Nutrient
Total Maximum Daily Load in Sawmill Run Watershed, Pennsylvania

Established by United States Environmental Protection Agency
Region III
June 30, 2008

....

Jon Capacasa, Director
Water Protection, Region 3

United States Environmental Protection Agency-Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Nutrient
Total Maximum Daily Load in
Sawmill Run Watershed, Pennsylvania

Prepared by

THE Louis Berger Group, INC.
2445 M Street, NW
Washington, DC 20037

June 30, 2008

Table of Contents

List of Figures

List of Tables

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 4 segments of Sawmill Run located in Allegheny County on Pennsylvania's 1996 and 2002 Section 303(d) list.

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

1.2 Impairment Listing

The Sawmill Run watershed is located entirely within Allegheny County in western Pennsylvania. The watershed contains only one major named stream, Sawmill Run. This stream accounts for 46% of the watershed's total stream mileage with the remainder accounted for in unnamed tributaries. The main stem of Sawmill Run begins in the southwestern tip of the watershed and flows northward. Stream orders 1 and 2 account for nearly 72% of the watershed's stream mileage (**Figure 1-1**).

Stream segments in the Sawmill Run watershed (located in Pennsylvania State Water Plan 20F) 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 2002 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 Sawmill Run are presented in **Figure 1-1**, and will be used to describe the impairment listings for these streams.

The full impairment listings for Sawmill Run are discussed below in Section 1.2.1. Stream segments in the watersheds are listed as impaired for nutrients and organic enrichment, metals, and siltation. A previous TMDL established by EPA in April 2007 addressed the metals and siltation impairments. The analyses and results presented in this report establish a nutrient TMDL for Sawmill Run.

1.2.1 Impaired Segment Listings

Four segments of the Sawmill Run (stream code: 37164) were reported on Pennsylvania's 1996 303(d) list as impaired due to nutrients from combined sewer overflow. In addition, these four segments on the mainstem of Sawmill Run were reported on the 1996 303(d) list as impaired due Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) caused by combined sewer overflows.

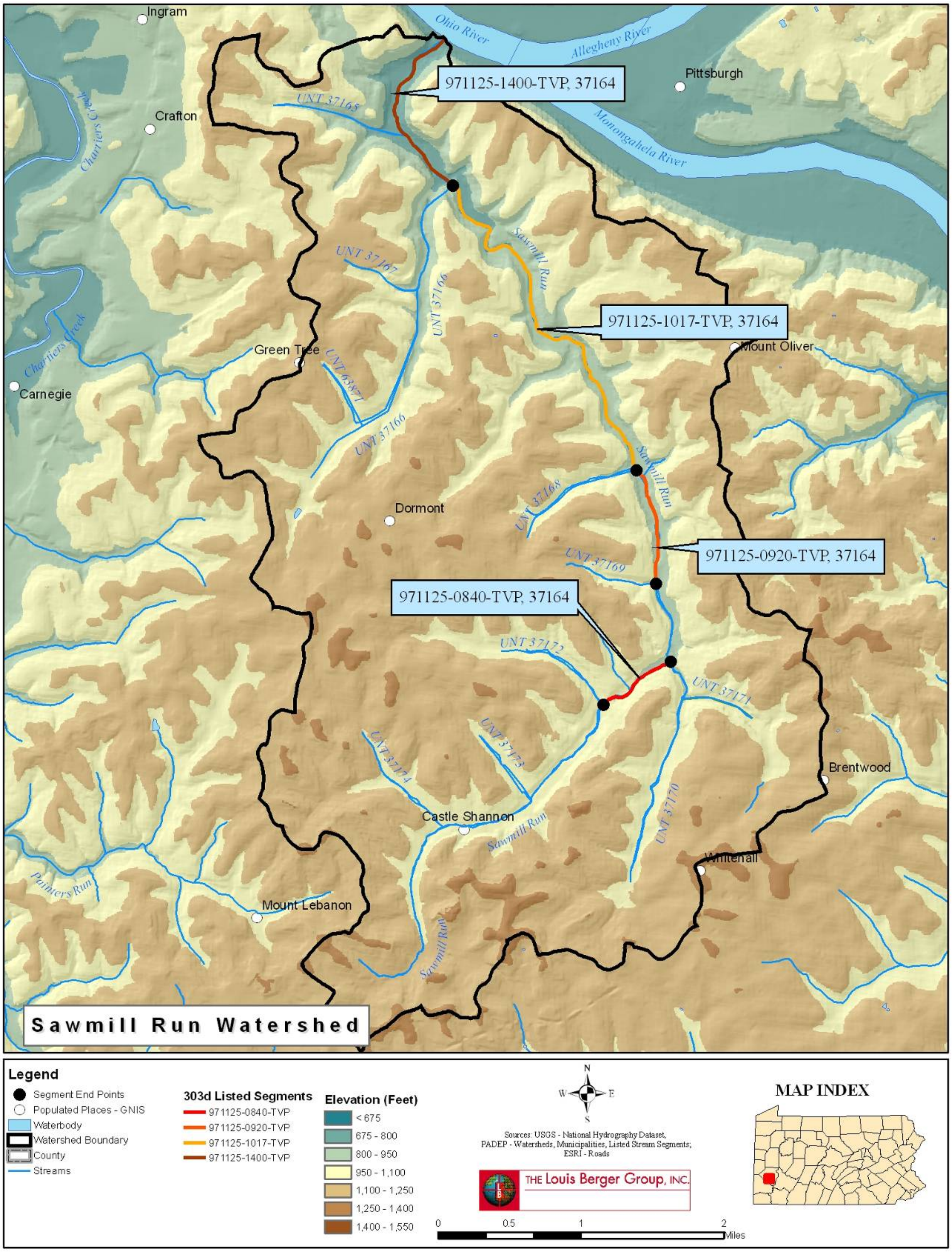


Figure 1-1: Impaired Segments in the Sawmill Run Watershed

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, as well as an antidegradation section. According to Pennsylvania Water Quality Standards, the term *water quality criteria* is 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 (25 PA Code Chapter 93, specifically § 93.3) designate water uses that 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 uses 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 fishes that 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 of 303(d) Listed Segments

303(d) Listed Segment (Assessment ID, Stream Code)	Stream Name	303(d) Impairment	Source of Impairment	Original Listing Year
971125-0840-TVP, 37164	Sawmill Run	Nutrients	Combined Sewer Overflow	1996
971125-0920-TVP, 37164	Sawmill Run	Nutrients	Combined Sewer Overflow	1996
971125-1017-TVP, 37164	Sawmill Run	Nutrients	Combined Sewer Overflow	1996
971125-1400-TVP, 37164	Sawmill Run	Nutrients	Combined Sewer Overflow	1996
WWF: Warm Water Fishes				

1.3.2 Water Quality Criteria

General Criteria

The General Criteria defined in Pennsylvania's Water Quality Standards (25 PA Code §93.6) provides narrative water quality criteria necessary to protect designated uses from substances that may interfere with their attainment. 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, ordors, turbidity or settle to form deposits."*

Dissolved Oxygen Criteria

Pennsylvania has developed specific water quality criteria (25 PA Code §93.7) for dissolved oxygen. These specific water quality criteria state:

"For flowing waters, minimum daily average 6.0 mg/l; minimum 5.0 mg/l. For lakes, ponds, and impoundments, minimum 5.0 mg/l.

In waters for warm water fish (WWF),

Minimum daily average 5.0 mg/l; minimum 4.0 mg/l.

Nutrient Criteria

Pennsylvania has developed specific water quality criteria (25 PA Code §93.7) for nitrate plus nitrite to protect drinking water uses, and ammonia to protect aquatic life uses from the toxic effects of ammonia. These specific water quality criteria state:

"Nitrate plus nitrite concentrations may not exceed 10 mg/L as nitrogen for waters used for potable water supply. Potable Water Supply constitutes water used by the public 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), or the act of June 24, 1939 (P. L. 842, No. 365) (32 P. S. § § 631—641), after conventional treatment, for drinking, culinary and other domestic purposes, such as inclusion into foods, either directly or indirectly."

And

"The maximum total ammonia nitrogen concentration at all times shall be the numerical value given by un-ionized ammonia nitrogen (NH3-N) x (log-1[pKT-pH] + 1), where:

un-ionized ammonia nitrogen = 0.12 x f(T)/f(pH), f(pH) = 1 + 101.03(7.32-pH), f(T) = 1, T ≥ 10°C, f(T) = (1 + 10(9.73-pH)) / (1 + 10(pKT-pH)), T ‹ 10°C, , and pKT = 0.090 +[2730 / (T+273.2)], the dissociation constant for ammonia in water."

*"The average total ammonia nitrogen concentration over any 30 consecutive days shall be less than or equal to the numerical value given by: un-ionized ammonia nitrogen (NH3-N) * (log-1[pKT-pH] + 1), where:*

un-ionized ammonia nitrogen = 0.025 x f(T)/f(pH), f(pH) = 1, pH ≥ 7.7, f(pH) = 100.74(7.7pH),

pH ‹ 7.7, f(T) = 1, T ≥ 10°C, f(T) = (1 + 10(9.73-pH))/(1 + 10(pKT-pH)), T ‹ 10°C"

Pennsylvania has not yet established numeric water quality criteria for nutrients to address other impairments of aquatic life, recreation or esthetic uses. In the absence of specific water quality criteria, the General Criteria defined by Pennsylvania provides narrative criteria for the protection of a waterbody's designated uses. Later sections of this report will describe EPA's interpretation of Pennsylvania's narrative criteria for purposes of TMDL development.

1.4 TMDL Development for Sawmill Run

Part of the TMDL development process includes 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 aquatic life uses. This report addresses the nutrient impairments and establishes the nutrient TMDL for Sawmill Run.

In the subsequent sections of this report, watershed and environmental monitoring data used in TMDL development for Sawmill Run is discussed and analyzed. Sources of the nutrient impairment in the watershed are also described and analyzed. After reviewing the available watershed and environmental monitoring data, a technical approach was developed and used to estimate loading rates from nutrients and to quantify the load reductions necessary to obtain designated uses for Sawmill Run.

The nutrient TMDL endpoint is outlined in Section 4.0 and the approach used to develop the allocation is described in Section 5.0 of this report. Reasonable assurance and implementation for the TMDL is discussed in Section 6.0, and the public participation process in Section 7.0.

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 uses 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 Sawmill Run 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
- State Soil Geographic Database (STATSGO)– 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 Sawmill Run drainage area is approximately 12,432 acres, or 19 square miles, and is located entirely within Allegheny County in western Pennsylvania **(Figure 2-1)**. The main stem of Sawmill Run begins in the southern tip of the watershed and flows north through the boroughs of Bethel Park, Castle Shannon, Mount Oliver, and the city of Pittsburgh. At the northern end of the watershed, Sawmill Run flows into the Ohio River, downstream of the confluence of the Allegheny and Monongahela Rivers.

Major transportation routes in the vicinity of the watershed include: Interstate 279 and State Route 60, which follow an east to west orientation through the upper third of the watershed; State Route 51, which enters from the southern portion of the watershed and follows the mainstem of Sawmill Run until it joins US Highway 19; US Highway 19, which splits upon entering the watershed and merges again to follow the tailwaters of the main stem; State Route 88, which follows headwaters of Sawmill Run before joining State Route 51; and State Route 121 which follows a path roughly parallel to the western border of the watershed before joining Interstate 279 **(Figure 2-1).**

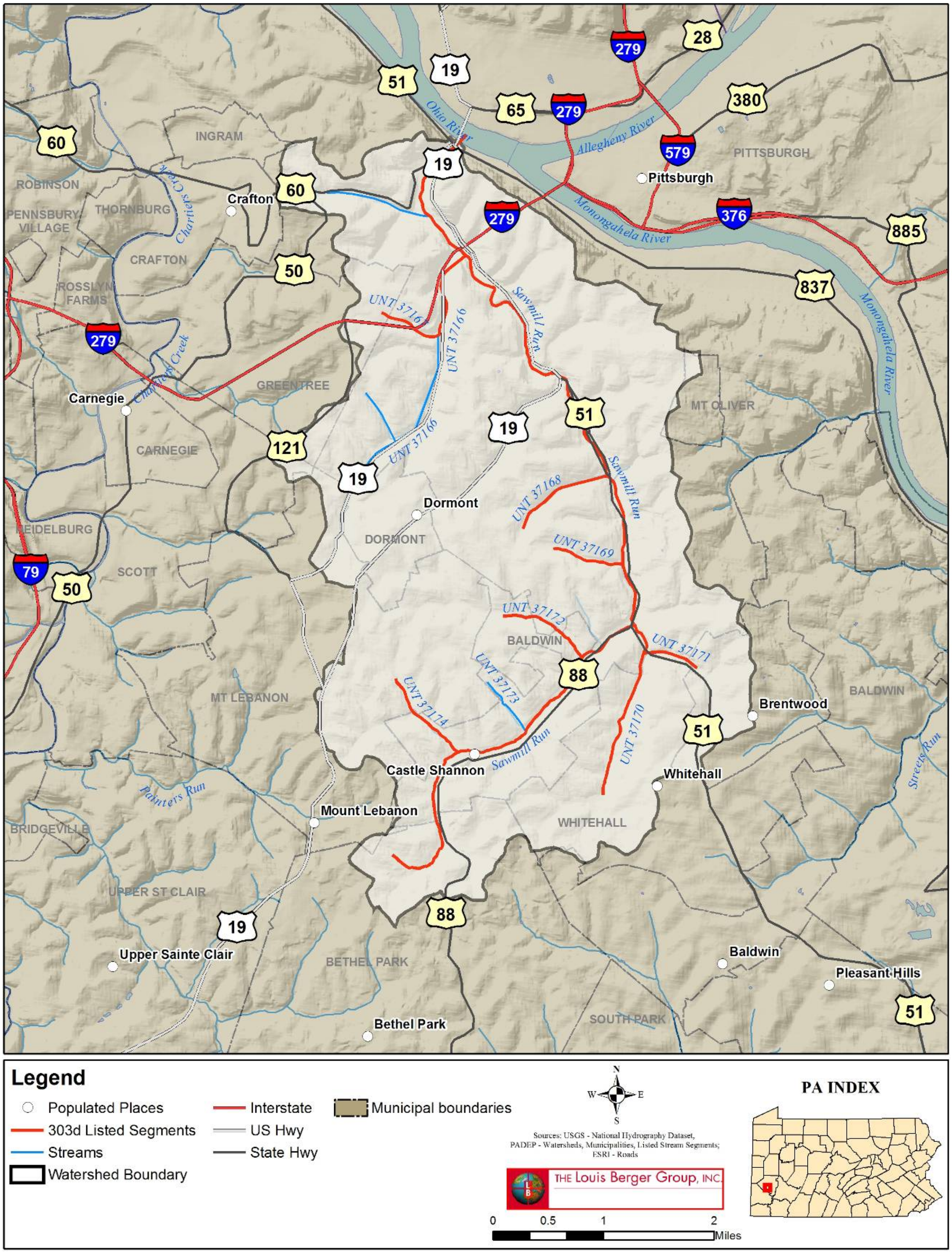


Figure 2-1. Sawmill Run Vicinity Map

2.1.2 Stream Network

The stream network for Sawmill Run was mapped and analyzed using GIS data provided by PADEP (**Figure 2-2**). Based on this data, there are 20 miles of stream in the watershed, approximately 16.3 miles of which are impaired and listed on either the 1996, 1998, or 2002 303d list. The listed segments consist of the mainstem of Sawmill Run and 8 of the 11 unnamed tributaries in the Sawmill Run watershed.

The Sawmill Run watershed contains only one major named stream, Sawmill Run. This stream accounts for 46% of the watershed's total stream mileage with the remainder accounted for in unnamed tributaries **(Table 2-2)**. The main stem of Sawmill Run begins in the southwestern tip of the watershed and flows northward. Stream orders 1 and 2 account for nearly 72% of the watershed's stream mileage **(Table 2-1)**.

Table 2-1: Streams Mileage by Stream Order in the Sawmill Run Watershed

Stream Order	Length (miles)
1	10.0
2	4.4
3	5.6
Total	**20.0**

Table 2-2: Major Tributaries in Sawmill Run Watershed

Name	Length (miles)
Sawmill Run	9.3
UNT 37165	1.0
UNT 37166	2.5
UNT 37167	0.6
UNT 37168	1.0
UNT 37169	0.7
UNT 37170	1.7
UNT 37171	0.5
UNT 37172	0.9
UNT 37173	0.6
UNT 37174	0.9
UNT 63871	0.5
Total	**26.7**

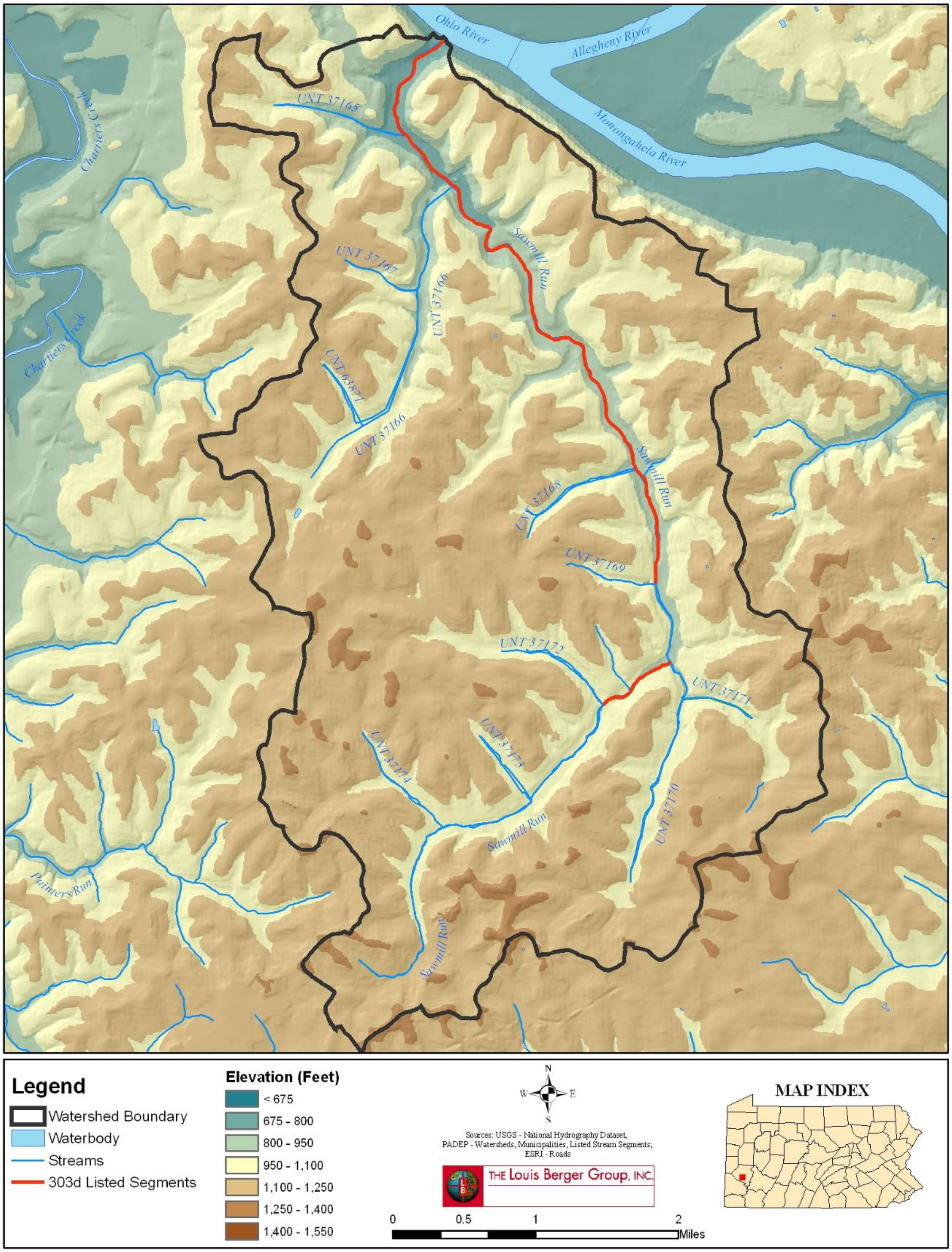


Figure 2-2: Stream Network and Topography of the Sawmill Run Watershed

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 714 to 1,316 feet above mean sea level with an average elevation of 1,112 feet.

Table 2-3: Percent Slope Classes in the Sawmill Run Watershed by Proportion

Slope Classes	Acres	Proportion of Watershed
0-5%	1,011	8.1%
5-10%	2,585	20.8%
10-25%	6,509	52.4%
25-50%	2,051	16.5%
50-100%	272	2.2%
>100%	5	<0.1%
TOTAL	12,432	100.0%

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) were as high as 150%, with the average slope in the watershed approximately 17%. Slope classes in the watershed are presented in **Table 2-3**.

2.1.4 Soils

There was no detailed county level soil survey data for Allegheny County available at the time of this characterization. As a result, state level soil characterization data from the State Soil Geographic (STATSGO) dataset, was used in the following characterization of soil conditions. STATSGO data is prepared by delineating generalized map unit areas that show similar combinations of soil types in reasonably predictable proportions.

Four STATSGO soil map units were found in the Sawmill Run watershed (**Figure 2-3**). The first is dominated by the Dormont, Culleoka, and Guermsey soil series which are all considered very deep, well drained, moderately slow permeable soils. This map unit is only found in a small portion of the southern tip of the watershed. The second soil map unit is dominated by the Gilpin, Dormont, and Culleoka series. The Gilpin soil series are moderately deep, well drained soils formed from nearly horizontal interbedded shale, siltstone, and some sandstone. This map unit occurs primarily in the upper third of the watershed. The third soil map unit in the watershed is only found in the northeast edge of the watershed, and is comprised predominately of areas delineated as urban, i.e. areas of disturbed or highly modified soils. The soil series of next highest proportion in this map unit include the Monongahela soil series, which consists of very deep, moderately well drained soils formed in old alluvium derived from acid sandstone and shale, and the Rainsboro soil series, which are very deep, moderately well drained soils that formed in loess. The fourth map unit, which is the most dominant in the watershed, consists of areas delineated as urban as well as the Culleoka and Guernsey soils series. **Table 2-4** lists the STATSGO soil map units found in the watershed.

Table 2-4: STATSGO Soil Map Units in the Sawmill Run Watershed

Map Unit ID	Soil Associations	Hydrologic Groups	Acres	Proportion of Watershed
PA040	Dormont/Culleoka/Guernsey	B/C	63	< 1%
PA041	Gilpin/Dormont/Culleoka	C	2,118	17%
PA045	Urban Land/Monongahela/Rainsboro	C	364	3%
PA047	Urban Land/Culleoka/Guernsey	B/C	9,887	80%
Totals			**12,432**	**100%**

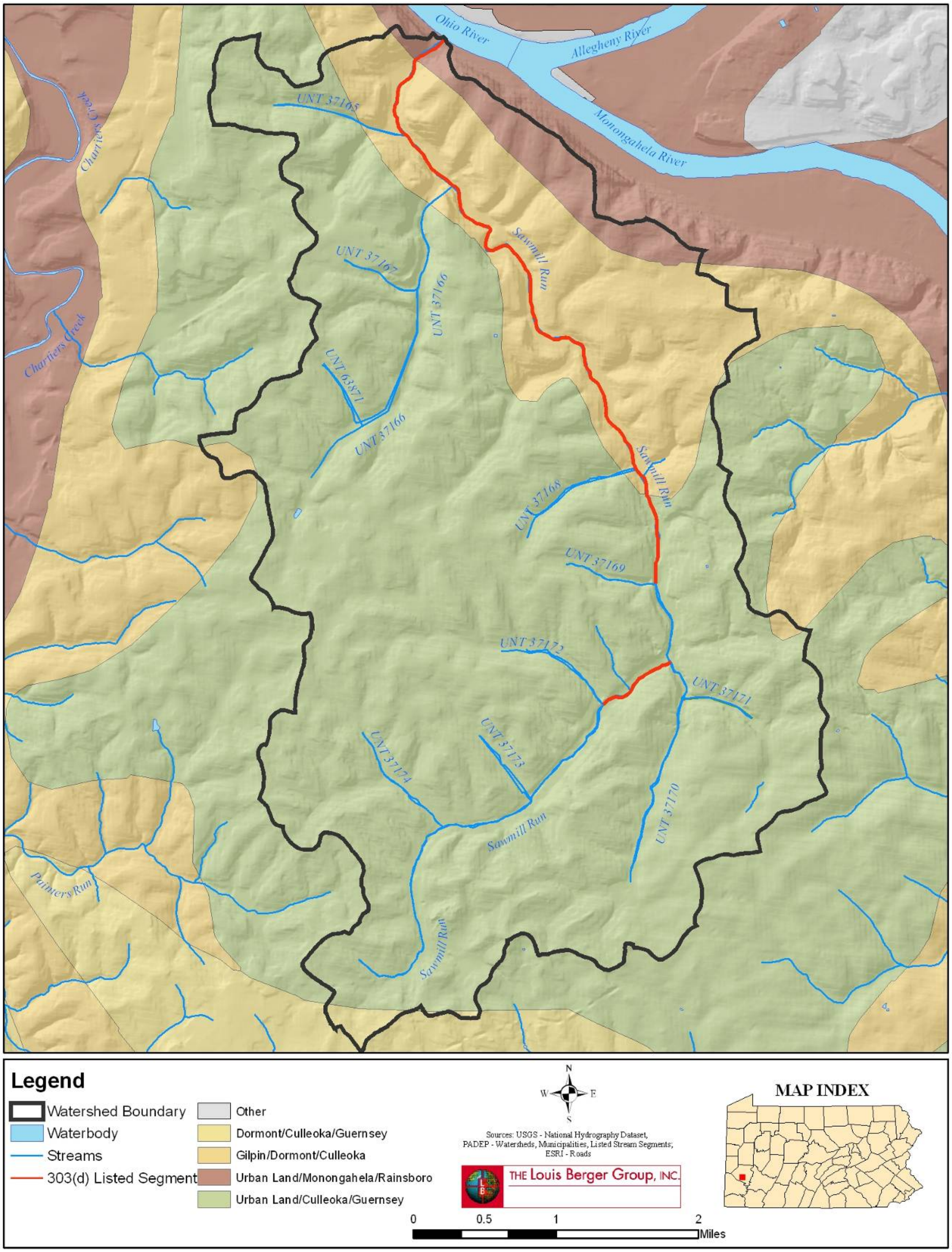


Figure 2-3. STATSGO Soil Map Units in the Sawmill Run Watershed

The hydrologic soil groups represent different levels of soil infiltration capacity as described in **Table 2-5**. Hydrologic soil group "A" designates soils that are well to excessively well drained, whereas hydrologic soil group "D" designates soils that are poorly drained. This means that 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.

Table 2-5: Descriptions of Hydrologic Soil Groups

Hydrologic Soil Group	Description
A	High infiltration rates. Soils are deep, well drained to excessively drained sand and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well-drained soils with moderately coarse textures.
C	Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures.
D	Very slow infiltration rates. Soils are clayey, have high water table, or shallow to an impervious cover
B/C	Combination of Soil Group B and C

2.1.5 Land Use

Land use characterization was based on 2001 National Land Cover Data (NLCD) developed by USGS. The distribution of land uses in the Sawmill Run watershed denoted by land area and percentage is presented in **Table 2-6**. Developed areas cover the majority of the watershed (89%). The majority of the remaining watershed area is dominated by deciduous forest (10%). **Figure 2-4** displays a map of the land uses within the Sawmill Run watershed. Brief descriptions of land use categories are presented in **Table 2-7.**

Table 2-6: Sawmill Run Watershed Land Use Distribution

General Land Use Category	NLCD Land Use Type	Acres	Percent of Watershed	Total Percent
Water/Wetlands	Open Water	<1	< 0.1%	< 0.1%
	Emergent Herbaceous Wetlands	<1	< 0.1%	
Developed	Developed, Open Space	3,209	26%	89%
	Developed, Low Intensity	4,684	38%	
	Developed, Medium Intensity	2,575	20%	
	Developed, High Intensity	701	5%	
Grassland	Grassland/Herbaceous	25	< 0.1%	< 0.1%
Forest	Deciduous Forest	1,228	10%	10%
	Evergreen Forest	7	< 0.1%	
	Mixed Forest	3	< 0.1%	
Total		**12,432**	**100%**	**100%**

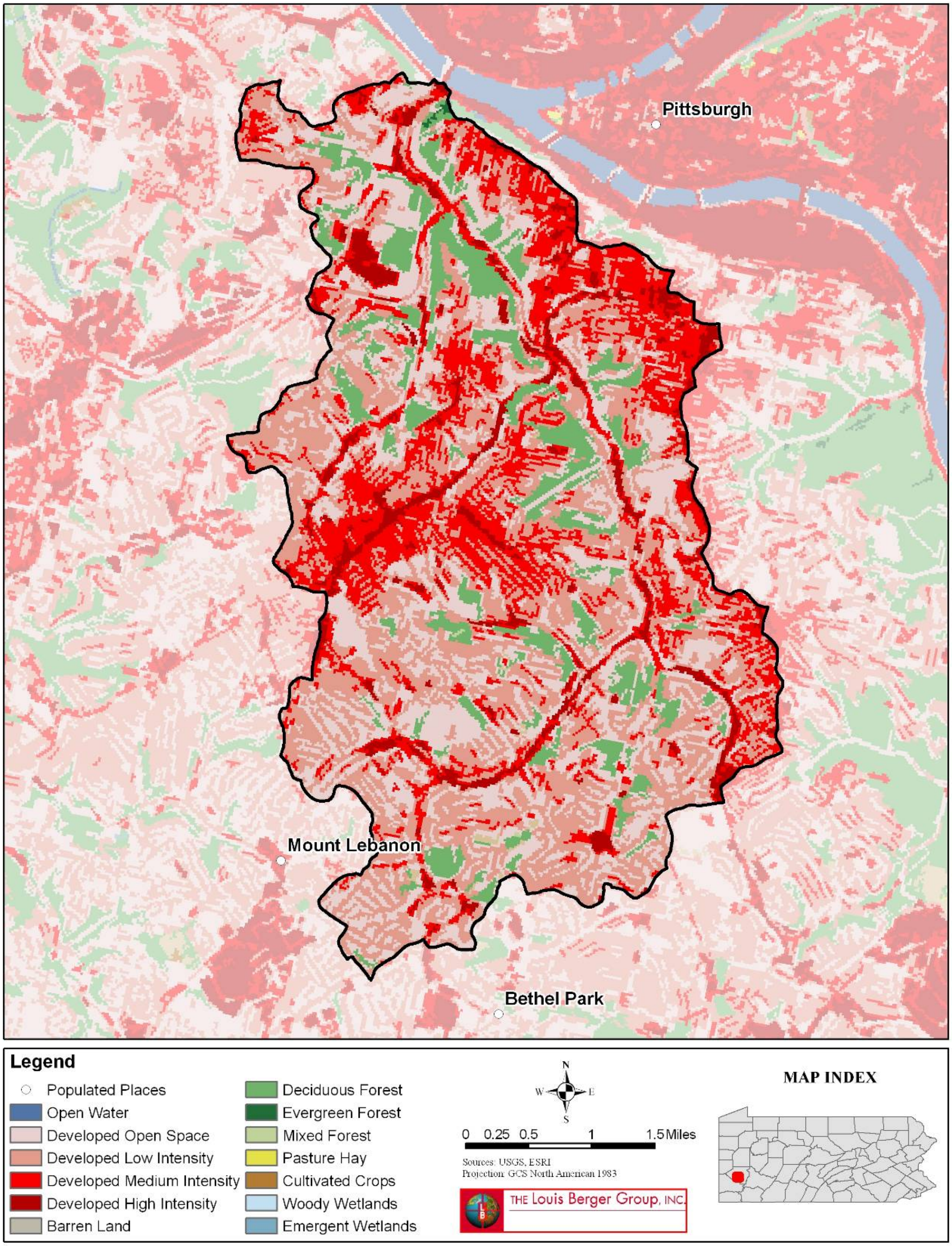


Figure 2-4. Land Use in the Sawmill Run Watershed

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 Sawmill Run watershed is located within the Monongahela Transition Zone and Pittsburgh Low Plateau ecoregions (**Figure 2.5**; Level IV Ecoregions, classification numbers 70b and 70c respectfully; Woods et al., 1999). About 99% of the watershed is located in the Monongahela Transition Zone ecoregion (12,246 acres), with the remaining area in the Pittsburgh Low Plateau ecoregion (186 acres). The following ecoregion descriptions are taken from Woods, Omernik, and Brown (1999).

The Monongahela Transition Zone ecoregion is made up of unglaciated hills, knobs, and ridges which are typically underlain by interbedded limestone, shale, sandstone, and coal of the Monongahela Group. There are occurrences of entrenched rivers, gently dipping strata, and land slips in this ecoregion. Today, forests are extensive and urban, suburban, and industrial activities are found in the river valleys that also serve as transportation corridors. Bituminous coal mining is common and some oil production occurs. The boundary between ecoregions 70b and 70c generally follows the geologic division between the limestone-bearing Monongahela Group and the noncarbonate Conemaugh Group.

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 both lower and less forested than neighboring ecoregions. The average annual growing season length varies inversely with elevation. 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 re-leveled but their soils are not always satisfactory for cultivation.

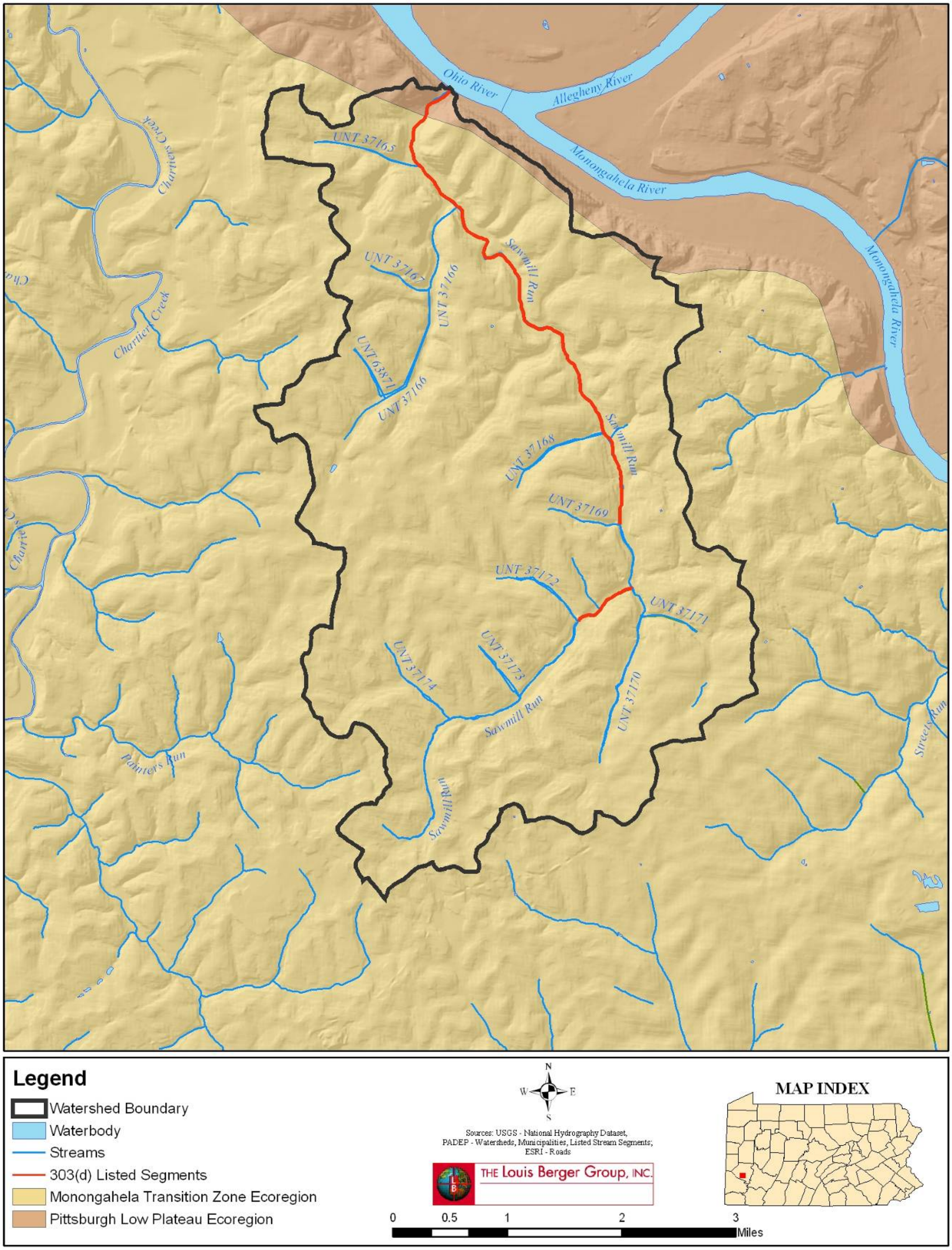


Figure 2-5. Ecoregions in the Sawmill Run Watershed

2.2 Monitoring Data

Before 2006, there was no available ambient or biological water quality monitoring data for the watershed from either the PADEP or the United States Geological Survey (USGS). The EPA's BASINS database listed one monitoring station established by the Allegheny County Department of Health (Station ID ACHDNET938). However, the data for this station could not be located in the EPA's databases. Some water quality monitoring has been conducted by the 3 Rivers 2nd Nature project.

2.2.1 Pennsylvania Department of Environmental Protection

In 2006, PADEP collected water quality data in the Sawmill Run watershed to identify the nutrient load under baseflow and high flow conditions. A total of seven instream sampling stations were selected for collecting nutrients and other parameters in the Sawmill Run watershed (**Figure 2-6**). The stations were selected based on the impaired segments, a review of potential pollutant sources and their spatial distribution. Descriptions of the water quality sampling stations are in **Table 2-8**.

Table 2-8: Instream Water Quality Sampling Stations for Nutrient/Low DO

Sample Station	Waterbody	Description
SMR_01	Sawmill Run	Upstream of confluence with Ohio River
SMR_02	Sawmill Run	Downstream of UNT 37168 at the Armory
SMR_05	UNT 37170	Upstream of confluence with Sawmill Run; behind Pharmacy Eckerd
SMR_06	Sawmill Run	Upstream of confluence with UNT 3717
SMR_07	Sawmill Run	Upstream of confluence with UNT 37173 at Aruba Tan

To identify the sources of nutrient and low DO under dry weather, water quality data were collected on two occasions (August 8 and September 18 in 2006, respectively).

To identify the sources of nutrient and low DO under wet weather, water quality data were collected at the mouth (SMR_01) on one occasion (October 17, 2006).

In addition, continuous diurnal DO, temperature, specific conductivity, and pH measurements were taken at SMR_01, SMR_02, SMR_06, and SMR_07 between August

8 and 10, 2006 and at SMR_01, SMR_03, SMR_06, and SMR_07 between September 18 and 20, 2006.

Section 3 provides a more detailed description and results of these sampling events. Appendix A provides the complete data set used for completing the Nutrient TMDLs.

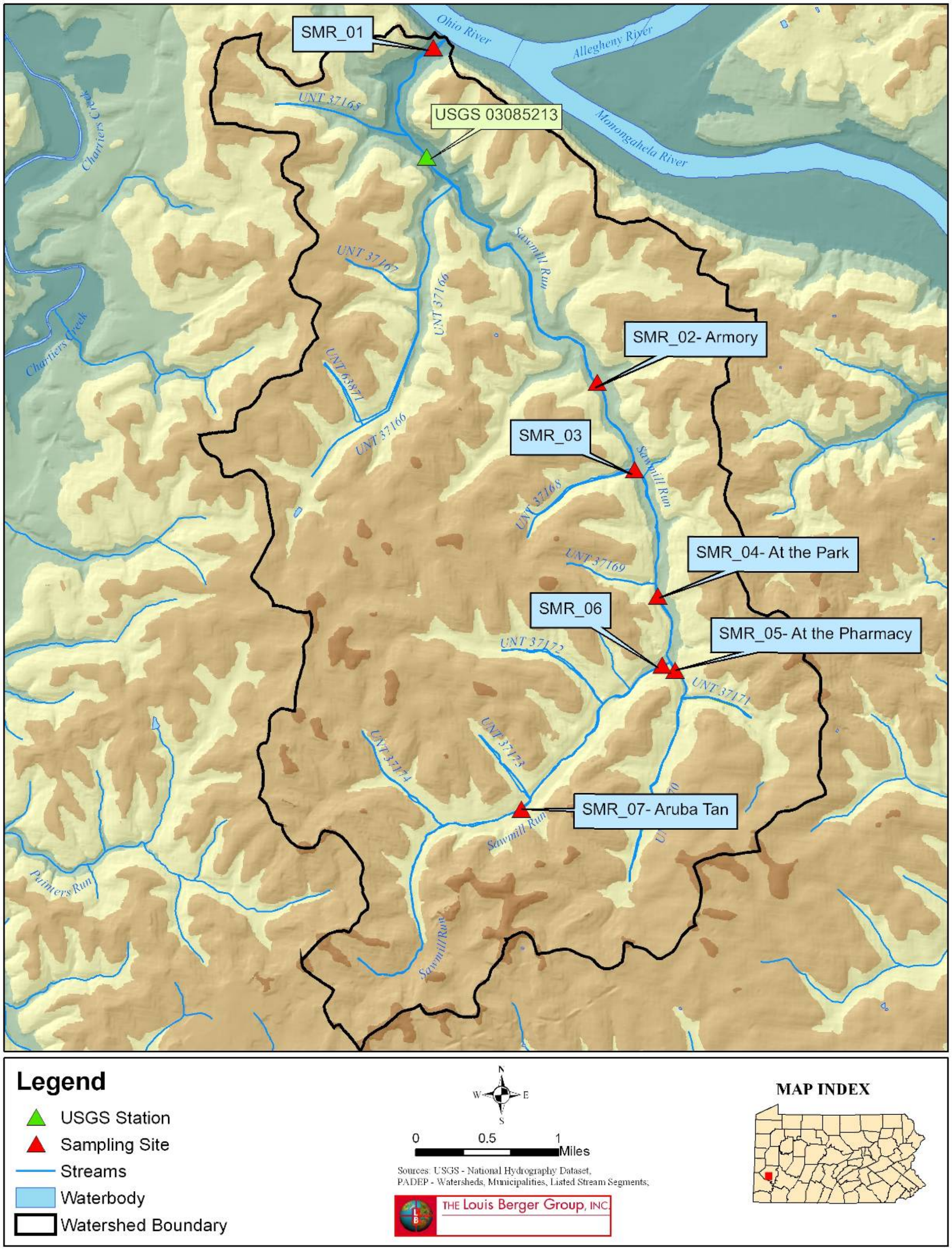


Figure 2-6. Location of PADEP Sampling Sites

Supplementary Data Sources

The 3 Rivers 2nd Nature project conducted various field studies in the region surrounding Pittsburgh with a focus on the major rivers (the Ohio, Allegheny, and Monongahela) and the 53 streams that flow into and through Allegheny County. The project examined water quality and urban riverbanks. **Table 2-9** presents the available water quality data from the 3 Rivers 2nd Nature project.

Table 2-9: 3 Rivers 2nd Nature Project Monitoring Sites

Station	Location	Type	Parameters Tested	Collection Period(s)	Number of Samples
SM01	Sawmill Run	Ambient and Biological	Temp, pH, DO Conductivity, Turbidity, Iron, Total Coliform, E. Coli, Enterococci, Fecal Coliform, Ammonia, Total Dissolved Solids, Alkalinity, Hardness,	6/2000, 7/2000, 8/2000, 10/2000 5/2001*	5

* Biological sampling only

2.2.2 Permitted Discharge Facilities

Based on data obtained from the EPA's online Permit Compliance System (PCS) database and Discharge Monitoring Records (DMR) records from PADEP, there are currently six discharge permits in the Sawmill Run watershed. These discharge permits are associated with construction or stormwater. The permit number, type, permitted flow, receiving waterbody, and status of each permit are presented in **Table 2-10**. Permitted discharge locations are presented in **Figure 2-7**.

Table 2-10: Facilities Holding Individual Permits in the Sawmill Run Watershed

Permit Number	Discharger Name	Category	Design Flow (gpd)	Receiving Waterbody	Status
PAR806118	Laid Law Transit Services	-	-	Sawmill Run	Active
PAR236126	Parker Plastics Corporation	-	-	-	Active
PAG056102	Cumberland Farms Inc	-	-	Sawmill Run	Active
PAR226108	Lozier Corporation	-	-	Sawmill Run - Tri Ohio & Monongahela	Active
PAG056204	Pit Stop Express	-	-	-	Active
PAR806194	PA National Guard	-	-	-	-

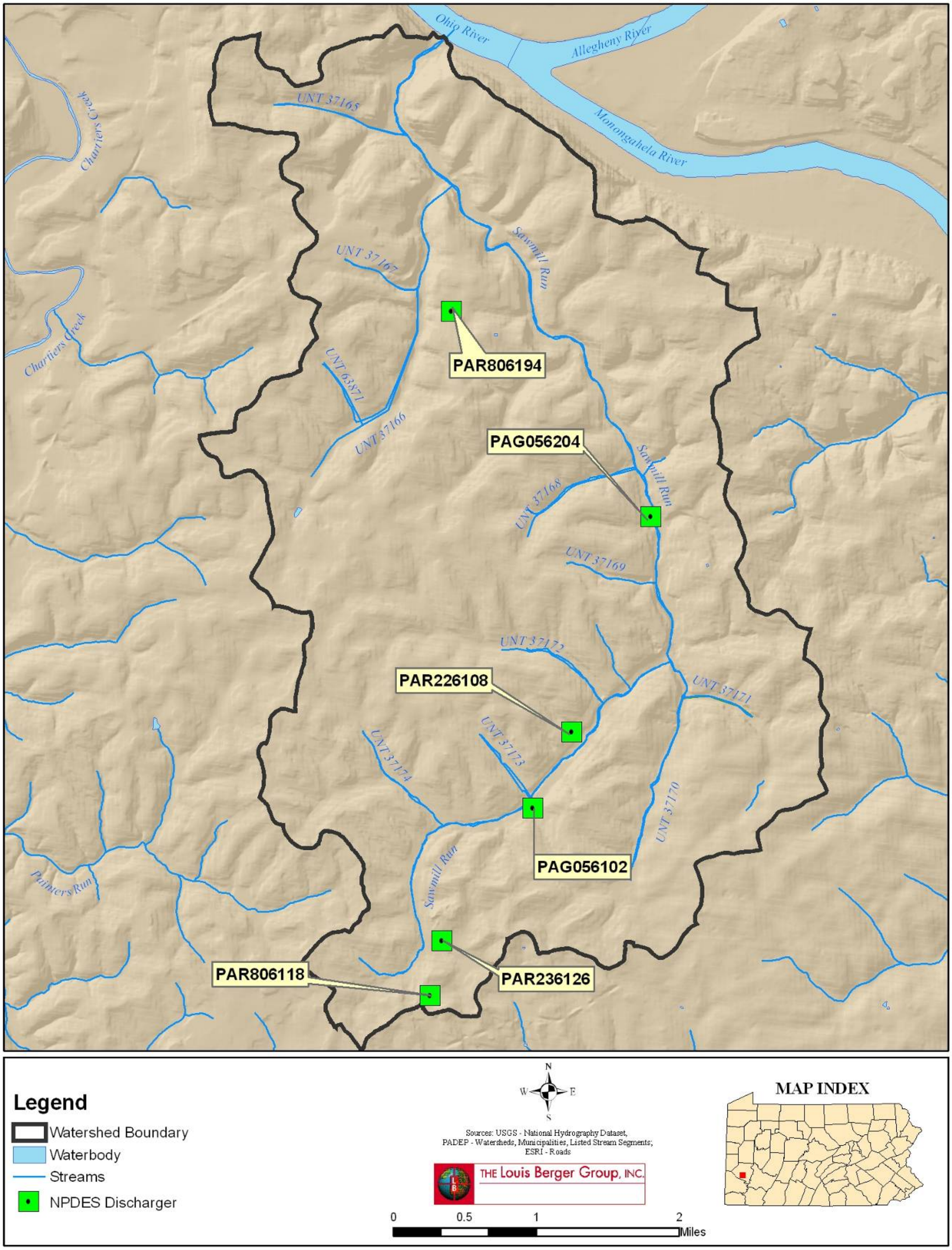


Figure 2-7. Discharge Locations in the Sawmill Run Watershed

In addition to the individual and general permits presented above, there are 12 Municipal Separate Storm Sewer (MS4) permits that have been issued to Municipalities within the Sawmill Run Watershed. **Table 2-11** lists all the MS4 permit holders with the area covered by each individual MS4. The MS4 areas were calculated using the US Census Urban Areas (2000). These MS4 areas comprise 46% of the total watershed area. **Figure 2-8** presents the major MS4 areas located within the Sawmill Run watershed.

Table 2-11: MS4 Permits located within the Sawmill Run Watershed

MS4 Permit Holder	Acres
Baldwin Borough	6
Baldwin Township	318
Bethel Park Borough	612
Brentwood Borough	378
Castle Shannon Borough	1,003
Dormont Borough	491
Green Tree Borough	292
Ingram Borough	2
Mt. Lebanon Township	1,483
Mt. Oliver Borough	29
Scott Township	39
Whitehall Borough	1,114
Total	**5,767**

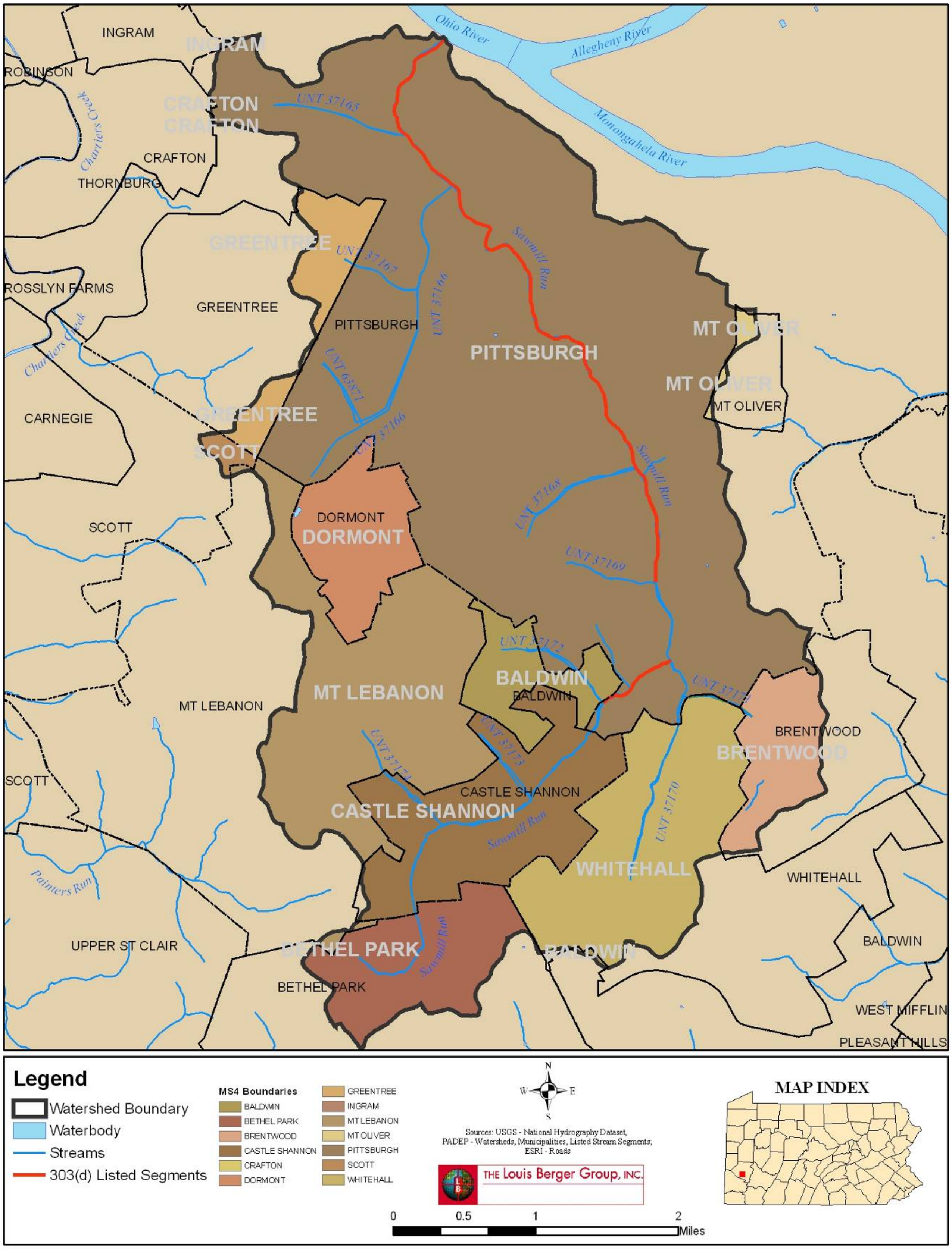


Figure 2-8. Approximate MS4 Boundaries in the Sawmill Run Watershed

2.3 Natural Resource Extraction

Based on data obtained from the Pennsylvania Spatial Data Access (PASDA) database, there is one mining operation within the Sawmill Run watershed that is now inactive and 10 identified abandoned mine lands (**Figure 2-9**). The inactive mining operation was managed by the Port Authority of Allegheny County and was permitted for LRT coal removal. Reclamation of the mine has been completed, though there was no record of when this occurred.

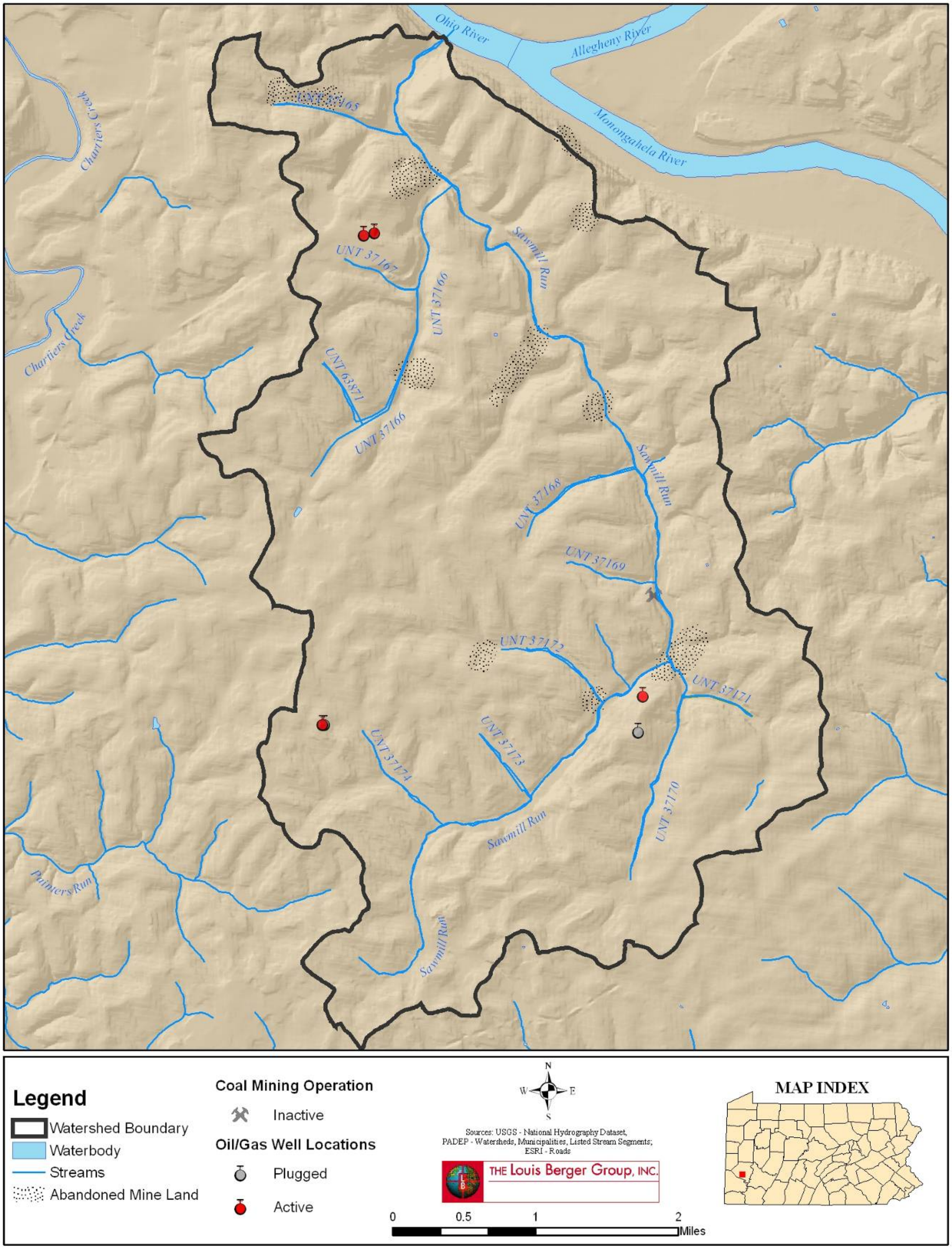


Figure 2-9. Mining/Drilling Activities in the Sawmill Run Watershed

2.4 Combined Sewer Overflows

Based on GIS data provided by the Pittsburgh Water and Sewer Authority (PWSA), there are a total of 47 combined sewer overflow (CSO) outfalls in the Sawmill Run watershed. 28 of these CSO outfalls are associated with the Allegheny County Sanitary Authority (ALCOSAN), while the remaining 19 outfalls are associated with the PWSA.

Currently, there is no information characterizing the volume or concentrations from these outfalls.

Figure 2-10 provides the location of these CSO outfalls in the watershed.

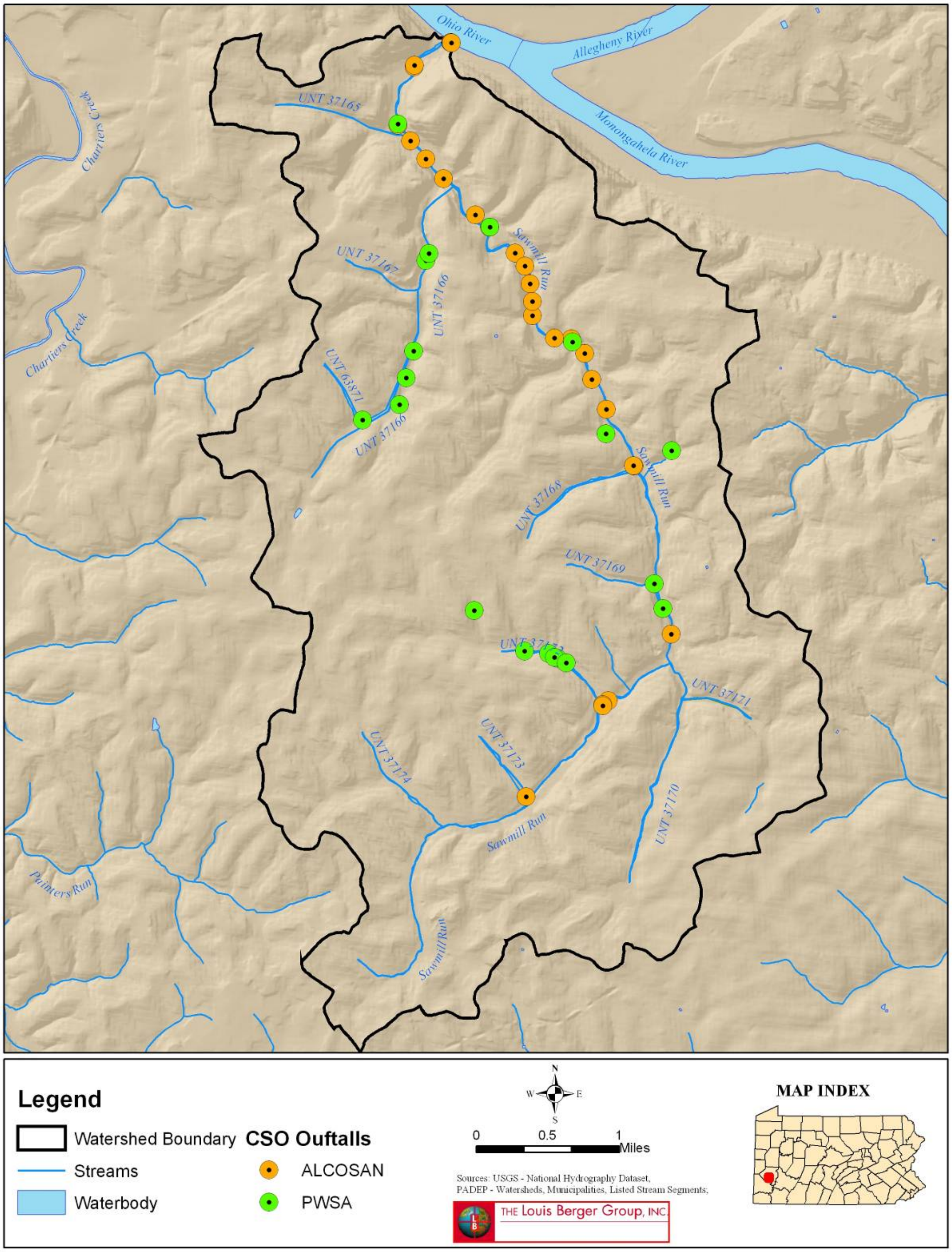


Figure 2-10. CSO Outfall Locations in the Sawmill Run Watershed

3.0 Environmental Monitoring

Environmental monitoring efforts in the Sawmill Run watershed include biological monitoring and ambient water quality data. Monitoring efforts within the watershed have been conducted by PADEP and 3 Rivers 2nd Nature. The following sections will summarize and present the available monitoring data used in TMDL development.

3.1 Pennsylvania Department of Environmental Quality Data

3.1.1 Ambient Water Quality Monitoring under Dry Weather Conditions

PADEP conducted water quality sampling on five occasions (four times in August 2006 and once in September 2006) at four stations under base, low flow, and high flow conditions. Samples were assessed for the following field and chemical water quality parameters: temperature, DO, pH, specific conductivity, total alkalinity, total hardness, alkalinity, sulfate, total dissolved solids (TDS), total suspended solids (TSS), carbonaceous biochemical oxygen demand over five and 20 days ($CBOD_5$ and $CBOD_{20}$), total organic carbon (TOC), ammonia, nitrite, nitrate, total nitrogen (TN), dissolved ortho-phosphorus, total ortho-phosphorus, dissolved phosphorus, total calcium, and total phosphorus (TP). In addition, samples were also analyzed for total metals (aluminum, magnesium, iron, and manganese). All sample measurements were assessed relative to Pennsylvania's established water quality standards.

A bulleted summary of the data derived from all in-stream monitoring data collected by PADEP within the Sawmill Run watershed is listed below. It should be noted that the unnamed tributary 37170 observed at station SMR_05 showed generally different results in comparison to samples collected on the Sawmill Run mainstem.

- TDS concentrations sampled at the majority of stations violated the maximum criteria of 750 mg/L (average: 858; range: between 1.05 and 1208 mg/L). The highest concentration was found at SMR_05 located on UNT 37170.

- TSS concentrations were on average 8.9 mg/L in the mainstem (range: 1.0 – 22 mg/L) and 36 mg/L in UNT 37170.
- Carbonaceous BOD_5 and BOD_{20} were on average 1.95 and 1.79 mg/L in the mainstem (range: 1.2 – 2.8 mg/L and 0.1 – 5.0 mg/L) and 10.8 and 13.1 mg/L in UNT 37170.
- TN and NO_3-N concentrations measured within the mainstem were on average at 1.06 and 0.71 mg/L and in UNT 37170 at 2.11 and 0.27 mg/L (**Figure 3-1**).

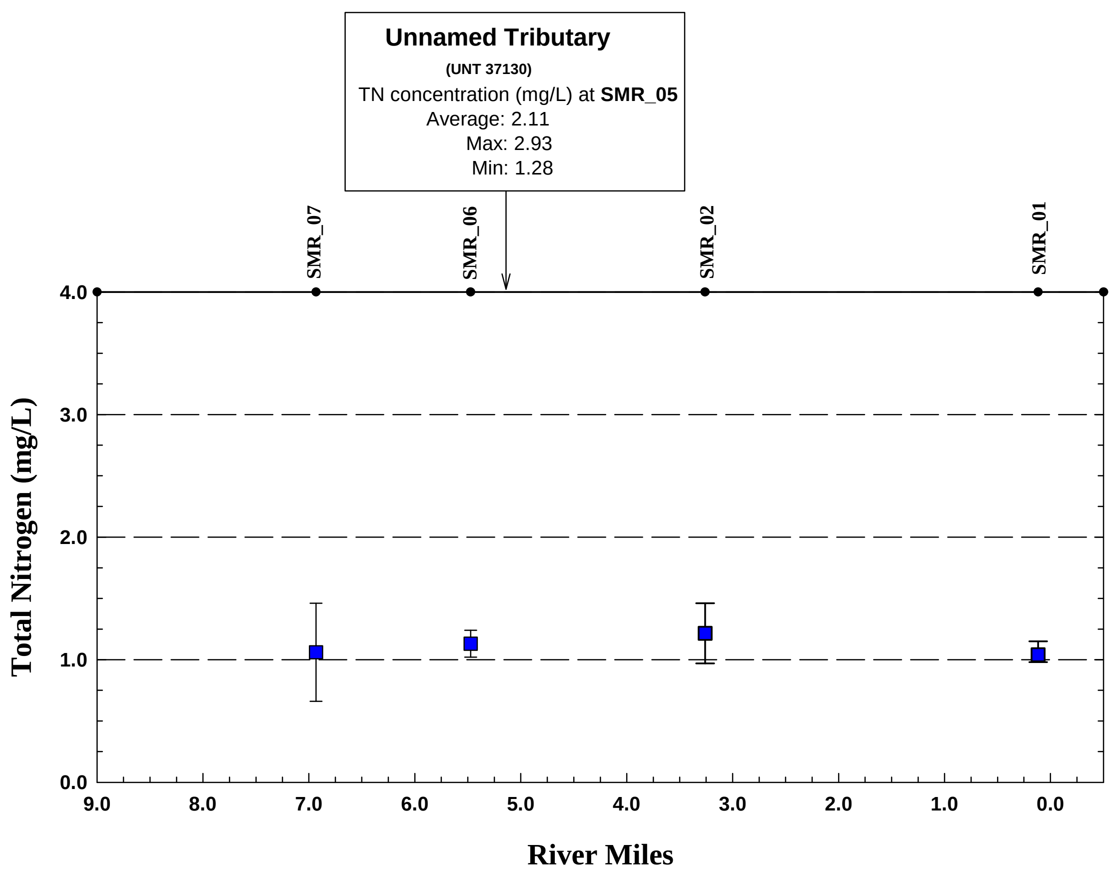


Figure 3-1 Maximum, Average, and Minimum Concentration for Total Nitrogen (TN) at stations on Sawmill Run

- TP and dissolved PO_4-P concentrations measured within the mainstem were on average at 0.04 and 0.03 mg/L and in UNT 37170 at 0.119 and 0.01 mg/L (**Figure 3-2**).

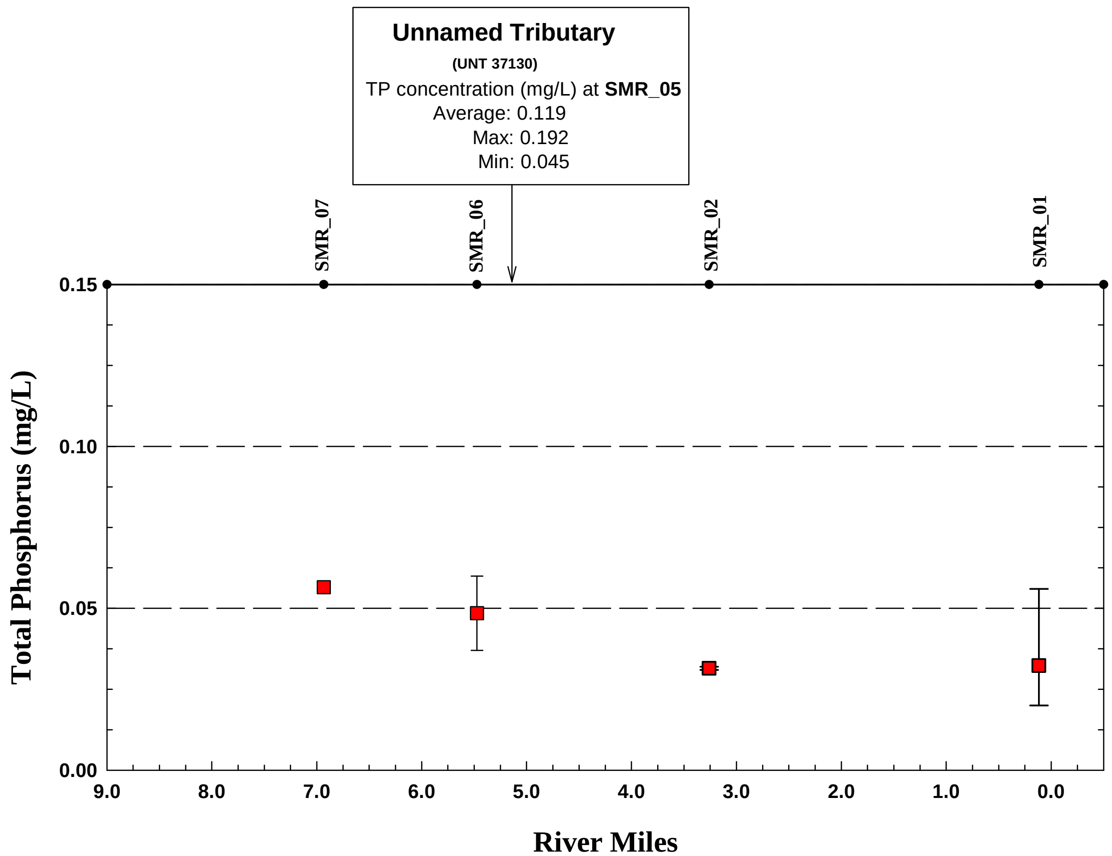


Figure 3-2 Maximum, Average, and Minimum Concentration for Total Phosphorus (TP) at stations on Sawmill Run.

- Alkalinity concentrations were on average 85.8 mg/L in the mainstem and never exceeded the PA standard of 20 mg/L. In contrast, the PA standard for alkalinity was violated in six out of seven sampling events at SMR_05 (average: 9.6 mg/L; range: 0.0 - 37.4 mg/L).

➢ Sulfate levels exceeded the maximum standard of 250 mg/L on eight occasions (twice at SMR04 and SMR03, respectively, and four times at SMR_05 on UNT 37170). No exceedances were found at the most upstream station (SMR06). The maximum, average, and minimum concentration for sulfate at each station is shown in **Figure 3-3**.

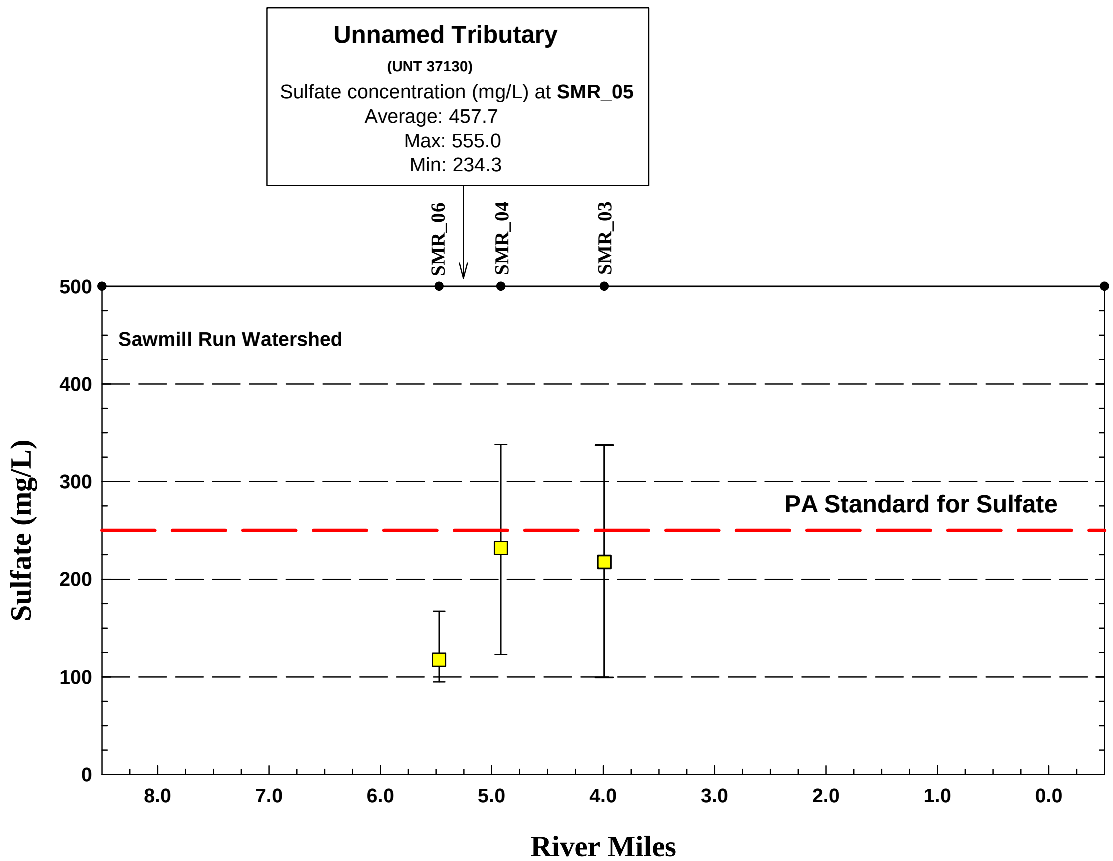


Figure 3-3 Maximum, Average, and Minimum Concentration for Sulfate at stations on Sawmill Run

- pH and net-alkalinity (total alkalinity minus total acidity) levels were in compliance with PA standard on the mainstem. In contrast, station SMR_05 (UNT 37170) exceeded the PA standard for pH on three occasions (average: 4.86, range: between 3.6 and 6.8) and the PA standard of 0 mg/L for net-alkalinity on four occasions (**Figure 3-4**).

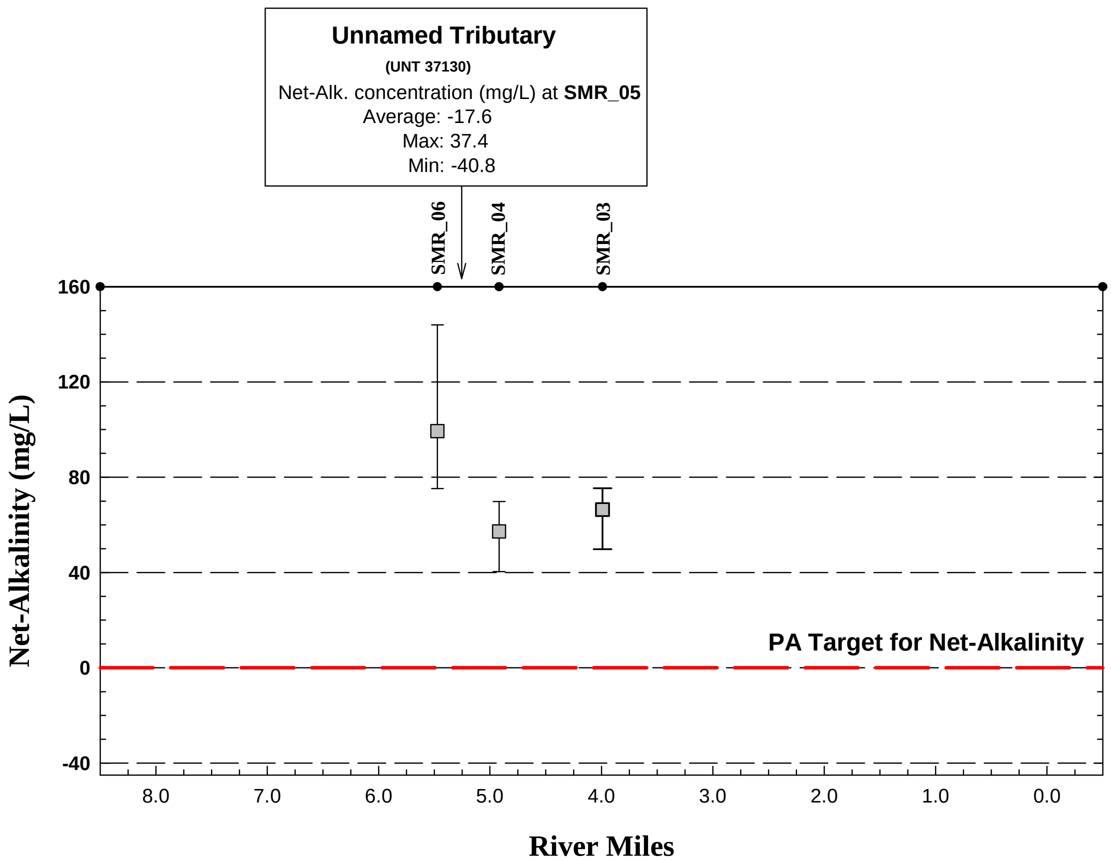


Figure 3-4 Maximum, Average, and Minimum Concentration for Net-Alkalinity at stations on Sawmill Run

- Total iron levels exceeded the maximum standard of 1.5 mg/L on nine occasions (four times at SMR04 and five times at SMR_05). No exceedances were found at the most upstream (SMR06) and downstream (SMR03) monitoring stations. The maximum, average, and minimum concentration for total iron at each station is shown in **Figure 3-5.**

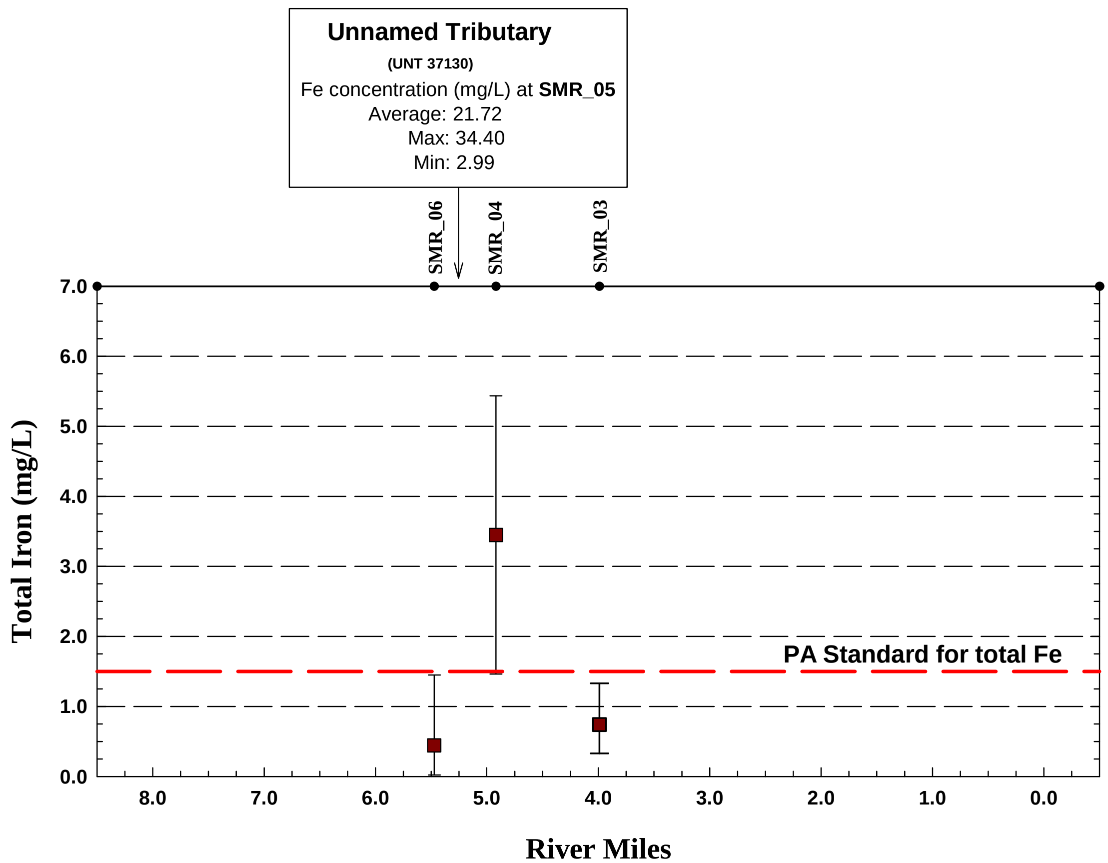


Figure 3-5 Maximum, Average, and Minimum Concentration for Total Iron at stations on Sawmill Run

- Total manganese levels were in compliance with the PA standard of 1.0 mg/L. The maximum, average, and minimum concentration for total manganese at each station is shown in **Figure 3-6.**

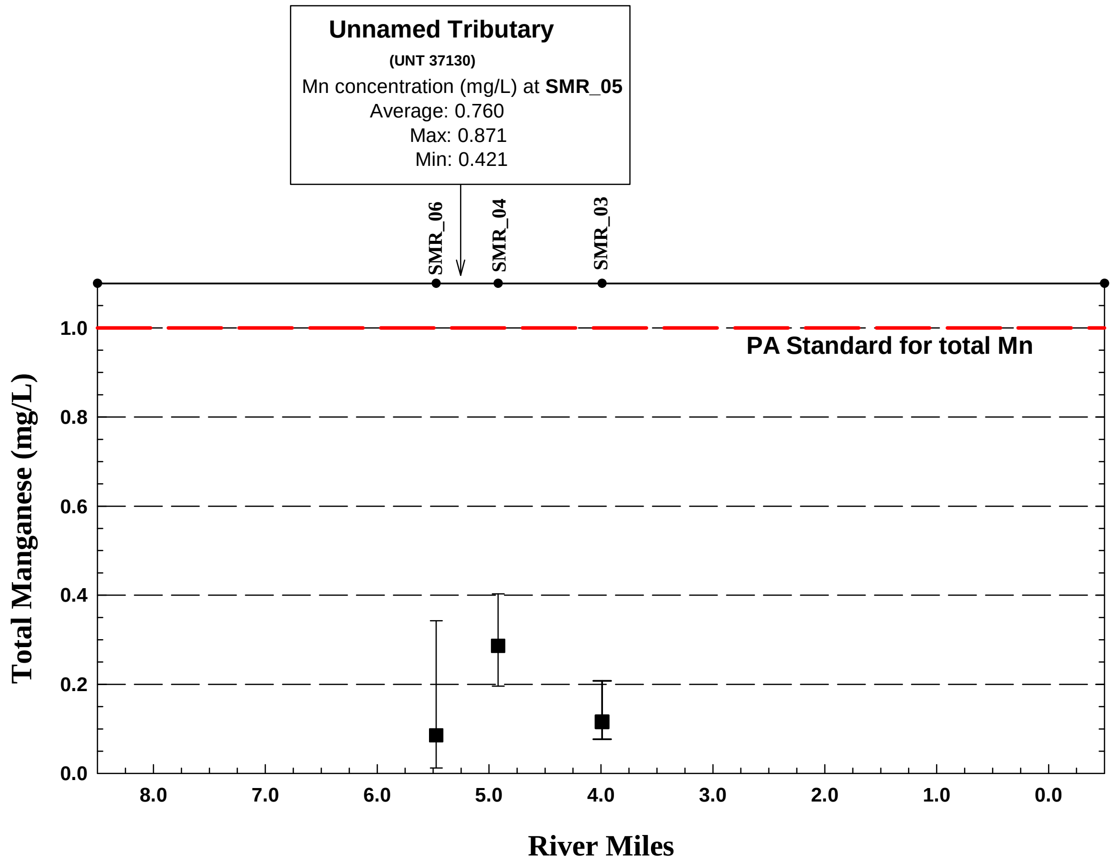


Figure 3-6 Maximum, Average, and Minimum Concentration for Total Iron at stations on Sawmill Run

- Total aluminum levels exceeded the maximum standard of 0.75 mg/L on four occasions (twice at SMR06 and SMR04, respectively). No exceedances were found at the downstream stations (SMR04) and (SMR03) and in the unnamed tributary 37170. The maximum, average, and minimum concentration for total aluminum at each station is shown in **Figure 3-7.**

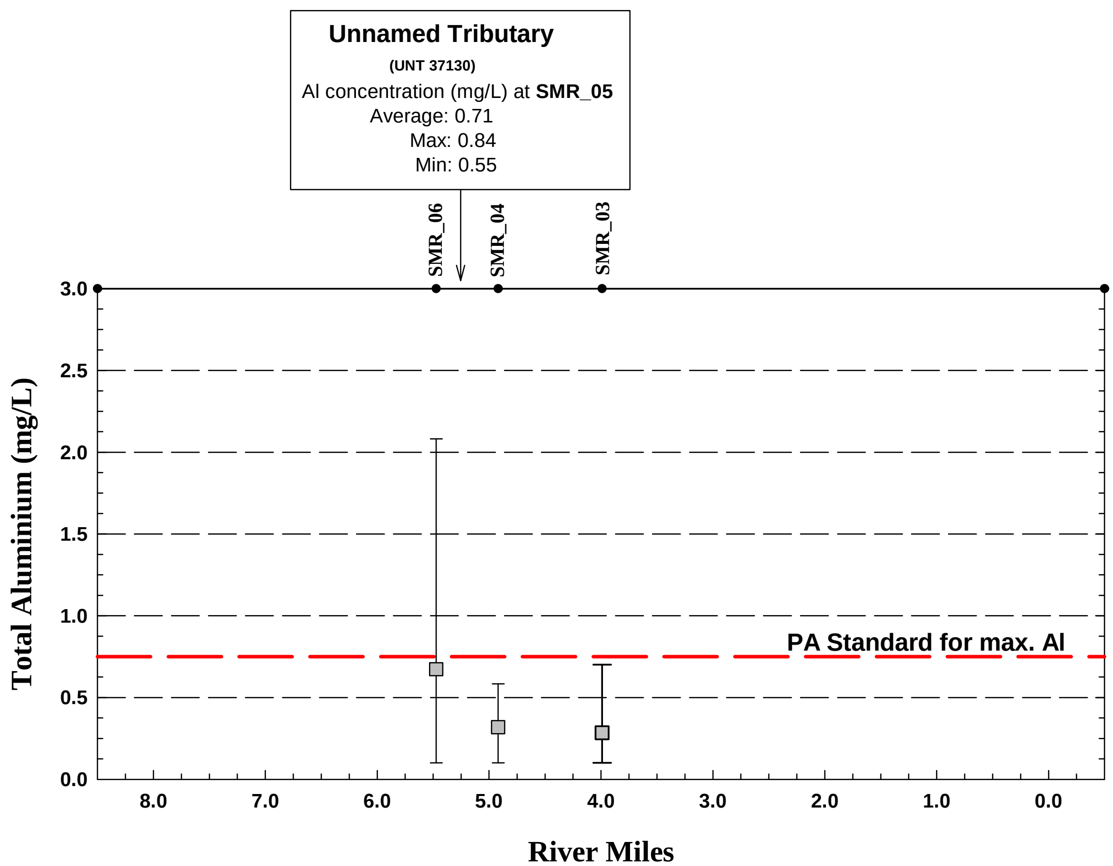


Figure 3-7 Maximum, Average, and Minimum Concentration for Total Aluminum in Sawmill Run.

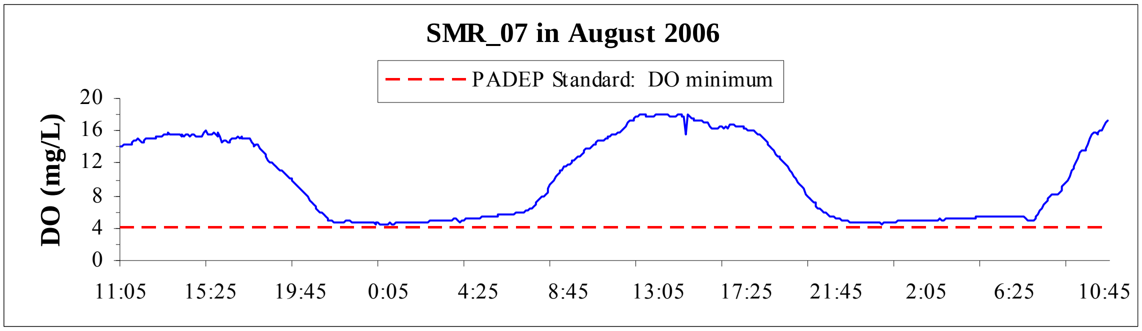
3.1.2 Continuous Measurements under Dry Weather Conditions

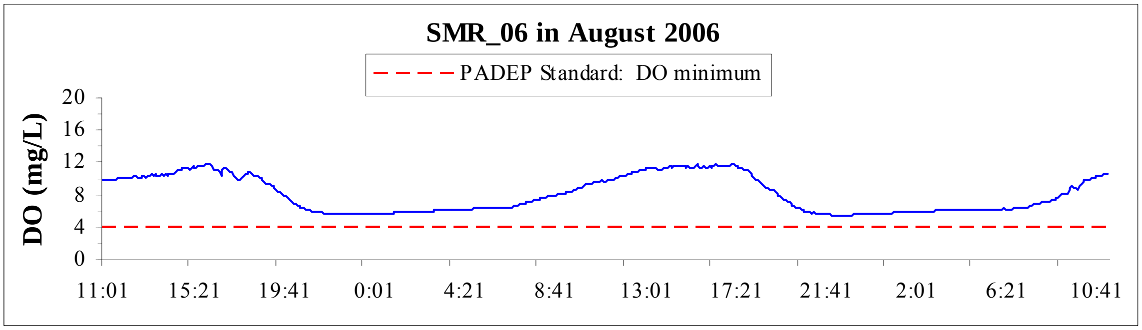
At four stations in the mainstem of Sawmill Run over approximately two days in August and September 2006, PADEP conducted continuous instream measurements for temperature, dissolved oxygen (DO sonde), specific conductivity, and pH. The following summarizes the results of all continuous monitoring data:

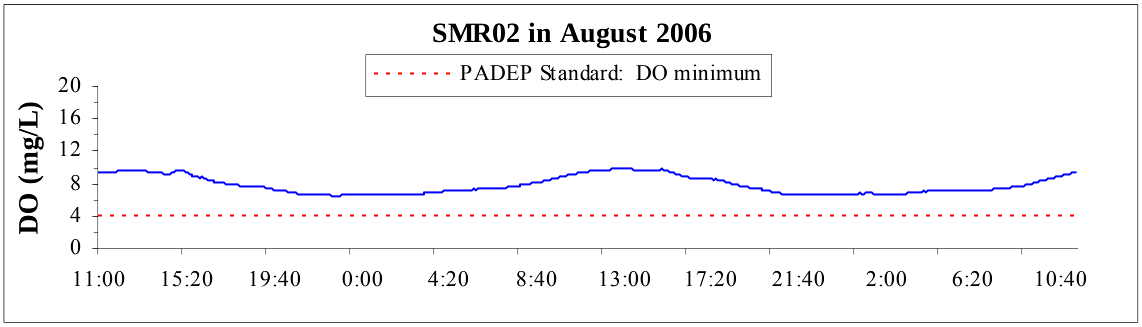
- Measurements for DO did not violate the Pennsylvania standard for a minimum DO concentration of 4 mg/L. The lowest DO level measured during the DO sonde sampling was 4.54 mg/L (**Figures 3-8 and 3-9**)
- Dissolved oxygen swings in Sawmill Run changed both spatially and temporally (**Table 3-1**). The headwater stations in Sawmill Run (SMR_7 and SMR_6) recorded large DO swings in August (13.52 mg/L for SMR_7 and 6.28 mg/L for SMR_6) as well as in September for SMR_7 (6.27 mg/L). Downstream of the headwater stations at the center and mouth of Sawmill Run (SMR_3, SMR_2, and SMR_1), DO swings were moderate, ranging between 1.70 and 3.26 mg/L.
- Measurements for pH complied with the state standard, with the exception of measurements recorded in September at station SMR_06. pH fluctuated on average between 0.7 and 0.9 (**Table 3-1**).
- Temperature levels averaged 23 °C in August and 19 °C in September, and fluctuated on average between 5 and 7 °C (**Table 3-1**).
- Specific conductivity levels for all measurements averaged 1257 µS/cm (range: 860 – 1487 µS/cm) for both surveys.

Table 3-1: Comparison of DO, Temperature, and pH Swing to Date and Station

	DO Swing		Temperature Swing		pH Swing	
Station	Aug-06	Sep-06	Aug-06	Sep-06	Aug-06	Sep-06
SMR_07	13.52	6.27	9.52	6.13	1.19	0.85
SMR_06	6.28	2.12	6.41	5.41	0.94	1.16
SMR_03	-	1.7	-	3.74	-	0.48
SMR_02	3.26	-	4.26	-	0.69	-
SMR_01	2.30	2.17	6.95	5.05	0.78	0.48







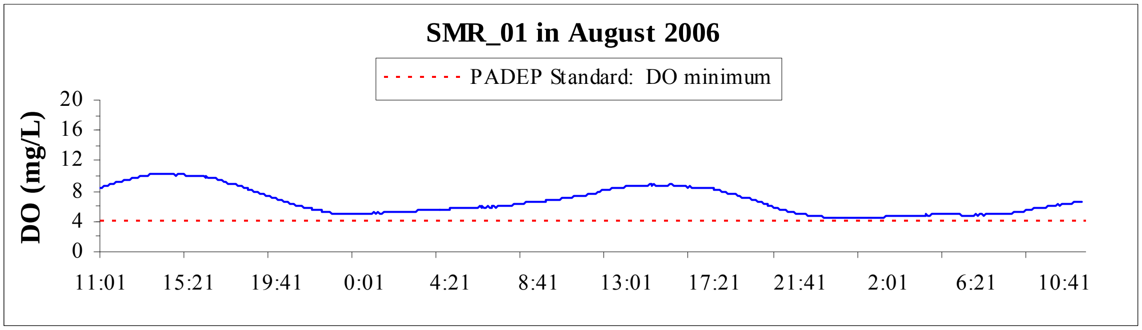
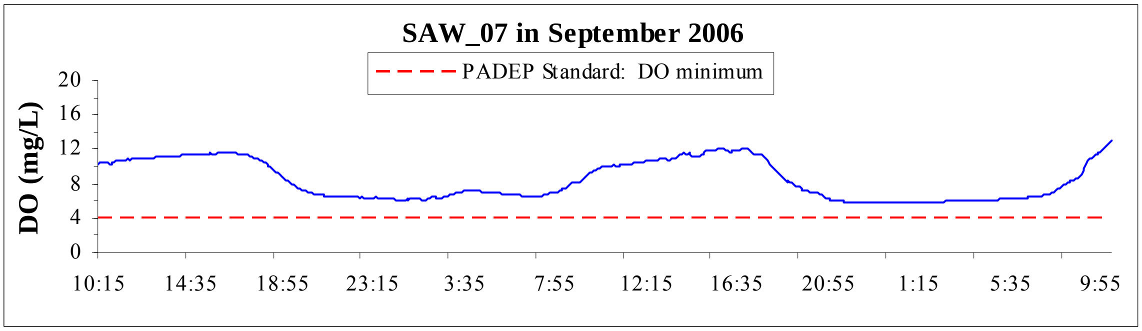
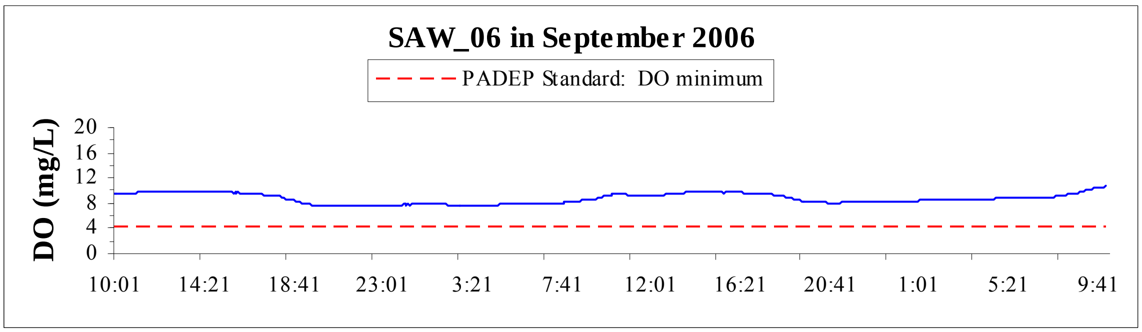
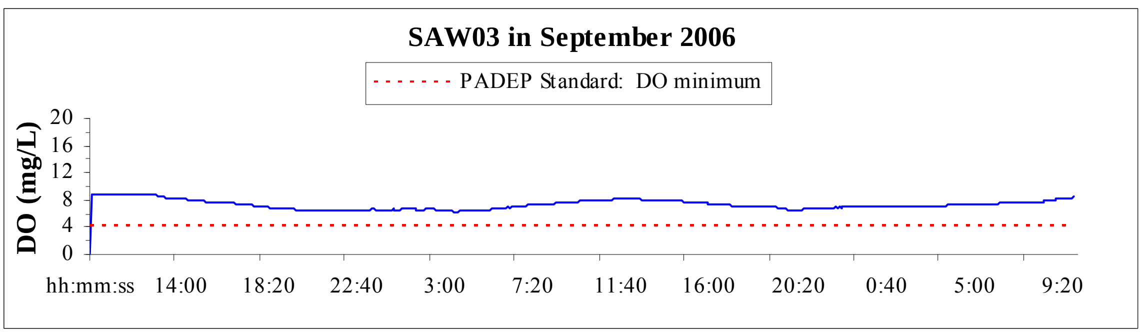


Figure 3-8 Continuous Dissolved Oxygen Measurements in the mainstem of Sawmill Run in August 2006.







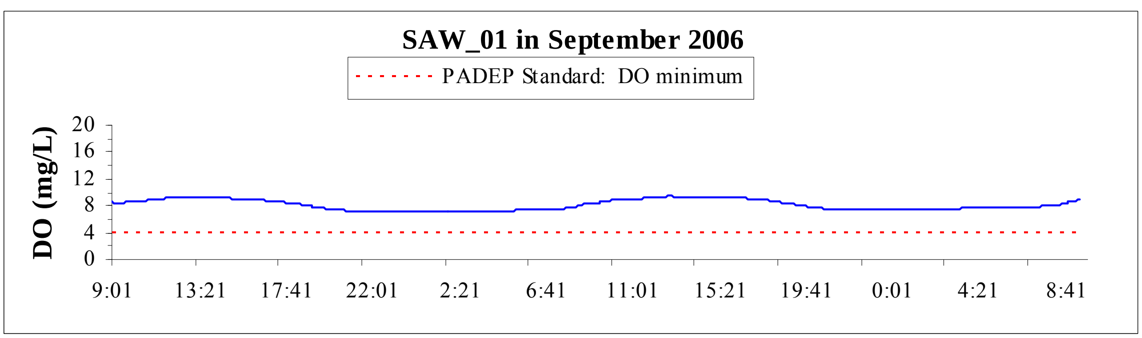


Figure 3-9 Continuous Dissolved Oxygen Measurements in the mainstem of Sawmill Run in September 2006.

3.1.3 Ambient Water Quality Monitoring under Wet Weather Conditions

Water quality data was collected once on October 17, 2006 during wet weather conditions at the mouth of Sawmill Run. The water quality sample was collected at the end of the rain event at 12:30 PM. The total rain depth was 1.52 inch over 12 hours. During the rain event, water quality samples were collected for TDS (total dissolved solids), TSS (total suspended solids), TOC (total organic carbon), total ammonia, nitrite, nitrate, TN, diss. PO_4-P, total PO_4-P, TP, $CBOD_5$ (carbonaceous BOD incubated over five days), and $CBOD_{20}$ (carbonaceous BOD incubated over 20 days). Some of these results are shown in **Table 3-2** and are compared to a total average of all dry weather measurements. From this comparison, the following results can be summarized (Note that results may not reflect maximum concentrations in Sawmill Run, since sampling occurred at the end of the rain event. Therefore, the first flush may not be captured):

- In general, nutrient, CBOD, and sediment concentrations increased significantly under wet weather conditions.

- Biochemical oxygen demand increased substantially and was probably attributed to the decay of biodegradable TOC under wet weather conditions. In addition, chemical oxidation may have played a minor role because TDS decreased by more than a third under wet weather conditions.

- Total phosphorus and total nitrogen concentrations collected under wet weather conditions were approximately nine times and two times higher (respectively) than measurements collected under dry weather. It should be noted that the majority of the nutrients were found in organic form.

Table 3-2: Comparison of water quality measurements under dry and wet weather conditions		
Parameter	**Dry Weather at the Mouth[4]**	**Wet Weather at the Mouth[5]**
	mg/L	**mg/L**
Alkalinity	97.53	49.80
TDS	929.33	228.00
TSS	6.00	192.00
TOC	2.23	6.30
$CBOD_5$[1]	1.83	9.77
TN	1.04	1.92
Total Ammonia	0.06	0.17
DIN (Diss. Inorg. Nitrogen)	0.83	1.28
Organic N[2]	0.21	0.64
TP	0.032	0.253
Diss. PO_4-P	0.021	0.030
Organic P[3]	0.012	0.223

[1] Carbonaceous BOD incubated over 5 days

[2] Organic N = TN - DIN

[3] Organic P = TP - Diss PO_4-P

[4] Based on 2 measurement in August and September 2006

[5] Based on 1 measurement in October 2006

3.2 3 Rivers 2nd Nature Data

3.2.1 Biological Monitoring Data

Biological sampling was conducted within the Sawmill Run watershed on May 31, 2001 as part of a study conducted by 3 Rivers 2nd Nature entitled "Biological Assessment of Aquatic Invertebrate Communities of Streams Tributary to the Emsworth Dam Pool (Pittsburgh Pool) on the Ohio, Allegheny, and Monongahela Rivers". Benthic macroinvertebrate samples were collected at station number 0012 on Sawmill Run in the west end of Pittsburgh. Out of 35 streams sampled within the entire three rivers (Ohio, Alleghany, and Monongahela) watershed, Sawmill run was ranked 25th due to a low percentage of sensitive organisms present within the sample. In addition, Sawmill Run received a Family Biotic Index (FBI) score which indicated that sewage pollution was impacting the benthic community in Sawmill Run more profoundly in comparison to other watersheds sampled in this study. Biological sampling notes added that a sewage odor was present and a large carp was observed in the creek.

3.2.2 Ambient Water Quality Monitoring

There is one ambient water quality monitoring station by 3 Rivers 2nd Nature project located in the Sawmill Run watershed (**Table 3-3**). The station was sampled five times between June and October 2004 and included general water quality parameters (alkalinity, ammonia, conductivity, DO, Escherichia Coli, fecal coliform, hardness, pH, temperature, total coliform, total dissolved solids, and turbidity) and one metal (iron).

Table 3-3: Ambient Water Quality Monitoring Stations

Station	Description
SM01	River Mile 0.8 on Sawmill Run

A bulleted summary of the general water quality parameter including iron derived from the 3 Rivers 2nd Nature project data is listed below (**Table 3-4**):

- Alkalinity, dissolved oxygen, pH, and ammonia levels have been in compliance with the criteria.
- Temperature measurements met the standard for Warm Water Fisheries (CWF).

- Four out of five total dissolved solid (TDS) concentrations exceeded both the monthly average and the maximum standard.
- Hardness concentrations ranged between 237 and 299 mg/L (average: 273 mg/L).
- Conductivity levels ranged between 140 and 1,400 µmMhos/cm (average: 818 µmMhos/cm) with 60% of the measurements greater than 1000 µmMhos/cm.
- Bacteria levels ranged between 85 and 14,000 col/100ml (Geometric mean for total coliform: 2,420 col /100ml, for escherichia coli: 1,711 col /100ml, for entero- cocci: 286 col /100ml, and fecal coliform: 2580 col /100ml).
- Iron concentrations exceeded the standard for dissolved iron once (range: 0.073 - 0.336 mg/L, average: 0.142).

Table 3-4: Water Quality Data sampled by 3 Rivers 2nd Nature project

Sample ID	Date	Temp.	DO	pH	Cond.	Tot. Alk.	Tot. Hard.	NH_3	TDS	Turb.	Fe	Tot. Col.	EColi	Ent.-coc.	Fec. Col.
		ºC	mg/L		µmMhos/cm	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	col/100mL	col/100mL	col/100mL	col/100mL
SM01-1	6/1/2000	18.6	8.16	7.7	1400							2420	1300	178	
SM01-2	7/10/2000	21.3	7.55	7.6	220	81	237	0.01	779	1.2	0.336	2420	2420	2420	14000
SM01-3	7/25/2000	17.9	8.79	7.5	150	90	280	0.05	918	0.39	0.082				3100
SM01-4	8/22/2000	17.1	9.24	7.7	1000	99	299	0.01	967	0.44	0.073	2420	2419	184	1300
SM01-5	10/16/2000	13.2	8.74	7.8	1320	110	279	0.02	866	0.38	0.078	2420	1414	85	785
Count		5	5	5	5	4	4	4	4	4	4	4	4	4	4
Ave		17.62	8.50	7.66	818	95	274	0.02	883	0.60	0.14				
Geom. Mean												2420	1811	286	2580
Min		13.20	7.55	7.48	150	81	237	0.01	779	0.38	0.07	2420	1300	85	785
Max		21.30	9.24	7.76	1400	110	299	0.05	967	1.20	0.34	2420	2420	2420	14000

Cond.: Specific Conductivity, Tot. Alk.: Total Alkalinity, Tot. Hard.: Total Hardness, TDS: Total Dissolved Solids, Turb.: Turbidity,
Tot. Col.: Total Coliform, Ecoli: Echia Coli, Ent.-cocc.: Entero-cocci, Fec. Col.: Fecal Coliform.

4.0 Nutrient TMDL Development

TMDL development requires determination of endpoints, or water quality goals/target for the impaired waterbody. TMDL endpoints represent the stream conditions at which a given stream would meet water quality standards. Endpoints are normally expressed as the numeric water quality criteria for the pollutant causing the impairment. Compliance with numeric water quality criteria, such as a maximum allowable pollutant concentration, is expected to achieve full use support for the waterbody. However, not all pollutants have established numeric water quality criteria. In these cases, alternative approaches may be used to define the TMDL endpoint for nutrients.

Stream segments in the Sawmill Run watershed were listed on Pennsylvania's 1996 303(d) List of Impaired Waters for nutrients by combined sewer overflows (1996). TMDL development is necessary to establish the numeric endpoints for nutrients at which the impaired segments of Sawmill Run could be expected to attain their designated uses. As discussed in Section 1.0, Pennsylvania currently has not established numeric criteria for nutrients. Therefore, an alternate approach for determining the nutrient TMDL endpoint was utilized.

4.1 Nutrient TMDL Approach

4.1.1 Endpoint Development Approach and Identification

As stated above, Pennsylvania does not currently have established numeric criteria for nutrients. A total phosphorus endpoint was determined using data extracted from the USGS, USEPA STORET, and USEPA EMAP. Nutrient endpoints were determined for Sawmill Run using a weight-of-evidence analysis drawing on different analytical approaches, however, there were more limited data for the Allegheny Plateau region, therefore the analyses were limited to fewer lines of evidence. The following is a summary of the findings:

- Distribution-based approaches led to values between 19 and 36 ug/L

- Modeled reference expectation approach produced a significant TN model of 302 ug/L TN which, based on average Allegheny Plateau site N:P molar ratios of 86:1, resulted in a value of 7 ug/L TP.
- Stressor-response analyses could not be conducted due to small sample size for sites with concurrent stressor and response data
- Scientific literature for this region included values ranging between 10 and 60 ug/L, with a central tendency towards the 20-30 ug/L range.

The reference based approach was weighed most strongly because stressor-response data were unavailable. Based on the analyses and balancing the values from other studies, a value of 35 µg/L was chosen to be the total phosphorus endpoint for the Sawmill Run watershed.

As stated above, Pennsylvania does not currently have established numeric criteria for nutrients. Therefore, nutrient endpoints were determined using a weight-of-evidence analysis drawing on different analytical approaches. Each of the different approaches produced slightly different endpoints. **Table 4-1** provides a summary of the different approaches evaluated and the corresponding endpoint

Table 4-1: Total Phosphorus Endpoint Development Approaches for Sawmill Run

Approach		Total Phosphorus Endpoint (ug/L)
Category	**Name**	
Reference Approach	Reference Site 75th Percentile	33 - 36
	All Sites 25th Percentile	19
	Modeled Reference Expectation	8
Other Literature	Various Sources	10-60

Table 4-2 summarizes the nutrient targets for the Sawmill Run Nutrient TMDL.

Table 4-2: : Sawmill Run Nutrient Targets

Total Phosphorus (µg/L)	35

The selected total phosphorus endpoint would be applied as an average concentration during the growing season from April to October (213 days), which is typically the time during which the highest algal growth exists in streams. Therefore, allocations based on growing season are more appropriate than annual or daily allocations in Sawmill Run

4.1.2 Identifying and Linking the Sources to the Endpoint

One of the essential steps in developing a TMDL is to establish a link or relationship between the nutrient instream targets developed previously and the predicted loadings in order to determine how much reduction in nutrient loading is required to attain the applicable targets. Once this link has been established, it is possible to determine the capacity of the waterbody to assimilate nutrient loadings and still support designated uses.

There are no wastewater treatment facilities discharging into Sawmill Run. During wet weather, nutrients are dominated by runoff from urban lands, the combined sewer overflows (CSOs) and the sanitary sewer overflow (SSOs). Under dry weather, nutrients originate from groundwater inflow in Sawmill Run.

Since nutrient concentrations are a combination of dry and wet weather impacts, the nutrient TMDL is required to address total nutrient loads originated from dry and wet weather. The key steps for the development of the nutrient TMDLs in Sawmill Run are outlined below:

- Use AVGWLF for a period of 10 years (1994-2004) to estimate the nutrient loadings form all land uses and the CSOs
- Perform a hydrology calibration for AVGWLF ensuring that the model adequately reproduces the hydrology in Sawmill Run
- Calibrate the CSOs and SSOs annual volumes in order to match the volumes reported in the Discharge Monitoring Report (DMR) and other reports.
- Develop a target nutrient load using the 10-year average simulated flow and the nutrient endpoints for total phosphorus (**Table 4-2**).

- Develop allocations by comparing the existing total phosphorus load to the total phosphorus targets using the as a basis the growing season period from April to October. Nutrient allocations will be developed for all land-use (including CSOs, SSOs, and MS4s) using the Equal Marginal Percent Reduction (EMPR). A description of the EMPR is presented in Appendix C.

4.1.3 Estimating the Existing Total Phosphorus Load

For the purpose of TMDL development, annual nitrogen and phosphorus loadings from nonpoint sources were determined using the ArcView Generalized Watershed Loading Functions (AVGWLF) model for Pennsylvania. AVGWLF is tailored for Pennsylvania, was developed by the Environmental Resources Research Institute of the Pennsylvania State University (Evans et al., 2006), and facilitates the use of the Generalized Watershed Loading Function (GWLF) model developed by Haith and Shoemaker (1987) via a GIS software interface.

GWLF is a time variable simulation model that simulates hydrology, sediment and nutrient loadings on a watershed basis. Observed daily precipitation data is required in GWLF as the basis for water budget calculations. Surface runoff, evapotranspiration and groundwater flows are calculated based on user specified parameters. Stream flow is the sum of surface runoff and groundwater discharge. Surface runoff is computed using the Soil Conservation Service Curve Number Equation. Curve numbers are a function of soils and land use type. Evapotranspiration is computed based on the method described by Hamon (1961) and is dependent upon temperature, daylight hours, saturated water vapor pressure, and a cover coefficient. Groundwater discharge to the stream is described by a lumped parameter watershed water balance for unsaturated and shallow saturated water zones. Infiltration to the unsaturated zone occurs when precipitation exceeds surface runoff and evapotranspiration. Percolation to the shallow saturated zone occurs when the unsaturated zone capacity is exceeded. The shallow saturated zone is modeled as a linear reservoir to calculate groundwater discharge. In addition, the model allows for seepage to a deep saturated zone.

Nutrient loading is a function of concentrations of dissolved nutrients in the groundwater and runoff from land sources areas, as well as particulate nutrients associated with sediments, and nutrients originating from septic systems. Groundwater nutrient concentrations are computed using an AVGWLF dataset derived from the U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) studies. Particulate nutrient levels are computed using a dataset derived from Pennsylvania soil test data compiled by the Pennsylvania State University. Nutrient loadings from surface runoff are determined based on land use and soils distributions, as well as groundwater and soil nutrient levels. Particulate nutrients associated with sediment are calculated by applying a nutrient loading coefficient to the computed sediment loads. Septic systems in the watershed are estimated using U.S. Census data. The AVGWLF implementation is presented in Section 4.1.5.

Point Source Load

Six permitted facilities are present in the Sawmill Run watershed, as shown in **Table 4-3**. All of the facilities have permits that are associated with stormwater and do not have reported design flows.

In addition, there are CSOs and SSOs that flow directly into Sawmill Run. Section 4.1.4 provides a characterization of the CSOs and SSOs loads in the Sawmill Run watershed.

Table 4-3: Point Sources in the Sawmill Run Watershed

Permit Number	Discharger Name	TP Load (lb/day)
PAR806118	Laid Law Transit Services	-
PAR236126	Parker Plastics Corporation	-
PAG056102	Cumberland Farms Inc	-
PAR226108	Lozier Corporation	-
PAG056204	Pit Stop Express	-
PAR806194	PA National Guard	-
Total		-

Municipal Separate Storm Sewer Systems (MS4 Permit Areas)

There are 12 Municipal Separate Storm Sewer Systems (MS4s) in the Sawmill Run watershed. These systems collect stormwater runoff and transfer this runoff and its associated nutrient loads to streams. Although the loads associated with the stream inputs from the storm sewer system are primarily non-point source in origin, each MS4 area is given a general permit. However, there are no specific limits for total phosphorus that the municipality is required to meet. The nutrient loads associated with MS4s were estimated using the AVGWLF model based on the nutrient unit loads for each land use in the MS4 area. The nutrient loads allocated to each MS4 area were included in the waste load allocation component of the TMDL. In the Sawmill Run watershed approximately 46% (5,767 acres) of the total watershed area is associated with MS4 areas.

4.1.4 Estimating the CSOs and SSOs Volume and Concentration in Sawmill Run

As mentioned in Chapter 2, there are CSOs outfalls as well SSOs outfalls present in the watershed that discharge directly into Sawmill Run. The CSOs and SSOs are associated with the Allegheny County Sanitary Authority (ALCOSAN) and the Pittsburgh Water and Sanitation Authority. In order to simulate the CSOs and SSOs in Sawmill Run, a specific land-use was added to the AVGWLF input file for the CSOs and SSOs, respectively.

The AVGWLF drainage areas, covered by the CSOs and SSOs, were taken proportionally from the low and high intensity development land uses and iteratively adjusted until the simulated annual average runoff volume for CSOs and SSOs match the annual average reported volumes.

CSOs Volume and Concentration

The annual average CSOs volumes reported for 2005 and 2006 in the "*2006 CSO Status Report*" by the Pittsburgh Water and Sewer Authority was used to calibrate the simulated CSOs volume. A concentration of 3 mg/L of total phosphorus was assigned to the CSOs (Thomann and Mueller, 1987).

SSOs Volume and Concentration

SSOs volumes were reported for the first quarter of 2008 in the ALCOSAN System Wide Model (Prevost, 2008). In order to estimate the total annual SSOs, a ratio between SSOs and CSOs reported volumes from the first quarter of 2008 (Prevost, 2008) was calculated and used to estimate the average annual SSOs volume used for the calibration of the model. A concentration of 10 mg/L of total phosphorus (Thomann and Mueller, 1987) was used to estimate the total phosphorus load originating from SSOs in Sawmill Run.

This approach insures that the total phosphorus loads from the CSOs and SSOs are taken into account in the estimation of the existing annual total phosphorus loads in Sawmill Run.

4.1.5 AVGWLF Model Implementation

AVGWLF model simulations were performed for a 10 year period to account for both seasonal and annual variations in hydrology and sediment loading. AVGWLF was set up using the available rainfall data for the period of 1995 to 2005, and the existing watershed conditions. Input parameters were computed from statewide datasets for Pennsylvania that were included with the AVGWLF model, as well as additional datasets such as the NLCD (2001) land use dataset. A complete list of the datasets used in the AVGWLF model is presented in **Table 4-4**.

Table 4-4: Description of Datasets Used to Generate Model Input Parameters	
AVGWLF Dataset	**Description**
Animal densities	Mean livestock densities in Pennsylvania
Census data	Dataset providing U.S. Census data, including information on septic systems used to compute nutrient loading.
County	Contains county soils information, including conservation practices and input values for the Universal Soil Loss Equation (USLE).
Digital elevation model	100 meter DEM used to characterize topography.
Groundwater nitrogen	Grid of background nitrogen concentrations present in groundwater.
Land use	National Land Cover Data (NLCD).
Point sources	Coverage of permitted point source dischargers. Updated based on more detailed point source information provided by DEP.
Physiographic providences	Physiographic providences in Pennsylvania.
Roads	Major roads in watershed.
Soils	Generalized soils from the STATSGO database.
Soil phosphorus	Grid of phosphorus loads generated from soil sample data.
Streams	1:24,000 stream coverage for Pennsylvania.
Surface geology	Dataset of surface geology types.
Weather	Long-term weather data for 80 stations in Pennsylvania

Model Input Parameters

The AVGWLF model requires specification of input parameters relating to climate, hydrology, erosion, and sediment yield. These parameters are automatically computed in AVGWLF using the input datasets described above.

Runoff curve numbers and USLE erosion factors are specified by AVGWLF as an average value for a given source area. These source areas are defined by the land use types present in the impaired and reference watersheds. Land use data from the Multi-Resolution Land Characteristic (MRLC) dataset (1992) is provided along with the AVGWLF model and is automatically used for the identification and tabulation of different source areas.

Precipitation data from the National Climate Data Center weather station, PITTSBURGH WSCOM 2 AP, for the period of 1995 to 2005 was used in the model. Area-weighted evapotranspiration cover coefficients were developed for each model source area in the AVGWLF model based on values suggested in Evans *et al.* (2006).

The STATSGO soils dataset was used by AVGWLF to examine soil properties for each model source area. USLE factors for soil erodibility (K), length-slope (LS), cover and management (C), and supporting practice (P) were derived from multiple data sources contained in the AVGWLF model, such as the STATSGO soil database, digital elevation models, and county-specific information. The sediment delivery ratio was applied directly by AVGWLF, and was based on the sizes of the watersheds.

Nutrient loads were computed based on land use, geology, soils, groundwater nitrogen, and soil phosphorus datasets contained in the AVGWLF model, as well as groundwater monitoring data collected in the watershed. Loads were determined by applying a dissolved coefficient to surface runoff calculations, and by applying a sediment coefficient to the load from each agricultural source area. Nutrient loads originating from urban sources were modeled in AVGWLF as solid-phase, using an exponential accumulation and washoff function. Groundwater contributions to stream nutrient loads are calculated using a dissolved phosphorus coefficient for shallow groundwater.

Table 4-5 provides a summary of the sources of information used in the AVGWLF parameterization.

Table 4-5: Summary of Sources of Information Used in AVGWLF Parameterization		
Input File Name	**Model Parameter**	**Source/Description**
WEATHER.DAT	-	Historical weather data from National Weather Service monitoring stations
TRANSPORT.DAT	Basin size	GIS/derived from basin boundaries
	Land use/cover distribution	GIS/derived from land use/cover map
	Curve numbers by source area	GIS/derived from land cover and soil maps
	USLE (KLSCP) factors by source area	GIS/derived from soil, DEM, and land cover
	ET cover coefficients	GIS/derived from land cover
	Erosivity coefficients	GIS/ derived from physiographic map
	Daylight hrs. by month	Computed automatically based on latitude
	Growing season months	Input by user
	Initial saturated storage	Default value of 10 cm
	Initial unsaturated storage	Default value of 0 cm
	Recession coefficient	GIS/derived from physiographic map
	Seepage coefficient	Default value of 0
	Initial snow amount (cm water)	Default value of 0
	Sediment delivery ratio	GIS/based on basin size
	Soil water (available water capacity)	GIS/derived from soil map
	Tile drain ratio and density	GIS/derived from optional tile drain map
	Water withdrawals	GIS/derived from water withdrawal map
NUTRIENT.DAT	Dissolved N in runoff by land cover type	Default values/adjusted using animal data
	Dissolved P in runoff by land cover type	Default values/adjusted using soil P
	N/P concentrations in manure runoff	Default values/adjusted using animal data
	N/P buildup in urban areas	Default values (from GWLF Manual)
	N and P point source loads	GIS/derived from NPDES point coverage
	Background N/P concentrations in GW	GIS/derived from new background N map
	Background P concentrations in soil	GIS/derived from soil P loading map
	Background N concentrations in soil	Based on map in GWLF Manual
	Months of manure spreading	Input by user
	Population on septic systems	GIS/derived from census tract map
	Per capita septic system loads (N/P)	Default values (from GWLF Manual)
	Dissolved N and P in tile drains	Derived tile drain flow times default values

4.1.6 Hydrology Calibration

Comparisons were made between predicted and observed stream flow to ensure an adequate hydrologic simulation in Sawmill Run.

USGS Station 03085213, located at the outlet of the watershed, was selected for the hydrology calibration. This station is currently active and has been recording discharge measurements in Sawmill Run since May 2004; flow from May 2004 to March 2005 (the most recent observed flow data) was used as a calibration period for the hydrology simulation in Sawmill Run. GWLF parameters relating to hydrology were calibrated based on the flow data collected at station 03085213. A visual comparison between observed and predicted flow (May 2004 – March 2005) is shown for Sawmill Run (**Figure 4-1**). The results of the hydrology calibration indicate a good fit between observed and simulated values.

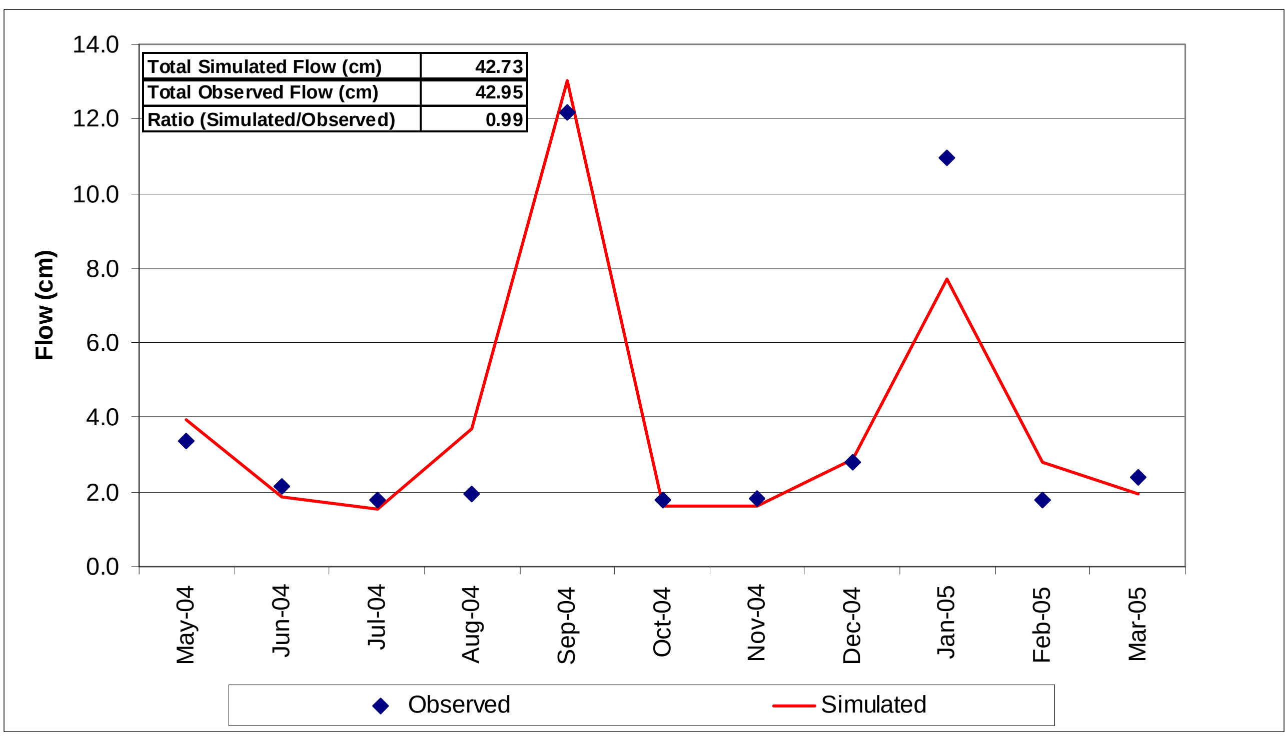


Figure 4-1: Hydrology Calibration Results for Sawmill Run (May 2004 to March 2005)

Total simulated streamflow volume is within 1 percent of total observed annual streamflow (**Figure 4-1**). In addition, the robustness of the calibration is verified by a coefficient of determination (R^2) value of 0.889 (**Figure 4-2**).

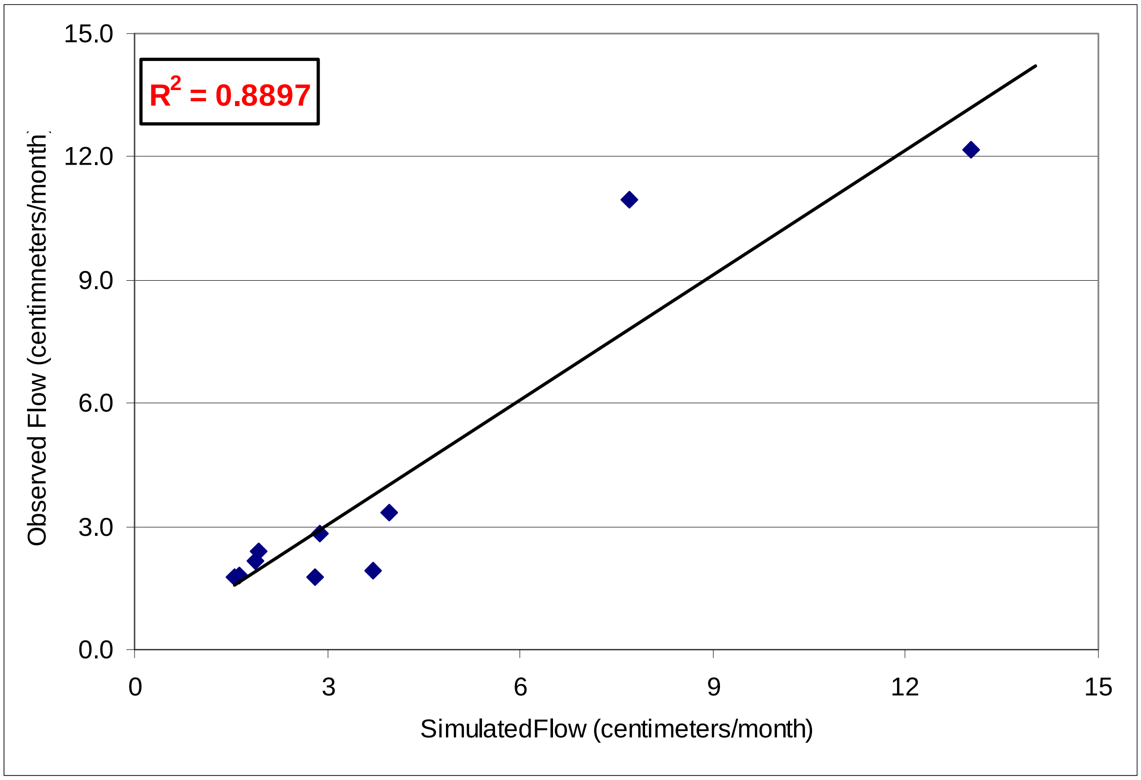


Figure 4-2: Regression between Monthly Observed and Simulated Flows (May 2004 to March 2005)

4.1.7 Existing Phosphorus Loads in Sawmill Run

The hydrologically calibrated model was used to estimate total phosphorus loadings from each source area in the Sawmill Run watershed. Based on the 10 year simulation period, from 1995 to 2005, the average annual total phosphorus loads were computed for each land source in the watershed (**Table 4-6**).

Table 4-6: Sawmill Run Average Annual Existing Phosphorus Loads	
Source	**Total Phosphorus (lb/yr)**
Hay/Pasture	22.0
Turf Grass	1.5
Low Intensity Dev	6,267.0
High Intensity Dev	16.9
CSOs	10,572.1
SSOs	2,879.3
Stream Bank	79.5
Total	**19,838.3**

The average load for the growing season was determined using the fraction of the annual average simulated load for the period of April to October (**Table 4-7**).

Table 4-7: Sawmill Run Average Annual Existing Phosphorus Loads (Growing Season)	
Source	**Total Phosphorus (lb/Growing Season)**
Hay/Pasture	15.0
Turf Grass	1.1
Low Intensity Development	4,245.5
High Intensity Development	11.5
CSOs	7,161.9
SSOs	1,950.4
Stream Bank	53.8
Total	**13,439.2**

4.1.8 Target Nutrient Load

The target nutrient load were developed using the 10-year average simulated flow over the growing season (April to October) and the nutrient endpoint for total phosphorus. The results are presented in **Table 4-8**, which also includes the existing annual nutrient load in Sawmill Run. **Table 4-8** indicates that total phosphorus reductions are necessary since the annual existing load (13,439.2 lb/yr) is larger than the target load (435.3 lb/yr).

Table 4-8: Sawmill Run Target Total Phosphorus Loads (Growing Season)	
Average Simulated Flow (million gallons/Growing Season)	1,490
End point (ug/L)	35
Target Load (lb/ Growing Season)	435.3
Existing Load (lb/ Growing Season)	13,439.2
Overall Required Reduction (%)	97%

5.0 Total Phosphorus 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 total phosphorus loads from each source in the impaired watershed to cumulatively meet the TMDL endpoint load is expected to ensure that Sawmill Run meets water quality standards and to restore its designated uses.

5.1 Basis for TMDL Allocations

The nutrient TMDL allocations for Sawmill Run were based on the following equation:

TMDL = WLA +LA + MOS

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

The wasteload allocation (WLA) represents the total nutrient loading allocated to point sources. The load allocation (LA) represents the total nutrient 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

An explicit MOS of 10% was used in the TMDL allocation for Sawmill Run to account for uncertainties associated with calculation of the TMDL phosphorus load. The use of a 10% MOS is consistent with previous TMDLs developed in Pennsylvania, and is appropriate to account for uncertainties associated with planning level water quality models such as AVGWLF. Based on this rationale, a total of 43.7 pounds/year, during the growing season, were allocated as a MOS for the Sawmill Run TMDL.

5.1.2 Wasteload Allocation

The wasteload allocation for the combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) was based on a 10-year simulation and the EMPR method used to make the necessary reductions. **Table 5-1** provides the reductions to be made to the CSO load. **Table 5-2** provides the reductions to be made to the SSO load.

Table 5-1: Existing and Allocated Total Phosphorus Loads for CSOs (Growing Season)	
Existing Load (lb/ Growing Season)	7,161.9
Allocated Load (lb/ Growing Season)	177.5
Percent Reduction (%)	98%

Table 5-2: Existing and Allocated Total Phosphorus Loads for SSOs (Growing Season)	
Existing Load (lb/ Growing Season)	1,950.4
Allocated Load (lb/ Growing Season)	0.0
Percent Reduction (%)	100%

Municipal Separate Storm Sewer Systems (MS4)

As shown in Section 2, there are 12 MS4 areas in the Sawmill Run watershed. Total phosphorus loads from these MS4 areas originate from both nonpoint sources and instream erosion processes. Because MS4 areas are permitted, the loads associated with these areas are formally considered within the TMDL allocation under the WLA component of the TMDL.

To allocate a portion of the TMDL load to the MS4 areas, total phosphorus load associated with MS4 areas was based on the proportion of the watershed occupied by the MS4 area using:

$$\frac{\textit{MS4 Area in the Watershed}}{\textit{Total Watershed Area}} \times \textit{Phosphorus Load}$$

Once the total phosphorus load associated with the MS4 area was calculated, the reductions determined by the EMPR were applied to each source area within the MS4 area. **Table 5-3** shows the total MS4 TP load allocation for each of the land sources and **Table 5-4** shows the total wasteload allocation for the MS4 areas

Table 5-3: Phosphorus MS4 Wasteload Allocation by Land Source			
Land Use	**Existing Load (lb/Growing Season)**	**Allocated Load (lb/Growing Season))**	**Percent Reduction**
Hay/Pasture	7.1	3.1	56%
Turf Grass	0.4	0.2	50%
Low Intensity Development	1,969.4	82.2	96%
High Intensity Development	5.3	2.4	55%
Stream Bank	24.9	11.2	55%
Total	**2,007.1**	**99.1**	**95%**

Table 5-4: Phosphorus MS4 Wasteload Allocation by Municipalities			
Municipality	**Existing Load (lb/Growing Season)**	**Allocated Load (lb/ Growing Season)**	**Percent Reduction**
Baldwin Borough	2.1	0.1	95%
Baldwin Township	110.7	5.5	95%
Bethel Park Borough	213	10.5	95%
Brentwood Borough	131.6	6.5	95%
Castle Shannon Borough	349.1	17.2	95%
Dormont Borough	170.9	8.4	95%
Green Tree Borough	101.6	5	95%
Ingram Borough	0.7	0	95%
Mt. Lebanon Township	516.1	25.5	95%
Mt. Oliver Borough	10.1	0.5	95%
Scott Township	13.6	0.7	95%
Whitehall Borough	387.7	19.1	95%
Total	**2,007.1**	**99.1**	**95%**

At this time, EPA cannot determine what portion of the municipalities are designated/used for collection or conveying stormwater, as opposed to portions that are truly nonpoint sources. As part of the Phase II stormwater permit process, MS4s will be responsible for evaluating and mapping out areas that are draining to or discharging to storm sewers. Since these systems have not yet been delineated, the TMDL lumps nonpoint source loadings into the WLA portion of the TMDL. Once these delineations are available, the nonpoint source loadings can then be separated out of the WLAs and moved under the LA. This TMDL modification could be initiated by the Pennsylvania Department of the Environment.

5.1.3 Load Allocation

The Equal Marginal Percent Reduction (EMPR) method was used to distribute the load allocations between appropriate contributing land use sources. **Table 5-5** provides the required reductions for the contributing land uses (not including MS4 areas).

Table 5-5: Phosphorus Load Allocations (not including MS4 areas)			
Land Use	**Existing Load (lb/ Growing Season)**	**Allocated Load (lb/ Growing Season)**	**Percent Reduction**
Hay/Pasture	7.9	3.7	53%
Turf Grass	0.7	0.2	71%
Low Intensity Development	2276.1	95.2	96%
High Intensity Development	6.2	2.9	53%
Stream Bank	28.9	13.2	54%
Total	**2,319.8**	**115.2**	**95%**

5.2 TMDL for Total Phosphorus

The load and wasteload allocations and margin of safety for the Sawmill Run nutrient TMDLs are summarized in **Tables 5-6** and **5-7.** The allocations shown in **Table 5-7** were computed by dividing the growing season load by number of days in the growing season (213 days). The recommended daily allocations (lb/growing season) for each source in the Sawmill Run watershed are provided in **Table 5-8**.

Table 5-6: Total Phosphorus TMDL (lb/Growing Season)			
TMDL	**Load Allocation**	**Wasteload Allocation** ***(Includes CSOs, SSOs, and MS4 areas)***	**Margin of Safety (10%)**
435.3	115.2	276.6	43.7

Table 5-7: Total Phosphorus TMDL (lb/day during Growing Season)			
TMDL	**Load Allocation**	**Wasteload Allocation** ***(Includes CSOs, SSOs, and MS4 areas)***	**Margin of Safety (10%)**
2.0	0.5	1.3	0.2

Table 5-8: Recommended Total Phosphorus TMDL Allocations (lb/ Growing Season)				
	Land Use	**Existing Load**	**Allocated Load**	**Percent Reduction**
Nonpoint Sources	Hay/Pasture	7.9	3.7	53%
	Turf Grass	0.7	0.2	71%
	Low Intensity Development	2,276.1	95.2	96%
	High Intensity Development	6.2	2.9	53%
	Stream Bank	28.9	13.2	54%
MS4	Hay/Pasture	7.1	3.1	56%
	Turf Grass	0.4	0.2	50%
	Low Intensity Development	1,969.4	82.2	96%
	High Intensity Development	5.3	2.4	55%
	Stream Bank	24.9	11.2	55%
CSOs		7,161.9	177.5	98%
SSOs		1,950.4	0.0	100%
	Total	**13,439.2**	**391.8**	**97%**

5.3 Dissolved Oxygen Considerations in Sawmill Run

This TMDL was specifically developed because of the Sawmill Run listing in the 303(d) list as impaired for nutrients. However, based on personal communications with Wade Trim, Inc., there is a potential for DO violations under wet weather conditions caused by the CSOs in Sawmill Run. It is projected that the completion of the Long Term Control Plan (LTCP) for the CSOs in Sawmill Run along with the TP allocations outlined in this report will be sufficient to help attain compliance with the Dissolved Oxygen state water quality standards.

5.4 Consideration of Critical Conditions for the TMDL

EPA regulations at 40 CFR 130.7 (c) (1) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that designated uses are protected throughout the year, including vulnerable periods.

5.5 Consideration of Seasonal Variability

Seasonal variations involve changes in stream flow and nutrient loading as a result of hydrologic and climatic patterns. Seasonal variations were explicitly incorporated in the modeling approach for these TMDLs. AVGWLF is a continuous simulation model that incorporates seasonal variations in hydrology and nutrient loading by using a daily time-step for water balance calculations. Therefore, the 10 year simulation performed with AVGWLF adequately captures seasonal variations.

6.0 Reasonable Assurance and Implementation

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. In order to make sure that the TMDLs are established successfully, there must be 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 Sawmill Run TMDLs identify the necessary overall load reductions for and nutrients that are currently causing use impairments, and distribute those reduction goals to the appropriate sources. Reaching the reduction goals established by these TMDLs will only occur through changes in current land use practices, including the incorporation of best management practices (BMPs).

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.

6.1.1 Nutrient Best Management Practices

The relative contribution of nutrients varies throughout the watershed according to the distribution of land use sources such as row crop and pasture lands, as well as the location of permitted point sources. Implementation of best management practices in the watershed and should reduce the non-point source loads of nutrients to levels that will assist in achieving the loading reduction goals established in these TMDLs. The implementation of the sediment TMDLs developed for Sawmill Run may also serve to reduce non-point sources of phosphorus and nitrogen. Since phosphorus can be dissolved or adsorbed in particulate matter, mainly sediment, control measures to reduce the sediment load will directly impact and reduce the phosphorus loading to the receiving stream. Examples of sediment and nutrient pollution reduction practices include:

- Agricultural Best Management Practices (BMP), which include practices to reduce or eliminate soil loss, prevent runoff, and provide for the proper application rates of nutrients to cropland, vegetated buffer strips at the edge of crop fields, conservation tillage, strip cropping, animal waste management, and stream bank fencing.
- Urban Best Management Practices, which include erosion and sediment BMPs to control runoff from areas under development and stormwater controls in developed areas. These practices are applied across a broad spectrum from industrial, commercial, and residential facility construction sites to the management of lawns and open spaces, reducing nutrient runoff.
- Stormwater Management controls, including Low Impact Development (LID)
- Upgrades made to wastewater treatment plants, many which are preformed during the installation of biological nutrient removal (BNR) process.
- Septic system maintenance.
- Stream Buffers: Streamside forest to reduce or remove excess nutrients and sediment from surface runoff and shallow groundwater and aid in shading streams to optimize light and temperature conditions for aquatic plants and animals.

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 the PA DEP's Bureau of Mining offers grant programs to fund mine reclamation efforts.

7.0 Public Participation

EPA regulations require that TMDLs be subject to public participation. In the case of the Sawmill Run watershed TMDL, a notice of availability for comments on the draft TMDL was published in The Pittsburgh-Post Gazette and on EPA Region 3's TMDL website on March 4, 2008. EPA is accepting public comments from March 4, 2008 through midnight on April 3, 2008. EPA will also be holding a public meeting to present details and answer questions regarding the proposed TMDLs on March 20, 2008 from 7:00-9:00 PM at the Castle Shannon Municipal Center, 3310 McRoberts Rd, Pittsburgh, Pennsylvania.

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, April 3, 2008**. All comments can be sent to Ms. Lenka Berlin at the address below. 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/index.htm). A copy of the report can also be requested through the contact provided below. Please direct any questions about the proposed TMDL document or meeting 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

Following receipt of comments during the public comment period, EPA will finalize the TMDL and make revisions as necessary. A document providing EPA's responses to public comments will also be prepared as part of the final TMDL.

Note that EPA is seeking public comment on two scenarios: (1) whether TP and TN endpoints are necessary to achieve necessary nutrient reductions within the Sawmill Run Watershed, or (2) if TP only endpoints are sufficient. To the extent that the commenters feel that both TP and TN endpoints are needed, EPA is also soliciting comment on whether the proposed TN endpoints are appropriate.

Data analysis and modeling runs have established a clear linkage between phosphorus loading and periphyton densities in the watershed; however, the linkage between nitrogen and periphyton in this system is somewhat less well-established. Nevertheless, EPA is proposing TN endpoints in this TMDL because of the potential downstream effects of excess nitrogen loading to coastal and estuarine waters. In a similar situation, NPDES permittees within Pennsylvania are currently receiving both TP and TN effluent limits in order to help meet water quality standards in the Chesapeake Bay. Additionally, PADEP is working on the development of numeric nutrient criteria development and is considering criteria adoption for multiple indicators including nitrogen, as other states have. EPA expects that establishment of nitrogen allocations at this time may enable permittees to address and plan for treatment upgrades and capital expenditures for compliance with both TP and TN limits together rather than requiring facilities to address phosphorus now and nitrogen at a later date.

8.0 References

EPA (2000). *Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams and Nutrient Ecoregion XI.* United States Environmental Protection Agency, Office of Water 4304, EPA 822-B-00-020.

EPA (2001). *Overview of Current Total Maximum Daily Load (TMDL) Program and Regulation.* U.S. Environmental Protection Agency. Available at <http://www.epa.gov/owow/tmdl/overviewfs.html>.

Evans, Barry M., Scott A. Sheeder, and Kenneth J. Corradini (2006). *AVGWL Version 6.2 Users Guide.* Penn State Institute of the Environment, The Pennsylvania State University.

Novotny, Vladimir and Harvey Olem (2003). *Water Quality, Diffuse Pollution and Watershed Management.* Second Edition. John Wiley & Sons, INC.

PADEP (2004). *Final Brubaker Run Watershed TMDL, Cambria County, For Acid Mine Drainage Affected Segments. Pennsylvania Department of Environmental Protection.*

PADEP (2005). *Final Raccoon Creek Watershed TMDL, Allegheny, Beaver, and Washington Counties, For Acid Mine Drainage Affected Segments. Pennsylvania Department of Environmental Protection.*

Pittsburgh Water and Sewer Authority. *2006 CSO Status Report*.

Prevost (2008). System *Wide Discharge Monitoring Report for First Quarter of 2008*.

Thomann, Robert V. and John A. Mueller (1987). *Principles of Surface Water Quality Modeling and Control.* Harper Collins Publishers.

Virginia Tech. (2006). *A Literature Review for Use in Nutrient Criteria Development for Freshwater Streams and Streams in Virginia.* Prepared for the Virginia Department of Environmental Quality, Division of Water Quality Programs. Virginia Polytechnic Institute and State University Blacksburg, Virginia.

Woods, A. J., Omernik, J. M., and D. D. Brown (1999). *Level III and IV Ecoregions of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia.* U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory. Corvallis, OR.

Appendix A. Water Quality Data

Appendix A provides the following data used for developing the sediment, and nutrient TMDL for the Sawmill Run watershed:

- Flow observed by USGS
- Water Quality observed by PADEP (Dry and wet weather, sonde measurements)

Table A-1 Flow at USGS Gage 03085213 at Sawmill Run, PA between May 2004 and March											
Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
1-May	13.0	1-Jul	7.1	1-Sep	7.4	1-Nov	6.7	1-Jan	11.0	1-Mar	20.0
2-May	16.0	2-Jul	8.8	2-Sep	7.0	2-Nov	25.0	2-Jan	10.0	2-Mar	14.0
3-May	12.0	3-Jul	8.2	3-Sep	7.3	3-Nov	15.0	3-Jan	124.0	3-Mar	12.0
4-May	11.0	4-Jul	7.8	4-Sep	11.0	4-Nov	14.0	4-Jan	34.0	4-Mar	13.0
5-May	11.0	5-Jul	8.7	5-Sep	7.3	5-Nov	10.0	5-Jan	628.0	5-Mar	13.0
6-May	11.0	6-Jul	6.6	6-Sep	7.0	6-Nov	7.1	6-Jan	674.0	6-Mar	17.0
7-May	30.0	7-Jul	9.1	7-Sep	48.0	7-Nov	7.4	7-Jan	122.0	7-Mar	27.0
8-May	11.0	8-Jul	7.6	8-Sep	573.0	8-Nov	7.6	8-Jan	169.0	8-Mar	47.0
9-May	9.7	9-Jul	7.5	9-Sep	166.0	9-Nov	6.9	9-Jan	187.0	9-Mar	17.0
10-May	9.1	10-Jul	6.3	10-Sep	20.0	10-Nov	6.3	10-Jan	204.0	10-Mar	15.0
11-May	8.7	11-Jul	7.3	11-Sep	16.0	11-Nov	6.0	11-Jan	239.0	11-Mar	23.0
12-May	8.5	12-Jul	20.0	12-Sep	12.0	12-Nov	39.0	12-Jan	165.0	12-Mar	21.0
13-May	9.5	13-Jul	20.0	13-Sep	10.0	13-Nov	9.4	13-Jan	69.0	13-Mar	15.0
14-May	12.0	14-Jul	13.0	14-Sep	9.5	14-Nov	8.5	14-Jan	168.0	14-Mar	13.0
15-May	15.0	15-Jul	7.5	15-Sep	8.8	15-Nov	8.3	15-Jan	48.0	15-Mar	12.0
16-May	9.8	16-Jul	6.9	16-Sep	9.3	16-Nov	8.2	16-Jan	38.0	16-Mar	11.0
17-May	8.7	17-Jul	9.7	17-Sep	1740.0	17-Nov	9.1	17-Jan	28.0	17-Mar	8.9
18-May	113.0	18-Jul	15.0	18-Sep	532.0	18-Nov	11.0	18-Jan	23.0	18-Mar	9.4
19-May	102.0	19-Jul	8.4	19-Sep	99.0	19-Nov	108.0	19-Jan	25.0	19-Mar	9.8
20-May	18.0	20-Jul	5.8	20-Sep	48.0	20-Nov	26.0	20-Jan	19.0	20-Mar	14.0
21-May	210.0	21-Jul	4.2	21-Sep	24.0	21-Nov	11.0	21-Jan	16.0	21-Mar	8.9
22-May	103.0	22-Jul	6.7	22-Sep	20.0	22-Nov	12.0	22-Jan	14.0	22-Mar	8.2
23-May	24.0	23-Jul	8.7	23-Sep	17.0	23-Nov	9.3	23-Jan	10.0	23-Mar	44.0
24-May	17.0	24-Jul	5.8	24-Sep	14.0	24-Nov	41.0	24-Jan	9.5	24-Mar	17.0
25-May	16.0	25-Jul	6.9	25-Sep	13.0	25-Nov	17.0	25-Jan	13.0	25-Mar	14.0
26-May	36.0	26-Jul	198.0	26-Sep	11.0	26-Nov	10.0	26-Jan	15.0	26-Mar	11.0
27-May	17.0	27-Jul	27.0	27-Sep	9.4	27-Nov	13.0	27-Jan	9.3	27-Mar	19.0
28-May	38.0	28-Jul	13.0	28-Sep	9.6	28-Nov	33.0	28-Jan	9.4	28-Mar	143.0
29-May	14.0	29-Jul	11.0	29-Sep	7.6	29-Nov	15.0	29-Jan	11.0	29-Mar	46.0
30-May	13.0	30-Jul	9.6	30-Sep	6.5	30-Nov	17.0	30-Jan	14.0	30-Mar	20.0
31-May	28.0	31-Jul	26.0	1-Oct	6.4	1-Dec	211.0	31-Jan	11.0	31-Mar	16.0
1-Jun	17.0	1-Aug	11.0	2-Oct	6.8	2-Dec	19.0	1-Feb	11.0		
2-Jun	16.0	2-Aug	11.0	3-Oct	5.4	3-Dec	14.0	2-Feb	9.8		
3-Jun	20.0	3-Aug	9.9	4-Oct	4.7	4-Dec	11.0	3-Feb	7.7		
4-Jun	11.0	4-Aug	23.0	5-Oct	3.5	5-Dec	9.9	4-Feb	8.1		
5-Jun	24.0	5-Aug	17.0	6-Oct	2.1	6-Dec	9.7	5-Feb	8.3		
6-Jun	13.0	6-Aug	9.5	7-Oct	2.2	7-Dec	32.0	6-Feb	9.2		
7-Jun	12.0	7-Aug	9.5	8-Oct	2.6	8-Dec	12.0	7-Feb	9.9		
8-Jun	11.0	8-Aug	8.7	9-Oct	2.5	9-Dec	79.0	8-Feb	14.0		
9-Jun	12.0	9-Aug	6.4	10-Oct	2.3	10-Dec	33.0	9-Feb	43.0		
10-Jun	13.0	10-Aug	6.3	11-Oct	2.2	11-Dec	19.0	10-Feb	19.0		
11-Jun	70.0	11-Aug	7.7	12-Oct	2.9	12-Dec	15.0	11-Feb	8.1		
12-Jun	15.0	12-Aug	13.0	13-Oct	27.0	13-Dec	13.0	12-Feb	5.6		
13-Jun	12.0	13-Aug	9.0	14-Oct	8.5	14-Dec	11.0	13-Feb	4.6		
14-Jun	87.0	14-Aug	8.7	15-Oct	36.0	15-Dec	12.0	14-Feb	109.0		
15-Jun	43.0	15-Aug	7.3	16-Oct	10.0	16-Dec	12.0	15-Feb	22.0		

Table A-1 Flow at USGS Gage 03085213 at Sawmill Run, PA between May 2004 and March											
16-Jun	20.0	16-Aug	8.3	17-Oct	5.2	17-Dec	11.0	16-Feb	19.0		
17-Jun	26.0	17-Aug	7.6	18-Oct	122.0	18-Dec	11.0	17-Feb	7.8		
18-Jun	23.0	18-Aug	10.0	19-Oct	40.0	19-Dec	14.0	18-Feb	5.8		
19-Jun	14.0	19-Aug	93.0	20-Oct	14.0	20-Dec	11.0	19-Feb	4.9		
20-Jun	13.0	20-Aug	82.0	21-Oct	7.1	21-Dec	12.0	20-Feb	27.0		
21-Jun	12.0	21-Aug	53.0	22-Oct	6.6	22-Dec	13.0	21-Feb	35.0		
22-Jun	43.0	22-Aug	10.0	23-Oct	6.3	23-Dec	113.0	22-Feb	16.0		
23-Jun	11.0	23-Aug	8.5	24-Oct	30.0	24-Dec	18.0	23-Feb	13.0		
24-Jun	11.0	24-Aug	7.8	25-Oct	6.8	25-Dec	15.0	24-Feb	17.0		
25-Jun	11.0	25-Aug	7.5	26-Oct	6.1	26-Dec	14.0	25-Feb	17.0		
26-Jun	9.8	26-Aug	23.0	27-Oct	5.7	27-Dec	12.0	26-Feb	13.0		
27-Jun	9.0	27-Aug	15.0	28-Oct	5.4	28-Dec	11.0	27-Feb	11.0		
28-Jun	18.0	28-Aug	17.0	29-Oct	107.0	29-Dec	11.0	28-Feb	30.0		
29-Jun	11.0	29-Aug	24.0	30-Oct	17.0	30-Dec	11.0				
30-Jun	9.4	30-Aug	17.0	31-Oct	9.6	31-Dec	11.0				
		31-Aug	7.8								

Table A-2 PADEP: Water Quality Measurements for Nutrient TMDL in Sawmill Run collected on August 8, 2006

Station	Alk	TDS	TOC	TSS	$CBOD_5$	$CBOD_{20}$	NO_2-N	NO_3-N	NH_3-N	TN	TP	Diss PO_4-P	Diss P	Tot PO_4-P
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SMR_01	85.4	978	-	16	1.7	5	0.01	0.66	0.15	1.15	0.056	0.033	0.042	0.037
SMR_02	61.8	862	-	20	1.2	2.1	<0.01	0.77	0.04	0.97	0.032	0.016	0.019	0.017
SMR_05		1208	-	56	18	23	0.04	0.21	1.73	2.93	0.192	0.010	<0.01	<0.01
SMR_06	118.6	834	-	16	1.4	1.7	0.07	0.72	0.06	1.02	0.060	0.032	0.044	0.037
SMR_07	175.8	994	-	22	2.1	3.4	0.01	0.35	0.05	0.66	0.058	0.025	0.034	0.024

Table A-3 PADEP: Water Quality Measurements for Nutrient TMDL in Sawmill Run collected on September 18, 2006

Station	Alk	TDS	TOC	TSS	$CBOD_5$	$CBOD_{20}$	NO_2-N	NO_3-N	NH_3-N	TN	TP	Diss PO_4-P	Diss P	Tot PO_4-P
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SMR_01	103	888	2.23	<0.5	1.8	1.4	<0.01	0.82	<0.02	0.99	0.02	0.014	0.019	0.016
SMR_01[1]	104.2	922	-	<0.5	2	<0.5	<0.01	0.81	<0.02	0.98	0.021	0.015	0.019	0.017
SMR_02	81.2	812	2.13	<0.5	2.2	1.2	0.02	0.99	0.03	1.28	0.031	0.013	0.02	0.019
SMR_05	5.4	978	1.61	16	3.6	3.2	0.02	0.32	0.91	1.46	0.045	<0.01	<0.01	<0.01
SMR_06	152.8	1.05	1.24	0.98	2.35	<0.5	0.051	0.04	0.01	922	0.037	0.039	<0.01	2
SMR_07	202	956	2.57	2	2.8	1.1	<0.01	1.24	<0.02	1.46	0.055	0.048	0.056	0.048

Alk Alkalinity; TDS Total Dissolved Solids; TOC Total Organic Carbon; TSS Total Suspended Solids;

$CBOD_5$ and $CBOD_{20}$ Carbonaceous BOD incubated over 5 and 20 days

[1] Duplicate

Table A-4: PADEP Wet Weather Water Quality Measurements in the Sawmill Run Watershed collected at the mouth on 10.17.06	
Parameter	**Conc. (mg/L)**
TN	1.92
TP	0.253
CBOD51	9.77
CBOD202	39.7
NO2-N	0.03
NO3-N	1.08
Tot NH3-N	0.17
Diss. P	0.099
Tot PO4	0.106
Diss. PO4	0.03
TOC	6.3
TSS	192
TDS	228
ALKALINITY	49.8
CBOD5 and CBOD20 = Carbonaceous BOD incubated over 5 and 20 days	
TOC = Total organic carbon; TSS = Total suspended solids; TDS = Total dissolved solids	

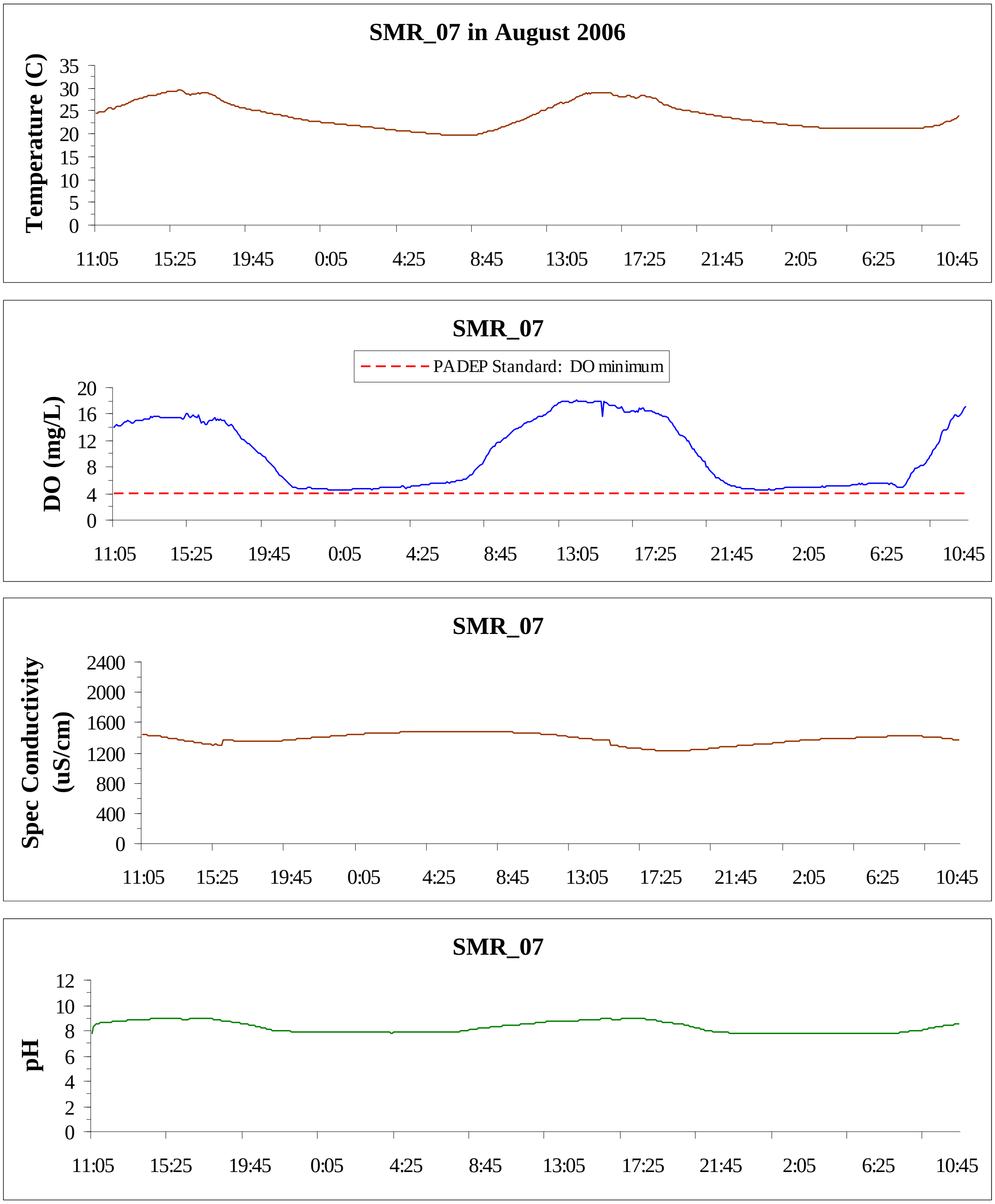


Figure A-1: Continuous Instream Measurements at SMR_07 (August 2007)

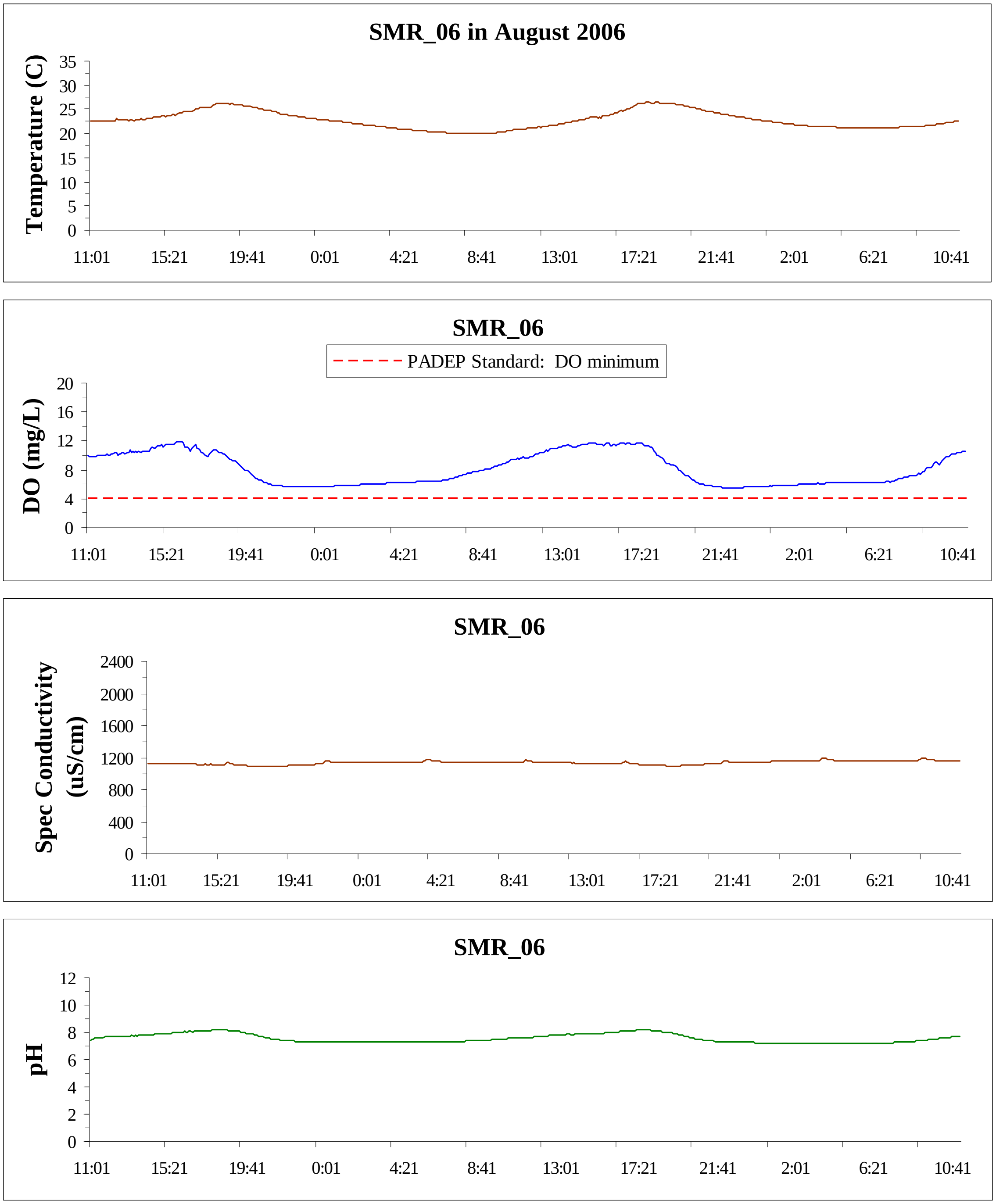


Figure A-2: Continuous Instream Measurements at SMR_06 (August 2007)

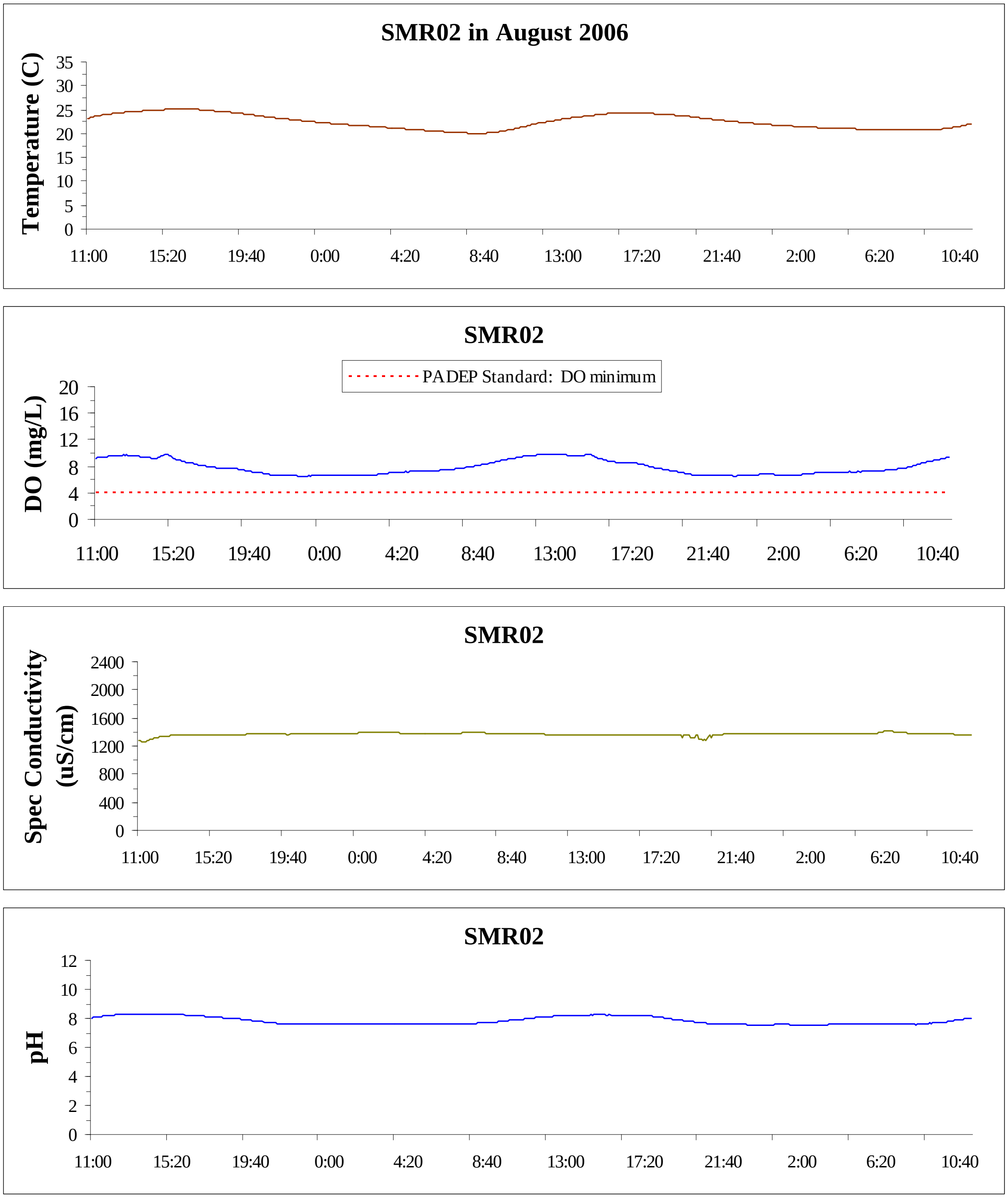


Figure A-3: Continuous Instream Measurements at SMR_02 (August 2007)

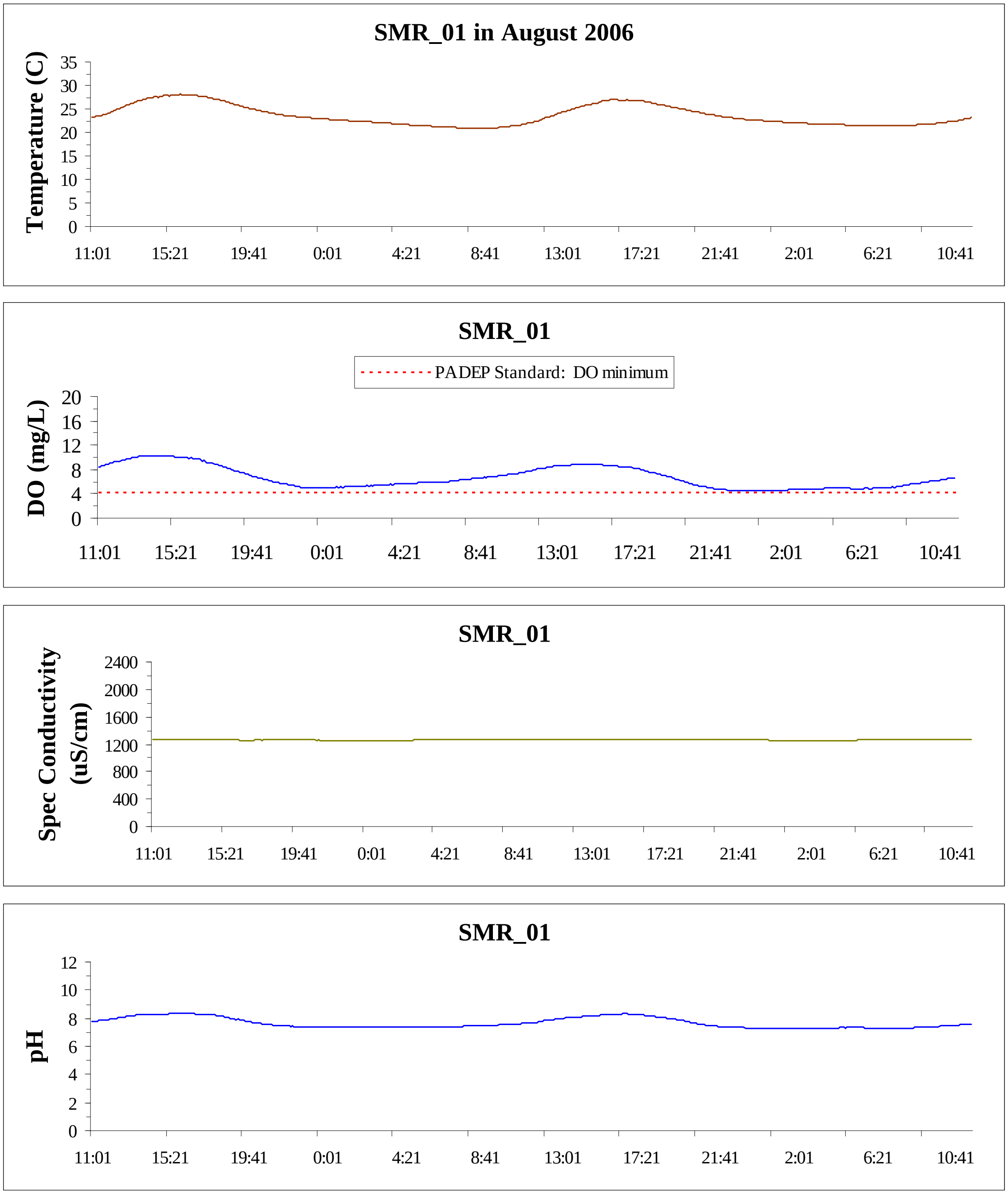


Figure A-4: Continuous Instream Measurements at SMR_01 (August 2007)

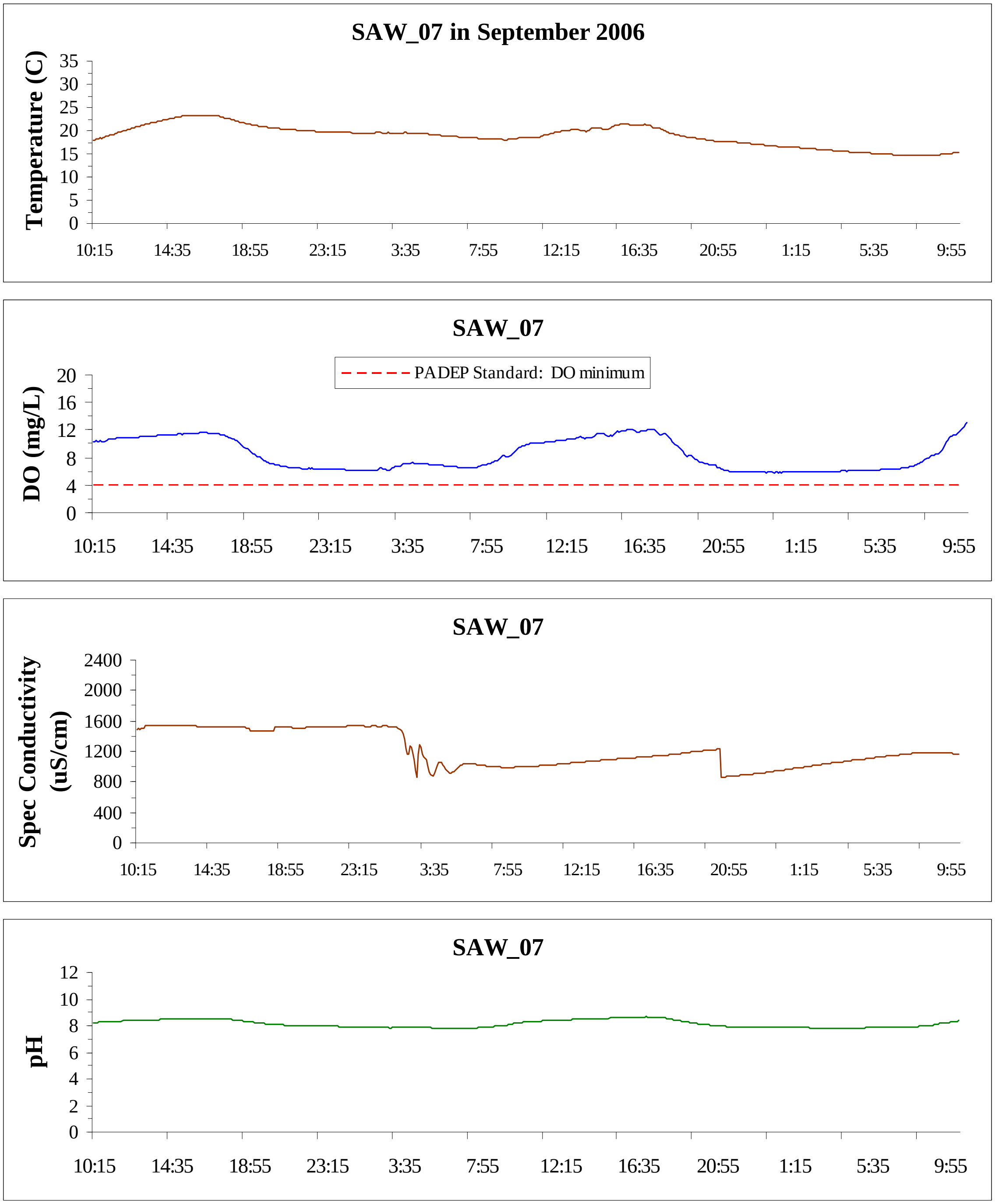


Figure A-5: Continuous Instream Measurements at SAW_07 (September 2007)

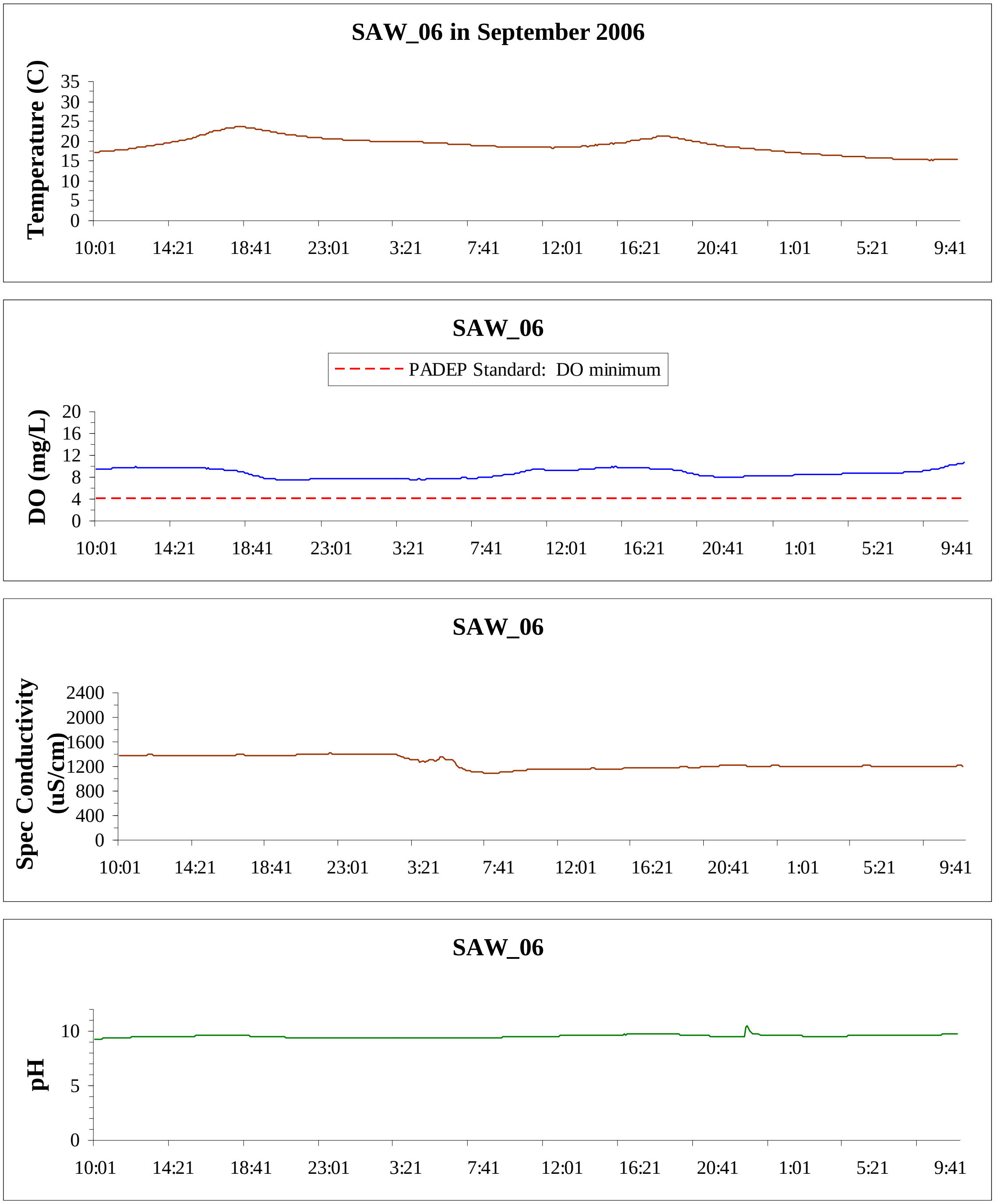


Figure A-6: Continuous Instream Measurements at SAW_06 (September 2007)

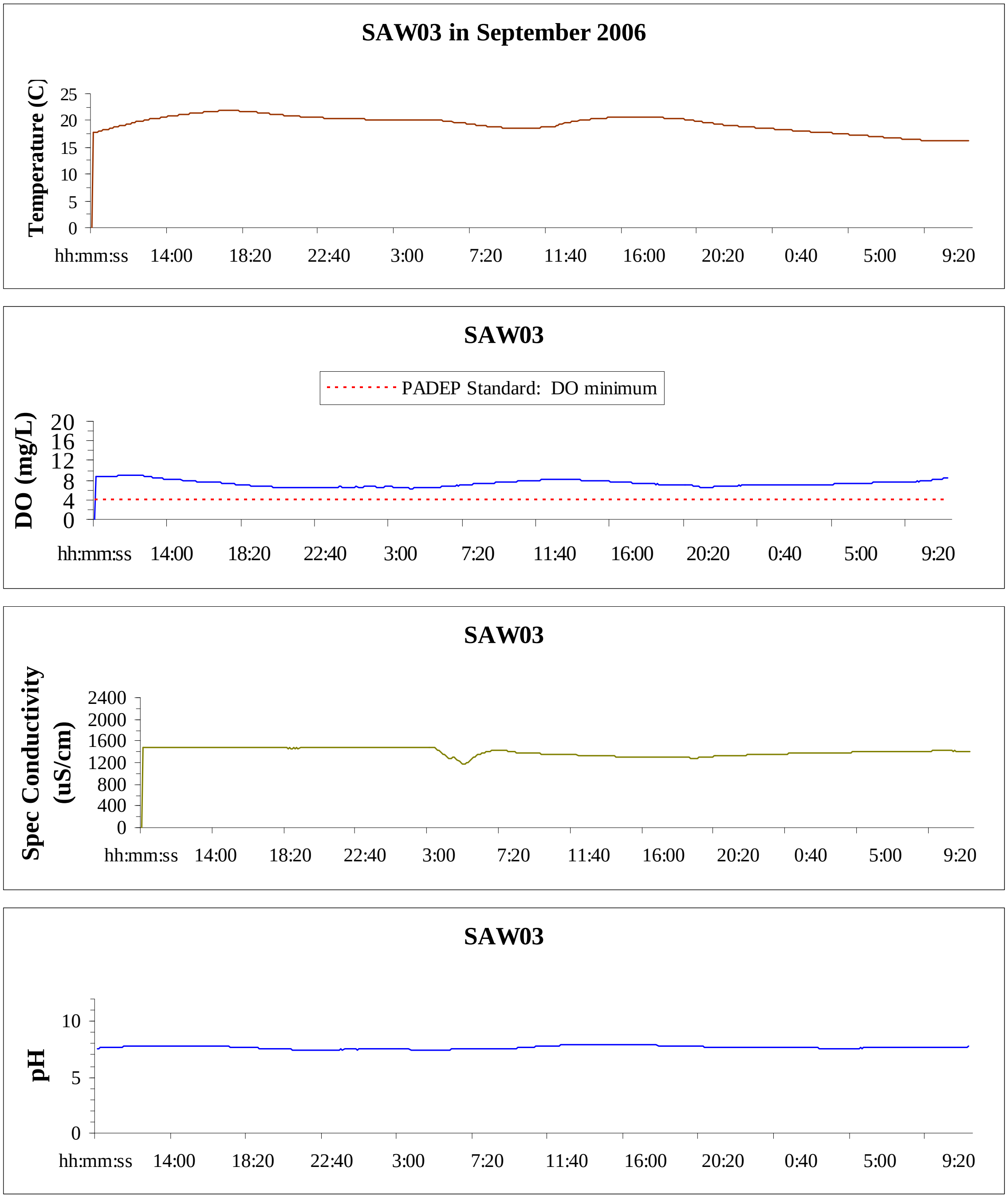


Figure A-7: Continuous Instream Measurements at SAW03 (September 2007)

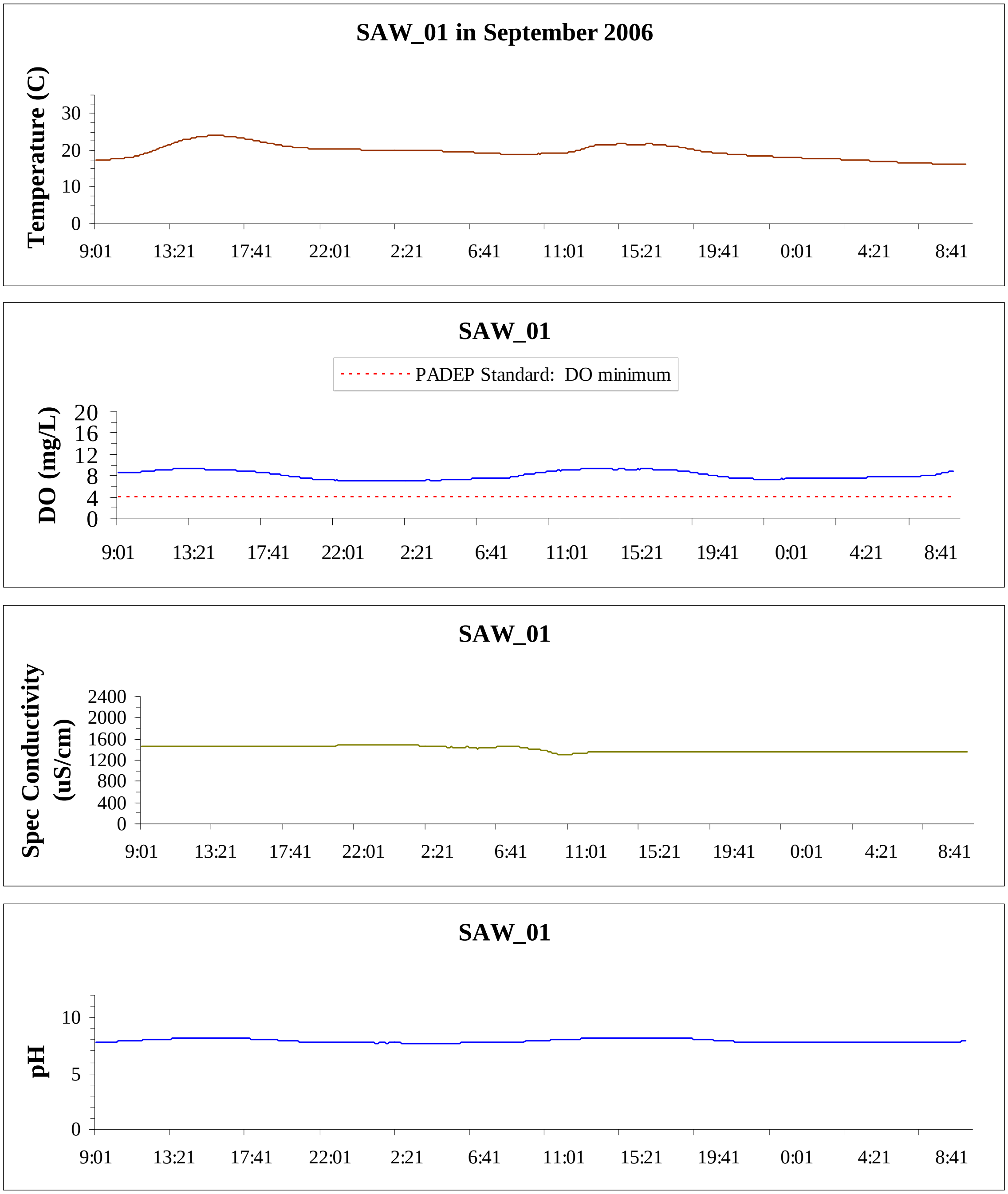


Figure A-8: Continuous Instream Measurements at SAW01 (September 2007)

Appendix B: Equal Marginal Percent Reduction Method

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Load Allocations (ALAs) between the appropriate contributing non-point sources. The load allocation and EMPR procedures were performed using MS Excel. The 4 major steps identified in the spreadsheet are summarized below:

- **Step 1**: Calculation of the TMDL based on a reference watershed area adjusted to the size of the impaired watershed.

- **Step 2**: Calculation of Adjusted Load Allocation (ALA) based on TMDL, Margin of Safety, and existing loads not reduced.

  ALA = TMDL – MOS – WLA – (Existing Loads not reduced, i.e. Forest)

- **Step 3**: Actual EMPR Process.

  - **a)** Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving water-body. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.

  - **b)** After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

Step 4: Calculation of total loading of all sources receiving reductions.