Total Maximum Daily Loads for the Lower Ohio River Watershed, West Virginia

Draft Report

November 2020- *REVISED 12/8/2020*

Revisions and additions are noted in Table of Contents and italicized in documented

On the cover:
Photos provided by WVDEP Division of Water and Waste Management

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FIGURES

ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

7Q10	7-day, 10-year low flow
AMD	acid mine drainage
AML	abandoned mine land
AML&R	[WVDEP] Office of Abandoned Mine Lands & Reclamation
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
CSGP	Construction Stormwater General Permit
CSR	Code of State Rules
DEM	Digital Elevation Model
DMR	[WVDEP] Division of Mining and Reclamation
DNR	West Virginia Division of Natural Resources
DO	dissolved oxygen
DWWM	[WVDEP] Division of Water and Waste Management
ERIS	Environmental Resources Information System
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
HAU	home aeration unit
LA	load allocation
ug/l	micrograms per liter
MDAS	Mining Data Analysis System
mg/L	milligrams per liter
mL	milliliter
MF	membrane filter counts per test
MPN	most probable number
MOS	margin of safety
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NLCD	National Land Cover Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OGCSGP	Oil and Gas Construction Stormwater General Permit
OOG	[WVDEP] Office of Oil and Gas
POTW	publicly owned treatment works
SI	stressor identification
SRF	State Revolving Fund
STATSGO	State Soil Geographic database
TMDL	Total Maximum Daily Load

TSS	total suspended solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UNT	unnamed tributary
WLA	wasteload allocation
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

Watershed

A general term used to describe a drainage area within the boundary of a United States Geologic Survey's 8-digit hydrologic unit code. Throughout this report, the Lower Ohio River watershed refers to the West Virginia tributary streams that drain to the segment of the Ohio River that falls between the confluences of the Kanawha River and the Guyandotte River (**Figure I-1**). The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the Lower Ohio River.

TMDL Watershed

This term is used to describe the total land area draining to an impaired stream for which a TMDL is being developed. This term also takes into account the land area drained by un-impaired tributaries of the impaired stream, and may include impaired tributaries for which additional TMDLs are presented. This report addresses 89 impaired streams contained within 10 TMDL watersheds in the Lower Ohio River watershed.

Subwatershed

The subwatershed delineation is the most detailed scale of the delineation that breaks each TMDL watershed into numerous catchments for modeling purposes. The TMDL watershed have been subdivided into 184 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

Assessment Units

Assessment units are the smallest reach of a stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS). Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Assessment unit identifiers (AUIDs) are created by combining NHD codes with an ordering system following a top-down schema with "01" being in the headwaters and orders increasing downstream.

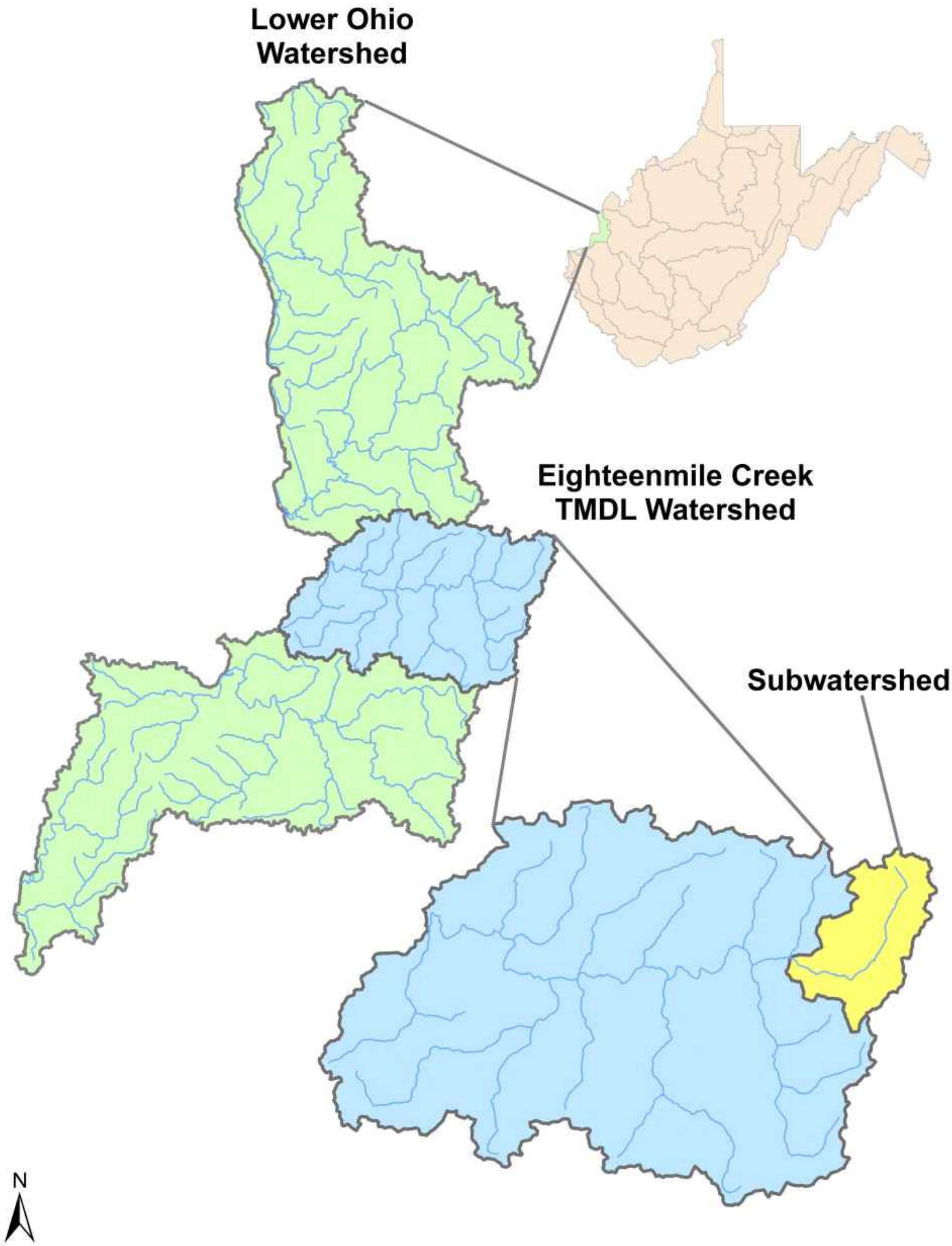


Figure I-1. Examples of a watershed and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 89 impaired streams in the Lower Ohio River watershed. The Lower Ohio River mainstem forms the state line between West Virginia and Ohio. This project was organized into 10 TMDL watersheds, which account for nearly all of the smaller tributary streams draining to the Lower Ohio River from the West Virginia side of the watershed between the confluences of the Kanawha and Guyandotte Rivers. The Lower Ohio River mainstem was not modeled under this effort. TMDLs are presented for assessment units. Assessment units are the smallest reach of the stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS). Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Depending upon the size of the drainage area and predominant land uses, some streams may be broken down into multiple assessment units.

A TMDL establishes the maximum allowable pollutant loading for a waterbody to comply with water quality standards, distributes the load among pollutant sources, and provides a basis for actions needed to restore water quality. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, and titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. The standards include designated uses of West Virginia waters and numeric and narrative criteria to protect those uses. The West Virginia Department of Environmental Protection routinely assesses use support by comparing observed water quality data with criteria and reports impaired waters every two years as required by Section 303(d) of the Clean Water Act ("303(d) list"). The Act requires that TMDLs be developed for listed impaired waters.

Many of the impaired streams are included on the West Virginia's 2016 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, dissolved oxygen, and fecal coliform bacteria. The narrative water quality criterion of 47 CSR 2–3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia Section 303(d) lists from 2002 through 2010.

In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent list in 2016. In response to the legislation, WVDEP prepared a procedural rule (47 CSR 2B) in 2019 establishing the methodology for determining compliance with the biological component of narrative criteria. A public comment period extended through May 6, 2019 and a public hearing was held the same day. Response to comment and final filing was delayed, requiring that the same procedural rule be proposed again in 2020. The public comment period ran through April 20, 2020 and a public hearing was held the same day. At the time of this TMDL completion, WVDEP was responding to comments and preparing to finalize the procedural rule. WVDEP has suspended biological impairment TMDL development pending approval of the procedural rule.

Although “biological impairment” TMDLs are not presented in this project, assessments for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in 47CSR2B, were subjected to a biological stressor identification (SI) process. The results of the SI process are discussed in **Section 4** of this report and displayed in **Appendix K** of the Technical Report. **Section 4** of this report also discusses the relationship of the pollutant-specific TMDLs developed herein to WVSCI-based biological impacts.

Impaired waters were organized into 10 TMDL watersheds. For hydrologic modeling purposes, watersheds of impaired and unimpaired streams in this TMDL watershed were further divided into 184 smaller subwatershed units. The subwatershed delineation provided a basis for georeferencing pertinent source information, monitoring data, and presentation of the TMDLs.

The Mining Data Analysis System (MDAS) was used to represent linkage between pollutant sources and instream responses for fecal coliform bacteria and iron. The MDAS is a comprehensive data management and modeling system that is capable of representing loads from nonpoint and point sources in the watershed and simulating instream processes.

In general, point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Failing on-site septic systems, direct discharges of untreated sewage, and precipitation runoff from agricultural and residential areas are nonpoint sources of fecal coliform bacteria. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities public and private. The presence of individual source categories and their relative significance varies by subwatershed.

There are 2 dissolved oxygen impairments in 2 TMDL watersheds. In general, sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Because of the effect of reducing organic loadings, the fecal coliform TMDLs developed by WVDEP are appropriate surrogates for the dissolved oxygen impairment for these streams.

Iron impairments are also attributable to both point and nonpoint sources. Nonpoint sources of iron include roads, oil and gas operations, timbering, agriculture, urban/residential land disturbance and streambank erosion. Iron point sources include the permitted discharges from industrial stormwater. The presence of individual source categories and their relative significance also varies by subwatershed. Iron is a naturally-occurring element that is present in soils and the iron loading from many of the identified sources is associated with sediment contributions.

This report describes the TMDL development and modeling processes, identifies impaired streams and existing pollutant sources, discusses future growth and TMDL achievability, and documents the public participation associated with the process. This report also contains a detailed discussion of the allocation methodologies applied for various impairments. Various provisions attempt to ensure the attainment of criteria throughout the watershed, achieve equity among categories of sources, and target pollutant reductions from the most problematic sources. Nonpoint source reductions were not specified beyond natural (background) levels. Similarly, point source WLAs were no more stringent than numeric water quality criteria.

Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. TMDL modeling is among the most sophisticated methods available, and incorporates sound scientific principles. TMDL outputs are presented in various formats to assist user comprehension and facilitate use in implementation, including allocation spreadsheets, an ArcGIS Viewer Project, and Technical Report.

Applicable TMDLs are displayed in **Section 8** of this report. The accompanying spreadsheets provide TMDLs and allocations of loads to categories of point and nonpoint sources that achieve the total TMDL.

Also provided is the ESRI Online Viewer Tool at https://arcg.is/1TWiij that allows for the exploration of spatial relationships among the source assessment data. A Technical Report is available that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

1.0 REPORT FORMAT

The following report describes the overall total maximum daily load (TMDL) development process for select streams in the Lower Ohio River watershed, identifies impaired streams, and outlines the source assessment for all pollutants for which TMDLs are presented. Also described are the modeling process, allocation approach, and measures that will be taken to ensure that the TMDLs are met. The applicable TMDLs are displayed in **Section 9** of this report. An ArcGIS Viewer Project supports this report by providing further details on the data and allows the user to explore the spatial relationships among the source assessment data, magnify streams and view other features of interest. In addition to the TMDL report, spreadsheets (in Microsoft Excel format) that display detailed source allocations associated with successful TMDL scenarios are provided. A Technical Report is included that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

2.0 INTRODUCTION

The West Virginia Department of Environmental Protection (WVDEP), Division of Water and Waste Management (DWWM), is responsible for the protection, restoration, and enhancement of the State's waters. Along with this duty comes the responsibility for TMDL development in West Virginia.

2.1 Total Maximum Daily Loads

Section 303(d) of the federal Clean Water Act and the U.S. Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to identify waterbodies that do not meet water quality standards and to develop appropriate TMDLs. A TMDL establishes the maximum allowable pollutant loading for a waterbody to achieve compliance with applicable standards. It also distributes the load among pollutant sources and provides a basis for the actions needed to restore water quality.

A TMDL is composed of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the following equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

WVDEP typically develops TMDLs in concert with a geographically-based approach to water resource management in West Virginia—the Watershed Management Framework. Adherence to the Framework ensures efficient and systematic TMDL development. Using the framework, each year, TMDLs are developed in specific geographic areas. In order to address priorities on the 303d list, WVDEP deviated from the framework for this TMDL project in Group E for the Big

Sandy, Lower Ohio, and Twelvepole Creek watersheds. **Figure 2-1** depicts the hydrologic groupings of West Virginia's watersheds.

WVDEP is committed to implementing a TMDL process that reflects the requirements of the TMDL regulations, provides for the achievement of water quality standards, and ensures that ample stakeholder participation is achieved in the development and implementation of TMDLs. A 48-month development process enables the agency to carry out an extensive data generating and gathering effort to produce scientifically defensible TMDLs. It also allows ample time for modeling, report finalization, and frequent public participation opportunities.

The TMDL development process begins with pre-TMDL water quality monitoring and source identification and characterization. Informational public meetings are held in the affected watersheds. Data obtained from pre-TMDL efforts are compiled, and the impaired waters are modeled to determine baseline conditions and the gross pollutant reductions needed to achieve water quality standards. The draft TMDL is advertised for public review and comment, and an informational meeting is held during the public comment period. Public comments are addressed, and the draft TMDL is submitted to USEPA for approval.

In 2002, USEPA developed TMDLs for aluminum and fecal coliform impaired streams in the Fourpole Creek Watershed (USEPA, 2002). Fourpole Creek was not modeled under this effort, and TMDLs developed in 2002 remain in effect.

Appendix A of the Technical Report lists TMDLs by pollutant and waterbody developed for this effort.

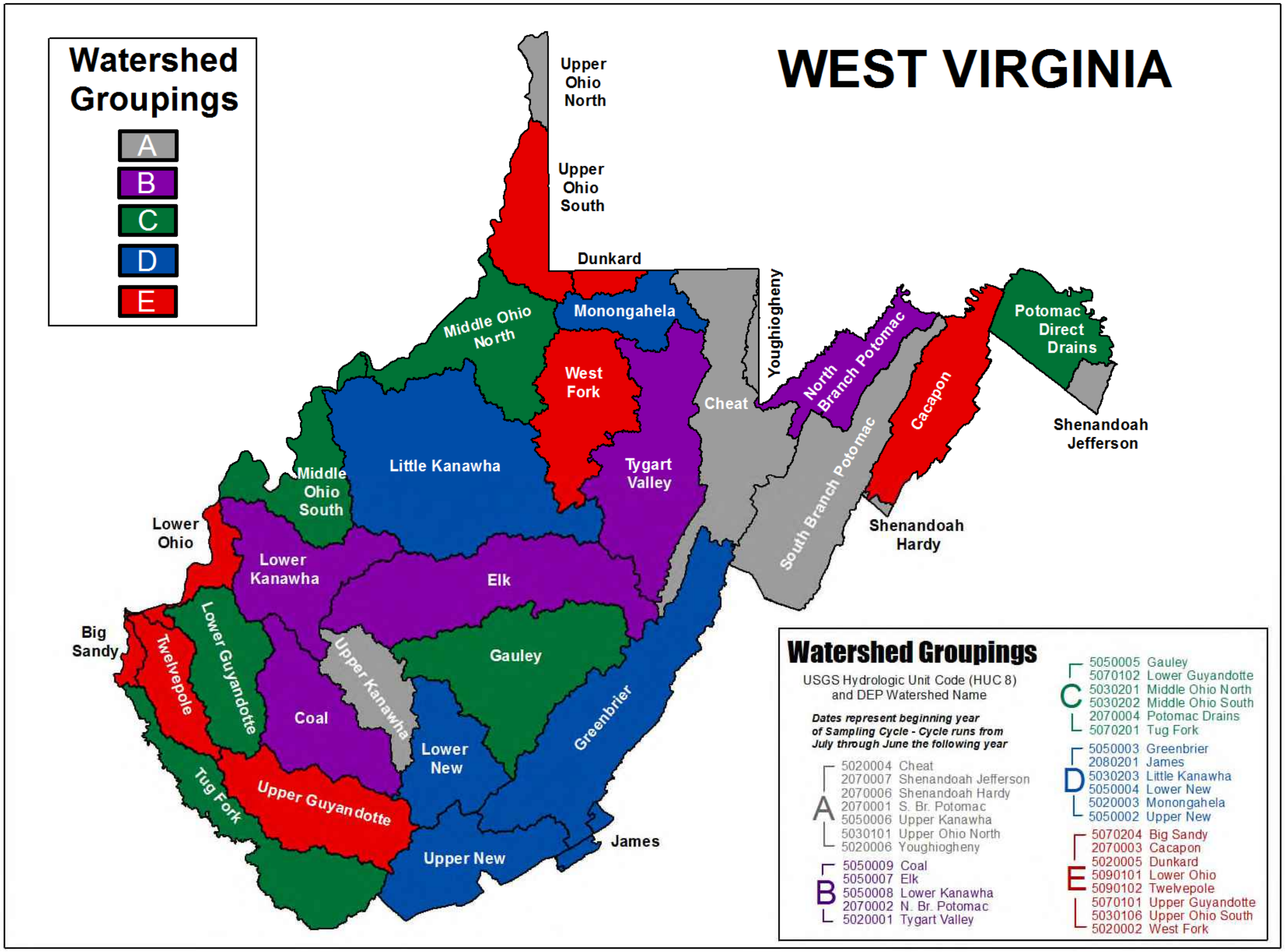


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing instream conditions to applicable water quality standards. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. These standards can be obtained online from the West Virginia Secretary of State Internet site (http://apps.sos.wv.gov/adlaw/csr/rule.aspx?rule=47-02.)

Water quality standards consist of three components: designated uses; narrative and/or numeric water quality criteria necessary to support those uses; and an antidegradation policy. Appendix E of the Standards contains the numeric water quality criteria for a wide range of parameters, while Section 3 of the Standards contains the narrative water quality criteria.

According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The TMDLs presented herein is based upon the water quality criteria that are currently effective. If the West Virginia Legislature adopts Water Quality Standard revisions that alter the basis upon which the TMDL is developed, then the TMDL and allocations may be modified as warranted. Any future Water Quality Standard revision and/or TMDL modification must receive USEPA approval prior to implementation.

Designated uses in the Lower Ohio River watershed include: propagation and maintenance of aquatic life in warmwater fisheries, water contact recreation, and public water supply. There are no trout waters identified in the Lower Ohio River watershed. In various streams in the Lower Ohio River watershed, warmwater fishery aquatic life use impairments have been determined pursuant to exceedances of dissolved oxygen and total iron numeric water quality criteria. Water contact recreation and/or public water supply use impairments have also been determined in various waters pursuant to exceedances of numeric water quality criteria for fecal coliform bacteria and total iron.

All West Virginia waters are subject to the narrative criteria in Section 3 of the Standards. That section, titled "Conditions Not Allowable in State Waters," contains various general provisions related to water quality. The narrative water quality criterion at Title 47 CSR Series 2 – 3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. This provision has historically been the basis for "biological impairment" determinations. Recent legislation has altered procedures used by WVDEP to assess biological integrity and, therefore, biological impairment TMDLs are not being developed. The legislation and related issues are discussed in detail in **Section 4** of this report.

The numeric water quality criteria applicable to the impaired streams addressed by this report are summarized in **Table 2-1**. The stream-specific impairments related to numeric water quality criteria are displayed in **Table 3-3**.

Table 2-1. Applicable West Virginia water quality criteria

POLLUTANT	USE DESIGNATION				
	Aquatic Life				Human Health
	Warmwater Fisheries		Troutwaters		Contact Recreation/Public Water Supply
	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]	
Iron, total (mg/L)	--	1.5	--	1.0	1.5
Dissolved oxygen	Not less than 5 mg/L at any time	Not less than 5 mg/L at any time	Not less than 6 mg/L at any time	Not less than 6 mg/L at any time	Not less than 5 mg/L at any time
Fecal coliform bacteria	**Human Health Contact Recreation/Public Water Supply**: Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.				

[a] One-hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[b] Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
Source: 47 *CSR*, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*.

3.0 WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

In West Virginia, the Ohio River forms the state line between West Virginia and Ohio. The Ohio River eventually joins the Mississippi, which flows to the Gulf of Mexico. The modeled portion of the Lower Ohio River watershed consists of land draining to the Ohio River through West Virginia streams that join the Ohio between the confluences of the Kanawha and Guyandotte Rivers. Modeled portions of the Lower Ohio River watershed encompass 155.0 square miles (401.5 km^2).

The modeled portion of the Lower Ohio River watershed lies within the Western Allegheny Plateau ecoregion of western West Virginia and occupies portions of Cabell, Mason, and Putnam Counties (**Figure 3-1**). Cities and towns near the study area are Point Pleasant, Gallipolis Ferry, Apple Grove, and Lesage. The highest point in the modeled portion of the Lower Ohio River watershed is 1,042 feet above sea level on Barker Ridge above the headwaters of Ninemile Creek. The lowest point in the modeled portion of the watershed is 520 feet at the confluence of Sevenmile Creek and the Ohio River near the community of Cox Landing. The average elevation in the modeled portion of the watershed is 741 feet. Major tributaries in the modeled portion of the Lower Ohio River watershed include Sevenmile Creek, Ninemile Creek, Guyan Creek, Eighteenmile Creek, Sixteenmile Creek, and Crab Creek. The total population living in the subject watersheds of this report is estimated to be 5,000 people.

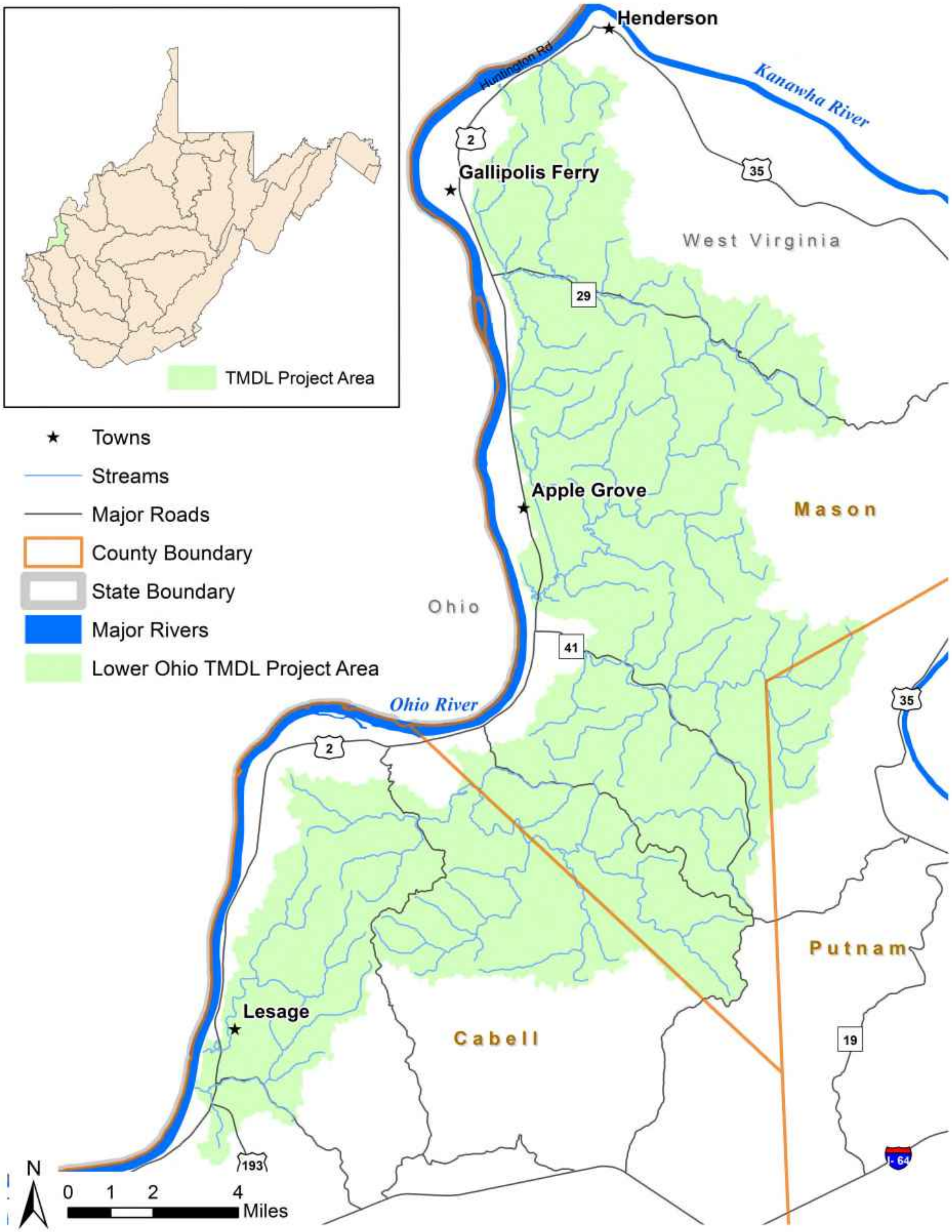


Figure 3-1. Location of the Lower Ohio River watershed TMDL Project Area in West Virginia

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) (USGS 2011). The Multi-Resolution Land Characteristics Consortium (MRLC) produced the NLCD coverage. The NLCD database for West Virginia was derived from satellite imagery taken during the mid-2000s, and it includes detailed vegetative spatial data. Enhancements and updates to the NLCD coverage were made to create a modeled landuse by custom edits derived primarily from WVDEP source tracking information and 2016 aerial photography with 1-meter resolution. Additional information regarding the NLCD spatial database is provided in **Appendix D** of the Technical Report.

Table 3-1 displays the landuse distribution for the TMDL watersheds derived from NLCD as described above. The dominant landuse is forest, which constitutes 77.49 percent of the total landuse area. Other important modeled landuse types are pasture (7.67 percent), grassland (7.50 percent), urban/residential (2.67 percent), oil and gas (2.55 percent) and cropland (1.29 percent). Individually, all other land cover types compose less than one percent of the total watershed area each.

Table 3-1. Modified landuse for the Lower Ohio River TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
AML	43.70	0.07	0.04%
Barren	86.31	0.13	0.09%
Cropland	1,281.66	2.00	1.29%
Forest	76,874.35	120.12	77.49%
Forestry	600.78	0.94	0.61%
Grassland	7,436.90	11.62	7.50%
Oil and Gas	2,530.45	3.95	2.55%
Pasture	7,607.65	11.89	7.67%
Urban/Residential	2,735.76	4.27	2.76%
Water	10.90	0.02	0.01%

3.2 Data Inventory

Various sources of data were used in the TMDL development process. The data were used to identify and characterize sources of pollution and to establish the water quality response to those sources. Review of the data included a preliminary assessment of the watershed's physical and socioeconomic characteristics and current monitoring data. **Table 3-2** identifies the data used to support the TMDL assessment and modeling effort. These data describe the physical conditions of the TMDL watersheds, the potential pollutant sources and their contributions, and the impaired waterbodies for which TMDLs need to be developed. Prior to TMDL development, WVDEP collected comprehensive water quality data throughout the watershed. This pre-TMDL monitoring effort contributed the largest amount of water quality data to the process and is summarized in the Technical Report, **Appendix J**. The geographic information is provided in the ArcGIS Viewer Project.

Table 3-2. Datasets used in TMDL development

Type of Information		Data Sources
Watershed physiographic data	Stream network	USGS National Hydrography Dataset (NHD)
	Landuse	National Land Cover Dataset 2011 (NLCD)
	National Agriculture Imagery Program (NAIP) 2016 Aerial Photography (1-meter resolution)	U.S. Department of Agriculture (USDA)
	Counties	U.S. Census Bureau
	Cities/populated places	U.S. Census Bureau
	Soils	State Soil Geographic Database (STATSGO) USDA, Natural Resources Conservation Service (NRCS) soil surveys
	Hydrologic Unit Code boundaries	U.S. Geological Survey (USGS)
	Topographic and digital elevation models (DEMs)	National Elevation Dataset (NED)
	Dam locations	USGS
	Roads	2015 U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing database (TIGER), WVU WV Roads
	Water quality monitoring station locations	WVDEP
	Meteorological station locations	National Oceanic and Atmospheric Administration, National Climatic Data Center (NOAA-NCDC)
	Permitted facility information	WVDEP Division of Water and Waste Management (DWWM), WVDEP Division of Mining and Reclamation (DMR)
	Timber harvest data	WV Division of Forestry
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP DMR
Monitoring data	Historical Flow Record (daily averages)	USGS
	Rainfall	NOAA-NCDC
	Temperature	NOAA-NCDC
	Wind speed	NOAA-NCDC
	Dew point	NOAA-NCDC
	Humidity	NOAA-NCDC
	Cloud cover	NOAA-NCDC

Type of Information		Data Sources
	grid-scale radar observations + climatologically-aided interpolation of complex climate regimes	Parameter-Elevation Regressions on Independent Slopes Model (PRISM), North American Land Data Assimilation System (NLDAS-2)
	Water quality monitoring data	WVDEP
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWWM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP DMR, WVDEP DWWM
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Nonpoint Source Management Plans	WVDEP

3.3 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring throughout the Lower Ohio River watershed from 2016 through 2017. The results of that effort were used to confirm the impairments of waterbodies identified on previous 303(d) lists and to identify other impaired waterbodies that were not previously listed.

In this TMDL development effort, modeling at baseline conditions demonstrated additional pollutant impairments to those identified via monitoring. The prediction of impairment through modeling is validated by applicable federal guidance for 303(d) listing. WVDEP could not perform water quality monitoring and source characterization at frequencies or sample location resolution sufficient to comprehensively assess water quality under the terms of applicable water quality standards, and modeling was needed to complete the assessment. Where existing pollutant sources were confidently predicted to cause noncompliance with a particular criterion, the subject water was characterized as impaired for that pollutant.

TMDLs were developed for impaired waters in 10 TMDL watersheds (**Figure 3-2**). The impaired waters for which TMDLs have been developed are presented in **Table 3-3**. The table includes the TMDL watershed, stream code, stream name, and impairments for each stream.

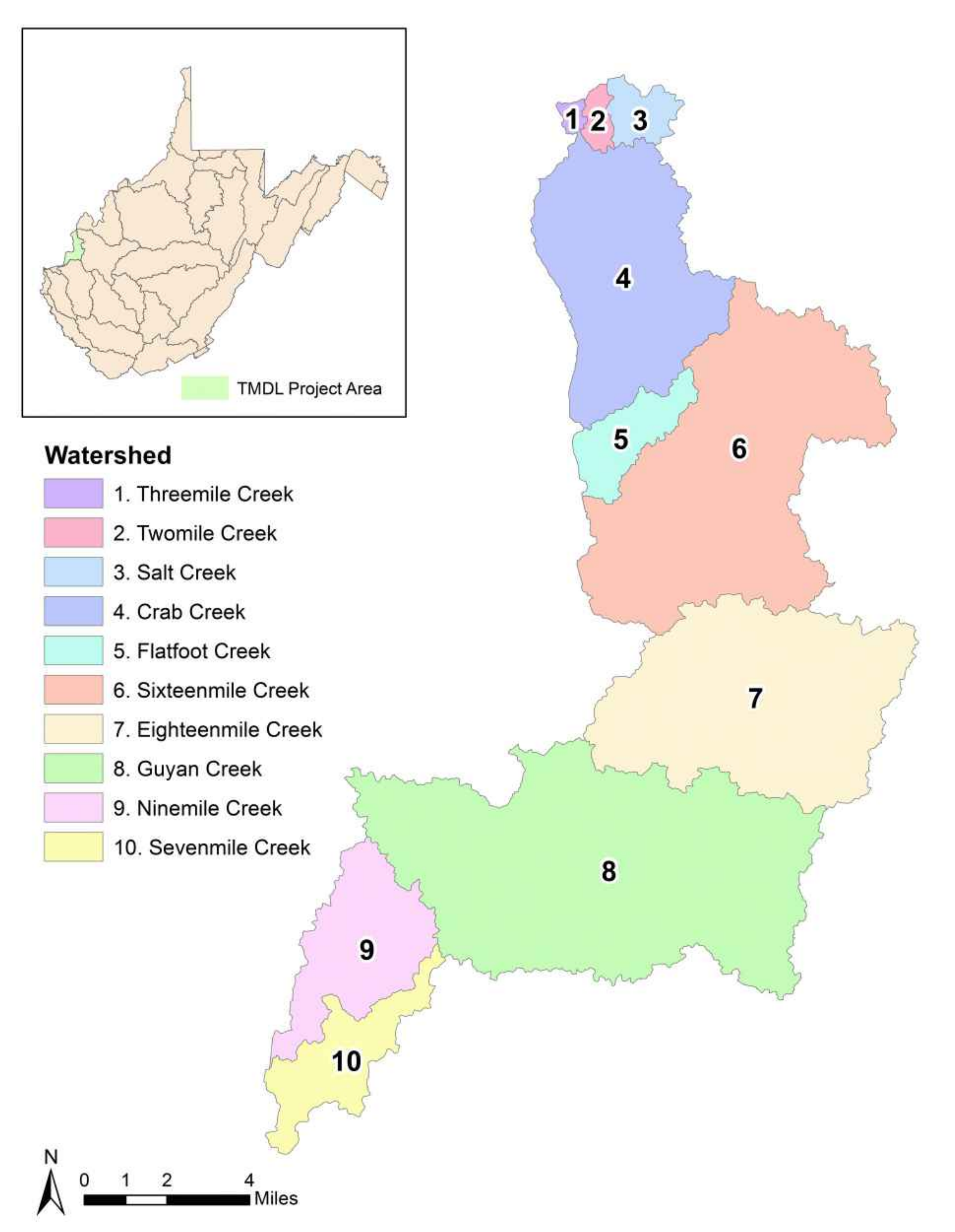


Figure 3-2. Lower Ohio River TMDL Watersheds

Table 3-3. Waterbodies and impairments for which TMDLs have been developed.

TMDL Watershed	NHD Code	Stream Name	WV Code	DO	Fe	FC
Sevenmile Creek	WV-OL-4	Sevenmile Creek	WVO-6		M	X
Sevenmile Creek	WV-OL-4-A	Little Sevenmile Creek	WVO-6-A		M	X
Sevenmile Creek	WV-OL-4-B	UNT/Sevenmile Creek RM 2.08			M	
Sevenmile Creek	WV-OL-4-E	UNT/Sevenmile Creek RM 3.11			M	
Ninemile Creek	WV-OL-5	Ninemile Creek	WVO-7		M	X
Ninemile Creek	WV-OL-5-A	UNT/Ninemile Creek RM 3.94	WVO-7-A		M	X
Ninemile Creek	WV-OL-5-A-4	UNT/UNT RM 1.61/Ninemile Creek RM 3.94			M	
Ninemile Creek	WV-OL-5-H	UNT/Ninemile Creek RM 5.75	WVO-7-H		M	X
Guyan Creek	WV-OL-12	Guyan Creek	WVO-9		X	X
Guyan Creek	WV-OL-12-C	Spurlock Creek	WVO-9-A		M	X
Guyan Creek	WV-OL-12-C-2	Left Fork/Spurlock Creek	WVO-9-A-2		M	X
Guyan Creek	WV-OL-12-C-2-C	Perry Creek	WVO-9-A-2-A		M	X
Guyan Creek	WV-OL-12-C-10	UNT/Spurlock Creek RM 3.39			M	
Guyan Creek	WV-OL-12-D	UNT/Guyan Creek RM 3.82			M	
Guyan Creek	WV-OL-12-K	McCowan Branch	WVO-9-B		M	
Guyan Creek	WV-OL-12-L	Bryan Creek	WVO-9-C	X	M	X
Guyan Creek	WV-OL-12-L-2	UNT/Bryan Creek RM 1.37	WVO-9-C-0.5		M	
Guyan Creek	WV-OL-12-L-6	UNT/Bryan Creek RM 3.25			M	
Guyan Creek	WV-OL-12-L-7	UNT/Bryan Creek RM 3.74	WVO-9-C-7		M	X
Guyan Creek	WV-OL-12-L-8	UNT/Bryan Creek RM 3.78			M	
Guyan Creek	WV-OL-12-L-10	UNT/Bryan Creek RM 4.67			M	
Guyan Creek	WV-OL-12-L-13	UNT/Bryan Creek RM 5.18			M	
Guyan Creek	WV-OL-12-M	Trace Fork	WVO-9-D		M	
Guyan Creek	WV-OL-12-M-5	Lynn Fork	WVO-9-D-2		M	X
Guyan Creek	WV-OL-12-M-6	Jenkins Branch	WVO-9-D-1		M	

TMDL Watershed	NHD Code	Stream Name	WV Code	DO	Fe	FC
Guyan Creek	WV-OL-12-M-6-C	UNT/Jenkins Branch RM 0.75	WVO-9-D-1-C		**M**	
Guyan Creek	WV-OL-12-P	Knife Branch	WVO-9-E		**M**	**X**
Guyan Creek	WV-OL-12-Q	Bear Hollow Creek	WVO-9-F		**M**	**X**
Guyan Creek	WV-OL-12-Q-2	UNT/Bear Hollow Creek RM 1.20	WVO-9-F-2		**M**	**X**
Guyan Creek	WV-OL-12-Q-7	UNT/Bear Hollow Creek RM 3.97			**M**	
Guyan Creek	WV-OL-12-W	UNT/Guyan Creek RM 13.17	WVO-9-W		**M**	**X**
Eighteenmile Creek	WV-OL-15	Eighteenmile Creek	WVO-10		**X**	**X**
Eighteenmile Creek	WV-OL-15-D	Rocky Fork	WVO-10-A		**M**	**X**
Eighteenmile Creek	WV-OL-15-D-4	UNT/Rocky Fork RM 1.29			**M**	
Eighteenmile Creek	WV-OL-15-H	UNT/Eighteenmile Creek RM 4.64			**M**	
Eighteenmile Creek	WV-OL-15-I	Hughes Branch	WVO-10-B		**M**	
Eighteenmile Creek	WV-OL-15-J	Fees Branch	WVO-10-C		**M**	**X**
Eighteenmile Creek	WV-OL-15-J-1	UNT/Fees Branch RM 0.87	WVO-10-C-1		**M**	
Eighteenmile Creek	WV-OL-15-K	UNT/Eighteenmile Creek RM 6.73			**M**	
Eighteenmile Creek	WV-OL-15-L	Mud Run	WVO-10-D		**M**	**X**
Eighteenmile Creek	WV-OL-15-N	UNT/Eighteenmile Creek RM 7.85			**M**	
Eighteenmile Creek	WV-OL-15-O	Right Fork/Eighteenmile Creek	WVO-10-D.5		**M**	**X**
Eighteenmile Creek	WV-OL-15-O-3	UNT/Right Fork RM 1.82/Eighteenmile Creek			**M**	
Eighteenmile Creek	WV-OL-15-R	Road Fork	WVO-10-E		**X**	
Eighteenmile Creek	WV-OL-15-S	White Pine Creek	WVO-10-F		**M**	
Eighteenmile Creek	WV-OL-15-S-1	Spring Branch	WVO-10-F-1		**X**	**X**
Eighteenmile Creek	WV-OL-15-V	UNT/Eighteenmile Creek RM 11.29			**M**	
Eighteenmile Creek	WV-OL-15-W	UNT/Eighteenmile Creek RM 11.85			**M**	
Sixteenmile Creek	WV-OL-16	Sixteenmile Creek	WVO-11		**X**	**X**
Sixteenmile Creek	WV-OL-16-A	UNT/Sixteenmile Creek RM 0.55	WVO-11-0.8A		**M**	
Sixteenmile Creek	WV-OL-16-B	UNT/Sixteenmile Creek RM 1.44			**M**	

TMDL Watershed	NHD Code	Stream Name	WV Code	DO	Fe	FC
Sixteenmile Creek	WV-OL-16-C	UNT/Sixteenmile Creek RM 1.96	WVO-11-0.9A		X	
Sixteenmile Creek	WV-OL-16-D	Stonecoal Run	WVO-11-A		M	
Sixteenmile Creek	WV-OL-16-G	Jerrys Run	WVO-11-B		M	X
Sixteenmile Creek	WV-OL-16-H	Daves Run	WVO-11-C		M	
Sixteenmile Creek	WV-OL-16-J	Millstone Creek	WVO-11-D		M	X
Sixteenmile Creek	WV-OL-16-J-3	UNT/Millstone Creek RM 1.19			M	
Sixteenmile Creek	WV-OL-16-K	Righthand Fork	WVO-11-E		M	X
Sixteenmile Creek	WV-OL-16-K-3	UNT/Righthand Fork RM 1.77	WVO-11-E-3		M	
Sixteenmile Creek	WV-OL-16-K-4	UNT/Righthand Fork RM 2.10	WVO-11-E-4		M	X
Sixteenmile Creek	WV-OL-16-K-5	UNT/Righthand Fork RM 3.44			M	
Sixteenmile Creek	WV-OL-16-P	Potts Hollow (Righthand Fork)	WVO-11-F		X	
Sixteenmile Creek	WV-OL-16-P-2	UNT/Potts Hollow RM 1.31			M	
Sixteenmile Creek	WV-OL-16-Y	UNT/Sixteenmile Creek RM 13.56	WVO-11-G.1		M	X
Sixteenmile Creek	WV-OL-16-AA	Willow Branch	WVO-11-H		M	X
Sixteenmile Creek	WV-OL-16-AB	Wolfpen Run	WVO-11-I		M	X
Sixteenmile Creek	WV-OL-16-AD	UNT/Sixteenmile Creek RM 15.47	WVO-11-K		X	X
Sixteenmile Creek	WV-OL-16-AD-3	UNT/UNT RM 1.39/Sixteenmile Creek RM 15.47			M	
Flatfoot Creek	WV-OL-17	Flatfoot Creek	WVO-12		M	X
Flatfoot Creek	WV-OL-17-B	UNT/Flatfoot Creek RM 3.42	WVO-12-B		X	X
Flatfoot Creek	WV-OL-17-D	UNT/Flatfoot Creek RM 5.40	WVO-12-D		M	X
Crab Creek	WV-OL-18	Crab Creek	WVO-13	X	X	X
Crab Creek	WV-OL-18-B	Mud Run	WVO-13-A		X	X
Crab Creek	WV-OL-18-B-1	UNT/Mud Run RM 1.29			M	
Crab Creek	WV-OL-18-C	UNT/Crab Creek RM 2.22	WVO-13-A.3		M	
Crab Creek	WV-OL-18-D	Sand Fork	WVO-13-B		M	X
Crab Creek	WV-OL-18-D-1	UNT/Sand Fork RM 0.33			M	

TMDL Watershed	NHD Code	Stream Name	WV Code	DO	Fe	FC
Crab Creek	WV-OL-18-D-3	UNT/Sand Fork RM 1.86			M	
Crab Creek	WV-OL-18-D-6	UNT/Sand Fork RM 2.90			M	
Crab Creek	WV-OL-18-E	Middle Fork/Crab Creek	WVO-13-D		M	X
Crab Creek	WV-OL-18-E-3	UNT/Middle Fork RM 2.10/Crab Creek			M	
Crab Creek	WV-OL-18-E-6	UNT/Middle Fork RM 3.52/Crab Creek	WVO-13-D-6		M	
Crab Creek	WV-OL-18-I	Righthand Fork	WVO-13-E		M	
Crab Creek	WV-OL-18-J	UNT/Crab Creek RM 7.00	WVO-13-F		M	X
Crab Creek	WV-OL-18-L	UNT/Crab Creek RM 7.81			M	
Threemile Creek	WV-OL-21	Threemile Creek	WVO-15		M	X
Twomile Creek	WV-OL-22	Twomile Creek	WVO-16		X	X
Salt Creek	WV-OL-23	Salt Creek	WVO-17		M	
Salt Creek	WV-OL-23-B	UNT/Salt Creek RM1.14			M	

Note:
RM river mile
UNT unnamed tributary
FC fecal coliform bacteria impairment
Fe iron impairment
pH acidity impairment
Se selenium impairment
Mn manganese impairment
M impairment determined via modeling
X impairment determined via sampling
XDMR impairment determined via self-reported discharge monitoring

4.0 BIOLOGICAL IMPAIRMENT AND STRESSOR IDENTIFICATION

The narrative water quality criterion of 47 CSR 2 §3.2.i prohibits the presence of wastes in State waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia's Section 303(d) lists from 2002 through 2010. In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent list in 2016. In response to the legislation, WVDEP prepared a procedural rule (47 CSR 2B) establishing the methodology for determining compliance with the biological component of narrative criteria. A public comment period extended through May 6, 2019 and a public hearing was held the same day. Response to comment and final filing was delayed, requiring that the same procedural rule be proposed again in 2020. The public comment period ran through April 20, 2020 and a public hearing was held the same day. At the time of this TMDL completion, WVDEP was responding to comments and preparing to finalize the procedural rule. WVDEP has suspended biological impairment TMDL development pending approval of the procedural rule.

The above notwithstanding, streams for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in 47CSR2B, were subjected to the biological stressor identification (SI) process described in this section. The biological SI process allowed stream-specific identification of the significant stressors associated with benthic macroinvertebrate community impact. If those stressors are resolved through the attainment of numeric water quality criteria, and TMDLs addressing such criteria are developed and approved, then additional "biological TMDL" development work is not needed. SI results are presented for streams with benthic macroinvertebrate impacts in **Appendix K** of the Technical Report, so that they may be considered in listing/delisting decision-making in future 303(d) processes. This project does not include "biological impairment" TMDLs. However, the SI process demonstrated that biological stress would be resolved in 40 assessment units (29 streams) through the implementation of numeric criterion TMDLs developed in this project.

4.1 Introduction

Impacts to benthic macroinvertebrate communities were rated using a multimetric index developed for use in the wadeable streams of West Virginia. The WVSCI (Gerritsen et al., 2000) was designed to identify streams with benthic communities that differ from the reference condition presumed to constitute biological integrity. WVSCI is composed of six metrics that were selected to maximize discrimination between streams with known impairments and reference streams. Streams are assessed using WVSCI if the data was comparable (e.g., collected utilizing the same methods used to develop the WVSCI, adequate flow in riffle/run habitat, and within the index period). A WVSCI score of 72 (representing the 5th percentile of reference scores) is considered the attainment threshold. Streams with WVSCI scores less than 72 were included in the SI process to identify significant stressors associated with impacts to aquatic life.

USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier et al., 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological impact. Elements of that guidance were used and custom analyses of biological data were performed to supplement the recommended framework.

The general SI process entailed reviewing available information, forming and analyzing possible stressor scenarios, and implicating causative stressors. The SI method provides a consistent process for evaluating available information. **Section 6** of the Technical Report discusses biological impairment and the SI process in detail.

4.2 Data Review

WVDEP generated the primary data used in SI through its pre-TMDL monitoring program. The program included water quality monitoring, benthic sampling, and habitat assessment. In addition, the biologists' comments regarding stream condition and potential stressors and sources were captured and considered. Other data sources were: source tracking data, WVDEP mining activities data, NLCD 2011 landuse information, Natural Resources Conservation Service (NRCS) State Soil Geographic database (STATSGO) soils data, National Pollutant Discharge Elimination System (NPDES) point source data, and literature sources.

4.3 Candidate Causes/Pathways

The first step in the SI process was to develop a list of candidate causes, or stressors. The candidate causes considered are listed below:

1. Metals contamination (including metals contributed through soil erosion) causes toxicity
2. Acidity (low pH <6) causes toxicity
3. Basic (high pH >9) causes toxicity
4. Increased ionic strength causes toxicity
5. Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other habitat alterations
6. Increased metals flocculation and deposition causes habitat alterations (e.g., embeddedness)
7. Organic enrichment (e.g. sewage discharges and agricultural runoff cause habitat alterations)
8. Altered hydrology causes higher water temperature, resulting in direct impacts

9. Altered hydrology, nutrient enrichment, and increased biochemical oxygen demand (BOD) cause reduced dissolved oxygen (DO)
10. Algal growth causes food supply shift
11. High levels of ammonia cause toxicity (including increased toxicity due to algal growth)
12. Chemical spills cause toxicity

A conceptual model was developed to examine the relationship between candidate causes and potential biological effects. The conceptual model (**Figure 4-1**) depicts the sources, stressors, and pathways that affect the biological community.

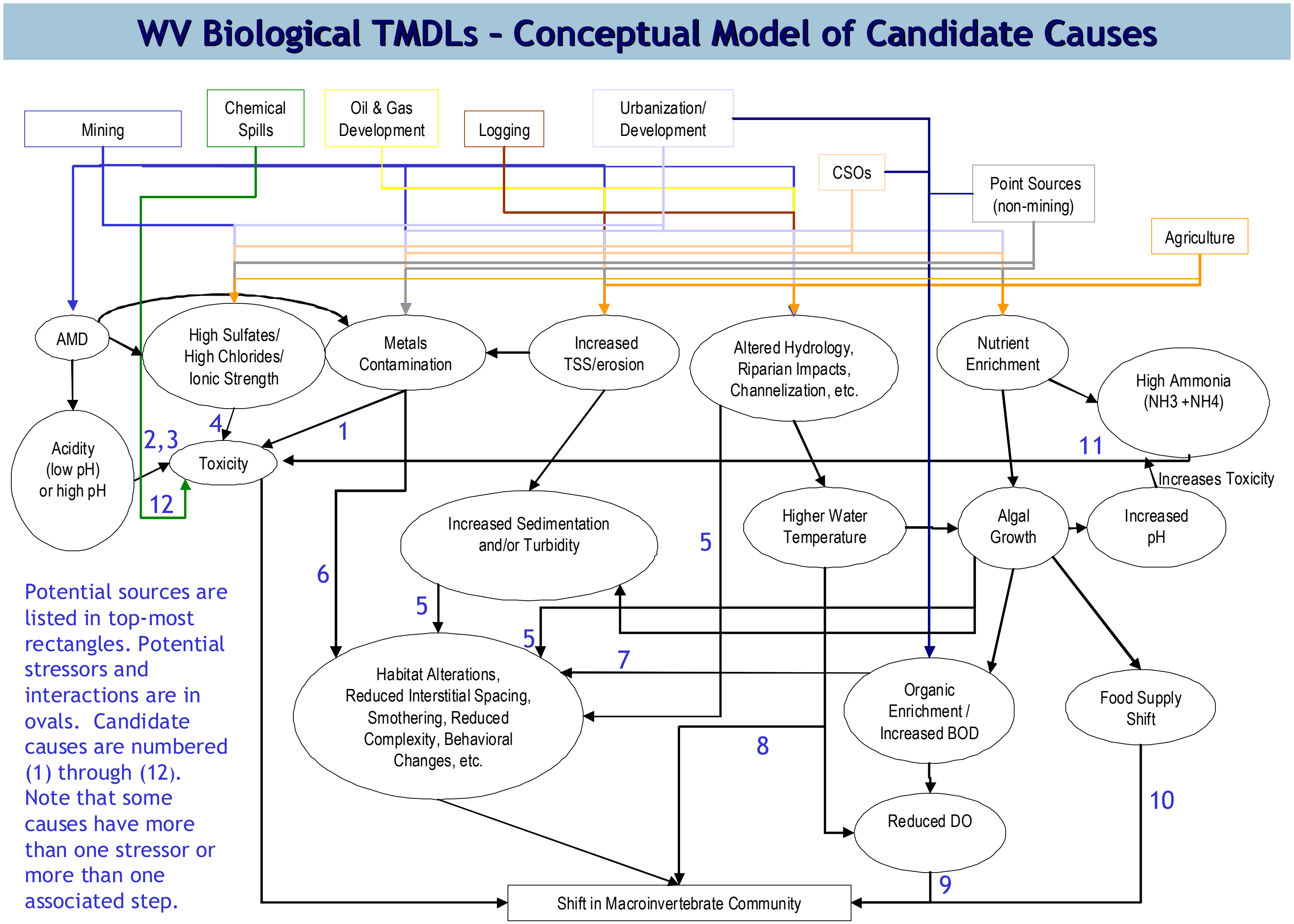


Figure 4-1. Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process identified significant biological stressors for each stream. Biological impact was linked to a single stressor in some cases and multiple stressors in others. The SI process identified the following stressors as present in the impacted waters in the Lower Ohio River watershed:

- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal growth and habitat alteration)). Organic enrichment can be associated with low dissolved oxygen and high pH instream.
- Sedimentation

After stressors were identified, WVDEP also determined the pollutants in need of control to address the impacts.

In all streams for which the SI process identified organic enrichment as a significant biological stressor, data also indicated violations of the fecal coliform water quality criteria. The predominant sources of both organic enrichment and fecal coliform bacteria in the watershed are inadequately treated sewage and runoff from agricultural landuses. In one stream, Lynn Fork (WV code: WVO-9-D-2, NHD Code: OL-12-M-5), high pH was identified as a stressor associated with organic enrichment, as evidenced by livestock access and manure in the stream. Organic enrichment leads to an abundance of periphyton/diatom growth, which in turn leads to high pH values as photosynthesis reduces carbon dioxide (and carbonic acid). WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and significantly reduce loadings in agricultural runoff and thereby resolve organic enrichment stress, including high pH due to photosynthesis.

Certain streams for which the SI process identified sedimentation as a significant stressor are also impaired pursuant to total iron water quality criteria and the TMDL assessment for iron included representation and allocation of iron loadings associated with sediment. WVDEP compared the amount of sediment reduction necessary in the iron TMDLs to the amount of reduction needed to achieve the normalized sediment loading of an unimpacted reference stream. In these streams, the sediment loading reduction necessary for attainment of water quality criteria for iron exceeds that which was determined to be necessary using the reference approach. Implementation of the iron TMDLs will resolve biological stress from sedimentation in these streams. See the Technical Report for further descriptions of the correlation between sediment and iron and the comparisons of sediment reductions under iron criterion attainment and reference watershed approaches.

The streams for which biological stress to benthic macroinvertebrates would be resolved through the implementation of the pollutant-specific TMDLs developed in this project are presented in **Table 4-1**.

Table 4-1. Biological impacts resolved by implementation of pollutant-specific TMDLs

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Guyan Creek	WV-OL-12	WVO-9	OL-12_01	organic enrichment, sedimentation	fecal coliform, total iron
Guyan Creek	WV-OL-12	WVO-9	OL-12_03	organic enrichment, sedimentation	fecal coliform, total iron
Guyan Creek	WV-OL-12	WVO-9	OL-12_04	organic enrichment, sedimentation	fecal coliform, total iron
Spurlock Creek	WV-OL-12-C	WVO-9-A	OL-12-C_01	organic enrichment, sedimentation	fecal coliform, total iron
Spurlock Creek	WV-OL-12-C	WVO-9-A	OL-12-C_02	organic enrichment, sedimentation	fecal coliform, total iron
Left Fork/Spurlock Creek	WV-OL-12-C-2	WVO-9-A-2	OL-12-C-2_01	organic enrichment, sedimentation	fecal coliform, total iron
Perry Creek	WV-OL-12-C-2-C	WVO-9-A-2-A	OL-12-C-2-C_01	organic enrichment, sedimentation	fecal coliform, total iron
McCowan Branch	WV-OL-12-K	WVO-9-B	OL-12-K_01	organic enrichment, sedimentation	*LA reductions fecal coliform, total iron
Bryan Creek	WV-OL-12-L	WVO-9-C	OL-12-L_01	organic enrichment, sedimentation	fecal coliform, total iron
Bryan Creek	WV-OL-12-L	WVO-9-C	OL-12-L_02	organic enrichment, sedimentation	fecal coliform, total iron
Lynn Fork	WV-OL-12-M-5	WVO-9-D-2	OL-12-M-5_01	organic enrichment including high pH associated with photosynthesis of periphyton algae, sedimentation,	fecal coliform, total iron
Jenkins Branch	WV-OL-12-M-6	WVO-9-D-1	OL-12-M-6_01	organic enrichment, sedimentation	*LA reductions fecal coliform, total iron
Knife Branch	WV-OL-12-P	WVO-9-E	OL-12-P_01	organic enrichment, sedimentation	fecal coliform, total iron
Bear Hollow Creek	WV-OL-12-Q	WVO-9-F	OL-12-Q_01	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Bear Hollow Creek	WV-OL-12-Q	WVO-9-F	OL-12-Q_02	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Guyan Creek RM 13.17	WV-OL-12-W	WVO-9-W	OL-12-W_01	organic enrichment, sedimentation	fecal coliform, total iron
Eighteenmile Creek	WV-OL-15	WVO-10	OL-15_01	organic enrichment, sedimentation	fecal coliform, total iron
Eighteenmile Creek	WV-OL-15	WVO-10	OL-15_02	organic enrichment, sedimentation	fecal coliform, total iron
Eighteenmile Creek	WV-OL-15	WVO-10	OL-15_03	organic enrichment, sedimentation	fecal coliform, total iron
Rocky Fork	WV-OL-15-D	WVO-10-A	OL-15-D_01	organic enrichment, sedimentation	fecal coliform, total iron
Mud Run	WV-OL-15-L	WVO-10-D	OL-15-L_01	organic enrichment, sedimentation	fecal coliform, total iron
Road Fork	WV-OL-15-R	WVO-10-E	OL-15-R_01	organic enrichment, sedimentation	*LA reductions fecal coliform, total iron
White Pine Creek	WV-OL-15-S	WVO-10-F	OL-15-S_01	organic enrichment, sedimentation	*LA reductions fecal coliform, total iron
Sixteenmile Creek	WV-OL-16	WVO-11	OL-16_03	organic enrichment, sedimentation	fecal coliform, total iron
Sixteenmile Creek	WV-OL-16	WVO-11	OL-16_04	organic enrichment, sedimentation	fecal coliform, total iron
Stonecoal Run	WV-OL-16-D	WVO-11-A	OL-16-D_01	organic enrichment, sedimentation	*LA reductions fecal coliform, total iron
Millstone Creek	WV-OL-16-J	WVO-11-D	OL-16-J_01	organic enrichment, sedimentation	fecal coliform, total iron
Righthand Fork	WV-OL-16-K	WVO-11-E	OL-16-K_01	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Righthand Fork RM 2.10	WV-OL-16-K-4	WVO-11-E-4	OL-16-K-4_01	organic enrichment, sedimentation	fecal coliform, total iron
Crab Creek	WV-OL-18	WVO-13	OL-18_01	organic enrichment, sedimentation	fecal coliform, total iron
Crab Creek	WV-OL-18	WVO-13	OL-18_03	organic enrichment, sedimentation	fecal coliform, total iron
Mud Run	WV-OL-18-B	WVO-13-A	OL-18-B_01	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Middle Fork/Crab Creek	WV-OL-18-E	WVO-13-D	OL-18-E_01	organic enrichment, sedimentation	fecal coliform, total iron
Salt Creek	WV-OL-23	WVO-17	OL-23_01	organic enrichment, sedimentation	fecal coliform, total iron
Sevenmile Creek	WV-OL-4	WVO-6	OL-4_01	organic enrichment, sedimentation	fecal coliform, total iron
Sevenmile Creek	WV-OL-4	WVO-6	OL-4_02	organic enrichment, sedimentation	fecal coliform, total iron
Ninemile Creek	WV-OL-5	WVO-7	OL-5_01	organic enrichment, sedimentation	fecal coliform, total iron
Ninemile Creek	WV-OL-5	WVO-7	OL-5_02	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Ninemile Creek RM 3.94	WV-OL-5-A	WVO-7-A	OL-5-A_01	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Ninemile Creek RM 5.75	WV-OL-5-H	WVO-7-H	OL-5-H_01	organic enrichment, sedimentation	fecal coliform, total iron

*Note: Although a fecal coliform TMDL was not developed for this stream, reductions to fecal coliform sources in this watershed that were necessary to attain State water quality standards in downstream water bodies were prescribed and will resolve stress to aquatic life.

5.0 METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments in the Lower Ohio River watershed. Sources can be classified as point (permitted) or nonpoint (non-permitted) sources. For the sake of consistency, the same modeled landuse setup was used for all metals nonpoint sources. Non-mining point sources were also modeled consistently in terms of drainage area and flow, although chemical concentrations (e.g. iron, TSS) were configured specifically for different pollutant sources.

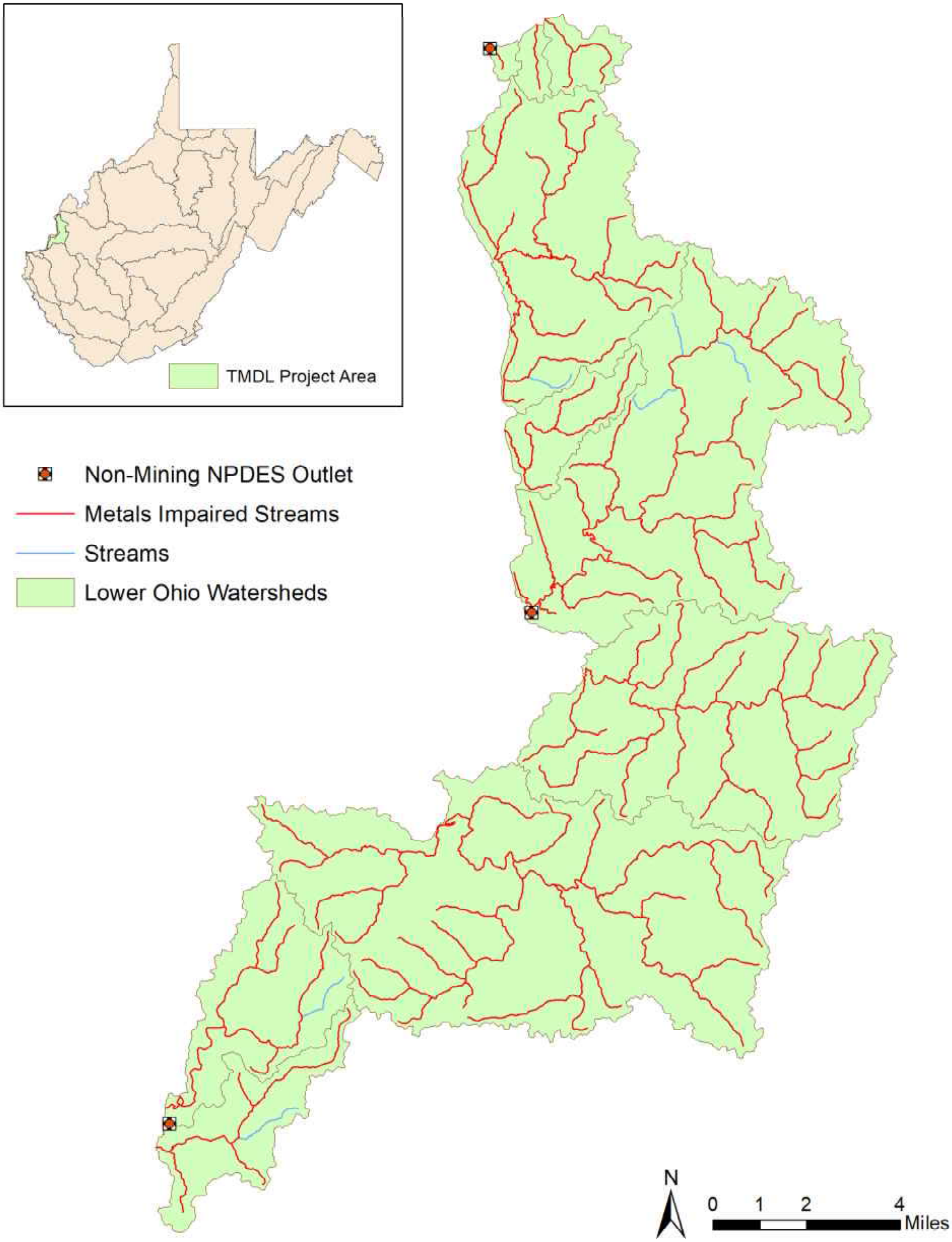
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel or other floating craft from which pollutants are or may be discharged. The NPDES program, established under Clean Water Act Sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. For purposes of this TMDL, NPDES-permitted discharge outfalls are considered point sources.

Nonpoint sources of pollutants are diffuse, non-permitted sources and they most often result from precipitation-driven runoff. For the purposes of these TMDLs only, WLAs are given to NPDES-permitted discharge points, and LAs are given to discharges from activities that do not have an associated NPDES permit, such as nonpoint source pollution associated with oil and gas wells (OOG). The assignment of LAs to OOG does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within this landuse. Likewise, by establishing these TMDLs with OOG discharges treated as LAs, WVDEP and USEPA are not determining that these discharges are exempt from NPDES permitting requirements.

The physiographic data discussed in **Section 3.2** enabled the characterization of pollutant sources. As part of the TMDL development process, WVDEP performed additional field-based source tracking activities to supplement the available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general stream condition in the vicinity of the sources. WVDEP collected global positioning system (GPS) data and water quality samples for laboratory analysis as necessary to characterize the sources and their impacts. Source tracking information was compiled and electronically plotted on maps using GIS software. Detailed information, including the locations of pollutant sources, is provided in the following sections, the Technical Report, and the ArcGIS Viewer Project.

5.1 Metals Point Sources

Metals point sources are classified by the type of permits issued by WVDEP. The following sections discuss the potential impacts and the characterization of these source types, the locations of which are displayed in **Figure 5-1**.



(Note: outlets in close proximity appear to overlap in the figure)

Figure 5-1. Point sources in the Lower Ohio River Watershed

5.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by a regulatory authority in the event that the applicant forfeits its permit. When a bond is forfeited, WVDEP assumes the responsibility for the reclamation requirements. In past TMDLs, bond forfeiture sites were classified as nonpoint sources. The judicial decision, West Virginia Highlands Conservancy, Inc., and West Virginia Rivers Coalition, Inc. v. Randy Huffman, Secretary, West Virginia Department of Environmental Protection. [1:07CV87]. 2009, requires WVDEP to obtain an NPDES permit for discharges from forfeited sites. As such, this project classifies bond forfeiture sites as point sources and provides WLAs.

Mines that ceased operations before the effective date of SMCRA (often called “pre-law” mines) are not subject to the requirements of the SMCRA.

SMCRA Title IV is designed to provide assistance for the reclamation and restoration of abandoned mines; whereas Title V states that any surface coal mining operations must be required to meet all applicable performance standards. Some general performance standards include the following:

- Restoring the affected land to a condition capable of supporting the uses that it was capable of supporting prior to any mining
- Backfilling and compacting (to ensure stability or to prevent leaching of toxic materials) to restore the approximate original contour of the land, including all highwalls
- Minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage

Untreated mining-related point source discharges from deep, surface, and other mines may have low pH values (i.e. acidic) and contain high concentrations of metals (iron and aluminum). Mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, total suspended solids, and pH. Many permits also include effluent monitoring requirements for total aluminum and some, more recently issued permits include aluminum water quality based effluent limits. WVDEP’s Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets. The discharge characteristics, related permit limits, and discharge data for these NPDES outlets were acquired from West Virginia’s ERIS database system. The spatial coverage was used to determine the location of the permit outlets. Additional information was needed, however, to determine the areas of the mining activities. WVDEP DMR also provided spatial coverage of the mining permit areas and related SMCRA Article 3 and NPDES permit information. WVDEP

DWWM personnel used the information contained in the SMCRA Article 3 and NPDES permits to further characterize the mining point sources. Information gathered included type of discharge, pump capacities, and drainage areas (including total and disturbed areas). Using this information, the mining point sources were then represented in the model and assigned individual WLAs for metals.

There are no mining-related NPDES permits or outlets in the metals impaired watersheds of the Lower Ohio River watershed.

5.1.2 Non-mining Point Sources

WVDEP DWWM controls water quality impacts from non-mining activities with point source discharges through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverage was used to determine the locations of these sources, and detailed permit information was obtained from WVDEP's ERIS database. Sources may include the process wastewater discharges from water treatment plants and industrial manufacturing operations, and stormwater discharges associated with industrial activity. There are 3 industrial wastewater discharges in the watersheds of metals impaired streams in the Lower Ohio River watershed.

In the Lower Ohio River watershed, there are limited sewage treatment facilities existing in the watersheds of metals impaired streams. The NPDES permits for those facilities do not contain iron effluent limitations; were not considered to be substantive metals sources; and were not explicitly represented in the modeling. Existing discharges from such sources do not require wasteload allocations pursuant to the metals TMDLs. A list of such negligible sources appears in **Appendix F** of the Technical Report. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

There are three modeled non-mining NPDES permitted outlets (one water treatment plant, one Multisector stormwater general permit for industrial discharge, and one WV DOH stormwater discharge) in the watersheds containing or contributing to metals impaired streams, which are displayed in **Figure 5-1**. The assigned WLAs for all non-mining NPDES outlets allow for continued discharge under existing permit requirements, whether those are expressed in effluent limits or benchmark values. For non-construction stormwater permits, BMP based limits with benchmark values to monitor BMP effectiveness constitute acceptable implementation of the WLAs. A complete list of the permits and outlets is provided in **Appendix F** of the Technical Report.

5.1.3 Construction Stormwater Permits

The discharges from construction activities that disturb more than one acre of land are legally defined as point sources and the sediment introduced from such discharges can contribute iron. WVDEP issues a general NPDES permit (permit WV0115924, referred to as the Construction Stormwater General Permit or CSGP) to regulate stormwater discharges associated with construction activities with a land disturbance greater than one acre.

WVDEP also issues a general NPDES permit to regulate the discharge of stormwater runoff associated with oil and gas related construction activities (permit WV0116815, referred to as the

Oil and Gas Construction Stormwater General Permit or OGCSGP) authorizes discharges composed entirely of stormwater associated with oil and gas field activities or operations associated with exploration, production, processing or treatment operations or transmission facilities, disturbing one acre or greater of land area, to the waters of the State.

Both of these permits require that the site have properly installed best management practices (BMPs), such as silt fences, sediment traps, seeding/mulching, and riprap, to prevent or reduce erosion and sediment runoff. The BMPs will remain intact until the construction is complete and the site has been stabilized. Individual registration under the General Permit is usually limited to less than one year.

At the time of model set-up, no active construction sites registered under the CSGP or OGCSGP were located within the project area in the Lower Ohio River watershed.

5.1.4 Municipal Separate Storm Sewer Systems (MS4) - *ADDED*

Runoff from residential and urbanized areas during storm events can be a significant sediment source. USEPA's stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, their stormwater discharges are considered point sources and are prescribed WLAs. One MS4 entity is registered under the MS4 General Permit (WV0116025). The individual registration number for the West Virginia Division of Highways (WVDOH) is WVR030004.

Approximately 7.5 acres of WVDOH MS4 area occur on the northern periphery of the greater City of Huntington municipal area.

MS4 source representation was based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data within the transportation-related drainage area for which WVDOH has MS4 responsibility. The representation also includes streambank erosion loads for the portions of streams within the MS4 boundaries.

5.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals. For modeling purposes, land disturbing activities that introduce excess sediment are considered nonpoint sources of metals.

5.2.1 Abandoned Mine Lands

WVDEP's Office of Abandoned Mine Lands & Reclamation (AML&R) was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of SMCRA in 1977. AML&R's mission is to protect public health, safety, and property from past coal mining and to enhance the environment through the reclamation and restoration of land and water resources. The AML program is funded by a fee placed on coal mining. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process.

The Office of AML&R identified locations of AML in the Lower Ohio River watershed from their records. In addition, source tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, and refuse piles). Field data, such as GPS locations, water samples, and flow measurements, were collected to represent these sources and characterize their impact on water quality. Based on this work, AML does not represent a significant source of metals in metals impaired streams for which TMDLs are presented. In TMDL watersheds with metals impairments, no seeps, highwalls, or AML areas associated with legacy mine practices at AML sites were incorporated into the TMDL model.

5.2.2 Sediment Sources

Land disturbance can increase sediment loading to impaired waters. The control of sediment-producing sources has been determined to be necessary to meet water quality criteria for total iron during high-flow conditions. Nonpoint sources of sediment include forestry operations, oil and gas operations, roads, agriculture, stormwater from construction sites less than one acre, and stormwater from urban and residential land in non-MS4 areas. Additionally, streambank erosion represents a significant sediment source throughout the watershed. Upland sediment nonpoint sources are summarized below.

Forestry

West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated access roads can increase sediment loading to streams. The West Virginia Bureau of Commerce’s Division of Forestry provided information on forest industry sites (registered logging sites) in the metals impaired TMDL watersheds. This information included the 2,471 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 198 acres. According to the Division of Forestry, illicit logging operations represent approximately 2.5 percent of the total harvested forest area (registered logging sites) throughout West Virginia. This rate of illicit activity has been represented in the model. These illicit operations do not have properly installed BMPs and can contribute sediment to streams. In addition, 60 acres of burned forest were reported and included as disturbed land for calibration purposes only. **Figure 5-3** displays metals nonpoint sources burned forest and logging operations in TMDL watersheds represented in the model.

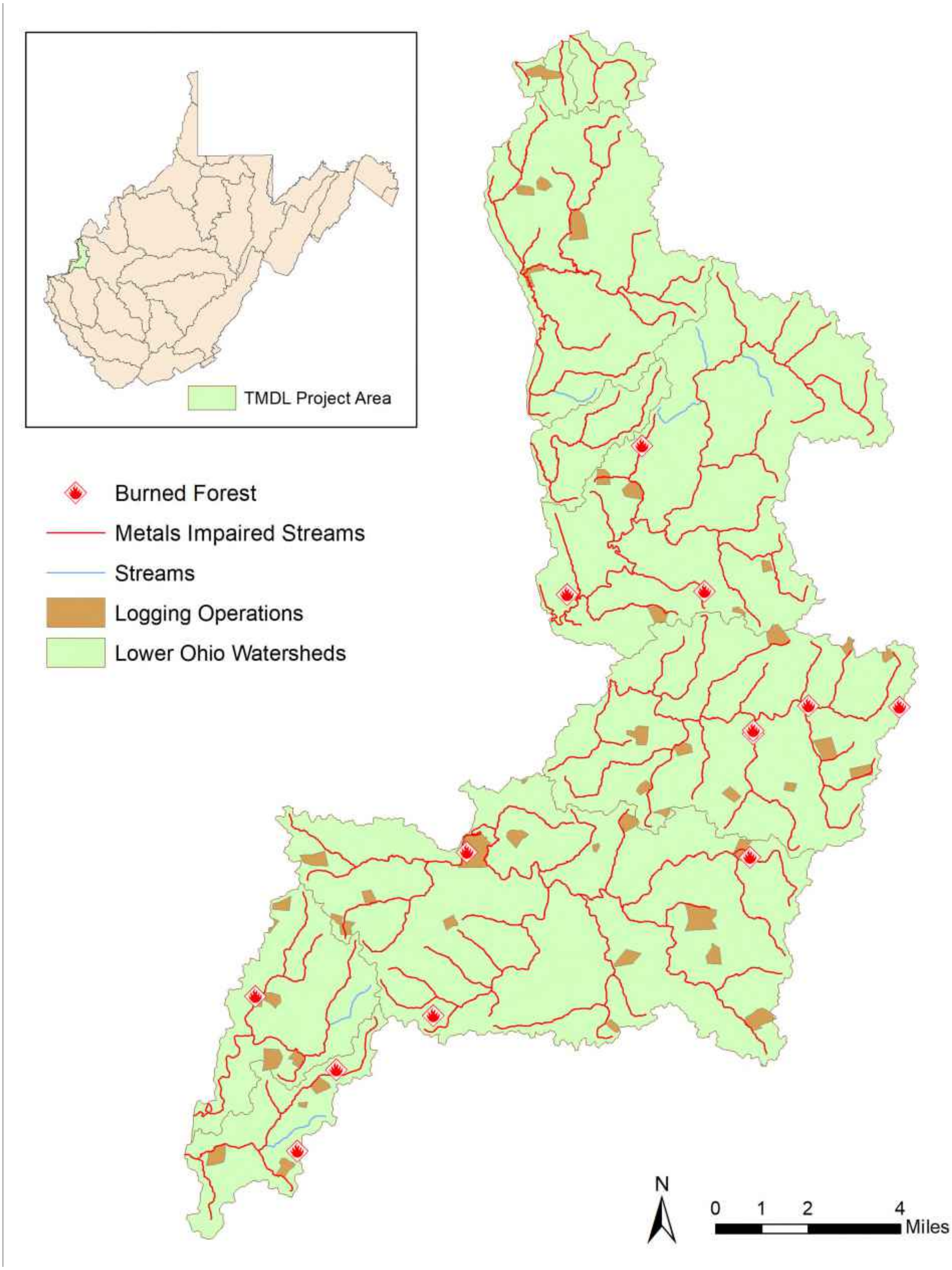


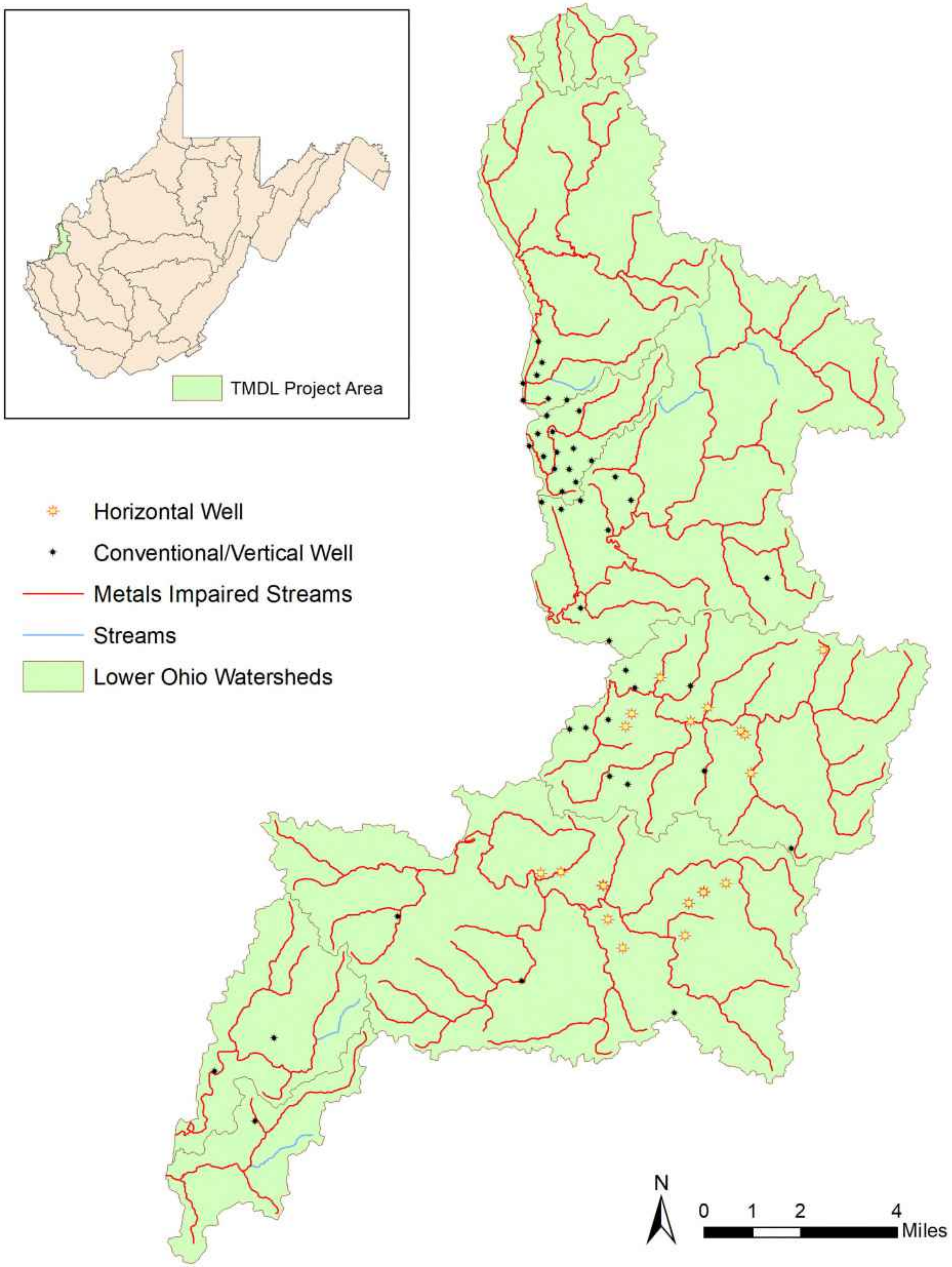
Figure 5-3. Logging and burned forest in the Lower Ohio River watershed

Oil and Gas

The WVDEP Office of Oil and Gas (OOG) is responsible for monitoring and regulating all actions related to the exploration, drilling, storage, and production of oil and natural gas in West Virginia. It maintains records on more than 55,000 active and 15,000 inactive oil and gas wells, and manages the Abandoned Well Plugging and Reclamation Program. The OOG also ensures that surface water and groundwater are protected from oil and gas activities.

Gas wells targeting the Marcellus Shale geologic formation use hydraulic fracturing techniques that result in significantly higher land disturbance than conventional wells. Horizontal Marcellus drilling sites typically require a flat "pad" area of several acres to hold equipment, access roads capable of supporting heavy vehicle traffic, and temporary ponds for storing water used during the drilling process. Vertical and horizontal Marcellus drilling sites were identified and represented in the model, in addition to conventional wells.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 45 active conventional and vertical oil and gas wells (represented as 62.1 acres), and 21 horizontal wells (represented as 43.7 acres) represented in the metals impaired TMDL watersheds addressed in this report. Runoff from unpaved access roads to these wells and the disturbed areas around the wells contribute sediment to adjacent streams (**Figure 5-4**).



(Note: wells in close proximity appear to overlap in the figure)

Figure 5-4. Oil and Gas Well locations in the Lower Ohio River watershed

Roads

Heightened stormwater runoff from paved roads (impervious surface) can increase erosion potential. Unpaved roads can contribute sediment through precipitation-driven runoff. Roads that traverse stream paths elevate the potential for direct deposition of sediment. Road construction and repair can further increase sediment loads if BMPs are not properly employed.

Modeled paved roads acreages were developed from paved road data obtained from the U.S. Census Bureau's 2015 TIGER line shapefiles. Modeled unpaved roads acreages were estimated using a combination of several sources. Baseline unpaved roads acreages were extracted from 2015 TIGER roads data. TIGER road data has been observed to be incomplete in many West Virginia rural areas, therefore an effort was made to account for additional unpaved roads present in the watershed but not captured by TIGER.

A sample of 10 subwatersheds was analyzed using 2016 NAIP aerial photographs to digitize unpaved roads not captured by TIGER. A 12-foot width of the digitized unpaved roads was assumed. For the modeled portion of the Lower Ohio watershed, the subwatersheds analyzed indicated that there could be an additional 0.23 percent of the subwatershed that consisted of unpaved roads not captured by TIGER.

Some of the unpaved roads in the Lower Ohio River watershed are recreational off-road vehicle trails. Many of these trails have been digitally mapped to facilitate use. West Virginia Trail Inventory GIS data is maintained by the West Virginia Department of Transportation (WVDOT 2019). Trail Inventory trails were assumed to be 12 feet wide for the purposes of calculating acreage. In the Lower Ohio watershed, the one trail from the Trail Inventory that fell within the project area overlapped with roads captured by TIGER, and this trail was not incorporated into the unpaved roads analysis to avoid double counting.

Agriculture

Agricultural landuses account for less than 10 percent of the modeled land area in the watershed. Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of iron and sediment. Upland loading representation was based on precipitation and runoff, in which accumulation rates were developed using source tracking information regarding number of livestock, proximity and access to streams, and overall runoff potential. Sedimentation/iron impacts from agricultural landuses are also indirectly reflected in the streambank erosion allocations.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source across the watershed. WVDEP conducted a series of special bank erosion pin studies in West Virginia watersheds which, combined with soils data and vegetative cover assessments, formed the foundation for representation of the baseline streambank sediment and iron loadings. The sediment loading from bank erosion is considered a nonpoint source and LAs are assigned for stream segments.

Other Land-Disturbance Activities

Stormwater runoff from residential and urban landuses in non-MS4 areas is a significant source of sediment in parts of the watershed. Outside urbanized area boundaries, these landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2011 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

The NLCD 2011 landuse data also classifies certain areas as "barren" land. In the model configuration process, portions of the barren landuse were reclassified to account for other known sources. The remainder is represented as a specific nonpoint source category in the model.

Construction activities disturbing less than one acre are not subject to construction stormwater permitting. While not specifically represented in the model, their impact is indirectly accounted for in the loading rates established for the urban/residential landuse category.

6.0 FECAL COLIFORM SOURCE ASSESSMENT

6.1 Fecal Coliform Point Sources

Publicly and privately owned sewage treatment facilities and home aeration units are point sources of fecal coliform bacteria. The following sections discuss the specific types of fecal coliform point sources that were identified in the Lower Ohio River watershed.

6.1.1 Individual NPDES Permits

WVDEP issues individual NPDES permits to both publicly owned and privately owned wastewater treatment facilities. Publicly owned treatment works (POTWs) are relatively large sewage treatment facilities with extensive wastewater collection systems, whereas private facilities are usually used in smaller applications such as subdivisions and shopping centers. Additionally specific discharges from industrial facilities are regulated for fecal coliform bacteria.

These sources are regulated by NPDES permits that require effluent disinfection and compliance with strict fecal coliform effluent limitations (200 counts/100 mL [geometric mean monthly] and 400 counts/100 mL [maximum daily]). Compliant facilities do not cause fecal coliform bacteria impairments because effluent limitations are more stringent than water quality criteria. Refer to the Technical Report **Appendix F** for details regarding NPDES permits.

In the subject watersheds of this report, no individually permitted POTWs or mining bathhouses discharge treated effluent to TMDL streams in the Lower Ohio River TMDL watersheds.

6.1.2 Overflows

CSOs are outfalls from POTW sewer systems that discharge untreated domestic waste and surface runoff. CSOs are permitted to discharge only during precipitation events. Sanitary sewer overflows (SSOs) are unpermitted overflows that occur as a result of excess inflow and/or infiltration to POTW separate sanitary collection systems. Both types of overflows contain fecal coliform bacteria.

In the subject watersheds, no CSO outlets associated with a POTW collection system discharge to TMDL streams. Likewise, no significant SSO discharges were represented in the model.

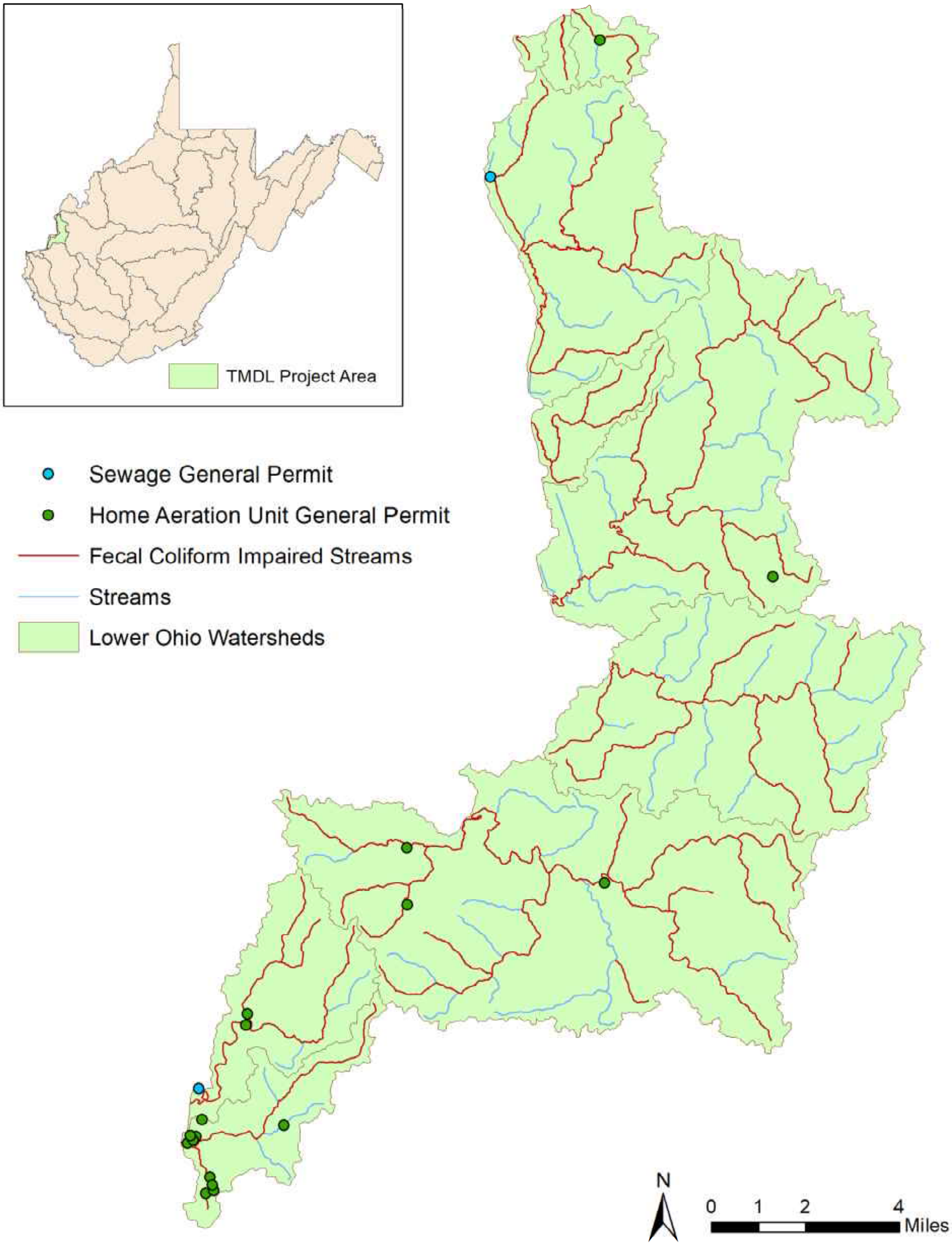
6.1.3 Municipal Separate Storm Sewer Systems (MS4) - *ADDED*

Runoff from residential and urbanized areas during storm events can be a significant fecal coliform source. USEPA's stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, MS4 stormwater discharges are considered point sources and are prescribed WLAs.

MS4 entities and their areas of responsibility are described in ***Section 5.1.4****. MS4 source representation is based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data and the transportation-related drainage areas for which WVDOH has MS4 responsibility.*

6.1.4 General Sewage Permits

General sewage permits are designed to cover like discharges from numerous individual owners and facilities throughout the state. General Permit WV0103110 regulates small, privately owned sewage treatment plants ("package plants") that have a design flow of 50,000 gallons per day (gpd) or less. General Permit WV0107000 regulates home aeration units (HAUs). HAUs are small sewage treatment plants primarily used by individual residences where site considerations preclude typical septic tank and leach field installation. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. In the areas draining to streams for which fecal coliform TMDLs have been developed, 2 facilities are registered under the "package plant" general permit, and 20 are registered under the HAU general permit. Modeled point source locations are shown on **Figure 6-1.**



(Note: outlets in close proximity appear to overlap in the figure)

Figure 6-1. Fecal coliform point sources

6.2 Fecal Coliform Nonpoint Sources

6.2.1 On-site Treatment Systems

Failing septic systems and straight pipes are significant nonpoint sources of fecal coliform bacteria. Information collected during source tracking efforts by WVDEP yielded an estimate of 13,500 homes that are not served by centralized sewage collection and treatment systems and are within 100 meters of a stream. Homes located more than 100 meters from a stream were not considered significant potential sources of fecal coliform because of the natural attenuation of fecal coliform concentrations that occurs because of bacterial die-off during overland travel (Walsh and Kunapo, 2009). Estimated septic system failure rates across the watershed range from 3 percent to 28 percent. Section 3.1.4 of the Technical Report describes the methods used to characterize failing septic systems.

Due to a wide range of available literature values relating to the bacteria loading associated with failing septic systems, a customized Microsoft Excel spreadsheet tool was created to represent the fecal coliform bacteria contribution from failing on-site septic systems. WVDEP's pre-TMDL monitoring and source tracking data were used in the calculations. To calculate loads, values for both wastewater flow and fecal coliform concentration are needed.

To calculate failing septic wastewater flows, the TMDL watersheds were divided into three septic failure zones. During the WVDEP source tracking process, septic failure zones were delineated by soil characteristics (soil permeability, depth to bedrock, depth to groundwater and drainage capacity) as shown in United States Department of Agriculture (USDA) county soil survey maps. Two types of failure were considered, complete failure and periodic failure. For the purposes of this analysis, complete failure was defined as 50 gallons per house per day of untreated sewage escaping a septic system as overland flow to receiving waters and periodic failure was defined as 25 gallons per house per day. **Figure 6-2** shows the fecal coliform counts per year represented in the model from failing septic systems relative to the total stream length in meters for each subwatershed.

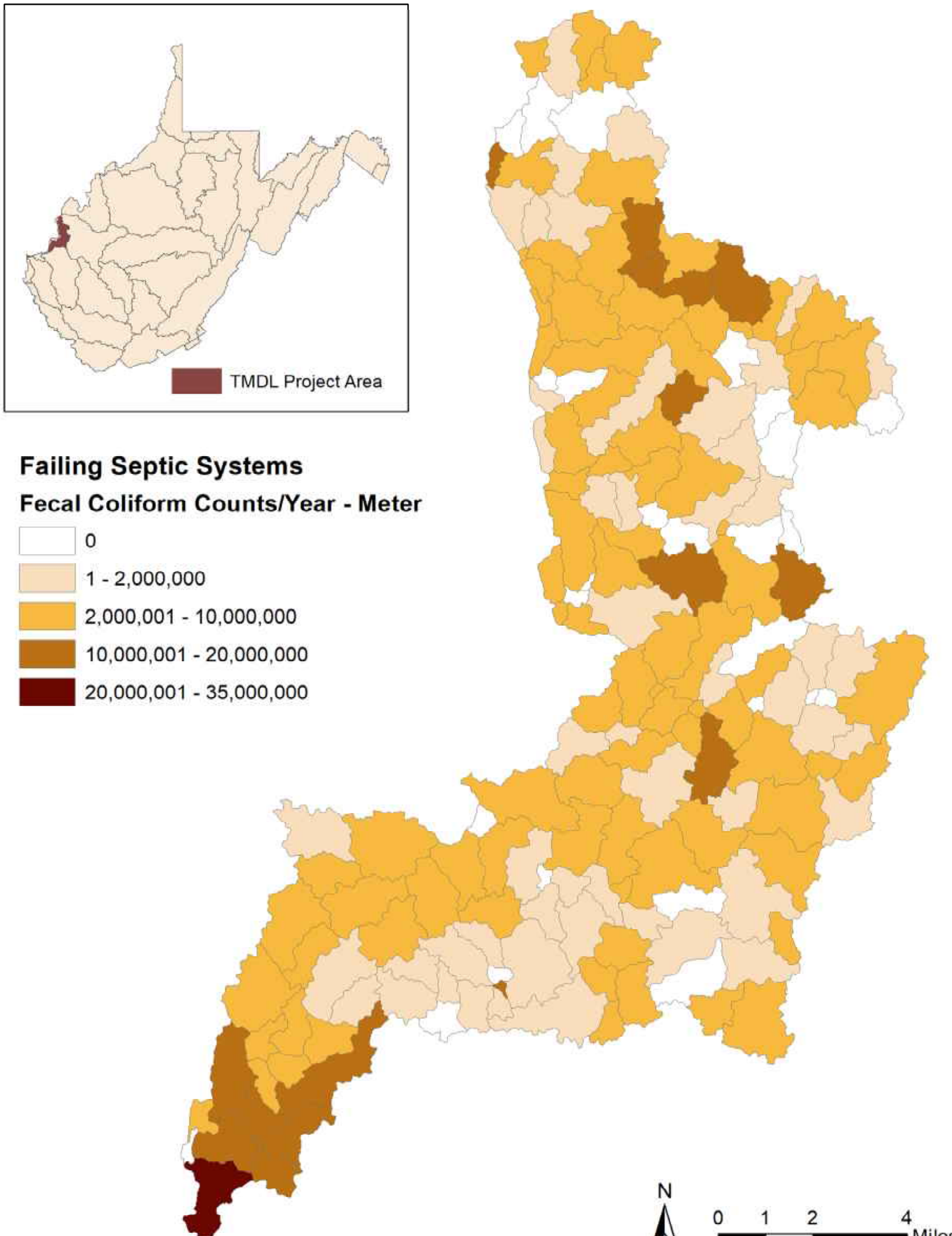


Figure 6-2. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in each subwatershed in the Lower Ohio River watershed as represented in modeling.

Once failing septic flows were modeled, a fecal coliform concentration was determined at the TMDL watershed scale. Based on past experience with other West Virginia TMDLs, a base concentration of 10,000 counts per 100 ml was used as a beginning concentration for failing septic systems, and was further refined during model calibration. A sensitivity analysis was performed by varying the modeled failing septic concentrations in multiple model runs, and then comparing model output to pre-TMDL monitoring data.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as failing septic systems and straight pipes, are considered nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with failing septic systems and straight pipes treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

6.2.2 Urban/Residential Runoff

Stormwater runoff from residential and urbanized areas that are not subject to MS4 permitting requirements can be a significant source of fecal coliform bacteria. These landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2011 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

6.2.3 Agriculture

Agricultural activities can contribute fecal coliform bacteria to receiving streams through surface runoff or direct deposition. Grazing livestock and land application of manure result in the deposition and accumulation of bacteria on land surfaces. These bacteria are then available for wash-off and transport during rain events. In addition, livestock with unrestricted access can deposit feces directly into streams.

Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of fecal coliform bacteria. Source tracking efforts identified pastures and feedlots near impaired segments that have localized impacts on instream bacteria levels. Source representation was based upon precipitation and runoff, and source tracking information regarding number of livestock, proximity and access to stream, and overall runoff potential were used to develop accumulation rates.

6.2.4 Natural Background (Wildlife)

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, which incorporated wildlife estimates obtained from West Virginia’s Division of Natural Resources (WVDNR). In addition, WVDEP conducted storm-sampling on a 100 percent forested subwatershed (Shrewsbury Hollow) within the Kanawha State Forest, Kanawha County, West Virginia to determine wildlife contributions of fecal coliform and these results were used during the model calibration process. On the basis of the low fecal accumulation rates for forested areas, the storm water sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the watershed.

7.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in **Table 3-3**, there are 2 streams that are impaired for dissolved oxygen and fecal coliform bacteria, both commonly associated with organic enrichment. Excessive amounts of organic matter increase fecal coliform bacteria counts and reduce dissolved oxygen levels. Generally, point and non-point sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Streams impaired for both dissolved oxygen and fecal coliform are listed below:

- Bryan Creek WV-OL-12-L
- Crab Creek WV-OL-18

Bryan Creek

Two DO violations occurred on Bryan Creek October 2016 & June 2017. Violations were observed at the monitoring station nearest the mouth of the stream. Two other monitoring stations higher up in the watershed did not record violations. WVDEP source tracking observed approximately 4 acres of riparian pasture with cattle access to the stream in an area immediately upstream of the monitoring station with DO violations. Livestock access, cattle, and horses were recorded in WAB field notes. Failing septic systems were predicted to be present at very low density. No NPDES permitted outlets discharging treated sewage were present in the TMDL watershed.

Organic loading associated with agricultural runoff and cattle access, particularly in the lower portion of the stream reach, causes the DO violations in Bryan Creek. Implementation of the fecal coliform TMDL for Bryan Creek will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Crab Creek

DO violations were observed in Crab Creek at two pre-TMDL water quality monitoring stations along the mainstem in August 2016 and July 2107. Crab Creek is a large watershed of over 10,000 acres that is also impaired for fecal coliform. Subwatersheds that contain the Crab Creek mainstem have significant upland and riparian pasture acreage. One package plant permit discharges to the watershed. Failing septic systems are predicted to occur in headwater subwatersheds of the catchment. WAB field notes document livestock and manure in the stream channel. The DO violations again are attributable to fecal coliform sources (agricultural and failing septic systems). Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

8.0 MODELING PROCESS

Establishing the relationship between the instream water quality targets and source loadings is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses with flow and loading conditions. This section presents the approach taken to develop the linkage between sources and instream response for TMDL development in the Lower Ohio River watershed.

8.1 Model Selection

Selection of the appropriate analytical technique for TMDL development was based on an evaluation of technical and regulatory criteria. The following key technical factors were considered in the selection process:

- Scale of analysis
- Point and nonpoint sources
- Metals and fecal coliform bacteria impairments are temporally variable and occur at low, average, and high flow conditions
- Total iron loadings and instream concentrations are related to sediment
- Time-variable aspects of land practices have a large effect on instream pollutant concentrations
- Pollutant transport mechanisms are variable and often weather-dependent

The primary regulatory factor that influenced the selection process was West Virginia's water quality criteria. According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The applicable water quality criteria for iron and fecal coliform bacteria in West Virginia are presented in **Section 2.2**, **Table 2-1**. West Virginia numeric water quality criteria are applicable at all stream flows greater than the 7-day, 10-year low flow (7Q10), defined as the lowest flow for seven day average flow that occurs once every ten years. The approach or modeling technique must permit representation of instream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison with criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and instream fate. In the Lower Ohio River watershed, an array of point and nonpoint sources contributes to the various impairments. Most nonpoint sources are rainfall-driven with pollutant loadings primarily related to surface runoff, but some, such as inadequate onsite residential sewage treatment systems, function as continuous discharges. Similarly, certain point sources are precipitation-induced while others are continuous discharges. While loading function variations must be recognized in the representation of the various sources, the TMDL allocation process must prescribe WLAs for all contributing point sources and LAs for all contributing nonpoint sources.

The MDAS was developed specifically for TMDL application in West Virginia to facilitate large scale, data intensive watershed modeling applications. The MDAS is a system designed to support TMDL development for areas affected by nonpoint and point sources. The MDAS component most critical to TMDL development is the dynamic watershed model because it provides the linkage between source contributions and instream response. The MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and instream water quality. It is capable of simulating different flow regimes and pollutant loading variations. A key advantage of the MDAS' development framework is that it has no inherent limitations in terms of modeling size or upper limit of model operations. In addition, the MDAS model allows for seamless integration with modern-day, widely available software such as Microsoft Access and Excel. Sediment, total iron, and fecal coliform bacteria were modeled using the MDAS.

8.2 Model Setup

Model setup consisted of configuring the following two separate MDAS models: iron/sediment and fecal coliform bacteria.

8.2.1 General MDAS Configuration

Configuration of the MDAS model involved subdividing the TMDL watersheds into subwatershed modeling units connected by stream reaches. Physical characteristics of the subwatersheds, weather data, landuse information, continuous discharges, and stream data were used as input. Flow and water quality were continuously simulated on an hourly time-step.

Two grid-based weather data products were used to develop MDAS model weather input files for TMDL modeling. The Parameter-Elevation Regressions on Independent Slopes Model (PRISM) and the North American Land Data Assimilation System (NLDAS-2) are both publicly available weather datasets. PRISM data features daily weather on 4 km grid spatial scale, and NLDAS-2 data has hourly weather on a 12 km grid scale. Both datasets combine rain gauge data with radar observations to predict hourly weather parameters such as precipitation, solar radiation, wind, and humidity. For more information on PRISM and NLDAS-2, refer to Section 2 of the Technical Report.

PRISM daily weather data and NLDAS-2 hourly precipitation data were obtained and processed to create a time series for each PRISM grid cell that contained modeled TMDL watersheds. Using the precipitation and temperature time series, a model weather input file was developed for each PRISM grid cell. Given that only slight variability was observed between the grid cells at the 12-digit Hydrologic Unit Code (HUC) scale, and to allow for faster model run times, one weather input file per each of the twenty-two 12-digit HUCs in the Lower Ohio River watershed was developed by taking an area-weighted average of PRISM values within each 12-digit HUC.

Model subwatersheds falling within each 12-digit HUC were then assigned the appropriate weather input file for hydrologic modeling purposes.

The 10 TMDL watersheds were broken into 184 separate subwatershed units, based on the groupings of impaired streams shown in **Figure 3-2**. The TMDL watersheds were divided to allow evaluation of water quality and flow at pre-TMDL monitoring stations. This subdivision process also ensures a proper stream network configuration within the basin.

8.2.2 Metals and Sediment Configuration

The modeled landuse categories contributing metals via precipitation and runoff include forest, pasture, cropland, wetlands, barren, residential/urban impervious, and residential/urban pervious. These sources were represented explicitly by consolidating existing NLCD 2011 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2011 and/or representing recent land disturbance activities (e.g., harvested forest and skid roads, oil and gas operations, paved and unpaved roads). The process of consolidating and updating the modeled landuses is explained in further detail in the Technical Report. Non-sediment related iron land-based sources were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget.

Traditional point sources (e.g., industrial discharges) were modeled as direct, continuous-flow sources in the model, with the baseline flow and pollutant characteristics obtained from permitting databases.

Sediment-producing landuses and bank erosion are sources of iron because the relatively high iron content of the soils in the watershed. Statistical analyses using pre-TMDL monitoring data collected in the TMDL watersheds were performed to establish the correlation between in-stream sediment and iron metals concentrations. The results were then applied to the sediment from sediment-producing landuses and stream bank erosion to calculate the iron loads delivered to the streams.

Generation of upland sediment loads depends on the intensity of surface runoff and varies by landuse and the characteristics of the soil. Surface sediment sources were modeled as soil detachment and sediment transport by landuse. Soil erodibility and sediment washoff coefficients varied among soil types and landuses and were used to simulate sediment erosion by surface runoff. Sediment delivery paths modeled were surface runoff erosion and streambank erosion. Streambank erosion was modeled as a unique sediment source independent of other upland-associated erosion sources.

The MDAS bank erosion model takes into account stream flow and bank stability using the following methodology. Each stream segment has a flow threshold (Q threshold) above which streambank erosion occurs. This threshold is estimated as the flow that occurs at bank full depth. The bank erosion rate per unit area is a function of bank flow volume above the specified threshold and the bank erodible area (Q Bank Erosion). The bank scouring process is a power function dependent on high-flow events, defined as exceeding the flow threshold. Bank erosion rates increase with flow above the Q Threshold.

The wetted perimeter and reach length represent ground area covered by water (**Figure 8-1**). The erodible wetted perimeter is equal to the difference between the actual wetted perimeter and wetted perimeter during threshold flow conditions. The bank erosion rate per unit area was multiplied by the erodible perimeter and the reach length to obtain an estimate of sediment mass eroded corresponding to the stream segment.

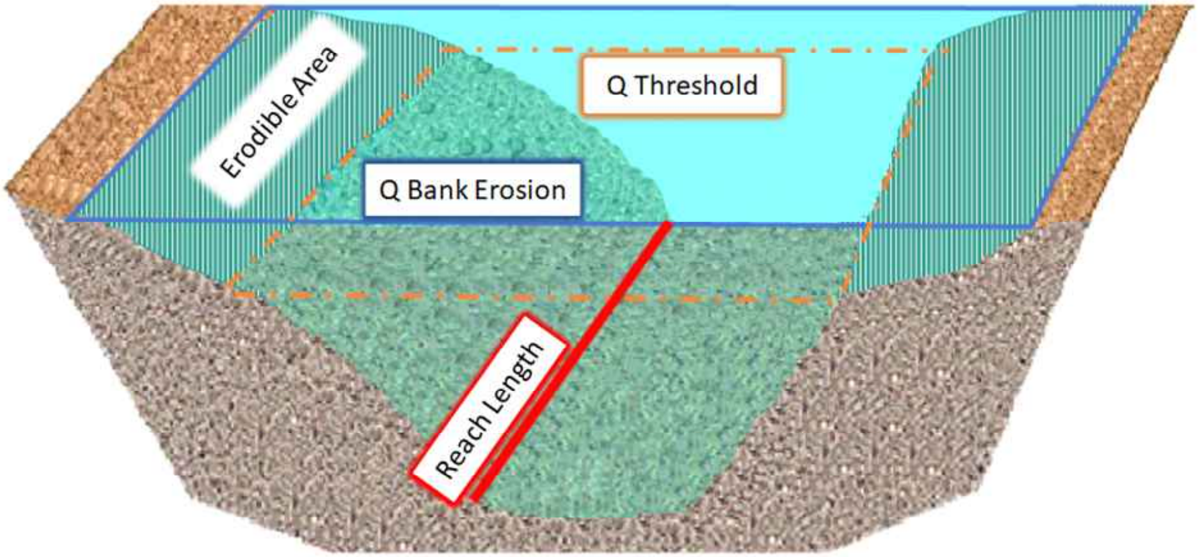


Figure 8-1. Conceptual diagram of stream channel components used in the bank erosion model

Another important variable in the prediction of sediment yield is bank stability as defined by coefficient for scour of the bank matrix soil (referred to as "kber") for the reach. Both quantitative and qualitative assessments indicated that vegetative cover was the most important factor controlling bank stability. Overall bank stability was initially characterized by assessing and rating bank vegetative cover from aerial photography on a subwatershed basis. The erodibility coefficient from soils data was used to refine this assessment. Using the aerial assessment and the soil erodibility data together, the subwatershed's bank condition was scored and each level was associated with a kber value. Modeled streambank erosion annual soil loss results were compared to field data available from previous WVDEP streambank erosion pin studies to verify that the amount of lost sediment generated by the model was within reason.

The Technical Report provides more detailed discussions on the technical approaches used for streambank erosion and sediment modeling.

8.2.3 Fecal Coliform Configuration

Modeled landuse categories contributing bacteria via precipitation and runoff include pasture, cropland, urban/residential pervious lands, urban/residential impervious lands, grassland, forest, barren land, and wetlands. Other sources, such as failing septic systems and discharges from sewage treatment facilities, were modeled as direct, continuous-flow sources in the model.

The basis for the initial bacteria loading rates for landuses and direct sources is described in the Technical Report. The initial estimates were further refined during the model calibration. A variety of modeling tools were used to develop the fecal coliform bacteria TMDLs, including the MDAS, and a customized spreadsheet to determine the fecal loading from failing residential septic systems identified during source tracking efforts by the WVDEP. **Section 6.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

8.3 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. Typically, hydrology calibration involves a comparison of model results to in-stream flow observations from USGS flow gauging stations throughout the watershed. However, there are no USGS flow gauging stations with adequate data records for model hydrology calibration on streams in the Lower Ohio River watershed modeled for this effort. Instead, a reference approach was used to define initial hydrologic parameters used in the model. Model hydrology parameters developed for the concurrently completed LSPC (MDAS) model for the nearby Twelvepole Creek watershed were applied to the Lower Ohio River model. As a starting point to parameterization for both models, many of the hydrology calibration parameters originated from the USGS Scientific Investigations Report 2005-5099 (Atkins, 2005).

Although there are no usable USGS gages on modeled streams in the Lower Ohio River watershed, some additional flow data are available within WVDEP water quality monitoring data. WVDEP flow data are limited one observation per monthly site visit collected when stream conditions were safe for wading. No high flows were observed. The Lower Ohio River model hydrology was validated by comparing model output to in-stream flow measurements obtained at pre-TMDL monitoring stations during WVDEP’s 2016-2017 pre-TMDL water quality monitoring. A detailed description of the hydrology calibration process and a summary of the results and validation are presented in the Technical Report in **Appendix I**.

8.4 Water Quality Calibration

After the model was configured and calibrated for hydrology, the next step was to perform water quality calibration for the subject pollutants. The goal of water quality calibration was to refine model parameter values to reflect the unique characteristics of the watershed so that model output would predict field conditions as closely as possible. Both spatial and temporal aspects were evaluated through the calibration process.

The water quality was calibrated by comparing modeled versus observed pollutant concentrations. The water quality calibration consisted of executing the MDAS model, comparing the model results to available observations, and adjusting water quality parameters within reasonable ranges. Initial model parameters for the various pollutant parameters were derived from previous West Virginia TMDL studies, storm sampling efforts, and literature values. Available monitoring data in the watershed were identified and assessed for application to calibration. Monitoring stations with observations that represented a range of hydrologic conditions, source types, and pollutants were selected. The time-period for water quality calibration was selected based on the availability of the observed data and their relevance to the current conditions in the watershed.

WVDEP also conducted storm monitoring on Shrewsbury Hollow in Kanawha State Forest, Kanawha County, West Virginia. The data gathered during this sampling episode was used in the calibration of fecal coliform and to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform calibration are shown in **Figure 8-2**.

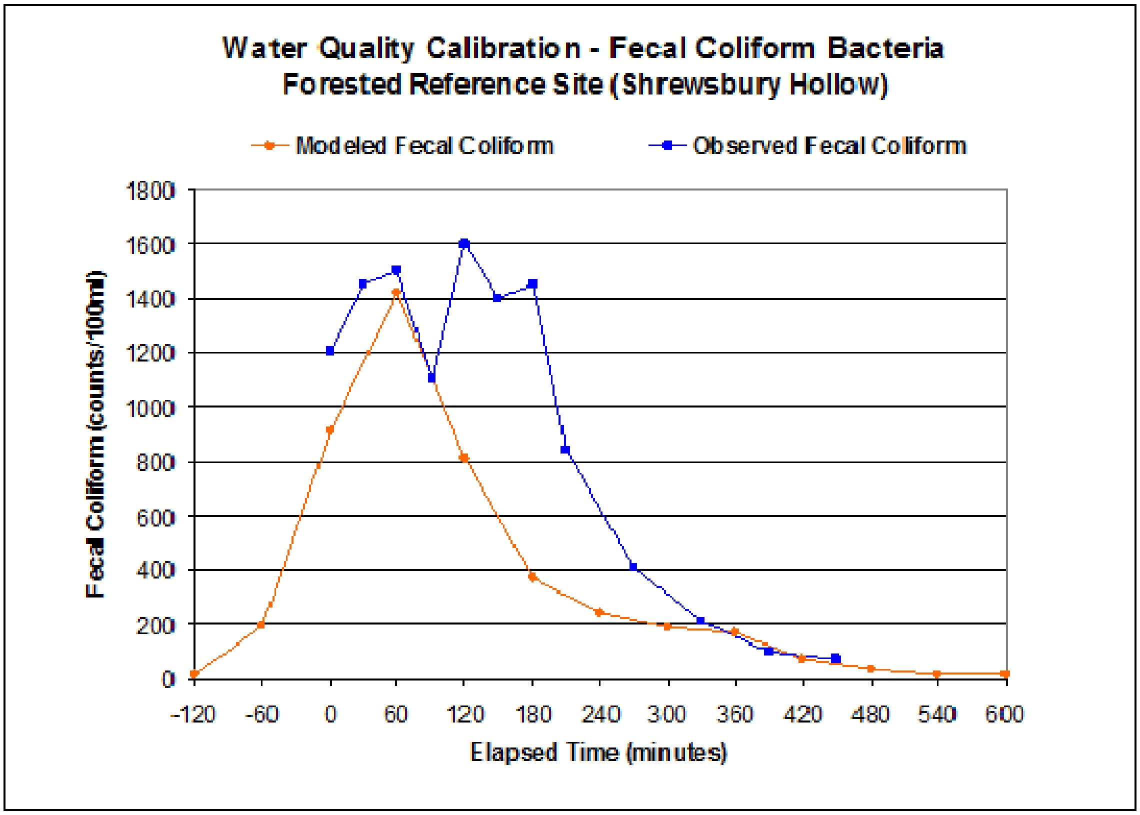


Figure 8-2. Shrewsbury Hollow fecal coliform observed data

Sediment calibration consisted of adjusting the soil erodibility and sediment transport parameters by landuse, and the coefficient of scour for bank-erosion. Initial values for these parameters were based on available landuse-specific storm-sampling monitoring data. Initial values were adjusted so that the model's suspended solids output closely matched observed instream data in watersheds with predominately one type of source.

8.5 Modeling Technique for Biological Impacts with Sedimentation Stressors

The SI process discussed in **Section 4** identified sedimentation as a significant biological stressor in some of the streams. Often streams with sedimentation impairments, are also impaired pursuant to the total iron criterion for aquatic life protection and WVDEP determined that implementation of the iron TMDLs would require sediment reductions sufficient to resolve the biological impacts. The sediment reduction necessary to attain iron criteria was compared to the sediment reduction necessary to resolve biological stress under a "reference watershed" approach. The approach was based on selecting watersheds with acceptable biological condition that share similar landuse, ecoregion, and geomorphologic characteristics with the watersheds of impacted streams. The normalized loading associated with the reference stream is assumed to represent the conditions needed to resolve sedimentation stress in impacted streams. A reference watershed was evaluated. Upon finalization of modeling based on the reference watershed approach, it was determined that sediment reductions necessary to ensure compliance with iron criteria are greater than those necessary to correct the biological impacts associated with sediment. As such, the iron TMDLs presented for the subject waters are appropriate surrogates to address impacts related to sediment. Refer to the Technical Report and **Appendix L** for details regarding the iron surrogate approach.

8.6 Allocation Strategy

As explained in **Section 2**, a TMDL is composed of the sum of individual WLAs for point sources, LAs for nonpoint sources, and natural background levels. In addition, the TMDL must include a MOS, implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

To develop the TMDLs for each of the impairments listed in **Table 3-3** of this report, the following approach was taken:

- Define TMDL endpoints
- Simulate baseline conditions
- Assess source loading alternatives
- Determine the TMDL and source allocations

8.6.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In general, West Virginia's numeric water quality criteria for the subject pollutants and an explicit five percent MOS were used to identify endpoints for TMDL development. The TMDL endpoints for the various criteria are displayed in **Table 8-1**.

The five percent explicit MOS was used to counter uncertainty in the modeling process. Long-term water quality monitoring data were used for model calibration. Although these data represented actual conditions, they were not of a continuous time series and might not have captured the full range of instream conditions that occurred during the simulation period. The allocation process prescribes criterion end of pipe WLAs for continuous discharges and instream treatment structures and thereby provides an implicit MOS for criterion attainment at all model assessment locations. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage.

Table 8-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Total Iron	Aquatic Life, warmwater fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)
Fecal Coliform	Water Contact Recreation and Public Water Supply	400 counts / 100 mL (Daily, 10% exceedance)	380 counts / 100 mL (Daily, 10% exceedance)

* Possible mining outlets with fish tissue study bioaccumulation criteria based limits.

TMDLs are presented as average daily loads that were developed to meet TMDL endpoints under a range of conditions observed throughout the year. For most pollutants, analysis of available data indicated that critical conditions occur during both high- and low-flow events. To appropriately address the low- and high-flow critical conditions, the TMDLs were developed using continuous simulation (modeling over a period of several years that captured precipitation extremes), which inherently considers seasonal hydrologic and source loading variability.

8.6.2 Baseline Conditions and Source Loading Alternatives

The calibrated model provides the basis for performing the allocation analysis. The first step is to simulate baseline conditions, which represent point sources loadings at permit limits and existing nonpoint source loadings. Baseline conditions allow for an evaluation of instream water quality under the highest expected loading conditions.

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative six-year simulation period (January 1, 2012 through December 31, 2017). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods. **Figure 8-3** presents the seasonal rainfall totals for the years 2007 through 2017 at the Huntington Tri-State Airport (WBAN 03860) weather station near Ceredo, West Virginia. The years 2012 to 2017 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Lower Ohio River watershed.

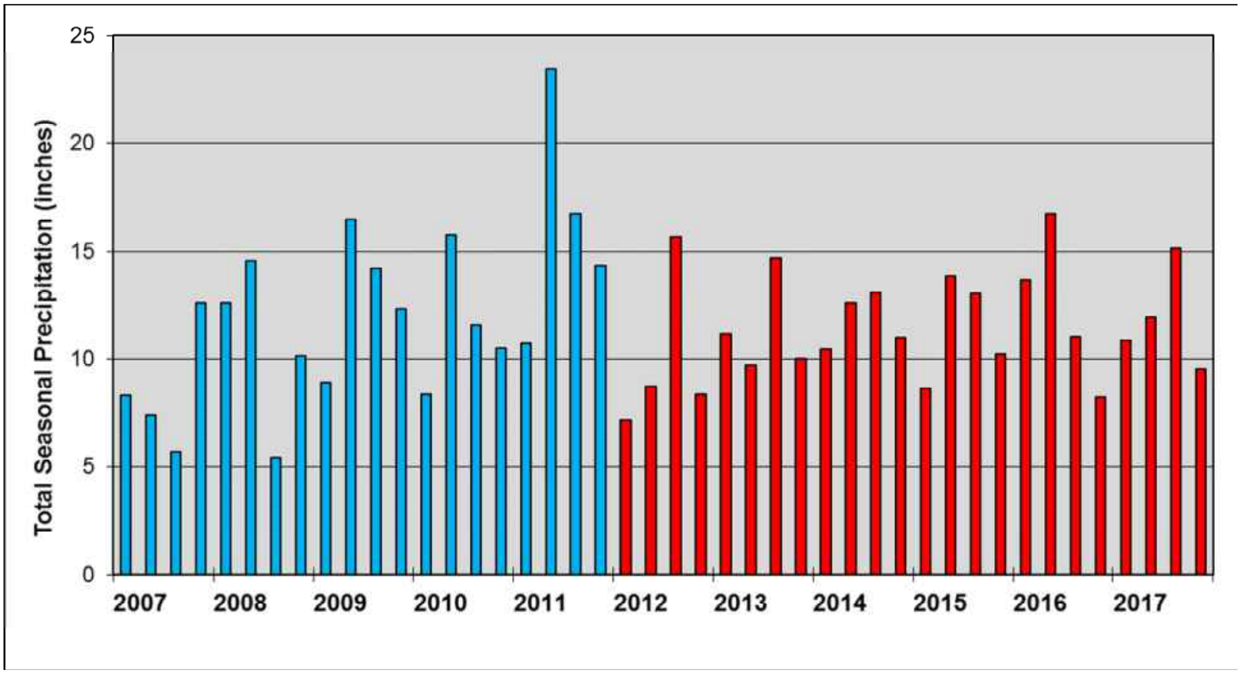


Figure 8-3. Seasonal precipitation totals for the Huntington Tri-State Airport (WBAN 03860) weather station

NPDES permits contain effluent limitations for iron concentrations. In the baseline condition, discharges that are influenced by precipitation were represented using precipitation and drainage area. Baseline concentrations varied by parameter. For iron, baseline concentrations were generally established at the technology based concentration (3.2 mg/l) or water quality based concentration (1.5 mg/l), as applicable to each permit.

Based upon guidance from WVDEP's permitting program, 2.5 percent of the total subwatershed area was allotted for concurrent construction activity under the CSGP, where possible. Baseline loadings were based upon precipitation and runoff and an assumption that proper installation and maintenance of required BMPs will achieve a total suspended solid (TSS) benchmark value of 100 mg/L.

Sediment producing nonpoint source and background loadings were represented using precipitation, drainage area, and the iron loading associated with their predicted sediment contributions.

Effluents from sewage treatment plants were represented under baseline conditions as continuous discharges, using the design flow for each facility and the monthly geometric mean fecal coliform effluent limitation of 200 counts/100 mL. Baseline characteristics for non-stormwater industrial wastewater sources were obtained from effluent limitations and other permitting information.

Source Loading Alternatives

Simulating baseline conditions allowed for the evaluation of each stream's response to variations in source contributions under a variety of hydrologic conditions. Performing this sensitivity analysis gave insight into the dominant sources and the mechanisms by which potential decreases in loads would affect instream pollutant concentrations. The loading contributions from the various existing sources were individually adjusted; and the modeled instream concentrations were then evaluated.

Multiple allocation scenarios were run for the impaired waterbodies. Successful scenarios achieved the TMDL endpoints under all flow conditions throughout the modeling period. The averaging period and allowable exceedance frequency associated with West Virginia water quality criteria were considered in these assessments. In general, loads contributed by sources that had the greatest impact on instream concentrations were reduced first. If additional load reductions were required to meet the TMDL endpoints, less significant source contributions were subsequently reduced. **Figure 8-4** shows an example of model output for a baseline condition and a successful TMDL scenario.

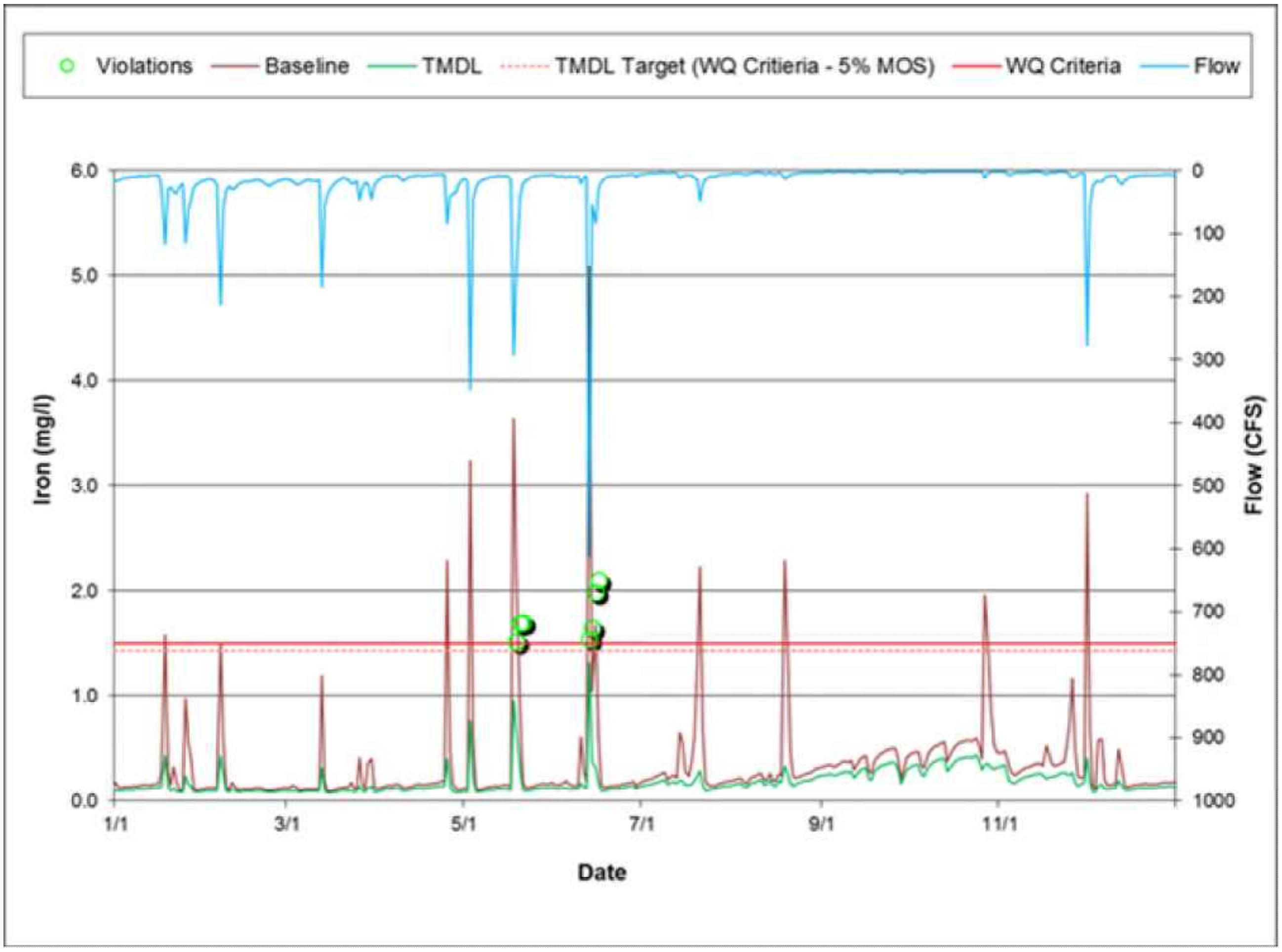


Figure 8-4. Example of baseline and TMDL conditions for total iron

8.7 TMDLs and Source Allocations

8.7.1 Total Iron TMDLs - *REVISED*

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Lower Ohio River watersheds. In order to meet iron criterion and allow for equitable allocations, reductions to existing sources were first assigned using the following iterative steps in a series of model runs, reducing to meet the TMDL endpoint:

1. The loading from streambank erosion was first reduced to the loading characteristics of the streams with the best observed streambank conditions.
2. The following land disturbing sources were equitably reduced to the iron loading associated with 100 mg/L TSS.
    - Barren
    - Cropland
    - Pasture
    - Urban Pervious
    - Oil and gas
    - Unpaved Roads
    - Forestry Skid Roads and Landings
3. Harvested Forest was reduced to the sediment and iron loading associated with Forest.
4. No point sources were greater than water quality criteria end of pipe (1.5 mg/L iron) in baseline, so no reductions to point sources were necessary.

In addition to reducing the streambank erosion and source contributions, activity under the CSGP and OGCSGP was considered. Area based WLAs were provided for each subwatershed to accommodate existing and future registrations under the CSGP or OGCSGP. 2.5 percent of the subwatershed area was allocated for activity in almost all subwatersheds to account for future growth.

After executing the above provisions, model output was evaluated to determine the criterion attainment status at all subwatershed pour points A pour point is the most downstream point of a modeled reach within a subwatershed, just before the modeled flow "pours" into the receiving stream of the next adjacent subwatershed.

Using this method ensured that contributions from all sources were weighted equitably and that cumulative load endpoints were met at the most downstream subwatershed for each impaired stream. Reductions in sources affecting impaired headwaters ultimately led to improvements downstream and effectively decreased necessary loading reductions from downstream sources. Nonpoint source reductions did not result in allocated loadings less than natural conditions. Permitted source reductions did not result in allocated loadings to a permittee that would be more stringent than water quality criteria.

Wasteload Allocations (WLAs)

WLAs were developed for all point sources permitted to discharge iron under a NPDES permit. Because of the established relationship between iron and TSS, iron WLAs are also provided for facilities with stormwater discharges that are regulated under NPDES permits that contain TSS and/or iron effluent limitations or benchmarks values, and facilities registered under the General NPDES permit for construction stormwater. NPDES permits must contain effluent limits and conditions consistent with the assumptions and requirements of the WLAs in the TMDL (40 CFR § 122.44(d)(1)(vii)(B)). WLAs for non-construction stormwater sources should be translated into effective, measurable water quality effluent limits in the form of numeric limits or measurable, objective BMP-based limits projected to achieve the WLAs, with benchmark values and monitoring to determine BMP effectiveness.

Discharges regulated by the Multi Sector Stormwater Permit

Certain registrations under the general permit for stormwater associated with industrial activity implement TSS and/or iron benchmark values. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions, whether those requirements are expressed in effluent limits or benchmark values. BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. In the TMDL watersheds of the Lower Ohio River there is one designated MS4 entity listed below. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs. The individual registration number for the Division of Highways MS4 is below:

- *West Virginia Division of Highways* *WVR030004*

In the majority of the subwatersheds where MS4 entities have areas of responsibility, the urban, residential and road landuses strongly influence bank erosion. As such, portions of the baseline and allocated loads associated with bank erosion are included in the MS4 WLAs. The subdivision of the bank erosion component between point and nonpoint sources, and where applicable, between multiple MS4 entities, is proportional to their respective drainage areas within each subwatershed. Model representation of bank erosion is accomplished through consideration of a number of inputs including slope, soils, imperviousness, and the stability of existing streambanks. Bank erosion loadings are most strongly influenced by upland impervious area and bank stability. The decision to include bank erosion in the MS4 WLAs results from the predominance of urban/residential/road landuses and impacts in MS4 areas. WVDEP's assumption is that upland management practices will be implemented under the MS4 permit to directly address impacts from bank erosion. However, even if the implementation of stormwater controls on uplands is maximized, and the volume and intensity of stormwater runoff are minimized, the existing degraded stability of streambanks may continue to accelerate erosion. The erosion of unstable streambanks is a nonpoint source of sediment that is included in the MS4 allocations. Natural attenuation of legacy impacts cannot be expected in the short term, but may be accelerated by bank stabilization projects. The inclusion of the bank erosion load component *in the WLAs of MS4 entities is not intended to prohibit or discourage cooperative bank stabilization projects between MS4 entities and WVDEP's Nonpoint Source Program, or to prohibit the use of Section 319 funding as a component of those projects.*

Construction Stormwater

Specific WLAs for activity under the CSGP are provided at the subwatershed scale and are described in **Section 5.1.3**. With several exceptions, an allocation of 2.5 percent of undeveloped subwatershed area was provided with loadings based upon precipitation and runoff and an assumption that required BMPs, if properly installed and maintained, will achieve a TSS benchmark value of 100 mg/L. In certain areas, the existing level of activity under the CSGP does not conform to the subwatershed allocations. In these instances the WVDEP, DWWM permitting program will require stabilization and permit termination in the shortest time possible. Thereafter the program will maintain concurrently disturbed area as allocated or otherwise control future activity through provisions described in **Section 10**.

Other Non-mining Point Sources

Non-stormwater municipal and industrial sources for which existing NPDES permits did not contain iron were not considered to be substantive sources and were not explicitly represented in the modeling. A list of such negligible sources appears in **Appendix F** of the Technical Report. Existing discharges from such sources do not require wasteload allocations pursuant to the iron TMDLs. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

Load Allocations (LAs)

LAs are made for the dominant nonpoint source categories as follows:

- Sediment sources: loading associated with sediment contributions from barren land, forestry skid roads and landings, oil and gas well operations, agricultural landuses, and residential/urban/road landuses and streambank erosion in non-MS4 areas
- Background and other nonpoint sources: loading from undisturbed forest and grasslands (loadings associated with this category were represented but not reduced)

8.7.2 Fecal Coliform Bacteria TMDLs - *REVISED*

TMDLs and source allocations were developed for impaired streams and their tributaries on a subwatershed basis throughout the watershed. The following general methodology was used when allocating loads to fecal coliform bacteria sources:

- The effluents from all NPDES permitted sewage treatment plants were set at the permit limit (200 counts/100 mL monthly geometric mean)

- Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit discharges of human waste (from failing septic systems and straight pipes) were reduced by 100 percent in the model
- If further reduction was necessary, non-point source loadings from agricultural lands and residential areas were subsequently reduced until in-stream water quality criteria were met

Wasteload Allocations (WLAs)

WLAs were developed for all facilities permitted to discharge fecal coliform bacteria, including MS4s, as described below.

Sewage Treatment Plant Effluents

The fecal coliform effluent limitations for NPDES permitted sewage treatment plants are more stringent than water quality criteria; therefore, all effluent discharges from sewage treatment facilities were given WLAs equal to existing monthly fecal coliform effluent limitations of 200 counts/100 mL. When there are permitted stormwater outlets at sewage treatment plants, BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. WVDOH is the only designated MS4 entity in the subject watersheds. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs.

Load Allocations (LAs)

Fecal coliform LAs are assigned to the following source categories:

- Pasture/Cropland
- On-site Sewage Systems — loading from all illicit discharges of human waste (including failing septic systems and straight pipes)
- Residential — loading associated with urban/residential runoff from non-MS4 areas
- Background and Other Nonpoint Sources — loading associated with wildlife sources from all other landuses (contributions/loadings from wildlife sources were not reduced)

8.7.3 Seasonal Variation

Seasonal variation was considered in the formulation of the modeling analysis. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers seasonal hydrologic and source loading variability**.** The pollutant concentrations simulated on a daily time step by the model were compared with TMDL endpoints. Allocations that met these endpoints throughout the modeling period were developed.

8.7.4 Critical Conditions

A critical condition represents a scenario where water quality criteria are most susceptible to violation. Analysis of water quality data for the impaired streams addressed in this effort shows high pollutant concentrations during both high- and low-flow thereby precluding selection of a single critical condition. Both high-flow and low-flow periods were taken into account during TMDL development by using a long period of weather data that represented wet, dry, and average flow periods.

Nonpoint source loading is typically precipitation-driven and impacts tend to occur during wet weather and high surface runoff. During dry periods little or no land-based runoff occurs, and elevated instream pollutant levels may be due to point sources (Novotny and Olem, 1994).

8.7.5 TMDL Presentation - *REVISED*

The TMDLs for all impairments are shown in **Section 9** of this report. The TMDLs for iron are presented as average daily loads, in pounds per day. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day. All TMDLs were developed to meet TMDL endpoints under a range of conditions observed over the modeling period. TMDLs and their components are also presented in the allocation spreadsheets associated with this report. The filterable spreadsheets also display detailed source allocations and include multiple display formats that allow comparison of pollutant loadings among categories and facilitate implementation of the TMDL to restore the waterbody.

The iron WLAs for future Construction Stormwater General Permit registrations are presented as both annual average loads, for comparison with other sources, and equivalent area registered under the permit. The registered area is the operable allocation. The iron WLAs for non-construction sectors registered under the Multi Sector Stormwater Permit are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are operable, and because they are equivalent to existing effluent limitations/benchmark values, they are to be directly implemented.

The fecal coliform bacteria WLAs for sewage treatment plant effluents are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations for NPDES permit implementation.

The WLAs for precipitation induced MS4 discharges are presented in terms of average annual daily loads (Fe) or average number of colonies per year (FC) and the percent pollutant reduction from baseline conditions. The "MS4 WLA Summary" tabs of the allocation spreadsheets contain the operable allocations expressed as percent reductions. That information is intended to assist registrants under the MS4 General Permit in describing the management practices to be employed to achieve prescribed allocations.

This TMDL does not mandate change to the form of regulation in existing NPDES permits that regulate stormwater discharges under the BMP basis and include benchmark values and monitoring to assess BMP effectiveness, when values are less than or equal to specified concentration-based wasteload allocations.

9.0 TMDL RESULTS

Table 9-1. Iron TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Sevenmile Creek	WV-OL-4_02	Sevenmile Creek	WVO-6	12.03	1.72	0.72	14.46
Sevenmile Creek	WV-OL-4-A_01	Little Sevenmile Creek	WVO-6-A	1.45	0.21	0.09	1.75
Sevenmile Creek	WV-OL-4-B_01	UNT/Sevenmile Creek RM 2.08		0.66	0.10	0.04	0.79
Sevenmile Creek	WV-OL-4_01	Sevenmile Creek	WVO-6	3.04	0.44	0.18	3.66
Sevenmile Creek	WV-OL-4-E_01	UNT/Sevenmile Creek RM 3.11		0.44	0.06	0.03	0.53
Ninemile Creek	WV-OL-5_02	Ninemile Creek	WVO-7	12.41	1.65	0.74	14.80
Ninemile Creek	WV-OL-5-A_01	UNT/Ninemile Creek RM 3.94	WVO-7-A	5.21	0.71	0.31	6.23
Ninemile Creek	WV-OL-5-A-4_01	UNT/UNT RM 1.61/Ninemile Creek RM 3.94		0.53	0.07	0.03	0.64
Ninemile Creek	WV-OL-5_01	Ninemile Creek	WVO-7	4.56	0.62	0.27	5.45
Ninemile Creek	WV-OL-5-H_01	UNT/Ninemile Creek RM 5.75	WVO-7-H	0.89	0.12	0.05	1.06
Guyan Creek	WV-OL-12-C_02	Spurlock Creek	WVO-9-A	19.15	3.19	1.18	23.52
Guyan Creek	WV-OL-12-C-2_01	Left Fork/Spurlock Creek	WVO-9-A-2	8.28	1.37	0.51	10.15
Guyan Creek	WV-OL-12-C-2-C_01	Perry Creek	WVO-9-A-2-A	2.74	0.49	0.17	3.40
Guyan Creek	WV-OL-12-C_01	Spurlock Creek	WVO-9-A	8.06	1.46	0.50	10.02
Guyan Creek	WV-OL-12-C-10_01	UNT/Spurlock Creek RM 3.39		1.65	0.30	0.10	2.05
Guyan Creek	WV-OL-12_04	Guyan Creek	WVO-9	97.53	12.58	5.80	115.91
Guyan Creek	WV-OL-12-D_01	UNT/Guyan Creek RM 3.82		3.78	0.66	0.23	4.68
Guyan Creek	WV-OL-12-K_01	McCowan Branch	WVO-9-B	2.66	0.44	0.16	3.26
Guyan Creek	WV-OL-12-L_02	Bryan Creek	WVO-9-C	18.80	2.86	1.14	22.80
Guyan Creek	WV-OL-12-L-2_01	UNT/Bryan Creek RM 1.37	WVO-9-C-0.5	1.83	0.29	0.11	2.23
Guyan Creek	WV-OL-12-L-6_01	UNT/Bryan Creek RM 3.25		1.20	0.18	0.07	1.45
Guyan Creek	WV-OL-12-L_01	Bryan Creek	WVO-9-C	9.61	1.52	0.59	11.72
Guyan Creek	WV-OL-12-L-7_01	UNT/Bryan Creek RM 3.74	WVO-9-C-7	2.09	0.34	0.13	2.56
Guyan Creek	WV-OL-12-L-8_01	UNT/Bryan Creek RM 3.78		0.51	0.08	0.03	0.62
Guyan Creek	WV-OL-12-L-10_01	UNT/Bryan Creek RM 4.67		0.92	0.17	0.06	1.15

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Guyan Creek	WV-OL-12-L-13_01	UNT/Bryan Creek RM 5.18		1.28	0.21	0.08	1.57
Guyan Creek	WV-OL-12_03	Guyan Creek	WVO-9	55.81	7.80	3.35	66.96
Guyan Creek	WV-OL-12-M_01	Trace Fork	WVO-9-D	22.86	3.42	1.38	27.66
Guyan Creek	WV-OL-12-M-5_01	Lynn Fork	WVO-9-D-2	1.87	0.31	0.11	2.29
Guyan Creek	WV-OL-12-M-6_01	Jenkins Branch	WVO-9-D-1	6.07	0.92	0.37	7.36
Guyan Creek	WV-OL-12-M-6-C_01	UNT/Jenkins Branch RM 0.75	WVO-9-D-1-C	0.82	0.13	0.05	1.01
Guyan Creek	WV-OL-12-P_01	Knife Branch	WVO-9-E	2.72	0.43	0.17	3.31
Guyan Creek	WV-OL-12-Q_02	Bear Hollow Creek	WVO-9-F	16.86	2.62	1.03	20.51
Guyan Creek	WV-OL-12-Q-2_01	UNT/Bear Hollow Creek RM 1.20	WVO-9-F-2	1.74	0.24	0.10	2.09
Guyan Creek	WV-OL-12-Q_01	Bear Hollow Creek	WVO-9-F	10.26	1.65	0.63	12.53
Guyan Creek	WV-OL-12-Q-7_01	UNT/Bear Hollow Creek RM 3.97		2.64	0.42	0.16	3.22
Guyan Creek	WV-OL-12_02	Guyan Creek	WVO-9	16.55	2.48	1.00	20.04
Guyan Creek	WV-OL-12_01	Guyan Creek	WVO-9	12.14	1.80	0.73	14.68
Guyan Creek	WV-OL-12-W_01	UNT/Guyan Creek RM 13.17	WVO-9-W	3.36	0.50	0.20	4.06
Eighteenmile Creek	WV-OL-15-D_01	Rocky Fork	WVO-10-A	3.40	0.57	0.21	4.18
Eighteenmile Creek	WV-OL-15-D-4_01	UNT/Rocky Fork RM 1.29		0.44	0.08	0.03	0.55
Eighteenmile Creek	WV-OL-15_04	Eighteenmile Creek	WVO-10	63.67	8.37	3.79	75.83
Eighteenmile Creek	WV-OL-15-H_01	UNT/Eighteenmile Creek RM 4.64		2.48	0.40	0.15	3.03
Eighteenmile Creek	WV-OL-15-I_01	Hughes Branch	WVO-10-B	2.76	0.49	0.17	3.42
Eighteenmile Creek	WV-OL-15-J_01	Fees Branch	WVO-10-C	8.02	1.28	0.49	9.79
Eighteenmile Creek	WV-OL-15-J-1_01	UNT/Fees Branch RM 0.87	WVO-10-C-1	3.07	0.51	0.19	3.77
Eighteenmile Creek	WV-OL-15_03	Eighteenmile Creek	WVO-10	40.79	5.64	2.44	48.87
Eighteenmile Creek	WV-OL-15-K_01	UNT/Eighteenmile Creek RM 6.73		2.22	0.37	0.14	2.73
Eighteenmile Creek	WV-OL-15-L_01	Mud Run	WVO-10-D	3.28	0.53	0.20	4.01
Eighteenmile Creek	WV-OL-15-N_01	UNT/Eighteenmile Creek RM 7.85		1.20	0.22	0.07	1.49
Eighteenmile Creek	WV-OL-15-O_01	Right Fork/Eighteenmile Creek	WVO-10-D.5	9.95	1.35	0.59	11.90
Eighteenmile Creek	WV-OL-15-O-3_01	UNT/Right Fork RM 1.82/Eighteenmile Creek		1.32	0.23	0.08	1.63
Eighteenmile Creek	WV-OL-15_02	Eighteenmile Creek	WVO-10	18.35	2.88	1.12	22.34
Eighteenmile Creek	WV-OL-15-R_01	Road Fork	WVO-10-E	1.57	0.27	0.10	1.93
Eighteenmile Creek	WV-OL-15-S_01	White Pine Creek	WVO-10-F	6.58	1.12	0.40	8.10
Eighteenmile Creek	WV-OL-15-S-1_01	Spring Branch	WVO-10-F-1	1.77	0.31	0.11	2.19

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Eighteenmile Creek	WV-OL-15_01	Eighteenmile Creek	WVO-10	7.08	1.16	0.43	8.67
Eighteenmile Creek	WV-OL-15-V_01	UNT/Eighteenmile Creek RM 11.29		0.82	0.14	0.05	1.01
Eighteenmile Creek	WV-OL-15-W_01	UNT/Eighteenmile Creek RM 11.85		1.68	0.28	0.10	2.06
Sixteenmile Creek	WV-OL-16-A_01	UNT/Sixteenmile Creek RM 0.55	WVO-11-0.8A	1.79	0.15	0.10	2.05
Sixteenmile Creek	WV-OL-16_04	Sixteenmile Creek	WVO-11	72.31	7.40	4.20	83.90
Sixteenmile Creek	WV-OL-16-B_01	UNT/Sixteenmile Creek RM 1.44		1.12	0.12	0.07	1.31
Sixteenmile Creek	WV-OL-16-C_01	UNT/Sixteenmile Creek RM 1.96	WVO-11-0.9A	4.20	0.44	0.24	4.89
Sixteenmile Creek	WV-OL-16-D_01	Stonecoal Run	WVO-11-A	3.86	0.51	0.23	4.61
Sixteenmile Creek	WV-OL-16-G_01	Jerrys Run	WVO-11-B	3.33	0.49	0.20	4.02
Sixteenmile Creek	WV-OL-16-H_01	Daves Run	WVO-11-C	1.18	0.19	0.07	1.44
Sixteenmile Creek	WV-OL-16-J_01	Millstone Creek	WVO-11-D	4.79	0.67	0.29	5.76
Sixteenmile Creek	WV-OL-16-J-3_01	UNT/Millstone Creek RM 1.19		0.90	0.11	0.05	1.06
Sixteenmile Creek	WV-OL-16_03	Sixteenmile Creek	WVO-11	34.34	4.14	2.02	40.50
Sixteenmile Creek	WV-OL-16-K_01	Righthand Fork	WVO-11-E	13.98	1.87	0.83	16.68
Sixteenmile Creek	WV-OL-16-K-3_01	UNT/Righthand Fork RM 1.77	WVO-11-E-3	1.47	0.25	0.09	1.81
Sixteenmile Creek	WV-OL-16-K-4_01	UNT/Righthand Fork RM 2.10	WVO-11-E-4	3.43	0.48	0.21	4.11
Sixteenmile Creek	WV-OL-16-K-5_01	UNT/Righthand Fork RM 3.44		0.51	0.09	0.03	0.63
Sixteenmile Creek	WV-OL-16-P_01	Potts Hollow (Righthand Fork)	WVO-11-F	2.00	0.29	0.12	2.41
Sixteenmile Creek	WV-OL-16-P-2_01	UNT/Potts Hollow RM 1.31		0.79	0.12	0.05	0.95
Sixteenmile Creek	WV-OL-16_02	Sixteenmile Creek	WVO-11	25.49	3.12	1.51	30.12
Sixteenmile Creek	WV-OL-16_01	Sixteenmile Creek	WVO-11	8.07	1.02	0.48	9.57
Sixteenmile Creek	WV-OL-16-Y_01	UNT/Sixteenmile Creek RM 13.56	WVO-11-G.1	1.47	0.18	0.09	1.74
Sixteenmile Creek	WV-OL-16-AA_01	Willow Branch	WVO-11-H	0.38	0.06	0.02	0.46
Sixteenmile Creek	WV-OL-16-AB_01	Wolfpen Run	WVO-11-I	0.98	0.14	0.06	1.18
Sixteenmile Creek	WV-OL-16-AD_01	UNT/Sixteenmile Creek RM 15.47	WVO-11-K	2.16	0.30	0.13	2.59
Sixteenmile Creek	WV-OL-16-AD-3_01	UNT/UNT RM 1.39/Sixteenmile Creek RM 15.47		0.53	0.08	0.03	0.64
Flatfoot Creek	WV-OL-17_01	Flatfoot Creek	WVO-12	5.43	0.59	0.32	6.34
Flatfoot Creek	WV-OL-17-B_01	UNT/Flatfoot Creek RM 3.42	WVO-12-B	0.98	0.12	0.06	1.15
Flatfoot Creek	WV-OL-17-D_01	UNT/Flatfoot Creek RM 5.40	WVO-12-D	1.24	0.11	0.07	1.43
Crab Creek	WV-OL-18-B_01	Mud Run	WVO-13-A	3.77	0.41	0.22	4.40
Crab Creek	WV-OL-18-B-1_01	UNT/Mud Run RM 1.29		0.43	0.04	0.02	0.50

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Crab Creek	WV-OL-18_03	Crab Creek	WVO-13	58.01	5.95	3.37	67.32
Crab Creek	WV-OL-18-C_01	UNT/Crab Creek RM 2.22	WVO-13-A.3	3.50	0.49	0.21	4.20
Crab Creek	WV-OL-18-D_01	Sand Fork	WVO-13-B	15.01	1.24	0.86	17.11
Crab Creek	WV-OL-18-D-1_01	UNT/Sand Fork RM 0.33		1.28	0.16	0.08	1.52
Crab Creek	WV-OL-18-D-3_01	UNT/Sand Fork RM 1.86		1.11	0.07	0.06	1.25
Crab Creek	WV-OL-18-D-6_01	UNT/Sand Fork RM 2.90		1.90	0.13	0.11	2.13
Crab Creek	WV-OL-18-E_01	Middle Fork/Crab Creek	WVO-13-D	31.30	3.41	1.83	36.53
Crab Creek	WV-OL-18-E-3_01	UNT/Middle Fork RM 2.10/Crab Creek		2.44	0.23	0.14	2.82
Crab Creek	WV-OL-18-E-6_01	UNT/Middle Fork RM 3.52/Crab Creek	WVO-13-D-6	4.59	0.50	0.27	5.36
Crab Creek	WV-OL-18_01	Crab Creek	WVO-13	21.41	2.77	1.27	25.46
Crab Creek	WV-OL-18-I_01	Righthand Fork	WVO-13-E	2.49	0.38	0.15	3.02
Crab Creek	WV-OL-18-J_01	UNT/Crab Creek RM 7.00	WVO-13-F	2.43	0.31	0.14	2.89
Crab Creek	WV-OL-18-L_01	UNT/Crab Creek RM 7.81		1.62	0.20	0.10	1.92
Threemile Creek	WV-OL-21_01	Threemile Creek	WVO-15	0.46	0.12	0.03	0.61
Twomile Creek	WV-OL-22_01	Twomile Creek	WVO-16	1.99	0.33	0.12	2.44
Salt Creek	WV-OL-23_01	Salt Creek	WVO-17	4.82	0.74	0.29	5.85
Salt Creek	WV-OL-23-B_01	UNT/Salt Creek RM1.14		0.78	0.14	0.05	0.97

UNT = unnamed tributary; RM = river mile.

Table 9-2. Fecal Coliform Bacteria TMDLs

TMDL Watershed	Assessment Unite ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Sevenmile Creek	WV-OL-4_01	Sevenmile Creek	WVO-6	5.49E+09	0.00E+00	2.89E+08	5.78E+09
Sevenmile Creek	WV-OL-4_02	Sevenmile Creek	WVO-6	1.53E+10	4.90E+07	8.06E+08	1.61E+10
Sevenmile Creek	WV-OL-4-A_01	Little Sevenmile Creek	WVO-6-A	4.03E+09	1.63E+07	2.13E+08	4.26E+09
Ninemile Creek	WV-OL-5_01	Ninemile Creek	WVO-7	8.65E+09	3.79E+06	4.55E+08	9.10E+09
Ninemile Creek	WV-OL-5_02	Ninemile Creek	WVO-7	2.08E+10	9.76E+07	1.10E+09	2.20E+10
Ninemile Creek	WV-OL-5-A_01	UNT/Ninemile Creek RM 3.94	WVO-7-A	8.96E+09	0.00E+00	4.72E+08	9.44E+09
Ninemile Creek	WV-OL-5-H_01	UNT/Ninemile Creek RM 5.75	WVO-7-H	2.07E+09	0.00E+00	1.09E+08	2.18E+09
Guyan Creek	WV-OL-12_01	Guyan Creek	WVO-9	9.96E+09	0.00E+00	5.24E+08	1.05E+10
Guyan Creek	WV-OL-12_02	Guyan Creek	WVO-9	1.34E+10	0.00E+00	7.06E+08	1.41E+10
Guyan Creek	WV-OL-12_03	Guyan Creek	WVO-9	4.03E+10	3.79E+06	2.12E+09	4.25E+10
Guyan Creek	WV-OL-12_04	Guyan Creek	WVO-9	6.26E+10	3.79E+06	3.30E+09	6.59E+10
Guyan Creek	WV-OL-12-C_01	Spurlock Creek	WVO-9-A	5.61E+09	3.79E+06	2.96E+08	5.91E+09
Guyan Creek	WV-OL-12-C_02	Spurlock Creek	WVO-9-A	1.32E+10	7.58E+06	6.96E+08	1.39E+10
Guyan Creek	WV-OL-12-C-2_01	Left Fork/Spurlock Creek	WVO-9-A-2	6.00E+09	3.79E+06	3.16E+08	6.32E+09
Guyan Creek	WV-OL-12-C-2-C_01	Perry Creek	WVO-9-A-2-A	1.99E+09	0.00E+00	1.05E+08	2.10E+09
Guyan Creek	WV-OL-12-L_01	Bryan Creek	WVO-9-C	7.68E+09	0.00E+00	4.04E+08	8.08E+09
Guyan Creek	WV-OL-12-L_02	Bryan Creek	WVO-9-C	1.37E+10	0.00E+00	7.23E+08	1.45E+10
Guyan Creek	WV-OL-12-L-7_01	UNT/Bryan Creek RM 3.74	WVO-9-C-7	1.50E+09	0.00E+00	7.90E+07	1.58E+09
Guyan Creek	WV-OL-12-M-5_01	Lynn Fork	WVO-9-D-2	1.30E+09	0.00E+00	6.82E+07	1.36E+09
Guyan Creek	WV-OL-12-P_01	Knife Branch	WVO-9-E	2.09E+09	0.00E+00	1.10E+08	2.20E+09
Guyan Creek	WV-OL-12-Q_01	Bear Hollow Creek	WVO-9-F	8.43E+09	0.00E+00	4.44E+08	8.87E+09
Guyan Creek	WV-OL-12-Q_02	Bear Hollow Creek	WVO-9-F	1.37E+10	0.00E+00	7.21E+08	1.44E+10
Guyan Creek	WV-OL-12-Q-2_01	UNT/Bear Hollow Creek RM 1.20	WVO-9-F-2	1.45E+09	0.00E+00	7.62E+07	1.52E+09
Guyan Creek	WV-OL-12-W_01	UNT/Guyan Creek RM 13.17	WVO-9-W	2.91E+09	0.00E+00	1.53E+08	3.06E+09
Eighteenmile Creek	WV-OL-15_01	Eighteenmile Creek	WVO-10	5.51E+09	0.00E+00	2.90E+08	5.79E+09

TMDL Watershed	Assessment Unite ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Eighteenmile Creek	WV-OL-15_02	Eighteenmile Creek	WVO-10	1.37E+10	0.00E+00	7.21E+08	1.44E+10
Eighteenmile Creek	WV-OL-15_03	Eighteenmile Creek	WVO-10	3.12E+10	0.00E+00	1.64E+09	3.28E+10
Eighteenmile Creek	WV-OL-15_04	Eighteenmile Creek	WVO-10	4.43E+10	0.00E+00	2.33E+09	4.67E+10
Eighteenmile Creek	WV-OL-15-D_01	Rocky Fork	WVO-10-A	3.03E+09	0.00E+00	1.60E+08	3.19E+09
Eighteenmile Creek	WV-OL-15-J_01	Fees Branch	WVO-10-C	6.31E+09	0.00E+00	3.32E+08	6.64E+09
Eighteenmile Creek	WV-OL-15-L_01	Mud Run	WVO-10-D	2.65E+09	0.00E+00	1.39E+08	2.79E+09
Eighteenmile Creek	WV-OL-15-O_01	Right Fork/Eighteenmile Creek	WVO-10-D.5	7.91E+09	0.00E+00	4.16E+08	8.32E+09
Eighteenmile Creek	WV-OL-15-S-1_01	Spring Branch	WVO-10-F-1	1.65E+09	0.00E+00	8.66E+07	1.73E+09
Sixteenmile Creek	WV-OL-16_01	Sixteenmile Creek	WVO-11	1.39E+10	0.00E+00	7.32E+08	1.46E+10
Sixteenmile Creek	WV-OL-16_02	Sixteenmile Creek	WVO-11	2.16E+10	0.00E+00	1.14E+09	2.27E+10
Sixteenmile Creek	WV-OL-16_03	Sixteenmile Creek	WVO-11	3.64E+10	4.55E+06	1.91E+09	3.83E+10
Sixteenmile Creek	WV-OL-16_04	Sixteenmile Creek	WVO-11	5.18E+10	4.55E+06	2.73E+09	5.46E+10
Sixteenmile Creek	WV-OL-16-G_01	Jerrys Run	WVO-11-B	2.00E+09	0.00E+00	1.05E+08	2.11E+09
Sixteenmile Creek	WV-OL-16-J_01	Millstone Creek	WVO-11-D	3.04E+09	0.00E+00	1.60E+08	3.20E+09
Sixteenmile Creek	WV-OL-16-K_01	Righthand Fork	WVO-11-E	9.97E+09	4.55E+06	5.25E+08	1.05E+10
Sixteenmile Creek	WV-OL-16-K-4_01	UNT/Righthand Fork RM 2.10	WVO-11-E-4	2.29E+09	0.00E+00	1.21E+08	2.42E+09
Sixteenmile Creek	WV-OL-16-Y_01	UNT/Sixteenmile Creek RM 13.56	WVO-11-G.1	2.41E+09	0.00E+00	1.27E+08	2.53E+09
Sixteenmile Creek	WV-OL-16-AA_01	Willow Branch	WVO-11-H	4.81E+08	0.00E+00	2.53E+07	5.06E+08
Sixteenmile Creek	WV-OL-16-AB_01	Wolfpen Run	WVO-11-I	2.48E+09	0.00E+00	1.31E+08	2.61E+09
Sixteenmile Creek	WV-OL-16-AD_01	UNT/Sixteenmile Creek RM 15.47	WVO-11-K	3.88E+09	0.00E+00	2.04E+08	4.09E+09
Flatfoot Creek	WV-OL-17_01	Flatfoot Creek	WVO-12	7.73E+09	0.00E+00	4.07E+08	8.13E+09
Flatfoot Creek	WV-OL-17-B_01	UNT/Flatfoot Creek RM 3.42	WVO-12-B	7.29E+08	0.00E+00	3.84E+07	7.67E+08
Flatfoot Creek	WV-OL-17-D_01	UNT/Flatfoot Creek RM 5.40	WVO-12-D	2.38E+09	0.00E+00	1.25E+08	2.51E+09
Crab Creek	WV-OL-18_01	Crab Creek	WVO-13	9.68E+09	0.00E+00	5.09E+08	1.02E+10
Crab Creek	WV-OL-18_03	Crab Creek	WVO-13	3.85E+10	3.79E+07	2.03E+09	4.06E+10
Crab Creek	WV-OL-18-B_01	Mud Run	WVO-13-A	5.82E+09	0.00E+00	3.06E+08	6.12E+09

TMDL Watershed	Assessment Unite ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Crab Creek	WV-OL-18-D_01	Sand Fork	WVO-13-B	1.07E+10	3.79E+07	5.63E+08	1.13E+10
Crab Creek	WV-OL-18-E_01	Middle Fork/Crab Creek	WVO-13-D	1.26E+10	0.00E+00	6.66E+08	1.33E+10
Crab Creek	WV-OL-18-J_01	UNT/Crab Creek RM 7.00	WVO-13-F	1.89E+09	0.00E+00	9.92E+07	1.98E+09
Threemile Creek	WV-OL-21_01	Threemile Creek	WVO-15	1.25E+09	0.00E+00	6.58E+07	1.32E+09
Twomile Creek	WV-OL-22_01	Twomile Creek	WVO-16	2.02E+09	0.00E+00	1.06E+08	2.12E+09
Salt Creek	WV-OL-23_01	Salt Creek	WVO-17	5.14E+09	4.55E+06	2.71E+08	5.42E+09

NA = not applicable; UNT = unnamed tributary; RM = river mile.

“Scientific notation” is a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation of 10,492, for example, is 1.0492 $\times 10^4$ or 1.0492E+4.

10.0 FUTURE GROWTH

10.1 Iron

With the exception of allowances provided for CSGP registrations discussed below, this TMDL does not include specific future growth allocations. However, the absence of specific future growth allocations does not prohibit the permitting of new or expanded activities in the watersheds of streams for which metals TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available WLAs for the discharge...." In addition, the federal regulations generally prohibit issuance of a permit to a new discharger "if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." A discharge permit for a new discharger could be issued under the following scenarios:

- A new facility could be permitted anywhere in the watershed, provided that effluent limitations are based on the achievement of water quality standards at end-of-pipe for the pollutants of concern in the TMDL.

- NPDES permitting rules mandate effluent limitations for metals to be prescribed in the total recoverable form. West Virginia water quality criteria for iron are in total recoverable form and may be directly implemented.

- The alternative precipitation provisions of 40 CFR 434 that suspend applicability of iron and TSS limitations, cannot be applied to new discharges in iron TMDL watersheds.

- Remining (under an NPDES permit) could occur without a specific allocation to the new permittee, provided that the requirements of existing State remining regulations are met and remining activities will not worsen water quality and in some instances may result in improved water quality in abandoned mining areas.

- Reclamation and release of existing permits could provide an opportunity for future growth provided that permit release is conditioned on achieving discharge quality better than the WLA prescribed by the TMDL.

- Most traditional, non-mining point source discharges are assigned technology-based TSS effluent limitations. The iron associated with such discharges would not cause or contribute to violations of iron water quality standards. For example, NPDES permits for sewage treatment and industrial manufacturing facilities contain monthly average TSS effluent limitations between 30 and 100 mg/L. New point sources may be permitted in the watersheds of iron impaired streams with the implementation of applicable technology based TSS requirements. If iron is identified as a pollutant of concern in a process wastewater discharge from a new, non-mining activity, then the discharge can be permitted if effluent limitations are based on the achievement of water quality standards at end-of-pipe.

- Subwatershed-specific future growth allowances have been provided for site registrations under the CSGP. The successful TMDL allocation provides subwatershed-specific disturbed areas that may be registered under the general permit at any point in time. The iron allocation spreadsheet also provides cumulative area allowances of disturbed area for the immediate subwatershed and all upstream contributing subwatersheds. Projects in excess of the acreage provided for the immediate subwatershed may also be registered under the general permit, provided that the total registered disturbed area in the immediate subwatershed and all upstream subwatersheds is less than the cumulative area provided. Furthermore, projects with disturbed area larger than allowances may be registered under the general permit under any of the following provisions:
    - A larger total project area can be registered if the construction activity is authorized in phases that adhere to the future growth area allowances.
    - All disturbed areas that will occur on non-background land uses can be registered without regard to the future growth allowances.
    - Registration may be conditioned by implementing controls beyond those afforded by the general permit, if it can be demonstrated that the additional controls will result in a lower unit area loading condition than the 100 mg/l TSS expectation for typical permit BMPs and that the improved performance is proportional to the increased area.

10.2 Fecal Coliform Bacteria

Specific fecal coliform bacteria future growth allocations are not prescribed. The absence of specific future growth allocations does not prohibit new development in the watersheds of streams for which fecal coliform bacteria TMDLs have been developed, or preclude the permitting of new sewage treatment facilities.

In many cases, the implementation of the TMDLs will consist of providing public sewer service to unsewered areas. The NPDES permitting procedures for sewage treatment facilities include technology-based fecal coliform effluent limitations that are more stringent than applicable water quality criteria. Therefore, a new sewage treatment facility may be permitted anywhere in the watershed, provided that the permit includes monthly geometric mean and maximum daily fecal coliform limitations of 200 counts/100 mL and 400 counts/100 mL, respectively. Furthermore, WVDEP will not authorize construction of combined collection systems nor permit overflows from newly constructed collection systems.

11.0 PUBLIC PARTICIPATION

11.1 Public Meetings

An informational public meeting was held on May 6, 2016 at Beale Elementary School, in Gallipolis Ferry, WV. The meetings occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities.

Due to COVID-19, no travel or public meetings are permitted during the comment period. WVDEP representatives will host a virtual meeting to present an overview of the TMDL development process and answer questions on: December 15, 2020 at 6:00 PM. Access the meeting via the link below.

Virtual Public Zoom Meeting
link: https://us02web.zoom.us/j/85775843610?pwd=R0N5Mk5vM2RPQXdUUDMxOE9qTS9qdz09

Meeting ID: 857 7584 3610
Passcode: 806865

Dial by Phone: 1-301-715-8592

12.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised via email, social media, and news release. The notice was shared directly with interested stakeholders. A the public comment period began on November 30, 2020 and ended on January 12, 2021. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl. An ESRI StoryMap has been created to provide an overview of the TMDL at https://arcg.is/1TWiij.

Submit comments no later than January 12, 2021. Comments should be emailed or sent to:

E-mail: Mindy.S.Neil@wv.gov
Mindy Neil, ATTN: Big Sandy, Lower Ohio, Twelvepole Draft TMDL comments
West Virginia Department of Environmental Protection
601 57th Street S.E.
Charleston, WV 25304

11.3 Response Summary

WVDEP will review written comments on the Draft TMDLs and respond in this section.

12.0 REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with two programs. The NPDES permitting program is implemented by WVDEP to control point source discharges. WVDEP's Watershed Improvement Branch (WIB) mission is to inspire and empower people to value and work for clean water. WIB administers programs that educate, provide assistance, plan and implement water quality protection, improvement and restoration projects.

12.1 NPDES Permitting - *REVISED*

WVDEP's Division of Water and Waste Management (DWWM) is responsible for issuing non-mining NPDES permits within the State. WVDEP's Division of Mining and Reclamation (DMR) develops NPDES permits for mining activities. As part of the permit review process, permit writers have the responsibility to incorporate the required TMDL WLAs into new or reissued permits. New facilities will be permitted in accordance with future growth provisions described in **Section 9**.

Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, intending that the TMDLs are completed just before the permit expiration/reissuance time frames. Permits for existing non-mining facilities in the Lower Ohio River watershed were reissued beginning in July 2019.

The MS4 permitting program is being implemented to address stormwater impacts from urbanized areas. West Virginia has developed a General NPDES Permit for MS4 discharges (WV0110625). The West Virginia Department of Transportation, WVDOH is registered under the permit. The permit is based upon national guidance and is non-traditional in that it does not contain numeric effluent limitations, but instead proposes Best Management Practices that must be implemented. At permit reissuance, registrants will be expected to specifically describe management practices intended for implementation that will achiever the WLAs prescribed in applicable TMDLs. A mechanism to assess the effectiveness of the BMPs in achieving the WLAs must also be provided. The TMDLs are not intended to mandate imposition of numerical effluent limitations and/or discharge monitoring requirements for MS4s. Reasonable alternative methodologies may be employed for targeting and assessing BMP effectiveness in relation to prescribed WLAs. Through consideration of anticipated removal efficiencies of selected BMPs and their areas of application, it is anticipated that this information will allow MS4 permittees to make meaningful predictions of performance under the permit.

12.2 Watershed Improvement Branch- Nonpoint Source Program

The mission of the WVDEP Watershed Improvement Branch Nonpoint Source (NPS) Program is to inspire and empower people to value and work for clean water. The NPS Program coordinates efforts by multi-agency and non-governmental organizations to address nonpoint sources of pollution. In relationship to implementation of TMDLs, one key role that the NPS Program plays is administering the Clean Water Act Section 319 grant funding program. These funds are available to restore impaired waters through the development of watershed based plans, execution of watershed projects, and support to watershed organizations and other nonpoint partners. To learn more about the NPS Program visit:

https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx

Additional information regarding support specifically in the Lower Ohio River Watershed, contact the Watershed Improvement Branch Western Basin Coordinator Tomi Bergstrom.

There are no active citizen-based watershed associations representing the modeled portion of the Lower Ohio River watershed. For additional information concerning associations, visit: https://dep.wv.gov/WWE/getinvolved/WSA_Support/Pages/WGs.aspx

12.3 Public Sewer Projects

Within WVDEP DWWM, the Engineering and Permitting Branch's Engineering Section is charged with the responsibility of evaluating sewer projects and providing funding, where available, for those projects. All municipal wastewater loans issued through the State Revolving Fund (SRF) program are subject to a detailed engineering review of the engineering report, design report, construction plans, specifications, and bidding documents. The staff performs periodic on-site inspections during construction to ascertain the progress of the project and compliance with the plans and specifications. Where the community does not use SRF funds to undertake a project, the staff still performs engineering reviews for the agency on all POTWs prior to permit issuance or modification. For further information on upcoming projects, a list of funded and pending water and wastewater projects in West Virginia can be found at http://www.wvinfrastructure.com/projects/index.php.

13.0 MONITORING PLAN

The following monitoring activities are recommended:

13.1 NPDES Compliance

WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs and to assess and compel compliance. Compliance schedules may be implemented that achieve compliance as soon as possible while providing the time necessary to accomplish corrective actions. The length of time afforded to achieve compliance may vary by discharge type or other factors and is a case-by-case determination in the permitting process. Permits will contain self-monitoring and reporting requirements that are periodically reviewed by WVDEP. WVDEP also inspects treatment facilities and independently monitors NPDES discharges. The combination of these efforts will ensure implementation of the TMDL WLAs.

13.2 Nonpoint Source Project Monitoring

All nonpoint source restoration projects should include a monitoring component specifically designed to document resultant local improvements in water quality. These data may also be used to predict expected pollutant reductions from similar future projects.

13.3 TMDL Effectiveness Monitoring

TMDL effectiveness monitoring should be performed to document water quality improvements after significant implementation activity has occurred where little change in water quality would otherwise be expected. Full TMDL implementation will take significant time and resources, particularly with respect to the abatement of nonpoint source impacts. WVDEP will continue monitoring on the rotating basin cycle and will include a specific TMDL effectiveness component in waters where significant TMDL implementation has occurred.

14.0 REFERENCES

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