UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Total Maximum Daily Load
For Sediment
Marsh Run and McCarthy Run Watersheds
Indiana County, Pennsylvania

_______/s/_________________
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Executive Summary

Introduction

As required by Section 303(d) of the Clean Water Act and current EPA regulations, states are required to develop Total Maximum Daily Loads (TMDLs) for waterbodies that exceed water quality standards. Marsh Run and McCarthy Run were listed on the Pennsylvania 1996 List of Impaired Waters (DEP, 1996) because of water quality violations of the Aquatic Life Use Standard (benthic impairment). Marsh Run and McCarthy Run are located in the central region of Indiana County, in western Pennsylvania (Figure 1-1). The streams are tributaries of Stoney Run, and are part of the Conemaugh River Basin (RF3 Reach ID 05010007).

Impairment Listing

The Pennsylvania Department of Environmental Protection (DEP) uses biological monitoring of benthic macroinvertebrates as one method to assess support of the aquatic life use for a waterbody. Bioassessments of the benthic macroinvertebrate communities in Marsh Run and McCarthy Run were performed by DEP using the EPA Rapid Bioassessment Protocols. Results of bioassessments indicated impaired benthic communities in both streams. Therefore, since the streams do not support adequate benthic invertebrate communities, the Aquatic Life Use Standard for Marsh Run and McCarthy Run is not being attained. As a result, the Pennsylvania Section 303(d) list includes Marsh Run for benthic impairments due to thermal modifications and McCarthy Run for impairments due to suspended solids (sediment) and thermal modifications. Although biological assessments indicated the creek is impaired, additional analyses described in this report were required to identify the causal pollutant (stressor) and sources within the watershed.

Watershed Characterization and Environmental Monitoring

The Marsh Run watershed is approximately 1,520 acres. Developed lands (59.8%) and forested lands (25.6%) represent the dominant land uses in the watershed. The McCarthy Run watershed is approximately 2,812 acres. Forested lands (43.0%) and agricultural lands (39.1%) represent the dominant land uses in the watershed. The watersheds are part of the Western Allegheny Plateau ecoregion, which extends from western Pennsylvania to southern Kentucky and is characterized by hills and wooded terrain. The soils in the watersheds are comprised mainly of the Gilpin-Wharton-Weikert soils series. Gilpin-Wharton-Weikert soils are moderately deep and deep, gently sloping to moderately steep, moderately well-drained soils characterized as the type ‘C’ hydrologic soils group.

Environmental monitoring data were vital to the identification of the pollutant stressor(s) that is impacting water quality conditions in Marsh Run and McCarthy Run. Available monitoring data included biological assessments, habitat assessments, visual surveys, and water quality monitoring data. Biological assessments were conducted at 2 stations on Marsh Run and 5 stations on McCarthy Run in May 2004. Assessments revealed impaired benthic communities at all stations on Marsh Run and McCarthy Run that were comprised almost exclusively of pollution-tolerant organisms. Habitat assessment scores were also performed at each bioassessment station, and visual surveys were taken throughout both watersheds. Excessive sedimentation and stream bank erosion were observed throughout both watersheds. Although no ambient water quality monitoring was conducted in Marsh Run or McCarthy Run, water quality data collected in a previous study of Marsh Run was used to assess potential toxicity from metals and organic compounds in that watershed. No violations of Pennsylvania aquatic life water quality criteria for metals or organic compounds were observed from these data.

Stressor Identification

The primary stressor to Marsh Run and McCarthy Run was determined based on evaluations of candidate stressors that potentially could be impacting the streams. The 1996 Pennsylvania Section 303(d) List of Impaired Waters identified thermal modifications resulting from urban runoff as a possible source of the benthic impairment in Marsh Run. McCarthy Run was also listed as impaired due to sediment and thermal modifications resulting from urban runoff. Therefore, these factors were considered in the evaluation of candidate stressors. Potential stressors in Marsh Run and McCarthy Run included temperature, toxics, sediment, and hydro-modification. Each candidate stressor was evaluated on the basis of available monitoring data, field observations, and consideration of potential sources in the watershed.

The 1996 Pennsylvania Section 303(d) List of Impaired Waters attributed the impaired benthic communities in Marsh Run to thermal modification and in McCarthy Run to excessive sediment loading, as well as thermal modification. Biomonitoring surveys conducted in May 2004 found no evidence of thermal modification impacting benthic invertebrates in either Marsh Run or McCarthy Run. However, siltation, sediment deposition, and stream bank erosion were observed throughout the watersheds, and are responsible for the poor conditions observed in these streams. The predominance of sediment particles in the substrate is detrimental to many invertebrate taxa, and was reflected by the sparse benthic communities observed, which were comprised almost exclusively of pollution-tolerant organisms.

Improvements in the benthic invertebrate communities of Marsh Run and McCarthy Run are dependent upon controlling excessive sedimentation from non-point sources, and subsequently restoring instream habitat within the streams. As such, it was determined that thermal modification did not pose an adverse impact to the benthic communities in these watersheds, and that only sediment TMDLs were necessary to address the aquatic life use impairments in Marsh Run and McCarthy Run.

Reference Watershed Approach

TMDL development requires determination of endpoints, or water quality goals/targets, for the impaired waterbody. TMDL endpoints represent stream conditions that meet water quality standards. Currently, Pennsylvania does not have numeric criteria for sediment. Therefore, a reference watershed approach was used to establish numeric TMDL endpoints for Marsh Run and McCarthy Run.

Due to differences in the physical characteristics of the Marsh Run and McCarthy Run watersheds, most notably differences in size and land use distributions, two reference watersheds were selected to determine the sediment TMDL endpoints. Pine Creek, located in Allegheny County, Pennsylvania, was selected as the reference watershed for the Marsh Run TMDL development. Elkhorn Run, located in Beaver County, Pennsylvania, was selected as the reference watershed for the McCarthy Run TMDL development. Reduction of the sediment unit loading in the impaired watersheds to the levels determined for the reference watersheds is expected to restore support of the aquatic life use for Marsh Run and McCarthy Run.

Sediment Loading Determination

Sediment sources within the Marsh Run and McCarthy Run watersheds include sediment derived from the erosion of lands present throughout the watershed, washoff from impervious surfaces, and the erosion of stream banks within Marsh Run and McCarthy Run.

Sediment loadings were determined for both the impaired and reference watersheds in order to quantify sediment loading reductions necessary to achieve the designated aquatic life use for Marsh Run and McCarthy Run. A sediment unit loading for each source area in the reference watersheds was computed using the reference watersheds average annual sediment loads and the land use distributions. The sediment unit loading was multiplied by the number of acres of each land use type in the Marsh Run and McCarthy Run impaired watersheds to determine the sediment TMDL endpoint loads for Marsh Run and McCarthy Run.

Sediment loadings from land erosion were determined using the ArcView Generalized Watershed Loading Functions (AVGWLF) model. AVGWLF model simulations were performed from a 10-year period in order to account for seasonal and annual variations in hydrologic conditions. For each impaired and reference watershed, average annual sediment loads were computed for each land source based on the 10-year simulation period. In addition, instream erosion was estimated in AVGWLF based on the stream bank lateral erosion rate equation introduced by Evans et al. (2003).

TMDL Allocation

Sediment TMDL allocations for Marsh Run and McCarthy Run were based on the following equation.

$$TMDL = WLA + LA + MOS$$

Where:

TMDL= Endpoint Sediment Load Based on Unit Loading from Reference Watershed

WLA = Wasteload Allocation

LA = Load Allocation

MOS = Margin of Safety

The wasteload allocation represents the total sediment loading allocated to point sources. The load allocation represents the total sediment loading allocated to non-point sources. A margin of safety is applied to account for uncertainty in methodologies and determination of sediment loadings. An explicit margin of safety of 10% was used for Marsh Run and McCarthy Run.

Load and wasteload allocations were based on an equal percent reduction from controllable sources. Because the town of Indiana has a Municipal Separate Storm Sewer (MS4) permit, sediment loads from developed lands in Marsh Run were allocated to the MS4 permit. An area weighted proportion of the sediment load from bank erosion in Marsh Run was also allocated to the Indiana MS4 permit. Loads from forested lands are considered to be representative of the natural condition and therefore were not subject to reductions. By reducing sediment loads from developed and agricultural lands and instream erosion by 57%, the sediment TMDL endpoint for Marsh Run is achieved. A 55% reduction in the sediment loads from agricultural and developed lands and instream erosion will achieve the sediment TMDL endpoint for McCarthy Run. The TMDLs for Marsh Run and McCarthy Run are shown in Table E-1 and Table E-2, respectively. The recommended TMDL allocations and the percent reduction required for all watershed sources for Marsh Run are presented in Table E-3, and for McCarthy Run are presented in Table E-4.

Table E-1: Sediment TMDL for Marsh Run (tons/year)

TMDL	Load Allocation	Wasteload Allocation	Margin of Safety (10%)
129.4	73.1	43.3	12.9

Table E-2: Sediment TMDL for McCarthy Run (tons/year)

TMDL	Load Allocation	Wasteload Allocation	Margin of Safety (10%)
571.6	514.4	0.0	57.2

Table E-3: Recommended TMDL Allocations for Marsh Run

Source	Land Use Type	Marsh Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	2.0	2.0	0
	Evergreen Forest	0.1	0.1	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	37.2	16.1	57
	Row Crop	15.5	6.7	57
	Low Intensity Residential	21.5	9.3	57
	High Intensity Residential	0.6	0.3	57
	Commercial/Industrial	2.2	0.9	57
	Urban/Recreational Grasses	1.9	0.8	57
	Instream Erosion	84.6	36.6	57
Point Sources - Indiana MS4	Deciduous Forest	0.4	0.4	0
	Evergreen Forest	0.0	0.0	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	2.0	0.9	57
	Row Crop	0.11	0.047	57
	Low Intensity Residential	34.9	15.1	57
	High Intensity Residential	1.6	0.7	57
	Commercial/Industrial	0.7	0.3	57
	Urban/Recreational Grasses	Not present	Not present	0
	Instream Erosion	59.5	25.8	57
Total		265.2	116.4	51

Table E-4: Recommended TMDL Allocations for McCarthy Run

Source	Land Use Type	McCarthy Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	9.6	9.6	0
	Evergreen Forest	1.3	1.3	0
	Mixed Forest	1.2	1.2	0
	Pasture/Hay	91.2	40.7	55
	Row Crop	559.6	249.6	55
	Low Intensity Residential	23.1	10.3	55
	High Intensity Residential	1.9	0.8	55
	Commercial/Industrial	3.5	1.6	55
	Quarries/Strip Mines/Gravel Pits	10.8	4.8	55
Instream Erosion	-	434.0	193.6	55
Point Sources	-	0.0	0.0	0
Total		1136.2	514.4	55

Implementation

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 Marsh Run and McCarthy Run TMDLs identify the necessary overall load reductions for sediment 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), and improvements in stormwater control.

The relative contribution of sediment varies throughout the watersheds according to the distribution of land use sources such as agricultural and developed lands. Instream bank erosion is also a very significant factor. Therefore, reductions in the sediment entrained in overland flow must be accompanied by substantial reductions in the volume of water delivered to the streams in order to achieve the water quality objectives of the TMDLs. Efforts must also be taken to control future potential sources of sediment and stormwater as new construction and redevelopment occurs. Because of the complexity of the problem and the potential solutions, an adaptive approach will be needed to achieve the TMDLs.

Public Participation

Watershed stakeholders had opportunities to provide input and to participate in the development of the TMDLs. A public meeting was held on June 28, 2004 in the town of Indiana. Stakeholders had the opportunity to comment on the identified pollutant stressor, the methodology employed to determine watershed loadings of the stressor, and the draft TMDLs.

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's (EPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are identified on the Section 303(d) list as not meeting their designated use(s). TMDLs represent the total pollutant loading from point, non-point, and natural background sources, including a margin of safety, which 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 pollutant 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 (DEP). As required by the Clean Water Act, Pennsylvania DEP 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 Section 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 Section 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 two segments on Pennsylvania's 1996 Section 303(d) list, Marsh Run and McCarthy Run, located in Indiana County.

1.2 Impairment Listing

Marsh Run and McCarthy Run were listed on Pennsylvania's 1996 Section 303(d) List of Impaired Waters (DEP, 1996) because DEP determined that they did not support the designated aquatic life use (benthic impairment). Biological assessments conducted in

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

these streams by DEP personnel indicated impaired benthic invertebrate communities, resulting in the Section 303(d) listing. The 1996 Section 303(d) list indicates that benthic impairments are caused by thermal modifications resulting from urban runoff in Marsh Run and both sediment and thermal modifications resulting from urban runoff in McCarthy Run. Table 1-1 tracks the various Section 303(d) listings.

Table 1-1: Pennsylvania Section 303(d) Listings for Marsh Run and McCarthy Run

Section 303(d) List	Stream	Stream Code	Impairment Listing	
1996	Marsh Creek*	Stream Code 44241	Urban Runoff/Storm Sewer	Thermal Modifications
	McCarthy Run	Stream Code 44230	Urban Runoff/Storm Sewer	Thermal Modifications; Suspended Solids
1998	Marsh Run	Segment ID 6323	Urban Runoff/Storm Sewer	Thermal Modifications
	McCarthy Run	Segment ID 6322	Urban Runoff/Storm Sewer	Thermal Modifications; Suspended Solids
2002	Marsh Run	Segment ID 6323	Urban Runoff/Storm Sewer	Thermal Modifications
	McCarthy Run	Segment ID 6322	Urban Runoff/Storm Sewer	Thermal Modifications; Suspended Solids

*Marsh Run was labeled on the 1996 Section 303(d) list as Marsh Creek.

Marsh Run and McCarthy Run are located in the central region of Indiana County, in western Pennsylvania (Figure 1-1) in Pennsylvania State Water Plan 18-D. The streams are tributaries of Stoney Run, and are part of the Conemaugh River Basin (RF3 Reach ID 05010007). A map of the Marsh Run and McCarthy Run stream networks, along with the stream codes for each stream segment which are used to describe impairment listings, is displayed in Figure 1-2.

Figure 1-1: Location of the Marsh Run and McCarthy Run Watersheds

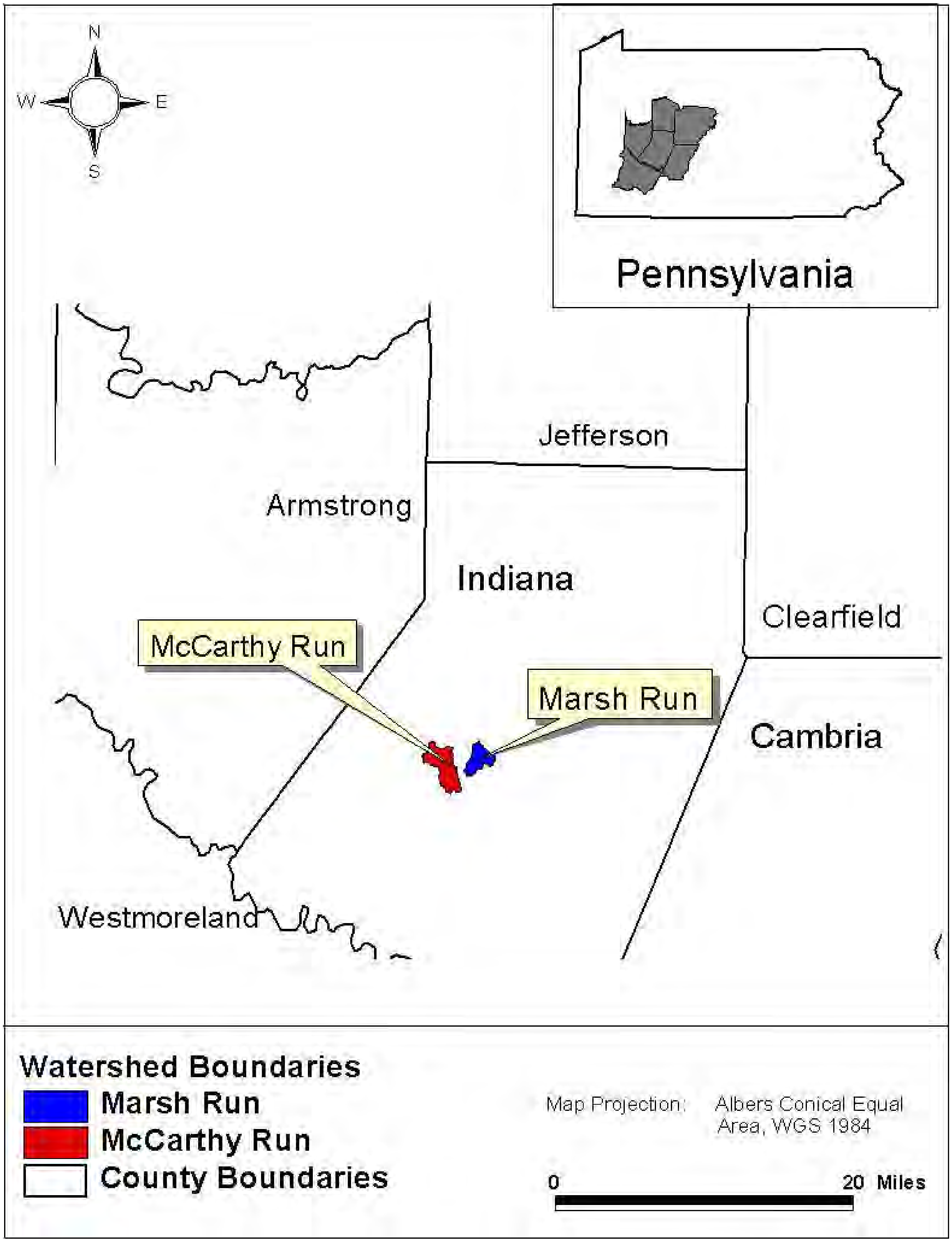
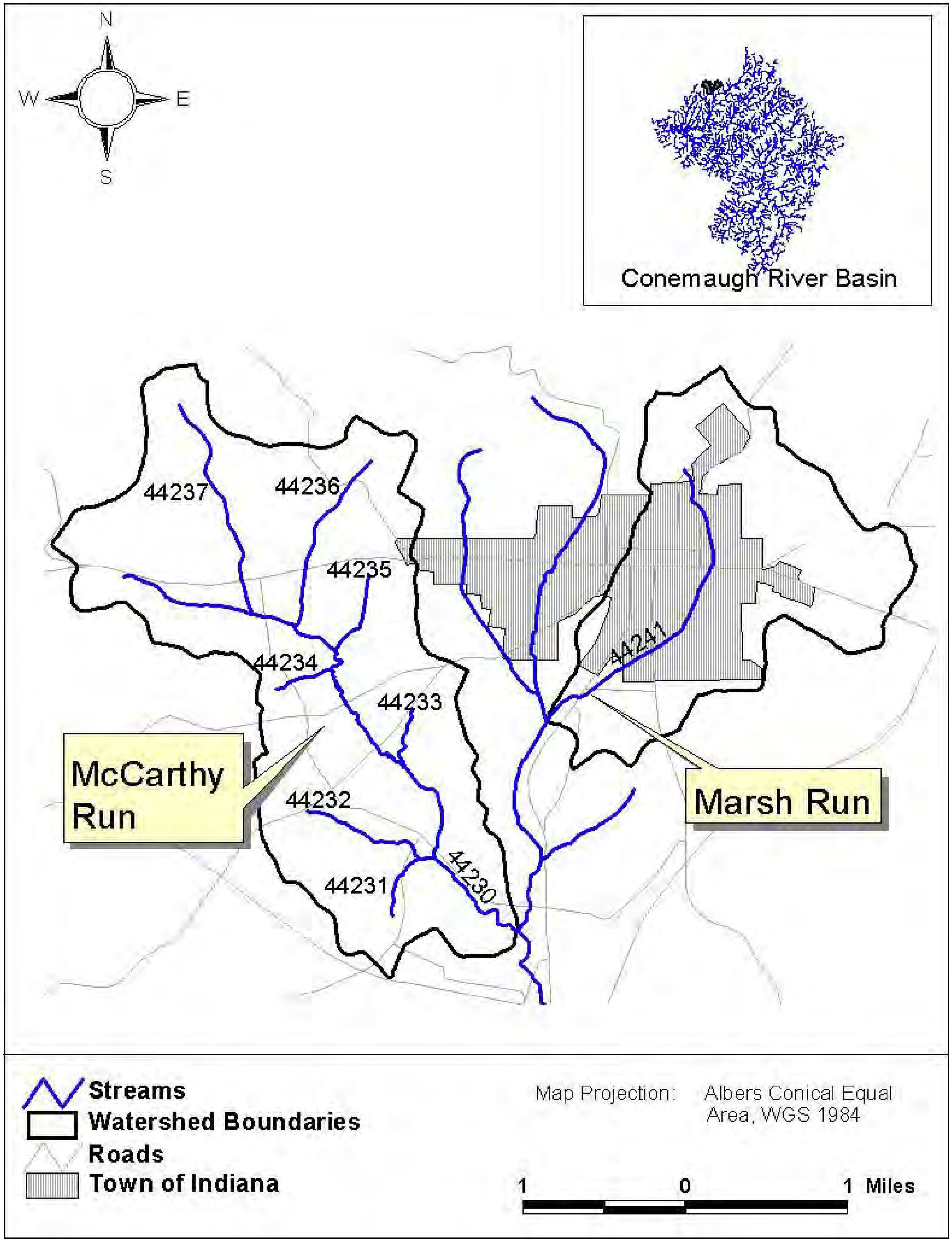


Figure 1-2: Marsh Run and McCarthy Run Stream Networks



1.3 Applicable Water Quality Standard

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

1.3.1 Designated Uses

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

1.3.2 Water Quality Criteria

1.3.2.1 Temperature Criteria

The Specific Temperature Criteria defined in Pennsylvania’s Water Quality Standards (§ 93.7 of the Code of Pennsylvania) provides specific criteria for the maximum allowable temperatures for waterbodies receiving discharge from heated waste sources, and are designed to protect designated and existing uses of the stream. Pennsylvania maximum temperature water quality criteria vary seasonally. The established maximum temperature water quality criteria for coldwater fisheries are presented in Table 1-2. In addition to these criteria, wastes discharged into receiving waters may not result in a change by more than 2°F during a 1-hour period.

Table 1-2: Maximum Temperature Water Quality Criteria for Pennsylvania

Critical Use Period	Maximum Temperature Criteria (degrees Fahrenheit)
January 1-31	38
February 1-29	38
March 1-31	42
April 1-15	48
April 16-30	52
May 1-15	54
May 16-31	58
June 1-15	60
June 16-30	64
July 1-31	66
August 1-15	66
August 16-30	66
September 1-15	64
September 16-30	60
October 1-15	54
October 16-31	50
November 1-15	46
November 16-30	42
December 1-31	40

1.3.2.2 Sediment Criteria

Sediment was also listed as a cause of impairment in McCarthy Run. However, Pennsylvania has not currently established numeric water quality criteria for sediment. In the absence of specific water quality criteria, the General Criteria defined by Pennsylvania provides a narrative criteria for the protection of a waterbodies designated uses.

1.3.2.3 General Criteria

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

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

Biological assessments conducted in 1996 indicated that Marsh Run and McCarthy Run are not supporting healthy benthic invertebrate communities, and thus do not support the Aquatic Life Use standard specified in Pennsylvania's general water quality criteria.

1.4 TMDL Development for Marsh Run and McCarthy Run

TMDL development requires a methodology to confirm impairment causes identified in the Section 303(d) list and to determine pollutant reductions that will allow the streams to attain their designated use. Marsh Run was identified to have thermal modification as the cause of impairment while McCarthy Run was identified to have both sediment and thermal modification as the cause of impairment.

In the subsequent sections of this report, the watershed and environmental monitoring data used in TMDL development for Marsh Run and McCarthy Run are discussed. Pollutants, also called *stressors*, which may be impacting the streams, are then analyzed in the stressor identification section. Based on this analysis, the causes of impairment identified on Pennsylvania's Section 303(d) list were confirmed through a stressor identification analysis as part of the TMDL development process. Stressor identification analysis uses available environmental monitoring and watershed characterization data to evaluate pollutants that may be resulting in the impairment observed in Marsh Run and McCarthy Run. Because thermal modification and sediment had been previously identified on the Section 303(d) list as sources of impairment, these pollutants were evaluated in this analysis. Through the stressor identification analysis, a primary stressor impacting Marsh Run and McCarthy Run was identified.

Once the primary pollutant impacting Marsh Run and McCarthy Run was identified, a technical approach was developed and used to estimate mass loading rates of the pollutant to the streams. In addition, the methodology used to quantify load reductions necessary to obtain designated uses for Marsh Run and McCarthy Run was developed. These approaches and calculations are presented in Sections 5.0 and 6.0 of this TMDL report. TMDL allocations for Marsh Run and McCarthy Run are presented in Section 7.0. Finally, reasonable assurance and implementation for these TMDLs is discussed in Section 8.0, and public participation is discussed in Section 9.0.

2.0 Watershed Characterization

The physical conditions of the Marsh Run and McCarthy Run watersheds were first characterized using geographic information systems (GIS) developed for the watersheds. The purpose of the watershed characterization was to provide an overview of the conditions in the watersheds related to the impairment listings of Marsh Run and McCarthy Run. Information obtained from the watershed characterization was used in identifying potential pollutant(s) causing the impairment to the benthic community, as well as for the subsequent TMDL development. In particular, watershed physical features such as topography, soil types, and land use types were characterized. In addition, any permitted discharge facilities or DEP monitoring stations present in the watersheds were documented.

2.1 Physical Characteristics

Important physical characteristics of the Marsh Run and McCarthy Run watersheds were analyzed using GIS coverages and other information describing physical conditions in the watersheds. GIS coverages of the watershed boundary, stream network, topography, soils, land use, and ecoregion for each watershed were compiled and analyzed. Sources of GIS data included the ArcView Generalized Watershed Loading Function (AVGWLF) model developed for Pennsylvania, BASINS, and the Pennsylvania DEP.

2.1.1 Watershed Location and Boundary

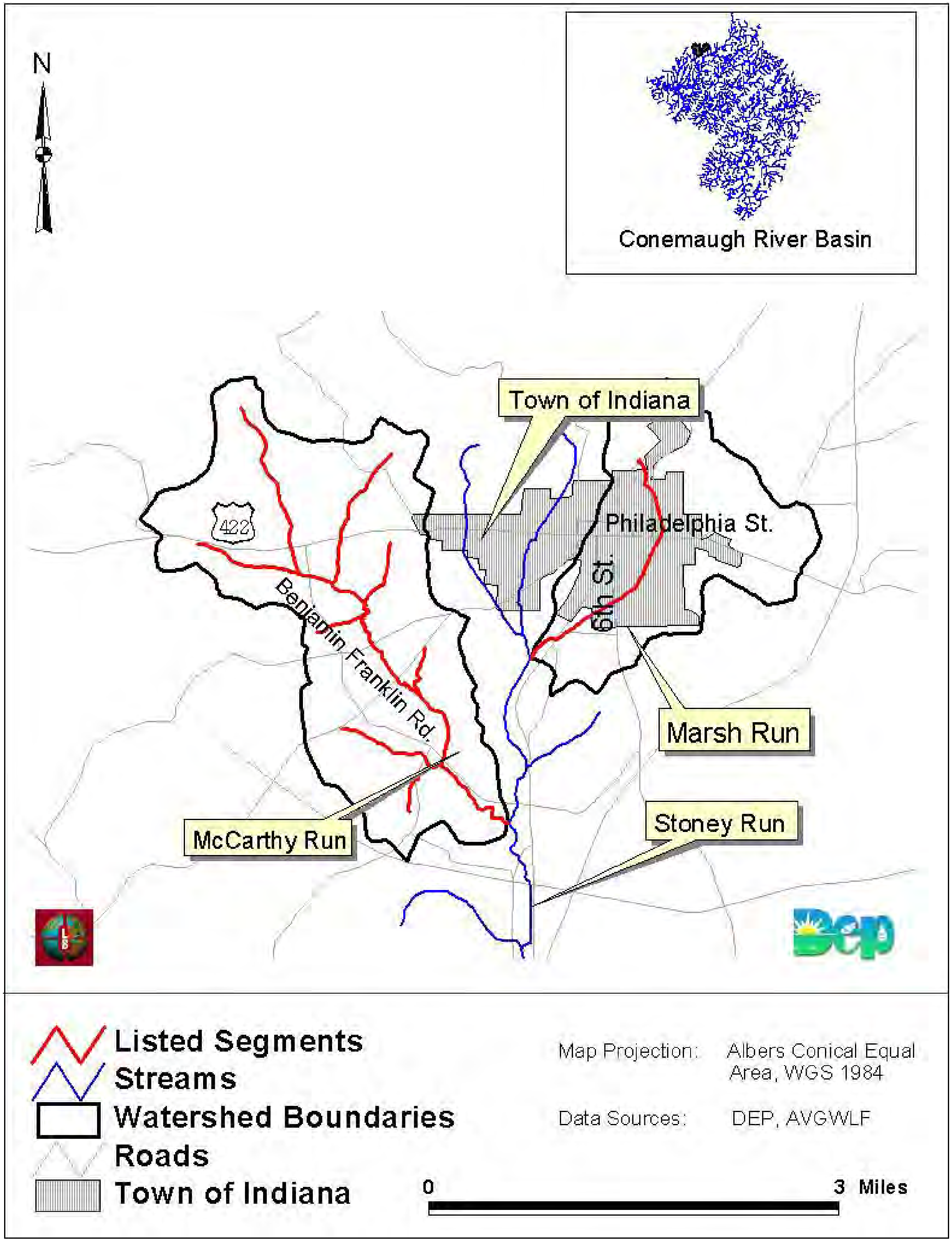
The Marsh Run and McCarthy Run watersheds are located in Indiana County, Pennsylvania. The Marsh Run watershed is approximately 1,520 acres, or 2.4 square miles. The McCarthy Run watershed is approximately 2,812 acres, or 4.4 square miles. Marsh Run and McCarthy Run are both tributaries of Stoney Run, and are located in the Conemaugh River Basin. The watershed boundaries of Marsh Run and McCarthy Run are shown in Figure 2-1. Route 422 runs through the northern section of the McCarthy Run watershed in an east to west direction. Benjamin Franklin Road runs through the center of the McCarthy Run watershed in a north to south direction. A large portion of the Marsh Run watershed is location within the boundary of the Town of Indiana.

Philadelphia Street runs through the center of the Marsh Run watershed in an east to west direction; 6th Street runs through the watershed in a north to south direction.

2.1.2 Stream Network

The stream networks for Marsh Run and McCarthy Run were obtained from BASINS Reach File 3 (RF3) and the ArcView Generalized Watershed Loading Functions (AVGWLF) model developed for Pennsylvania. Figure 2-1 displays a map of the streams, including the benthic impairment listed segments of Marsh Run and McCarthy Run. Both Marsh Run and McCarthy Run flow into Stoney Run, also depicted in Figure 2-1.

Figure 2-1: Watershed Boundaries and Stream Networks for Marsh Run and McCarthy Run



2.1.3 Topography

A 30-meter digital elevation model (DEM) and USGS 7.5 minute quadrangle maps were used to characterize topography in the watersheds. DEM data were obtained from the Pennsylvania Geospatial Data Clearinghouse and compared to the Indiana County USGS 7.5 minute quadrangle maps. Elevation in the Marsh Run watershed ranged from 1,107 to 1,422 feet above mean sea level with an average elevation of 1,263 feet. Elevation in the McCarthy Run watershed ranged from 1,032 to 1,527 feet above mean sea level, with an average elevation of 1,281 feet.

2.1.4 Soils

The Marsh Run and McCarthy Run watershed soil characterizations were based on the State Soil Geographic (STATSGO) dataset, obtained from the AVGWLF model. There are two general soil associations located in the Marsh Run watershed: Gilpin-Wharton-Weikert and Gilpin-Wharton-Ernest. There are three general soil associations located in the McCarthy Run watershed: Gilpin-Wharton-Weikert, Gilpin-Wharton-Ernest, and Gilpin-Weikert-Ernest. The majority of the soils in the Marsh Run and McCarthy Run watersheds are comprised of Gilpin-Wharton-Weikert soils. Gilpin-Wharton-Weikert soils are soils are moderately deep and deep, gently sloping to moderately steep, moderately well-drained soils that formed in residual and colluvial material on uplands. Gilpin-Wharton-Ernest soils are also moderately deep and deep, gently sloping to moderately steep, moderately well-drained soils that formed in the uplands in residual and colluvial material. Gilpin-Weikert-Ernest soils are medium-textured and moderately coarse-textured soils, located on moderately sloping to steep valley slopes and narrow to broad, rolling ridgetops. The distribution of soils in the Marsh Run and McCarthy Run watersheds is presented in Table 2-1.

Table 2-1: Soil Types and Characteristics in the Marsh Run and McCarthy Run Watersheds

Map Unit ID	Soil Association	Percent of Marsh Run Watershed	Percent of McCarthy Run Watershed	Hydrologic Soil Group
PA044	Gilpin-Wharton-Weikert	88.1	80.8	C
PA051	Gilpin-Weikert-Ernest	0.0	16.6	C
PA053	Gilpin-Wharton-Ernest	11.9	2.6	C

Source: AVGWLF

The hydrologic soil groups represent different levels of infiltration capacity of the soils as described in Table 2-2. 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. Marsh Run and McCarthy Run have soils which have moderate to slow infiltration rates.

Table 2-2: 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

2.1.5 Land Use

Land use characterization was based on National Land Cover Data (NLCD) developed by USGS. The distribution of land uses in the Marsh Run watershed, by land area and percentage, is presented in Table 2-3. The table indicates that developed lands, mostly associated with the Town of Indiana, comprise almost 60% of the land uses in the Marsh Run watershed. Forested lands (25.6%), agricultural lands (14.0%), and other land uses (0.6%) are also present in the watershed. Developed lands are ubiquitous throughout the Marsh Run watershed. Forested and agricultural lands are concentrated in the northern sections of the watershed.

The distribution of land uses in the McCarthy Run watershed, by land area and percentage, is presented in Table 2-4. The table indicates that forested lands (43.0%) and agricultural lands (39.1%) represent the dominant land uses in the McCarthy Run watershed. Developed lands (17.8%) and other land uses (0.1%) are also present in the watershed. Forested and agricultural lands are relatively evenly dispersed throughout the McCarthy Run watershed. Developed lands are concentrated in the central section of the watershed.

Figure 2-2 displays a map of the land uses within the Marsh Run and McCarthy Run watersheds. Brief descriptions of land use classifications are presented in Table 2-5.

Table 2-3: Marsh Run Watershed Land Use Distribution

General Land Use Category	NLCD Land Use Type	Acres	Percent of Watershed	Total Percent
Developed	Low Intensity Residential	745.8	49.1	59.8
	High Intensity Residential	70.8	4.7	
	Commercial/Industrial/Transportation	91.9	6.0	
Agriculture	Pasture/Hay	190.3	12.5	14.0
	Row Crop	22.4	1.5	
Forest	Deciduous Forest	283.8	18.7	25.6
	Evergreen Forest	24.8	1.6	
	Mixed Forest	81.0	5.3	
Other	Quarries/Strip Mines/Gravel Pits	0.5	0.0	0.6
	Urban/Recreational Grasses	9.0	0.6	
Total		**1,520**	**100**	**100**

Table 2-4: McCarthy Run Watershed Land Use Distribution

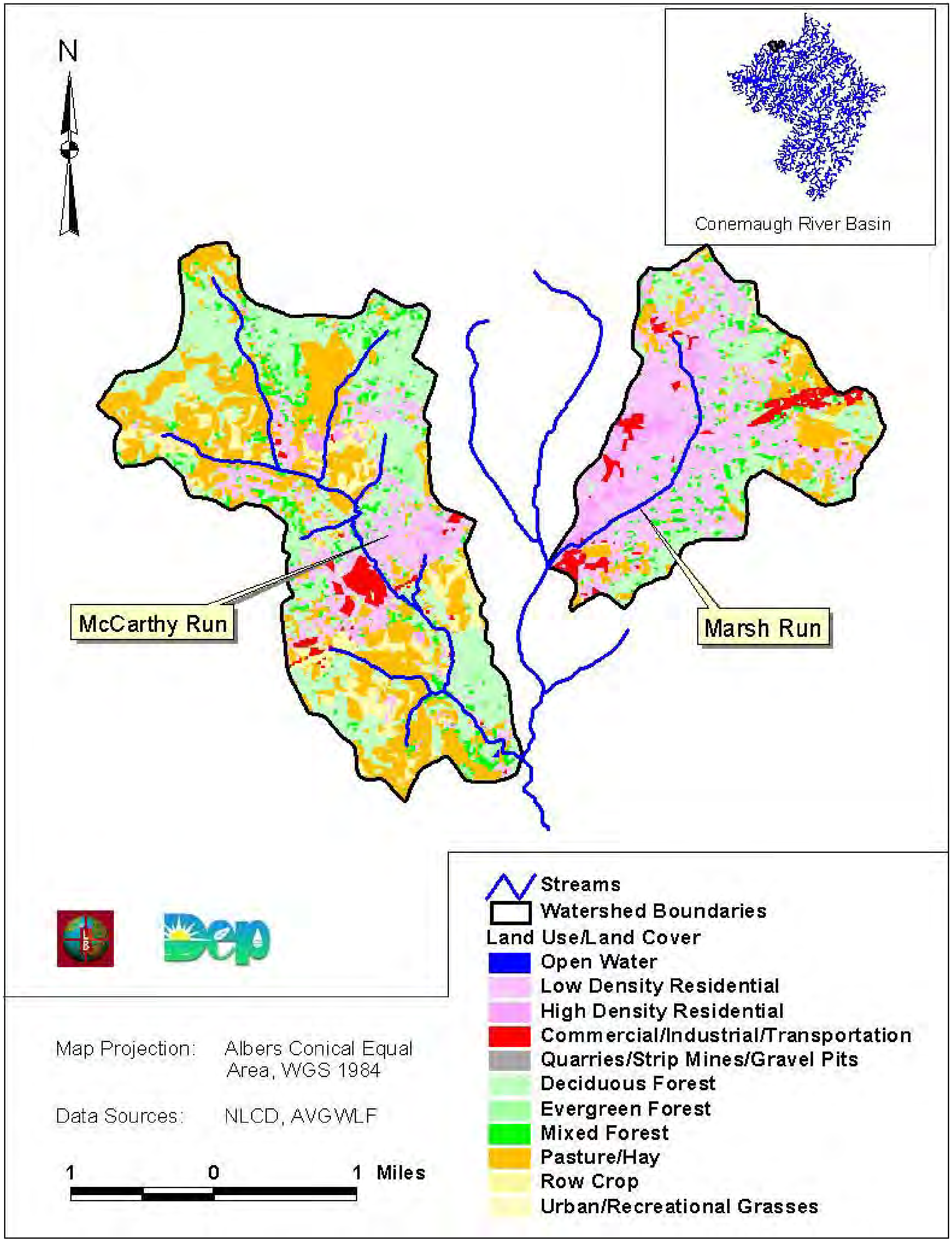
General Land Use Category	NLCD Land Use Type	Acres	Percent of Watershed	Total Percent
Water	Open Water	0.7	0.0	0.0
Developed	Low Intensity Residential	406.8	14.5	17.8
	High Intensity Residential	33.4	1.2	
	Commercial/Industrial/Transportation	61.8	2.2	
Agriculture	Pasture/Hay	841.2	29.9	39.1
	Row Crop	257.1	9.1	
Forest	Deciduous Forest	983.8	35.0	43.0
	Evergreen Forest	76.4	2.7	
	Mixed Forest	148.7	5.3	
Other	Quarries/Strip Mines/Gravel Pits	2.0	0.1	0.1
Total		**2,812**	**100**	**100**

Table 2-5: Descriptions of NLCD Land Use Types

Land Use Type	Description
Open Water	Areas of open water, generally with less than 25 percent or greater cover of water
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.
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
Row Crop	Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
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.
Quarries/Strip Mines/Gravel Pits	Areas of extractive mining activities with significant surface expression.
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.

Source: National Land Cover Data (NLCD)

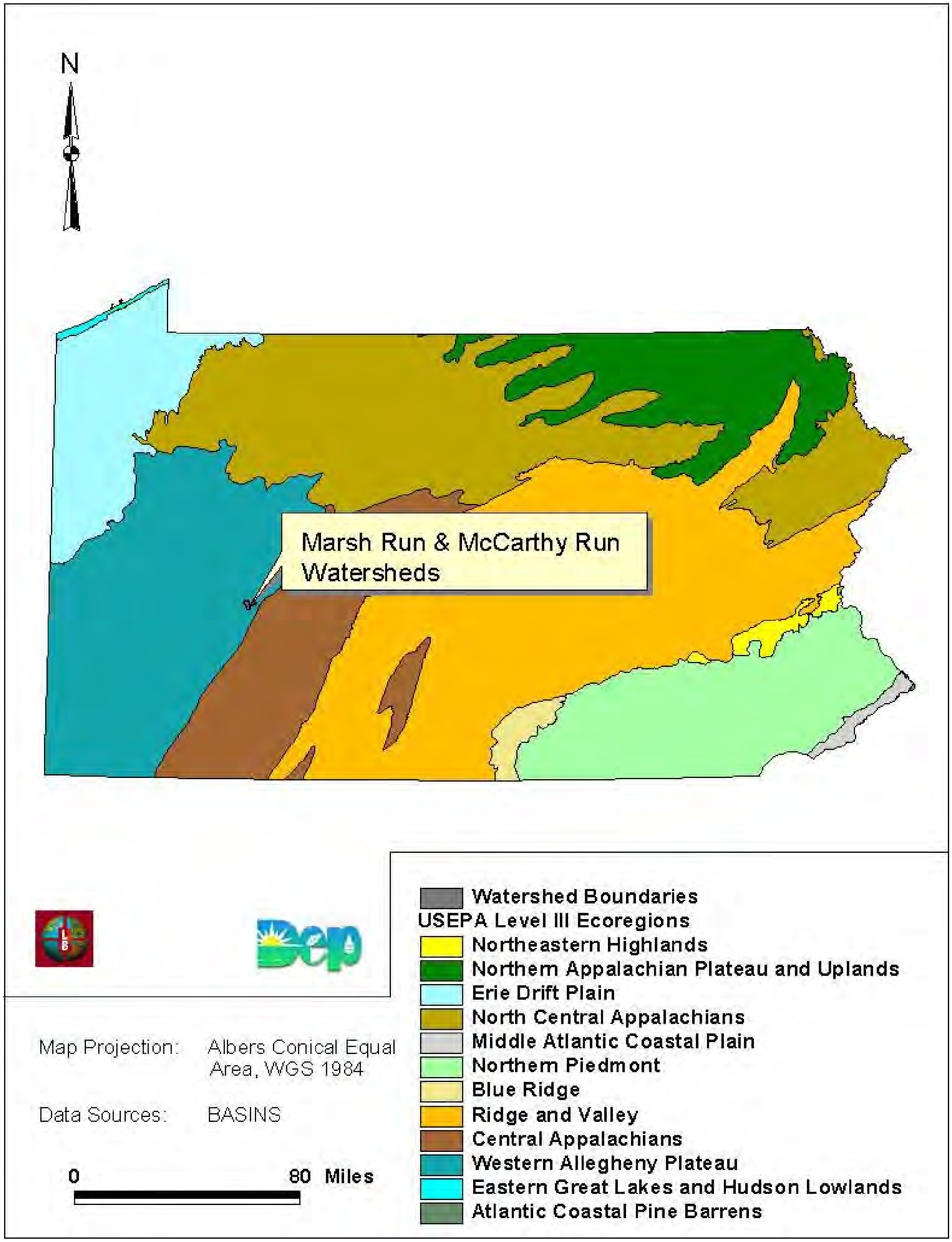
Figure 2-2: Land Use in the Marsh Run and McCarthy Run Watersheds



2.1.6 Ecoregion Classification

Marsh Run and McCarthy Run are located within the Western Allegheny Plateau ecoregion, Level III, classification number 70 (Woods et al., 1999). This ecoregion extends from western Pennsylvania southwest to southern Kentucky, and is characterized by hills and wooded terrain. The topography of the Western Allegheny Plateau is more rugged than the agricultural till plains of ecoregions to the north and west, but is less rugged and less forested than ecoregions to the east and south. Much of the hills in this region remain forested; agricultural and residential developments are concentrated in the valleys. The underlying geology of this region consists of horizontally-bedded sedimentary rock that has been frequently mined for bituminous coal. The location of the Marsh Run and McCarthy Run watersheds within the Western Allegheny Plateau ecoregion is displayed in Figure 2-3.

Figure 2-3: Pennsylvania Level III Ecoregions



2.2 Permitted Discharge Facilities

Based on the DEP Southwest Regional office, there are currently no permitted discharge facilities located in either the Marsh Run or McCarthy Run watersheds. In terms of Municipal Separate Storm Sewer (MS4) permits, there is one MS4 community, Indiana Borough, which covers approximately 41 percent of the Marsh Run watershed (Figure 2-1).

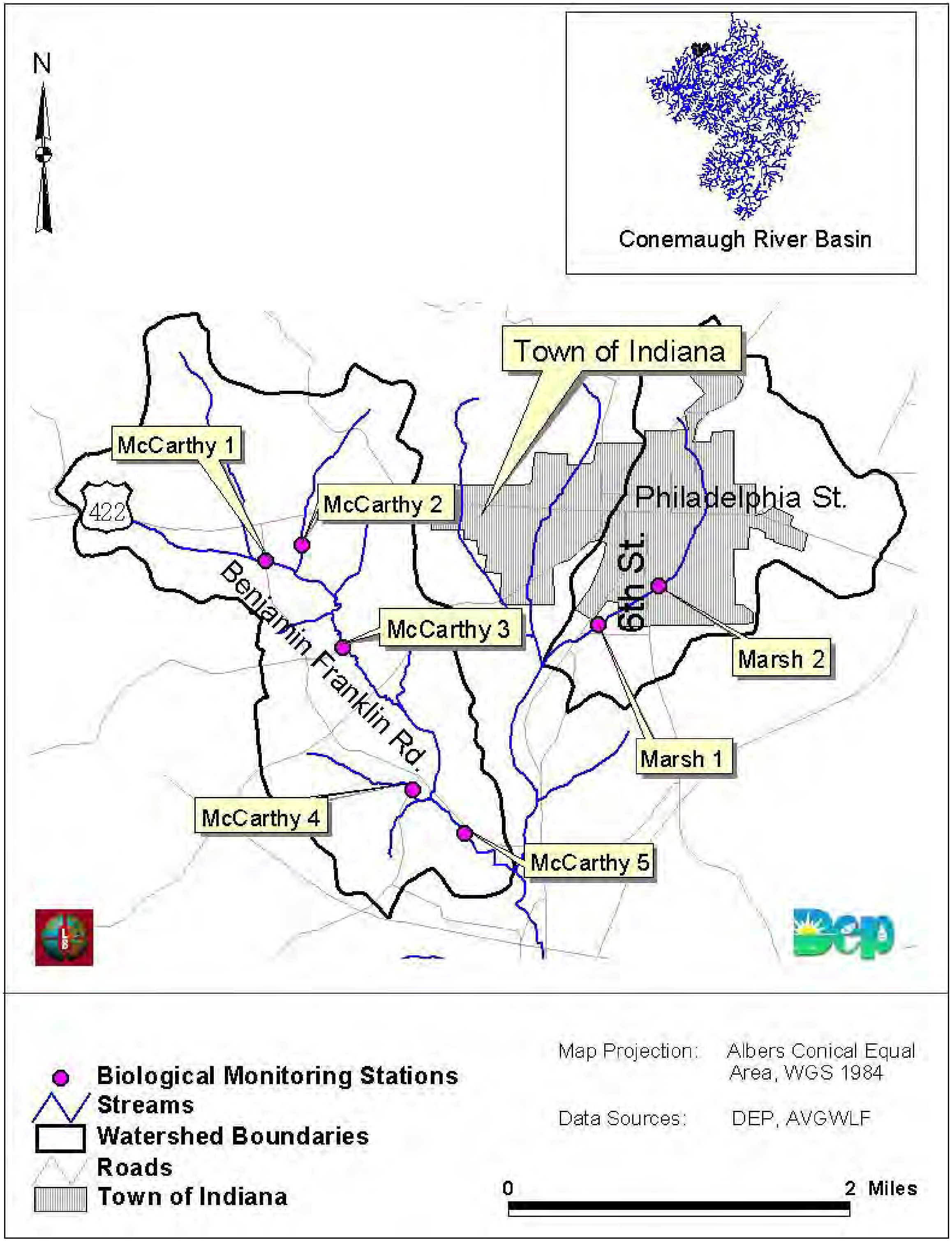
2.3 Biological Monitoring Stations

Prior to TMDL development, Marsh and McCarthy Runs had not been reassessed since they had been identified on the Section 303(d) list in 1996. To update and confirm the impairment status and listings for Marsh Run and McCarthy Run, additional biological monitoring was conducted in May 2004. DEP performed biological assessments at several stations on Marsh Run and McCarthy Run using their standard biological monitoring protocol. A summary list of the biomonitoring stations located in the Marsh Run and McCarthy Run watersheds is presented in Table 2-6 and the locations of these stations are presented in Figure 2-4. Locations of the monitoring stations were selected after field evaluations of watershed conditions and site accessibility, and were determined to be representative of the various sections of the Marsh Run and McCarthy Run watersheds. One monitoring assessment was conducted near the mouth of Marsh Run, and another assessment was conducted midway up the channel in the town of Indiana, where land use was predominantly urban and other developed lands. Biological assessments on McCarthy Run were conducted in the headwaters, on the mainstem midway between the headwaters and mouth, and near the mouth, as well as on several tributaries, in order to represent the various sections of the McCarthy Run watershed. A detailed discussion of the available environmental monitoring data is presented in Section 3.0.

Table 2-6: Location of Biological Monitoring Stations

Stream	Station	Location
Marsh Run	Marsh 1	Below the town of Indiana, near mouth
Marsh Run	Marsh 2	In the town of Indiana at the intersection of 5th St. and Elm St.
McCarthy Run	McCarthy 1	Headwaters, adjacent to Benjamin Franklin Rd.
Unnamed Tributary to McCarthy Run	McCarthy 2	Headwaters, south-east of intersection of Benjamin Franklin Rd. and Philadelphia St.
McCarthy Run	McCarthy 3	Mainstem midway up from mouth, at the intersection of Warren Rd. and Indian Springs Rd.
Unnamed Tributary to McCarthy Run	McCarthy 4	Adjacent to Indian Springs Rd., near mouth
McCarthy Run	McCarthy 5	Mainstem near mouth

Figure 2-4: Biological Monitoring Stations in the Marsh Run and McCarthy Run Watersheds



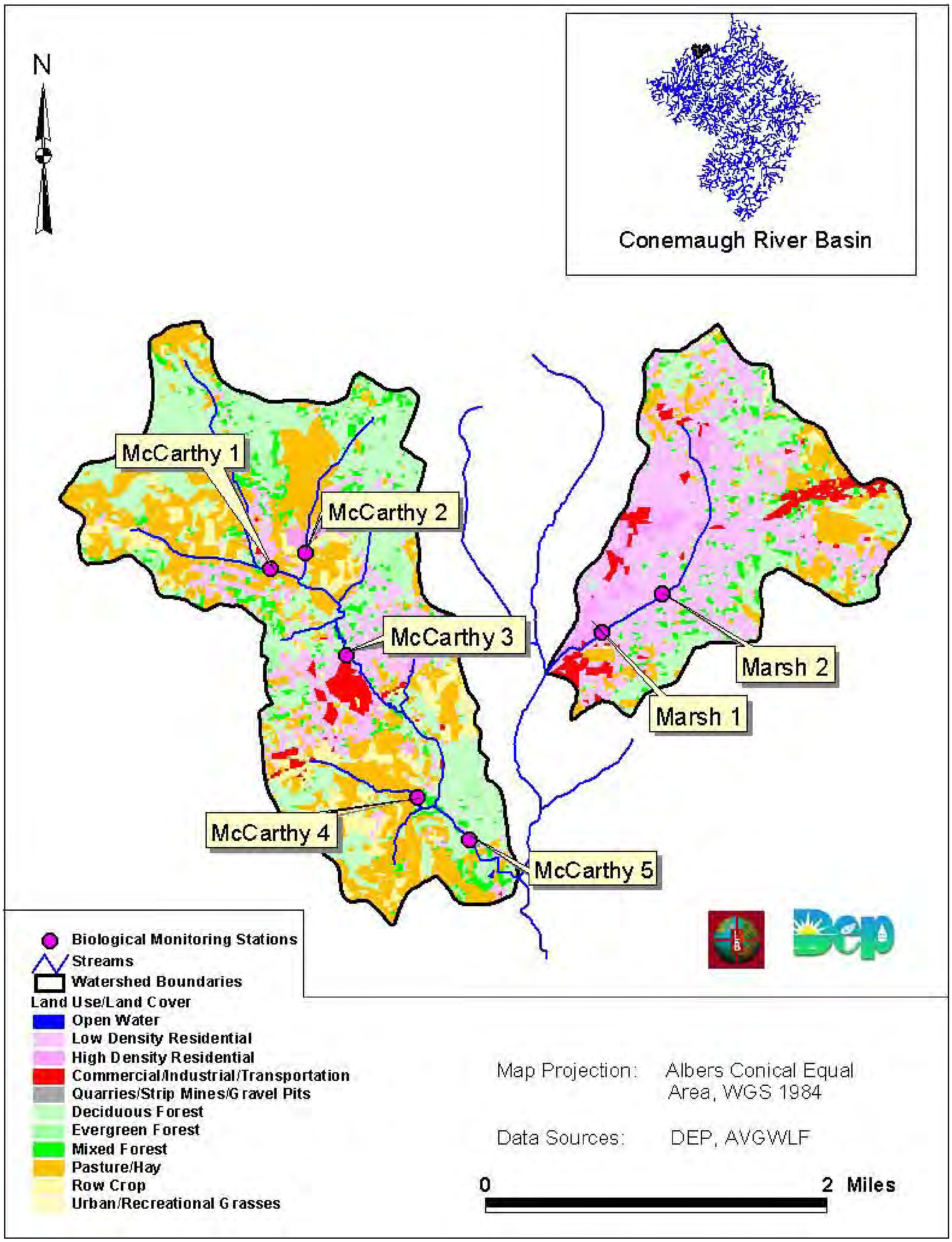
2.4 Water Quality Monitoring Stations

There are no fixed ambient water quality monitoring stations located in either the Marsh Run or McCarthy Run watersheds.

2.5 Overview of Marsh Run and McCarthy Run Watersheds

Developed lands (59.8%) represent the dominant land use in the Marsh Run watershed. Forested lands (43.0%) and agricultural lands (39.1%) represent the dominant land uses in the McCarthy Run watershed. There are also a significant (17.8%) percentage of developed lands present in the McCarthy Run watershed. There are no permitted discharge facilities located in either watershed. The town of Indiana is an MS4 community, and covers a large portion of the Marsh Run watershed. Biological monitoring surveys have been conducted at 2 stations in the Marsh Run watershed, and 5 stations in the McCarthy Run watershed. There are no ambient water quality stations on either Marsh Run or McCarthy Run. The land use and the location of the monitoring stations are shown in the summary map provided in Figure 2-5.

Figure 2-5: Overview of the Marsh Run and McCarthy Run Watersheds



3.0 Environmental Monitoring

The following sections summarize and present the available monitoring data used in the TMDL development for Marsh Run and McCarthy Run. Additional monitoring was conducted during development of the TMDL to confirm and update the original 1996 Section 303(d) impairment listings for these waterbodies. Analyzed data sources included available biological monitoring data, habitat assessments conducted at the monitoring stations, and other information. The locations of the monitoring stations in the Marsh Run and McCarthy Run watersheds were presented previously in Figure 2-4.

3.1 Biological Monitoring Data

Marsh Run and McCarthy Run were included on the 1996 Pennsylvania Section 303(d) List of Impaired Waters based on biomonitoring surveys that indicated the invertebrate communities in these streams were impaired. Due to the uncertainty of the original impairment causes, and to evaluate current conditions in these streams, additional biomonitoring surveys were conducted by DEP at 2 stations on Marsh Run and 5 stations on McCarthy Run in May 2004. Generally, DEP monitors the biological health of wadeable streams using a protocol based on EPA's Rapid Bioassessment Protocol (RBP) I (Plafkin et al., 1989). Monitoring stations are chosen in order to characterize the diversity of habitats, as well as to represent the mainstem and all major tributaries of the watershed. Benthic invertebrates are sampled from the best available riffle habitat using a minimum of 2 kick screens (3ft x 3ft). Invertebrates are identified to the family level in the field by the DEP biologist conducting the surveys. Several water chemistry parameters, including temperature and dissolved oxygen, are measured in the field at the monitoring stations. Visual habitat assessments examining channel, substrate, flow, and stream bank characteristics are also conducted at each monitoring station.

3.1.1 Benthic Invertebrate Data

Current biological assessments conducted at stations on Marsh Run and McCarthy Run revealed poor invertebrate populations in both streams. Relatively few taxa were observed; of the taxa present, most were classified as tolerant taxa often present in impaired waters. Biomonitoring surveys conducted at the 2 stations on Marsh Run revealed sparse invertebrate assemblages dominated by flatworms (Turbellaria), earthworms (Oligochaeta), and chironomids (Chironomidae). No pollution-sensitive taxa were observed at either monitoring station located on Marsh Run.

Biomonitoring surveys indicated that invertebrate abundance and taxa diversity were higher at the 5 biomonitoring stations located on McCarthy Run than those located on Marsh Run. However, with the exception of one family of stoneflies (Perlodidae), all of the taxa observed were tolerant taxa often present in polluted waters. Chironomids (Chironomidae) were the most dominant taxa across the 5 monitoring stations on McCarthy Run. Other common taxa in McCarthy Run included earthworms (Oligochaeta), beetles (Elmidae), and Hydropsychids (Hydropsychidae), a pollution-tolerant caddisfly. The DEP biologist conducting the biomonitoring surveys rated all 5 stations on McCarthy Run, as well as both stations on Marsh Run, as impaired based on the benthic invertebrate communities observed in the streams.

A summary of the biomonitoring results for Marsh Run and McCarthy Run are presented in Table 3-1. Descriptions and locations of the monitoring stations were previously presented in Table 2-6 and Figure 2-4.

Table 3-1: Summary of Biomonitoring Results for Marsh Run and McCarthy Run

Common Name	Order	Family	Biomonitoring Stations						
			Marsh 1	Marsh 2	McCarthy 1	McCarthy 2	McCarthy 3	McCarthy 4	McCarthy 5
Earthworms	Annelida (phylum)	Oligochaeta (class)	P	C	P	C	P	P	P
Beetles	Coleoptera	Elmidae			P	P	P		R
Beetles	Coleoptera	Psephenidae							P
Crayfish	Decapoda	Cambaridae		R	R	R		P	P
Chironomids	Diptera	Chironomidae	P	P	A	P	C	C	C
True Flies	Diptera	Tipulidae	R	R	P			P	P
True Flies	Diptera	Simuliidae			A				
True Flies	Diptera	Other Diptera			R		P		
Snails	Gastropoda	Physidae	R						
Sow Bugs	Isopoda	Asellidae				C	P		P
Dragonflies	Odonata	Aeshnidae				R			
Flatworms	Platyhelminthes (phylum)	Turbellaria (class)	C	P					
Stoneflies	Plecoptera	Perlodidae			P	P	R		
Caddisflies	Trichoptera	Hydropsychidae			R	P	P	P	P

Relative Abundance: Rare (R) <2, Present (P) 3-8, Common (C)10-24, Abundant (A) 25-100

3.1.2 Habitat Assessment Scores

A suite of habitat variables were visually inspected at each biomonitoring station on Marsh Run and McCarthy Run. Habitat parameters that were examined include instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alteration, sediment deposition, riffle frequency, channel flow, stream bank condition and vegetation, and riparian zone width and stability. Each parameter was assigned a score from 0 to 20, with 20 indicating optimal conditions, and 0 indicating very poor conditions. All biomonitoring stations located on Marsh Run and McCarthy Run scored low for embeddedness and sediment deposition. Some biomonitoring stations also scored low for other habitat variables such as velocity regime, channel alteration, bank condition, and riparian width. Habitat assessment scores for Marsh Run and McCarthy Run are presented in Table 3-2 and Table 3-3, respectively.

Table 3-2: Habitat Assessment Scores for Marsh Run Biomonitoring Stations

Station	Instream Cover	Epifaunal Substrate	Embeddedness	Velocity Regime	Channel Alteration	Sediment Deposition
Marsh 1	12	12	11	13	12	11
Marsh 2	13	13	11	13	13	12

Table 3-2: Habitat Assessment Scores for Marsh Run Biomonitoring Stations (Continued)

Station	Riffle Frequency	Channel Flow	Bank Condition	Bank Vegetation	Vegetation Disruption	Riparian Width
Marsh 1	13	16	10	14	12	10
Marsh 2	12	15	14	13	11	7

Table 3-3: Habitat Assessment Scores for McCarthy Run Biomonitoring Stations

Station	Instream Cover	Epifaunal Substrate	Embeddedness	Velocity Regime	Channel Alteration	Sediment Deposition
McCarthy 1	10	12	10	11	11	10
McCarthy 2	10	10	11	11	11	10
McCarthy 3	13	11	11	14	11	10
McCarthy 4	13	12	11	13	11	13
McCarthy 5	14	15	12	14	12	12

Table 3-3: Habitat Assessment Scores for McCarthy Run Biomonitoring Stations (Continued)

Station	Riffle Frequency	Channel Flow	Bank Condition	Bank Vegetation	Vegetation Disruption	Riparian Width
McCarthy 1	12	15	11	11	10	5
McCarthy 2	11	12	13	11	10	5
McCarthy 3	10	17	11	13	12	13
McCarthy 4	12	16	12	14	13	12
McCarthy 5	14	16	15	13	14	9

3.2 Field Water Quality Data from Biomonitoring Surveys

Field measurements for dissolved oxygen and temperature collected midday were recorded as part of the biomonitoring surveys conducted in May 2004. Field water quality data, presented in Table 3-4, indicate that dissolved oxygen concentrations in Marsh Run and McCarthy Run on the sampling date were well above the Pennsylvania minimum dissolved oxygen water quality criteria, which is designated as 5 mg/L for waters supporting coldwater fisheries, and 4 mg/L for waters supporting warmwater fisheries. Temperature values measured in Marsh Run and McCarthy Run also fell well below the Pennsylvania maximum temperature water quality criteria, which are designated as 54 degrees for waters supporting coldwater fisheries, and 64 degrees for waters supporting warmwater fisheries during the time period of May 1-15, when these data were collected.

Table 3-4: Field Water Quality Data for Marsh Run and McCarthy Run Biomonitoring Stations

Station	Dissolved Oxygen (mg/L)	Temperature (degrees Celsius)
Marsh 1	13.2	9.6
Marsh 2	14.9	10.3
McCarthy 1	12.4	13.3
McCarthy 2	13.6	15.0
McCarthy 3	12.8	10.7
McCarthy 4	11.5	10.5
McCarthy 5	13.3	11.1

3.3 Visual Surveys

Visual surveys were conducted throughout the Marsh Run and McCarthy Run watersheds in February and May of 2004. Siltation and heavy sediment deposition were observed throughout the Marsh Run watershed, and sand bars were observed along the stream channel (Figures 3-1 and 3-2). There was little riparian vegetation along most of the stream lengths of Marsh Run, the stream banks were heavily eroded in some areas, and stream bank stabilization practices were observed throughout the watershed (Figures 3-3 and 3-4). Because the stream flows through an urban setting, much of Marsh Run runs underground before it exits the Indiana city limits.

Similar sediment problems were observed throughout the McCarthy Run watershed. Heavy sediment accumulation was observed, and much of the substrate was comprised almost entirely of sediment (Figure 3-5). Like Marsh Run, there was little riparian vegetation along McCarthy Run, particularly in the headwater areas, highly eroded stream banks were observed in some areas, and stream bank stabilization practices were present throughout the watershed (Figures 3-6 to 3-8).

Figure 3-1: Sediment Deposition in Marsh Run

Figure 3-2: Siltation and Substrate Embeddedness in Marsh Run

Figure 3-3: Stream Bank Erosion in Marsh Run

Figure 3-4: Stream Bank Stabilization in the Marsh Run Watershed

Figure 3-5: Sand Dominated Substrate in McCarthy Run

Figure 3-6: Stream Bank Erosion in the Headwaters of McCarthy Run

Figure 3-7: Channel Modification and Stream Bank Stabilization on the McCarthy Run Mainstem

Figure 3-8: Bank Erosion and Exposed Soil in the McCarthy Run Watershed

3.4 Water Quality Monitoring

As stated previously in Section 2.0, there are no ambient water quality monitoring stations present in either the Marsh Run or McCarthy Run watersheds. However, after contacting various watershed associations and other stakeholders present in the area, it was determined that several instream water quality samples had been collected at the mouth of Marsh Run as part of a previous study conducted in the watershed. These data were collected as part of a site characterization report for the Kovalchick Salvage Company, which encompasses the confluence of Marsh Run and Whites Run, as well as the upper portion of Stoney Run. Segments of Marsh Run, Whites Run, and Stoney Run all flow through the Kovalchick Salvage Company property. A total of eighteen surface water samples were collected at 9 sites on the premises in September and October, 2003. Of these 9 sampling sites, 3 were located on Marsh Run. Two sites, labeled SW03 and SW07, were sampled for semi-volatile and volatile organic compounds. The other site, labeled SW08, was sampled for semi-volatile and volatile organic compounds, and dissolved metals. A complete list of the parameters analyzed is presented in Table 3-5.

Numeric water quality criteria for semi-volatile and volatile organic compounds and dissolved metals are described in section 16.24 of the Code of Pennsylvania. Laboratory analyses indicated that the instream samples collected from Marsh Run were below detection limits for almost all semi-volatile and volatile organic compounds, and that there were no observed violations of numeric criteria (acute and chronic) for the aquatic life use. It is noted, however, that observed chloroform concentrations at sites SW03 and SW07 exceeded the Pennsylvania 5.7 µg/L human health water quality criteria. Though water quality concerns regarding human health chloroform are not within the scope of this TMDL, EPA suggests that this be further investigated. Dissolved metals concentrations at site SW08 were below analytical detection limits for almost all monitored parameters. For parameters that were detected, no violations of Pennsylvania metals criteria were observed at site SW08.

Table 3-5: Water Quality Parameters Analyzed in Marsh Run

Semi-Volatile Organic Compounds	Semi-Volatile Organic Compounds (continued)	Volatile Organic Compounds	Dissolved Metals
Acenaphthene	4,6-Dinitro-2-methylphenol	Acetone	Aluminum
Acenaphthylene	2,4-Dinitrophenol	Benzene	Antimony
Anthracene	2,4-Dinitrotoluene	Bromodichloromethane	Arsenic
Benzo(a)anthracene	2,6-Dinitrotoluene	Bromoform	Barium
Benzo(a)pyrene	Fluoranthene	Bromomethane	Beryllium
Benzo(b)fluoranthene	Fluorene	2-Butanone	Cadmium
Benzo(ghi)perylene	Hexachlorobenzene	Carbon Disulfide	Calcium
Benzo(k)fluoranthene	Hexachlorobutadiene	Carbon Tetrachloride	Chromium
Bis(2-Chloroethoxy)methane	Hexachlorocyclopentadiene	Chlorobenzene	Cobalt
Bis(2-Chloroethyl)ether	Hexachloroethane	Chloroethane	Copper
Bis(2-Chloroisopropyl)ether	Indeno(1,2,3-cd)pyrene	Chloroform	Iron
Bis(2-Ethylhexyl)phthalate	Isophorone	Chloromethane	Lead
4-Bromophenyl-phenylether	2-Methylnaphthalene	Dibromochloromethane	Magnesium
Butylbenzylphthalate	N-nitrosodi-n-propylamine	1,1-Dichloroethane	Manganese
Carbazole	N-nitrosodiphenylamine	1,2-Dichloroethane	Mercury
4-Chloro-3-methylphenol	Naphthalene	1,1-Dichloroethene	Nickel
4-Chloroaniline	2-Nitroaniline	cis-1,2-Dichloroethene	Potassium
2-Chloroaphthalene	3-Nitroaniline	trans-1,2-Dichloroethene	Selenium
2-Chlorophenol	4-Nitroaniline	1,2-Dichloropropane	Silver
4-Chlorophenyl-phenylether	Nitrobenzene	cis-1,3-Dichloropropene	Sodium
Chrysene	2-Nitrophenol	trans-1,3-Dichloropropene	Thallium
o-Cresol	4-Nitrophenol	Ethylbenzene	Vanadium
p-Cresol	Pentachlorophenol	2-Hexanone	Zinc
Di-n-butylphthalate	Phenanthrene	4-Methyl-2-pentanone	
Di-n-octylphthalate	Phenol	Methylene chloride	
Dibenz(a,h)anthracene	Pyrene	Styrene	
Dibenzofuran	1,2,4-Trichlorobenzene	1,1,2,2-Tetrachloroethane	
1,2-Dichlorobenzene	2,4,5-Trichlorophenol	Tetrachloroethene	
1,3-Dichlorobenzene	2,4,6-Trichlorophenol	Toluene	
1,4-Dichlorobenzene		1,1,1-Trichloroethane	
3,3’-Dichlorobenzidine		1,1,2-Trichloroethane	
2,4-Dichlorophenol		Trichloroethene	
Diethylphthalate		Vinyl chloride	
2,4-Dimethylphenol		m,p-Xylene	
Dimethylphthalate		o-Xylene	

4.0 Stressor Identification Analysis

As a part of the TMDL development, a stressor identification analysis was performed for Marsh Run and McCarthy Run. This analysis was conducted for the purpose of confirming that the original sediment and thermal modification impairment listings identified on Pennsylvania's Section 303(d) list are accurately described before the pollutant loadings are characterized. This entails an identification of pollutant stressor(s) that are impacting the benthic invertebrate community, which was performed using the available environmental monitoring and watershed characterization data discussed in previous sections.

The primary stressor to benthic invertebrate communities in Marsh Run and McCarthy Run was determined based on evaluations of candidate stressors that can potentially impact the creek. The 1996 Pennsylvania Section 303(d) List of Impaired Waters identified possible sources of the benthic impairment in Marsh Run to be thermal modification resulting from urban runoff and in McCarthy Run to be both thermal modification and sediment resulting from urban runoff. Therefore, these factors were considered in the evaluation of candidate stressors. Potential stressors to the benthic communities in Marsh Run and McCarthy Run included temperature, toxics, sediment, and hydro-modification. Each candidate stressor was evaluated on the basis of available monitoring data, field observations, and consideration of potential sources in the watershed.

4.1 Temperature

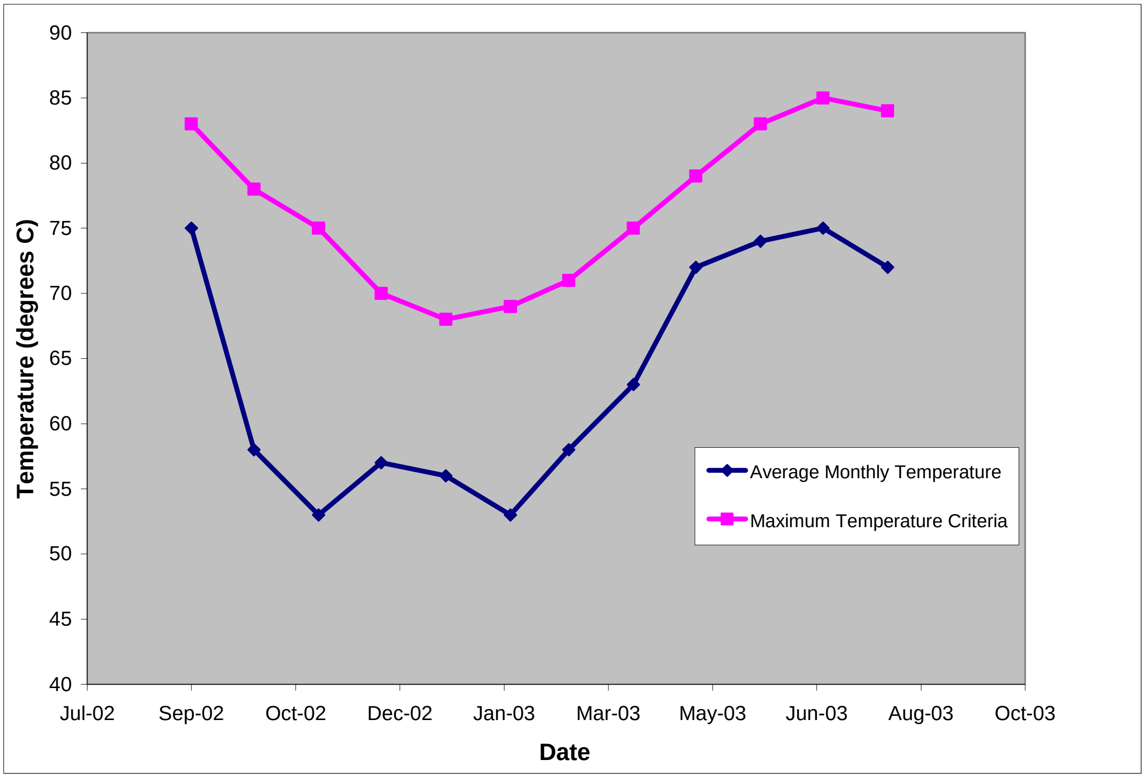
Thermal modification was listed as a cause of benthic impairment in Marsh Run and McCarthy Run on the 1996 Pennsylvania Section 303(d) List of Impaired Waters. Benthic invertebrate data upon which the stream was classified as impaired are no longer available. However, a notice of violation obtained from the DEP Southwest Regional office indicated that thermal modification resulting from a discharging point source had been observed in an unnamed tributary of Whites Run, which is also located in the Stoney Run watershed, immediately above both Marsh Run and McCarthy Run. Although this point source, the Specialty Tires of America plant (NPDES permit #

PA0004057), is located immediately above Marsh Run and McCarthy Run in the headwaters of the Stoney Run watershed, it is not located in the contributing drainage area of either of these streams, and therefore should not be considered as a pollutant source. However, DEP believes that the close proximity of this point source to Marsh Run and McCarthy Run may have resulted in their listing for thermal modification on the 1996 Pennsylvania Section 303(d) list, based on the assessment protocols of DEP at the time of the listings.

To investigate the current impacts of the Specialty Tires of America plant on the unnamed tributary to White's Run, discharge monitoring reports (DMR) from the facility for the time period of September 2002 to August 2003 were obtained and analyzed. For all available DMR, average monthly temperatures in the Specialty Tires of America effluent were below the Pennsylvania maximum temperature water quality criteria (Figure 4-1). These data suggest that there are also no current thermal modification impacts from this facility in the larger Stoney Run watershed, which encompasses Marsh Run and McCarthy Run.

Biomonitoring surveys conducted in May 2004 did not provide any evidence of thermal modification contributing to benthic impairment in Marsh Run or McCarthy Run. Field measurements recorded at each monitoring station showed that instream temperatures on the sampling date were well below the Pennsylvania maximum temperature water quality criteria for the time of year these data were collected (Table 3-4). Dissolved oxygen concentrations, which decrease with increasing temperature, were also well above Pennsylvania's minimum dissolved oxygen water quality criteria. Additionally, the available DMR data suggest that the permitted point source located on the unnamed tributary to Whites Run that was responsible for the thermal modification listings for Marsh Run and McCarthy Run is currently in compliance with Pennsylvania's maximum temperature water quality criteria. Therefore, thermal modification does not appear to be a stressor, or source of impairments, to benthic invertebrates in Marsh Run and McCarthy Run at this time.

Figure 4-1: Average Monthly Temperatures in Effluent of Specialty Tires of America, Located on an Unnamed Tributary to Whites Run in the Stoney Run Watershed



4.2 Toxics

Water quality samples taken at three stations on Marsh Run in the fall of 2003 were analyzed for a suite of toxic compounds, including, semi-volatile and volatile organic compounds, and dissolved metals. Laboratory results indicated that concentrations of volatile and semi-volatile organic compounds did not violate Pennsylvania aquatic life water quality standards. Additionally, no metals violations were observed at the station where water samples were analyzed for dissolved metals. There is no additional data or evidence to suggest that toxicity is impacting the benthic invertebrate assemblages in Marsh Run or McCarthy Run. Therefore, based on the available data toxics do not appear to be impacting benthic invertebrates in Marsh Run or McCarthy Run at this time.

4.3 Sedimentation

As indicated by habitat assessment data collected at the biomonitoring stations (Tables 3-2 and 3-3), as well as visual surveys taken throughout the watershed (Figures 3-1, 3-2, 3-5), heavy siltation and sediment deposition are present throughout the Marsh Run and McCarthy Run watersheds. Eroded stream channels and sand bars were also observed in both watersheds. Impacts of sediment loading were noted along the entire length of both streams, from the headwaters to the mouth. The DEP biologist conducting the biomonitoring surveys indicated that sediment was the primary stressor impacting the benthic invertebrate assemblages in Marsh Run and McCarthy Run (J. Boylan, personal communication).

Invertebrate taxa are adversely affected by siltation and excessive sedimentation in several ways. A healthy and diverse benthic invertebrate assemblage requires suitable habitat in which to live. However, the habitat assessment scores for embeddedness and sediment deposition (Tables 3-2 and 3-3) indicate that a large percentage of the benthic habitat in Marsh Run and McCarthy Run is being silted over by the heavy sediment loading present in the streams. Additionally, during high flow events suspended sediment in the streams may suffocate benthic invertebrates, or interfere with filtering mechanisms. The heavy siltation and sediment deposition present in Marsh Run and McCarthy Run are reflected in the invertebrate data collected, which shows relatively sparse benthic assemblages dominated by pollution-tolerant taxa.

Visual inspection identified several potential sources of sediment in the Marsh Run and McCarthy Run watersheds. Eroded stream banks were present throughout both watersheds (Figures 3-3, 3-6, 3-8), likely resulting from the elevated stream flows associated with the high degree of developed lands in the watersheds, or non-point source runoff from urban and agricultural lands. Very little riparian vegetation was observed at many of the biomonitoring stations (Tables 3-2, 3-3), which may result in an increased sediment load being transported to the streams from the surrounding watersheds. Construction sites and exposed soils were also observed in some places in the watersheds (i.e., Figure 3-8), and the sediment present in the streams appears to be originating from non-point sources and bank erosion. Due to land development, stormwater runoff, and other disturbances, a positive relationship exists between MS4 communities and sediment loading from stream bank erosion, land-based sources, and areas of exposed soil such as construction sites. The town of Indiana is an MS4 community, which provides further evidence for erosion and sedimentation problems impacting Marsh Run.

Based on the biomonitoring results, habitat assessment data, and visual observations, it is apparent that overland sources of sediment are impacting the streams, both in the headwaters and downstream. Therefore, excessive sediment loading appears to be the primary stressor impacting the benthic communities in Marsh Run and McCarthy Run.

4.4 Hydro-modification

The high percentages of developed lands in the Marsh Run and McCarthy Run watersheds likely contribute to increased stream flows during precipitation events, particularly in Marsh Run, which is highly urbanized. As stated above, increased stream flows can destabilize stream banks, increase stream bank erosion, and result in increased siltation of the substrate. High runoff events can also scour stream banks and flush benthic invertebrates and their habitat downstream.

Both streams flow through urban settings, particularly Marsh Run, which flows directly through the town of Indiana. Thus, it is likely that the hydrology of both Marsh Run and McCarthy Run, and subsequently the benthic communities in these streams, are impacted by impervious lands within the watersheds. However, many of the problems associated with hydro-modification are manifested as increased instream erosion and sediment loadings. While sediment loading resulting from altered hydrology likely impacts benthic invertebrates in Marsh Run and McCarthy Run, other sources of sediment, such as land-based sources, also contribute to sediment loading in these streams. Therefore, while hydrologic modification contributes to the sediment loading in Marsh Run and McCarthy Run, it alone is not the primary stressor impacting benthic invertebrates in these streams.

4.5 Stressor Identification Summary

Based on the evidence and data discussed in the preceding sections, sedimentation was identified as the primary stressor impacting Marsh Run and McCarthy Run. Excessive sediment loading has resulted in the highly embedded substrate and large sediment deposits observed in both streams. The available data suggest that overland/runoff sources and stream bank erosion represent the primary sources of sediment to Marsh Run and McCarthy Run.

As previously noted, the 1996 Pennsylvania Section 303(d) List of Impaired Waters attributed the impaired benthic communities in Marsh Run to thermal modification and in McCarthy Run to excessive sediment loading, as well as thermal modification. Biomonitoring surveys conducted in May 2004 found no evidence of thermal modification impacting benthic invertebrates in either Marsh Run or McCarthy Run. However, siltation, sediment deposition, and stream bank erosion were observed throughout the watershed, and are responsible for the poor conditions observed in these streams. The predominance of sediment particles in the substrate is detrimental to many invertebrate taxa, which was reflected by the sparse benthic communities observed, which were comprised almost exclusively of pollution-tolerant organisms. While hydro-modification related to developed lands in these watersheds also contributes to the benthic impairment, these problems are not the primary stressor to the benthic invertebrate communities in Marsh Run and McCarthy Run, and regardless would be addressed in the implementation of sediment-reducing management practices.

Improvements in the benthic invertebrate communities of Marsh Run and McCarthy Run are dependent upon controlling excessive sedimentation from non-point sources, and subsequently restoring instream habitat within the streams. As such, it was determined that thermal modification did not pose an adverse impact to the benthic communities in these watersheds, and that only sediment TMDLs were necessary to address the aquatic life use impairments in Marsh Run and McCarthy Run.

5.0 TMDL Endpoint Identification

TMDL development requires determination of endpoints, or water quality goals/targets, for the impaired waterbody. TMDL endpoints represent stream conditions that 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, a reference watershed approach may be used to define the TMDL endpoint.

Marsh Run and McCarthy Run were initially included on Pennsylvania's 1996 Section 303(d) List of Impaired Waters for violations of the General Water Quality Standard. Benthic invertebrate surveys performed by DEP indicated that Marsh Run and McCarthy Run were not attaining the aquatic life use protected under the General Standard. As detailed in the prior section, excessive sedimentation was identified as the primary stressor causing the benthic impairment in the streams, and sediment TMDLs were developed for Marsh Run and McCarthy Run. Currently, Pennsylvania has not established numeric criteria for sediment. Therefore, a reference watershed approach was used to determine the numeric sediment endpoint for Marsh Run and McCarthy Run.

5.1 Reference Watershed Approach

Under the reference watershed approach, the TMDL endpoint for an impaired watershed is established based on conditions in a similar, but non-impaired reference watershed. In the case of sediment, the TMDL endpoint is the sediment unit loading in the non-impaired reference watershed. Reduction of the sediment unit loading in the impaired watershed to levels comparable to the reference watershed is assumed to be sufficient for recovery of the benthic community in the impaired watershed.

Selection of an appropriate reference watershed is based on similarities in watershed characteristics such as soils, topography, land uses, and ecology. Similar watersheds help to ensure similarities in the benthic communities that potentially may inhabit the streams.

Similar watersheds also provide for similar watershed hydrology which influences pollutant loading rates to the stream.

5.2 Selected Reference Watersheds

Due to differences in the physical characteristics of the Marsh Run and McCarthy Run watersheds, most notably differences in size and land use distributions, two reference watersheds were selected to determine the sediment TMDL endpoints. Pine Creek, located in Allegheny County, Pennsylvania, was selected in consultation with DEP as the reference watershed for the Marsh Run TMDL development. Elkhorn Run, located in Beaver County, Pennsylvania, was selected as the reference watershed for the McCarthy Run TMDL development. Reference watersheds were selected based largely on their size and land use distributions, and DEP biomonitoring assessments that indicated the reference watersheds were attaining the Aquatic Life standard.

Table 5-1 summarizes important criteria considered in the selection of the reference watershed. Comparisons of key watershed characteristics are provided in the following sections.

Table 5-1: Criteria Used in Reference Watershed Selection

Criteria	Relevance
Biomonitoring Data	Biomonitoring data is required to confirm the non-impairment status of the reference watershed.
Location	Close proximity to the impaired watershed generally improves overall watershed similarity.
Ecoregion	The reference and impaired watersheds should belong to the same ecoregion to help ensure similarities in stream ecology.
Land Uses	The selected reference watersheds should reflect similar land use distributions. The water quality of streams in a watershed is greatly influenced by land use. Similar land use distributions help to establish achievable TMDL endpoints.
Soils	Soil composition influences watershed runoff, erosion, and stream ecology.
Topography	Topography influences hydrology and is a major component of stream habitat that affects the structure and composition of benthic communities.
Watershed Size	The reference watershed should be similar in size to the impaired watershed since watershed area influences pollutant loading rates to the stream.

5.2.1 Watershed Locations

The Pine Creek reference watershed drains an area of about 1,525 acres, or 2.4 square miles. It is located approximately 45 miles southwest of the Marsh Run watershed (Figure 5-1). The Elkhorn Run reference watershed drains approximately 3,022 acres, or 4.7 square miles. It is located approximately 55 miles west of the McCarthy Run watershed (Figure 5-2). Both the reference and impaired watersheds are located in the Western Allegheny Plateau ecoregion.

Figure 5-1: Location of the Marsh Run Watershed and the Pine Creek Reference Watershed

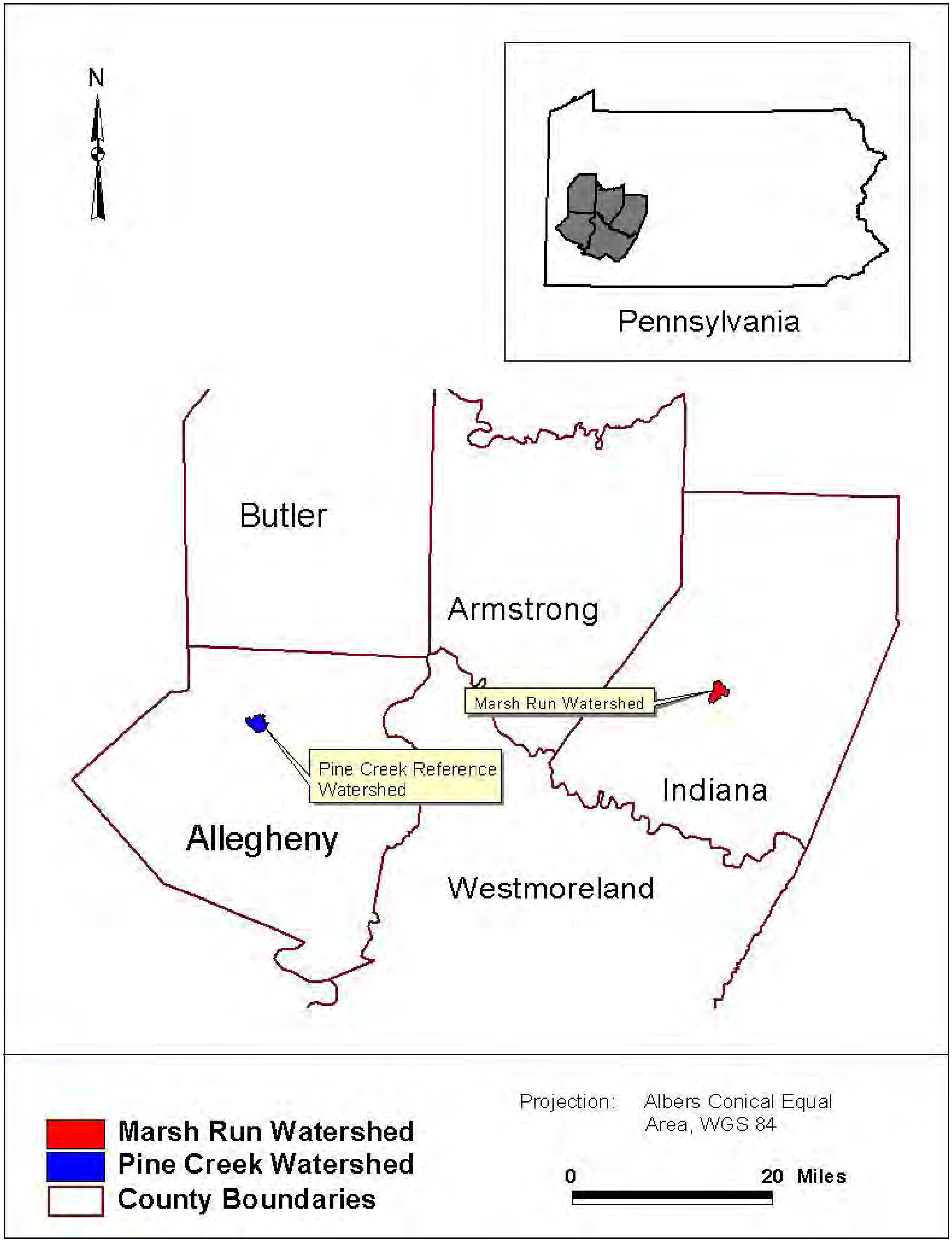
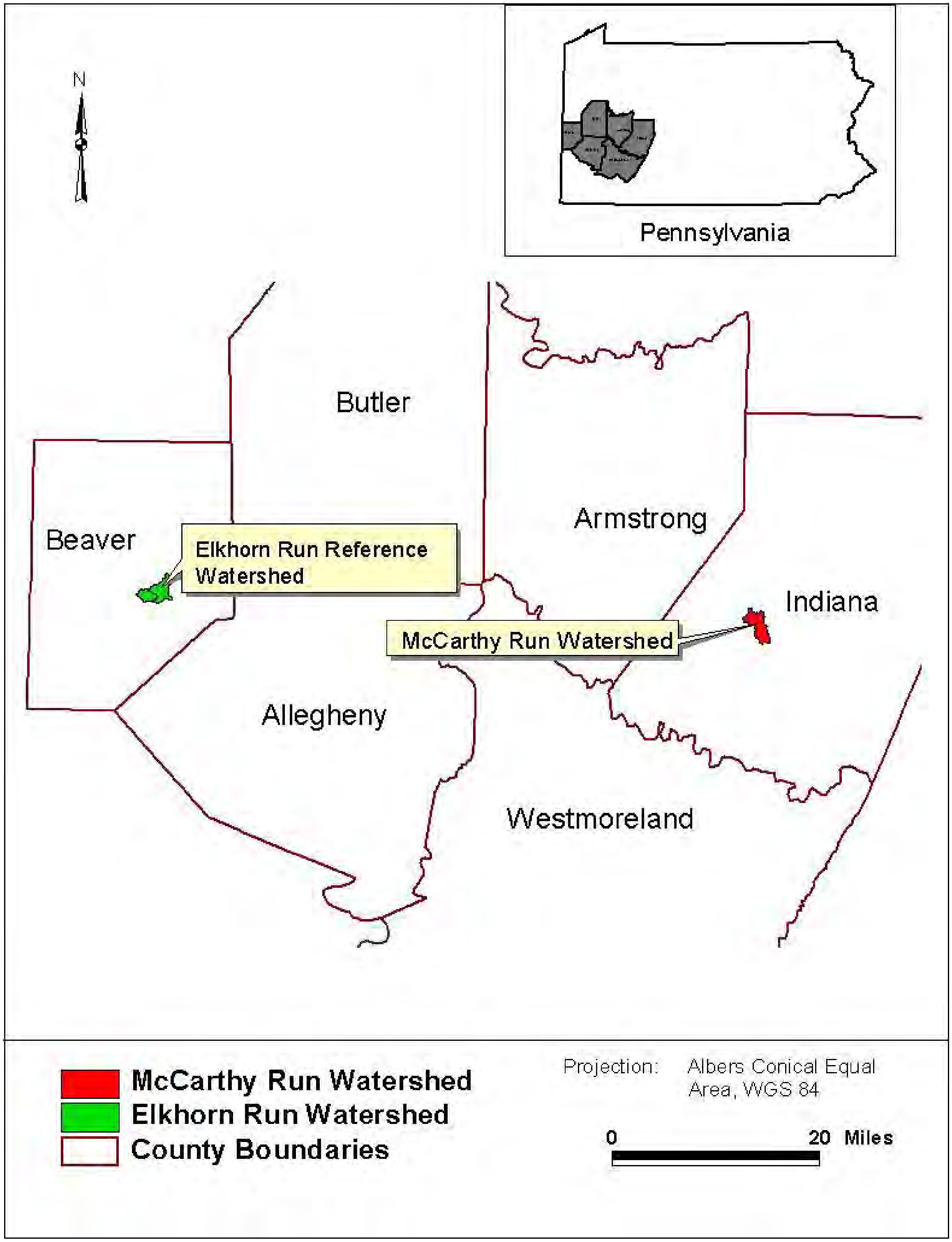


Figure 5-2: Location of the McCarthy Run Watershed and the Elkhorn Run Reference Watershed



5.2.2 Land Use

A comparison of land use distributions in the Marsh Run and Pine Creek watersheds is provided in Table 5-2. The Pine Creek reference watershed is comprised primarily of developed lands (42.8%) and forested lands (41.3%). The Marsh Run watershed is also dominated by developed (59.8%) and forested lands (25.6%).

Table 5-2: Summary of Land Use Distributions for Marsh Run and Pine Creek

Land Use Category	% of Total Watershed	
	Marsh Run	Pine Creek
Forest	25.6	42.8
Agricultural	14.0	1.2
Developed	59.8	41.3
Other	0.6	14.7[1]
Total	**100**	**100**

1: Urban/recreational grasses comprise 14.7 percent of the Pine Creek watershed

A comparison of land use distributions in the McCarthy Run and Elkhorn Run watersheds is provided in Table 5-3. The Elkhorn Run reference watershed is primarily forested (55.3%), but also has a significant percentage of agricultural lands (22.1%) and developed lands (19.9%). The McCarthy Run watershed has similar percentages of forested lands (43.0%), agricultural lands (39.1%) and developed lands (17.8%).

Table 5-3: Summary of Land Use Distributions for McCarthy Run and Elkhorn Run

Land Use Category	% of Total Watershed	
	McCarthy Run	Elkhorn Run
Forest	43.0	55.3
Agricultural	39.1	22.1
Developed	17.8	19.9
Other	0.1	2.7
Total	**100**	**100**

5.2.3 Soils Distribution

A comparison of soil distributions for the Marsh Run and Pine Creek watersheds is provided in Table 5-4. Soil distributions in both the Marsh Run and Pine Creek watersheds consist of soil series classified as hydrologic soil group C. Therefore, soils in the Pine Creek reference watershed are representative of soils in the Marsh Run watershed.

Table 5-4: Summary of Soil Distributions for Marsh Run and Pine Creek

Soil Id	Soil Name	Hydrologic Group	% of Total Watershed	
			Marsh Run	Pine Creek
PA044	Gilpin-Wharton-Weikert	C	88.1	100
PA051	Gilpin-Weikert-Ernest	C	0.0	0.0
PA053	Gilpin-Wharton-Ernest	C	11.9	0.0

A comparison of soil distributions for the McCarthy Run and Elkhorn Run watersheds is provided in Table 5-5. Soil distributions in both the McCarthy Run and Elkhorn Run watersheds consist of soil series classified as hydrologic soil group C. Therefore, soils in the Elkhorn Run reference watershed are representative of soils in the McCarthy Run watershed.

Table 5-5: Summary of Soil Distributions for McCarthy Run and Elkhorn Run

Soil Id	Soil Name	Hydrologic Group	% of Total Watershed	
			McCarthy Run	Elkhorn Run
PA044	Gilpin-Wharton-Weikert	C	80.8	92.6
PA045	Urban Land-Monongahela-Rainsboro	C	0.0	7.4
PA051	Gilpin-Weikert-Ernest	C	16.6	0.0
PA053	Gilpin-Wharton-Ernest	C	2.6	0.0

6.0 Sediment Loading Determination

A reference watershed approach was used to develop sediment TMDLs for Marsh Run and McCarthy Run, as discussed in the previous section. Pine Creek, located in Allegheny County, served as the reference watershed for Marsh Run (Figure 5-1), and Elkhorn Run, located in Beaver County, served as the reference watershed for McCarthy Run. Sediment unit loadings developed for land use types in the reference watersheds were used to define the numeric TMDL endpoint for the impaired watersheds. Therefore, sediment loadings were determined for both the reference and impaired watersheds in order to quantify sediment loading reductions necessary to achieve the designated aquatic life use for Marsh Run and McCarthy Run.

6.1 Sediment Source Assessment

Excessive sedimentation can adversely affect benthic invertebrate communities through the loss of habitat or food sources. Sediment can be delivered to the stream from point sources located in the watershed and it can be carried in the form of non-point source runoff from non-vegetated or protected land areas. In addition, sediment can be generated in the stream through the processes of scour and deposition which are primarily a function of stream flow. During periods of high flow, erosion of the stream channel occurs. The eroded materials are deposited downstream as stream flow decreases. These processes adversely impact the benthic invertebrate community through loss of habitat and degradation of water quality.

Potential sediment sources within the Marsh Run and McCarthy Run watersheds are discussed in the next section followed by a presentation of the methodology used to quantify these sources for the TMDL development.

6.1.1 Non-Point Sources

The erosion of land is dependent upon many factors including land use type and cover, soils type, and topography. The land use types in the Marsh Run and McCarthy Run watersheds were characterized using NLCD data, while soil types were characterized using the STATSGO database. The land use distribution for the Marsh Run and

McCarthy Run watersheds were previously shown in Table 2-3 and Table 2-4, and a summary of soil types was provided in Table 2-1. The delivery of eroded soils to the stream is primarily influenced by watershed size. Sediment loadings from generalized land use types present in the Marsh Run and McCarthy Run watersheds are discussed below.

Forested Lands

Sediment loads from forested lands are typically low due to extensive root systems and vegetative cover that serve to stabilize soils. In addition, forest canopies intercept and dampen rainfall impacts.

Agricultural lands

Sediment loads from agricultural lands tend to be elevated due to the exposure of soil that occurs in agricultural practices. Cropland and pastureland are two sources of elevated sediment loads.

Developed Lands

Developed lands consist of both pervious and impervious surfaces. Impervious surfaces are not subject to soil erosion, but sediment loads may result from the washoff of solids deposited on impervious surfaces. Sediment loads from developed lands tend to be high. In addition, elevated levels of uncontrolled stormwater runoff from developed lands contribute to stream bank erosion as discussed below.

Other Lands

Other lands can include areas of sparse vegetative cover, such as quarries, strip mines, or gravel pits, as well as parks or other urban recreational areas. Mining lands, quarries, and other transitional lands typically have elevated sediment loads due to increased levels of soil exposure.

6.1.2 Point Sources

Sediment loadings from point sources can result from suspended solids being present in discharge effluent. There are no permitted NPDES dischargers present in either the Marsh Run or McCarthy Run watersheds. The borough of Indiana has an MS4 permit for its stormwater discharges, as required by EPA's stormwater permitting regulations. Marsh Run is listed in the Indiana MS4 permit as one of the water bodies into which MS4s discharge.

6.1.3 Instream Bank Erosion

Sediment derived from instream bank erosion is also dependent upon numerous watershed characteristics. Land use types present in the watershed may affect hydrology of the watershed. In particular, highly developed lands may lead to increased stream flows that erode the stream channel and banks. Likewise, watersheds defined by steep topography may experience high levels of runoff that cause instream erosion. The level of instream erosion is dependent on the erodibility of the soil, normally defined as the soil K factor.

6.2 Technical Approach for Estimating Sediment Loads

6.2.1 AVGWLF Model Description

For the purpose of TMDL development, annual sediment loadings from land erosion were determined using the ArcView Generalized Watershed Loading Functions (AVGWLF) model. AVGWLF was developed by the Environmental Resources Research Institute of the Pennsylvania State University (Evans et al., 2001), 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 and sediment 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.

Erosion and sediment loading is a function of the land source areas present in the watershed. Multiple source areas may be defined based on land use type, the underlying soils type, and the management practices applied to the lands. The Universal Soil Loss Equation (USLE) is used to compute erosion for each source area and a sediment delivery ratio is applied to determine the sediment loadings to the stream. Sediment loadings from each source area are summed to obtain a watershed total.

6.2.1.1 Instream Erosion

Instream erosion was calculated in the AVGWLF model using an algorithm developed by Evans et al. (2003) that estimates stream bank erosion based on watershed characteristics. Using this method, a watershed-specific lateral erosion rate is calculated as follows:

$$LER = aQ^{0.6}$$

Where:
LER = an estimated lateral erosion rate, expressed as meters per month
a = an empirically-derived “erosion potential factor”
Q = monthly stream flow, expressed as cubic meters per second.

The ‘a’ factor is computed based on a wide variety of watershed parameters including the fraction of developed area of the watershed, average field slope, mean soil erodibility (K factor), average curve number value, and the mean livestock density for the watershed.

$$a = (0.00147*PD) + (0.000143*AD) - (0.000001*CN) + (0.000425*KF) + (0.000001*MS) - 0.000016$$

Where:
PD = fraction developed land
AD = animal density measured in animal equivalent units/acre
CN = area-weighted runoff curve number value
KF = area-weighted K factor
MS = mean field slope

The fraction of developed land in the impaired and reference watersheds was obtained from NLCD data. All other input parameters were calculated in AVGWLF based on GIS data layers for Pennsylvania that were provided with the model. The mean soil erodibility K factor and mean field slope of the watersheds were computed from the STATSGO database contained in AVGWLF. The average watershed curve number was developed based on curve numbers applied in the model. Livestock densities for the watersheds were based on county livestock inventories. The ‘a’ factors for both the impaired and reference watersheds were computed.

LER values were calculated in AVGWLF using predicted stream flow from the model. Monthly sediment loads from stream bank erosion (kg/month) were then calculated as the product of the LER (meters/month), total stream length (meters), average stream bank height (meters), and average soil bulk density (kg/m^3). Total stream lengths for the impaired and reference watersheds were obtained from the 1:24,000 streams dataset contained in the AVGWLF model. The default model input of 1.5 m was used as the average stream bank height, and the default model value of 1500 kg/m^3 was used as the mean soil bulk density. Annual sediment loads from stream bank erosion were computed as the summation of monthly loads.

6.2.2 Point Source Load

As stated above, there are no permitted point sources present in the Marsh Run, McCarthy Run, or Elkhorn Run watersheds. There is one point source facility, the McCandless Township Sewage Treatment Plant (STP), present in the Pine Creek watershed (Table 6-1). Review of the discharge monitoring reports (DMR) for this facility indicated that the average suspended solids concentration in the effluent was approximately 5 mg/L. At this level the loading is relatively small compared to the watershed sediment load. In addition, the sediment load from this facility typically consists of the non-setteable sediment fraction. Therefore, the loading from this point source was not included in the calculation of sediment TMDL endpoint for Marsh Run.

Table 6-1: Point Sources in the Pine Creek Reference Watershed

Facility Name	Permit No.	Permitted Total Suspended Solids (mg/L)	Design Flow (million gallons/day)
McCandless STP	PA0025992	30	1.2

The Indiana MS4 permit states that MS4s are permitted to discharge into Marsh Run. However, stormwater permits typically do not have numeric limits for sediment. The sediment load for the MS4s is comprised of sediment originating from land-based sources, as well as sediment originating from stream bank erosion. An area weighted percentage of the land-based load was allocated to the Indiana MS4. To separate sediment loading attributed to the MS4 from other land-based sediment loading, an area weighted sediment load was determined for the Indiana MS4, in which the percentage of sediment loading from each source area attributed to the MS4 was proportional to the percentage of that source area in the Marsh Run watershed covered by the Indiana MS4 permit. The percentage of sediment loads attributed from source areas is presented in Table 6-2. Additionally, stormwater runoff from MS4s results in increased stream bank erosion. Bank erosion resulting from MS4 stormwater runoff and bank erosion resulting from overland runoff were also separated using an area weighted approach, in which the percentage of sediment loading from bank erosion attributed to the MS4 was proportional to the percentage of the Marsh Run watershed covered by the Indiana MS4 permit. Since 620 acres of the 1,520 total acres in the Marsh Run watershed is covered by the Indiana MS4 permit, 41 percent of the sediment load from instream erosion was attributed to the Indiana MS4. Sediment from other land sources in the watershed and the remainder of the bank erosion sediment load were attributed to the land-based load rather than treated as a point source load.

Table 6-2: Area Weighted Percentages for Indiana MS4 Sediment Load Allocation for Land Sources

Source	Land Use Type	Acres in Marsh Run Watershed	Acres in Indiana town limits	Percent of Load Attributed to Indiana MS4
Land Sources	Deciduous Forest	283.8	42.4	14.9
	Evergreen Forest	24.8	1.4	5.5
	Mixed Forest	81.0	30.5	37.7
	Pasture/Hay	190.3	9.8	5.2
	Row Crop	22.4	0.15	0.7
	Urban/Recreational Grasses	9.0	0.0	0.0
	Low Intensity Residential	745.8	461.4	61.9
	High Intensity Residential	70.8	51.8	73.2
	Commercial/Industrial	91.9	22.8	24.9
Total	-	1,520	620	41.0

6.3 AVGWLF Model Setup and Calibration

6.3.1 AVGWLF Model Development

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 1983 to 1993, and the existing watershed conditions. Models were developed for both the reference and impaired watersheds. 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 land use dataset. A complete list of the datasets used in the AVGWLF model is presented in Table 6-3.

Table 6-3: 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

6.3.2 Model Input Parameters

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

Runoff curve numbers and USLE erosion factors were specified by AVGWLF as an average value for a given source area. The land use types present in the impaired and reference watersheds (Table 6-4) were used to define model source areas. Although the AVGWLF model provides land use data from the Multi-Resolution Land Characteristic (MRLC) dataset, the land use distributions in Marsh Run, McCarthy Run, Pine Creek, and Elkhorn Run watersheds were updated based on the more recent NLCD dataset. A total of 9, 9, 8, and 10 source areas were defined in the model for Marsh Run, McCarthy Run, Pine Creek, and Elkhorn Run, respectively.

Table 6-4: Land Use Distributions Used in AVGWLF Model

General Land Use Category	NLCD Land Use Type	Percentage of Watershed			
		Marsh Run	Pine Creek	McCarthy Run	Elkhorn Run
Forested	Deciduous Forest	18.7	27.9	35.0	42.7
	Evergreen Forest	1.6	0.9	2.7	2.3
	Mixed Forest	5.3	12.6	5.3	10.4
Agricultural	Pasture/Hay	12.5	1.2	29.9	20.4
	Row Crops	1.5	NA	9.1	1.7
Developed	Low Intensity Residential	49.1	38.3	14.5	18.5
	High Intensity Residential	4.7	2.5	1.2	0.1
	Commercial/Industrial	6.0	2.0	2.2	2.5
Other	Urban/Recreational Grasses	0.6	14.7	NA	NA
	Quarries/Strip Mines/Gravel Pits	0.0	NA	0.1	2.5
	Transitional	NA	NA	NA	0.2
Total		**100**	**100**	**100**	**100**
NA: Land use not present in watershed.					

The GWLF model was originally developed as a planning tool for estimating nutrient and sediment loadings on a watershed basis. Designers of the model intended it to be implemented without calibration. Precipitation data were computed in AVGWLF using weather station data included in the model. Area-weighted evapotranspiration cover coefficients were developed for each model source area in the AVGWLF model based on values suggested by Haith et al. (1992).

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.

6.4 Sediment Load Estimates

6.4.1 Sediment Loads from Non-point Sources

The AVGWLF model was used to estimate sediment loadings from each source area in the impaired and reference watersheds. Based on the 10-year simulation period, average annual sediment loads were computed for each land source in each watershed. In addition, average annual sediment loads for the reference watersheds were computed for the purpose of TMDL development. A sediment unit loading for each source area in the reference watershed was computed using the reference watersheds average annual sediment loads and the land use distributions. The sediment unit loading was multiplied by the number of acres of each land use type in the Marsh Run and McCarthy Run impaired watersheds to determine the sediment TMDL endpoints. The results for the Marsh Run watershed and the Pine Creek reference watershed are provided in Table 6-5. The results for the McCarthy Run watershed and the Elkhorn Run reference watershed are provided in Table 6-6.

Table 6-5: Marsh Run Average Annual Existing Sediment Loads and TMDL Endpoint Loads from Land Sources

Land Use Type	Marsh Run Existing Loads (tons/yr)	Marsh Run Watershed (acres)	Pine Creek Unit Loading (tons/acre/yr)	TMDL Endpoint Load (tons/yr)
Deciduous Forest	2.4	283.8	0.002	0.5
Evergreen Forest	0.1	24.8	0.002	0.1
Mixed Forest	0.4	81.0	0.002	0.2
Pasture/Hay	39.2	190.3	0.03	5.3
Row Crop	15.6	22.4	0.60	13.4
Low Intensity Residential	56.4	745.8	0.03	25.7
High Intensity Residential	2.2	70.8	0.05	3.2
Commercial/Industrial	2.9	91.9	0.05	4.2
Urban/Recreational Grasses	1.9	9.0	0.03	0.2

Table 6-6: McCarthy Run Average Annual Existing Sediment Loads and TMDL Endpoint Loads from Land Sources

Land Use Type	McCarthy Run Existing Loads (tons/yr)	McCarthy Run Watershed (acres)	Elkhorn Run Unit Loading (tons/acre/yr)	TMDL Endpoint Load (tons/yr)
Deciduous Forest	9.6	983.8	0.050	48.8
Evergreen Forest	1.3	76.4	0.007	0.6
Mixed Forest	1.2	148.7	0.003	0.4
Pasture/Hay	91.2	841.2	0.049	41.2
Row Crop	559.6	257.1	0.621	159.7
Low Intensity Residential	23.1	406.8	0.030	12.3
High Intensity Residential	1.9	33.4	0.023	0.8
Commercial/Industrial	3.5	61.8	0.028	1.7
Quarries/Strip Mines/Gravel Pits	10.8	2.0	5.663	11.5

6.4.2 Sediment Loads from Instream Erosion

Instream erosion was estimated in AVGWLF based on the stream bank lateral erosion rate equation introduced by Evans et al. (2003), as described in Section 6.2.3. The 'a' factor used in the stream bank erosion equation was computed using watershed specific data for the impaired and reference watersheds. Annual sediment loads from stream bank erosion are presented in Table 6-7.

Table 6-7: Annual Instream Erosion Estimates for Impaired Watersheds and TMDL Endpoint Loads

Watershed	Instream Erosion (tons/yr)
Marsh Run Impaired Watershed	144.1
Marsh Run TMDL Endpoint Load	76.6
McCarthy Run Impaired Watershed	434.0
McCarthy Run TMDL Endpoint Load	294.6

6.5 Existing Sediment Loadings – All Sources

In summary, average annual sediment loads for the Marsh Run and McCarthy Run watersheds and the Pine Creek and Elkhorn Run reference watersheds were determined as follows:

- Erosion and sediment yield from land sources were modeled using AVGWLF.
- Instream bank erosion was computed in AVGWLF based on the method described by Evans et al. (2003).
- An area-weighted percentage of the land based and bank erosion sediment load was used to partition sediment loading attributed to the Indiana MS4s and sediment loading attributed to other sources.

Results for all sources are summarized in Table 6-8 and Table 6-9. The total existing sediment load in the Marsh Run impaired watershed is 265.2 tons per year. The TMDL endpoint load of 129.4 tons per year represents the TMDL endpoint for Marsh Run. The total existing sediment load for the McCarthy Run impaired watershed is 1136.2 tons per year. The TMDL endpoint load of 571.6 tons per year represents the TMDL endpoint for McCarthy Run. Reduction of sediment loading in the impaired watersheds to the levels computed for the TMDL endpoint loads is expected to restore support of the aquatic life use for Marsh Run and McCarthy Run.

As stated previously, the existing sediment load in Marsh Run was distributed between the Indiana MS4 and other non-point sources using an area weighted method. Table 6-10 presents the existing sediment loading in Marsh Run attributed to the Indiana MS4 and other non-point sources. Because there were no MS4s or other point sources present in the McCarthy Run watershed, all of the sediment loading in McCarthy Run is attributed to non-point sources.

Table 6-8: Marsh Run Existing Sediment Loadings and TMDL Endpoint Loadings (tons/yr)

Source	Land Use Type	Marsh Run Watershed (tons/yr)	TMDL Endpoint Load (tons/yr)
Non-Point Sources	Deciduous Forest	2.4	0.5
	Evergreen Forest	0.1	0.1
	Mixed Forest	0.4	0.2
	Pasture/Hay	39.2	5.3
	Row Crop	15.6	13.4
	Urban/Recreational Grasses	1.9	25.7
	Low Intensity Residential	56.4	3.2
	High Intensity Residential	2.2	4.2
	Commercial/Industrial	2.9	0.2
Instream Erosion	-	144.1	76.6
Point Sources	-	0.0	0.0
Total		265.2	129.4

Table 6-9: McCarthy Run Existing Sediment Loadings and TMDL Endpoint Loadings (tons/yr)

Source	Land Use Type	McCarthy Run Watershed (tons/yr)	TMDL Endpoint Load (tons/yr)
Non-Point Sources	Deciduous Forest	9.6	48.8
	Evergreen Forest	1.3	0.6
	Mixed Forest	1.2	0.4
	Pasture/Hay	91.2	41.2
	Row Crop	559.6	159.7
	Low Intensity Residential	23.1	12.3
	High Intensity Residential	1.9	0.8
	Commercial/Industrial	3.5	1.7
	Quarries/Strip Mines/Gravel Pits	10.8	11.5
Instream Erosion	-	434.0	294.6
Point Sources	-	0.0	0.0
Total		1136.2	571.6

Table 6-10: Existing Sediment Loading in Marsh Run Attributed to the Indiana MS4 and other Non-Point Sources

Source	Land Use Type	Total Sediment Load (tons/year)	Percent Attributed to Indiana MS4	Sediment Load Attributed to Indiana MS4 (tons/year)	Sediment Load Attributed to Land Sources (tons/year)
Non-Point Sources	Deciduous Forest	2.4	14.9	0.4	2.0
	Evergreen Forest	0.1	5.5	0.0	0.1
	Mixed Forest	0.4	37.7	0.2	0.2
	Pasture/Hay	39.2	5.2	2.0	37.2
	Row Crop	15.6	0.7	0.1	15.5
	Urban/Recreational Grasses	1.9	0.0	0.0	1.9
	Low Intensity Residential	56.4	61.9	34.9	21.5
	High Intensity Residential	2.2	73.2	1.6	0.6
	Commercial/Industrial	2.9	24.9	0.7	2.2
Instream Erosion	-	144.1	41.0	59.5	84.6
Total		265.2		99.4	165.8

7.0 TMDL Allocation

The purpose of TMDL allocation is to quantify pollutant load reductions necessary for each source to achieve water quality standards. Sediment was identified as the primary stressor to the benthic communities in Marsh Run and McCarthy Run, and a reference watershed approach was used for TMDL development. The TMDL endpoint sediment loads were computed using the sediment loading per acre ratio of the reference watersheds and multiplying that ratio by the acres of the different land use types present in the impaired watersheds. Reduction of sediment loading in the impaired watersheds to the level computed for the TMDL endpoint loads is expected to restore support of the aquatic life use for Marsh Run and McCarthy Run.

7.1 Basis for TMDL Allocations

Sediment TMDL allocations for Marsh Run and McCarthy Run were based on the following equation.

$$TMDL = WLA + LA + MOS$$

Where:

TMDL= Endpoint Sediment Load Based on Unit Loading from Reference Watershed

WLA = Wasteload Allocation

LA = Load Allocation

MOS = Margin of Safety

The wasteload allocation represents the total sediment loading allocated to point sources. The load allocation represents the total sediment loading allocated to non-point sources. The margin of safety is a required TMDL element to account for uncertainties in TMDL development.

7.1.1 Margin of Safety

An explicit margin of safety of 10% was used for Marsh Run and McCarthy Run to account for uncertainties in the methodologies used to determine sediment loadings. A 10% MOS is consistent with the methodology used in previous TMDLs developed in

Pennsylvania, and is appropriate to account for uncertainties associated with planning level water quality models such as AVGWLF. Therefore, 12.9 tons/year were allocated for the MOS in the Marsh Run TMDL, and 57.2 tons/year were allocated for the MOS in the McCarthy Run TMDL.

7.1.2 Wasteload and Load Allocation

Tables 6-8 and 6-9 identify the existing sediment loading totals for Marsh Run Watershed and McCarthy Run Watershed as 265.2 tons/yr and 1136.2 tons/yr, respectively. Modeling the sources by using techniques discussed in previous sections determined that each watershed required sediment load reductions to achieve reference watershed targets (i.e., TMDLs) of 129.4 tons/yr for Marsh Run Watershed and 571.6 tons/yr for McCarthy Run Watershed. From these TMDLs, each watershed was designated wasteload and load allocations based on an equal percent reduction from controllable sources. Loads from forested lands were considered to be representative of the natural condition and were not subject to reductions. Therefore, reducing Marsh Run Watershed's total load by 57% and applying a 55% reduction to McCarthy Run Watershed resulted in the allocable loads of 116.4 tons/yr and 514.4 tons/yr for each watershed, respectively. Lastly, a 10% MOS was assigned to the sediment loads. The TMDL equations are summarized in Tables 7-1 and 7-2. Subsequent tables detail the allocations to specific land use types.

Table 7-1: Sediment TMDL for Marsh Run (tons/year)

TMDL	Load Allocation	Wasteload Allocation	Margin of Safety (10%)
129.4	73.1	43.3	12.9

Table 7-2: Sediment TMDL for McCarthy Run (tons/year)

TMDL	Load Allocation	Wasteload Allocation	Margin of Safety (10%)
571.6	514.4	0.0	57.2

7.1.2.1 Wasteload Allocation

There are no permitted dischargers located in the Marsh Run and McCarthy Run watersheds, other than the Indiana Borough MS4, which is not regulated under Phase II of the NPDES Stormwater Regulations. The borough of Indiana has an MS4 permit to discharge into Marsh Run. As stated in Section 6.0, a percentage of the sediment loads from land sources and bank erosion in Marsh Run were attributed to the Indiana MS4 based on an area weighted method. This loading was included in the wasteload allocation. Sediment loads from other lands sources and the remaining sediment load from bank erosion are included in the load allocation for Marsh Run.

Using the area weighted method, it was determined that 39.9 tons/year of sediment form land sources (deciduous forest, evergreen forest, mixed forest) and 59.5 tons/year of sediment from instream erosion were assigned to the Indiana MS4 permit under the existing watershed loading condition (see Table 7-3). Therefore a total of 99.4 tons/year were attributed to Marsh Run's wasteload allocation. By reducing sediment loads from land sources (excluding forested lands) and bank erosion by 57%, the sediment TMDL endpoint for Marsh Run is achieved.

Table 7-3: Recommended Wasteload Allocations for Marsh Run

Source	Land Use Type	Marsh Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Point Sources - Indiana MS4	Deciduous Forest	0.4	0.4	0
	Evergreen Forest	0.0	0.0	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	2.0	0.9	57
	Row Crop	0.11	0.047	57
	Low Intensity Residential	34.9	15.1	57
	High Intensity Residential	1.6	0.7	57
	Commercial/Industrial	0.7	0.3	57
	Instream Erosion	59.5	25.8	57
Total		99.4	43.3	57

Because there were no MS4s or other point sources in the McCarthy Run Watershed, the wasteload allocation is zero.

7.1.2.2 Load Allocation

A 55% reduction in sediment loads from agricultural, developed, and transitional lands and instream erosion will achieve the sediment TMDL endpoint in McCarthy Run. The existing and allocated sediment loads for each source in the Marsh Run Watershed are presented in Table 7-4, which maintains the 57% reduction rate designated for its point sources. Existing and allocated sediment loads for each source in the McCarthy Run Watershed are presented in Table 7-5.

Table 7-4: Recommended Load Allocations for Marsh Run

Source	Land Use Type	Marsh Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	2.0	2.0	0
	Evergreen Forest	0.1	0.1	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	37.2	16.1	57
	Row Crop	15.5	6.7	57
	Low Intensity Residential	21.5	9.3	57
	High Intensity Residential	0.6	0.3	57
	Commercial/Industrial	2.2	0.9	57
	Urban/Recreational Grasses	1.9	0.8	57
	Instream Erosion	84.6	36.6	57
Total		165.8	73.1	57

Table 7-5: Recommended Load Allocations for McCarthy Run

Source	Land Use Type	McCarthy Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	9.6	9.6	0
	Evergreen Forest	1.3	1.3	0
	Mixed Forest	1.2	1.2	0
	Pasture/Hay	91.2	40.7	55
	Row Crop	559.6	249.6	55
	Low Intensity Residential	23.1	10.3	55
	High Intensity Residential	1.9	0.8	55
	Commercial/Industrial	3.5	1.6	55
	Quarries/Strip Mines/Gravel Pits	10.8	4.8	55
Instream Erosion	-	434.0	193.6	55
Total		1136.2	514.4	55

7.2 Overall Recommended TMDL Allocations

Table 7-6: Recommended TMDL Allocations for Marsh Run

Source	Land Use Type	Marsh Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	2.0	2.0	0
	Evergreen Forest	0.1	0.1	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	37.2	16.1	57
	Row Crop	15.5	6.7	57
	Low Intensity Residential	21.5	9.3	57
	High Intensity Residential	0.6	0.3	57
	Commercial/Industrial	2.2	0.9	57
	Urban/Recreational Grasses	1.9	0.8	57
	Instream Erosion	84.6	36.6	57
Point Sources - Indiana MS4	Deciduous Forest	0.4	0.4	0
	Evergreen Forest	0.0	0.0	0
	Mixed Forest	0.2	0.2	0
	Pasture/Hay	2.0	0.9	57
	Row Crop	0.11	0.047	57
	Low Intensity Residential	34.9	15.1	57
	High Intensity Residential	1.6	0.7	57
	Commercial/Industrial	0.7	0.3	57
	Urban/Recreational Grasses	Not present	Not present	0
	Instream Erosion	59.5	25.8	57
Total		265.2	116.4	51

Table 7-7: Recommended TMDL Allocations for McCarthy Run

Source	Land Use Type	McCarthy Run Average Annual Sediment Load (tons/yr)		Percent Reduction
		Existing	Allocated	
Non-Point Sources	Deciduous Forest	9.6	9.6	0
	Evergreen Forest	1.3	1.3	0
	Mixed Forest	1.2	1.2	0
	Pasture/Hay	91.2	40.7	55
	Row Crop	559.6	249.6	55
	Low Intensity Residential	23.1	10.3	55
	High Intensity Residential	1.9	0.8	55
	Commercial/Industrial	3.5	1.6	55
	Quarries/Strip Mines/Gravel Pits	10.8	4.8	55
Instream Erosion	-	434.0	193.6	55
Point Sources	-	0.0	0.0	0
Total		1136.2	514.4	55

7.3 Consideration of Critical Conditions

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

In the case of Marsh Run and McCarthy Run, the primary stressor to the benthic invertebrates in the creek is excessive sediment loading, which has led to siltation and the loss of benthic habitat. Sediment is primarily delivered to the stream in stormwater runoff from non-point sources. In these watersheds, non-point sources and instream erosion account for 100% of the total sediment load to the stream. Therefore, most of the sediment load is delivered under high flow conditions associated with stormwater runoff.

Since sediment loading occurs throughout the year and its impacts on benthic invertebrates are often a function of cumulative loading rather than particular events, it is appropriate to consider sediment loading an annual basis. Therefore, TMDL allocations were developed based on average annual loads determined from the 10-year simulation period used in the AVGWLF model.

7.4 Consideration of Seasonal Variability

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

8.0 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. Reasonable assurance that the TMDLs established for sediment will require a comprehensive, adaptive approach that addresses:

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

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Marsh Run and McCarthy Run TMDLs identify the necessary overall load reductions for sediment 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), and improvements in stormwater control.

By developing TMDLs for the Marsh Run and McCarthy Run watersheds, the stage has been set for local citizens to design and implement watershed restoration plans based on the reduction goals specified in the TMDLs. Interested parties should contact the appropriate watershed manager in the PA DEP's Southwest Regional Office (412-442-4000) for information regarding technical and financial assistance currently available. Individuals and/or local watershed groups interested in helping to solve the identified problems in the Marsh Run and McCarthy Run watersheds are strongly encouraged to avail themselves of funding sources available through DEP and other state and federal agencies.

The relative contribution of sediment varies throughout the watersheds according to the distribution of land use sources such as agricultural and developed lands. Instream bank erosion is also a very significant factor. Therefore, reductions in the sediment entrained in overland flow must be accompanied by substantial reductions in the volume of water delivered to the streams in order to achieve the water quality objectives of the TMDLs. Efforts must also be taken to control future potential sources of sediment and stormwater as new construction and redevelopment occurs. Because of the complexity of the problem and the potential solutions, an adaptive approach will be needed to achieve the TMDLs.

8.1 Pennsylvania's Approach to Control Stormwater

Both regulatory and nonregulatory approaches will be needed to achieve the necessary load reductions. Pennsylvania's program is being constructed to integrate state requirements under Act 167 for stormwater management planning, federal requirements for permitting through the National Pollutant Discharge Elimination System (NPDES) program, and voluntary financial incentives provided to communities and project sponsors. Pennsylvania also adopted a Comprehensive Stormwater Management Policy on September 28, 2002.

8.1.1 PA Comprehensive Stormwater Management Policy

Stormwater management was identified as a priority in Pennsylvania during 15 water forums held throughout the state during 2001. As a result, DEP proposed a comprehensive stormwater management plan to more fully integrate post-construction stormwater planning requirements, emphasizing the use of ground water infiltration and volume and rate control best management practices (BMPs), into the NPDES permitting program. The Policy also emphasizes the obligation under Pennsylvania's water quality standards (section 93.4 of the Code of Pennsylvania) for stormwater management programs to maintain and protect existing uses and the level of water quality necessary to protect those uses.

8.1.2 PA Stormwater Management Act of 1978 (Act 167)

In Pennsylvania, Act 167 requires each county to develop plans for each of its watersheds within its boundaries. This would be an excellent mechanism to properly plan watershed improvement projects in Marsh Run and McCarthy Run. Watersheds covered by an Act

167 Plan may cover a number of municipalities and could also cross county boundaries. Act 167 Plans must include provisions for improved water quality, groundwater recharge, post-construction stormwater control standards, and stream bank protection strategies in addition to other stormwater controls. In addition, a community must enact, administer, and enforce stormwater ordinances within six months of PA DEP's approval of the Act 167 Plans. Since 1985, Pennsylvania has been authorized to provide grants to counties up to 75% of costs of preparing the plans. Funds are also authorized to provide municipalities with grants for implementation.

The Act 167 regulations specify that stormwater management plans be undertaken in two phases: Phase I, preparation of the Scope of Study; and Phase II, the actual plan preparation. Participation in Act 167 to date has been limited and most existing plans were developed to address flooding issues and not water quality. Pennsylvania is hopeful that participation in the program will increase now that more than 700 communities in Pennsylvania will need to have stormwater management plans in place to meet NPDES program requirements. Several benefits can accrue to communities who pursue Act 167 planning. As stated earlier, state funds are available for plan development. In addition, once a community has enacted its stormwater ordinances, the community may be eligible for PENNVEST low interest loans to correct existing stormwater drainage problems. Projects may include transport, storage and infiltration of stormwater and best management practices to address point or non-point source pollution associated with stormwater.

8.2 Phase II Stormwater Permits or MS4s

Under the NPDES stormwater program, operators of large, medium, and regulated small municipal separate storm sewer systems (MS4s) require authorization to discharge pollutants under an NPDES permit. The NPDES permitting program is implemented by PA DEP under a delegation agreement with EPA. Phase I of the Federal Stormwater NPDES program began in 1990 and cover municipalities having a MS4 and a population greater than 100,000. Phase I also extended to construction activities which disturbed more than 5 acres of land and to 11 categories of industrial activity. Phase II requirements for the Federal NPDES stormwater program were described in Federal regulations at 40 CFR 122(a)(16) issued in December 1999. Phase II extended the requirement to small MS4s in urbanized areas as defined by the 1990 and 2000 census data and for construction activities requiring stormwater permits, and reduced the threshold for the land area disturbed to one acre. As a result, the Indiana borough municipality is now required to hold an NPDES permit for stormwater.

MS4s were required to apply for permit coverage by March 10, 2003. The application must describe the stormwater management program they intend to implement, including a schedule, best management practices, and measurable goals for each element of the municipal program.

MS4 communities are required to implement a stormwater management program in their jurisdiction by the end of their 5-year permit term in March 2008. Pennsylvania issued a general permit to be used for MS4 permits (PAG-13). MS4s encompassing special protection watersheds in Pennsylvania will be covered through individual permits. Implementation of BMPs consistent with the stormwater management program and the minimum control measures outlined in 40 CFR 132.34 is considered to constitute compliance to the maximum extent practicable. To achieve reductions in stormwater discharges, EPA regulations established 6 categories of minimum control measures BMPs that must be met by permittees. These 6 BMP categories, also called “minimum control measures” in the Federal regulations, are:

1) Public education and outreach on stormwater impacts
2) Public involvement/participation consistent with state/local requirements in the development of a stormwater management plan
3) Illicit discharge detection and elimination, including mapping of the existing stormwater sewer system (including at least the outfalls) and adoption of an ordinance to prohibit illicit connections and control erosion and sedimentation from development
4) Control of runoff from construction sites where 1 to 5 acres of land are disturbed
5) Post-construction stormwater monitoring and management in new development and redevelopment
6) Pollution prevention and good housekeeping for municipal operations and maintenance facilities

Under Phase II, permittees are also required to establish measurable goals for each BMP. Pennsylvania has also developed a protocol which MS4s covered under the general permit can adopt to satisfy the requirements of the permit. MS4s can also choose to develop their own programs, but they must seek DEP approval. EPA has established a national menu of BMPs available for meeting the minimum control measures. Information can be found on EPA's website at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu/cfm

8.3 Implementation Funding Sources

Potential funding mechanisms for implementation include federal grants (i.e., CWA Section 104(b)(3), CWA Section 319, State Revolving Fund), state grants (i.e., Act 167 grant, Growing Greener, PENNVEST), and local stormwater utility fees. One of the best and most readily available funding sources of those listed above is Pennsylvania's Stormwater Management Act, Act 167. Since 1985, Pennsylvania has been authorized to provide grants to counties up to 75% of costs of preparing the plans. Municipalities are provided similar grants for implementation. EPA funds are available through Pennsylvania under CWA Section 319 or the Non-point Source Program to fund some of those projects. Funds are also available for activities related to the implementation of the NPDES Stormwater Phase II program for fiscal year 2004.

Growing Greener provides state funding as the mechanism to fund projects under Section 319. Growing Greener has provided funding for stormwater retrofits, demonstrated by grants given throughout Pennsylvania to address stormwater. The DEP Southwest Regional office has also placed a high priority on activities to better control stormwater, reflecting the strong public interest in the area.

9.0 Public Participation

The development of the Marsh Run and McCarthy Run TMDLs would not have been possible without the participation of the public and various state and federal agencies. A draft stressor identification report was prepared and distributed to EPA Region 3 and PA DEP for review and comments.

A public meeting was held at the Indiana Fire Association in the town of Indiana, Pennsylvania on June 28, 2004 to discuss TMDL development for Marsh Run and McCarthy Run, the identified pollutant stressor, the methodology employed to determine watershed loadings of the stressor, and the draft TMDLs. Copies of the draft report were available for public distribution. The meeting was public noticed in *The Indiana Gazette.* The public had the opportunity to comment on the draft TMDL report, stressor identification, pollutant loadings, and the proposed allocation scenarios. No comments were received by EPA Region 3 during the 30-day comment period.

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