February 2022

USEPA Approved Report

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

Prepared for
West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Assessment Branch, TMDL Section

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

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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 Guyandotte River watershed refers to the tributary streams that ultimately drain to the Lower Guyandotte River (**Figure I-1**). Tributaries of Lower Guyandotte River have been dammed to create Upper Mud River Reservoir in Lincoln County. However, TMDLs for the reservoir were not developed in this modeling effort. The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the mouth of the Lower Guyandotte 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 278 impaired streams contained within 92 TMDL watersheds in the Lower Guyandotte 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 543 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.

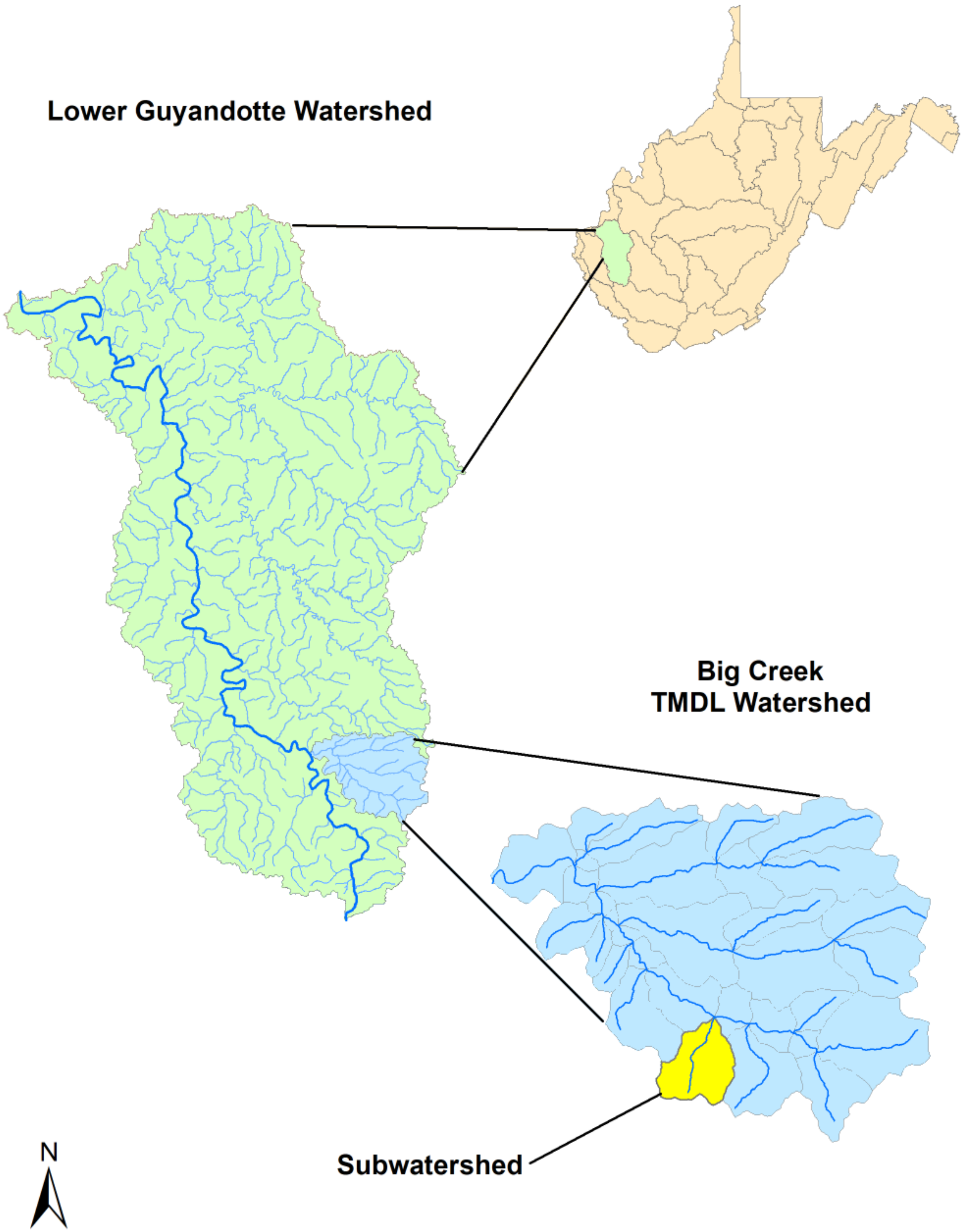


Figure I-1. Examples of a watershed and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 278 impaired streams in the Lower Guyandotte River watershed. This project was organized into 92 TMDL watersheds, which account for all streams draining to the Lower Guyandotte River. 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 subject 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, pH, aluminum, selenium, 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'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 draft procedural rule (47 CSR 2B) in 2019 establishing the methodology for determining compliance with the biological component of narrative criteria. The procedural rule has been modified in response to public comment and readvertised on two occasions. At the time of this TMDL completion, WVDEP was considering comments in order to respond and 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, assessment units for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in the proposed rule 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 92 TMDL watersheds. For hydrologic modeling purposes, watersheds of impaired and unimpaired streams in this TMDL watershed were further divided into 543 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, pH, aluminum, selenium, 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 two dissolved oxygen (DO) impairments (Left Fork/Davis Creek and Trace Fork) in two TMDL watersheds. In general, sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. However, streams impaired for DO will be retained on the 303d list until a time when DEP has a better understanding of the stream conditions and pollutant sources that are contributing to the low DO.

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 and construction sites. 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.

Eight selenium impaired streams in 8 TMDL watersheds are addressed in this report. Active, reclaimed, and abandoned mining are dominant landuses in these TMDL watersheds and presumed to be the contributing sources of selenium.

The pH and dissolved aluminum impairments in the watershed are attributable to legacy mining (including abandoned mine lands and permitted bond forfeited sites). In certain watersheds with low buffering capacity, acidic precipitation decreases pH below the pH criterion. Decreased pH may in turn increase the portion of aluminum in solution and result in exceedances of the dissolved aluminum criterion. Atmospheric deposition was not found to be a causative source of impairment as effects are mitigated by available watershed buffering capacity. All active mining sources were represented. Prescribed WLAs were not more stringent than existing NPDES permit limits. Abandoned mine land sources (seeps) are a source of dissolved aluminum and acidity resulting in criteria impairments. In most cases the acidic pH impairments coincide with overlapping metals impairments and the TMDLs for pH impairments were developed using an approach where instream metal (iron and aluminum) concentrations were reduced for attainment of iron and aluminum water quality criteria coupled with direct pollutant reductions to offset acid load from acid precipitation and legacy mine sources. Pollutant reductions are measured and expressed in the amount of alkalinity needed to offset the acid load.

The 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. The 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.

In 2004, USEPA, with support from WVDEP, developed TMDLs for pH, metals, and fecal coliform impaired streams in the Guyandotte River Watershed (USEPA, 2004). In total, TMDLs were developed for 66 streams within the Upper and Lower Guyandotte River Watersheds. Iron, aluminum, manganese, pH, and fecal coliform impairments were addressed. In this project, all impaired streams for which TMDLs were developed in 2004 have been re-evaluated and new TMDLs, consistent with currently effective water quality criteria, are presented for all current identified impairments. Upon approval, all of the TMDLs presented herein shall supersede those developed previously. Re-evaluation also determined that certain impairments for which TMDLs were developed are no longer effective due to West Virginia water quality standard revisions and new water quality monitoring. All previously developed total aluminum and manganese TMDLs are not effective because of water quality criteria revisions.

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 10** 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 StoryMap at https://arcg.is/0qjmCm 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 Guyandotte 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 10** 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 is developing 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. Each year, TMDLs are developed in specific geographic areas. The Framework dictates that 2021 TMDLs should be pursued in Hydrologic Group C, which includes the Lower Guyandotte River watershed. **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 2004 USEPA, with support from WVDEP, developed TMDLs for metals, pH and fecal coliform impaired streams in the Guyandotte Watershed (USEPA, 2004). In total, TMDLs were developed for 66 streams within the Upper and Lower Guyandotte River Watersheds. Iron, aluminum, manganese, pH, and fecal coliform impairments were addressed. These older TMDLs were developed with a less robust stream monitoring and source tracking dataset and a lower resolution modeling approach. Without a stressor identification process, it was assumed that impairments to aquatic life would be resolved through pollutants TMDLs. Streams for which this assumption were made have been re-evaluated in this project through a formal stressor identification process and specific pollutant TMDLs are identified that will address stress (e.g., total iron to resolve sedimentation stress). In this current project, all impaired streams for which TMDLs were developed in 2004 have been re-evaluated. While pursuing TMDL development for other impairments, WVDEP obtained more comprehensive data and developed new TMDLs under a more refined modeling approach. Upon approval, the TMDLs presented herein for iron and fecal coliform shall supersede those developed previously.

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

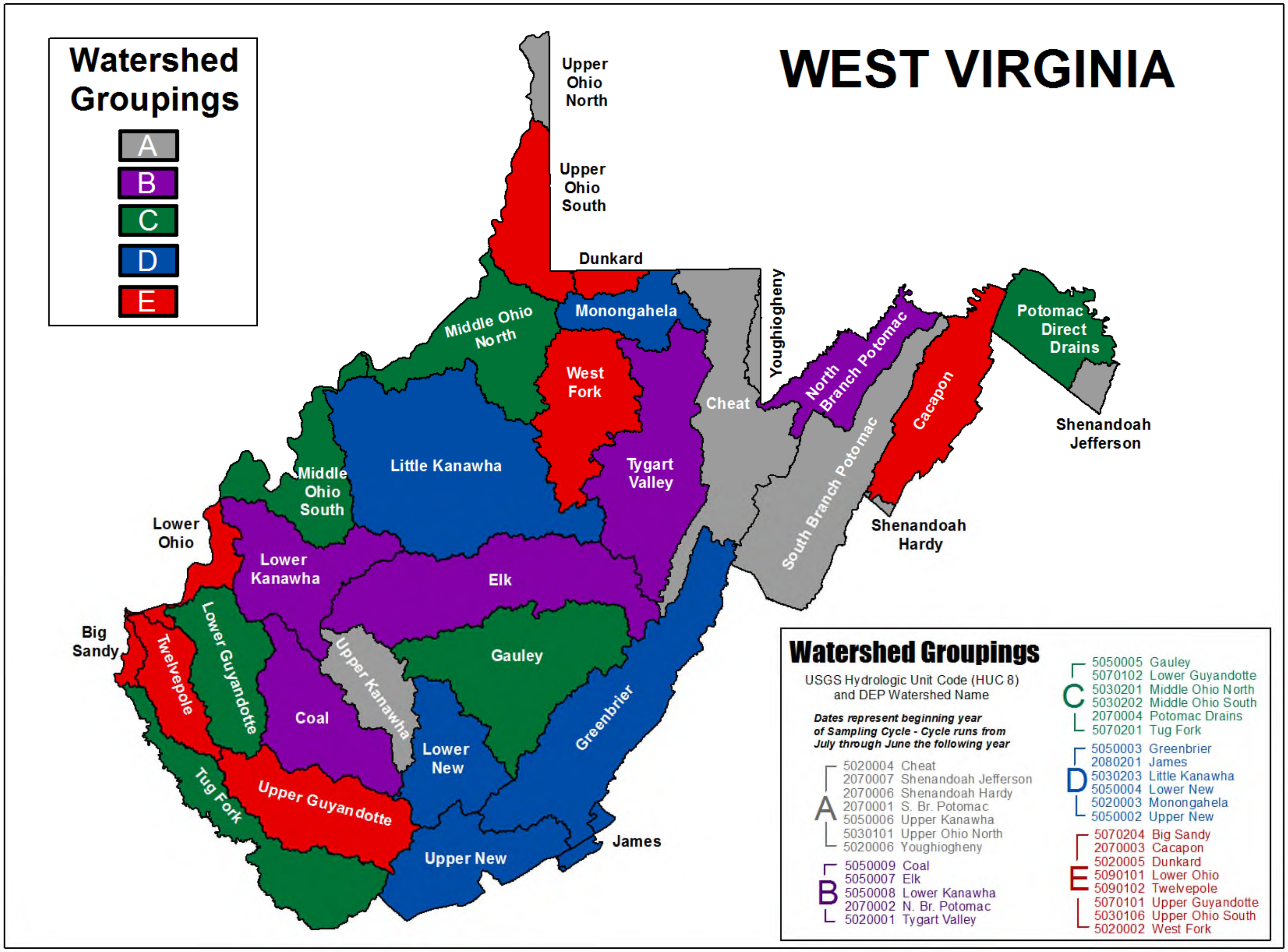


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

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 TMDL 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 Guyandotte River watershed include: propagation and maintenance of aquatic life in warmwater fisheries, water contact recreation, and public water supply. In various streams in the Lower Guyandotte River watershed, warmwater fishery aquatic life use impairments have been determined based on exceedances of dissolved oxygen, dissolved aluminum, total iron, total selenium, and/or pH numeric water quality criteria. Water contact recreation and/or public water supply use impairments have also been determined in various waters based on exceedances of numeric water quality criteria for fecal coliform bacteria, pH, dissolved aluminum, total selenium, 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[3]/Public Water Supply[4]
	Acute[1]	Chronic[2]	Acute[1]	Chronic[2]	
Aluminum, dissolved (µg/L)	750	750	750	87	--
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
Selenium, total (µg/L) [f]		5		5	50
8.27.1 Selenium (ug/g) [g] (based on instantaneous measurement) 8.0 ug/g Fish Whole-Body Concentration or 11.3 ug/g Fish Muscle (skinless, boneless filet)		--		--	
Selenium (ug/g) Fish Egg/Ovary Concentration [h] (based on instantaneous measurement)		15.8		15.8	
pH	No values below 6.0 or above 9.0				
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.				

[1] One-hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[2] Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[3] These criteria have been calculated to protect human health from toxic effects through fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.
[4] These criteria have been calculated to protect human health from toxic and/or organoleptic effects through drinking water and fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.
[f] Water column values take precedence over fish tissue values when new inputs of selenium occur in waters previously unimpacted by selenium, until equilibrium is reached between the water column and fish tissue.
[g] Overrides any water column concentration when water concentrations and either fish whole body or fish muscle (skinless, boneless filet) are measured, except in situations described in footnote [f]
[h] Overrides any fish whole-body, fish muscle (skinless, boneless filet), or water column concentration when fish egg/ovary concentrations are measured, except in situations described in footnote [f]
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

Located within the Western Allegheny Plateau and Central Appalachian ecoregions, the Guyandotte River is a tributary of the Ohio River, which joins the Mississippi and flows to the Gulf of Mexico. The Lower Guyandotte River watershed consists of land draining to the lower portion of the Guyandotte River, which begins at its confluence with Island Creek in the City of Logan and flows northward to join the Ohio River in the City of Huntington. The Lower Guyandotte River is approximately 80.5 miles (129.6 km) long from the confluence with Island Creek to the Ohio River, and its watershed encompasses 739.7 square miles (1915.9 km^2). One major tributary of the Lower Guyandotte River has been dammed to create a small lake. Mud River has been dammed just below the confluence of the Left Fork of Mud River to create Upper Mud River Reservoir. For TMDL purposes, the lake is considered an independent water body. Upper Mud River Reservoir is not considered impaired for metals or fecal coliform bacteria and did not receive TMDL allocations.

The Lower Guyandotte River watershed occupies most of West Virginia’s Cabell and Lincoln Counties, as well as the northern third of Logan County, and small portions of Putnam, Boone, Kanawha, and Mason Counties (**Figure 3-1**). Cities and towns in the study area are Huntington, Barboursville, Milton, Hamlin, Chapmanville, and Logan. The highest point in the Lower Guyandotte River watershed is 2,124 feet above sea level on an unnamed ridge above the headwaters of Peach Creek. The lowest point in the watershed is 515 feet at the confluence of the Lower Guyandotte River and the Ohio River in the City of Huntington. The average elevation in the watershed is 897 feet. Major tributaries in the Lower Guyandotte River watershed include Mud River, Trace Fork, Middle Fork/Mud River, Fourmile Creek, Big Harts Creek, and Big Ugly Creek. The total population living in the subject watersheds of this report is estimated to be 100,000 people.

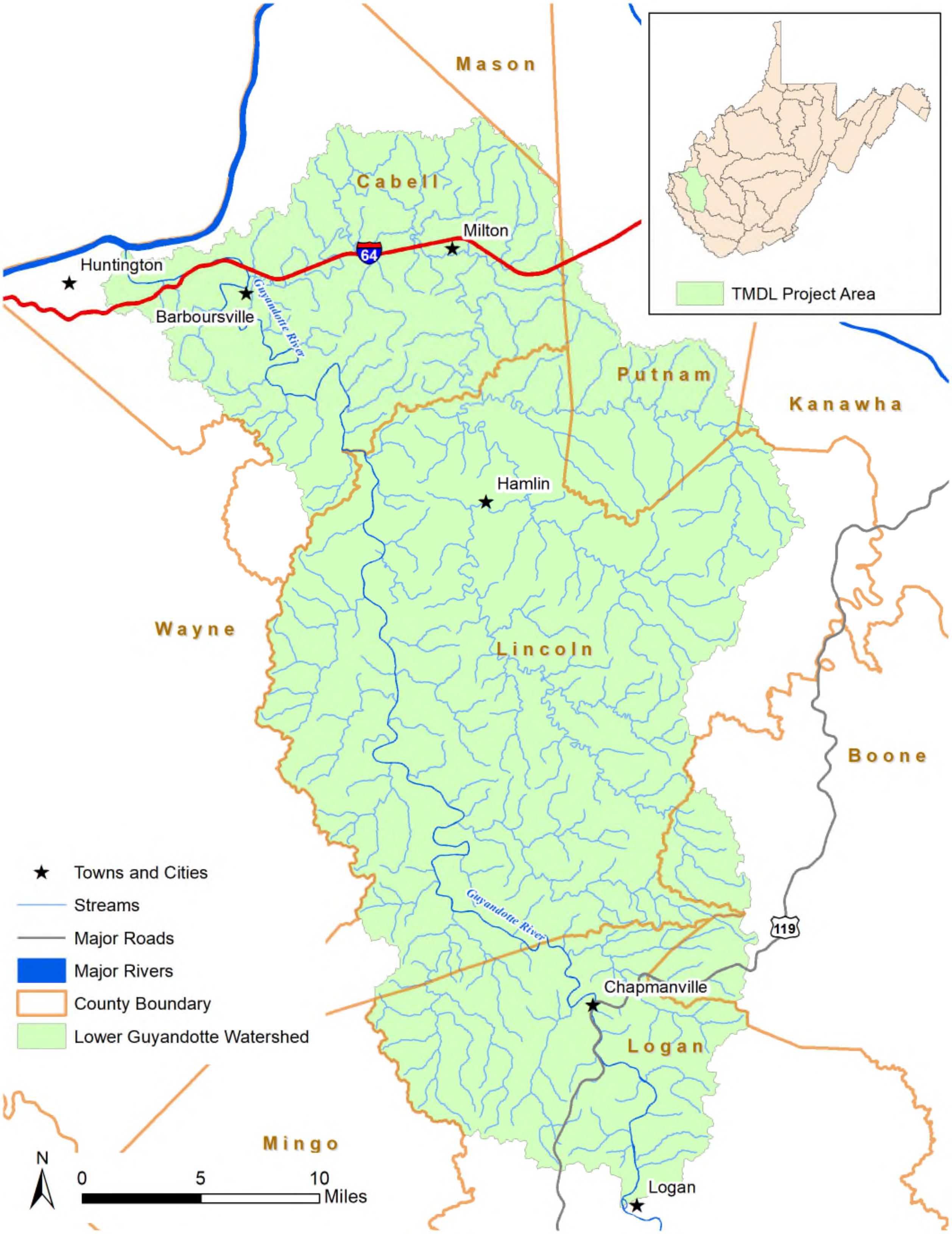


Figure 3-1. Location of the Lower Guyandotte River watershed TMDL Project Area in West Virginia

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) (USGS 2016). 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 82.29 percent of the total landuse area. Other important modeled landuse types are urban/residential (5.05 percent), grassland (4.81 percent), mining/quarry (2.11 percent), forestry (1.87 percent), oil and gas (1.66 percent), and pasture (1.03 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 Guyandotte River TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
AML	227.36	0.36	0.05%
Barren	3,896.78	6.09	0.82%
Cropland	39.36	0.06	0.01%
Forest	389,586.38	608.73	82.29%
Forestry	8,897.36	13.90	1.88%
Grassland	22,773.87	35.58	4.81%
Mining/Quarry	9,974.30	15.58	2.11%
Oil and Gas	7,846.36	12.26	1.66%
Pasture	4,858.26	7.59	1.03%
Urban/Residential	23,901.69	37.35	5.05%
Water	1,427.35	2.23	0.30%

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 2016 (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, West Virginia Trail Inventory (WVDOT)
	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 Office of Abandoned Mine Lands and Reclamation
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

Type of Information		Data Sources
	Cloud cover	NOAA-NCDC
	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 Office of Abandoned Mine Lands and Reclamation, 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 Guyandotte River watershed from 2017 through 2018. 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 92 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.

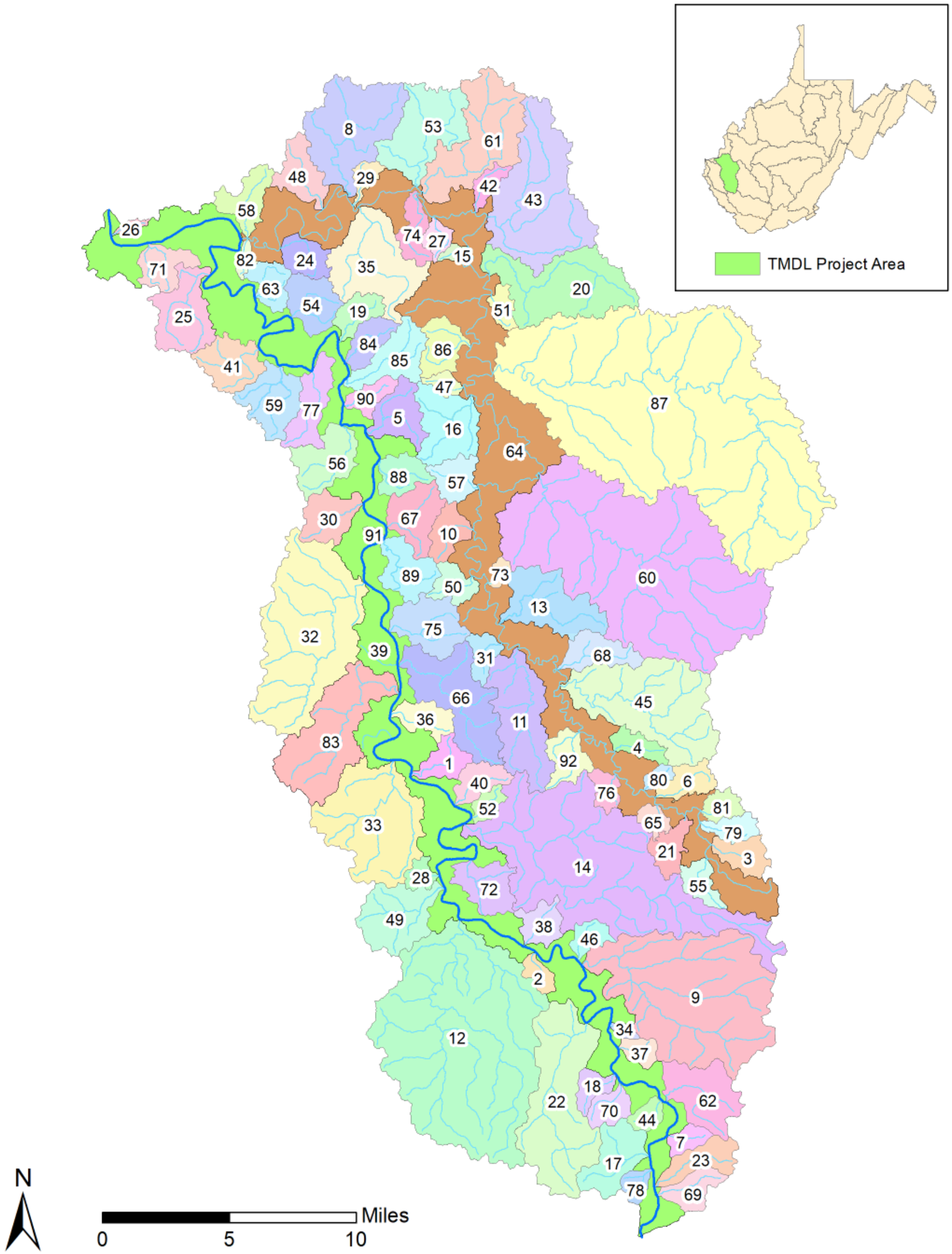


Figure 3-2. Lower Guyandotte River TMDL Watersheds

Key	TMDL Watershed	Key	TMDL Watershed
1	Aarons Creek	47	Little Buffalo Creek
2	Abbott Branch	48	Little Cabell Creek
3	Ballard Fork	49	Little Harts Creek
4	Bear Branch	50	Little Laurel Creek
5	Bear Creek	51	Little Twomile Creek
6	Berry Branch	52	Little Ugly Creek
7	Big Branch	53	Lower Creek
8	Big Cabell Creek	54	Lower Tom Creek
9	Big Creek	55	Lukey Fork
10	Big Creek (OGL-10-BU)	56	Madison Creek
11	Big Creek (OGL-10-CL)	57	Mahone Creek
12	Big Harts Creek	58	Merrick Creek
13	Big Laurel Creek	59	Merritt Creek
14	Big Ugly Creek	60	Middle Fork/Mud River
15	Brush Creek	61	Mill Creek
16	Buffalo Creek	62	Mill Creek (OGL-135)
17	Buffalo Creek (OGL-137)	63	Mill Creek (OGL-15)
18	Caney Branch	64	Mud River
19	Cavill Creek	65	Mullins Branch
20	Charley Creek	66	Ninemile Creek
21	Connelly Branch	67	Onemile Creek
22	Crawley Creek	68	Parsner Creek
23	Crooked Creek	69	Peach Creek
24	Cyrus Creek	70	Rocky Branch
25	Davis Creek	71	Russell Creek
26	Deitz Hollow (Pats Branch)	72	Sand Creek
27	Dry Creek	73	Sandlick Branch
28	Dry Run	74	Saunders Creek
29	Edmonds Branch	75	Sixmile Creek
30	Falls Creek	76	Slab Creek
31	Fez Creek	77	Smith Creek
32	Fourmile Creek	78	Snap Creek
33	Fourteenmile Creek	79	Stanley Fork
34	Fowler Branch	80	Stonecoal Branch
35	Fudges Creek	81	Sugartree Branch
36	Furnett Creek	82	Tanyard Branch
37	Godby Branch	83	Tenmile Creek
38	Green Shoals Branch	84	Tom Creek
39	Guyandotte River (Lower)	85	Trace Creek
40	Hamilton Creek	86	Trace Creek (OGL-10-AX)
41	Heath Creek	87	Trace Fork
42	Johns Branch	88	Twomile Creek
43	Kilgore Creek	89	Twomile Creek (OGL-47)
44	King Shoal Branch	90	Tyler Creek
45	Left Fork/Mud River	91	UNT/Guyandotte River RM 33.39
46	Limestone Branch	92	Upton Branch

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

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Guyandotte River (Lower)	WV-OGL	Guyandotte River (Lower)	WVOG-lo			X			X
Deitz Hollow (Pats Branch)	WV-OGL-1	Deitz Hollow (Pats Branch)	WVOG-0.5						X
Russell Creek	WV-OGL-5	Russell Creek	WVOG-1			M			X
Russell Creek	WV-OGL-5-A	UNT/Russell Creek RM 0.20	WVOG-1-A			M			X
Davis Creek	WV-OGL-12	Davis Creek	WVOG-3			M			X
Davis Creek	WV-OGL-12-B	Edens Branch	WVOG-3-0.5A			M			X
Davis Creek	WV-OGL-12-D	Left Fork/Davis Creek	WVOG-3-A			M			X
Davis Creek	WV-OGL-12-C	Right Fork/Davis Creek	WVOG-3-B			M			X
Mill Creek	WV-OGL-15	Mill Creek	WVOG-6			M			X
Mill Creek	WV-OGL-15-A	UNT/Mill Creek RM 0.21	WVOG-6-A			M			X
Lower Tom Creek	WV-OGL-18	Lower Tom Creek	WVOG-8			M			X
Lower Tom Creek	WV-OGL-18-B	UNT/Lower Tom Creek RM 0.63				M			
Heath Creek	WV-OGL-23	Heath Creek	WVOG-9			M			X
Heath Creek	WV-OGL-23-B	Upper Heath Creek	WVOG-9-A			M			X
Heath Creek	WV-OGL-23-C	UNT/Heath Creek RM 1.56				M			
Merritt Creek	WV-OGL-24	Merritt Creek	WVOG-10			M			X
Merritt Creek	WV-OGL-24-B	Right Fork/Merritt Creek	WVOG-10-A			M			X
Smith Creek	WV-OGL-27	Smith Creek	WVOG-11			M			X
Cavill Creek	WV-OGL-28	Cavill Creek	WVOG-12						X
Tom Creek	WV-OGL-29	Tom Creek	WVOG-13			M			X
Trace Creek	WV-OGL-30	Trace Creek	WVOG-14			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Trace Creek	WV-OGL-30-C	UNT/Trace Creek RM 2.88	WVOG-14-C			M			X
Tyler Creek	WV-OGL-31	Tyler Creek	WVOG-15			M			X
Madison Creek	WV-OGL-34	Madison Creek	WVOG-17			X			X
Madison Creek	WV-OGL-34-B	UNT/Madison Creek RM 2.11	WVOG-17-B			M			
Bear Creek	WV-OGL-35	Bear Creek	WVOG-18			M			X
Bear Creek	WV-OGL-35-B	UNT/Bear Creek RM 1.23				M			
Twomile Creek	WV-OGL-38	Twomile Creek	WVOG-20			M			X
Falls Creek	WV-OGL-42	Falls Creek	WVOG-22			M			
Onemile Creek	WV-OGL-44	Onemile Creek	WVOG-23			M			X
Onemile Creek	WV-OGL-44-B	UNT/Onemile Creek RM 0.55				M			
Onemile Creek	WV-OGL-46	UNT/Guyandotte River RM 33.39	WVOG-23.8			X			X
Twomile Creek	WV-OGL-47	Twomile Creek	WVOG-24			M			X
Twomile Creek	WV-OGL-47-D	Bee Branch	WVOG-24-A			M			
Fourmile Creek	WV-OGL-53	Fourmile Creek	WVOG-27			M			X
Fourmile Creek	WV-OGL-53-B	Lowgap Branch	WVOG-27-A						X
Fourmile Creek	WV-OGL-53-C	Trace Fork	WVOG-27-B			M			X
Fourmile Creek	WV-OGL-53-D	Harless Fork	WVOG-27-C			X			X
Fourmile Creek	WV-OGL-53-G	Kentuck Fork	WVOG-27-D						X
Fourmile Creek	WV-OGL-53-O	Red River Fork	WVOG-27-G			M			X
Fourmile Creek	WV-OGL-53-O-2	Sulphur Spring Branch	WVOG-27-G-1			M			
Fourmile Creek	WV-OGL-53-W	Falls Branch	WVOG-27-H			M			X
Fourmile Creek	WV-OGL-53-X	McClarity Branch	WVOG-27-I			M			X
Sixmile Creek	WV-OGL-60	Sixmile Creek	WVOG-29			M			
Sixmile Creek	WV-OGL-60-C	Bluelick Branch	WVOG-29-B			M			

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Guyandotte River (Lower)	WV-OGL-63	Stout Creek	WVOG-30			M			
Ninemile Creek	WV-OGL-64	Ninemile Creek	WVOG-31			M			X
Ninemile Creek	WV-OGL-64-D	Hager Fork	WVOG-31-0.5A			M			X
Ninemile Creek	WV-OGL-64-G	Dick Fork	WVOG-31-A			M			
Ninemile Creek	WV-OGL-64-I	Spears Fork	WVOG-31-B			M			
Tenmile Creek	WV-OGL-66	Tenmile Creek	WVOG-32			X			X
Tenmile Creek	WV-OGL-66-C	Buck Branch	WVOG-32-A			M			
Tenmile Creek	WV-OGL-66-I	Upper Twin Branch	WVOG-32-C			M			
Tenmile Creek	WV-OGL-66-O	Plum Branch	WVOG-32-F			M			
Furnett Creek	WV-OGL-69	Furnett Creek	WVOG-33			M			
Fourteenmile Creek	WV-OGL-75	Fourteenmile Creek	WVOG-34			M			X
Fourteenmile Creek	WV-OGL-75-A	Lick Branch	WVOG-34-A			M			X
Fourteenmile Creek	WV-OGL-75-B	East Fork/Fourteenmile Creek	WVOG-34-B			M			X
Fourteenmile Creek	WV-OGL-75-F	Sulphur Spring Fork	WVOG-34-D			M			X
Fourteenmile Creek	WV-OGL-75-H	Steer Fork	WVOG-34-E			M			
Fourteenmile Creek	WV-OGL-75-H-1	Nelson Fork	WVOG-34-E-1			M			
Aarons Creek	WV-OGL-80	Aarons Creek	WVOG-35			M			X
Hamilton Creek	WV-OGL-86	Hamilton Creek	WVOG-36			M			X
Little Ugly Creek	WV-OGL-88	Little Ugly Creek	WVOG-37			M			X
Big Ugly Creek	WV-OGL-89	Big Ugly Creek	WVOG-38			M			X
Big Ugly Creek	WV-OGL-89-B	Pigeonroost Creek	WVOG-38-A			M			
Big Ugly Creek	WV-OGL-89-C	Bobby Creek	WVOG-38-B			M			
Big Ugly Creek	WV-OGL-89-E	Big Branch	WVOG-38-C			M			
Big Ugly Creek	WV-OGL-89-G	Laurel Creek	WVOG-38-D			M			X
Big Ugly Creek	WV-OGL-89-G-4	Back Fork	WVOG-38-D-0.7			M			

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Big Ugly Creek	WV-OGL-89-G-5	Lick Branch	WVOG-38-D-0.8			M			
Big Ugly Creek	WV-OGL-89-G-6	Charley Trace Fork	WVOG-38-D-1			M			
Big Ugly Creek	WV-OGL-89-G-10	Chestnut Oak Creek	WVOG-38-D-4			M			
Big Ugly Creek	WV-OGL-89-G-11	Right Fork/Laurel Creek	WVOG-38-D-5			M			
Big Ugly Creek	WV-OGL-89-J	Rockhouse Branch	WVOG-38-E			M			
Big Ugly Creek	WV-OGL-89-M	Sulphur Creek	WVOG-38-G			M			X
Big Ugly Creek	WV-OGL-89-R	Broad Branch	WVOG-38-J			M			X
Big Ugly Creek	WV-OGL-89-R-2	Left Fork/Broad Branch	WVOG-38-J-1			M			
Big Ugly Creek	WV-OGL-89-T	Lefthand Creek	WVOG-38-K			M			X
Big Ugly Creek	WV-OGL-89-Y	Little Deadening Creek	WVOG-38-K.7			M			
Big Ugly Creek	WV-OGL-89-Z	Big Deadening Creek	WVOG-38-L			M			
Big Ugly Creek	WV-OGL-89-AA	Fawn Hollow	WVOG-38-M			M			
Big Ugly Creek	WV-OGL-89-AD	Skinned Poplar Branch	WVOG-38-N			M			
Big Ugly Creek	WV-OGL-89-AJ	Trace Branch	WVOG-38-O			M			
Big Ugly Creek	WV-OGL-89-AN	Grassy Fork	WVOG-38-P			M			
Sand Creek	WV-OGL-93	Sand Creek	WVOG-40			M			X
Sand Creek	WV-OGL-93-D	Big Fork	WVOG-40-A			M			
Dry Run	WV-OGL-95	Dry Run	WVOG-41			M			X
Little Harts Creek	WV-OGL-96	Little Harts Creek	WVOG-42			M			X
Little Harts Creek	WV-OGL-96-C	Short Bend Fork	WVOG-42-A			M			X
Little Harts Creek	WV-OGL-96-D	Harvey Fork	WVOG-42-B			M			
Little Harts Creek	WV-OGL-96-E	Laurel Fork	WVOG-42-C			M			X
Little Harts Creek	WV-OGL-96-G	Mudlick Branch	WVOG-42-D			M			X
Big Harts Creek	WV-OGL-99	Big Harts Creek	WVOG-44			M			X
Big Harts Creek	WV-OGL-99-A	West Fork/Big Harts Creek	WVOG-44-A			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Big Harts Creek	WV-OGL-99-A-3	Piney Fork	WVOG-44-A-1			M			X
Big Harts Creek	WV-OGL-99-A-4	Marsh Fork	WVOG-44-A-2			M			X
Big Harts Creek	WV-OGL-99-A-5	Workman Fork	WVOG-44-A-3			M			X
Big Harts Creek	WV-OGL-99-B	Big Branch	WVOG-44-B			M			X
Big Harts Creek	WV-OGL-99-D	Coal Branch	WVOG-44-C			M			
Big Harts Creek	WV-OGL-99-E	Caney Branch	WVOG-44-C.3			M			X
Big Harts Creek	WV-OGL-99-G	Thompson Branch	WVOG-44-C.7			M			X
Big Harts Creek	WV-OGL-99-H	Rockhouse Fork	WVOG-44-D			X			X
Big Harts Creek	WV-OGL-99-J	Smokehouse Fork	WVOG-44-E			M			X
Big Harts Creek	WV-OGL-99-J-5	Browns Run	WVOG-44-E-1			M			X
Big Harts Creek	WV-OGL-99-J-9	White Oak Branch	WVOG-44-E-2			M			X
Big Harts Creek	WV-OGL-99-K	Trace Fork	WVOG-44-F			M			X
Big Harts Creek	WV-OGL-99-K-6	Ivy Branch	WVOG-44-F-3			M			X
Big Harts Creek	WV-OGL-99-L	Buck Fork	WVOG-44-G			M			X
Big Harts Creek	WV-OGL-99-M	Hoover Fork	WVOG-44-H			M			X
Big Harts Creek	WV-OGL-99-N	Henderson Branch	WVOG-44-I			M			X
Big Harts Creek	WV-OGL-99-Q	Bulwark Branch	WVOG-44-K			M			X
Green Shoals Branch	WV-OGL-106	Green Shoals Branch	WVOG-45			M			X
Abbott Branch	WV-OGL-108	Abbott Branch	WVOG-46			M			X
Limestone Branch	WV-OGL-111	Limestone Branch	WVOG-48			X			X
Big Creek	WV-OGL-112	Big Creek	WVOG-49			M			X
Big Creek	WV-OGL-112-D	Ed Stone Branch	WVOG-49-A			M			X
Big Creek	WV-OGL-112-D-1	North Branch/Ed Stone Branch	WVOG-49-A-1			M			X
Big Creek	WV-OGL-112-E	North Fork/Big Creek	WVOG-49-B			M			X
Big Creek	WV-OGL-112-E-7	Chapman Branch	WVOG-49-B-1			M			X
Big Creek	WV-OGL-112-E-11	Harmon Branch	WVOG-49-B-2			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Big Creek	WV-OGL-112-E-10	Ellis Fork	WVOG-49-B-3			M			X
Big Creek	WV-OGL-112-F	Vickers Branch	WVOG-49-C			M			
Big Creek	WV-OGL-112-G	UNT/Big Creek RM 3.28	WVOG-49-C.1	X		M	X		
Big Creek	WV-OGL-112-I	Trace Fork	WVOG-49-D			M			X
Big Creek	WV-OGL-112-I-4	Hurricane Branch	WVOG-49-D-1			M			X
Big Creek	WV-OGL-112-I-7	Dog Fork	WVOG-49-D-2			M			
Big Creek	WV-OGL-112-H	Garrett Fork	WVOG-49-E			M			X
Big Creek	WV-OGL-112-H-1	Perrys Branch	WVOG-49-E-1			M			
Big Creek	WV-OGL-112-H-2	Kanawha Branch	WVOG-49-E-2			M			X
Big Creek	WV-OGL-112-H-3	Cloverlick Branch	WVOG-49-E-3			M			
Big Creek	WV-OGL-112-H-4	Rocklick Branch	WVOG-49-E-4			M			
Big Creek	WV-OGL-112-H-5	Barker Fork	WVOG-49-E-7			M			
Big Creek	WV-OGL-112-H-5-A	Gore Fork	WVOG-49-E-6			M			
Big Creek	WV-OGL-112-H-6	Hainer Branch	WVOG-49-E-5			M			X
Crawley Creek	WV-OGL-117	Crawley Creek	WVOG-51			X			X
Crawley Creek	WV-OGL-117-B	Canoe Fork	WVOG-51-B			M			X
Crawley Creek	WV-OGL-117-C	Striker Fork	WVOG-51-C			M			
Crawley Creek	WV-OGL-117-H	Tims Fork	WVOG-51-F			X			X
Crawley Creek	WV-OGL-117-J	Brushy Fork	WVOG-51-G			M			
Crawley Creek	WV-OGL-117-M	South Fork/Crawley Creek	WVOG-51-G.5			M			X
Crawley Creek	WV-OGL-117-M.1	Middle Fork/Crawley Creek	WVOG-51-G.6			M			X
Fowler Branch	WV-OGL-121	Fowler Branch	WVOG-51.5			M			X
Godby Branch	WV-OGL-125	Godby Branch	WVOG-53			M			X
Caney Branch	WV-OGL-129	Caney Branch	WVOG-54			X			X
Rocky Branch	WV-OGL-130	Rocky Branch	WVOG-55			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
King Shoal Branch	WV-OGL-134	King Shoal Branch	WVOG-58			M			X
Mill Creek	WV-OGL-135	Mill Creek	WVOG-59			M			X
Mill Creek	WV-OGL-135-F	Long Fork	WVOG-59-C			M			X
Mill Creek	WV-OGL-135-G	Butch Fork	WVOG-59-D			M			X
Big Branch	WV-OGL-136	Big Branch	WVOG-60			M			X
Buffalo Creek	WV-OGL-137	Buffalo Creek	WVOG-61			M			X
Buffalo Creek	WV-OGL-137-E	Right Fork/Buffalo Creek	WVOG-61-A			M			
Snap Creek	WV-OGL-138	Snap Creek	WVOG-62			M			X
Snap Creek	WV-OGL-138-A	UNT/Snap Creek RM 0.43				M			
Snap Creek	WV-OGL-138-B	UNT/Snap Creek RM 0.63	WVOG-62-B			X			X
Crooked Creek	WV-OGL-139	Crooked Creek	WVOG-63			M			X
Peach Creek	WV-OGL-140	Peach Creek	WVOG-64			M			X
Mud River	WV-OGL-10	Mud River	WVOGM			X		X	X
Merrick Creek	WV-OGL-10-A	Merrick Creek	WVOGM-1			M			X
Merrick Creek	WV-OGL-10-B	Tanyard Branch	WVOGM-1.5			M			X
Cyrus Creek	WV-OGL-10-D	Cyrus Creek	WVOGM-2			M			X
Little Cabell Creek	WV-OGL-10-O	Little Cabell Creek	WVOGM-3			M			
Big Cabell Creek	WV-OGL-10-Q	Big Cabell Creek	WVOGM-4			M			X
Big Cabell Creek	WV-OGL-10-Q-6	Rush Hollow	WVOGM-4-F			M			
Big Cabell Creek	WV-OGL-10-Q-7	UNT/Big Cabell Creek RM 3.79				M			
Big Cabell Creek	WV-OGL-10-Q-9	Big Hill Hollow	WVOGM-4-I			M			X
Edmonds Branch	WV-OGL-10-R	Edmonds Branch	WVOGM-5			M			X
Fudges Creek	WV-OGL-10-S	Fudges Creek	WVOGM-6			M			X
Fudges Creek	WV-OGL-10-S-2	Wire Branch	WVOGM-6-0.5A			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Fudges Creek	WV-OGL-10-S-5	Little Fudges Creek	WVOGM-6-A			M			X
Lower Creek	WV-OGL-10-AC	Lower Creek	WVOGM-7			M			X
Lower Creek	WV-OGL-10-AC-2	McComas Branch	WVOGM-7-A			M			
Lower Creek	WV-OGL-10-AC-5	Right Fork/Lower Creek	WVOGM-7-B			M			
Lower Creek	WV-OGL-10-AC-5-B	Tony Branch	WVOGM-7-B-1			M			X
Mill Creek	WV-OGL-10-AD	Mill Creek	WVOGM-8			X			X
Mill Creek	WV-OGL-10-AD-7	Long Branch	WVOGM-8-A			M			X
Mill Creek	WV-OGL-10-AD-9	Left Fork/Mill Creek	WVOGM-8-B			M			
Mill Creek	WV-OGL-10-AD-9-F	UNT/Left Fork RM 2.48/Mill Creek	WVOGM-8-B-6			M			
Mill Creek	WV-OGL-10-AD-10	Right Fork/Mill Creek	WVOGM-8-C			M			X
Saunders Creek	WV-OGL-10-AE	Saunders Creek	WVOGM-9			M			X
Dry Creek	WV-OGL-10-AF	Dry Creek	WVOGM-10			M			X
Johns Branch	WV-OGL-10-AH	Johns Branch	WVOGM-11			M			X
Kilgore Creek	WV-OGL-10-AJ	Kilgore Creek	WVOGM-12			M			X
Kilgore Creek	WV-OGL-10-AJ-2	Indian Fork	WVOGM-12-A			X			X
Kilgore Creek	WV-OGL-10-AJ-4	Lee Creek	WVOGM-12-B						X
Kilgore Creek	WV-OGL-10-AJ-7	Little Creek	WVOGM-12-C			M			X
Brush Creek	WV-OGL-10-AM	Brush Creek	WVOGM-13			M			X
Charley Creek	WV-OGL-10-AO	Charley Creek	WVOGM-14			X			X
Charley Creek	WV-OGL-10-AO-11	Panther Lick	WVOGM-14-D			M			X
Little Twomile Creek	WV-OGL-10-AQ	Little Twomile Creek	WVOGM-15			M			X
Mud River	WV-OGL-10-AR	Big Twomile Creek	WVOGM-16			M			
Trace Creek	WV-OGL-10-AX	Trace Creek	WVOGM-19			M			
Trace Creek	WV-OGL-10-AX-1	Porter Creek				M			
Trace Fork	WV-OGL-10-AY	Trace Fork	WVOGM-20			X			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Trace Fork	WV-OGL-10-AY-7	Coon Creek	WVOGM-20-A			X			X
Trace Fork	WV-OGL-10-AY-10	Big Creek	WVOGM-20-D			M			X
Trace Fork	WV-OGL-10-AY-10-B	Harvey Creek	WVOGM-20-D-1			M			X
Trace Fork	WV-OGL-10-AY-13	Hungry Creek	WVOGM-20-E			M			
Trace Fork	WV-OGL-10-AY-14	Sycamore Creek	WVOGM-20-F			M			X
Trace Fork	WV-OGL-10-AY-20	Clymer Creek	WVOGM-20-H			M			X
Trace Fork	WV-OGL-10-AY-22	Trace Creek	WVOGM-20-I			M			X
Trace Fork	WV-OGL-10-AY-22-A	Kellys Creek	WVOGM-20-I-1			M			X
Trace Fork	WV-OGL-10-AY-22-A-2	UNT/Kellys Creek RM 1.27	WVOGM-20-I-1-B			M			X
Trace Fork	WV-OGL-10-AY-24	Lick Creek	WVOGM-20-J			M			X
Trace Fork	WV-OGL-10-AY-26	Turkey Creek	WVOGM-20-K			M			X
Trace Fork	WV-OGL-10-AY-26-F	Lefthand Fork	WVOGM-20-K-1			M			X
Trace Fork	WV-OGL-10-AY-30	Bridge Creek	WVOGM-20-M			M			X
Trace Fork	WV-OGL-10-AY-36	Twomile Branch	WVOGM-20-O			M			
Trace Fork	WV-OGL-10-AY-38	Trace Branch	WVOGM-20-P			M			
Trace Fork	WV-OGL-10-AY-39	Tony Branch	WVOGM-20-Q			M			
Trace Fork	WV-OGL-10-AY-40	Hayzlett Fork	WVOGM-20-R			M			X
Trace Fork	WV-OGL-10-AY-40-G	Donley Fork	WVOGM-20-R-2			M			
Trace Fork	WV-OGL-10-AY-42	Joes Creek	WVOGM-20-T			X			X
Trace Fork	WV-OGL-10-AY-42-D	Laurel Fork	WVOGM-20-T-1			M			X
Trace Fork	WV-OGL-10-AY-42-F	Tango Branch	WVOGM-20-T-2			M			X
Trace Fork	WV-OGL-10-AY-46	Dry Branch	WVOGM-20-W			M			X
Little Buffalo Creek	WV-OGL-10-AZ	Little Buffalo Creek	WVOGM-21			M			X
Buffalo Creek	WV-OGL-10-BA	Buffalo Creek	WVOGM-22			M			X
Buffalo Creek	WV-OGL-10-BA-1	Straight Fork	WVOGM-22-A			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Buffalo Creek	WV-OGL-10-BA-2	UNT/Buffalo Creek RM 1.45				M			
Mud River	WV-OGL-10-BD	Laurel Creek	WVOGM-23			M			
Middle Fork/Mud River	WV-OGL-10-BL	Middle Fork/Mud River	WVOGM-25			X			X
Middle Fork/Mud River	WV-OGL-10-BL-2	Meadow Branch	WVOGM-25-A			M			X
Middle Fork/Mud River	WV-OGL-10-BL-3	Trace Creek	WVOGM-25-B			M			X
Middle Fork/Mud River	WV-OGL-10-BL-4	Middle Creek	WVOGM-25-C			M			X
Middle Fork/Mud River	WV-OGL-10-BL-10	Davis Trace Branch	WVOGM-25-D			M			X
Middle Fork/Mud River	WV-OGL-10-BL-12	Scary Creek	WVOGM-25-E			M			X
Middle Fork/Mud River	WV-OGL-10-BL-12-B	Ruffie Branch	WVOGM-25-E-1			M			
Middle Fork/Mud River	WV-OGL-10-BL-15	Merritt Creek	WVOGM-25-F			M			X
Middle Fork/Mud River	WV-OGL-10-BL-18	Straight Fork	WVOGM-25-H			X			X
Middle Fork/Mud River	WV-OGL-10-BL-18-A	Valley Fork	WVOGM-25-H-1			M			X
Middle Fork/Mud River	WV-OGL-10-BL-18-A-1	Sams Branch	WVOGM-25-H-1-A			M			
Middle Fork/Mud River	WV-OGL-10-BL-18-E	Bear Fork	WVOGM-25-H-2			M			
Middle Fork/Mud River	WV-OGL-10-BL-18-G	Porter Fork	WVOGM-25-H-3			M			
Middle Fork/Mud River	WV-OGL-10-BL-19	Sugartree Fork	WVOGM-25-I			M			X
Middle Fork/Mud River	WV-OGL-10-BL-19-A	Big Branch	WVOGM-25-I-1			M			X
Middle Fork/Mud River	WV-OGL-10-BL-19-B	Sycamore Fork	WVOGM-25-I-2			M			X
Middle Fork/Mud River	WV-OGL-10-BL-19-E	Sand Fork	WVOGM-25-I-4			X			
Middle Fork/Mud River	WV-OGL-10-BL-19-G	Maul Fork	WVOGM-25-I-6			M			X
Mahone Creek	WV-OGL-10-BR	Mahone Creek	WVOGM-26			M			X
Big Creek	WV-OGL-10-BU	Big Creek	WVOGM-28			M			X
Little Laurel Creek	WV-OGL-10-CB	Little Laurel Creek	WVOGM-30			M			X
Sandlick Branch	WV-OGL-10-CC	Sandlick Branch	WVOGM-31			M			X
Mud River	WV-OGL-10-CF	Panther Branch	WVOGM-32			M			

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Big Laurel Creek	WV-OGL-10-CH	Big Laurel Creek	WVOGM-33			M			X
Big Laurel Creek	WV-OGL-10-CH-5	Dry Fork	WVOGM-33-B			M			
Big Laurel Creek	WV-OGL-10-CH-7	Big Branch	WVOGM-33-C			M			
Fez Creek	WV-OGL-10-CK	Fez Creek	WVOGM-34			M			X
Big Creek	WV-OGL-10-CL	Big Creek	WVOGM-35			M			X
Big Creek	WV-OGL-10-CL-1	First Fork	WVOGM-35-A			M			
Big Creek	WV-OGL-10-CL-2	Second Fork	WVOGM-35-A.5			M			
Big Creek	WV-OGL-10-CL-7	Lick Fork	WVOGM-35-C			M			
Big Creek	WV-OGL-10-CL-10	Laurel Fork	WVOGM-35-E			M			
Parsner Creek	WV-OGL-10-CR	Parsner Creek	WVOGM-38			M			X
Parsner Creek	WV-OGL-10-CR-2	Pigeon Branch	WVOGM-38-A			M			
Left Fork/Mud River	WV-OGL-10-CS	Left Fork/Mud River	WVOGM-39			M			X
Left Fork/Mud River	WV-OGL-10-CS-1	Richs Branch	WVOGM-39-A			M			
Left Fork/Mud River	WV-OGL-10-CS-3	Senging Branch	WVOGM-39-B			M			
Left Fork/Mud River	WV-OGL-10-CS-5	Elkins Branch	WVOGM-39-D			M			
Left Fork/Mud River	WV-OGL-10-CS-6	Stinson Branch	WVOGM-39-E			M			X
Left Fork/Mud River	WV-OGL-10-CS-6-A	UNT/Stinson Branch RM 0.88				M			
Left Fork/Mud River	WV-OGL-10-CS-8	Sycamore Fork	WVOGM-39-G			M			X
Left Fork/Mud River	WV-OGL-10-CS-8-E	Owl Creek	WVOGM-39-G-3			M			
Left Fork/Mud River	WV-OGL-10-CS-10	Dogbone Branch	WVOGM-39-H			M			X
Left Fork/Mud River	WV-OGL-10-CS-11	Barkcamp Branch	WVOGM-39-I			M			
Upton Branch	WV-OGL-10-CY	Upton Branch	WVOGM-40			M			X
Upton Branch	WV-OGL-10-CY-1	UNT/Upton Branch RM 0.37 (Laurel Fork)	WVOGM-40-A			M			
Bear Branch	WV-OGL-10-DC	Bear Branch	WVOGM-41			M			X
Slab Creek	WV-OGL-10-DG	Slab Creek	WVOGM-42			M			X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Se	FC
Stonecoal Branch	WV-OGL-10-DM	Stonecoal Branch	WVOGM-43			M		X	
Berry Branch	WV-OGL-10-DN	Berry Branch	WVOGM-44			M		X	
Mullins Branch	WV-OGL-10-DO	Mullins Branch	WVOGM-45			M		X	
Connelly Branch	WV-OGL-10-DS	Connelly Branch	WVOGM-46			M		X	
Sugartree Branch	WV-OGL-10-DW	Sugartree Branch	WVOGM-47			M		X	
Stanley Fork	WV-OGL-10-DX	Stanley Fork	WVOGM-48			M		X	
Ballard Fork	WV-OGL-10-EA	Ballard Fork	WVOGM-49			M			
Lukey Fork	WV-OGL-10-EC	Lukey Fork	WVOGM-50			X		X	

Note:
RM river mile
UNT unnamed tributary
Al aluminum impairment
DO dissolved oxygen impairment
FC fecal coliform bacteria impairment
Fe iron impairment
pH acidity impairment
Se selenium impairment
M impairment determined via modeling
X impairment determined via sampling

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. As with the 2019 rule, the final filing was delayed in 2020 resulting in a third version of the procedural rule in 2021 with a comment period ending on March 26, 2021. The procedural rule can be accessed at the following webpage: http://apps.sos.wv.gov/adlaw/csr/ruleview.aspx?document=17375 .

At the time of this TMDL completion, WVDEP was considering comments in order to respond and 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 128 assessment units (115 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 5^{th} 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 7** 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 2016 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 (USEPA 2010).

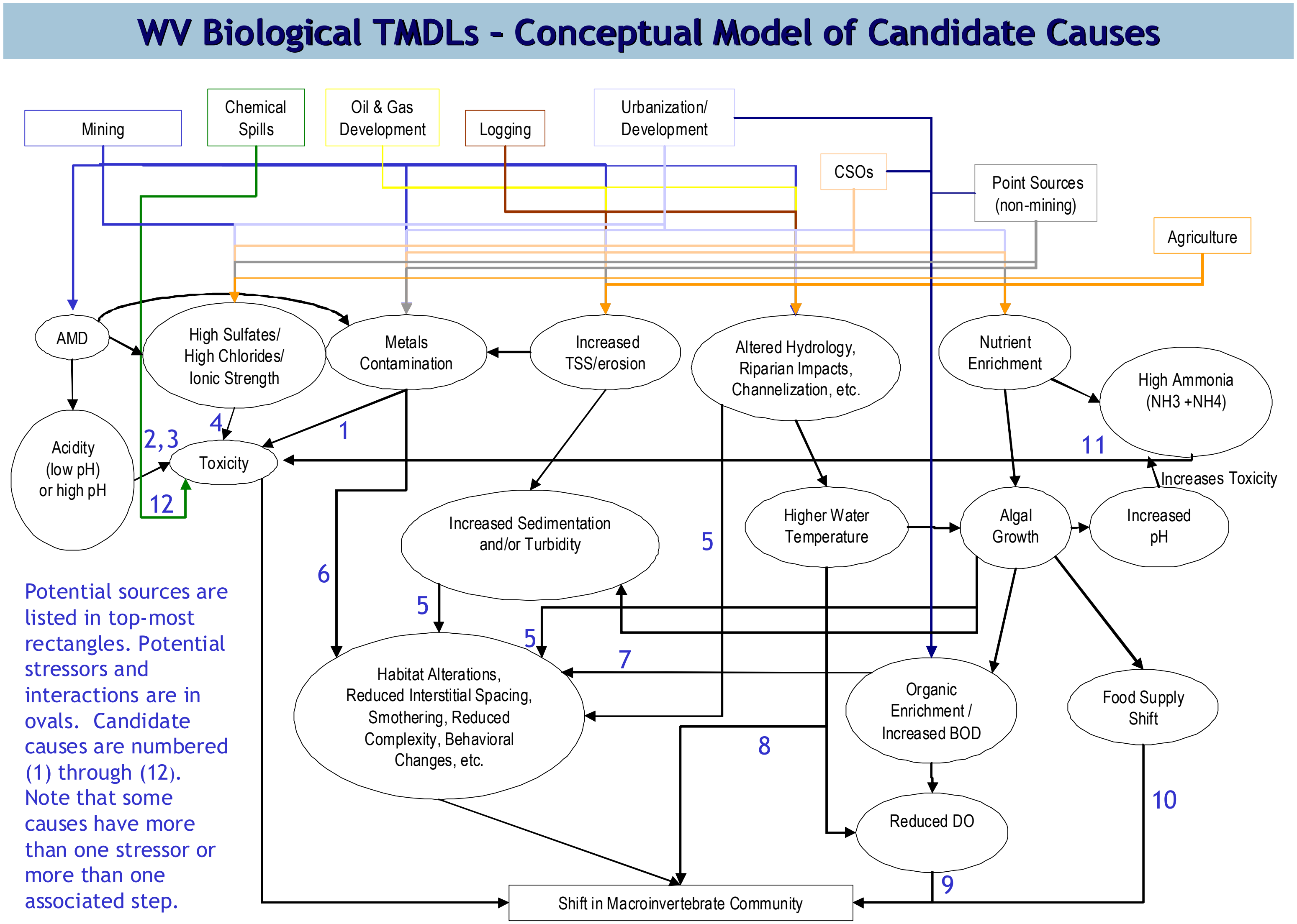


Figure 4-1. Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process identified significant biological stressors for each assessment unit. 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 Guyandotte River watershed:

- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal and habitat alteration)
- Sedimentation
- Low pH
- Dissolved metals
- Metals flocculants
- Ionic strength

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. 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.

There is a relationship between iron and sediment in West Virginia because there is a high iron content in soils and geology. Total iron is delivered to streams through erosion and sedimentation. Certain streams for which the SI process identified sedimentation as a significant stressor are also impaired pursuant to total iron water quality criteria. 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**. There are 24 assessment units (21 streams) for which the SI process did not indicate that TMDLs for numeric criteria would resolve the biological impacts. These streams are listed in **Appendix K**.

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

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-5_01	Russell Creek	WVOG-1	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-5-B_01	UNT/Russell Creek RM 0.98	WVOG-1-B	sedimentation	total iron load reduction for downstream impairment This stream drains a portion of the subwatershed (SUBID 106) delineated for Russell Creek.
WV-OGL-10-O_01	Little Cabell Creek	WVOGM-3	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-Q_02	Big Cabell Creek	WVOGM-4	sedimentation	total iron
WV-OGL-10-R_01	Edmonds Branch	WVOGM-5	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-S_01	Fudges Creek	WVOGM-6	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-S-2_01	Wire Branch	WVOGM-6-0.5A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-S-5_01	Little Fudges Creek	WVOGM-6-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AC_02	Lower Creek	WVOGM-7	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AC-2_01	McComas Branch	WVOGM-7-A	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-AC-5_01	Right Fork/Lower Creek	WVOGM-7-B	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-AD_02	Mill Creek	WVOGM-8	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AD-10_01	Right Fork/Mill Creek	WVOGM-8-C	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AD-9_01	Left Fork/Mill Creek	WVOGM-8-B	sedimentation	total iron
WV-OGL-10-AE_01	Saunders Creek	WVOGM-9	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AH_01	Johns Branch	WVOGM-11	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AJ_02	Kilgore Creek	WVOGM-12	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AJ-2_01	Indian Fork	WVOGM-12-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AM_01	Brush Creek	WVOGM-13	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AO_01	Charley Creek	WVOGM-14	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AQ_01	Little Twomile Creek	WVOGM-15	organic enrichment, sedimentation	total iron, fecal coliform

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-10-AR_01	Big Twomile Creek	WVOGM-16	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-AX_01	Trace Creek	WVOGM-19	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-AY_06	Trace Fork	WVOGM-20	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY_04	Trace Fork	WVOGM-20	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY_03	Trace Fork	WVOGM-20	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-10_02	Big Creek	WVOGM-20-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-10_01	Big Creek	WVOGM-20-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-13_01	Hungry Creek	WVOGM-20-E	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-AY-20_01	Clymer Creek	WVOGM-20-H	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-22_01	Trace Creek	WVOGM-20-I	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-22-A_01	Kellys Creek	WVOGM-20-I-1	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-24_01	Lick Creek	WVOGM-20-J	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-26_01	Turkey Creek	WVOGM-20-K	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-40_01	Hayzlett Fork	WVOGM-20-R	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-42_02	Joes Creek	WVOGM-20-T	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-42_01	Joes Creek	WVOGM-20-T	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-46_01	Dry Branch	WVOGM-20-W	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AY-7_01	Coon Creek	WVOGM-20-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-AZ_01	Little Buffalo Creek	WVOGM-21	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BA_01	Buffalo Creek	WVOGM-22	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL_04	Middle Fork/Mud River	WVOGM-25	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-10_01	Davis Trace Branch	WVOGM-25-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-15_01	Merritt Creek	WVOGM-25-F	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-18_02	Straight Fork	WVOGM-25-H	organic enrichment, sedimentation	total iron, fecal coliform

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-10-BL-18-A_01	Valley Fork	WVOGM-25-H-1	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-19_02	Sugartree Fork	WVOGM-25-I	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-19_01	Sugartree Fork	WVOGM-25-I	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-BL-19-E_01	Sand Fork	WVOGM-25-I-4	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-BL-3_01	Trace Creek	WVOGM-25-B	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-CR_01	Parsner Creek	WVOGM-38	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-CS_02	Left Fork/Mud River	WVOGM-39	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-10-CS_01	Left Fork/Mud River	WVOGM-39	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-CS-6_01	Stinson Branch	WVOGM-39-E	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-CS-8_01	Sycamore Fork	WVOGM-39-G	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-10-DC_01	Bear Branch	WVOGM-41	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-12-B_01	Edens Branch	WVOG-3-0.5A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-12-D_01	Left Fork/Davis Creek	WVOG-3-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-15_01	Mill Creek	WVOG-6	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-15-A_01	UNT/Mill Creek RM 0.21	WVOG-6-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-18_01	Lower Tom Creek	WVOG-8	organic enrichment	fecal coliform
WV-OGL-23_01	Heath Creek	WVOG-9	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-23-B_01	Upper Heath Creek	WVOG-9-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-24_01	Merritt Creek	WVOG-10	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-24-B_01	Right Fork/Merritt Creek	WVOG-10-A	organic enrichment, sedimentation	total iron, fecal coliform - replaces 2004 TMDL
WV-OGL-27_01	Smith Creek	WVOG-11	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-29_01	Tom Creek	WVOG-13	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-30_01	Trace Creek	WVOG-14	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-30-C_01	UNT/Trace Creek RM 2.88	WVOG-14-C	organic enrichment, sedimentation	total iron, fecal coliform

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-31_01	Tyler Creek	WVOG-15	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-34_01	Madison Creek	WVOG-17	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-35_01	Bear Creek	WVOG-18	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-38_01	Twomile Creek	WVOG-20	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-42_01	Falls Creek	WVOG-22	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-47_01	Twomile Creek	WVOG-24	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-53_03	Fourmile Creek	WVOG-27	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-60_01	Sixmile Creek	WVOG-29	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform
WV-OGL-64_02	Ninemile Creek	WVOG-31	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-64_01	Ninemile Creek	WVOG-31	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-66_02	Tenmile Creek	WVOG-32	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-69_01	Furnett Creek	WVOG-33	sedimentation	total iron
WV-OGL-75_02	Fourteenmile Creek	WVOG-34	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-75_01	Fourteenmile Creek	WVOG-34	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-75-B_01	East Fork/Fourteenmile Creek	WVOG-34-B	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-75-F_01	Sulphur Spring Fork	WVOG-34-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-80_01	Aarons Creek	WVOG-35	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89_04	Big Ugly Creek	WVOG-38	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89_03	Big Ugly Creek	WVOG-38	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89_01	Big Ugly Creek	WVOG-38	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89-G_02	Laurel Creek	WVOG-38-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89-R_01	Broad Branch	WVOG-38-J	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-89-T_01	Lefthand Creek	WVOG-38-K	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-93_01	Sand Creek	WVOG-40	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-95_01	Dry Run	WVOG-41	organic enrichment, sedimentation	total iron, fecal coliform

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-96_01	Little Harts Creek	WVOG-42	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-96-C_01	Short Bend Fork	WVOG-42-A	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-96-E_01	Laurel Fork	WVOG-42-C	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99_04	Big Harts Creek	WVOG-44	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99_01	Big Harts Creek	WVOG-44	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-A-3_01	Piney Fork	WVOG-44-A-1	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-A-4_01	Marsh Fork	WVOG-44-A-2	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-B_01	Big Branch	WVOG-44-B	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-E_01	Caney Branch	WVOG-44-C.3	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-G_01	Thompson Branch	WVOG-44-C.7	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-J_02	Smokehouse Fork	WVOG-44-E	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-J_01	Smokehouse Fork	WVOG-44-E	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-J-9_01	White Oak Branch	WVOG-44-E-2	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-K_01	Trace Fork	WVOG-44-F	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-L_01	Buck Fork	WVOG-44-G	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-99-Q_01	Bulwark Branch	WVOG-44-K	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-108_01	Abbott Branch	WVOG-46	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-D-1_01	North Branch/Ed Stone Branch	WVOG-49-A-1	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-E_01	North Fork/Big Creek	WVOG-49-B	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-E-10_01	Ellis Fork	WVOG-49-B-3	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-E-11_01	Harmon Branch	WVOG-49-B-2	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-G_01	UNT/Big Creek RM 3.28	WVOG-49-C.1	sedimentation, metals	total iron, dissolved aluminum, pH
WV-OGL-112-H_02	Garrett Fork	WVOG-49-E	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-H_01	Garrett Fork	WVOG-49-E	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-112-I-7_01	Dog Fork	WVOG-49-D-2	organic enrichment, sedimentation	total iron, load reductions for downstream fecal coliform

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-OGL-117-B_01	Canoe Fork	WVOG-51-B	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-117-H_01	Tims Fork	WVOG-51-F	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-129_01	Caney Branch	WVOG-54	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-134_01	King Shoal Branch	WVOG-58	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-135_01	Mill Creek	WVOG-59	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-135-F_01	Long Fork	WVOG-59-C	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-135-G_01	Butch Fork	WVOG-59-D	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-139_01	Crooked Creek	WVOG-63	organic enrichment, sedimentation	total iron, fecal coliform
WV-OGL-140_01	Peach Creek	WVOG-64	organic enrichment, sedimentation	total iron, fecal coliform

5.0 METALS AND SELENIUM SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments in the Lower Guyandotte 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 points are considered point sources. Municipal Separate Storm Sewer Systems (MS4) are also 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 permitted through the WVDEP Office of Oil and Gas (OOG). The assignment of LAs to OOG permitted wells 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 permitted 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.

Selenium is a naturally occurring element that is found in Cretaceous marine sedimentary rocks, coal and other fossil fuel deposits (Dreher and Finkelman 1992; CCREM 1987; Haygarth 1994). When such deposits are mined, mobilization of selenium is typically enhanced from crushing of ore and waste materials along with the resulting increase in surface area of material exposed to weathering processes. Studies have shown that selenium mobilization appears to be associated with various surface disturbance activities associated with surface coal mining in Wyoming and western Canada (Dreher and Finkelman 1992; McDonald and Strosher 1998). In West Virginia coal beds of the Middle Pennsylvanian era exhibit the highest selenium contents. Lower selenium content is found in both the Lower Pennsylvanian and Upper Pennsylvanian eras (WVGES, 2002). Selenium is contained in those coals and mining often exposes partings and interburden of selenium containing shales.

The Lower Guyandotte watershed is comprised of four major geologic formation groups within the lower and middle Pennsylvanian geologic systems that create the surface lithology (**Figure 5-6**). The predominant being the Pottsville group which makes up approximately 33.6% of the Lower Guyandotte watershed and the Conemaugh group comprising approximately 33.3%. The Monongahela group and the Allegheny formation make up the remaining 13.8% and 12.4% respectively. The Dunkard group and alluvium deposits along the mainstem of the Guyandotte River make up the remaining lithology, having little to no contribution to Selenium discharge within the watershed.

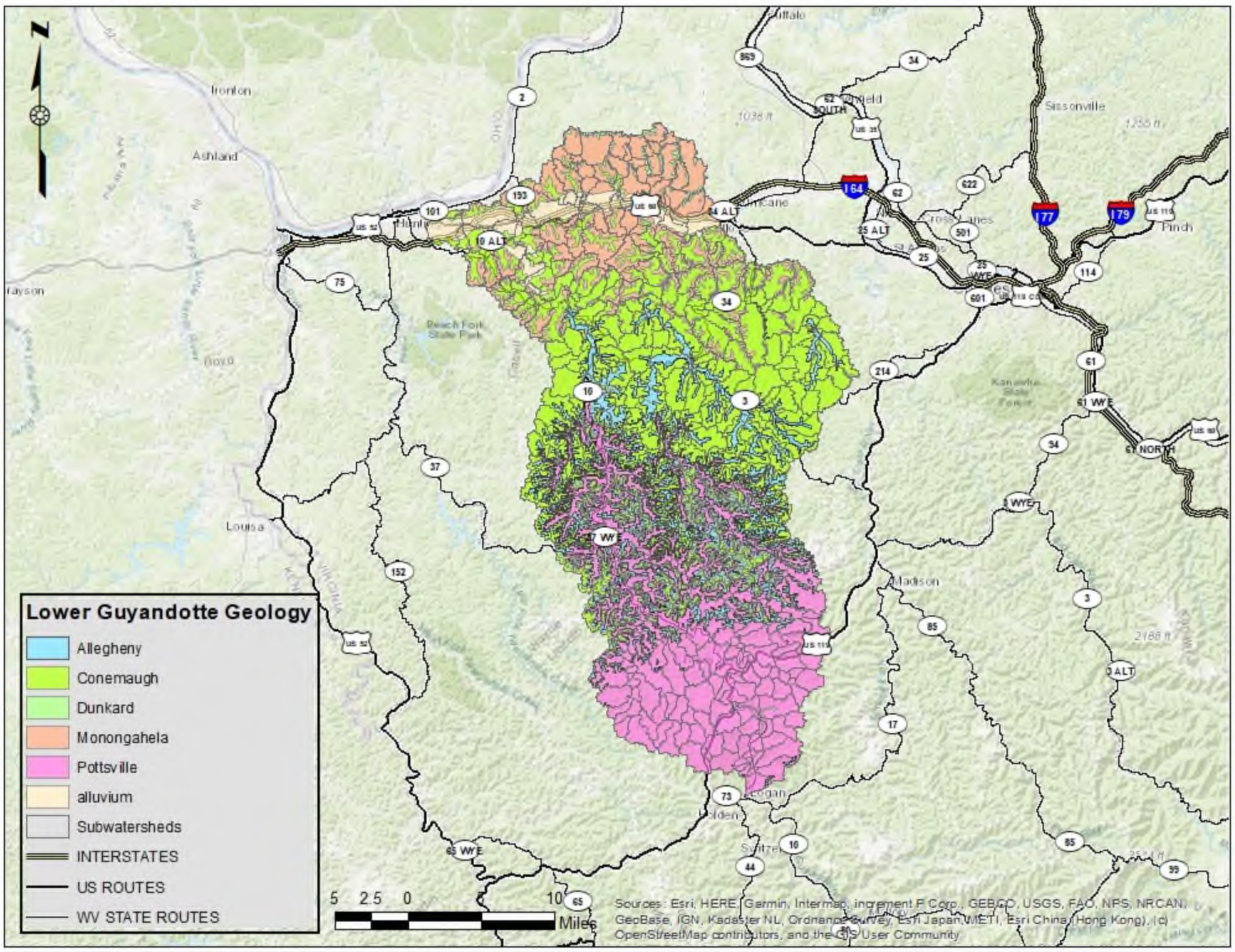


Figure 5-1 Lower Guyandotte geologic formations

These formations are comprised mainly of sandstone, limestone and shale interburden with coal beds and coal lenses dispersed throughout the stratigraphic column. Within the Lower Guyandotte watershed stratigraphy, the Upper Freeport coal seam of the lower Conemaugh group contains significant reserve coal assets. The Pottsville group of the Kanawha formation holds significant mineable coal reserves such as Mercer, Stockton, Coalburg and Winifrede seams. Mineable reserve seams such as the Freeport, Kittanning, Stockton, No. 5 Block and Upper No. 5 Block coal seams are found within the Allegheny formation.

West Virginia University published a study in 2008 focusing on concentrations of Selenium specifically in the Kanawha formation of southern West Virginia. The 2008 study noted, "The Low-S Coalburg and Winifrede coals of the upper Kanawha Formation in West Virginia contain Se at higher concentrations than found in many other West Virginia coal beds." (Vesper, 2008) This study directly correlates with the WV DEP mandate to encapsulate coal partings and interburden within these seams that exceed 1mg/kg Se > 1ft of interburden thickness when mined.

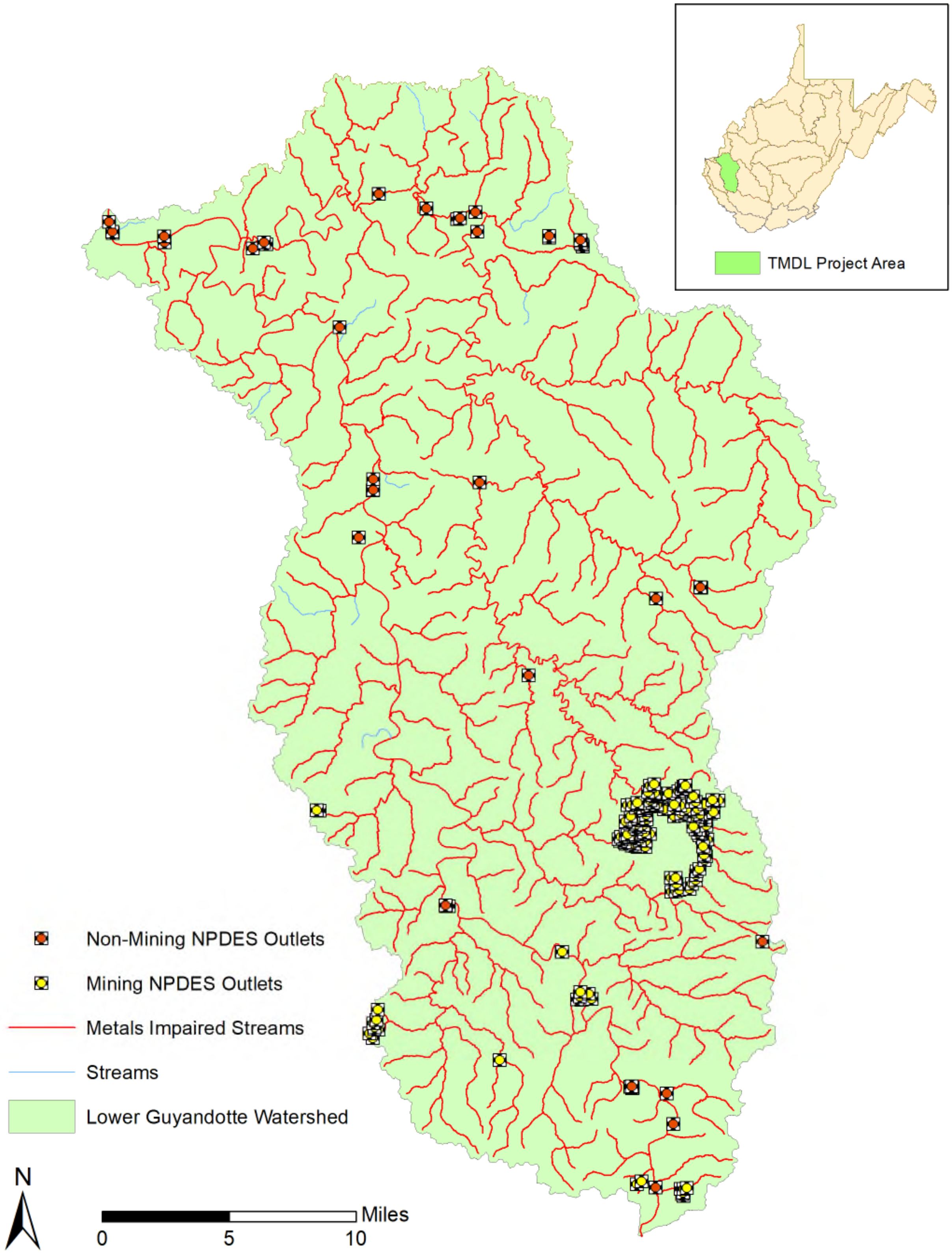
The higher concentrations of selenium found within the interburden layers of shale and coal within the Pottsville and Allegheny groups create potential for discharge of excess levels of Selenium into adjacent streams. This potential is increased by surface mining activities but can also be discharged naturally due to pressure induced fracturing of overburden in non-mining areas. Approximately 47% of the Lower Guyandotte watershed has potential to produce above average selenium discharge rates, especially in the headwater regions where surface and underground mining is more prevalent.

Although the Conemaugh group demonstrates increased potential for selenium discharge due to elevated in-situ selenium concentrations, the majority of the Lower Guyandotte watershed does not contain minable reserves, therefore mining influence is reduced and selenium discharge is less prevalent for the majority of the watershed.

Ten streams in this TMDL project have been listed in the WV 2016 303(d) list pursuant to the aquatic life criteria for selenium, based on pre-TMDL data collected by WVDEP from 2016-2017. Extensive surface mining operations exist in the impaired watersheds; and both active and reclaimed mining are the dominant landuses. Given the selenium content of coals being mined in this region, and the prevalence of mining activity in proximity to observed exceedances of the selenium water quality criterion, it can be concluded that the disturbances associated with the existing and legacy mining operations directly contribute to the selenium impairment.

5.1 Metals and Selenium 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 5-2. Point sources in the Lower Guyandotte 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 commingled mines may have low pH values (i.e., acidic) and contain high concentrations of metals (e.g., 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).

The permitted mining point sources (open NPDES outlets) were grouped into landuse categories based on the type and status of mining activity and effluent discharge characteristics. Commingled discharges contain effluent discharges from both surface and deep mining activities. Surface mines, and commingled surface mines were treated as land-based precipitation-induced sources. The deep mine portions of commingled mines were characterized as continuous flow point sources. Deep mines were also characterized as continuous flow point sources.

There are 16 mining-related NPDES permits, with 153 active associated outlets in the metals impaired watersheds of the Lower Guyandotte River watershed (Appendix F, HPU Outlets Metals Calls Tab). Point sources are represented differently during model calibration than they were during the allocation process. To match model results to historical water quality data for calibration, it is necessary to represent the existing point sources using available historical data. During the allocation process, permitted sources are represented at their allowable permit limits in the baseline condition. Reductions are made to the baseline when necessary to attain the TMDL endpoint in the allocated condition.

For metals modeling, Phase II and Completely Released permitted facilities were represented at concentrations similar to background because reclamation of these mines is completed or nearly complete and have programmatically progressed to the point where NPDES permit limits for TMDL endpoints of metals such as total iron, total aluminum, or manganese have been removed from the permit (WVDEP, 2000). There are 5 reclamation-related NPDES permits, with 22 associated outlets present in the watershed (Appendix F, HPU Outlets Metals Calls Tab). These outlets were represented as selenium sources contributing to impairment in the model.

Details for both active and reclaimed mining point sources are provided in **Appendix F** of the Technical Report. **Figure 5-1** illustrates the extent of the mining NPDES outlets in the 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 2 industrial wastewater discharges under one permit in the watersheds of metals impaired streams in the Lower Guyandotte River watershed.

In the Lower Guyandotte 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 51 modeled non-mining NPDES permitted outlets (1 solid waste landfill, 3 water treatment plants, 34 Multi Sector Stormwater general permit outlets for industrial discharges, 2 individual permits, and 11 WV DOH stormwater discharges) 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.

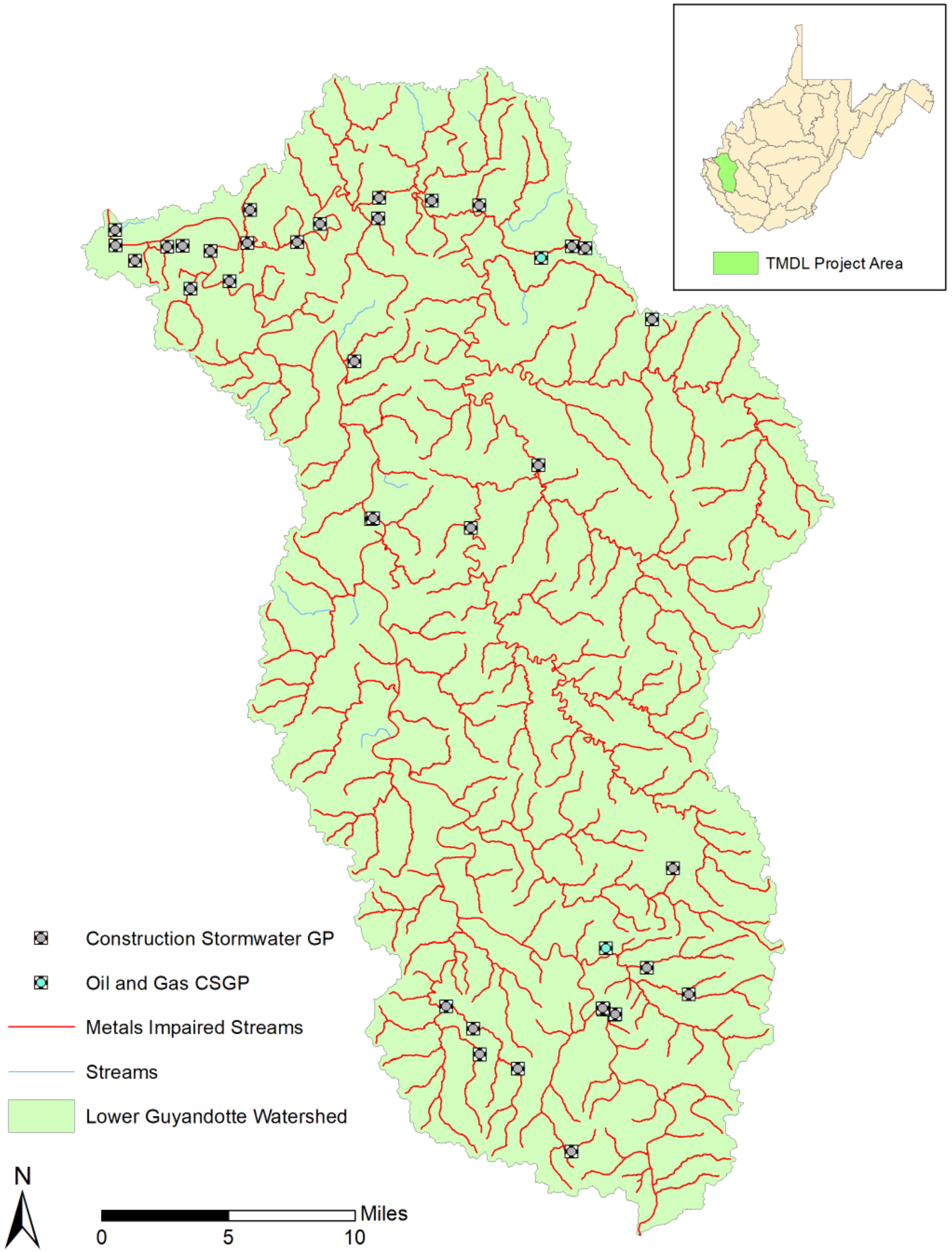
5.1.3 Construction Stormwater Permits

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.

At the time of model set-up, 38 active construction sites with a total disturbed area of 325.56 acres registered under the CSGP were represented in the Lower Guyandotte River watershed. Two registrations under the OGCSGP were represented in the model with a total disturbance of 6 acres. CSGP and OGCSGP registrations are shown in **Figure 5-2.** Specific WLAs are not prescribed for individual sites. Instead, subwatershed-based allocations are provided for concurrently disturbed area registered under the permits as described in **Sections 9.7.1** and **11.0**.



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

Figure 5-3. Construction stormwater permits in the Lower Guyandotte River watershed

5.1.4 Municipal Separate Storm Sewer Systems (MS4)

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. The MS4 entities are registered under the MS4 General Permit (WV0116025). Individual registration numbers for the MS4 entities are Village of Barboursville (WVR030011), City of Huntington (WVR030033), City of Hurricane (WVR030010), the Town of Milton (WVR030003), and the West Virginia Division of Highways (WVDOH) (WVR030004).

The MS4 permit areas fall within established city limits. WVDOH MS4 area occurs inside and on the southern 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 2016 landuse data, the jurisdictional boundary of the city, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. The representation also includes streambank erosion loads for the portions of streams within the MS4 boundaries. The location and extent of the MS4 jurisdictions are shown in **Figure 5-3**.

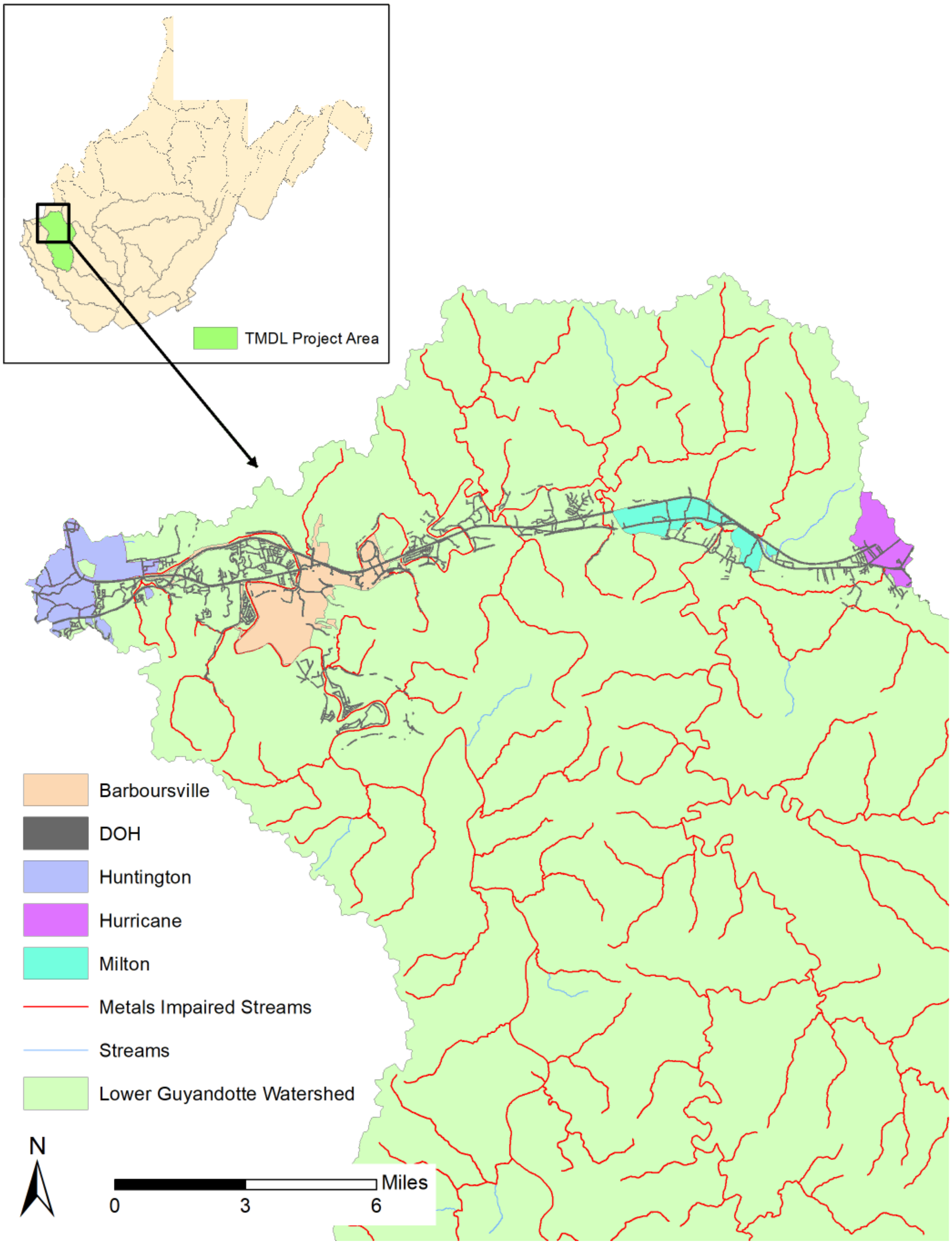


Figure 5-4. Municipal Separate Storm Sewer System permits in the Lower Guyandotte watershed

5.2 Metals and Selenium 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 Guyandotte 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 represent a significant source of metals in certain metals impaired streams for which TMDLs are presented. In TMDL watersheds with metals, aluminum, pH, and selenium impairments, a total of 19 seeps associated with legacy mine practices, 28.6 acres of AML highwall and 198.6 acres of AML area were incorporated into the TMDL model. **Figure 5-4** displays metals nonpoint AML sources represented in the metals model.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as AML discharges are modeled as 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 these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

5.2.2 Legacy Mine Sources

Legacy mines are mining areas permitted and released after 1977 when SMCRA took effect but continue to contribute above-background loadings selenium. Some of these legacy mine sources are comprised of mining permits that were reclaimed and released before selenium was understood to be a pollutants of concern. Pollutant source tracking efforts in selenium impaired streams identified problem areas for selenium from mining areas, particularly those associated with valley fills. Legacy mine areas without an active NPDES permit are treated as nonpoint source LAs for TMDL purposes. There are 17 nonpoint source legacy mine areas represented in the model similar to background for metals modeling. For selenium modeling, these 17 areas were represented as nonpoint sources contributing to impairment with loading rates above background.

5.2.3 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.

Other nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, and oil and gas well operations) were considered to be negligible sources of selenium similar to background because these land disturbances typically do not disrupt subsurface strata that contain selenium. In this and prior TMDL development efforts, WVDEP did not identify selenium impairments in streams where surface-disturbing nonpoint sources were prevalent in the watershed and mining activities were absent.

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 8,897 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 712 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, 2,059 acres of burned forest were reported and included as disturbed land for calibration purposes only. **Figure 5-4** displays modeled metals nonpoint sources burned forest and logging operations in TMDL watersheds represented in the metals model.

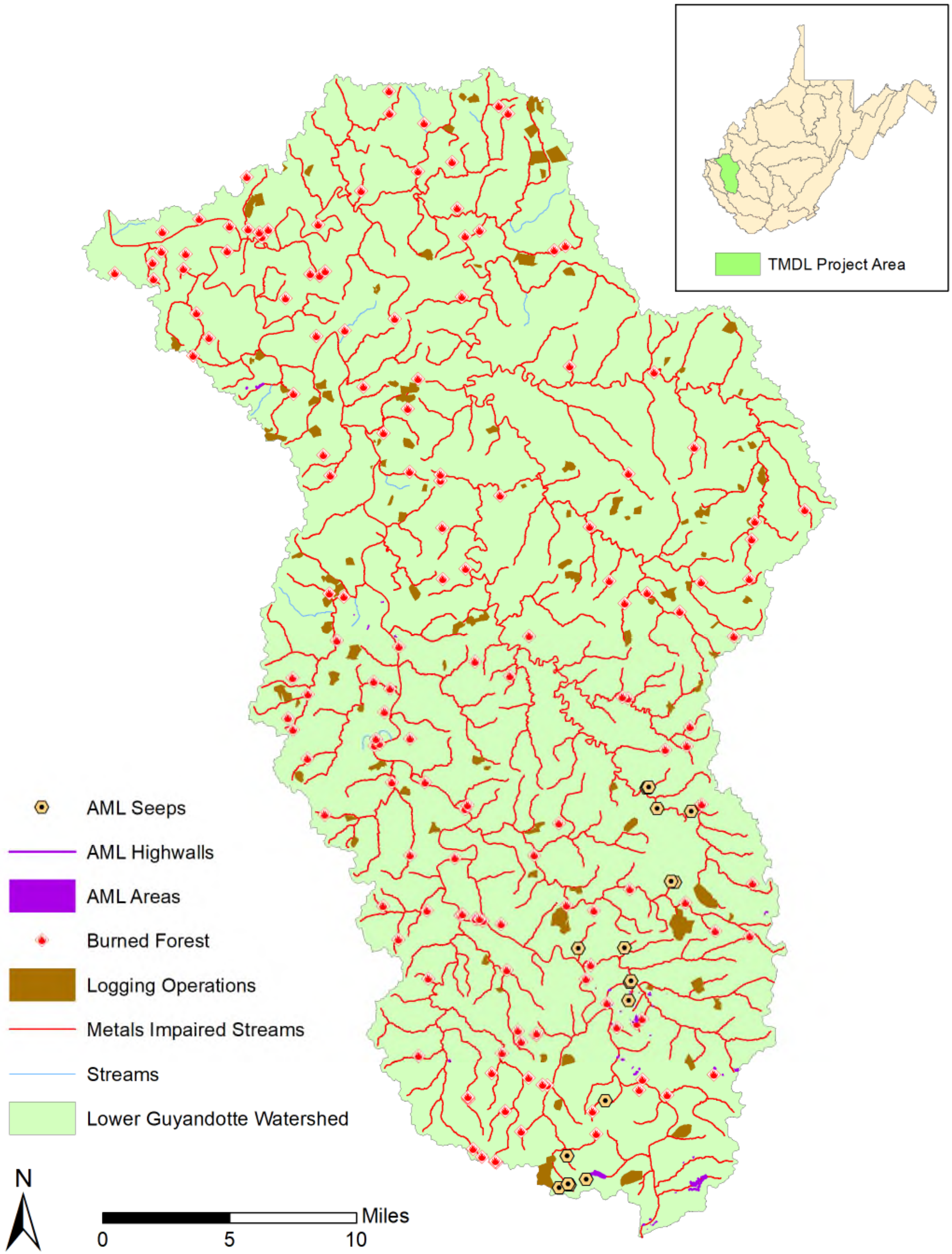


Figure 5-5. Nonpoint sources in the Lower Guyandotte River watershed

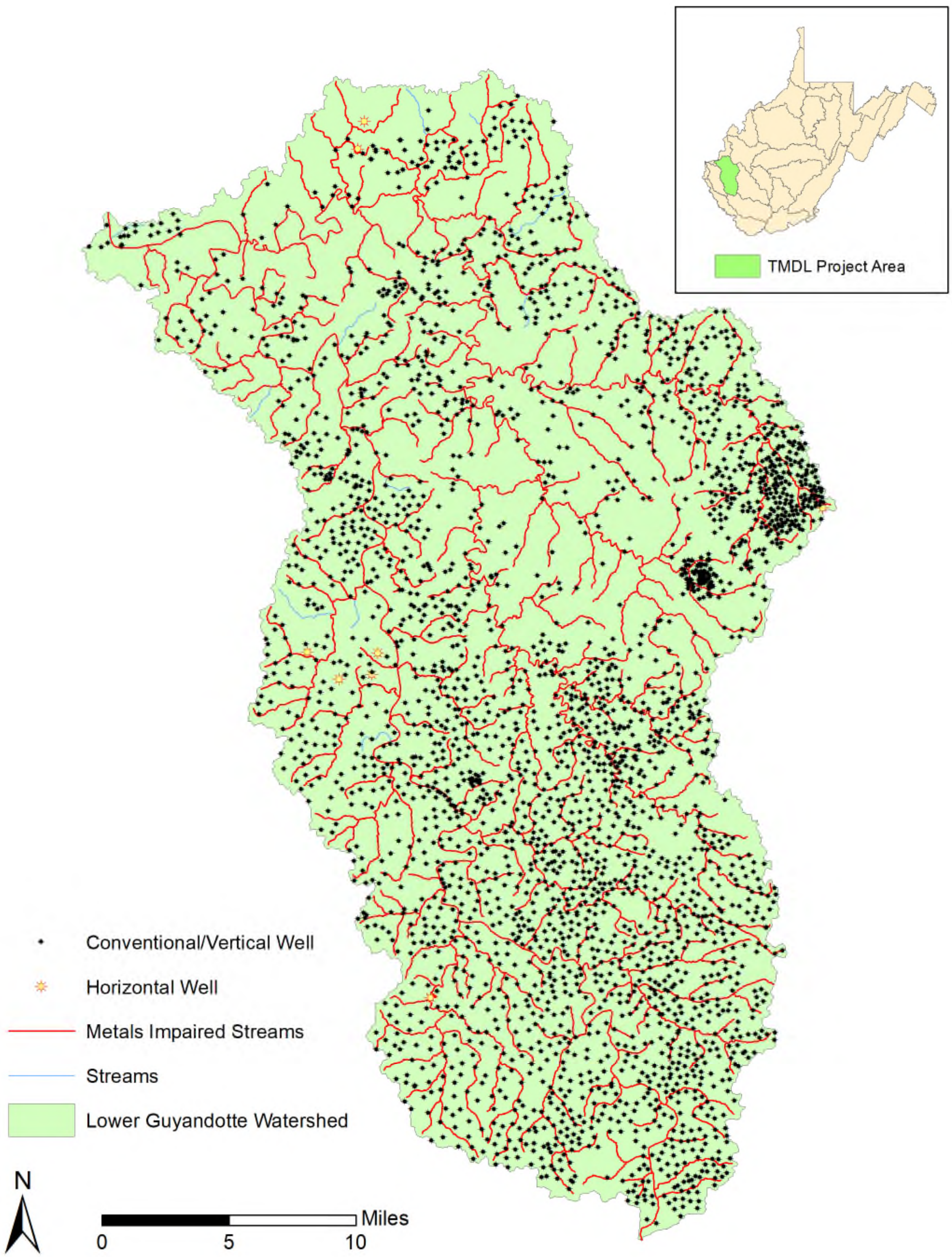
Oil and Gas

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 site 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 3,012 active conventional and vertical oil and gas wells (represented as 7,821 acres), and 9 horizontal wells (represented as 25 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 5-5**).

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as oil and gas discharges are modeled as 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 these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.



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

Figure 5-6. Oil and Gas Well locations in the Lower Guyandotte 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 50 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 Lower Guyandotte River watershed, the subwatersheds analyzed indicated that in the northern half of the watershed (subwatersheds 101-622) there could be an additional 0.29 percent of the subwatershed that consisted of unpaved roads not captured by TIGER, and in the southern half of the watershed (subwatersheds 623-796) there could be an additional 0.56 percent not captured by TIGER.

Some of the unpaved roads in the Lower Guyandotte River watershed are recreational off-road vehicle trails. Most of these trails exist in the southern half of the watershed. 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. To avoid double counting unpaved roads in areas with significant recreational trail acreage, a formula was applied to calculate the final modeled unpaved road acreage. Where Trail Inventory unpaved roads exceeded 0.56 percent of the subwatershed, then the total modeled unpaved roads acreage equaled TIGER unpaved roads plus the Trail Inventory unpaved roads. If the Trail Inventory road acreage was less than 0.56 percent of the subwatershed (in many subwatersheds it was zero), then the total modeled unpaved roads acreage equaled the sum of the TIGER unpaved roads plus the additional unpaved road acreage estimate by subwatershed that was derived from digitizing the sample of unpaved roads from the aerial photos (0.56 percent).

Agriculture

Agricultural landuses account for roughly 1 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 when considering vegetative cover.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source across the watershed. In past TMDL projects, WVDEP conducted a series of special bank erosion pin studies (WVDEP, 2012) 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 2016 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 2016 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 pH SOURCE ASSESSMENT

pH impairments in the study area were caused by acidity introduced by historical mining activities and atmospheric acid deposition in the Lower Guyandotte River watershed. WVDEP source tracking and pre-TMDL water quality monitoring observations were used to characterize the causative sources. Acid precipitation and the low buffering capacity of certain watersheds can contribute to lower observed pH. Atmospheric acid deposition was represented in the model at background levels, but it was not found to be the causative source for one impaired stream (UNT/Big Creek RM 3.28 WV-OGL-112-G) in the Lower Guyandotte River watershed.

6.1 Abandoned Mine Land Seeps

Discharges from historical mining activities can cause low pH impairments, iron and/or aluminum impairments. Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations to meet metals and associated pH water quality criteria while accounting for watershed dynamics associated with buffering capacity. The AML source in UNT/Big Creek RM 3.28 (WV-OGL-112-G) was prescribed metals reductions in the TMDL allocation scenario to allow the stream to meet water quality standards.

6.2 Acid Deposition

Acid rain is produced when atmospheric moisture reacts with gases to form sulfuric acid, nitric acid, and carbonic acid. These gases are primarily formed from nitrogen dioxides and sulfur dioxide, which enter the atmosphere through exhaust and smoke from burning fossil fuels such as gas, oil, and coal. Two-thirds of sulfur dioxides and one-fourth of nitrogen oxides present in the atmosphere are attributed to fossil fuel burning electric power generating plants (USEPA, 2005). Acid rain crosses watershed boundaries and may originate in the Ohio River Valley or the Midwestern United States.

The majority of the acid deposition occurs in the eastern United States. In March 2005, the USEPA issued the Clean Air Interstate Rule (CAIR), which places caps on emissions for sulfur dioxide and nitrogen dioxides for the eastern United States. It was expected that CAIR would reduce sulfur dioxide emissions by over 70 percent and nitrogen oxides emissions by over 60 percent from the 2003 emission levels (USEPA, 2005).

Effective January 1, 2015, CAIR was replaced by the Cross-State Air Pollution Rule (CSAPR). Similar to CAIR, CSAPR also places caps on emissions for sulfur dioxide and nitrogen oxides for the eastern United States. Combined with other final state and EPA actions, CSAPR will reduce power plant SO_2 emissions by 73 percent and NO_X emissions by 54 percent from 2005 levels in the CSAPR region (USEPA, 2016).

On October 15, 2020, EPA proposed the Revised Cross-State Air Pollution Rule Update in order to fully address 21 states' outstanding interstate pollution transport obligations for the 2008 ozone National Ambient Air Quality Standards (NAAQS). Starting in the 2021 ozone season, the proposed rule would require additional emissions reductions of nitrogen oxides (NOx) from power plants in 12 states, including West Virginia (USEPA, 2021). Because pollution is highly mobile in the atmosphere, reductions based on the Revised CSAPR Update in West Virginia, Ohio, and Pennsylvania will likely improve the quality of precipitation in the watershed.

Acid deposition occurs by two main methods: wet and dry. Wet deposition occurs through rain, fog, and snow. Dry deposition originates from gases and particles. Dry deposition accounts for approximately half of the atmospheric deposition of acidity (USEPA, 2005). Winds blow the particles and gases contributing to acid deposition over large distances, including political boundaries, such as state boundaries. After dry deposition occurs, particles and gases can be washed into streams from trees, roofs, and other surfaces by precipitation.

Weekly wet deposition data were retrieved from National Atmospheric Deposition Program station WV04-Babcock State Park in Fayette County from 2000 to the most recent data 2014. The Clean Air Status and Trends Network (CASTNET) was accessed to retrieve dry deposition data from CDR119 in Gilmer County.

6.3 pH – Natural Alkalinity Sources

Soils with moderate buffering capacity such as skeletal loamy residuum weathered from sandstone and shale, as well as colluvium derived from sandstone and siltstone, could be a source of alkalinity in some modeled subwatersheds. Dissolution of carbonate rocks neutralizes the excessive acidity from atmospheric precipitation and provides natural loading of alkalinity to the streams. As a result, alkaline conditions are commonly, but not exclusively, observed in the streams from geologic formations present in the Lower Guyandotte River Watershed.

Parameters such as base saturation, cation exchange capacity, dissolution susceptibility of aluminum minerals (aluminum hydroxides), and soil CO_2 control acidification of soils and the land outflows. The heterogeneous nature of these parameters results in different buffering capacities for different soil types. Thus, different soil types in subwatersheds were assumed to react differently to the acidity from atmospheric deposition.

7.0 FECAL COLIFORM SOURCE ASSESSMENT

7.1 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 Guyandotte River watershed.

7.1.1 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.

In the subject watersheds of this report, 11 individually permitted POTWs discharge treated effluent at 11 outlets. POTWs include: Pea Ridge PSD, Salt Rock PSD, City of Milton Sanitary Department, Hamlin PSD, Barboursville Sanitary Board, Williamsburg Sewer System, Town of West Hamlin, Pleasant View PSD, Town of Chapmanville, City of Logan, and the Logan County PSD Wastewater Division.

One mining bathhouse permit discharges to Fourteenmile Creek (WV-OGL-75) in the Lower Guyandotte River TMDL watersheds via 1 outlet. One private facility discharges to Mud River (WV-OGL-10) through 1 outlet.

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.

7.1.2 Overflows

Combined sewer 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, there were a total of 5 CSO outlets associated with the POTW collection system operated by the City of Huntington/Huntington Sanitary Board. CSOs discharge to the Lower Guyandotte River mainstem near its confluence with the Ohio River. No significant SSO discharges were represented in the model.

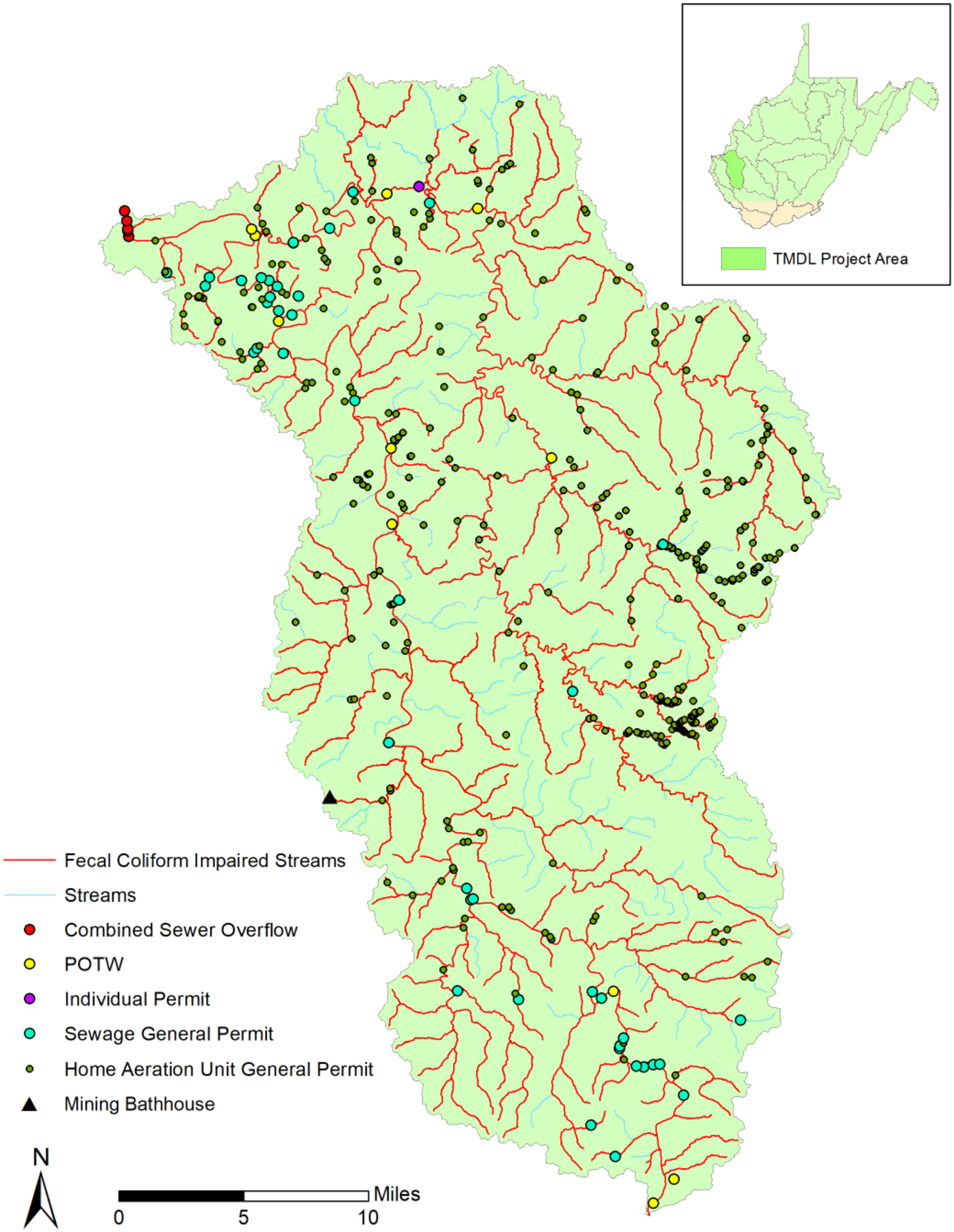
7.1.3 Municipal Separate Storm Sewer Systems (MS4)

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** and displayed in **Figure 5-3**. MS4 source representation is based upon precipitation and runoff from landuses determined from the modified NLCD 2016 landuse data, the jurisdictional boundary of the cities, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. In certain areas, urban/residential stormwater runoff may drain to both CSO and MS4 systems. WVDEP consulted with local governments and obtained information to determine drainage areas to the respective systems and best represent MS4 pollutant loadings.

7.1.4 General Sewage Permits

General sewage permits are designed to cover a class of facilities with similar type discharges from numerous individual owners and facilities throughout the state under one permit. 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, 43 facilities are registered under the "package plant" general permit, and 391 are registered under the HAU general permit. Modeled point source locations are shown on **Figure 7-1.**



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

Figure 7-1. Fecal coliform point sources

7.2 Fecal Coliform Nonpoint Sources

7.2.1 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 were 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 7-2** 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.

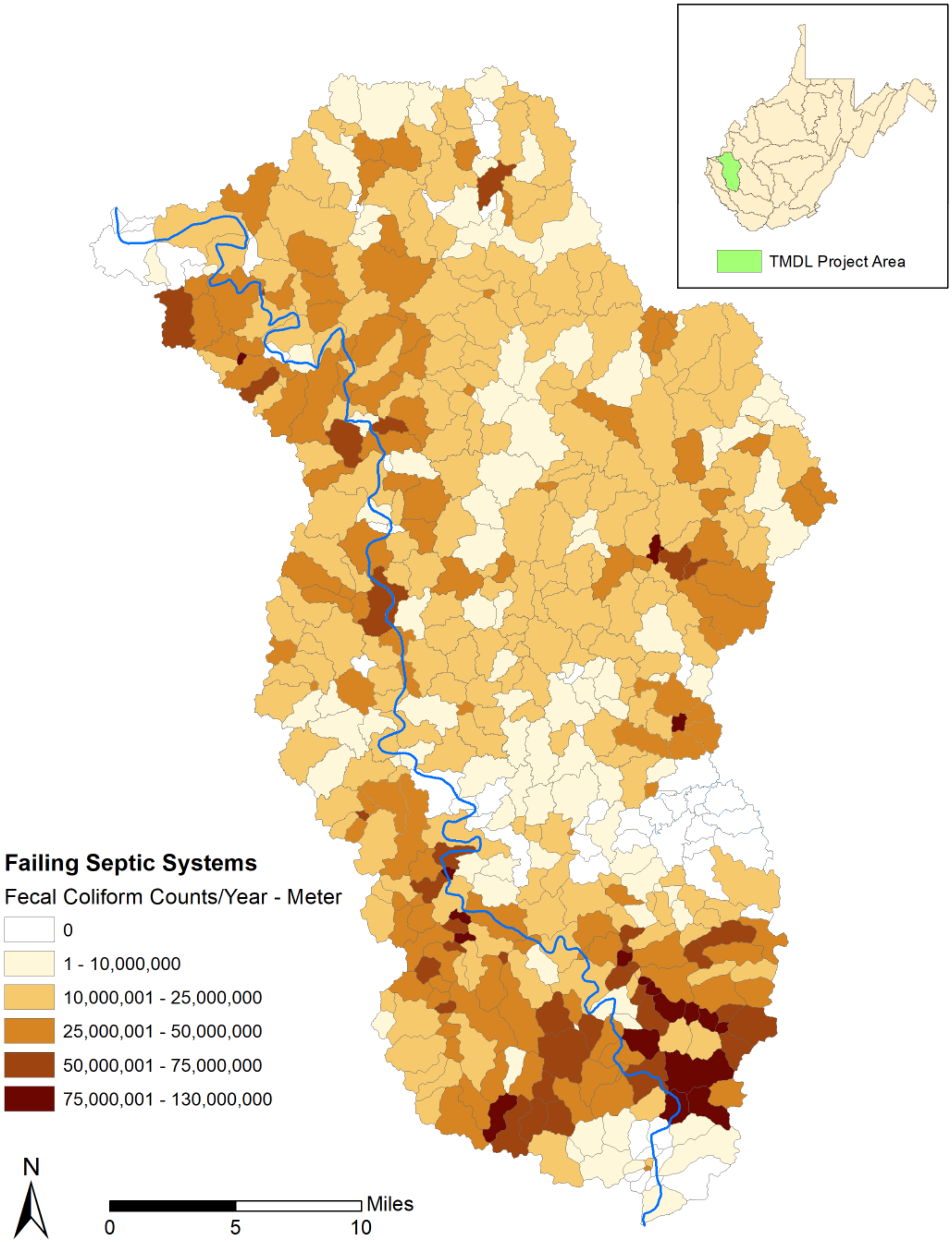


Figure 7-2. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in each subwatershed in the Lower Guyandotte River watershed as represented in modeling.

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.

7.2.2 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 2016 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.

7.2.3 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.

7.2.4 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.

8.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in the **Executive Summary**, there are two streams, Trace Fork (WV-OGL-10-AY) and Left Fork/Davis Creek (WV-OG-12-D), 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.

Four DO violations occurred on Trace Fork in August and October 2017, and June and July of 2018. Violations were observed at pre-TMDL water quality monitoring stations at river miles 6.2 and 13.2. Other monitoring stations above and below the stations with low DO observations did not record violations. WVDEP source tracking observed approximately 138 total acres of pasture immediately upstream of the monitoring station at river mile 13.2, including 4 acres of riparian pasture with cattle access to the stream. Cattle trails for stream access, cow manure in pastures, and manure in the stream channel were documented in WAB field notes. Failing septic systems were predicted to be present in the watershed at a moderate failure rate.

In Left Fork/Davis Creek, at the pre-TMDL monitoring station at the mouth of the stream, one DO violation was observed in September 2017 and another in October 2020. WVDEP source tracking did not indicate any active pasture in the subwatershed. WAB field notes indicate a pipe discharging sewage into the stream. Failing septic systems were predicted to be present in the watershed at a moderate failure rate.

Organic loading associated with agricultural runoff and cattle access would be the expected cause of DO violations in Trace Fork. In both streams, failing septic systems, and the observed illicit sewage discharge in Left Fork/Davis Creek also contribute bacterial loading that would reduce the assimilative capacity of the stream during periods of low flow. For a discussion of best management practices (BMP) pollutant reduction efficiencies see Section 8 of the TMDL Technical Report. However, streams impaired for DO will be retained on the 303d list until a time when DEP has a better understanding of the stream conditions and pollutant sources that are contributing to the low DO.

9.0 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 Guyandotte River watershed.

9.1 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, aluminum, pH, selenium, 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). 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 Guyandotte 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, aluminum, pH, selenium, and fecal coliform bacteria were modeled using the MDAS.

9.2 Model Setup

Model setup consisted of configuring the following four separate MDAS models: iron/sediment; aluminum/pH, selenium, and fecal coliform bacteria.

9.2.1 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 inputs. 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 Guyandotte 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 1 TMDL watershed was broken into 446 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.

9.2.2 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 2016 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2016 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 instream sediment and iron metals concentrations. The results were then applied to the sediment from sediment-producing landuses and streambank 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. 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 upon high-flow events exceeding the flow threshold. Bank erosion rates increase when the flow is above the Q Threshold.

The wetted perimeter and reach length represent ground area covered by water (**Figure 9-1**). 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 eroded sediment mass corresponding to the stream segment.

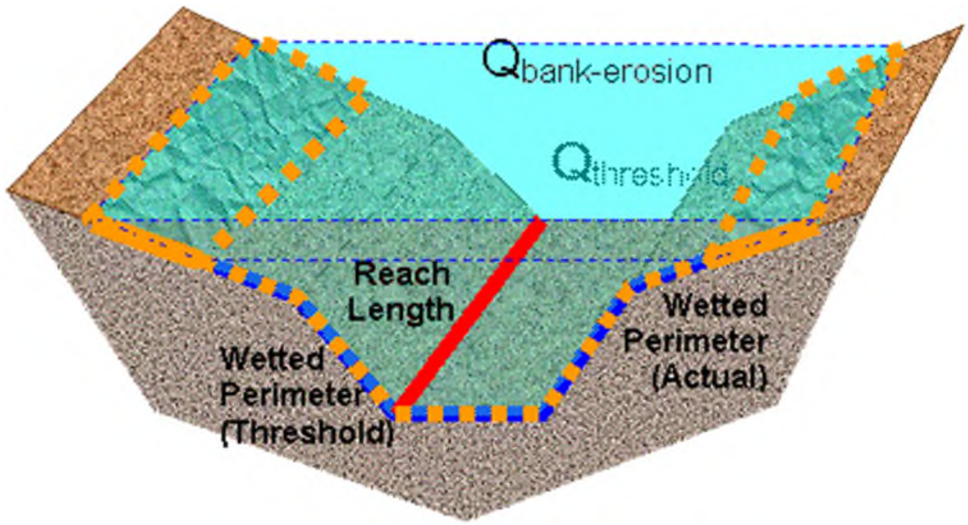


Figure 9-1. Conceptual diagram of stream channel components used in the bank erosion model

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. Streambank erosion soil loss results from the model 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.

9.2.3 Aluminum and pH Configuration

The MDAS model includes a dynamic chemical species fate and transport module that simulates soil subsurface and in-stream water quality taking into account chemical species interaction and transformation. The time series for total chemical concentration and flows generated by MDAS are used as inputs for the modules' pollutant transformation and transport routines. The modules simulate soil subsurface and in-stream chemical reactions, assuming instant mixing and concentrations equally distributed throughout soil and stream segments. The model supports major chemical reactions, including acid/base, complexation, precipitation, and dissolution reactions and some kinetic reactions. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

Pollutant Source Configuration

Legacy mining discharges generate metal and acidity loadings. These sources were identified and sampled for pH, cations and anions including targeted metals during source tracking. Flow rates from these sources were measured simultaneously. The model incorporates these stationary sources as direct, continuous-flow sources based on the observed data. Due to the potential time variable nature of the sources, the constant loadings were adjusted during the model calibration using the instream water quality data.

Precipitation induced land-based sources of total aluminum and total iron were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget. The contributions of acidity and species that impact the calculation of alkalinity and pH were represented in the land-based loadings in the model.

In order to represent the effects of acid precipitation, soil type parameters were selected using the literature and refined based on site data ranges. The concentrations of the wet deposition data were assigned to rainfall events. The dry deposition was assumed to accumulate daily and wash off during the precipitation events and was assumed to be included implicitly in the loads being generated at the surface. Clean Air Status and Trends Network (CASTNET) was accessed to retrieve the dry deposition data. Adjustment and verification of these parameters occurred by examining water quality data in streams where watersheds did not include legacy mine discharges or alkalinity mitigation. This aspect of the model provided the link between atmospheric deposition and soil buffering capacity.

Instream Chemical Reaction

All the loadings from the previously described upland loading sources were discharged to the stream via the hydrologic functionalities of the model. All added loadings were subjected to subsequent instream chemical reactions. The important reactions identified to control instream pH and dissolved aluminum are:

- Mineral precipitation
- Stream travel time relative to reaction time
- Stream buffering capacity
- Sediment deposition rates in relation to stream velocity

During the model calibration, it was identified that the instream dissolved aluminum/pH conditions were mostly influenced by mineral precipitation. Precipitation and deposition were more likely to occur during low flow conditions when more time was available for chemical reactions. The model indicated that the available buffering capacity of the stream to counteract hydrogen acidity from the precipitation reaction was also important. Alkalinity dosing scenarios provided more buffering capacity. Buffering and dilution positively affected downstream concentrations.

9.2.4 Selenium Configuration

Modeled landuse categories contributing selenium via precipitation and runoff include background undeveloped land, AML lands, AML highwalls, legacy mine areas, and active surface mining permits. Other sources, such as pumped discharges from active mines and legacy mine seeps were modeled as direct, continuous-flow sources in the model.

Selenium loading rates for background and AML sources were derived through model calibration to replicate in-stream selenium concentrations observed during pre-TMDL monitoring. Legacy mine loading rates were developed from WVDEP source tracking sampling during field investigations. Active mining permits were characterized by their contributing acreage for surface mines, or flow volume for mine sources with continuous flow. For mine outlets with selenium permit limits, modeled selenium concentrations were the same as the permit limit. For mine outlets without selenium limits, an estimate of selenium concentration derived from Discharge Monitoring Report data was used.

WVDEP pre-TMDL monitoring and source tracking field investigations observed that some ended outlets of active mining permits had the potential to be significant sources of selenium. For model configuration under baseline condition, selenium concentrations assigned to ended outlets of active permits were derived from loading estimates developed during model calibration at the subwatershed level. Because open outlets with limits were assumed to be meeting their limits under baseline condition, ended outlets could not be excluded as potential sources of excess selenium loads contributing to stream impairment. In the selenium TMDL allocations Mining WLAs table, ended outlets of active permits are displayed by subwatershed with the permit ID followed by “Ended Outlet.”

9.2.5 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 7.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

9.3 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 with instream 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 Guyandotte 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 Guyandotte 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 Guyandotte 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 Guyandotte River model hydrology was validated by comparing model output to in-stream flow measurements obtained at pre-TMDL monitoring stations during WVDEP's 2017-2018 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**.

9.4 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 9-2**.

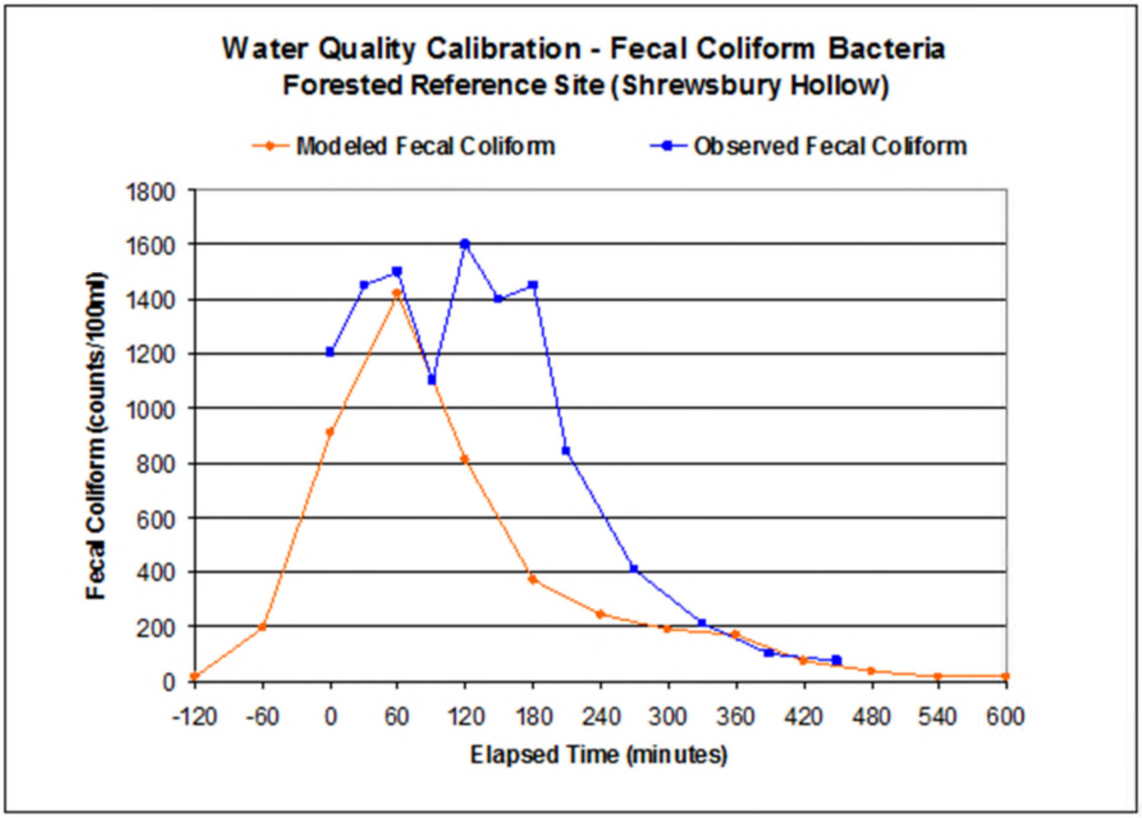


Figure 9-2. Shrewsbury Hollow fecal coliform observed data

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 landuse.

9.5 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. Two reference watersheds, Maul Fork (WV-OGL-10-BL-19-G) and McClarity Branch (WV-OGL-53-X), were 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.

9.6 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:

TMDL = sum of WLAs + sum of LAs + 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

9.6.1 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 9-1**.

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. Similarly, an explicit MOS was not applied for total iron and selenium TMDLs in certain subwatersheds where mining point sources create an effluent dominated scenario and/or the regulated mining activity encompasses a large percentage of the watershed area. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage. The TMDL endpoints for the various criteria are displayed below.

Table 9-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Dissolved Aluminum	Aquatic Life, warmwater fisheries	0.75 mg/L (1-hour average)	0.7125 mg/L (1-hour average)
Total Iron	Aquatic Life, warmwater fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
Total Selenium	Aquatic Life	0.005 mg/L (4-day average)	0.005 mg/L (4-day average)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)
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)

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.

9.6.2 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, 2013 through December 31, 2018). 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 9-3** presents the seasonal rainfall totals for the years 2008 through 2018 at the Huntington Tri-State Airport (WBAN 03860) weather station near Ceredo, West Virginia. The years 2013 to 2018 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Lower Guyandotte River watershed.

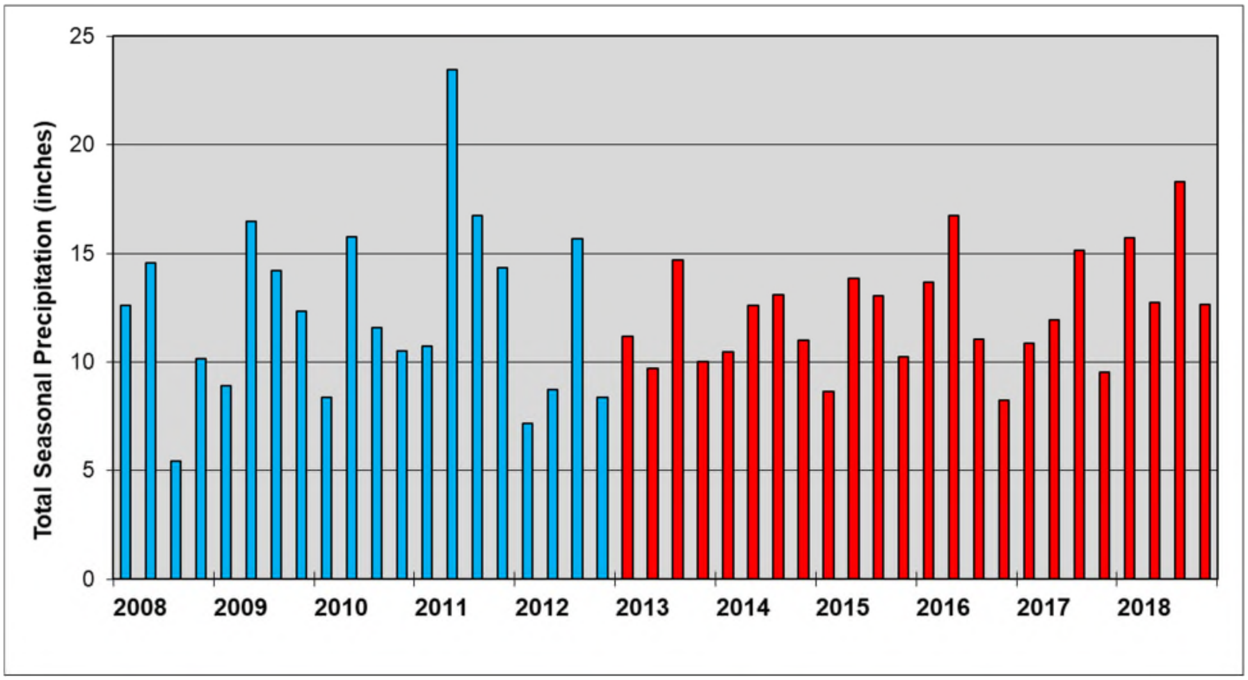


Figure 9-3. Seasonal precipitation totals for the Huntington Tri-State Airport (WBAN 03860) weather station

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.

In order to establish allocated load, 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 Solids (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.

CSO outlets were represented as discreet point sources in the model. CSO flow and discharge frequency was derived from overflow data supplied by the POTWs, when available. This information was augmented with precipitation analysis and watershed modeling to develop model inputs needed to build fecal coliform loading values for a ten-year time series from which annual average fecal coliform loading values could be calculated. CSO effluent was represented in the model at a concentration of 100,000 counts/100 mL to reflect baseline conditions for untreated CSO discharges. MS4, nonpoint source and background loadings for fecal coliform were represented using drainage area, precipitation, and pollutant accumulation and wash off rates, as appropriate for each landuse.

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; 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 9-4 shows an example of model output for a baseline condition and a successful TMDL scenario.

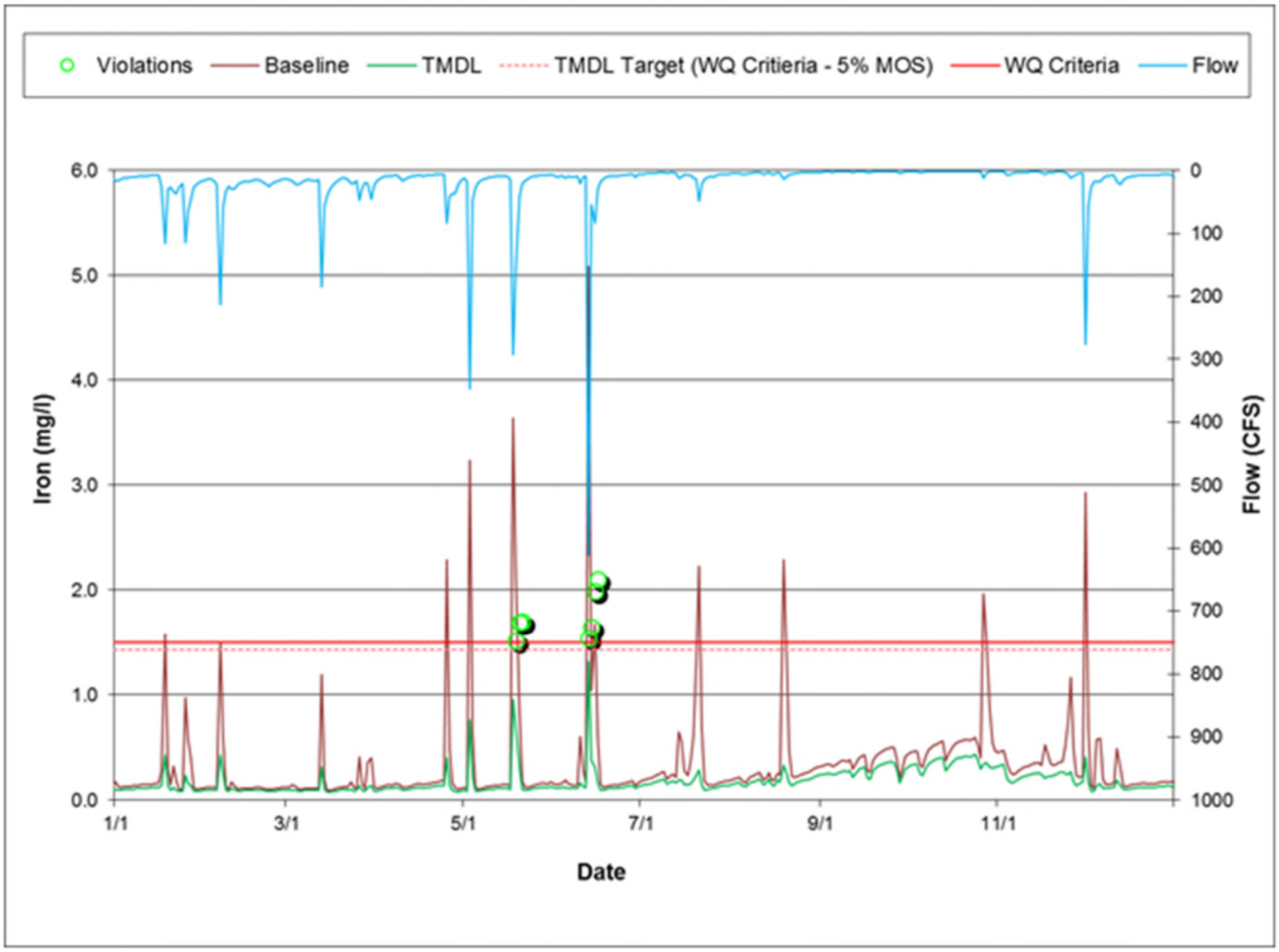


Figure 9-4. Example of baseline and TMDL conditions for total iron

9.7 TMDLs and Source Allocations

9.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Lower Guyandotte 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 in the next step when needed 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/MS4 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. AMD seeps were reduced to water quality criterion end of pipe (1.5 mg/L iron).
5. Active mining permits and other point sources discharging to warm-water streams were reduced to water quality criterion end of pipe (1.5 mg/L iron) in subwatersheds where the model indicated non-attainment after reductions associated with Steps 1-4. Likewise, active mining permits in trout streams were reduced to 1.0 mg/L iron in subwatersheds where the model indicated non-attainment after reductions associated with Steps 1-4.

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. Two and a half (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.

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.

Active Mining Operations

WLAs are provided for all existing outlets of NPDES permits for mining activities, except those where reclamation has progressed to the point where existing limitations are based upon the Post-Mining Area provisions of Subpart E of 40 CFR 434. The WLAs for active mining operations consider the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, gravity continuous flow, commingled) and their respective impacts at high and low flow conditions.

The federal effluent guidelines for the coal mining point source category (40 CFR 434) provide various alternative limitations for discharges caused by precipitation. Under those technology-based guidelines, effluent limitations for total iron and TSS may be replaced with an alternative limitation for "settleable solids" during certain magnitude precipitation events that vary by mining subcategory. The water quality-based WLAs and future growth provisions of the iron TMDLs preclude the applicability of the "alternative precipitation" iron provisions of 40 CFR 434. Also, the established relationship between iron and TSS requires continuous control of TSS concentration in permitted discharges to achieve iron WLAs. As such, the "alternative precipitation" TSS provisions of 40 CFR 434 should not be applied to point source discharges associated with the iron TMDLs.

The limits set forth in the NPDES permits for the point sources were calculated in a site-specific manner consistent with West Virginia's anti-degradation procedures and West Virginia's NPDES permit regulations. This TMDL is not intended to serve as a basis for relaxation of effluent limitations in existing permits pursuant to CWA Section 303(d)(4)(A)(i) or otherwise, nor is this TMDL intended to serve as a basis for departing from applicable regulations and processes for calculating water quality-based effluent limitations to address site-specific conditions.

Specific WLAs are not provided for "post-mining" outlets because programmatic reclamation was assumed to have returned disturbed areas to conditions that approach background. Barring unforeseen circumstances that alter their current status, such outlets are authorized to continue to discharge under the existing terms and conditions of their NPDES permit.

Bond Forfeiture Sites

WLAs were established for bond forfeiture sites. Baseline iron conditions were generally established under the same protocols used for active mining operations. In instances where effluent characteristics were not directly available, baseline conditions were established at the technology based effluent limits of 40 CFR 434 and reduced as necessary to attain the TMDL endpoints.

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 Guyandotte there are five designated MS4 entities 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. Individual registration numbers for the MS4 entities are as follows:

- Village of Barboursville WVR030011
- City of Huntington WVR030033
- City of Hurricane WVR030010
- Town of Milton WVR030003
- 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 9.6.2**. 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 11**.

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 negligible 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:

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps.
- 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 sources: loading from undisturbed forest and grasslands (loadings associated with this category were represented but not reduced).

9.7.2 Dissolved Aluminum and pH TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the dissolved aluminum and/or pH impaired streams of the Lower Guyandotte River watershed. The allocation approach focused on reducing metals concentrations and increasing pH by assigning buffering capacity (alkalinity) using the MDAS model to meet metals water quality criteria and then verifying that the resultant pH under these conditions would be in compliance with pH criteria.

Aluminum and pH are dynamically affected by chemical interactions with dissolved metals constituents in the water column. Dissolved aluminum and pH model results were evaluated under the modeled instream water chemistry conditions created by reductions to iron sources necessary to achieve the iron TMDL endpoint. Modeled iron source reductions necessary for iron TMDL development were performed first, using a step-wise approach described in **Section 9.7.1**. Those source reductions were held constant during model runs for aluminum and pH TMDL development. If aluminum and pH model results predicted non-attainment of the pH and dissolved aluminum criteria, then alkalinity additions were prescribed, and total aluminum was reduced from primary causative sources such as AML seeps.

Initially, the pH and aluminum model was calibrated against observed data to quantify certain characteristics of sources, such as the aluminum partitioning ratio between solid and dissolved phases. The baseline metal and hydrogen acidity loadings from sources were used to estimate the required alkalinity and total aluminum reduction necessary to achieve improved water quality conditions for pH and aluminum concentrations. If criteria were not met, acidity and metal sources were evaluated and prioritized per subwatershed based on the source loading magnitude. In keeping with the same allocation philosophy used for iron TMDL development, significant sources of aluminum and pH (e.g., seeps) were reduced first. To raise pH, alkalinity was applied to offset the pollutant loads from modeled sources to achieve the pH criterion.

In some instances, acidity released from instream metal precipitation lowered the pH and resulted in re-suspension of dissolved aluminum. If these reactions resulted in non-attainment of pH and/or dissolved aluminum criteria, additional alkalinity was prescribed to seeps and then mining sources of acidity.

The mitigation of acid loadings by alkalinity addition coupled with reductions of total aluminum loading from land-based sources are predicted to result in attainment of both dissolved aluminum and pH water quality criteria at all evaluated locations in the pH and dissolved aluminum impaired streams.

Wasteload Allocations (WLAs)

No active mining NPDES point sources were present in aluminum and pH impaired streams in the Lower Guyandotte River Watershed. Had point sources been present, WLAs would have been developed for active point source discharges by starting with their current NPDES permit effluent limits and design flows.

No non-mining point sources were present in the one pH and aluminum impaired watershed for which TMDLs were developed. Had they been present, baseline loadings from non-mining point sources, including facilities registered under the Construction Stormwater General Permits, would have been represented to properly account for aluminum associated with sediment sources. Negligible amounts of acidity or dissolved aluminum are typically attributed to these sources, thus no reductions are typically necessary and aluminum-specific control actions would have been prescribed.

Load Allocations (LAs)

LAs of total aluminum and acidity were determined for contributing nonpoint source categories as follows:

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps.
- Other nonpoint sources: loading associated with acid precipitation influences from barren land, harvested forest, oil and gas well operations, agriculture, and residential/urban/road landuses.
- Background sources: loading associated with acid precipitation influences from undisturbed forest, wetlands, and grasslands.

All sources were represented and provided allocations in terms of the total aluminum and net acidity loadings. No reductions were prescribed for background nonpoint sources. For abandoned mine sources, aluminum allocations represent the background loading from precipitation runoff from land and the reduced loads from AML seeps.

Baseline and TMDL load allocations (LAs) include the natural background sources of buffering capacity. The TMDLs prescribe additional acidity reduction (alkalinity addition) for acidic sources to meet instream pH water quality criterion and associated aluminum reductions.

9.7.3 Total Selenium TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the selenium impaired streams of the Lower Guyandotte River watershed. In order to meet water quality criterion, reductions to existing sources were applied to the model following iterative steps in a series of model runs, reducing in the next steps only when needed to meet the TMDL endpoint:

1. The loading from AML seeps was reduced to water quality end of pipe (5 ug/L selenium).
2. The loading from instream ponds was reduced to water quality criterion end of pipe.
3. The loading from continuous discharges was reduced to water quality criterion end of pipe.
4. The loading from on bench structures was reduced to water quality criterion end of pipe using a top-down approach in subwatersheds where the model indicated non-attainment.
5. The loading from closed/ended mining permits was reduced to water quality criterion end of pipe in subwatersheds where the model indicated non-attainment.

Using this method ensured that the relative contributions from all sources under both high- and low-flow conditions were taken into consideration, 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.

The presented Selenium TMDLs are based solely upon the water column concentration component of the aquatic life protection criteria of the currently effective West Virginia Water Quality Standards (47 CSR 2-8.27.1). The operable wasteload allocations for point sources are also presented in concentration terms with expected implementation in accordance with the TSD.

It is important to note that the water quality standards include selenium criteria in terms of fish whole-body/muscle and egg/ovary concentrations. The water quality standards state that when equilibrium is reached between water column and fish tissue, whole-body/muscle criterion assessment results override those based upon the water column concentration criterion, and egg/ovary criterion assessment results override those based upon whole-body/muscle and/or water column concentration criteria. As such, the water quality standards recognize that site specific conditions in waters of the State may allow attainment and protection of aquatic life designated uses in the presence of selenium concentrations lesser than or greater than those prescribed by the water column concentration criterion component. (*See 47 CSR-2-8.27.1, 47 CSR-2-8.27.2, 47 CSR-2-8.27.3 and footnotes f and g*).

Wasteload Allocations (WLAs)

WLAs were developed for all mining related point source discharges into impaired streams in the Mud River watershed. WLAs for active mining operations considered the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, or commingled) and their respective impacts at high and low flow conditions. WLAs are based on the water column concentration of 5 ug/l, because of known impairments downstream of the TMDL streams in the Mud River Reservoir.

Load Allocations (LAs)

LAs were developed for background sources, and other nonpoint sources. LAs were divided into several landuse categories: undisturbed forest and grasslands; abandoned mine lands; and legacy mine areas that include forfeited or closed permits. Legacy mine areas that contributed significantly to selenium impairment in streams with no other sources were reduced to the water quality criterion. Loadings associated with background and other nonpoint sources were represented but not reduced.

9.7.4 Fecal Coliform Bacteria TMDLs

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
- All CSO discharges were assigned WLAs at the value of the fecal coliform water quality criterion (200 counts/100ml); and
- If further reductions were necessary, MS4s, non-point source loadings from agricultural lands and residential areas were subsequently reduced until instream 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.

Combined Sewer Overflows

In TMDL watersheds there are a total of 5 CSO outlets associated with the POTW operated by the City of Huntington/Huntington Sanitary Board (WV0023159).

All fecal coliform bacteria WLAs for CSO discharges have been established at 200 counts/100mL. Implementation can be accomplished by CSO elimination or by disinfection treatment to make the discharge be in compliance with the operable, concentration-based allocations.

In establishing the WLAs for CSOs, WVDEP first considered the appropriateness of mixing zones for bacteria. WVDEP concluded that mixing zones would allow elevated levels of bacteria that may not conform to the mixing zone provisions at 47 CSR 2 §5.2.c., 5.2.g. and 5.2.h.3. Because 47 CSR 2 §5.2.c. prohibits pollutant concentrations greater than criteria for the protection of human health at any point unless a mixing zone has been assigned, the CSO WLAs were established at the value of the fecal coliform water quality criterion.

It is important to note that even if mixing zone rules are alternatively interpreted or changed in the future, dilution is generally not available to allow CSO allocations to be substantively greater than criteria. In previous projects, WVDEP used the calibrated model to examine the magnitude of CSO allocations that could be shown to result in criteria attainment when coupled with the allocations for other sources prescribed in this project and demonstrated nonattainment at multiple modeled locations when CSO were modestly increased above 200 counts/100 ml.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. The Village of Barboursville, City of Huntington, City of Hurricane, Town of Milton, and the WVDOH are designated MS4 entities 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)

9.7.5 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.

9.7.6 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).

9.7.7 TMDL Presentation

The TMDLs for all impairments are shown in **Section 10** of this report. Loads are divided into assessment units. The TMDLs for iron, aluminum and selenium are presented as average daily loads derived from annual loads, in pounds per day. TMDLs for pH are presented as average daily net acidity load expressed in pounds of $CaCO_3$/day equivalent derived from annual loads. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day derived from annual colonies. 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.

Maximum daily loads derived from maximum in-stream concentrations are described in the technical report and presented in **Appendix M**.

The iron WLAs for active mining operations and bond forfeitures are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations and are to be implemented by conversion to monthly average and daily maximum effluent limitations using USEPA's Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991). In a number of subwatersheds, reductions from existing effluent limits for individual outlets were not prescribed, thus multiple operable allocations may be presented for a single permit. Appendix F provides a list of outlets and their baseline representation in the modeling effort to determine which operable allocation applies to permits for which no reductions were prescribed.

The iron WLAs for future CSGP registrations are presented as both annual average loads (for comparison with other sources) and equivalent areas 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 also 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 and CSOs 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. The "MS4 WLA Detailed" tabs on the allocation spreadsheets provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. 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.

The maximum daily loads for instream conditions are described in the Technical Report. **Appendix M** of the Technical Report displays the maximum daily loads by assessment unit.

10.0 TMDL RESULTS

Table 10-1. Iron TMDLs

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Guyandotte River (Lower)	WV-OGL_13	Guyandotte River (lower)	WVOG-lo	11070.68	2754.98	727.67	14553.33
Russell Creek	WV-OGL-5_01	Russell Creek	WVOG-1	5.62	1.10	0.35	7.08
Russell Creek	WV-OGL-5-A_01	UNT/Russell Creek RM 0.20	WVOG-1-A	1.64	0.31	0.10	2.05
Mud River	WV-OGL-10_08	Mud River	WVOGM	1484.07	425.81	100.52	2010.41
Merrick Creek	WV-OGL-10-A_01	Merrick Creek	WVOGM-1	5.26	1.33	0.35	6.94
Tanyard Branch	WV-OGL-10-B_01	Tanyard Branch	WVOGM-1.5	0.03	1.87	0.10	2.00
Cyrus Creek	WV-OGL-10-D_01	Cyrus Creek	WVOGM-2	3.73	1.29	0.26	5.28
Little Cabell Creek	WV-OGL-10-O_01	Little Cabell Creek	WVOGM-3	5.68	0.97	0.35	7.00
Big Cabell Creek	WV-OGL-10-Q_02	Big Cabell Creek	WVOGM-4	20.07	3.13	1.22	24.42
Big Cabell Creek	WV-OGL-10-Q-6_01	Rush Hollow	WVOGM-4-F	1.85	0.33	0.11	2.30
Big Cabell Creek	WV-OGL-10-Q-7_01	UNT/Big Cabell Creek RM 3.79		1.77	0.28	0.11	2.16
Big Cabell Creek	WV-OGL-10-Q-9_01	Big Hill Hollow	WVOGM-4-I	3.16	0.54	0.19	3.90
Big Cabell Creek	WV-OGL-10-Q_01	Big Cabell Creek	WVOGM-4	6.45	1.09	0.40	7.94
Edmonds Branch	WV-OGL-10-R_01	Edmonds Branch	WVOGM-5	1.89	0.30	0.12	2.31
Fudges Creek	WV-OGL-10-S_01	Fudges Creek	WVOGM-6	17.80	2.80	1.08	21.68
Fudges Creek	WV-OGL-10-S-2_01	Wire Branch	WVOGM-6-0.5A	2.00	0.35	0.12	2.47
Fudges Creek	WV-OGL-10-S-5_01	Little Fudges Creek	WVOGM-6-A	3.39	0.58	0.21	4.17
Lower Creek	WV-OGL-10-AC_02	Lower Creek	WVOGM-7	15.41	2.28	0.93	18.63
Lower Creek	WV-OGL-10-AC-2_01	McComas Branch	WVOGM-7-A	3.00	0.49	0.18	3.67
Lower Creek	WV-OGL-10-AC-5_01	Right Fork/Lower Creek	WVOGM-7-B	5.05	0.77	0.31	6.13
Lower Creek	WV-OGL-10-AC-5-B_01	Tony Branch	WVOGM-7-B-1	1.27	0.19	0.08	1.53
Mill Creek	WV-OGL-10-AD_02	Mill Creek	WVOGM-8	22.71	3.19	1.36	27.27
Mill Creek	WV-OGL-10-AD-7_01	Long Branch	WVOGM-8-A	1.75	0.25	0.11	2.11
Mill Creek	WV-OGL-10-AD-9_01	Left Fork/Mill Creek	WVOGM-8-B	9.37	1.24	0.56	11.17
Mill Creek	WV-OGL-10-AD-9-F_01	UNT/Left Fork RM 2.48/Mill Creek	WVOGM-8-B-6	1.63	0.20	0.10	1.92

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Mill Creek	WV-OGL-10-AD-10_01	Right Fork/Mill Creek	WVOGM-8-C	4.45	0.70	0.27	5.42
Saunders Creek	WV-OGL-10-AE_01	Saunders Creek	WVOGM-9	4.64	0.75	0.28	5.67
Dry Creek	WV-OGL-10-AF_01	Dry Creek	WVOGM-10	2.04	0.36	0.13	2.53
Johns Branch	WV-OGL-10-AH_01	Johns Branch	WVOGM-11	2.26	0.84	0.16	3.26
Kilgore Creek	WV-OGL-10-AJ_03	Kilgore Creek	WVOGM-12	29.36	10.35	2.09	41.79
Kilgore Creek	WV-OGL-10-AJ-2_01	Indian Fork	WVOGM-12-A	7.48	5.72	0.70	13.90
Kilgore Creek	WV-OGL-10-AJ_02	Kilgore Creek	WVOGM-12	19.98	3.70	1.25	24.92
Kilgore Creek	WV-OGL-10-AJ-7_01	Little Creek	WVOGM-12-C	2.75	0.45	0.17	3.36
Kilgore Creek	WV-OGL-10-AJ_01	Kilgore Creek	WVOGM-12	7.93	1.19	0.48	9.60
Mud River	WV-OGL-10_07	Mud River	WVOGM	1103.64	293.24	73.52	1470.40
Brush Creek	WV-OGL-10-AM_01	Brush Creek	WVOGM-13	1.02	0.15	0.06	1.23
Charley Creek	WV-OGL-10-AO_02	Charley Creek	WVOGM-14	22.17	3.58	1.36	27.11
Charley Creek	WV-OGL-10-AO_01	Charley Creek	WVOGM-14	9.41	1.68	0.58	11.68
Charley Creek	WV-OGL-10-AO-11_01	Panther Lick	WVOGM-14-D	1.52	0.26	0.09	1.87
Little Twomile Creek	WV-OGL-10-AQ_01	Little Twomile Creek	WVOGM-15	2.17	0.36	0.13	2.67
Mud River	WV-OGL-10-AR_01	Big Twomile Creek	WVOGM-16	6.24	1.03	0.38	7.65
Trace Creek	WV-OGL-10-AX_01	Trace Creek	WVOGM-19	8.27	1.38	0.51	10.15
Trace Creek	WV-OGL-10-AX-1_01	Porter Creek		2.84	0.52	0.18	3.53
Trace Fork	WV-OGL-10-AY_06	Trace Fork	WVOGM-20	265.96	33.04	15.74	314.75
Trace Fork	WV-OGL-10-AY-7_01	Coon Creek	WVOGM-20-A	5.46	1.05	0.34	6.85
Trace Fork	WV-OGL-10-AY-10_02	Big Creek	WVOGM-20-D	25.25	4.37	1.56	31.19
Trace Fork	WV-OGL-10-AY-10-B_01	Harvey Creek	WVOGM-20-D-1	5.31	1.01	0.33	6.65
Trace Fork	WV-OGL-10-AY-10_01	Big Creek	WVOGM-20-D	16.35	2.87	1.01	20.23
Trace Fork	WV-OGL-10-AY_05	Trace Fork	WVOGM-20	210.25	26.17	12.44	248.86
Trace Fork	WV-OGL-10-AY-13_01	Hungry Creek	WVOGM-20-E	4.95	0.95	0.31	6.21
Trace Fork	WV-OGL-10-AY-14_01	Sycamore Creek	WVOGM-20-F	9.31	1.63	0.58	11.51
Trace Fork	WV-OGL-10-AY-20_01	Clymer Creek	WVOGM-20-H	13.89	2.36	0.86	17.10
Trace Fork	WV-OGL-10-AY_04	Trace Fork	WVOGM-20	150.88	19.09	8.95	178.91
Trace Fork	WV-OGL-10-AY-22_01	Trace Creek	WVOGM-20-I	7.38	1.07	0.44	8.89
Trace Fork	WV-OGL-10-AY-22-A_01	Kellys Creek	WVOGM-20-I-1	3.38	0.51	0.20	4.09
Trace Fork	WV-OGL-10-AY-22-A-2_01	UNT/Kellys Creek RM 1.27	WVOGM-20-I-1-B	0.64	0.09	0.04	0.77

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Trace Fork	WV-OGL-10-AY-24_01	Lick Creek	WVOGM-20-J	8.71	1.53	0.54	10.78
Trace Fork	WV-OGL-10-AY-26_01	Turkey Creek	WVOGM-20-K	14.30	2.34	0.88	17.52
Trace Fork	WV-OGL-10-AY-26-F_01	Lefthand Fork	WVOGM-20-K-1	2.30	0.43	0.14	2.87
Trace Fork	WV-OGL-10-AY-30_01	Bridge Creek	WVOGM-20-M	7.34	1.32	0.46	9.12
Trace Fork	WV-OGL-10-AY-36_01	Twomile Branch	WVOGM-20-O	2.19	0.39	0.14	2.72
Trace Fork	WV-OGL-10-AY_03	Trace Fork	WVOGM-20	72.65	9.74	4.34	86.72
Trace Fork	WV-OGL-10-AY-38_01	Trace Branch	WVOGM-20-P	2.72	0.49	0.17	3.38
Trace Fork	WV-OGL-10-AY-39_01	Tony Branch	WVOGM-20-Q	2.79	0.52	0.17	3.48
Trace Fork	WV-OGL-10-AY-40_01	Hayzlett Fork	WVOGM-20-R	16.97	2.42	1.02	20.41
Trace Fork	WV-OGL-10-AY-40-G_01	Donley Fork	WVOGM-20-R-2	3.04	0.46	0.18	3.68
Trace Fork	WV-OGL-10-AY-42_02	Joes Creek	WVOGM-20-T	23.24	3.61	1.41	28.26
Trace Fork	WV-OGL-10-AY-42-D_01	Laurel Fork	WVOGM-20-T-1	6.96	1.15	0.43	8.54
Trace Fork	WV-OGL-10-AY-42_01	Joes Creek	WVOGM-20-T	8.58	1.49	0.53	10.60
Trace Fork	WV-OGL-10-AY-42-F_01	Tango Branch	WVOGM-20-T-2	3.31	0.59	0.21	4.10
Trace Fork	WV-OGL-10-AY_01	Trace Fork	WVOGM-20	12.35	1.87	0.75	14.97
Trace Fork	WV-OGL-10-AY-46_01	Dry Branch	WVOGM-20-W	2.85	0.39	0.17	3.41
Mud River	WV-OGL-10_06	Mud River	WVOGM	644.36	251.15	47.13	942.64
Little Buffalo Creek	WV-OGL-10-AZ_01	Little Buffalo Creek	WVOGM-21	2.31	0.42	0.14	2.87
Buffalo Creek	WV-OGL-10-BA_01	Buffalo Creek	WVOGM-22	15.01	2.50	0.92	18.42
Buffalo Creek	WV-OGL-10-BA-1_01	Straight Fork	WVOGM-22-A	2.67	0.46	0.16	3.30
Buffalo Creek	WV-OGL-10-BA-2_01	UNT/Buffalo Creek RM 1.45		4.35	0.78	0.27	5.39
Mud River	WV-OGL-10-BD_01	Laurel Creek	WVOGM-23	2.97	0.54	0.18	3.69
Middle Fork/Mud River	WV-OGL-10-BL_04	Middle Fork/Mud River	WVOGM-25	161.64	21.11	9.62	192.37
Middle Fork/Mud River	WV-OGL-10-BL-2_01	Meadow Branch	WVOGM-25-A	1.71	0.32	0.11	2.14
Middle Fork/Mud River	WV-OGL-10-BL-3_01	Trace Creek	WVOGM-25-B	9.36	1.71	0.58	11.64
Middle Fork/Mud River	WV-OGL-10-BL-4_01	Middle Creek	WVOGM-25-C	6.48	1.13	0.40	8.01
Middle Fork/Mud River	WV-OGL-10-BL-10_01	Davis Trace Branch	WVOGM-25-D	3.79	0.71	0.24	4.74
Middle Fork/Mud River	WV-OGL-10-BL-12_01	Scary Creek	WVOGM-25-E	7.93	1.33	0.49	9.75
Middle Fork/Mud River	WV-OGL-10-BL-12-B_01	Ruffie Branch	WVOGM-25-E-1	1.22	0.23	0.08	1.53
Middle Fork/Mud River	WV-OGL-10-BL-15_01	Merritt Creek	WVOGM-25-F	4.35	0.78	0.27	5.40
Middle Fork/Mud River	WV-OGL-10-BL-18_02	Straight Fork	WVOGM-25-H	43.61	6.78	2.65	53.05

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Middle Fork/Mud River	WV-OGL-10-BL-18-A_01	Valley Fork	WVOGM-25-H-1	10.86	1.76	0.66	13.28
Middle Fork/Mud River	WV-OGL-10-BL-18-A-1_01	Sams Branch	WVOGM-25-H-1-A	1.73	0.32	0.11	2.17
Middle Fork/Mud River	WV-OGL-10-BL-18-E_01	Bear Fork	WVOGM-25-H-2	4.87	0.87	0.30	6.05
Middle Fork/Mud River	WV-OGL-10-BL-18-G_01	Porter Fork	WVOGM-25-H-3	9.78	1.64	0.60	12.02
Middle Fork/Mud River	WV-OGL-10-BL-18_01	Straight Fork	WVOGM-25-H	9.43	1.73	0.59	11.74
Middle Fork/Mud River	WV-OGL-10-BL-19_02	Sugartree Fork	WVOGM-25-I	29.78	4.88	1.82	36.49
Middle Fork/Mud River	WV-OGL-10-BL-19-A_01	Big Branch	WVOGM-25-I-1	1.76	0.31	0.11	2.19
Middle Fork/Mud River	WV-OGL-10-BL-19-B_01	Sycamore Fork	WVOGM-25-I-2	6.07	1.08	0.38	7.53
Middle Fork/Mud River	WV-OGL-10-BL-19-E_01	Sand Fork	WVOGM-25-I-4	5.80	1.06	0.36	7.22
Middle Fork/Mud River	WV-OGL-10-BL-19_01	Sugartree Fork	WVOGM-25-I	8.49	1.54	0.53	10.56
Middle Fork/Mud River	WV-OGL-10-BL-19-G_01	Maul Fork	WVOGM-25-I-6	3.23	0.61	0.20	4.04
Mud River	WV-OGL-10_05	Mud River	WVOGM	367.70	223.36	31.11	622.18
Mahone Creek	WV-OGL-10-BR_01	Mahone Creek	WVOGM-26	5.65	1.01	0.35	7.01
Big Creek	WV-OGL-10-BU_01	Big Creek	WVOGM-28	5.53	1.00	0.34	6.87
Little Laurel Creek	WV-OGL-10-CB_01	Little Laurel Creek	WVOGM-30	4.62	0.84	0.29	5.74
Sandlick Branch	WV-OGL-10-CC_01	Sandlick Branch	WVOGM-31	1.46	0.27	0.09	1.82
Mud River	WV-OGL-10-CF_01	Panther Branch	WVOGM-32	3.42	0.59	0.21	4.22
Big Laurel Creek	WV-OGL-10-CH_01	Big Laurel Creek	WVOGM-33	16.92	2.84	1.04	20.79
Big Laurel Creek	WV-OGL-10-CH-5_01	Dry Fork	WVOGM-33-B	2.56	0.44	0.16	3.16
Big Laurel Creek	WV-OGL-10-CH-7_01	Big Branch	WVOGM-33-C	1.01	0.17	0.06	1.24
Fez Creek	WV-OGL-10-CK_01	Fez Creek	WVOGM-34	3.73	0.68	0.23	4.65
Big Creek	WV-OGL-10-CL_02	Big Creek	WVOGM-35	23.30	3.68	1.42	28.40
Big Creek	WV-OGL-10-CL-1_01	First Fork	WVOGM-35-A	1.77	0.34	0.11	2.22
Big Creek	WV-OGL-10-CL-2_01	Second Fork	WVOGM-35-A.5	1.54	0.27	0.10	1.91
Big Creek	WV-OGL-10-CL-7_01	Lick Fork	WVOGM-35-C	2.12	0.38	0.13	2.64
Big Creek	WV-OGL-10-CL_01	Big Creek	WVOGM-35	11.22	1.92	0.69	13.83
Big Creek	WV-OGL-10-CL-10_01	Laurel Fork	WVOGM-35-E	3.75	0.65	0.23	4.64
Mud River	WV-OGL-10_04	Mud River	WVOGM	200.86	208.05	21.52	430.42
Parsner Creek	WV-OGL-10-CR_01	Parsner Creek	WVOGM-38	7.57	1.30	0.47	9.34
Parsner Creek	WV-OGL-10-CR-2_01	Pigeon Branch	WVOGM-38-A	1.42	0.27	0.09	1.77
Mud River	*OGL-10_Lake	Mud River	WVOGM	173.31	205.48	19.94	398.73

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Left Fork/Mud River	*OGL-10-CS_lake	Left Fork/Mud River	WVOGM-39	53.67	7.19	3.20	64.07
Left Fork/Mud River	WV-OGL-10-CS-1_01	Richs Branch	WVOGM-39-A	1.46	0.24	0.09	1.79
Left Fork/Mud River	WV-OGL-10-CS-3_01	Senging Branch	WVOGM-39-B	1.90	0.32	0.12	2.33
Left Fork/Mud River	WV-OGL-10-CS_02	Left Fork/Mud River	WVOGM-39	41.41	6.07	2.50	49.98
Left Fork/Mud River	WV-OGL-10-CS-5_01	Elkins Branch	WVOGM-39-D	2.19	0.37	0.14	2.70
Left Fork/Mud River	WV-OGL-10-CS-6_01	Stinson Branch	WVOGM-39-E	5.64	0.95	0.35	6.94
Left Fork/Mud River	WV-OGL-10-CS-6-A_01	UNT/Stinson Branch RM 0.88		0.65	0.11	0.04	0.80
Left Fork/Mud River	WV-OGL-10-CS-8_01	Sycamore Fork	WVOGM-39-G	9.73	1.55	0.59	11.88
Left Fork/Mud River	WV-OGL-10-CS-8-E_01	Owl Creek	WVOGM-39-G-3	1.32	0.24	0.08	1.64
Left Fork/Mud River	WV-OGL-10-CS_01	Left Fork/Mud River	WVOGM-39	12.75	1.97	0.78	15.50
Left Fork/Mud River	WV-OGL-10-CS-10_01	Dogbone Branch	WVOGM-39-H	3.27	0.55	0.20	4.02
Left Fork/Mud River	WV-OGL-10-CS-11_01	Barkcamp Branch	WVOGM-39-I	1.88	0.30	0.11	2.30
Upton Branch	WV-OGL-10-CY_01	Upton Branch	WVOGM-40	8.67	1.31	0.53	10.51
Upton Branch	WV-OGL-10-CY-1_01	UNT/Upton Branch RM 0.37 (Laurel Fork)	WVOGM-40-A	2.53	0.40	0.15	3.09
Mud River	WV-OGL-10_03	Mud River	WVOGM	90.88	195.71	15.08	301.67
Bear Branch	WV-OGL-10-DC_01	Bear Branch	WVOGM-41	5.48	0.84	0.33	6.65
Slab Creek	WV-OGL-10-DG_01	Slab Creek	WVOGM-42	4.42	0.69	0.27	5.38
Stonecoal Branch	WV-OGL-10-DM_01	Stonecoal Branch	WVOGM-43	2.27	3.02	0.28	5.56
Mud River	WV-OGL-10_02	Mud River	WVOGM	53.83	185.76	12.61	252.20
Berry Branch	WV-OGL-10-DN_01	Berry Branch	WVOGM-44	1.47	37.19	2.03	40.70
Mullins Branch	WV-OGL-10-DO_01	Mullins Branch	WVOGM-45	1.47	14.79	0.86	17.12
Connelly Branch	WV-OGL-10-DS_01_NC	Connelly Branch	WVOGM-46	3.30	27.45	1.62	32.36
Sugartree Branch	WV-OGL-10-DW_01	Sugartree Branch	WVOGM-47	2.13	18.55	1.09	21.77
Stanley Fork	WV-OGL-10-DX_01	Stanley Fork	WVOGM-48	0.45	29.30	1.57	31.31
Ballard Fork	WV-OGL-10-EA_01	Ballard Fork	WVOGM-49	9.65	4.60	0.75	15.00
Lukey Fork	WV-OGL-10-EC_01	Lukey Fork	WVOGM-50	5.41	8.43	0.73	14.57
Mud River	WV-OGL-10_01	Mud River	WVOGM	11.50	4.61	0.85	16.95
Guyandotte River (Lower)	WV-OGL_12	Guyandotte River (lower)	WVOG-lo	9417.57	2101.83	606.28	12125.68
Davis Creek	WV-OGL-12_01	Davis Creek	WVOG-3	10.03	1.75	0.62	12.40
Davis Creek	WV-OGL-12-B_01	Edens Branch	WVOG-3-0.5A	0.74	0.13	0.05	0.92

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Davis Creek	WV-OGL-12-C_01	Right Fork/Davis Creek	WVOG-3-B	4.19	0.72	0.26	5.16
Davis Creek	WV-OGL-12-D_01	Left Fork/Davis Creek	WVOG-3-A	3.11	0.54	0.19	3.84
Mill Creek	WV-OGL-15_01	Mill Creek	WVOG-6	3.86	0.95	0.25	5.06
Mill Creek	WV-OGL-15-A_01	UNT/Mill Creek RM 0.21	WVOG-6-A	2.27	0.69	0.16	3.11
Lower Tom Creek	WV-OGL-18_01	Lower Tom Creek	WVOG-8	5.86	1.02	0.36	7.25
Lower Tom Creek	WV-OGL-18-B_01	UNT/Lower Tom Creek RM 0.63		1.96	0.36	0.12	2.44
Heath Creek	WV-OGL-23_01	Heath Creek	WVOG-9	6.89	1.13	0.42	8.44
Heath Creek	WV-OGL-23-B_01	Upper Heath Creek	WVOG-9-A	2.40	0.42	0.15	2.97
Heath Creek	WV-OGL-23-C_01	UNT/Heath Creek RM 1.56		1.56	0.26	0.10	1.91
Merritt Creek	WV-OGL-24_01	Merritt Creek	WVOG-10	7.87	1.29	0.48	9.65
Merritt Creek	WV-OGL-24-B_01	Right Fork/Merritt Creek	WVOG-10-A	2.97	0.51	0.18	3.66
Smith Creek	WV-OGL-27_01	Smith Creek	WVOG-11	6.47	1.07	0.40	7.94
Tom Creek	WV-OGL-29_01	Tom Creek	WVOG-13	3.88	0.65	0.24	4.76
Trace Creek	WV-OGL-30_01	Trace Creek	WVOG-14	7.15	1.18	0.44	8.77
Trace Creek	WV-OGL-30-C_01	UNT/Trace Creek RM 2.88	WVOG-14-C	1.65	0.29	0.10	2.04
Tyler Creek	WV-OGL-31_01	Tyler Creek	WVOG-15	3.21	0.45	0.19	3.86
Madison Creek	WV-OGL-34_01	Madison Creek	WVOG-17	8.04	1.23	0.49	9.76
Madison Creek	WV-OGL-34-B_01	UNT/Madison Creek RM 2.11	WVOG-17-B	2.63	0.42	0.16	3.20
Bear Creek	WV-OGL-35_01	Bear Creek	WVOG-18	6.49	0.99	0.39	7.87
Bear Creek	WV-OGL-35-B_01	UNT/Bear Creek RM 1.23		2.10	0.31	0.13	2.54
Twomile Creek	WV-OGL-38_01	Twomile Creek	WVOG-20	4.40	0.67	0.27	5.34
Falls Creek	WV-OGL-42_01	Falls Creek	WVOG-22	5.89	0.94	0.36	7.19
Onemile Creek	WV-OGL-44_01	Onemile Creek	WVOG-23	7.27	1.12	0.44	8.83
Onemile Creek	WV-OGL-44-B_01	UNT/Onemile Creek RM 0.55		2.09	0.32	0.13	2.54
UNT/Guyandotte River RM 33.39	WV-OGL-46_01	UNT/Guyandotte River RM 33.39	WVOG-23.8	0.44	0.06	0.03	0.53
Twomile Creek	WV-OGL-47_01	Twomile Creek	WVOG-24	6.53	1.03	0.40	7.96
Twomile Creek	WV-OGL-47-D_01	Bee Branch	WVOG-24-A	1.30	0.21	0.08	1.59
Fourmile Creek	WV-OGL-53_03	Fourmile Creek	WVOG-27	40.13	5.59	2.41	48.13
Fourmile Creek	WV-OGL-53-C_01	Trace Fork	WVOG-27-B	4.26	0.67	0.26	5.19
Fourmile Creek	WV-OGL-53-D_01	Harless Fork	WVOG-27-C	3.32	0.52	0.20	4.05

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Fourmile Creek	WV-OGL-53-O_01	Red River Fork	WVOG-27-G	5.49	0.81	0.33	6.64
Fourmile Creek	WV-OGL-53-O-2_01	Sulphur Spring Branch	WVOG-27-G-1	2.83	0.45	0.17	3.45
Fourmile Creek	WV-OGL-53_01	Fourmile Creek	WVOG-27	10.27	1.58	0.62	12.47
Fourmile Creek	WV-OGL-53-W_01	Falls Branch	WVOG-27-H	1.98	0.32	0.12	2.42
Fourmile Creek	WV-OGL-53-X_01	McClarity Branch	WVOG-27-I	3.34	0.54	0.20	4.09
Guyandotte River (Lower)	WV-OGL_11	Guyandotte River (lower)	WVOG-lo	7660.96	1998.60	508.40	10167.96
Sixmile Creek	WV-OGL-60_01	Sixmile Creek	WVOG-29	7.68	1.20	0.47	9.35
Sixmile Creek	WV-OGL-60-C_01	Bluelick Branch	WVOG-29-B	2.39	0.38	0.15	2.92
Guyandotte River (Lower)	WV-OGL-63_01	Stout Creek	WVOG-30	1.78	0.28	0.11	2.17
Ninemile Creek	WV-OGL-64_02	Ninemile Creek	WVOG-31	15.56	2.34	0.94	18.84
Ninemile Creek	WV-OGL-64-D_01	Hager Fork	WVOG-31-0.5A	2.56	0.40	0.16	3.12
Ninemile Creek	WV-OGL-64_01	Ninemile Creek	WVOG-31	9.39	1.42	0.57	11.38
Ninemile Creek	WV-OGL-64-G_01	Dick Fork	WVOG-31-A	1.93	0.31	0.12	2.36
Ninemile Creek	WV-OGL-64-I_01	Spears Fork	WVOG-31-B	1.70	0.27	0.10	2.07
Tenmile Creek	WV-OGL-66_02	Tenmile Creek	WVOG-32	28.76	4.66	1.76	35.18
Tenmile Creek	WV-OGL-66-C_01	Buck Branch	WVOG-32-A	1.08	0.19	0.07	1.34
Tenmile Creek	WV-OGL-66-I_01	Upper Twin Branch	WVOG-32-C	2.13	0.38	0.13	2.64
Tenmile Creek	WV-OGL-66_01	Tenmile Creek	WVOG-32	17.15	2.92	1.06	21.12
Tenmile Creek	WV-OGL-66-O_01	Plum Branch	WVOG-32-F	4.86	0.88	0.30	6.04
Furnett Creek	WV-OGL-69_01	Furnett Creek	WVOG-33	3.58	0.58	0.22	4.38
Fourteenmile Creek	WV-OGL-75_02	Fourteenmile Creek	WVOG-34	41.42	6.59	2.53	50.54
Fourteenmile Creek	WV-OGL-75-A_01	Lick Branch	WVOG-34-A	4.80	0.81	0.30	5.91
Fourteenmile Creek	WV-OGL-75-B_01	East Fork/Fourteenmile Creek	WVOG-34-B	9.31	1.56	0.57	11.45
Fourteenmile Creek	WV-OGL-75-F_01	Sulphur Spring Fork	WVOG-34-D	7.76	1.33	0.48	9.56
Fourteenmile Creek	WV-OGL-75_01	Fourteenmile Creek	WVOG-34	10.01	1.85	0.62	12.49
Fourteenmile Creek	WV-OGL-75-H_01	Steer Fork	WVOG-34-E	3.42	0.56	0.21	4.19
Fourteenmile Creek	WV-OGL-75-H-1_01	Nelson Fork	WVOG-34-E-1	1.54	0.27	0.10	1.90
Aarons Creek	WV-OGL-80_01	Aarons Creek	WVOG-35	3.96	0.62	0.24	4.81
Hamilton Creek	WV-OGL-86_01	Hamilton Creek	WVOG-36	4.33	0.64	0.26	5.23
Little Ugly Creek	WV-OGL-88_01	Little Ugly Creek	WVOG-37	2.20	0.33	0.13	2.66

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Big Ugly Creek	WV-OGL-89_04	Big Ugly Creek	WVOG-38	92.65	21.94	6.03	120.63
Big Ugly Creek	WV-OGL-89-B_01	Pigeonroost Creek	WVOG-38-A	3.64	0.57	0.22	4.42
Big Ugly Creek	WV-OGL-89-C_01	Bobby Creek	WVOG-38-B	2.60	0.39	0.16	3.15
Big Ugly Creek	WV-OGL-89-E_01	Big Branch	WVOG-38-C	3.15	0.46	0.19	3.80
Big Ugly Creek	WV-OGL-89-G_02	Laurel Creek	WVOG-38-D	20.95	14.16	1.85	36.96
Big Ugly Creek	WV-OGL-89-G-4_01	Back Fork	WVOG-38-D-0.7	5.82	0.88	0.35	7.05
Big Ugly Creek	WV-OGL-89-G_01	Laurel Creek	WVOG-38-D	11.08	12.79	1.26	25.12
Big Ugly Creek	WV-OGL-89-G-5_01	Lick Branch	WVOG-38-D-0.8	1.75	0.25	0.11	2.10
Big Ugly Creek	WV-OGL-89-G-6_01	Charley Trace Fork	WVOG-38-D-1	1.16	0.18	0.07	1.41
Big Ugly Creek	WV-OGL-89-G-10_01	Chestnut Oak Creek	WVOG-38-D-4	1.67	7.86	0.50	10.04
Big Ugly Creek	WV-OGL-89-G-11_01	Right Fork/Laurel Creek	WVOG-38-D-5	1.66	3.90	0.29	5.85
Big Ugly Creek	WV-OGL-89_03	Big Ugly Creek	WVOG-38	47.58	5.72	2.81	56.11
Big Ugly Creek	WV-OGL-89-J_01	Rockhouse Branch	WVOG-38-E	2.07	0.31	0.13	2.51
Big Ugly Creek	WV-OGL-89-M_01	Sulphur Creek	WVOG-38-G	3.03	0.43	0.18	3.65
Big Ugly Creek	WV-OGL-89-R_01	Broad Branch	WVOG-38-J	4.41	0.66	0.27	5.33
Big Ugly Creek	WV-OGL-89-R-2_01	Left Fork/Broad Branch	WVOG-38-J-1	1.49	0.23	0.09	1.81
Big Ugly Creek	WV-OGL-89_02	Big Ugly Creek	WVOG-38	25.00	2.99	1.47	29.46
Big Ugly Creek	WV-OGL-89-T_01	Lefthand Creek	WVOG-38-K	3.05	0.45	0.18	3.68
Big Ugly Creek	WV-OGL-89-Y_01	Little Deadening Creek	WVOG-38-K.7	0.43	0.07	0.03	0.53
Big Ugly Creek	WV-OGL-89-Z_01	Big Deadening Creek	WVOG-38-L	1.53	0.23	0.09	1.86
Big Ugly Creek	WV-OGL-89-AA_01	Fawn Hollow	WVOG-38-M	2.08	0.18	0.12	2.37
Big Ugly Creek	WV-OGL-89_01	Big Ugly Creek	WVOG-38	11.93	1.43	0.70	14.06
Big Ugly Creek	WV-OGL-89-AD_01	Skinned Poplar Branch	WVOG-38-N	1.72	0.00	0.09	1.81
Big Ugly Creek	WV-OGL-89-AJ_01	Trace Branch	WVOG-38-O	1.32	0.20	0.08	1.60
Big Ugly Creek	WV-OGL-89-AN_01	Grassy Fork	WVOG-38-P	1.01	0.15	0.06	1.22
Guyandotte River (Lower)	WV-OGL_10	Guyandotte River (lower)	WVOG-lo	6585.48	1956.04	449.55	8991.07
Sand Creek	WV-OGL-93_01	Sand Creek	WVOG-40	10.05	1.64	0.62	12.30
Sand Creek	WV-OGL-93-D_01	Big Fork	WVOG-40-A	2.66	0.45	0.16	3.27
Dry Run	WV-OGL-95_01	Dry Run	WVOG-41	2.99	0.50	0.18	3.67
Little Harts Creek	WV-OGL-96_01	Little Harts Creek	WVOG-42	18.50	2.82	1.12	22.44

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Little Harts Creek	WV-OGL-96-C_01	Short Bend Fork	WVOG-42-A	2.61	0.42	0.16	3.19
Little Harts Creek	WV-OGL-96-D_01	Harvey Fork	WVOG-42-B	2.15	0.37	0.13	2.66
Little Harts Creek	WV-OGL-96-E_01	Laurel Fork	WVOG-42-C	2.94	0.48	0.18	3.60
Little Harts Creek	WV-OGL-96-G_01	Mudlick Branch	WVOG-42-D	1.11	0.19	0.07	1.36
Big Harts Creek	WV-OGL-99_04	Big Harts Creek	WVOG-44	173.99	32.36	10.86	217.21
Big Harts Creek	WV-OGL-99-A_02	West Fork/Big Harts Creek	WVOG-44-A	26.14	4.11	1.59	31.84
Big Harts Creek	WV-OGL-99-A-3_01	Piney Fork	WVOG-44-A-1	5.02	0.88	0.31	6.21
Big Harts Creek	WV-OGL-99-A-4_01	Marsh Fork	WVOG-44-A-2	9.21	1.53	0.57	11.31
Big Harts Creek	WV-OGL-99-A-5_01	Workman Fork	WVOG-44-A-3	5.93	0.98	0.36	7.28
Big Harts Creek	WV-OGL-99-B_01	Big Branch	WVOG-44-B	4.35	0.73	0.27	5.36
Big Harts Creek	WV-OGL-99-D_01	Coal Branch	WVOG-44-C	3.13	0.55	0.19	3.88
Big Harts Creek	WV-OGL-99-E_01	Caney Branch	WVOG-44-C.3	1.49	0.26	0.09	1.83
Big Harts Creek	WV-OGL-99-G_01	Thompson Branch	WVOG-44-C.7	2.11	0.36	0.13	2.60
Big Harts Creek	WV-OGL-99-H_01	Rockhouse Fork	WVOG-44-D	3.99	0.63	0.24	4.86
Big Harts Creek	WV-OGL-99-J_02	Smokehouse Fork	WVOG-44-E	30.77	13.05	2.31	46.13
Big Harts Creek	WV-OGL-99-J-5_01	Browns Run	WVOG-44-E-1	3.88	8.88	0.67	13.43
Big Harts Creek	WV-OGL-99-J_01	Smokehouse Fork	WVOG-44-E	17.50	2.74	1.07	21.31
Big Harts Creek	WV-OGL-99-J-9_01	White Oak Branch	WVOG-44-E-2	3.79	0.61	0.23	4.63
Big Harts Creek	WV-OGL-99_03	Big Harts Creek	WVOG-44	58.64	11.05	3.67	73.36
Big Harts Creek	WV-OGL-99-K_01	Trace Fork	WVOG-44-F	11.61	4.16	0.83	16.59
Big Harts Creek	WV-OGL-99-K-6_01	Ivy Branch	WVOG-44-F-3	1.58	0.58	0.11	2.27
Big Harts Creek	WV-OGL-99-L_01	Buck Fork	WVOG-44-G	12.29	2.08	0.76	15.13
Big Harts Creek	WV-OGL-99-M_01	Hoover Fork	WVOG-44-H	7.40	1.28	0.46	9.14
Big Harts Creek	WV-OGL-99_01	Big Harts Creek	WVOG-44	19.31	3.10	1.18	23.58
Big Harts Creek	WV-OGL-99-N_01	Henderson Branch	WVOG-44-I	3.08	0.53	0.19	3.81
Big Harts Creek	WV-OGL-99-Q_01	Bulwark Branch	WVOG-44-K	2.89	0.50	0.18	3.57
Green Shoals Branch	WV-OGL-106_01	Green Shoals Branch	WVOG-45	6.48	1.02	0.40	7.90
Abbott Branch	WV-OGL-108_01	Abbott Branch	WVOG-46	3.20	0.53	0.20	3.92
Limestone Branch	WV-OGL-111_01	Limestone Branch	WVOG-48	4.88	0.66	0.29	5.83
Big Creek	WV-OGL-112_03	Big Creek	WVOG-49	87.96	10.98	5.21	104.15

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Big Creek	WV-OGL-112-D_01	Ed Stone Branch	WVOG-49-A	3.42	0.48	0.21	4.10
Big Creek	WV-OGL-112-D-1_01	North Branch/Ed Stone Branch	WVOG-49-A-1	1.16	0.13	0.07	1.36
Big Creek	WV-OGL-112-E_01	North Fork/Big Creek	WVOG-49-B	12.96	1.95	0.78	15.69
Big Creek	WV-OGL-112-E-7_01	Chapman Branch	WVOG-49-B-1	1.21	0.20	0.07	1.48
Big Creek	WV-OGL-112-E-11_01	Harmon Branch	WVOG-49-B-2	2.92	0.47	0.18	3.56
Big Creek	WV-OGL-112-E-10_01	Ellis Fork	WVOG-49-B-3	2.95	0.47	0.18	3.61
Big Creek	WV-OGL-112-F_01	Vickers Branch	WVOG-49-C	2.02	0.34	0.12	2.49
Big Creek	WV-OGL-112-G_01	UNT/Big Creek RM 3.28	WVOG-49-C.1	0.86	0.14	0.05	1.05
Big Creek	WV-OGL-112-I_01	Trace Fork	WVOG-49-D	15.69	2.26	0.94	18.90
Big Creek	WV-OGL-112-I-4_01	Hurricane Branch	WVOG-49-D-1	1.77	0.28	0.11	2.16
Big Creek	WV-OGL-112-I-7_01	Dog Fork	WVOG-49-D-2	2.67	0.40	0.16	3.24
Big Creek	WV-OGL-112-H_02	Garrett Fork	WVOG-49-E	35.04	4.92	2.10	42.07
Big Creek	WV-OGL-112-H-1_01	Perrys Branch	WVOG-49-E-1	0.97	0.15	0.06	1.18
Big Creek	WV-OGL-112-H-2_01	Kanawha Branch	WVOG-49-E-2	3.46	0.56	0.21	4.23
Big Creek	WV-OGL-112-H-3_01	Cloverlick Branch	WVOG-49-E-3	3.66	0.62	0.23	4.51
Big Creek	WV-OGL-112-H-4_01	Rocklick Branch	WVOG-49-E-4	3.94	0.66	0.24	4.85
Big Creek	WV-OGL-112-H_01	Garrett Fork	WVOG-49-E	13.30	2.09	0.81	16.21
Big Creek	WV-OGL-112-H-6_01	Hainer Branch	WVOG-49-E-5	1.31	0.24	0.08	1.63
Big Creek	WV-OGL-112-H-5-A_01	Gore Fork	WVOG-49-E-6	3.13	0.50	0.19	3.82
Big Creek	WV-OGL-112-H-5_01	Barker Fork	WVOG-49-E-7	6.13	1.01	0.38	7.52
Guyandotte River (Lower)	WV-OGL_09	Guyandotte River (lower)	WVOG-lo	5219.70	1900.25	374.73	7494.69
Crawley Creek	WV-OGL-117_02	Crawley Creek	WVOG-51	56.66	7.40	3.37	67.44
Crawley Creek	WV-OGL-117-B_01	Canoe Fork	WVOG-51-B	1.79	0.32	0.11	2.22
Crawley Creek	WV-OGL-117-C_01	Striker Fork	WVOG-51-C	4.33	0.75	0.27	5.34
Crawley Creek	WV-OGL-117-H_01	Tims Fork	WVOG-51-F	4.57	0.71	0.28	5.56
Crawley Creek	WV-OGL-117-J_01	Brushy Fork	WVOG-51-G	3.44	0.59	0.21	4.24
Crawley Creek	WV-OGL-117-M.1_01	Middle Fork/Crawley Creek	WVOG-51-G.6	1.81	0.19	0.11	2.10
Crawley Creek	WV-OGL-117-M_01	South Fork/Crawley Creek	WVOG-51-G.5	4.89	0.71	0.29	5.89
Crawley Creek	WV-OGL-117_01	Crawley Creek	WVOG-51	11.80	1.28	0.69	13.77
Fowler Branch	WV-OGL-121_01	Fowler Branch	WVOG-51.5	1.37	0.21	0.08	1.66

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Godby Branch	WV-OGL-125_01	Godby Branch	WVOG-53	3.53	0.60	0.22	4.35
Caney Branch	WV-OGL-129_01	Caney Branch	WVOG-54	4.65	0.74	0.28	5.68
Rocky Branch	WV-OGL-130_01	Rocky Branch	WVOG-55	7.71	0.91	0.45	9.07
King Shoal Branch	WV-OGL-134_01	King Shoal Branch	WVOG-58	3.28	0.57	0.20	4.05
Mill Creek	WV-OGL-135_01	Mill Creek	WVOG-59	17.36	2.87	1.07	21.30
Mill Creek	WV-OGL-135-F_01	Long Fork	WVOG-59-C	3.99	0.70	0.25	4.93
Mill Creek	WV-OGL-135-G_01	Butch Fork	WVOG-59-D	3.28	0.60	0.20	4.09
Big Branch	WV-OGL-136_01	Big Branch	WVOG-60	4.69	0.63	0.28	5.60
Buffalo Creek	WV-OGL-137_01	Buffalo Creek	WVOG-61	13.18	2.18	0.81	16.17
Buffalo Creek	WV-OGL-137-E_01	Right Fork/Buffalo Creek	WVOG-61-A	3.87	0.72	0.24	4.82
Snap Creek	WV-OGL-138_01	Snap Creek	WVOG-62	3.90	2.94	0.36	7.20
Snap Creek	WV-OGL-138-A_01	UNT/Snap Creek RM 0.43		1.32	0.00	0.07	1.39
Snap Creek	WV-OGL-138-B_01	UNT/Snap Creek RM 0.63	WVOG-62-B	0.79	2.69	0.18	3.66
Crooked Creek	WV-OGL-139_01	Crooked Creek	WVOG-63	8.33	1.45	0.51	10.29
Peach Creek	WV-OGL-140_01	Peach Creek	WVOG-64	6.94	1.42	0.44	8.79

UNT = unnamed tributary; RM = river mile.

* Loads presented to show iron contribution from Mud River Reservoir to downstream portion of Mud River. The Mud River Reservoir has not been assessed for iron impairment.

Table 10-2. pH TMDL

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	LA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	WLA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	MOS daily average net acidity load (lbs as CaCO3/day)	TMDL daily average net acidity load (lbs as CaCO3/day)
Lower Guyandotte River	WV-OGL-112-G_01	UNT/Big Creek RM 3.28	WVOG-49-C.1	-759.94	0.00	37.80	-722.14

Table 10-3. Aluminum TMDL

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Al TMDL (lbs/day)
Lower Guyandotte River	WV-OGL-112-G_01	UNT/Big Creek RM 3.28	WVOG-49-C.1	1.807	0.000	0.095	1.902

Table 10-4. Selenium TMDLs

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Se TMDL (lbs/day)
Mud River	WV-OGL-10_05	Mud River	WVOGM	0.9896	0.6723	0.0875	1.7494
Mud River	WV-OGL-10_04	Mud River	WVOGM	0.5845	0.6723	0.0661	1.3229
Mud River	WV-OGL-10_03	Mud River	WVOGM	0.2688	0.6723	0.0495	0.9907
Mud River	WV-OGL-10_02	Mud River	WVOGM	0.1510	0.6533	0.0423	0.8467
Mud River	WV-OGL-10_01	Mud River	WVOGM	0.0491	0.0000	0.0026	0.0517
Stonecoal Branch	WV-OGL-10-DM_01	Stonecoal Branch	WVOGM-43	0.0213	0.0088	0.0016	0.0317
Berry Branch	WV-OGL-10-DN_01	Berry Branch	WVOGM-44	0.0088	0.1292	0.0073	0.1453
Mullins Branch	WV-OGL-10-DO_01	Mullins Branch	WVOGM-45	0.0050	0.0535	0.0031	0.0615
Connelly Branch	WV-OGL-10-DS_01_NC	Connelly Branch	WVOGM-46	0.0084	0.0944	0.0054	0.1083
Sugartree Branch	WV-OGL-10-DW_01	Sugartree Branch	WVOGM-47	0.0031	0.0733	0.0040	0.0805
Stanley Fork	WV-OGL-10-DX_01	Stanley Fork	WVOGM-48	0.0004	0.1019	0.0054	0.1076
Lukey Fork	WV-OGL-10-EC_01	Lukey Fork	WVOGM-50	0.0172	0.0343	0.0027	0.0542

Table 10-5. Fecal Coliform Bacteria TMDLs

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Guyandotte River (Lower)	WV-OGL_13	Guyandotte River (Lower)	WVOG-lo	5.07E+12	1.59E+11	2.75E+11	5.50E+12
Guyandotte River (Lower)	WV-OGL_12	Guyandotte River (Lower)	WVOG-lo	3.93E+12	5.14E+10	2.10E+11	4.19E+12
Guyandotte River (Lower)	WV-OGL_11	Guyandotte River (Lower)	WVOG-lo	3.45E+12	2.91E+10	1.83E+11	3.66E+12
Guyandotte River (Lower)	WV-OGL_10	Guyandotte River (Lower)	WVOG-lo	3.09E+12	2.89E+10	1.64E+11	3.29E+12
Guyandotte River (Lower)	WV-OGL_09	Guyandotte River (Lower)	WVOG-lo	2.66E+12	2.87E+10	1.42E+11	2.83E+12
Deitz Hollow (Pats Branch)	WV-OGL-1_01	Deitz Hollow (Pats Branch)	WVOG-0.5	3.97E+08	1.28E+09	8.84E+07	1.77E+09
Russell Creek	WV-OGL-5_01	Russell Creek	WVOG-1	1.70E+10	1.05E+09	9.49E+08	1.90E+10
Russell Creek	WV-OGL-5-A_01	UNT/Russell Creek RM 0.20	WVOG-1-A	4.91E+09	3.54E+08	2.77E+08	5.54E+09
Davis Creek	WV-OGL-12_01	Davis Creek	WVOG-3	2.01E+10	4.90E+08	1.08E+09	2.17E+10
Davis Creek	WV-OGL-12-B_01	Edens Branch	WVOG-3-0.5A	2.50E+09	6.34E+05	1.32E+08	2.64E+09
Davis Creek	WV-OGL-12-D_01	Left Fork/Davis Creek	WVOG-3-A	6.59E+09	1.16E+07	3.48E+08	6.95E+09
Davis Creek	WV-OGL-12-C_01	Right Fork/Davis Creek	WVOG-3-B	8.19E+09	2.35E+07	4.32E+08	8.65E+09
Mill Creek	WV-OGL-15_01	Mill Creek	WVOG-6	9.03E+09	1.82E+09	5.71E+08	1.14E+10
Mill Creek	WV-OGL-15-A_01	UNT/Mill Creek RM 0.21	WVOG-6-A	4.56E+09	1.66E+09	3.27E+08	6.55E+09
Lower Tom Creek	WV-OGL-18_01	Lower Tom Creek	WVOG-8	1.26E+10	4.77E+06	6.65E+08	1.33E+10
Heath Creek	WV-OGL-23_01	Heath Creek	WVOG-9	1.51E+10	9.62E+07	8.02E+08	1.60E+10
Heath Creek	WV-OGL-23-B_01	Upper Heath Creek	WVOG-9-A	5.76E+09	1.21E+07	3.04E+08	6.07E+09
Merritt Creek	WV-OGL-24_01	Merritt Creek	WVOG-10	1.83E+10	1.14E+07	9.64E+08	1.93E+10
Merritt Creek	WV-OGL-24-B_01	Right Fork/Merritt Creek	WVOG-10-A	7.28E+09	0.00E+00	3.83E+08	7.66E+09
Smith Creek	WV-OGL-27_01	Smith Creek	WVOG-11	1.45E+10	3.79E+06	7.65E+08	1.53E+10
Cavill Creek	WV-OGL-28_01	Cavill Creek	WVOG-12	6.65E+09	0.00E+00	3.50E+08	7.00E+09
Tom Creek	WV-OGL-29_01	Tom Creek	WVOG-13	8.39E+09	0.00E+00	4.42E+08	8.83E+09
Trace Creek	WV-OGL-30_01	Trace Creek	WVOG-14	1.62E+10	0.00E+00	8.53E+08	1.71E+10
Trace Creek	WV-OGL-30-C_01	UNT/Trace Creek RM 2.88	WVOG-14-C	4.12E+09	0.00E+00	2.17E+08	4.34E+09
Tyler Creek	WV-OGL-31_01	Tyler Creek	WVOG-15	7.77E+09	0.00E+00	4.09E+08	8.18E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Madison Creek	WV-OGL-34_01	Madison Creek	WVOG-17	1.40E+10	3.79E+06	7.36E+08	1.47E+10
Bear Creek	WV-OGL-35_01	Bear Creek	WVOG-18	1.32E+10	1.14E+07	6.94E+08	1.39E+10
Twomile Creek	WV-OGL-38_01	Twomile Creek	WVOG-20	1.22E+10	1.21E+07	6.44E+08	1.29E+10
Onemile Creek	WV-OGL-44_01	Onemile Creek	WVOG-23	1.26E+10	1.52E+07	6.62E+08	1.32E+10
UNT/Guyandotte River RM 33.39	WV-OGL-46_01	UNT/Guyandotte River RM 33.39	WVOG-23.8	1.89E+09	2.73E+08	1.14E+08	2.28E+09
Twomile Creek	WV-OGL-47_01	Twomile Creek	WVOG-24	1.18E+10	0.00E+00	6.23E+08	1.25E+10
Fourmile Creek	WV-OGL-53_03	Fourmile Creek	WVOG-27	6.44E+10	1.97E+07	3.39E+09	6.78E+10
Fourmile Creek	WV-OGL-53_01	Fourmile Creek	WVOG-27	1.85E+10	0.00E+00	9.71E+08	1.94E+10
Fourmile Creek	WV-OGL-53-B_01	Lowgap Branch	WVOG-27-A	2.01E+09	0.00E+00	1.06E+08	2.11E+09
Fourmile Creek	WV-OGL-53-C_01	Trace Fork	WVOG-27-B	6.60E+09	0.00E+00	3.47E+08	6.95E+09
Fourmile Creek	WV-OGL-53-D_01	Harless Fork	WVOG-27-C	5.91E+09	3.79E+06	3.11E+08	6.23E+09
Fourmile Creek	WV-OGL-53-G_01	Kentuck Fork	WVOG-27-D	4.53E+09	0.00E+00	2.38E+08	4.77E+09
Fourmile Creek	WV-OGL-53-O_01	Red River Fork	WVOG-27-G	1.01E+10	3.79E+06	5.31E+08	1.06E+10
Fourmile Creek	WV-OGL-53-W_01	Falls Branch	WVOG-27-H	3.64E+09	0.00E+00	1.92E+08	3.83E+09
Fourmile Creek	WV-OGL-53-X_01	McClarity Branch	WVOG-27-I	5.89E+09	0.00E+00	3.10E+08	6.20E+09
Ninemile Creek	WV-OGL-64_02	Ninemile Creek	WVOG-31	2.25E+10	3.79E+06	1.18E+09	2.37E+10
Ninemile Creek	WV-OGL-64_01	Ninemile Creek	WVOG-31	1.32E+10	3.79E+06	6.97E+08	1.39E+10
Ninemile Creek	WV-OGL-64-D_01	Hager Fork	WVOG-31-0.5A	4.44E+09	0.00E+00	2.33E+08	4.67E+09
Tenmile Creek	WV-OGL-66_02	Tenmile Creek	WVOG-32	2.99E+10	7.58E+06	1.58E+09	3.15E+10
Tenmile Creek	WV-OGL-66_01	Tenmile Creek	WVOG-32	1.86E+10	0.00E+00	9.79E+08	1.96E+10
Fourteenmile Creek	WV-OGL-75_02	Fourteenmile Creek	WVOG-34	4.46E+10	6.03E+07	2.35E+09	4.70E+10
Fourteenmile Creek	WV-OGL-75_01	Fourteenmile Creek	WVOG-34	1.06E+10	5.28E+07	5.62E+08	1.12E+10
Fourteenmile Creek	WV-OGL-75-A_01	Lick Branch	WVOG-34-A	5.17E+09	0.00E+00	2.72E+08	5.44E+09
Fourteenmile Creek	WV-OGL-75-B_01	East Fork/Fourteenmile Creek	WVOG-34-B	1.14E+10	0.00E+00	5.99E+08	1.20E+10
Fourteenmile Creek	WV-OGL-75-F_01	Sulphur Spring Fork	WVOG-34-D	8.07E+09	0.00E+00	4.25E+08	8.50E+09
Aarons Creek	WV-OGL-80_01	Aarons Creek	WVOG-35	6.85E+09	0.00E+00	3.61E+08	7.21E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Hamilton Creek	WV-OGL-86_01	Hamilton Creek	WVOG-36	7.25E+09	0.00E+00	3.81E+08	7.63E+09
Little Ugly Creek	WV-OGL-88_01	Little Ugly Creek	WVOG-37	2.32E+09	0.00E+00	1.22E+08	2.44E+09
Big Ugly Creek	WV-OGL-89_04	Big Ugly Creek	WVOG-38	1.17E+11	7.58E+06	6.15E+09	1.23E+11
Big Ugly Creek	WV-OGL-89_03	Big Ugly Creek	WVOG-38	6.16E+10	7.58E+06	3.25E+09	6.49E+10
Big Ugly Creek	WV-OGL-89_02	Big Ugly Creek	WVOG-38	3.52E+10	3.79E+06	1.85E+09	3.70E+10
Big Ugly Creek	WV-OGL-89_01	Big Ugly Creek	WVOG-38	1.74E+10	3.79E+06	9.18E+08	1.84E+10
Big Ugly Creek	WV-OGL-89-G_02	Laurel Creek	WVOG-38-D	2.94E+10	0.00E+00	1.55E+09	3.10E+10
Big Ugly Creek	WV-OGL-89-G_01	Laurel Creek	WVOG-38-D	1.36E+10	0.00E+00	7.14E+08	1.43E+10
Big Ugly Creek	WV-OGL-89-M_01	Sulphur Creek	WVOG-38-G	2.99E+09	0.00E+00	1.57E+08	3.14E+09
Big Ugly Creek	WV-OGL-89-R_01	Broad Branch	WVOG-38-J	7.28E+09	0.00E+00	3.83E+08	7.66E+09
Big Ugly Creek	WV-OGL-89-T_01	Lefthand Creek	WVOG-38-K	5.33E+09	0.00E+00	2.81E+08	5.61E+09
Sand Creek	WV-OGL-93_01	Sand Creek	WVOG-40	1.01E+10	0.00E+00	5.32E+08	1.06E+10
Dry Run	WV-OGL-95_01	Dry Run	WVOG-41	4.22E+09	0.00E+00	2.22E+08	4.44E+09
Little Harts Creek	WV-OGL-96_01	Little Harts Creek	WVOG-42	2.04E+10	1.14E+07	1.07E+09	2.14E+10
Little Harts Creek	WV-OGL-96-C_01	Short Bend Fork	WVOG-42-A	2.85E+09	0.00E+00	1.50E+08	3.00E+09
Little Harts Creek	WV-OGL-96-E_01	Laurel Fork	WVOG-42-C	3.80E+09	0.00E+00	2.00E+08	4.00E+09
Little Harts Creek	WV-OGL-96-G_01	Mudlick Branch	WVOG-42-D	1.20E+09	3.79E+06	6.33E+07	1.27E+09
Big Harts Creek	WV-OGL-99_04	Big Harts Creek	WVOG-44	1.51E+11	6.44E+07	7.94E+09	1.59E+11
Big Harts Creek	WV-OGL-99_03	Big Harts Creek	WVOG-44	5.52E+10	0.00E+00	2.90E+09	5.81E+10
Big Harts Creek	WV-OGL-99_01	Big Harts Creek	WVOG-44	2.07E+10	0.00E+00	1.09E+09	2.18E+10
Big Harts Creek	WV-OGL-99-A_02	West Fork/Big Harts Creek	WVOG-44-A	2.98E+10	7.58E+06	1.57E+09	3.14E+10
Big Harts Creek	WV-OGL-99-A-3_01	Piney Fork	WVOG-44-A-1	5.90E+09	0.00E+00	3.11E+08	6.21E+09
Big Harts Creek	WV-OGL-99-A-4_01	Marsh Fork	WVOG-44-A-2	1.22E+10	7.58E+06	6.45E+08	1.29E+10
Big Harts Creek	WV-OGL-99-A-5_01	Workman Fork	WVOG-44-A-3	6.44E+09	0.00E+00	3.39E+08	6.78E+09
Big Harts Creek	WV-OGL-99-B_01	Big Branch	WVOG-44-B	5.07E+09	0.00E+00	2.67E+08	5.33E+09
Big Harts Creek	WV-OGL-99-E_01	Caney Branch	WVOG-44-C.3	1.51E+09	0.00E+00	7.93E+07	1.59E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Big Harts Creek	WV-OGL-99-G_01	Thompson Branch	WVOG-44-C.7	2.69E+09	0.00E+00	1.41E+08	2.83E+09
Big Harts Creek	WV-OGL-99-H_01	Rockhouse Fork	WVOG-44-D	4.07E+09	0.00E+00	2.14E+08	4.29E+09
Big Harts Creek	WV-OGL-99-J_02	Smokehouse Fork	WVOG-44-E	3.49E+10	4.55E+07	1.84E+09	3.68E+10
Big Harts Creek	WV-OGL-99-J_01	Smokehouse Fork	WVOG-44-E	2.10E+10	0.00E+00	1.11E+09	2.22E+10
Big Harts Creek	WV-OGL-99-J-5_01	Browns Run	WVOG-44-E-1	4.51E+09	0.00E+00	2.37E+08	4.75E+09
Big Harts Creek	WV-OGL-99-J-9_01	White Oak Branch	WVOG-44-E-2	5.34E+09	0.00E+00	2.81E+08	5.62E+09
Big Harts Creek	WV-OGL-99-K_01	Trace Fork	WVOG-44-F	1.05E+10	0.00E+00	5.54E+08	1.11E+10
Big Harts Creek	WV-OGL-99-K-6_01	Ivy Branch	WVOG-44-F-3	1.78E+09	0.00E+00	9.35E+07	1.87E+09
Big Harts Creek	WV-OGL-99-L_01	Buck Fork	WVOG-44-G	1.37E+10	0.00E+00	7.22E+08	1.44E+10
Big Harts Creek	WV-OGL-99-M_01	Hoover Fork	WVOG-44-H	6.79E+09	0.00E+00	3.58E+08	7.15E+09
Big Harts Creek	WV-OGL-99-N_01	Henderson Branch	WVOG-44-I	3.47E+09	0.00E+00	1.82E+08	3.65E+09
Big Harts Creek	WV-OGL-99-Q_01	Bulwark Branch	WVOG-44-K	3.45E+09	0.00E+00	1.82E+08	3.64E+09
Green Shoals Branch	WV-OGL-106_01	Green Shoals Branch	WVOG-45	8.01E+09	0.00E+00	4.22E+08	8.43E+09
Abbott Branch	WV-OGL-108_01	Abbott Branch	WVOG-46	3.35E+09	0.00E+00	1.76E+08	3.53E+09
Limestone Branch	WV-OGL-111_01	Limestone Branch	WVOG-48	5.15E+09	8.33E+06	2.72E+08	5.43E+09
Big Creek	WV-OGL-112_03	Big Creek	WVOG-49	1.07E+11	3.64E+07	5.61E+09	1.12E+11
Big Creek	WV-OGL-112-D_01	Ed Stone Branch	WVOG-49-A	5.99E+09	0.00E+00	3.15E+08	6.31E+09
Big Creek	WV-OGL-112-D-1_01	North Branch/Ed Stone Branch	WVOG-49-A-1	1.61E+09	0.00E+00	8.45E+07	1.69E+09
Big Creek	WV-OGL-112-E_01	North Fork/Big Creek	WVOG-49-B	2.35E+10	1.21E+07	1.24E+09	2.47E+10
Big Creek	WV-OGL-112-E-7_01	Chapman Branch	WVOG-49-B-1	2.39E+09	0.00E+00	1.26E+08	2.52E+09
Big Creek	WV-OGL-112-E-11_01	Harmon Branch	WVOG-49-B-2	5.23E+09	8.33E+06	2.76E+08	5.52E+09
Big Creek	WV-OGL-112-E-10_01	Ellis Fork	WVOG-49-B-3	6.07E+09	3.79E+06	3.20E+08	6.40E+09
Big Creek	WV-OGL-112-I_01	Trace Fork	WVOG-49-D	2.64E+10	1.67E+07	1.39E+09	2.78E+10
Big Creek	WV-OGL-112-I-4_01	Hurricane Branch	WVOG-49-D-1	2.70E+09	0.00E+00	1.42E+08	2.84E+09
Big Creek	WV-OGL-112-H_02	Garrett Fork	WVOG-49-E	3.97E+10	7.58E+06	2.09E+09	4.18E+10
Big Creek	WV-OGL-112-H_01	Garrett Fork	WVOG-49-E	1.66E+10	7.58E+06	8.72E+08	1.74E+10

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Big Creek	WV-OGL-112-H-2_01	Kanawha Branch	WVOG-49-E-2	4.24E+09	0.00E+00	2.23E+08	4.46E+09
Big Creek	WV-OGL-112-H-6_01	Hainer Branch	WVOG-49-E-5	1.63E+09	0.00E+00	8.55E+07	1.71E+09
Crawley Creek	WV-OGL-117_02	Crawley Creek	WVOG-51	5.50E+10	3.79E+08	2.91E+09	5.83E+10
Crawley Creek	WV-OGL-117_01	Crawley Creek	WVOG-51	9.29E+09	0.00E+00	4.89E+08	9.78E+09
Crawley Creek	WV-OGL-117-B_01	Canoe Fork	WVOG-51-B	2.42E+09	0.00E+00	1.27E+08	2.55E+09
Crawley Creek	WV-OGL-117-H_01	Tims Fork	WVOG-51-F	5.10E+09	0.00E+00	2.68E+08	5.37E+09
Crawley Creek	WV-OGL-117-M_01	South Fork/Crawley Creek	WVOG-51-G.5	4.31E+09	3.79E+08	2.47E+08	4.93E+09
Crawley Creek	WV-OGL-117-M.1_01	Middle Fork/Crawley Creek	WVOG-51-G.6	2.58E+09	0.00E+00	1.36E+08	2.72E+09
Fowler Branch	WV-OGL-121_01	Fowler Branch	WVOG-51.5	4.17E+09	0.00E+00	2.19E+08	4.39E+09
Godby Branch	WV-OGL-125_01	Godby Branch	WVOG-53	5.14E+09	0.00E+00	2.71E+08	5.42E+09
Caney Branch	WV-OGL-129_01	Caney Branch	WVOG-54	6.07E+09	3.79E+06	3.20E+08	6.39E+09
Rocky Branch	WV-OGL-130_01	Rocky Branch	WVOG-55	6.00E+09	0.00E+00	3.16E+08	6.32E+09
King Shoal Branch	WV-OGL-134_01	King Shoal Branch	WVOG-58	5.19E+09	0.00E+00	2.73E+08	5.46E+09
Mill Creek	WV-OGL-135_01	Mill Creek	WVOG-59	2.36E+10	3.79E+06	1.24E+09	2.49E+10
Mill Creek	WV-OGL-135-F_01	Long Fork	WVOG-59-C	5.40E+09	0.00E+00	2.84E+08	5.68E+09
Mill Creek	WV-OGL-135-G_01	Butch Fork	WVOG-59-D	3.83E+09	0.00E+00	2.02E+08	4.03E+09
Big Branch	WV-OGL-136_01	Big Branch	WVOG-60	3.58E+09	0.00E+00	1.88E+08	3.77E+09
Buffalo Creek	WV-OGL-137_01	Buffalo Creek	WVOG-61	1.63E+10	2.27E+07	8.59E+08	1.72E+10
Snap Creek	WV-OGL-138_01	Snap Creek	WVOG-62	3.74E+09	0.00E+00	1.97E+08	3.94E+09
Snap Creek	WV-OGL-138-B_01	UNT/Snap Creek RM 0.63	WVOG-62-B	6.08E+08	0.00E+00	3.20E+07	6.40E+08
Crooked Creek	WV-OGL-139_01	Crooked Creek	WVOG-63	1.06E+10	0.00E+00	5.55E+08	1.11E+10
Peach Creek	WV-OGL-140_01	Peach Creek	WVOG-64	7.61E+09	4.02E+09	6.12E+08	1.22E+10
Mud River	WV-OGL-10_08	Mud River	WVOGM	1.08E+12	6.43E+10	6.00E+10	1.20E+12
Mud River	WV-OGL-10_07	Mud River	WVOGM	7.45E+11	3.34E+09	3.94E+10	7.87E+11
Mud River	WV-OGL-10_06	Mud River	WVOGM	4.28E+11	2.77E+09	2.27E+10	4.53E+11

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Mud River	WV-OGL-10_05	Mud River	WVOGM	2.61E+11	5.77E+08	1.38E+10	2.75E+11
Mud River	WV-OGL-10_04	Mud River	WVOGM	1.59E+11	5.33E+08	8.39E+09	1.68E+11
Mud River	WV-OGL-10_03	Mud River	WVOGM	7.34E+10	7.46E+07	3.86E+09	7.73E+10
Mud River	WV-OGL-10_02	Mud River	WVOGM	3.92E+10	0.00E+00	2.06E+09	4.12E+10
Mud River	WV-OGL-10_01	Mud River	WVOGM	1.09E+10	0.00E+00	5.75E+08	1.15E+10
Merrick Creek	WV-OGL-10-A_01	Merrick Creek	WVOGM-1	1.56E+10	1.60E+09	9.06E+08	1.81E+10
Tanyard Branch	WV-OGL-10-B_01	Tanyard Branch	WVOGM-1.5	4.01E+07	5.22E+09	2.77E+08	5.54E+09
Cyrus Creek	WV-OGL-10-D_01	Cyrus Creek	WVOGM-2	7.36E+09	2.05E+09	4.95E+08	9.90E+09
Big Cabell Creek	WV-OGL-10-Q_02	Big Cabell Creek	WVOGM-4	3.60E+10	3.79E+06	1.90E+09	3.79E+10
Big Cabell Creek	WV-OGL-10-Q_01	Big Cabell Creek	WVOGM-4	1.31E+10	0.00E+00	6.91E+08	1.38E+10
Big Cabell Creek	WV-OGL-10-Q-9_01	Big Hill Hollow	WVOGM-4-I	5.82E+09	0.00E+00	3.06E+08	6.13E+09
Edmonds Branch	WV-OGL-10-R_01	Edmonds Branch	WVOGM-5	3.63E+09	8.43E+06	1.92E+08	3.83E+09
Fudges Creek	WV-OGL-10-S_01	Fudges Creek	WVOGM-6	3.53E+10	3.19E+07	1.86E+09	3.72E+10
Fudges Creek	WV-OGL-10-S-2_01	Wire Branch	WVOGM-6-0.5A	3.74E+09	8.70E+06	1.97E+08	3.95E+09
Fudges Creek	WV-OGL-10-S-5_01	Little Fudges Creek	WVOGM-6-A	5.92E+09	0.00E+00	3.12E+08	6.23E+09
Lower Creek	WV-OGL-10-AC_02	Lower Creek	WVOGM-7	3.19E+10	7.58E+06	1.68E+09	3.36E+10
Lower Creek	WV-OGL-10-AC-5-B_01	Tony Branch	WVOGM-7-B-1	3.22E+09	0.00E+00	1.69E+08	3.39E+09
Mill Creek	WV-OGL-10-AD_02	Mill Creek	WVOGM-8	3.85E+10	4.89E+08	2.05E+09	4.10E+10
Mill Creek	WV-OGL-10-AD-7_01	Long Branch	WVOGM-8-A	3.19E+09	3.79E+06	1.68E+08	3.36E+09
Mill Creek	WV-OGL-10-AD-10_01	Right Fork/Mill Creek	WVOGM-8-C	7.81E+09	3.79E+06	4.11E+08	8.23E+09
Saunders Creek	WV-OGL-10-AE_01	Saunders Creek	WVOGM-9	8.89E+09	1.29E+08	4.75E+08	9.50E+09
Dry Creek	WV-OGL-10-AF_01	Dry Creek	WVOGM-10	4.35E+09	3.64E+07	2.31E+08	4.62E+09
Johns Branch	WV-OGL-10-AH_01	Johns Branch	WVOGM-11	3.37E+09	1.32E+09	2.47E+08	4.94E+09
Kilgore Creek	WV-OGL-10-AJ_03	Kilgore Creek	WVOGM-12	5.36E+10	9.89E+09	3.34E+09	6.68E+10
Kilgore Creek	WV-OGL-10-AJ_02	Kilgore Creek	WVOGM-12	3.17E+10	8.80E+08	1.72E+09	3.43E+10

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Kilgore Creek	WV-OGL-10-AJ_01	Kilgore Creek	WVOGM-12	1.30E+10	0.00E+00	6.84E+08	1.37E+10
Kilgore Creek	WV-OGL-10-AJ-2_01	Indian Fork	WVOGM-12-A	1.92E+10	8.37E+09	1.45E+09	2.90E+10
Kilgore Creek	WV-OGL-10-AJ-4_01	Lee Creek	WVOGM-12-B	8.46E+09	3.79E+08	4.65E+08	9.31E+09
Kilgore Creek	WV-OGL-10-AJ-7_01	Little Creek	WVOGM-12-C	4.72E+09	0.00E+00	2.48E+08	4.97E+09
Brush Creek	WV-OGL-10-AM_01	Brush Creek	WVOGM-13	2.13E+09	0.00E+00	1.12E+08	2.24E+09
Charley Creek	WV-OGL-10-AO_02	Charley Creek	WVOGM-14	3.80E+10	3.93E+08	2.02E+09	4.04E+10
Charley Creek	WV-OGL-10-AO_01	Charley Creek	WVOGM-14	2.00E+10	3.89E+08	1.07E+09	2.15E+10
Charley Creek	WV-OGL-10-AO-11_01	Panther Lick	WVOGM-14-D	2.84E+09	0.00E+00	1.49E+08	2.99E+09
Little Twomile Creek	WV-OGL-10-AQ_01	Little Twomile Creek	WVOGM-15	4.27E+09	0.00E+00	2.24E+08	4.49E+09
Trace Fork	WV-OGL-10-AY_06	Trace Fork	WVOGM-20	2.22E+11	1.65E+08	1.17E+10	2.34E+11
Trace Fork	WV-OGL-10-AY_05	Trace Fork	WVOGM-20	1.81E+11	1.42E+08	9.56E+09	1.91E+11
Trace Fork	WV-OGL-10-AY_04	Trace Fork	WVOGM-20	1.38E+11	1.31E+08	7.27E+09	1.45E+11
Trace Fork	WV-OGL-10-AY_03	Trace Fork	WVOGM-20	6.94E+10	1.05E+08	3.66E+09	7.32E+10
Trace Fork	WV-OGL-10-AY_01	Trace Fork	WVOGM-20	1.47E+10	2.73E+07	7.75E+08	1.55E+10
Trace Fork	WV-OGL-10-AY-7_01	Coon Creek	WVOGM-20-A	5.76E+09	7.58E+06	3.04E+08	6.07E+09
Trace Fork	WV-OGL-10-AY-10_02	Big Creek	WVOGM-20-D	2.62E+10	1.52E+07	1.38E+09	2.76E+10
Trace Fork	WV-OGL-10-AY-10_01	Big Creek	WVOGM-20-D	1.67E+10	7.58E+06	8.79E+08	1.76E+10
Trace Fork	WV-OGL-10-AY-10-B_01	Harvey Creek	WVOGM-20-D-1	5.62E+09	0.00E+00	2.96E+08	5.91E+09
Trace Fork	WV-OGL-10-AY-14_01	Sycamore Creek	WVOGM-20-F	9.84E+09	3.79E+06	5.18E+08	1.04E+10
Trace Fork	WV-OGL-10-AY-20_01	Clymer Creek	WVOGM-20-H	1.48E+10	0.00E+00	7.79E+08	1.56E+10
Trace Fork	WV-OGL-10-AY-22_01	Trace Creek	WVOGM-20-I	9.41E+09	1.14E+07	4.96E+08	9.92E+09
Trace Fork	WV-OGL-10-AY-22-A_01	Kellys Creek	WVOGM-20-I-1	3.77E+09	0.00E+00	1.98E+08	3.97E+09
Trace Fork	WV-OGL-10-AY-22-A-2_01	UNT/Kellys Creek RM 1.27	WVOGM-20-I-1-B	8.40E+08	0.00E+00	4.42E+07	8.84E+08
Trace Fork	WV-OGL-10-AY-24_01	Lick Creek	WVOGM-20-J	1.08E+10	3.79E+06	5.66E+08	1.13E+10
Trace Fork	WV-OGL-10-AY-26_01	Turkey Creek	WVOGM-20-K	1.67E+10	3.79E+06	8.77E+08	1.75E+10

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Trace Fork	WV-OGL-10-AY-26-F_01	Lefthand Fork	WVOGM-20-K-1	3.12E+09	0.00E+00	1.64E+08	3.29E+09
Trace Fork	WV-OGL-10-AY-30_01	Bridge Creek	WVOGM-20-M	7.88E+09	3.79E+06	4.15E+08	8.30E+09
Trace Fork	WV-OGL-10-AY-40_01	Hayzlett Fork	WVOGM-20-R	1.71E+10	1.89E+07	9.00E+08	1.80E+10
Trace Fork	WV-OGL-10-AY-42_02	Joes Creek	WVOGM-20-T	2.56E+10	3.56E+07	1.35E+09	2.69E+10
Trace Fork	WV-OGL-10-AY-42_01	Joes Creek	WVOGM-20-T	1.08E+10	2.05E+07	5.71E+08	1.14E+10
Trace Fork	WV-OGL-10-AY-42-D_01	Laurel Fork	WVOGM-20-T-1	8.25E+09	1.52E+07	4.35E+08	8.70E+09
Trace Fork	WV-OGL-10-AY-42-F_01	Tango Branch	WVOGM-20-T-2	4.50E+09	7.58E+06	2.37E+08	4.74E+09
Trace Fork	WV-OGL-10-AY-46_01	Dry Branch	WVOGM-20-W	3.50E+09	3.79E+06	1.84E+08	3.69E+09
Little Buffalo Creek	WV-OGL-10-AZ_01	Little Buffalo Creek	WVOGM-21	2.52E+09	0.00E+00	1.33E+08	2.65E+09
Buffalo Creek	WV-OGL-10-BA_01	Buffalo Creek	WVOGM-22	1.30E+10	3.79E+06	6.83E+08	1.37E+10
Buffalo Creek	WV-OGL-10-BA-1_01	Straight Fork	WVOGM-22-A	2.61E+09	0.00E+00	1.37E+08	2.75E+09
Middle Fork/Mud River	WV-OGL-10-BL_04	Middle Fork/Mud River	WVOGM-25	1.29E+11	2.89E+08	6.80E+09	1.36E+11
Middle Fork/Mud River	WV-OGL-10-BL-2_01	Meadow Branch	WVOGM-25-A	1.87E+09	3.79E+06	9.86E+07	1.97E+09
Middle Fork/Mud River	WV-OGL-10-BL-3_01	Trace Creek	WVOGM-25-B	8.38E+09	0.00E+00	4.41E+08	8.82E+09
Middle Fork/Mud River	WV-OGL-10-BL-4_01	Middle Creek	WVOGM-25-C	7.93E+09	4.55E+06	4.18E+08	8.35E+09
Middle Fork/Mud River	WV-OGL-10-BL-10_01	Davis Trace Branch	WVOGM-25-D	3.85E+09	7.58E+06	2.03E+08	4.06E+09
Middle Fork/Mud River	WV-OGL-10-BL-12_01	Scary Creek	WVOGM-25-E	8.31E+09	0.00E+00	4.37E+08	8.75E+09
Middle Fork/Mud River	WV-OGL-10-BL-15_01	Merritt Creek	WVOGM-25-F	4.37E+09	9.09E+06	2.30E+08	4.61E+09
Middle Fork/Mud River	WV-OGL-10-BL-18_02	Straight Fork	WVOGM-25-H	3.96E+10	2.25E+08	2.10E+09	4.19E+10
Middle Fork/Mud River	WV-OGL-10-BL-18_01	Straight Fork	WVOGM-25-H	8.52E+09	1.21E+07	4.49E+08	8.99E+09
Middle Fork/Mud River	WV-OGL-10-BL-18-A_01	Valley Fork	WVOGM-25-H-1	1.11E+10	1.06E+07	5.83E+08	1.17E+10
Middle Fork/Mud River	WV-OGL-10-BL-19_02	Sugartree Fork	WVOGM-25-I	3.15E+10	1.14E+07	1.66E+09	3.32E+10
Middle Fork/Mud River	WV-OGL-10-BL-19_01	Sugartree Fork	WVOGM-25-I	1.04E+10	3.79E+06	5.46E+08	1.09E+10
Middle Fork/Mud River	WV-OGL-10-BL-19-A_01	Big Branch	WVOGM-25-I-1	1.44E+09	0.00E+00	7.58E+07	1.52E+09
Middle Fork/Mud River	WV-OGL-10-BL-19-B_01	Sycamore Fork	WVOGM-25-I-2	5.88E+09	7.58E+06	3.10E+08	6.20E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Middle Fork/Mud River	WV-OGL-10-BL-19-G_01	Maul Fork	WVOGM-25-I-6	4.59E+09	0.00E+00	2.42E+08	4.83E+09
Mahone Creek	WV-OGL-10-BR_01	Mahone Creek	WVOGM-26	5.26E+09	7.58E+06	2.77E+08	5.54E+09
Big Creek	WV-OGL-10-BU_01	Big Creek	WVOGM-28	6.05E+09	3.79E+06	3.19E+08	6.38E+09
Little Laurel Creek	WV-OGL-10-CB_01	Little Laurel Creek	WVOGM-30	4.53E+09	0.00E+00	2.38E+08	4.77E+09
Sandlick Branch	WV-OGL-10-CC_01	Sandlick Branch	WVOGM-31	1.99E+09	0.00E+00	1.05E+08	2.09E+09
Big Laurel Creek	WV-OGL-10-CH_01	Big Laurel Creek	WVOGM-33	1.62E+10	3.79E+06	8.52E+08	1.70E+10
Fez Creek	WV-OGL-10-CK_01	Fez Creek	WVOGM-34	3.84E+09	3.79E+06	2.02E+08	4.04E+09
Big Creek	WV-OGL-10-CL_02	Big Creek	WVOGM-35	2.31E+10	3.79E+06	1.22E+09	2.44E+10
Big Creek	WV-OGL-10-CL_01	Big Creek	WVOGM-35	1.18E+10	0.00E+00	6.23E+08	1.25E+10
Parsner Creek	WV-OGL-10-CR_01	Parsner Creek	WVOGM-38	9.57E+09	0.00E+00	5.04E+08	1.01E+10
Left Fork/Mud River	lake*	Left Fork/Mud River	WVOGM-39	4.95E+10	3.29E+08	2.62E+09	5.25E+10
Left Fork/Mud River	WV-OGL-10-CS_01	Left Fork/Mud River	WVOGM-39	1.52E+10	2.17E+08	8.10E+08	1.62E+10
Left Fork/Mud River	WV-OGL-10-CS-6_01	Stinson Branch	WVOGM-39-E	6.79E+09	1.25E+07	3.58E+08	7.16E+09
Left Fork/Mud River	WV-OGL-10-CS-8_01	Sycamore Fork	WVOGM-39-G	1.13E+10	8.14E+07	6.00E+08	1.20E+10
Left Fork/Mud River	WV-OGL-10-CS-10_01	Dogbone Branch	WVOGM-39-H	4.59E+09	5.30E+07	2.44E+08	4.88E+09
Upton Branch	WV-OGL-10-CY_01	Upton Branch	WVOGM-40	8.34E+09	0.00E+00	4.39E+08	8.78E+09
Bear Branch	WV-OGL-10-DC_01	Bear Branch	WVOGM-41	5.52E+09	6.25E+07	2.94E+08	5.88E+09
Slab Creek	WV-OGL-10-DG_01	Slab Creek	WVOGM-42	4.39E+09	0.00E+00	2.31E+08	4.62E+09

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

* Loads presented to show fecal coliform contribution from Mud River Reservoir to downstream portion of Mud River. The Mud River Reservoir has not been assessed for fecal coliform impairment.

"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.

11.0 FUTURE GROWTH

11.1 Iron, Aluminum, pH, and Selenium

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.
- Because aluminum water quality criteria are in dissolved form, a dissolved/total pollutant translator is needed to determine total aluminum effluent limitations. In aluminum impaired warmwater fisheries, a new facility could be permitted if total aluminum effluent limitations are based on the dissolved aluminum, acute, aquatic life protection criterion and dissolved/total aluminum translation equal to 1.0.

- 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. 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.

- Lands associated with the Construction Stormwater and Multi-sector Stormwater General Permits are not significant or causative sources of dissolved aluminum, pH, or selenium impairments. New registrations may be permitted in the watersheds of impaired streams without specific wasteload allocations for those parameters.

- 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.

11.2 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.

12.0 PUBLIC PARTICIPATION

12.1 Public Meetings

An informational public meeting was held on May 16 at Cabell Midland High School near Ona, WV, and on May 18, 2017 at Chief Logan State Park near Logan, 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 were permitted during the comment period. WVDEP representatives hosted a virtual meeting to present an overview of the TMDL development process and answer questions on June 24, 2021 at 6:00 PM Eastern Time.

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. Interested parties were invited to submit comments during the public comment period, which began on June 14, 2021 and ended on July 14, 2021. WVDEP re-published the draft with corrections on Oct 4, 2021, and the second comment period ended Nov 4, 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/0qjmCm

12.3 Response Summary

WVDEP received written comments on the Draft TMDLs from the WV Coal Association, West Virginia Rivers Coalition, League of Women Voters of West Virginia, Ohio Valley Environmental Coalition, and the Sierra Club. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text. The WV Coal Associated incorporated technical comments filed on the Upper Guyandotte Draft TMDL, including their original Upper Guyandotte TMDL comments. Many comments for the draft Upper Guyandotte River TMDL are not applicable to the draft Lower Guyandotte River TMDL (e.g., comments relative to trout streams or specific permits discharging into the Upper Guyandotte River watershed), and thus are not addressed in this responsiveness summary.

One commenter expressed concerns that mining outlets are over-represented in the TMDL Baseline, pointing to effluent limits that are higher than concentrations reported in Discharge Monitoring Reports, and to loads attributed to permits/outlets not yet constructed. These concerns have led commenters to an inaccurate interpretation that sources of existing loads other than mining permits are excluded in the model and thus TMDLs cannot reach goals.

Commenters will benefit from examining and understanding the baseline condition for the models. The modeling used to develop the TMDLs in the Lower Guyandotte River watershed, has three conditions: calibration, baseline, and allocated. The distinction between calibration and baseline is particularly important in watersheds with point sources, such as mining outlets. Section 5.1.1 of the public report states, “Point sources are represented differently during model calibration than they were during the allocation process. To match model results to historical water quality data for calibration, it was necessary to represent the existing point sources using available historical data. During the allocation process, permitted sources are represented at their allowable permit limits in the baseline condition. Reductions are made to the baseline when necessary to attain the TMDL endpoint in the allocated condition.” The reference to allocation process in this section is describing the process of allocating load, including setting a baseline condition and making subsequent reductions to result in an allocated condition that attains the TMDL endpoint.

Section 9.6.2 states, “Baseline conditions allow for an evaluation of instream water quality under the highest expected loading conditions.”

During calibration, when relative contributions are being attributed to pollutant sources, mining outlet representation is based on available monthly discharge data submitted via eDMR. These data are analyzed to determine calibration conditions for mining landuses. The commenters are correct, those concentrations are lower than concentration permissible in the NPDES effluent limits. Once the model is properly calibrated, baseline is reset to conditions representative of existing NPDES effluent limits for mining outlets because that is the highest expected loading condition. When the model predicts attainment of water quality criteria under baseline conditions, the TMDL does not prescribe reduction and validates the existing limits. If baseline were established at concentrations for permitted sources that are less than existing NPDES effluent limits, then the model would only be able to assess/confirm attainment under the alternate (lesser) concentrations. The DEP avoided this approach because the resulting wasteload allocations would be more stringent than existing limits without confirmation of the necessity of reduction.

The baseline condition for sources other than permitted sources matches the calibrated conditions – thus the overall percent contributions are preserved. The allocation strategy for iron in Section 9.7.1. describes prescribed reductions to all other sources of iron before mining outlets are reduced from their baseline representation.

One commenter misinterpreted the model representation of precipitation-induced outlets, saying “assigned loading for precipitation-induced outlets based on a maximum flow rate when the outlets discharge only during storm events. These outlets discharge only for a limited duration in response to larger rainfall events. The Draft TMDL grossly mishandles the discharge from precipitation-induced outlets.”

The commenters have misunderstood the hydrological representation of the landuse areas associated with mining permits. The maximum flow rate is not used for precipitation-induced outlets. Section 5.1.1 Mining Point Sources states, “the permitted mining point sources (open NPDES outlets) were grouped into landuse categories based on the type and status of mining activity and effluent discharge characteristics. Co-mingled discharges contain effluent discharges from both surface and deep mining activities. Surface mines, and co-mingled surface mines were treated as land-based precipitation-induced sources."

Flow rates for land-based precipitation-induced sources are based on the model response to precipitation on various landuse types (e.g., disturbed mining, undisturbed mining), and is influenced by infiltration and evapotranspiration. See Technical Document Section 6.1 Hydrology Calibration for additional details pertaining to hydrologic flow.

One commenter perceived problems with the baseline condition for selenium similar to those in the iron baseline. Commenters also questioned the representation of outlets as selenium source where selenium had previously not been identified as a parameter of concern.

As described in Section 9.2.4 Selenium Configuration of the TMDL report, the model baseline representation is based on the permit effluent limits. In the Mud River watershed, all active permits with open outlets were permitted at water quality-based limits, thus, were represented at water quality in the baseline condition. Given measured exceedances of selenium water quality standards in the Mud River watershed, and to account for all potential sources of selenium in the watershed, areas draining to ended outlets of active mining permits were also considered. To clarify how ended outlets of active permits were characterized, the text below was added to Section 9.2.4:

"WVDEP pre-TMDL monitoring and source tracking field investigations observed that some ended outlets of active mining permits had the potential to be significant sources of selenium. For model configuration under baseline condition, selenium concentrations assigned to ended outlets of active permits were derived from loading estimates developed during model calibration at the subwatershed level. Because open outlets with limits were assumed to be meeting their limits under baseline condition, ended outlets could not be excluded as potential sources of excess selenium loads contributing to stream impairment. In the selenium TMDL allocations Mining WLAs table, ended outlets of active permits are displayed by subwatershed with the permit ID followed by "Ended Outlet."

Permit effluent limits may still be avoided if a permittee can document that there is no reasonable potential to discharge in excess of the wasteload allocation concentration through application of methodologies provided in EPA's Technical Support Document for Water Quality Based Toxics Control to monitoring results for the permitted outlet.

One commenter accurately stated that reductions to mining permits in the TMDL allocated condition will be implemented upon permit reissuances, adding that reductions were made to concentrations based on WLAs in the 2004 Guyandotte River TMDL. A related comment expressed concern that there is no clear plan to implement necessary controls for nonpoint sources.

The purpose of a TMDL is to determine sources of pollutant that cause or contribute to impaired streams and prescribe reductions that, when implemented, will result in attainment of applicable water quality standards (e.g., warm water or trout criteria). Reductions are incrementally prescribed to point (permitted sources) and to nonpoint sources using an allocation approach described in Section 9.7.1 Total Iron TMDLs. Reductions are only prescribed to mining permits in watersheds where reductions to all other sources do not result in attainment of the applicable water quality standards. Pursuant to 40 CFR §122.44(d)(1)(vii)(B), NPDES permits must be consistent with the assumptions and requirements of applicable TMDL wasteload allocations. Thus, reductions to effluent limits for permitted source will be made during reissuance.

As explained in Section 2.1 all impaired streams for which TMDLs were developed in 2004 have been re-evaluated. While pursuing TMDL development for other impairments, WVDEP obtained more comprehensive data and developed new TMDLs under a more refined modeling approach. Upon approval, the TMDLs presented for iron and fecal coliform shall supersede those developed previously.

WVDEP does not have jurisdiction to issue NPDES permits to nonpoint sources of iron. WVDEP partners with federal and state agencies, as well as with watershed associations, to identify opportunities to advance restoration activities.

One commenter requested clarification for the intended impact to mining permits that have reached post-mining status, and in which DEP has determined the outlets do not have reasonable potential to cause or contribute to an exceedance of the iron water quality criterion.

During the TMDL development, identifying sources of pollution and determining model representation of those sources begins by capturing the existing sources at a static point in time. The mining industry and permitting process, in contrast, is dynamic and ever changing as land is reclaimed, treatment structures removed, and permittees demonstrate no reasonable potential to exceed permit limits. The intent of the TMDL is for WLAs to be implemented through permit reissuances for active permits. The existence of a WLA is not intended to impact those permits that have programmatically progressed to post mining conditions during the development of the TMDLs in this project.

WVDEP included additional information in Section 9.7.1 regarding implementation of TMDL WLAs to mining outlets. This language had been inadvertently omitted in the draft report and provides further clarification for permittees and permit writers.

One commenter inadequately described the selenium water quality criteria, omitting application of the water column criteria exclusive of fish tissue or egg/ovary criteria in streams with new selenium sources that have not yet reached equilibrium. Commenters expressed concern that the TMDL WLAs and the allowances of site-specific effluent limits based on fish tissue, egg/ovary studies, could not exist harmoniously.

Table 2-1 of the TMDL provides the water quality standards from 47CSR2, along with footnotes describing the application of selenium water column criteria. Use of water column concentration is appropriate before streams reach equilibrium for selenium and when there are no other data. Fish tissue or egg ovary criteria override the water column criterion when these data exist in streams that have reached equilibrium. These determinations are made on a site-by-site basis and influence permitted effluent limits. Selenium WLAs are presented for outlets discharging into the Mud River watershed, upstream of the Mud River Reservoir. Because of downstream impairment, outlets are not eligible for alternative effluent limits at this time.

One commenter criticized the Draft TMDL for following the same tired techniques used in other mining watersheds throughout West Virginia, with no clear strategy to reduce loads from nonpoint sources.

The approach taken to develop the Lower Guyandotte TMDLs does employ the same techniques from past projects because of the cost saving associated with using established tools, as well as the assurance that the TMDL meets requirements of 40CFR130.7 for approval. The development of TMDLs represents the first step in restoration of water quality in impaired streams. Implementation of the TMDL wasteload allocations is required through NPDES permits (40 CFR 122.44(d)(1)(vii)(B). See **Section 13.2** of the TMDL to learn more about efforts that WVDEP Watershed Improvement Branch takes to collaborate with volunteers who shares a common goal for stream restoration through reductions to nonpoint sources.

Multiple commenters expressed concern that the TMDL is lacking in a comprehensive analysis of implementation strategies, as well as a discussion on how future development will affect cleanup and attainment of water quality standards.

WV TMDLs primarily define allocations necessary to achieve standards in a wide array of streams throughout the watershed. They attempt to provide implementation guidance for various sources or categories of sources but are not intended to be a detailed implementation plan. The development of TMDLs is the first step toward stream restoration.

The TMDL addresses future growth related to point (permitted) sources. See Section 11.0 for additional details. WVDEP will continue to monitor and report on water quality throughout the state according to the Watershed Framework described in Section 13.0. As with this TMDL for the Lower Guyandotte River, TMDLs can be updated in the future to capture the most up to date information.

Multiple commenters referenced the development of a procedural rule describing the assessment methodology for the biological component of the narrative criteria in wadeable streams, as well as the direction in 2012 from the State legislature to develop this rule pointing out that WVDEP has not accomplished this task in over 9 years. The commenters also expressed that the assessment methodology should be based on a genus level IBI referred to GLIMPSS.

As described in Section 4.0, assessment units with WVSCI scores below the threshold for attainment were subject to a stressor identification process. One hundred twenty-eight assessment units with biological stressors of organic enrichment, pH, metals toxicity and/or sedimentation, will be addressed through pollutant TMDLs for fecal coliform, pH, dissolved aluminum, or total iron. Technical Report Appendix K provides details on impaired assessment unit in Lower Guyandotte that can be resolved through pollutant TMDLs and list those that will not be resolved due to stress from ionic strength. Impaired assessment units will be retained on the 303d list and be the subject of future TMDL efforts to address pollution associated with unresolved stressors. WVDEP and the USEPA are collaborating in a project to study possible TMDL endpoints and sources of ions in West Virginia. Comments on the use of GLIMPSS in the assessment methodology are noted.

Multiple commenters expressed disagreement with the assumption in the TMDL that compliant permits are not causing fecal coliform impairment in the streams. The commenter disagrees that the permit limits are protective of the water quality standards. The commenter asserted that the TMDL should address permit non-compliance, that permits should require continuous monitoring, and the TMDL should require reductions from permitted facilities. Commenters also asked for clarification of what is meant by language in the TMDL document saying, "no significant SSOs were represented in the model", asserting that it would be unlikely that there were no significant overflows in the watershed in a 10-year period.

WVDEP contends that permit limits are at least equivalent to the fecal coliform water quality criteria, because both include a 200 counts/100ml monthly geometric mean component and a 400 counts/ 100ml daily maximum component. DEP views the effluent limits as more restrictive because the water quality criteria allow daily values to be exceeded 10% of the time in a month whereas the permitted effluent limits allow no exceedance of the daily value.

Per the Technical Support Document (https://www3.epa.gov/npdes/pubs/owm0264.pdf), wasteload allocations based upon a human health criteria are to be implemented as the monthly average limit in a permit. As such, the baseline and allocated concentrations established in the TMDL are consistent with the existing limitations in the permits.

Attainment of instream water quality standards in the TMDL allocated scenario are based on attaining both the monthly geomean and maximum daily. The model demonstrates that when in compliance, wastewater treatment plants discharging at existing limits are protective of water quality standards. Permit monitoring frequencies and non-compliance are outside of the purview of the TMDL development.

The Technical Report Section 3.2.1 Combined Sewer Overflows (CSO) Representation explains the way these outlets are permitted and represented in the model. Sections 9.7.4 and 13.1 explain CSO allocated WLAs and how they impact the permitting of these discharges.

WVDEP acknowledges that episodic SSOs from permitted wastewater collection systems may contribute loads impairing streams and are not directly represented during calibration and baseline scenarios. The availability of SSO release data is limited to spill reports, making identification of these potential sources arduous. The benefits of informing calibration do not justify the time-consuming task of identifying SSOs, given their episodic nature. Based on a long-standing interpretation of the Clean Water Act, SSOs are illegal and cannot be permitted. When SSOs are known to be present, they should receive a zero wasteload allocation in a TMDL.

The pollutant loads from SSOs are most likely captured in urban/residential landuse representation in specific subwatershed during calibration, opposed to being attributed to or masking impacts from unrelated nonpoint sources. Prescribed reductions to urban residential sources may be accomplished, in part, through identification of and resolution of SSOs and illicit discharges into stormwater systems.

Multiple commenters expressed disagreement with reducing impermissible discharges of human waste 100% in the TMDL allocated scenario, stating, "if the final TMDL assumes all

illicit discharges will be corrected but that does not reflect reality, the TMDL endpoints will not be reached." Commenters also expressed concern that the TMDL is lacking information on pollution remediation from nonpoint sources and asserts that the Draft TMDL should explore alternative allocations that will meet the TMDL endpoints, including seeking further reductions from point sources.

Discharges from failing septic systems are represented in the TMDL calibration and baseline condition, with loads attributed to an estimated number of households per subwatershed. Because the discharging untreated waste is impermissible, no loads are allocated to failing septic systems in the TMDL, which effectively means the TMDL prescribes elimination. The TMDL is a restoration plan. Identifying the contributions from failing septic systems in the baseline model establishes the need for implementation. Implementation planning is the next step in the restoration process. Section 11.3 provides a brief description of WVDEPs responsibility related to evaluating and funding sewer projects, which may extend service to unsewered areas, assimilate sewage currently routed through failing onsite systems and accomplish the local fecal coliform bacteria reductions prescribed by the TMDLs.

The WVDEP maintains that permitted outlets discharging at water quality criteria end-of-pipe are protective of water quality standards. Fecal coliform allocations for wastewater treatment plant point sources reflect existing technology-based effluent limits, which are at least equivalent to water quality criteria end-of-pipe. Including failing septic system loads in allocated conditions would not influence the allocation strategy and policy for permitted sources.

Multiple commenters pointed out that the Draft TMDL's source identification work related to Abandoned Mine Land (AML) as a significant nonpoint source of metals in certain metal-impaired streams is important to allow state authorities to take necessary steps to address those pollution problems. Commenters also express concern that while identification represents the first step, the TMDL does not discuss use of AML project funding for projects to remediate metals impairments. Commenters assert that the TMDL should prioritize sources to be remediated.

WVDEP agrees with the importance of identifying AML sources. In addition to mapped sources through the AML program, instream water quality conditions may point to unidentified legacy mining sources of pollution. Source tracking efforts endeavor to identify pollutant sources and report on their location in the TMDL report. In addition to identifying sources, the purpose of the TMDL is to prescribe reductions to nonpoint source loads as necessary to attain water quality standards. Prioritizing projects and detailing funding is outside the purview of the TMDL. These decisions are made by the WVDEP Office of Abandoned Mine Lands & Reclamation, whose mission is to protect public health, safety, and property from past coal mining and enhance the environment through reclamation and restoration of land and water resources. The responsibility of prioritizing and allocating funding must account for AML sources throughout the State of WV.

Multiple commenters described the importance of the TMDL as a step to protecting the Lower Guyandotte Watershed as a resource to local communities, including four drinking water utilities. The commenters shared that many of the utilities have experienced exceedances of the EPA's Maximum Contaminant Levels in their finished drinking water and believe that

improving the source water for these water utilities will also improve the quality of the finished drinking water. Lastly the commenters shared that efforts are underway to improve recreational opportunities and access with the Guyandotte Water Trail.

WVDEP agrees with the importance of the Lower Guyandotte River as a source of drinking water and a resource for recreation. WVDEP is committed to identifying impairments for these designated uses and developing TMDLs to create the groundwork for implementation and future restoration.

13.0 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.

13.1 NPDES Permitting

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 11**.

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. In order to address priorities on the 303d list, WVDEP deviated from the framework for this TMDL project in Group C for the Lower Guyandotte watersheds. Because this TMDL was developed ahead of the scheduled sequence, implementation of this TMDL will be accomplished in the next reissuance.

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). All of the cities with MS4 permits in subject waters of this report, plus the West Virginia Department of Transportation (WVDOH) are 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 achieve 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. The "MS4 WLA Detailed" tabs on the allocation spreadsheets WLAs provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. 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.

DWWM also implements a program to control discharges from CSOs. Specified fecal coliform WLAs for CSOs will be implemented in accordance with the provisions of the national Combined Sewer Overflow Control Policy and the state Combined Sewer Overflow Strategy. Those programs recognize that comprehensive CSO control may require significant resources and an extended period of time to accomplish. The WLAs prescribed for CSOs are necessary to achieve current fecal coliform water quality criteria. However, the TMDL should not be construed to supersede the prioritization and scheduling of CSO controls and actions pursuant to the national CSO program. Nor are the TMDLs intended to prohibit the pursuit of the water quality standard revisions envisioned in the national policy. TMDLs may be modified to properly implement future water quality standard revisions (designated use and/or criteria), if enacted and approved by the USEPA.

13.2 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 Guyandotte River Watershed, contact the Watershed Improvement Branch Western Basin Coordinator Tomi Bergstrom.

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

13.3 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.

14.0 MONITORING PLAN

The following monitoring activities are recommended:

14.1 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. 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.

14.2 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.

14.3 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.

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