing Load Tracked from Upstream	15.25
Total Load Tracked	30.85
Allocated Load	41.95
Load Reduction	0.00
% Reduction Required	0.00

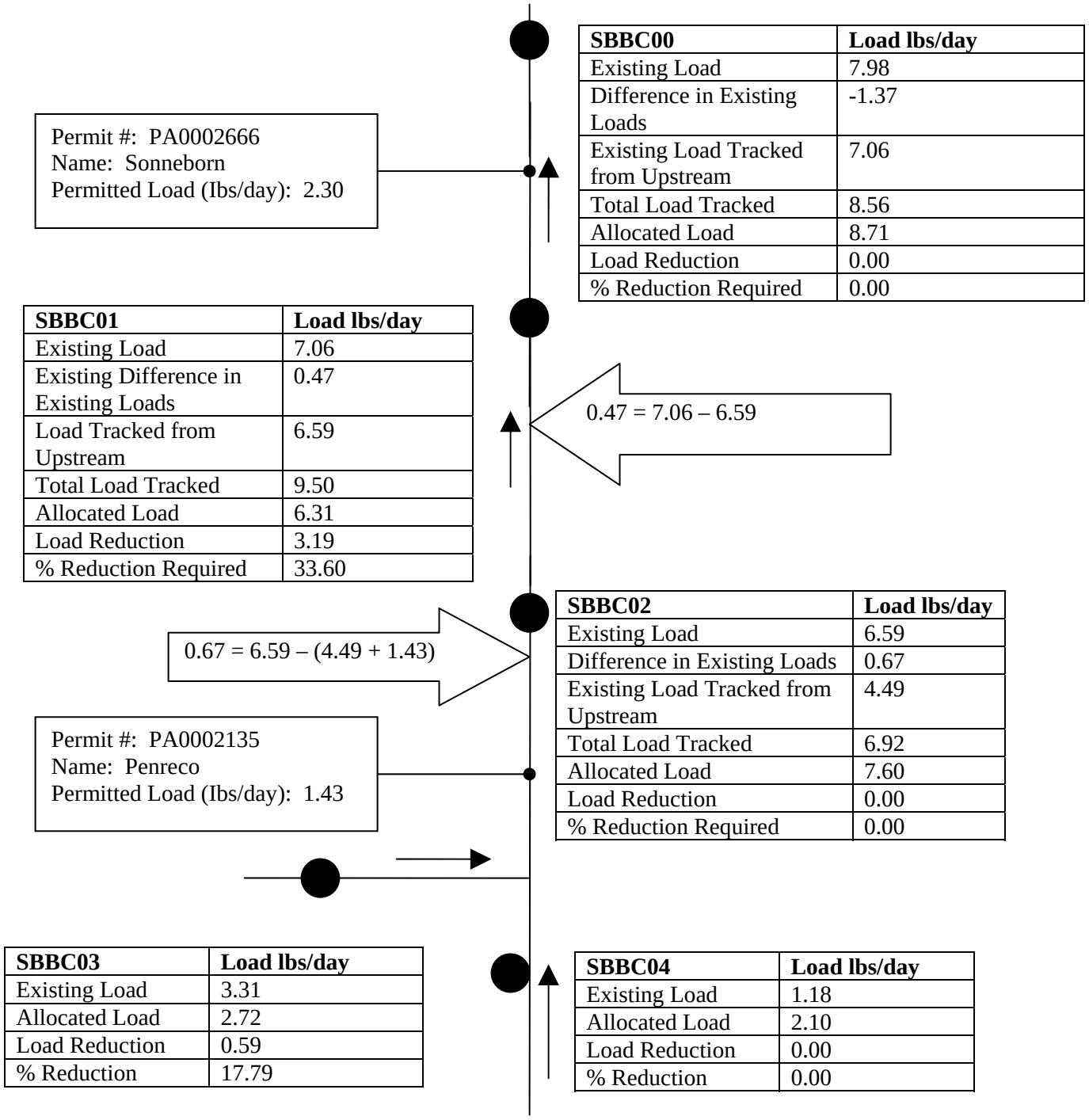
SBBC01	Load lbs/day
Existing Load	15.25
Difference in Existing Loads	-1.57
Existing Load Tracked from Upstream	16.82
Total Load Tracked	31.74
Allocated Load	29.68
Load Reduction	2.06
% Reduction Required	6.48

SBBC02	Load lbs/day
Existing Load	16.82
Difference in Existing Loads	2.65
Existing Load Tracked from Upstream	10.67
Total Load Tracked	15.62
Allocated Load	32.70
Load Reduction	0.00
% Reduction Required	0.00

SBBC03	Load lbs/day
Existing Load	8.51
Allocated Load	5.08
Load Reduction	3.43
% Reduction	40.34

SBBC04	Load lbs/day
Existing Load	3.36
Allocated Load	5.59
Load Reduction	0.00
% Reduction	0.00

Figure 5-2. Allowable and Existing Manganese Loads



SBBC00	Load lbs/day
Existing Load	7.98
Difference in Existing Loads	-1.37
Existing Load Tracked from Upstream	7.06
Total Load Tracked	8.56
Allocated Load	8.71
Load Reduction	0.00
% Reduction Required	0.00

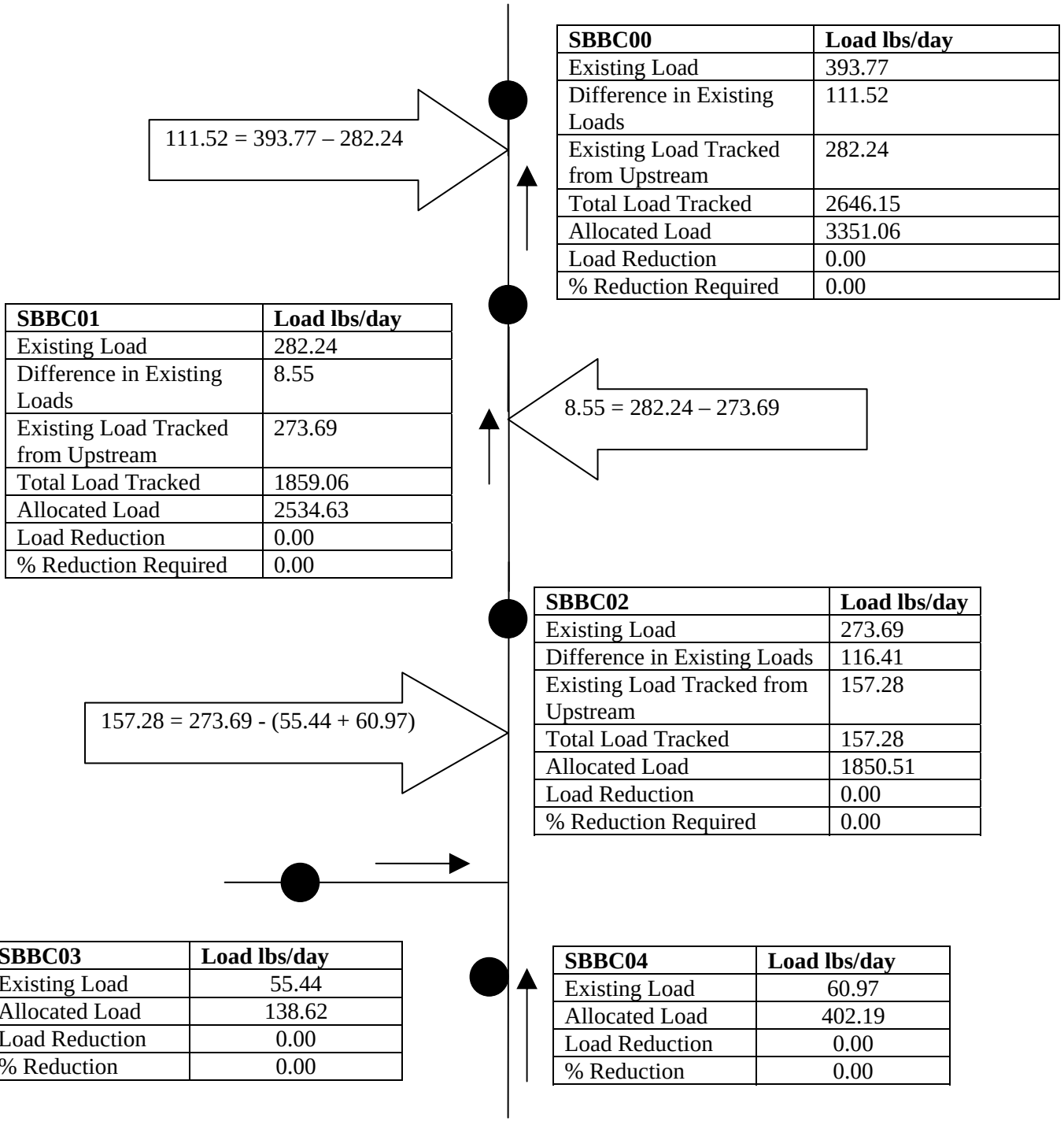
SBBC01	Load lbs/day
Existing Load	7.06
Existing Difference in Existing Loads	0.47
Load Tracked from Upstream	6.59
Total Load Tracked	9.50
Allocated Load	6.31
Load Reduction	3.19
% Reduction Required	33.60

SBBC02	Load lbs/day
Existing Load	6.59
Difference in Existing Loads	0.67
Existing Load Tracked from Upstream	4.49
Total Load Tracked	6.92
Allocated Load	7.60
Load Reduction	0.00
% Reduction Required	0.00

SBBC03	Load lbs/day
Existing Load	3.31
Allocated Load	2.72
Load Reduction	0.59
% Reduction	17.79

SBBC04	Load lbs/day
Existing Load	1.18
Allocated Load	2.10
Load Reduction	0.00
% Reduction	0.00

Figure 5-3. Allowable and Existing Aluminum Loads



SBBC00	Load lbs/day
Existing Load	393.77
Difference in Existing Loads	111.52
Existing Load Tracked from Upstream	282.24
Total Load Tracked	2646.15
Allocated Load	3351.06
Load Reduction	0.00
% Reduction Required	0.00

SBBC01	Load lbs/day
Existing Load	282.24
Difference in Existing Loads	8.55
Existing Load Tracked from Upstream	273.69
Total Load Tracked	1859.06
Allocated Load	2534.63
Load Reduction	0.00
% Reduction Required	0.00

SBBC02	Load lbs/day
Existing Load	273.69
Difference in Existing Loads	116.41
Existing Load Tracked from Upstream	157.28
Total Load Tracked	157.28
Allocated Load	1850.51
Load Reduction	0.00
% Reduction Required	0.00

SBBC03	Load lbs/day
Existing Load	55.44
Allocated Load	138.62
Load Reduction	0.00
% Reduction	0.00

SBBC04	Load lbs/day
Existing Load	60.97
Allocated Load	402.19
Load Reduction	0.00
% Reduction	0.00

Figure 5-4. Allowable and Existing Acidity Loads

5.3 Consideration of Critical Conditions

EPA regulations at 40 CFR 130.7 (c) (1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis.

5.4 Consideration of Seasonal Variability

Seasonal variations involve changes in stream flow and AMD loading as a result of hydrologic and climatological patterns. Since the model was based on observed data collected during different flow regimes, seasonal variations were explicitly incorporated in the modeling approach for these TMDLs.

6.0 Reasonable Assurance and Public Participation

There is reasonable assurance that the goals of these TMDLs can be met with proper watershed planning, implementation of pollution reduction best management practices (BMPs), and strong political and financial mechanisms. Reasonable assurance that the TMDLs established will require a comprehensive, adaptive approach that addresses:

- non-point source pollution and stream bank erosion,
- existing and future sources,
- regulatory and voluntary approaches.

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The South Branch Bear Creek TMDL identify the necessary overall load reductions for AMD currently causing use impairments and distributes those reduction goals to the appropriate sources. Reaching the reduction goals established by this TMDL will occur through changes in current land use practices, including the incorporation of best management practices (BMPs). Additionally, federal regulations at 40 CFR 122.44 require NPDES permit effluent limits to be consistent with the assumptions and requirements of the approved WLA.

6.1 *Best Management Practices*

Best management practices (BMPs) are methods and practices for preventing or reducing non-point source pollution to a level compatible with water quality goals. BMPs can be classified as structural, vegetative, or management, and each class is somewhat more effective in controlling certain types of diffuse pollution than others (Novotny and Olem, 1994). BMPs can be selected either to control a known type of pollution, or to prevent pollution from certain land use activities. The following approach has been suggested by Novotny and Olem (1994) when selecting BMPs to address water quality problems:

- Identify the water quality problem
- Identify the pollutants contributing to the problem and their probable sources
- Determine the dominant method of pollutant delivery to the water
- Set a reasonable water quality goal and determine the level of treatment needed to meet that goal
- Evaluate feasible BMPs for water quality effectiveness, effect on groundwater, economic feasibility, and site suitability.

Implementation of the AMD TMDL will contribute to PADEP's on-going water quality improvement efforts aimed at resorting areas effected by acid mine drainage through efforts to reclaim abandoned mine lands along with the issuing NPDES permits. In addition, the PADEP Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, mine subsidence regulation, mine subsidence insurance, and coal refuse disposal. The responsibilities of PADEP Bureau of Mining and Reclamation's regulation program include administration of a mining license and permit program, a loan program for bonding anthracite underground mines, and the EPA watershed Assessment Grant Program as well as other programs.

By instituting mine reclamation and well plugging efforts, the effects on water quality can be reduced and the land can be returned to a productive condition. Since the 1960s, Pennsylvania has been a national leading in establishing laws and regulations to ensure reclamation and plugging occurs after mining operations are completed. In order to make reclamation easier, PADEP has developed concepts collectively entitled Reclaim PA and includes legislation and policy land management initiatives. Reclaim PA has the following objectives: encourage private and public participation in abandoned mine reclamation efforts, improve reclamation efficiency through improved communication between reclamation partners, increase reclamation by reducing remining risks, and maximize reclamation funding by expanding existing sources and finding new sources.

6.2 *Implementation of Best Management Practices*

Implementation of best management practices (BMPs) should eventually achieve the loading reduction goals established in these TMDLs. Further ground-truthing should be performed in order to determine the most cost-effective and environmentally protective combination of BMPs required for meeting the reductions outlined in this report.

6.3 *Implementation Funding Sources*

Potential funding mechanisms for implementation include federal grants (i.e., CWA Section 104(b)(3), CWA Section 319, State Revolving Fund), and state grants (i.e., Growing Greener, PENNVEST). EPA funds are available through Pennsylvania under CWA Section 319 or the Non-point Source Program to fund some projects. Also PADEP's Bureau of Mining offers grant programs to fund mine reclamation efforts.

Public Participation

Federal regulations require that there is a public participation process as part of the TMDL development process. The public comment period for this TMDL begins on February 8, 2007 and ends March 9, 2007. A public notice was published in *The Butler Eagle* on February 7, 2007.

During this time, EPA welcomes input from interested parties and the general public on the proposed TMDL document. **All comments must be postmarked no later than the close of the comment period, March 9, 2007.** All comments can be sent to Ms. Lenka Berlin at the address below and should clearly identify the TMDL being commented on. Electronic submission of comments is encouraged. The TMDL report is available at the EPA Region III office or website (http://www.epa.gov/reg3wapd/tmdl). A copy of either report can also be requested through the contact provided below. Please direct any questions about the proposed TMDL document to Ms. Mary Kuo at (215) 814-5721 or kuo.mary@epa.gov.

berlin.lenka@epa.gov
or
Ms. Lenka Berlin (3WP30)
US EPA, Region III
1650 Arch Street, Philadelphia, PA 19103
Phone: 215-814-5259

7.0 References

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Appendix A: Water Quality Data

Appendix A provides the following data used for completing the AMD TMDL for the South Branch Bear Creek watershed:

- AMD Measurements collected by PADEP

Table A-1: AMD Water Quality Data from SBBC00

Sampling Round	Date	Flow cfs	Hardness T mg/L	MAGNESIUM T mg/L	T SUSP SOLID mg/L	MANGANESE T ug/L	pH	FERROUS IRON ug/L	HOT ACIDITYTY mg/L	CALCIUM T mg/L	SULFATE T mg/L	ALKALINITY mg/L	IRON T ug/L	ALUMINUM T ug/L
1	7/13/2006	-	-	-	-	-	-	-	-	-	-	-	-	-
2	7/19/2006	6.30	143	8.29	4	305	8	80	-53	43.5	100	60.8	522	100
3	7/25/2006	8.56	133	327	10	327	7.9	100	-49.2	40.1	80.2	54.8	563	100
4	8/1/2006	20.62	112	6.26	14	297	7.8	200	-50.2	34.5	58.8	58.6	936	292
5	8/8/2006	4.55	163	9.846	24	295	8.1	160	-58.4	49.1	121.3	65.8	606	100

Table A-2: AMD Water Quality Data from SBBC01

Sampling Round	Date	Flow cfs	Hardness T mg/L	MAGNESIUM T mg/L	T SUSP SOLID mg/L	MANGANESE T ug/L	pH	FERROUS IRON ug/L	HOT ACIDITYTY mg/L	CALCIUM T mg/L	SULFATE T mg/L	ALKALINITY mg/L	IRON T ug/L	ALUMINUM T ug/L
1	7/13/2006	9.15	116	7.518	18	452	7.8	1400	-45.2	34	86.1	51.6	1047	361
2	7/19/2006	2.02	151	9.88	<2	406	7.7	90	-49.6	44	125.5	57.6	549	100
3	7/25/2006	4.94	136	8.67	8	425	7.8	110	-45.4	40	118	52.2	552	100
4	8/1/2006	13.30	114	6.49	10	387	7.8	190	-49.2	34.8	69	59	1048	309
5	8/8/2006	4.33	171	11.7	4	427	7.8	110	-53.6	49.3	136.6	61.4	550	100

Table A-3: AMD Water Quality Data from SBBC02

Sampling Round	Date	Flow cfs	Hardness T mg/L	MAGNESIUM T mg/L	T SUSP SOLID mg/L	MANGANESE T ug/L	pH	FERROUS IRON ug/L	HOT ACIDITYTY mg/L	CALCIUM T mg/L	SULFATE T mg/L	ALKALINITY mg/L	IRON T ug/L	ALUMINUM T ug/L
1	7/13/2006	10.1	116	7.425	12	442	7.9	130	-46	34.3	79.8	51.8	962	347
2	7/19/2006	3.2	153	10.1	2	429	7.7	80	-47	44.4	113.4	54.6	513	100
3	7/25/2006	4.79	136	8.85	2	447	7.8	100	-43.4	39.7	110.8	49.4	578	100
4	8/1/2006	####	115	6.594	12	404	7.7	190	-50.4	35.1	54.7	58.8	859	205
5	8/8/2006	3.69	168	11.6	22	454	7.8	100	-50.4	47.9	121.5	58	586	100

Table A-4: AMD Water Quality Data from SBBC03

Sampling Round	Date	Flow cfs	Hardness T mg/L	MAGNESIUM T mg/L	T SUSP SOLID mg/L	MANGANESE T ug/L	pH	FERROUS IRON ug/L	HOT ACIDITYTY mg/L	CALCIUM T mg/L	SULFATE T mg/L	ALKALINITY mg/L	IRON T ug/L	ALUMINUM T ug/L
1	7/13/2006	1.27	161	12.6	18	1378	7.5	1040	-24.4	43.8	141.3	33.8	3161	740
2	7/19/2006	0.83	170	13.9	12	1270	7.1	1180	-20.6	45.1	148	26.4	2763	494
3	7/25/2006	1.25	176	14.3	12	1280	7.4	1200	-19.2	46.9	153.6	27.8	2460	445
4	8/1/2006	1.90	146	11.2	12	1134	7.5	520	-30.8	39.8	87.1	38.6	1760	373
5	8/8/2006	0.73	209	17.4	22	1537	7.2	1220	-13.4	54.9	186.2	24.8	2799	518

Table A-5: AMD Water Quality Data from SBBC04

Sampling Round	Date	Flow cfs	Hardness T mg/L	MAGNESIUM T mg/L	T SUSP SOLID mg/L	MANGANESE T ug/L	pH	FERROUS IRON ug/L	HOT ACIDITYTY mg/L	CALCIUM T mg/L	SULFATE T mg/L	ALKALINITY mg/L	IRON T ug/L	ALUMINUM T ug/L
1	7/13/2006	1.76	96	7.074	8	491	7.7	160	-29	26.8	61.9	40	754	251
2	7/19/2006	0.62	120	8.615	6	501	7.5	150	-36.2	33.7	74.5	45.4	844	100
3	7/25/2006	0.93	104	7.41	6	402	7.7	160	-37.8	29.2	78.9	43.2	685	100
4	8/1/2006	2.92	83	5.379	<2	367	7.5	180	-31.6	24.2	46.5	39	786	229
5	8/8/2006	0.77	116	8.169	10	467	7.8	200	-46.2	32.8	62.1	53.6	820	100