State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Yellow Creek Watershed

Yellow Creek near Hammondville, Ohio

November 2, 2009
Final Report

Ted Strickland, Governor
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List of Acronyms and Abbreviations

AMDAT	Acid Mine Drainage Abatement and Treatment
BIT	Bacteria Indicator Tool
BMP	best management practice
cm	centimeter
CNMP	Comprehensive Nutrient Management Plan
cnt/seas	counts per season
Corps	U.S. Army Corps of Engineers
CRP	Conservation Reserve Program
CWA	Clean Water Act
CWH	Cold Water Habitat
DA	drainage area
DEFA	Division of Environmental and Financial Assistance
DFFOs	Directors Final Findings and Orders
DNAP	Division of Natural Areas and Preserves
DSW	Division of Surface Water
DSWC	Division of Soil and Water Conservation
EQIP	Environmental Quality Incentives Program
EWH	Exceptional Warmwater Habitat
FC	Fecal Coliform
FSA	Farm Service Agency
gpd	gallons per day
GPS	geographic positioning system
GW	groundwater
HSTS	household sewage treatment system
HUC	hydrologic unit code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LA	load allocations
lb/yr	pounds per year
LEAP	Livestock Environmental Assurance Program
LID	low impact development
mg/L	milligrams per liter
MGD	million gallons per day
MHP	Mobile Home Park
MiWB	Modified Index of Well-Being
mi^2	square mile
ml	milliliter
MOR	monthly operating reports
MOS	margin of safety
MS4	municipal separate storm sewer system
MWH	Modified Warmwater Habitat
NACD	National Association of Conservation Districts
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
OAEA	Ohio Agricultural Environmental Assurance
ODNR	Ohio Department of Natural Resources

ODOT	Ohio Department of Transportation
OFAER	On Farm Assessment and Environmental Review
OFBF	Ohio Farm Bureau Federation
OLC	Ohio Livestock Coalition
ORC	Ohio Revised Code
PCR	Primary Contact Recreation
PIR	Pollution Investigation Report
PTI	Permit to Install
QHEI	Qualitative Habitat Evaluative Index
RC&D	Resource Conservation and Development
RI	return interval
RM	river mile
SCR	Secondary Contact Recreation
SCS	Soil Conservation Service
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
tn/yr	tons per year
TP	total phosphorus
TSS	total suspended solids
U.S. EPA	U.S. Environmental Protection Agency
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
USGS	U.S. Geologic Survey
WLA	wasteload allocations
WPCLF	Water Pollution Control Loan Fund
WQS	water quality standards
WRP	Wetland Reserve Program
WRRSP	Water Resource Restoration Sponsor Program
WTP	water treatment plant
WWH	Warmwater Habitat
WWTP	Wastewater treatment plant

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1.0 INTRODUCTION

Yellow Creek, Little Yellow Creek, and smaller nearby Ohio River tributaries are located in eastern Ohio in portions of Columbiana, Carroll, and Jefferson counties near the Ohio, Pennsylvania, and West Virginia borders. This 285 square mile area contains all or parts of ten municipalities. Overall the population in this historically mined area is low. Currently some mining continues but much of this area has recovered from these activities and now forest is the dominant land cover. The large proportion of forest and the generally high gradient of the streams are primary reasons for the excellent water quality found here. The streams within the Yellow Creek watershed are among the healthiest in the state.

In 2005, the Ohio EPA surveyed 63 sites to assess the overall water quality in the watershed. The results indicated exceptional quality however water quality standards that protect designated uses were not met all locations. Affected water uses were those supporting recreation activity and aquatic life. The results of this study were published in the document entitled *Biological and Water Quality Study of Yellow Creek and Selected Tributaries, 2005-2006. Columbiana, Carroll, and Jefferson Counties, Ohio* (Ohio EPA, 2008). Additionally, a study was carried out concurrently with this TMDL project regarding the impact acid mine drainage is having on water quality (Ohio University, 2008). This acid mine drainage abatement and treatment plan (AMDAT) quantifies pollutant loading at several locations within the Yellow Creek watershed (i.e., does not include the little Yellow Creek watershed which this report does) and makes recommendations for abating those issues based on technical feasibility and cost efficiencies.

In the Yellow Creek basin, only nine assessed streams or reaches (14%) failed to meet, at minimum, warmwater habitat. In addition, a majority of sites (65%) exhibited higher levels of performance associated with their recommended exceptional or coldwater habitat designation. In contrast, the Little Yellow Creek watershed and small streams clustered along the more densely populated Ohio River corridor did not perform as well. Only one of nine sites (11%) in this watershed met its use designation. Three stream reaches downstream of reservoirs/lakes were also biologically impaired. These reaches were Town Fork, downstream of Jefferson Lake and two segments on Little Yellow Creek, downstream of Highlandtown Reservoir and downstream of Wellsville Reservoir.

Total Maximum Daily Loads (TMDLs) were developed to address the issues precluding full attainment of the water quality standards and are documented in this report. The specific water quality stressors addressed in this report are ***pathogens*** (via fecal coliform bacteria), ***nutrients*** (via total phosphorus), and analyses were done to address parameters associated with acid mine drainage. Sections 4.5 and 5.1 of this report provide a more detailed description of the TMDL coverage.

In developing the TMDLs the current pollutant loading was estimated and the necessary abatement calculated. Pathogens require a 26% to 89% reduction at locations that are impaired by this stressor. Phosphorus reductions needed to abate impairment related to the three reservoirs in the project area ranged from 61% to 91%. Acid mine drainage parameters exceeded target values by 93% to 7186% depending on the AMD parameter and the type of stream.

The final chapter in this report provides strategies for restoring the full uses of surface waters in the Yellow Creek watershed. Conditions under regulatory control include discharge limits for permitted dischargers in the basin. However, recommendations are given for land management, which falls outside of regulatory authority. These include changes in the management of livestock operations, better sediment control and nutrient management on lands producing row crops, and improvements in the maintenance of home sewage treatment systems. These actions largely depend on voluntary adoption either with or without financial and technical assistance.

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritizes waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment, then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified the Yellow Creek watershed (assessment units 05030101-180; 05030101-190; 05030101-100) as impaired on the 2008 303(d) list (available at www.epa.ohio.gov/dsw/tmdl/2008IntReport/2008OhioIntegratedReport.aspx).

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of Water Quality Standards (WQS), which would subsequently lead to the removal of the water bodies from the 303(d) list. Table 1.1 summarizes how the impairments identified in the Yellow Creek and Little Yellow Creek watershed are addressed in this TMDL report.

1.2 Public Involvement

Public involvement is the key to the success of water restoration projects, including TMDL efforts. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group in 1998 to assist the Agency with the development of the TMDL program in Ohio. The advisory group issued a report in July 2000 to the Director of Ohio EPA on their findings and recommendations. The Yellow Creek watershed TMDL project has been completed using the process endorsed by the advisory group.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was public noticed from July 2 through August 3, 2009. A copy of the draft report was posted on Ohio EPA's web page (www.epa.ohio.gov/dsw/tmdl/index.aspx). A summary of the comments received and the associated responses is included in Appendix G.

Continued public involvement is critical to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to restore the Yellow Creek watershed.

Table 1.1. Summary of the causes of impairment for the Yellow Creek TMDL project area that are listed in the 2008 Integrated Report (303(d) list) and how they are addressed through the TMDL program.

Assessment Unit (last 6 digits of HUC14)	Narrative Description	Causes of Impairment	Action Taken
05030101-100 Ohio River (below Little Beaver Cr to Above Yellow Cr)			**Priority Points = 1**
100-240	-below L. Beaver to above Yellow Ck.	Flow alteration Habitat alteration Metals pH	AMD parameters (e.g., metals) analyzed and concentration-based targets recommended but no load-based TMDLs developed. TMDLs not developed for habitat and flow alterations due to limited scope and severity of the habitat alteration. Flow alteration not addressed because it is attributable to temporary highway construction.
100-260	-Little Yellow Ck.	Silt/sediment Flow alteration Fish passage barrier Excess algal growth Nutrients Metals TDS Natural conditions	TMDLs developed for total phosphorus loading to lakes where lake discharges are responsible for downstream impairment due to gross algal production in the lakes. AMD parameters (e.g., TDS, metals) analyzed and concentration-based targets recommended but no load-based TMDLs developed. Flow alteration not addressed because it is attributable to reservoirs and natural conditions.
05030101-180 Yellow Creek (upper)			**Priority Points = 10**
180-010	-Yellow Ck above Elkhorn Ck.	Bacteria Organic enrichment	TMDLs developed for bacteria. which is also used as a surrogate for organic enrichment.
180-020	-Elkhorn Ck.	Bacteria	TMDLs developed for bacteria.
180-040	-Yellow Ck. Below Elkhorn Ck. To above Town Fk. (except Upper N. Fk.)	Bacteria Organic enrichment Natural conditions	TMDLs developed for bacteria, which is also used as a surrogate for organic enrichment.
05030101-190 Yellow Creek (lower)			**Priority Points = 8**
190-010	-Town Fork	Flow alteration	TMDLs developed for total phosphorus loading to lakes where lake discharges are responsible for downstream impairment due to gross algal production in the lakes. Flow alteration not addressed because it is attributable to reservoir.
190-030	-Riley Run below Nancy Run	Flow alteration Metals	AMD parameters (e.g., metals) analyzed and concentration-based targets recommended but no load-based TMDLs

Assessment Unit (last 6 digits of HUC14)	Narrative Description	Causes of Impairment	Action Taken
			developed. Flow alteration not addressed because it is attributable to the impact of mining.
190-040	-N. Fork below Nancy Run to Yellow Creek	pH Metals Flow alteration Bacteria	TMDLs developed for bacteria. Flow alteration not addressed because it is attributable to natural conditions and temporary highway construction. AMD parameters (e.g., metals) analyzed and concentration-based targets recommended but no load-based TMDLs developed.
190-050	Yellow Ck. Below N. Fork to Ohio River	Habitat alteration Metals	TMDLs not developed for habitat due to limited scope and severity of the habitat alteration. AMD parameters (e.g., metals) analyzed and concentration-based targets recommended but no load-based TMDLs developed.

To this end, Ohio EPA has been in communication with local Soil and Water Conservation Districts and an affiliated watershed group, as well as the Jefferson County Health Department. These communications have dealt with study site selection, water quality survey results and subsequent discussions on potential abatement strategies to address the identified problems. The Yellow Creek Watershed Restoration Coalition (affiliated with Jefferson Soil and Water Conservation District), has hosted public meetings to provide a forum for Ohio EPA staff to discuss the TMDL project with the public. Continued communications and collaboration is anticipated to go on into the future.

1.3 Organization of this Report

This report documents the results of the TMDL analysis. Section 2 briefly describes the watershed. Section 3 discusses the applicable water quality standards, which form the basis of the TMDLs, while Section 4 discusses the locations in the project area that WQS are not being met. Section 5 defines the specific causes of water quality problems and then the target conditions which would result in the attainment of the WQS. Section 6 defines the sources of the stressors discussed in Chapter 5 and summarizes the approach for quantifying the needed level of abatement of the stressors. Section 7 elaborates on where the specific sources of stressors are found in the Yellow Creek and Little Yellow Creek watersheds. Section 8 discusses the results of the analyses, which includes the specific loads and allocations to the individual sources. Finally Section 9 discusses management options to abate the water quality problems as well as Ohio EPA programs or other organizations and programs that may facilitate abatement.

Additionally, Appendices A, B, C, and D go into greater detail regarding the technical approaches used in developing this report and Appendix E is a list of all NPDES permit holders located within the project area. Appendix F is a copy of the approved AMDAT report. Appendix G contains responses to public comments on the draft TMDL report.

2.0 WATER BODY OVERVIEW

Yellow Creek and Little Yellow Creek are located in eastern Ohio. They are both direct tributaries to the Ohio River. The headwaters of Yellow Creek begin in Carroll County, with the confluence of Elk Lick and Elk Fork, and continue to flow through Jefferson County. North Fork of Yellow Creek, a major tributary to Yellow Creek, has its headwaters in Columbiana County, and flows south into Yellow Creek. Yellow Creek is 31.6 miles long, and drains 239 square miles, and has an average fall of 17.8 feet/mile. Yellow Creek enters the Ohio River at RM 931.0.

Little Yellow Creek flows entirely through Columbiana County, and enters the Ohio River at RM 934.3, just north of the City of Wellsville. It is a small stream, only 11.3 miles long with a total drainage area of 22.22 square miles. Its HUC unit is 05030101-100 and includes some small, direct tributaries to the Ohio River between Wellsville and East Liverpool.

2.1 Project Delineation

The 2005 Yellow Creek study area was divided into three Watershed Assessment Units (WAUs) aligned with the United States Geological Service 11 digit HUC units (Figure 1). The 11 digit HUC units are as follows including the drainage area of the assessment unit:

- **05030101-180:** Yellow Creek (headwaters to upstream Town Fork). Drainage area = 118.7 square miles
- **050301010-190:** Yellow Creek (upstream Town Fork to mouth). Drainage area = 120.4 square miles
- **05030101-100:** Ohio River tributaries (downstream Little Beaver Creek to upstream Yellow Creek). Drainage area = 45.2 square miles

Yellow Creek drains HUC units 05030101-180 (upper Yellow Creek), and 05030101-190 (lower Yellow Creek). In the upper Yellow Creek watershed, Yellow Creek, down to just above the confluence of Town Fork, and all its tributaries are included in this HUC. Major tributaries include Elkhorn Creek, Upper North Fork, and Long Run. This HUC unit drains parts of both Carroll and Jefferson Counties.

HUC unit 05030101-190 (lower Yellow Creek) includes the main stem of Yellow Creek, from below the confluence of Town Fork to the Ohio River, and all tributaries entering Yellow Creek. Major tributaries include North Fork Yellow Creek and its tributaries, Town Fork, and Brush Creek. North Fork begins in Columbiana County, but most of this HUC unit is within the boundaries of Jefferson County.

HUC unit 050301010-100 (Ohio River tributaries) includes Little Yellow Creek, and several smaller tributaries to the Ohio River, located in Columbiana County between Wellsville and East Liverpool.

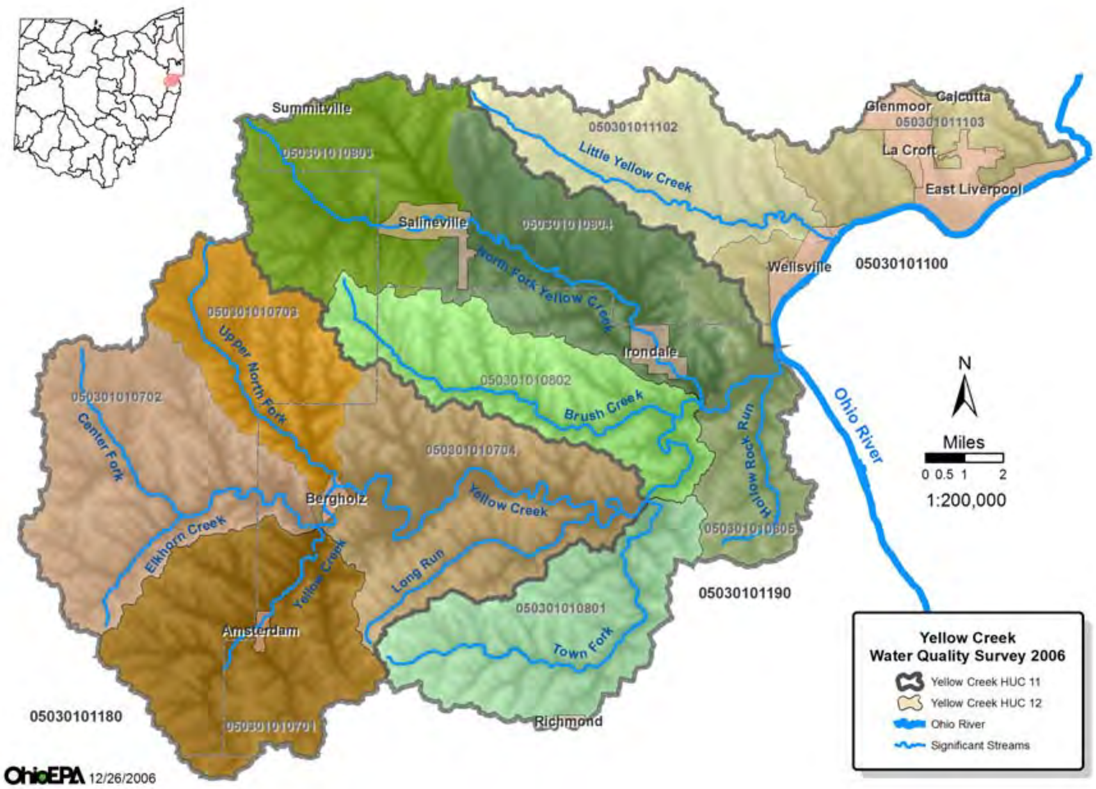

Figure 2.1. Location of the Yellow Creek watershed.

2.2 Ecoregion

The Yellow Creek watershed is located within the Western Allegheny Plateau (WAP) ecoregion. An ecoregion is an area having broad similarity with respect to climate, soil, topography and dominant natural vegetation. Less variation of aquatic biological communities, chemical water quality and physical stream attributes is expected within an individual ecoregion compared to the variation of these characteristics throughout all of Ohio. For this reason some of Ohio's WQS are ecoregion-specific.

Topography of the WAP ecoregion is within the Monongahela Transition Zone and is characterized by rounded hills and steep ridges. Soils are unstable and consist of clay, with underlying coal-bearing strata. The area has characteristic gas wells, coal mining, and extensive reclaimed lands. Forests occupy the steeper slopes, and some dairy, livestock, and cropland production is found in areas of lower relief.

2.3 Land Use

Over two-thirds of the watershed is forested, with some agriculture and scattered areas of historical mining. There is also a small portion that is actively being strip-mined for coal. See Figure 2-2 and Table 2-1 for an overview of land use within the watershed.

Table 2.1. Land use in the Yellow Creek basin study area by percent.

Land Use	Headwaters to Town Fork (05030101-180)	Town Fork to mouth (05030101-190)	Ohio River Tributaries (05030101-100-240)	Little Yellow Cr. (05030101-100-260)
Open Water	0.2	0.5	1.0	1.6
Developed, Open Space	5.6	6.2	28.1	8.1
Developed, Low Intensity	0.2	0.4	10.5	0.7
Developed, Med. Intensity	0.1	0.1	5.2	0.1
Developed, High Intensity	0.0	0.0	2.2	0.0
Barren Land	0.0	0.0	0.0	0.0
Deciduous Forest	70.8	72.0	43.9	61.1
Evergreen Forest	1.6	0.8	0.5	1.6
Mixed Forest	0.0	0.0	0.0	0.0
Shrub/Scrub	0.1	0.0	0.1	0.0
Grassland/Herbaceous	1.8	2.0	1.6	1.8
Pasture/Hay	12.7	12.7	5.9	19.1
Cultivated Crops	6.9	5.2	0.9	5.9
Woody Wetlands	0.0	0.0	0.0	0.1
Emergent Herbaceous Wetlands	0.0	0.0	0.0	0.0

Multi-Resolution Land Characteristics Consortium, National Land Cover Dataset 2001, www.mrlc.gov/mrlc2k_nlcd.asp

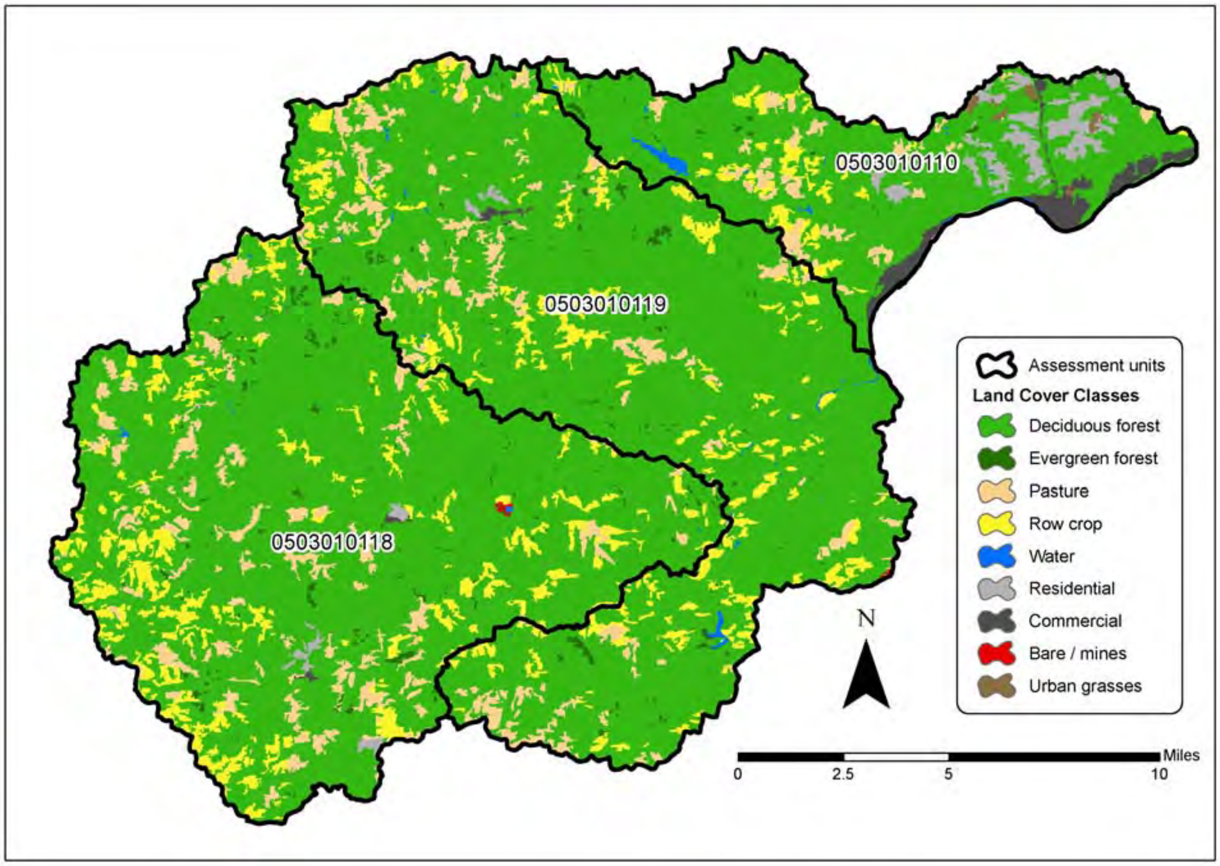

Figure 2.2. Land use in Yellow Creek and Little Yellow Creek basin

2.4 Population and Growth Projections

The Yellow Creek watershed is very rural in nature. Four small villages comprise the bulk of the population within the watershed. These include Salineville, Amsterdam, Bergholz, and Irondale. The unincorporated area, known as Hammondsville, does not have village status, but is located immediately downstream of Irondale and has a concentrated area of population. All the areas mentioned above, are unsewered, with the exception of Salineville, which does have central sewage collection and treatment to handle the town's wastewater.

Population in these villages has remained somewhat stable, with slight decreases in Amsterdam and Salineville, and slight increases in Bergholz and Irondale. Table 2.2 shows population changes within each of these areas.

Table 2.2. Population changes within selected villages within the Yellow Creek watershed

Village	2006	2000	1990
Amsterdam	553	568	669
Bergholz	748	769	713
Irondale	408	418	382
Salineville	1354	1397	1474

Source: US Census Bureau, 2006 Estimates, Census 2000, 1990 census

Based on county statistics from the U.S. Census Bureau, the watershed has generally lost population from 2000 to 2006. Specifically, Jefferson County which constitutes the largest area of the watershed suffered a population decline over this interval of 5.1%, while Columbiana County lost 1.4%. Carroll County saw a modest gain in population of 1.2%. This growth trend is not expected to change appreciably in to the future.

3.0 WATER QUALITY STANDARDS

TMDLs are required when a water body fails to meet water quality standards (WQS). Every state must adopt WQS to protect, maintain, and improve the quality of the nation's surface waters. WQS represent a level of water quality that will support the Clean Water Act goal of swimmable and fishable waters. Ohio's WQS, set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC), include four major components: beneficial use designations, narrative criteria, numeric criteria, and anti-degradation provisions.

Beneficial use designations describe the existing or potential uses of a water body. They consider the use and value of a water body for public water supply; protection and propagation of aquatic life; recreation in and on the water; and agricultural, industrial or other purposes. Ohio EPA assigns beneficial use designations to each water body in the state. Use designations are defined in paragraph (B) of rule 3745-1-07 of the OAC and are assigned in rules 3745-1-08 to 3745-1-32. Attainment of uses is based on specific numeric and narrative criteria. Not all uses apply to all waters.

Numeric criteria are estimations of chemical concentrations, degree of aquatic life toxicity, and physical conditions allowable in a water body without adversely impacting its beneficial uses. Chemical criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the water body. Biological criteria indicate the health of the in stream biological community by using one of three indices: Index of Biotic Integrity (IBI) which measures fish health; Modified Index of Well being (MIwb) which measures fish health; and Invertebrate Community Index (ICI) which measures benthic macroinvertebrate health. Narrative criteria, located in rule 3745-1-04 of the OAC, describe general water quality goals that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil, scum, color and odor-producing materials; substances that are harmful to human or animal health; and nutrients in concentrations that may cause excessive algal growth.

Antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Under such conditions water quality may not be lowered below criteria protective of existing beneficial uses unless lower quality is deemed necessary to allow important economic or social development. Antidegradation provisions are in Sections 3745-1-05 and 3745-1-54 of the OAC.

3.1 Aquatic Life Use

3.1.1 Aquatic Life Use Designations

Four aquatic life beneficial use designations are applicable in the Yellow Creek watershed: Warmwater Habitat, Exceptional Warmwater Habitat, Coldwater Habitat, and Modified Warmwater Habitat. The aquatic life use assigned to a water body is dependent upon its present or potential condition and the biological community it is capable of supporting.

<u>Warmwater Habitat (WWH)</u> is characterized by the typical assemblage of aquatic organisms in Ohio rivers and streams. WWH represents the principal restoration target for the majority of water resource management efforts in Ohio, and is in line with the Clean Water Act goal of fishable waters.

Exceptional Warmwater Habitat (EWH) is applied to waters that support unusual and exceptional assemblages of aquatic organisms. These assemblages are characterized by a high diversity of species, particularly those that are highly intolerant, threatened, endangered, or of special status (i.e., declining species). EWH represents a protection goal for the management of Ohio's best water resources.

Cold Water Habitat (CWH) is applied to waters that support native communities of cold-water organisms, and/or those that support trout stocking and management under the auspices of the Ohio Department of Natural Resources. Only two segments were previously designated CWH; however twenty-one segments are being recommended for this designation, based on the biological survey work.

Modified Warmwater Habitat (MWH) is applied to waters that have been subject to maintained and essentially permanent modification. The MWH designation is appropriate if the modification is such that WWH criteria are unattainable. Additionally, the modification must be sanctioned by state or federal law. MWH aquatic communities are generally composed of species that are tolerant to low dissolved oxygen, silt, nutrient enrichment and poor quality habitat. Where this use designation is applied, the allowable conditions in the MWH-designated stream may be driven by the need to protect a higher downstream aquatic life use designation (e.g., WWH, EWH).

Aquatic life use attainment is dependent upon numeric biological criteria (biocriteria). Biocriteria are based on aquatic community characteristics that are measured both structurally and functionally. The rationale for using biocriteria have been extensively discussed elsewhere (Karr, 1991; Ohio EPA, 1987a,b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991; Yoder and Rankin, 1995).

A number of the tributary streams evaluated as part of this study were originally designated for aquatic life use in the 1978 and 1985 Ohio WQS; others were previously undesignated. This study is the first comprehensive and robust use evaluation in these watersheds.

Overall, biological performance in the study area was quite high and assessments in 36 stream segments resulted in aquatic life use upgrades to Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH), or both. Included were two former Limited Resource Water (LRW) streams affected by mine drainage (Wolf Run and Salisbury Run) that are now recommended for CWH. Currently, the headwaters of Wolf Run remain impacted by acid mine drainage. However, over the last 20 years, historic reclamation activity and natural attenuation has resulted in far-field recovery, sufficient to support good to exceptional quality communities in the lower reaches.

Center Fork, a tributary to Elkhorn Creek, is recommended for redesignation from CWH to EWH. Biological performance in the Yellow Creek mainstem, particularly among the fish, has improved to the extent that an upgrade from WWH to EWH is recommended for the 21 mile reach between Bergholz and Hammondsville (RMs 24.3-3.3). Current and recommended aquatic life, water supply and recreation uses are presented in Table 3.2.

3.1.2 Criteria Used for Aquatic Life Uses

Ohio's biocriteria are based upon three evaluation tools: the Index of Biotic Integrity (IBI), the Modified Index of Well-Being (MIwb) and the Invertebrate Community Index (ICI). These three indices are based on species richness, trophic composition, diversity, presence of pollution-tolerant individuals or species, abundance of biomass and the presence of diseased or abnormal organisms. The IBI and the MIwb apply to fish; the ICI applies to macroinvertebrates. Details regarding IBI, MIwb and ICI sampling procedures are described in the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (Ohio EPA, 1987c). Provisions addressing biocriteria are in paragraph (A)(6) of Section 3745-1-07 of the OAC.

Ohio EPA uses IBI, MIwb, and ICI assessment results of reference-site sampling to establish biocriteria. Least-impacted reference sites are periodically evaluated to determine minimum-expected index scores associated with various stream sizes, designations, and ecoregions. Attainment of aquatic life use designation is determined by comparison of biological assessment results to biocriteria. If an assessment site meets all applicable biocriteria for the IBI, MIwb and ICI, then it is in full attainment. If it achieves none of the applicable biocriteria, then it is in non-attainment. If it achieves some, but not all, then it is in partial attainment. Table 3-1 presents biocriteria applicable in the Yellow Creek watershed for Western Allegheny Plateau ecoregion. Biocriteria do not currently exist for CWH; attainment is determined on a case-by-case basis.

Table 3.1. Western Allegheny Plateau Ecoregion criteria.

Biological Index	Assessment Method	WWH	EWH	MWH
IBI	Headwater	44	50	24
IBI	Wading	44	50	24
IBI	Boat	40	48	24
MIwb	Headwater	NA[1]	NA[1]	NA[1]
MIwb	Wading	8.4	9.4	6.2
MIwb	Boat	8.6	9.6	5.8/5.5[2]
ICI	All[2]	36	46	22

1. Not applicable to drainage areas less than 20 mile^2.
2. Channel modified/mine affected have slightly different values

3.2 Recreational Beneficial Use Designations

3.2.1 Recreational Use Designations

Primary Contact Recreation (PCR) is the only recreational use designation applicable to stream and river segments in the Yellow Creek watershed. PCR is applied to waters suitable for full-body contact such as swimming and canoeing. Recreational use designations are in effect for only the recreation season, which is defined as May 1st through October 15th. Recreational use designations are further described in Section 3745-1-7 of the OAC. No waters within the Yellow Creek basin are designated for Secondary Contact Recreation (SCR), even those headwater streams with drainage areas less than 20 square miles. Secondary Contact Recreation (SCR) mean waters that, during the recreation season, are suitable for partial body contact recreation such a wading with minimal threat to public health.

3.2.2 Criteria for Recreational Uses

Attainment of recreational use designation is evaluated by comparison to bacteriological numeric and narrative criteria. Ohio currently has bacteriological criteria for two indicator groups, fecal coliform and *Escherichia coli* (*E. coli*). Narrative criteria state that only one of the two indicator groups must meet all of their associated criteria to be in full use attainment. Bacteriological criteria apply outside the mixing zone of permitted discharges.

The numeric criteria for PCR state the geometric-mean fecal coliform content shall not exceed 1,000 per 100 ml, and fecal coliform content shall not exceed 2,000 per 100 ml in more than ten percent of samples taken. The numeric criteria for PCR also state that the geometric-mean *E. coli* content shall not exceed 126 per 100 ml, and *E. coli* content shall not exceed 298 per 100 ml in more than ten percent of samples takes. Fecal coliform and *E. coli* content is to be evaluated on no less than 5 samples collected within a 30-day period for PCR.

For purpose of this TMDL, recreational impairment is determined on a HUC 14 sub-watershed basis, using fecal coliform bacteria as the indicator. Impairment is assessed at the sub-watershed scale, because this level of detail is a compromise between project manageability and fidelity to the data. Fecal coliform is used to establish impairment, because it is more commonly associated with attainment than E.coli in Ohio's streams and rivers. Under Ohio's current WQS, a waterbody is in attainment of its recreational use if either indicator group (i.e., E. coli or fecal coliform) meets its applicable criteria irrespective of the results for the other indicator group.

A pooled dataset is assembled for each HUC14 sub-watershed to determine recreational impairment. Each dataset contains all applicable fecal coliform sample results collected within the sub-watershed during the recreational season of 2005. The geometric mean of each dataset is compared to the fecal coliform geometric mean criterion. Additionally, the 90^{th} percentile of each dataset is compared to the ten-percent-allowable exceedance level.

Streams undesignated in OAC 3745-1-13 were evaluated against the PCR criteria. The rationale for this approach is that, in all cases, the drainage areas of the undesignated streams were similar to the drainage areas of headwater streams currently protected for PCR, and thus should offer the same potential for full-body contact. Even streams with small watersheds can have pools of water, especially downstream from road culverts, where full body contact is possible for young children.

Table 3.2. Waterbody use designations for the Yellow Creek basin. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+) and a delta (Δ) indicates a new recommendation based on the findings of this report. Plus sign (+) designations shaded in gray are to be replaced by the new recommendations (Δ). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the left of existing markers.

Water Body		Use Designations												
		Aquatic Life							Water Supply				Recreation	
		SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Yellow Creek	- Headwater to Upper North Fk.		+							+	+		+	
	- Upper North Fk. to North Fk.		+	Δ						+	+		+	
	- North Fk. to mouth		+							+	+		+	
Hollow Rock Run			+				Δ			+	+		+	
Tarburner Run			*				Δ			*+	*+		*+	
North Fork Yellow Creek			+							+	+		+	
Salt Run	- Headwater to Irondale		*				Δ		+	*+	*+		*+	
	- Irondale to mouth (RM 0.3-0.0)		*							*+	*+		*+	
Salisbury Run							Δ	+		+	+		+	
Randolph Run								+		+	+		+	
Trib. to North Fk. (RM 6.1)			+							+	+		+	
Trib. to North Fk. (RM 8.96)														
	RM 0.18 Trib. to mouth						Δ			Δ	Δ		Δ	
Trib. to North Fk. (RM 9.65)							Δ			Δ	Δ		Δ	
Nancy Run				Δ			+			+	+		+	
Roses Run			*	Δ			Δ			*+	*+		*+	
Riley Run	- Headwater to UTrib. (3.75)		+						+	+	+		*+	
	- UTrib. (3.75) to mouth		+				Δ		+	+	+		*+	
Trib. to Riley Run (RM 3.75)							Δ			Δ	Δ		Δ	
Brush Creek	- Headwater to Rose Run (RM 6.32)		*							*	*		*	
	- Rose Run (RM 6.32) to mouth		*	Δ			Δ			*+	*+		*+	
Dennis Run			*	Δ			Δ			*+	*+		*+	
Town Fork	- Headwater to Jefferson Lake		*				Δ			*+	*+		*+	
	- Jefferson Lake to mouth		*	Δ						*+	*+		*+	
Keyhole Run				Δ			Δ			Δ	Δ		Δ	
Ralston Run			+	Δ			Δ			+	+		+	
Long Run	- Headwater to Hildebrand Run		*+							*+	*+		*+	
	- Hildebrand Run to mouth		*	Δ			Δ			*+	*+		*+	
Upper North Fork	- Headwater to Hump Run		+							+	+		+	
	- Hump Run to mouth		+	Δ			Δ			+	+		+	
Hump Run			*	Δ			Δ			*+	*+		*+	
Carroll Run			*				Δ			*+	*+		*+	
Hazel Run			*				Δ			*+	*+		*+	
Elkhorn Creek	- Headwater to Center Fork			+			Δ			+	+		+	
	- Center Fork to mouth			+						+	+		+	
Strawcamp Run	- Headwater to Chase Rd.			+			Δ			+	+		+	

Water Body	Use Designations												
	Aquatic Life							Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
- Chase Rd to mouth			+						+	+		+	
Center Fork			Δ			+			+	+		+	
Trail Run			Δ			+			+	+		+	
Frog Run			*			Δ			*+	*+		*+	
Gault Run		Δ							Δ	Δ		Δ	
Wolf Run (Creek in WQS)						Δ	+		+	+		+	
Cox Creek		*							*+	*+		*+	
Goose Creek		*				Δ			*+	*+		*+	
Yellow Cr. Trib. @ RM 30.22						Δ			Δ	Δ		Δ	
Elk Fork		*				Δ			*+	*+		*+	
Elk Lick		*				Δ			*+	*+		*+	
McQueen Run		*				Δ			*+	*+		*+	
Little Yellow Creek`		*+						+	*+	*+		*+	
Bailey Run						Δ			Δ	Δ		Δ	
Alder Lick Run		*+							*+	*+		*+	
Wells Run		*				Δ			*+	*+		*+	
Jethro Run						Δ			Δ	Δ		Δ	
Carpenter Run		*				Δ			*+	*+		*+	

4.0 ATTAINMENT STATUS

TMDLs are required in this project area because portions of Yellow Creek and Little Yellow Creek and their tributaries do not attain their beneficial use designations for aquatic life and recreation. When a water body fails to attain its designated uses, it is said to be impaired. Impairment in the Yellow Creek watershed was determined based upon an assessment conducted primarily from June through October 15, 2005. The assessment included biological, water chemistry and sediment sampling. Detailed results of the assessment can be found in the report titled *Biological and Water Quality Study of the Yellow Creek and Selected Tributaries, 2005-2006.* (Ohio EPA, 2008a).

4.1 Aquatic Life Use Attainment

Of 77 sites evaluated, 72% (55 sites) had biological communities fully meeting their designated or recommended aquatic life use while only 21% (16 sites) were impaired. Due to insufficient data, the attainment status at 8% (6 sites) was considered unknown.

Out of sixteen impaired sampling sites in the study area, eight (50%) were concentrated in WAU 100, the small, 45 square mile Ohio River watershed that includes Little Yellow. Many of the small, high gradient streams are clustered along the Ohio River corridor and tend to reflect impairment associated with urban runoff, highway construction (isolation or historic elimination of fish populations) and mining. In contrast, the Yellow Creek basin approached 100% attainment in both the upper and lower basins (96% and 88% attainment in WAUs 180 and 190, respectively). Basinwide, the levels of performance in Yellow Creek are among the highest found in the state. While coldwater communities were generally restricted to small drainages (<10 sq. mi.), very good and exceptional quality communities were typical across all stream sizes. Factors contributing to outstanding performance included intact stream habitats and adequate gradient, coupled with an almost pervasive groundwater recharge that tended to maintain cool, late summer flow in even the smallest drainages. These factors result in remarkable stream assimilative capacity across the landscape and tend to blunt the influence of local pollutant stressors.

All mainstem Yellow Creek and North Fork Yellow Creek sites supported biological communities meeting expectations for warmwater habitat (WWH) or EWH with one exception. The site that did not attain, Yellow Creek RM 3.3, was located immediately downstream from North Fork Yellow Creek. Mine drainage, associated with a problematic abandoned shaft seep at the mouth of the North Fork, was the suspected source of impairment (Ohio EPA, 2003). Biological and physical habitat impacts in this complex reach were exacerbated by flooding and channel movement, habitat alteration (with associated bank destabilization and sedimentation), and excessive all terrain vehicle traffic.

Of the remaining 15 impaired tributary sites, 9 were affected by flow alteration associated with impoundment, highway construction, mining or natural conditions, 3 were affected by mine drainage associated with coal mining, 1 was impaired by sewage from on-site septic tank systems (Cox Creek), 1 was impaired by siltation (upper Little Yellow Creek), and 1, upper Long Run, was impaired by natural, wetland conditions. Salt Run appeared impaired downstream from on-site septic systems in the Village of Irondale but attainment status was listed as unknown due to insufficient data collection (no fish sample).

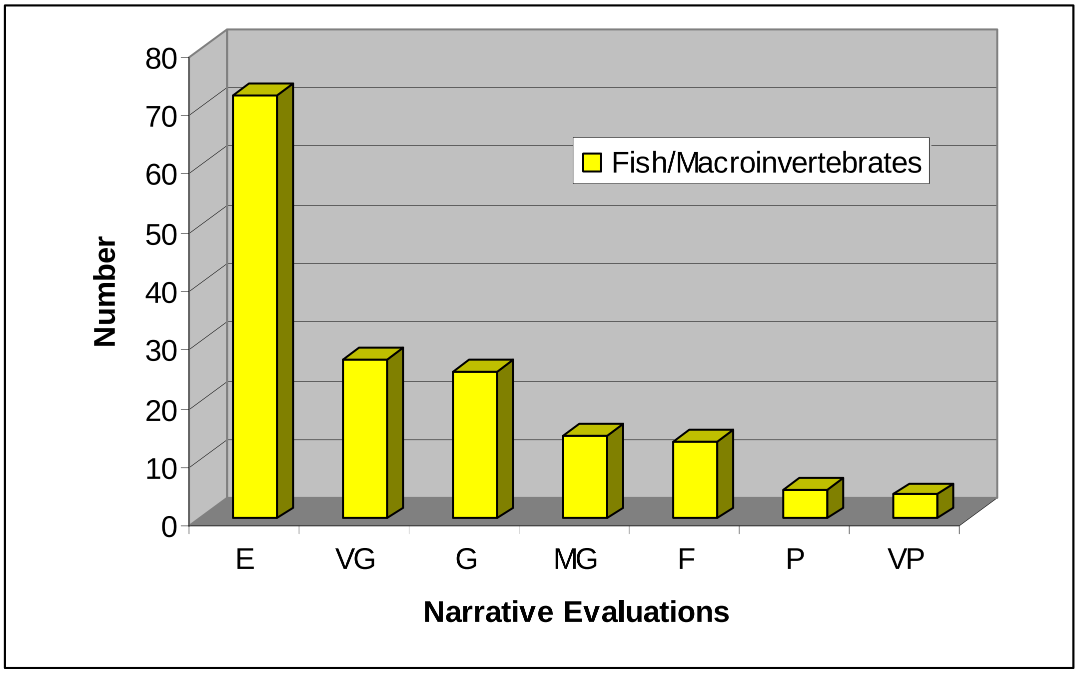

Figure 4.1. Narrative evaluations associated with fish and macroinvertebrate sampling. IBI, MIwb, ICI scores, Qual. Narrative evaluation are from the Yellow Creek and Ohio River Tribs./Little Yellow Creek basin surveys (WAUs 100, 180, 190) in 2005-2006. [E=Exceptional, VG=Very Good, G=Good, MG=Marginally Good, F=Fair, P=Poor, VP=Very Poor]

4.1.1 Ohio River Tribs./Little Yellow Creek Basin (Little Beaver Creek to Yellow Creek) WAU 05030101 - 100

With the exception of Little Yellow Creek, most tributaries in the basin are small, cool and high gradient and discharge directly to the Ohio River. Urban populations, highway constructions and industrial land usage is concentrated along this narrow Ohio River corridor and biological communities tended to reflect commensurate impacts associated with urban runoff, mine drainage, and disruption of fish colonization potential. Marginal biological performance in Little Yellow Creek was a result of nutrient enrichment and physical disruption of the flow regime along its length by a series of permanent impoundments and the Ohio River. As a result of these influences, very few streams in this small WAU met their aquatic life use.

Table 4.1 shows the assessment score for this assessment unit. Similar tables are created for the other assessment units in the following sub-sections. The assessment unit score is an average grade of aquatic life use status. A maximum assessment unit score of 100 is possible if all monitored sites meet designated aquatic life uses. The method of calculation is presented in the 2008 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2008).

Table 4.1. Summary of Yellow Creek study area assessment unit scoring.

Assessment Area	Aquatic Life Attainment Status							WAU Score
	Total number of sites	Full		Partial		NON		
		#	%	#	%	#	%	
Sites ≤ 50 square miles drainage area	9	1	7.1	3	39.3	5	53.6	**7**

4.1.2 Upper Yellow Creek Watershed: Headwaters to Town Fork (WAU 05030101-180)

Large proportions of the assessment unit fully met the existing or recommended aquatic life use designations and many sites reflected exceptional biological performance (48%) or coldwater potential (52%). Despite fairly pervasive agricultural land usage along valley floors (cattle, pasture), elevated fecal coliform levels (particularly near unsewered communities), and land disturbance from past and present mining activity, most streams performed at high levels. Cool water temperatures, high groundwater recharge resulting in sustained summer flows, and intact stream habitat appeared to result in remarkable assimilative capacity and minimal impairments in stream. One tributary (Cox Creek) was impacted by sewage and the headwaters of Long Run were naturally limited by wetland conditions and beaver dam impoundment. One additional site of less than 50 square miles was sampled that did not meet credible data requirements to completely evaluate aquatic life status; however, it supported exceptional macroinvertebrate assemblages.

Table 4.2. Summary of Upper Yellow Creek study area watershed assessment unit scoring (WAU -180).

Assessment area	Aquatic Life Attainment Status							WAU Score
	Total number of sites	Full		Partial		NON		
		#	%	#	%	#	%	
Sites ≤ 50 square miles drainage area	28	25	89.3	3	10.7	0	0	97
Miles of assessed streams with drainage area > 50 square miles and < 500 square miles	3	3	100	0	0	0	0	

4.1.3 Lower Yellow Creek Basin (Town Fork to mouth) WAU 05030101 -190

Like the headwaters of Yellow Creek, large proportions of the assessment unit fully met the existing or recommended aquatic life use designations and many sites reflected exceptional biological performance (35%) or coldwater potential (52%). The landscape tended to be more wooded with higher relief and localized, but more pronounced impacts from past and present mining activity. Again, cool water temperatures, high groundwater recharge, sustained summer flows, and intact stream habitat appeared to increase assimilative capacity and limit significant impairment in stream.

An additional three sites of less than 50 square miles were sampled that did not meet credible data requirements to completely evaluate aquatic life status. Two sites supported attaining macroinvertebrate assemblages and one site had macroinvertebrate assemblages that failed to meet ecoregional aquatic life expectations.

Table 4.3. Summary of Lower Yellow Creek study area assessment unit scoring (WAU -190).

Assessment area	Aquatic Life Attainment Status							WAU Score
	Total number of sites	Full		Partial		NON		
		#	%	#	%	#	%	
Sites ≤ 50 square miles drainage area	26	20	77.0	3	11.5	3	11.5	90
Miles of assessed streams with drainage area > 50 square miles and < 500 square miles	10.3	9.7	94.2	0.6	5.8	0	0	

4.2 Recreational Use Attainment

Recreational use impairment is fairly widespread in the Yellow Creek watershed. Recreational use impairment is caused by bacterial contamination associated with warm-blooded animals. Human sources of contamination include household sewage systems and storm sewer discharges. Animal sources are usually more intermittent than human sources because manure enters a stream via runoff associated with rainfall. However, if livestock has direct access to streams, the effects on water quality are much greater. Some livestock operations in the project area allow unrestricted cattle access to streams which provides a direct route for bacteria. Bacteriological contamination was also found near population centers and livestock operations in the upper Yellow Creek basin. The overall attainment status and summary data for the assessment units are presented in Table 4.4, while. Tables 4.5, 4.6, and 4.7, show data results for individual sites broken down by HUC unit and Figure 4.2 is a map of the distribution of geometric means for individual sites based on value ranges.

Table 4.4. Recreational use attainment status by watershed assessment unit.

			Fecal Colifom #cfu/100mL)		Attainment Status
WAU	**Location**	**N**	**75th %tile**	**90th %tile**	
100	Little Yellow Cr./Ohio River Tribs.	26	495	1750	FULL
180	Upper Yellow Cr. basin	106	2400*	7050**	NON
190	Lower Yellow Cr. basin	132	685	2090**	NON

75th percentile exceeds 1,000 cfu/100 mL **
90th percentile exceeds 2,000 cfu/100 mL

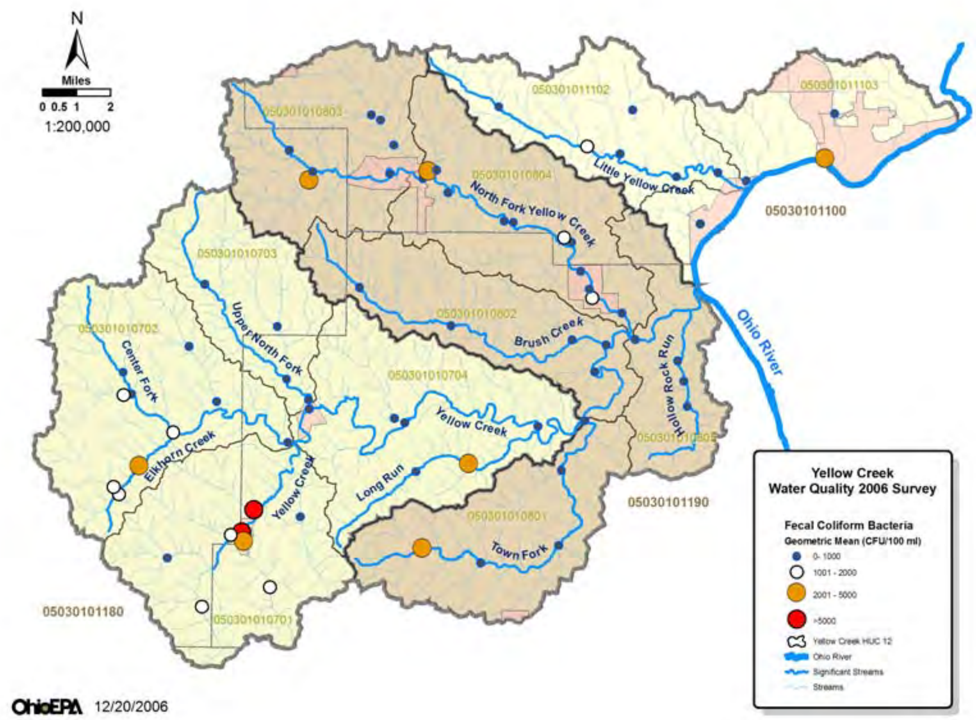

Figure 4.2. Summary of fecal coliform bacteria counts (geometric mean) in the Yellow Creek basin, 2005 data.

Table 4.5. Recreational use attainment impairment for HUC 05030101-100.

HUC 11	HUC 14	Stream Name	RM	Location	Storet Code	# Samples	Fecal Coliform (#cfu/100mL) Geometric Mean	Fecal Coliform (#cfu/100mL) 90th percentile	Attainment Status
HUC 05030101-100 Ohio R. (below L. Beaver Cr. to above Yellow Creek)	05030101-100-240	Carpenter Run	1.20	Adj. US RT 30	C04K13	2	480	923	FULL
		Jethroe Run	0.30	Upst. SR 7/39	C04K23	2	**3660**	**6230**	**NON**
		McQueen Run	0.20	Upst. SR 7	C04K08	3	42	59	FULL
		Wells Run	0.20	Upst. SR 7	C04K09	2	41	48	FULL
	05030101-100-260	Alder Lick Run	0.10	At mouth adj. Fife Coal Rd	C04K12	2	190	198	FULL
		Bailey Run	1.95	Osbourne Rd	C04K10	2	671	1380	FULL
		Little Yellow Creek	1.10	Hibbits-Mill Rd	C04K07	6	59	120	FULL
			3.30	Forbes Rd	C04K44	2	235	549	FULL
			6.70	McCormick Run Rd	C04K40	2	**1277**	**3108**	**NON**
			11.10	Clarks Mill Rd	C04K11	3	447	490	FULL

Table 4.6. Recreational use attainment impairment for HUC 05030101-180

HUC 11	HUC 14	Stream Name	RM	Location	Storet Code	# Samples	Fecal Colifom (#cfu/100mL)		Attainment Status
							Geometric Mean	90th percentile	
HUC 05030101-180 Yellow Creek (headwaters to above Town Fork)	05030101-180-010	Cox Creek	0.10	SR 164	C04K17	4	**11411**	**39400**	**NON**
		Elk Fork	1.60	Senlac Rd (TR 606)	C04K21	3	281	514	FULL
		Elk Lick	1.70	Queens Rd (TR 394)	C04K18	3	**1312**	**2020**	**NON**
		Goose Creek	0.10	Ridgewood St	C04W55	2	**2891**	**3640**	**NON**
			1.90	CR 267	C04W53	2	**1744**	**3588**	**NON**
		Trib Yellow Cr RM 30.22	0.10	Bear Rd (CR 28)	C04K16	3	**1382**	**5680**	**NON**
		Wolf Run	1.50	Wolf Run Rd	C04K22	3	326	640	FULL
		Yellow Creek	27.60	CR 75(A)	C04S29	6	**1495**	**6550**	**NON**
			29.84	Liberty St., Amsterdam	C04W51	6	**19205**	**57000**	**NON**
			30.00	Upst. Goose Creek	C04W50	6	**5191**	**18500**	**NON**
	05030101-180-020	Center Fork	0.10	Carry Rd	C04S54	3	**1222**	**2320**	**NON**
		Center Fork	1.90	Apollo Rd at ballpark	C04K54	2	476	783	FULL
		Elkhorn Creek	0.20	SR 164	C04S40	4	798	**2184**	**NON**
			6.80	SR 43	C04K04	3	**2098**	**2180**	**NON**
			7.90	Plane Rd	C04K14	2	**1775**	**2040**	**NON**
		Frog Run	0.10	At mouth	C04K46	1	240	240	FULL
		Gault Run	0.20	Apollo Rd (CR 12)	C04K49	3	**1305**	**2120**	**NON**
		Strawcamp Run	0.30	Bay Rd	C04K05	3	799	**2340**	**NON**
			2.20	Lane off Cinder Rd	C04K19	3	435	1204	FULL
		Trail Run	0.30	Bay Rd	C04K06	3	**1871**	**2340**	**NON**
	05030101-180-030	Carroll Run	0.10	Orchard Rd (TR 314)	C04K15	2	234	727	FULL
		Hump Run	0.10	SR 524, at mouth	C04K37	3	224	800	FULL
		Upper North Fork	0.30	Lane at SR 524	C04K45	3	563	1666	FULL
			5.70	Avon at TR 21	C04K25	3	421	1580	FULL
	05030101-180-040	Long Run	2.70	TR 284	C04K53	2	**3344**	**23443**	**NON**
		Long Run	4.30	CR 54	C04K26	3	348	518	FULL
		Ralston Run	0.30	CR 53	C04K24	4	417	**4657**	**NON**
		Yellow Creek	11.80	CR 53, Upst Long Run	C04K57	6	195	840	FULL
			17.90	CR 54, Upst Ralston	C04K55	5	343	**3396**	**NON**
			24.20	SR 164, Upst North Fork	C04S27	5	777	1660	FULL
			25.10	SR 164, Dst Elkhorn	C04S28	5	564	1996	FULL

Table 4.7. Recreational use attainment impairment for HUC 05030101-190

HUC 11	HUC 14	Stream Name	RM	Location	Storet Code	# Samples	Fecal Colifom (#cfu/100mL)		Attainment Status
							Geometric Mean	90th percentile	
HUC 05030101-190 Yellow Creek (above Town Fork to Ohio River)	05030101-190-010	Keyhole Run, trib Town Fk.	0.10	Dst TR 248, dst Austin Lake	C04K52	2	51	235	FULL
		Town Fork	0.10	CR 53, at mouth	C04S38	5	210	1528	FULL
			5.20	Shane Rd., CR 56	C04K43	3	726	**3390**	**NON**
			8.00	At ballpark, dst Lake	C04K39	4	252	1577	FULL
			10.40	Upst Jefferson Lake TR 262	C04K36	3	**2452**	**5920**	**NON**
	05030101-190-020	Brush Creek	0.10	CR 72, at mouth	C04S37	5	181	398	FULL
			6.10	TR 290	C04K38	2	357	833	FULL
			9.50	Dst Sterling Mine	C04K34	1	260	260	FULL
		Dennis Run	0.10	TR 61, at mouth	C04K51	2	35	109	FULL
		Yellow Creek	2.51	SR 213	609260	6	341	970	FULL
			5.70	Hammondsville USGS Gage	C04S24	14	206	889	FULL
	05030101-190-030	Nancy Run	1.00	Foundary Mill Rd (TR 740)	C04S53	3	127	160	FULL
			2.20	Dobson Rd	C04K31	3	140	416	FULL
		Riley Run	1.80	SR 39	C04K42	3	355	400	FULL
			4.80	April Rd	C04K29	3	179	610	FULL
		Roses Run	0.10	Foundary Mill Rd (TR 740)	C04K27	3	53	110	FULL
		Trib to Riley Run RM 3.75	0.30	Avon Rd	C04K33	3	**2324**	**2540**	**NON**
		Trib to Riley Run RM 3.76	0.01	At mouth	300015	3	273	618	FULL
	05030101-190-040	North Fk. Yellow Creek	0.80	Main St, upst SR 213	C04S31	3	457	640	FULL
			1.90	Dst Irondale & Dry Run, at park	C04K58	8	**1208**	**3520**	**NON**
			2.19	Upst Irondale, Creek St	C99Q01	3	222	532	FULL
			6.20	Adj. Salineville Rd	C04S33	3	74	100	FULL
			10.10	Dst WWTP at Haiti Rd	C04K48	3	**2147**	**4040**	**NON**
			10.35	Upst Salineville WWTP	C04S35	3	617	1260	FULL
		Randolf Run	0.20	CR 776	C04K01	2	**1265**	**3640**	**NON**
		Salisbury Run	0.10	CR 776	C04S36	3	7	20	FULL
		Salt Run	0.01	At mouth	C04K35	3	434	**2760**	**NON**
		Trib NF Yellow RM 6.08	0.10	Hazel Run Rd	C04K04	3	150	368	FULL
		Trib NF Yellow RM 8.96	0.10	Adj. Salineville Rd	C04K28	5	119	300	FULL
		Trib NF Yellow RM 9.96	0.40	Jackoblonski Rd	C04K30	3	40	506	FULL
	05030101-190-050	Hollow Rock Run	2.20	Hollow Rock Rd	C04K62	6	214	660	FULL
			3.00	Upst Carter Run	C04K32	3	209	708	FULL
		Tarburner Run	0.10	Hollow Rock Rd, at mouth	C04K50	3	178	440	FULL

5.0 PROBLEM STATEMENT AND NUMERIC TARGETS

TMDLs are required for the Yellow Creek watershed because portions of it fail to meet quality criteria associated with their beneficial use designations for aquatic life and recreation. This section of the report discusses the conditions sufficient to achieve these WQS. These target conditions are then compared to the existing water quality conditions to determine the level of abatement that is needed in order to meet WQS as well as for developing the necessary TMDLs.

The quality criteria for recreational uses are straightforward and based solely on specific pollutant concentrations in stream water that are found in the WQS (see Section 3.2.2). However, quality criteria for aquatic life uses are based on the performance of the aquatic community (see Section 3.1 regarding biological indices) and do not directly provide abatement targets for meeting the WQS. Unlike recreational uses, targets for biological criteria must be derived from other surrogate measures.

The assessment information discussed in Chapter 4 and the published Technical Support Document (TSD) cover attainment status and the stressors that preclude ALU attainment. The 303(d) list summarizes these results and provides the basis for TMDL development for this project area. Targets are established for these causes of impairment based on the best available scientific data, namely for total phosphorus (loading to three lakes associated with ALU impairment). Table 1.1 in Section 1.3 of this report summarizes the causes of impairment as found in the 2008 303(d) list and is organized by HUC 14 sub-watersheds. How these causes of impairment are handled in terms of TMDL development is also included in this table.

In addition to total phosphorus, targets are established for some AMD parameters which have been based on watershed specific data. Although not formal TMDLs, these targets can be used to provide additional insight on how aquatic life use attainment may be achieved throughout this project area.

The following is a basic description of the three stressor conditions that are the focus of this TMDL effort:

- ***Eutrophication** of Lakes* is the process by which a body of water becomes enriched in dissolved nutrients (as phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen.

- ***Acid Mine Drainage (AMD)*** is the seepage or runoff of groundwater and precipitation which has come into contact with coal or coal mine waste materials called ‘gob’. Drainage from these materials is often acidic and discharges from underground mines, surface mines, or mine waste disposal areas. AMD is often associated with abandoned coal mine lands (AML). AMD in Ohio is typically characterized by low pH, high metal concentrations, and low buffering capacity because of the lack of alkalinity. AMD can have a devastating effect with varying severity upon the aquatic life of a stream or river.

- ***Contamination by pathogens*** occurs when human or animal waste reaches the stream. Pathogenic organisms include bacteria, viruses, and protozoan. Contamination by pathogens is a human health issue, as skin contact or accidental ingestion can lead to various conditions such as skin irritation, gastroenteritis, or to more serious illnesses.

5.1 Water Quality Targets for Nutrient Enrichment

Nutrient enrichment is a cause of impairment downstream of three lakes within the Yellow Creek basin. The Ohio EPA does not currently have statewide numeric criteria for nutrients entering lakes; however, modeling of eutrophic state utilizing common standard limnologic targets can be accomplished.

A frequently used biomass-related trophic state index is that of Carlson (1977). Carlson's trophic state index uses algal biomass as the basis for trophic state classification, and there are three variables, chlorophyll pigments, Secchi depth, and total phosphorus, that independently estimate algal biomass. The relationship between Carlson's TSI and relative algal abundance is given in Table 5.1. For all three lakes modeled, the target trophic state index was set at 60, because of the need to reduce algal levels below nuisance conditions.

For the purpose of this TMDL, total phosphorus, chlorophyll *a*, and Secchi disk visibility is used as an indicator for the trophic state of each waterbody. Phosphorus is used because it is frequently the limiting nutrient to primary production in streams, rivers, and lakes of Ohio. The range that corresponds to a Carlson Index value of 60 is 24-48 μg/L of total phosphorus. Appendix A presents watershed survey data, modeling results, and source load allocations of total phosphorus.

The loading, or assimilative, capacity of the lakes in terms of total phosphorus delivery was determined by adjusting the simulated total phosphorus load to the lakes in the lake computer model (see Section 6.2.1 regarding the lake water quality model) such that the lake response was a trophic state below the value of 60 in the Carlson Index. The result varies from lake to lake and ultimately is considered to be the TMDL, which is synonymous with the assimilative capacity. The results of the total phosphorus TMDL for each of the lakes as they correspond to achieving the established target for the Carlson Index in Chapter 8 (see Table 8.1).

5.2 Water Quality Targets for Acid Mine Drainage

Acid mine drainage from abandoned strip and underground mines continue to effect portions of the Yellow Creek basin. Locations of biological impairment were found during the watershed survey. Water quality data collected during 2005 were compared to statewide values in order to identify potential mine drainage influences. Sites identified were put into two groups based on attainment status (full attainment versus partial and non attainment) and statistically compared. These sites were also stratified based on watershed size. Results of the statistical inference by comparative watershed approach and resulting percent reductions of mine drainage analytes are presented in Appendix B.

5.3 Water Quality Targets for Pathogens

Excessive loading of pathogenic organisms is the cause of recreational use impairment in four 14 digit HUC areas of the Yellow Creek basin. The targets used in developing the pathogen TMDLs are the numeric water quality standards that are discussed in Section 3.3 of this report. Namely, the target is the geometric mean criterion for fecal coliform which is 1000 counts per 100ml of sample.

Table 5.1. Explanation of the index values for the Carlson Trophic State Index (Carlson, 1977).

TSI	Attributes	Water Supply	Fisheries & Recreation
<30	**Oligotrophy:** Clear water, oxygen throughout the year in the hypolimnion	Water may be suitable for an unfiltered water supply	Salmonid fisheries dominate
30-40	Hypolimnia of shallower lakes may become anoxic		Salmonid fisheries in deep lakes only
40-50	**Mesotrophy:** Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	**Eutrophy:** Anoxic hypolimnia, macrophyte problems possible		Warm-water fisheries only. Bass may dominate
60-70	Blue-green algae dominate, algal scums and macrophyte problems	Episodes of severe taste and odor possible	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating
70-80	**Hypereutrophy:** (light limited productivity). Dense algae and macrophytes		
>80	Algal scums, few macrophytes		Rough fish dominate; summer fish kills possible

6.0 SOURCES OF IMPAIRMENT

This chapter discusses the various sources from which the stressors causing impaired uses emanate. In order for these stressors to be abated the sources that contribute the pollutant loading must be investigated and their contributions quantified. In all, TMDLs must identify significant sources of impairment, quantify their magnitude, and recommend a corrective action, such as load reduction or alternative management practice, to mitigate the effect of the source.

The first part of this chapter (Section 6.1) provides a definition of these sources whereas Chapter 7 discusses where they are found in the watershed. The second part of this chapter (Section 6.2) summarizes the technical approaches taken to quantify pollutant loads and how much comes from the respective sources in the watershed.

6.1 Definition of Sources

Sources of impairment to the Yellow Creek watershed include household sewage treatment systems, livestock with stream access, stream impoundments, current and past mining practices. These sources are defined in the following sections. Each section provides information concerning pollutant delivery pathway, and the primary environmental condition affected by the source.

Also included in the definition of sources is a statement on whether the load is considered to be a waste load or simply a load. Specifically, waste load allocations (WLA) are those that are applied to regulated entities such as wastewater dischargers and/or any holder of a NPDES permit. Load allocations (LA) are those applied to unregulated sources of the pollutant such as run-off from cropland, and are closely associated with nonpoint source pollution. This distinction is made because load reductions can be required via regulatory means for WLAs but not LAs.

6.1.1 Household Sewage Treatment Systems

Household Sewage Treatment Systems (HSTSs) are small wastewater treatment units serving individual homes or businesses. HSTSs are typically located on the property of the home or business that generates the waste.

There are many types of HSTSs, but those most common in the Yellow Creek basin are septic tanks with or without soil-adsorption fields, and aeration systems. The efficacy with which each system treats waste is dependent upon its age, the manner in which it is maintained, and characteristics of the site where it is located. Important site characteristics include soil drainage, water table depth, bedrock depth, land slope, and parcel lot sizes.

HSTSs affect water quality under multiple conditions. HSTSs discharging directly to a stream or river, such as many aeration or illicit systems, behave similarly to a point source. These types of systems primarily affect water quality under dry, low-flow conditions. HSTSs discharging indirectly to a stream via a tile drain or intermittent ditch may exhibit effects akin to a non-point source. Wastewater discharged to a dry tile or ditch may be of insufficient volume to sustain flow to the stream, but pollutants can accumulate and eventually be flushed by rainfall. These types of systems primarily affect water quality under wet-weather, high-flow conditions. Additional pollutant delivery pathways associated with HSTSs exist, but those discussed above are believed the most significant in the Yellow Creek watershed.

HSTSs are regulated by general permits issued by the local county health department. Many of the older systems may have been installed without any types of approvals, and have been grandfathered until such a time that the system shows failure or if a complaint is filed. Many of these systems are concentrated in the villages, and there are no alternatives for replacement of on-lot systems in many of these areas. Pollution from HSTSs contributes to the total wasteload.

6.1.2 Livestock with Stream Access

Livestock with stream access is a relatively minor source of impairment to the Yellow Creek watershed. Livestock is granted stream access to provide a source of water or to allow movement to pasture. Either of these situations can result in the contribution of large pollutant loads to the stream system. Of particular concern is bacterial contamination, because unrestricted livestock can deposit waste directly into the stream. This results in very high local bacteria concentrations, and can potentially affect downstream use as well. Livestock with stream access can also contribute to habitat and channel degradation. Livestock often graze to the stream's edge, eliminating essential riparian vegetation. Further, livestock trample, collapse, and destabilize stream banks. This can result in elevated instream TSS concentrations and downstream siltation. The pollution from livestock with stream access is not regulated by permit; therefore, it contributes to the total load.

6.1.3 Stream Impoundment

Stream impoundment describes the installation of a flow-control structure that restricts the downstream movement of water. Streams are impounded for multiple reasons. Flow control structures are installed for downstream flood control, to create a public water supply reservoir, to simplify sewer or utility crossing, to enhance recreational opportunities, or for aesthetic purposes. Historically, dams were used to provide local power for industries such as mills. The extent of the impoundment is depended upon the intended use.

Stream impoundments result in an area of pooled water behind the flow-control structure, which is characterized by greater depth and slower velocity than what would be expected if the flow was unrestricted. Stream impoundments alter the habitat of the channel by inundating pool-riffle-run complexes and facilitating deposition of fine sediments which blanket the bed material. Generally, this reduces the diversity of habitat available to aquatic organisms. Stream impoundments also increase the residence time of water behind the flow control structure, which has multiple impacts upon its chemical, physical, and biological properties. Specifically, algae production can be substantial in the upper profile of the reservoir which is transport to the downstream reaches of the stream. The export of this material degrades habitat through deposition of fine seston materials, and can lead to oxygen depletion accompanying the decay of this plant material.

The poor habitat quality upstream of the reservoirs and poor water quality downstream from the reservoirs is responsible biological impairments.

6.1.4 Mining

Acid mine drainage (AMD) is the seepage or runoff of groundwater and precipitation which has come into contact with coal or coal mine waste materials called “gob”. Drainage from these materials is often more acidic and discharges from underground mines, surface mines, or mine waste disposal areas. AMD is often associated with abandoned mine lands (AML). AMD in Ohio is typically characterized by low pH, high metal concentrations, and low buffering capacity because of the lack of alkalinity. AMD can have a devastating effect with varying severity upon the aquatic life of a stream or river.

Often, water bodies that receive AMD, have certain characteristic signatures. These include:

- low pH, especially if measured close to the source
- elevated iron other elevated metals associated with coal, including aluminum, arsenic, cadmium, copper, lead, manganese, and zinc
- visual precipitate formed by manganese (bluish-black precipitate), aluminum (grayish-white precipitate), and iron (reddish-orange precipitate, also known as “yellow boy”)
- elevated sulfates
- depletion of alkalinity and increase in acidity, hardness, conductivity, and total dissolved solids
- low dissolved oxygen.

6.2 Summary of Methods to Quantify Source Loading

This section of the report provides a brief summary of the technical approach used in developing the TMDLs. Chapter 8 presents the results of the technical analyses.

A TMDL includes existing loads, loading capacity, allocation of the loading capacity to sources, a margin of safety, and an explanation of how seasonality and critical conditions have been accounted for in developing the TMDLs. Existing loads reflect the current pollutant loading to surface waters and the loading capacity is the TMDL itself, which is typically determined by the target concentrations relative to the average hydrologic conditions in the watershed. Allocations are loading rates permissible to each of the sources of the pollutant of interest. A margin of safety (MOS) is some portion of the TMDL that has been discounted in the allocations to the relevant sources of the pollutant to ensure that WQS will be met with the TMDL allocations developed. The MOS is designed to offset uncertainty surrounding estimation of the loads as well as the target values used. Critical conditions and seasonality are considered in developing TMDLs to ensure that pollutant controls or other abatement will be implemented effectively.

The remainder of this section is organized according to the technical tools used in to quantify the magnitude of the pollution contribution from each source of impairment. Table 6.1 shows where these respective tools are applied in the project area.

6.2.1 Generalized Watershed Loading Functions (GWLF)/BATHTUB

Two major processes were modeled to estimate algae production in the reservoirs. A steady-state model is used to estimate algae production relative to the existing total phosphorus in the lake. In developing the TMDL, therefore, total phosphorus loading to the lakes must also be estimated.

The Generalized Watershed Loading Functions model (Haith *et al.*, 1992), coupled with BATHTUB (Walker, 1987), were used to develop phosphorus TMDLs for Jefferson Lake, Highlandtown Lake, and Wellsville Reservoir. BATHTUB models the trophic state (e.g., algae production) of each of the lakes, while GWLF predicts the nutrient loads and hydraulic flows received by each of the reservoirs. The purpose of the modeling effort was to determine the nutrient loads from each significant source category (specifically agricultural runoff and septic systems). The U.S. Army Corps of Engineers’ BATHTUB model was selected to simulate trophic conditions (i.e., algae productivity).

Table 6.1. Models utilized for TMDL development of Yellow Creek

HUC_14	NARRATIVE	Method of TMDL Modeling			
		BIT/ SCS CN pathogens	GWLF nutrient	BATHTUB eutrophication	Comparative Analysis AMD
100-240	Ohio River below L. Beaver Cr. to above Yellow Cr. [except Mill Cr.(PA) & L. Yellow Cr.]				
100-260	Little Yellow Creek		√	√	√
180-010	Yellow Creek above Elkhorn Cr.	√			
180-020	Elkhorn Creek	√			
180-030	Upper North Fork				
180-040	Yellow Creek below Elkhorn Cr. to above Town Fk. [except Upper N. Fk.]	√			
190-010	Town Fork		√	√	
190-020	Yellow Creek below Town Fork to above N. Fk. Yellow Cr.				√
190-030	Riley Run to below Nancy Run				√
190-040	North Fork Yellow Cr. below Nancy Run to Yellow Cr.	√			√
190-050	Yellow Creek below North Fork to Ohio River				√

BATHTUB is an empirical, steady-state model which simulates the relationship between phosphorus, nitrogen, and chlorophyll a concentrations and water transparency. It incorporates several empirical equations of nutrient settling and algal growth to predict steady-state nutrient and chlorophyll *a* concentrations based on waterbody characteristics, hydraulic characteristics, and nutrient loadings. Total phosphorus and chlorophyll *a* were the primary indicators of eutrophication (i.e., high algae production); however, nitrogen and secchi disk readings were analyzed in the modeling as well. The BATHTUB model was selected because it does not require extensive data, which is lacking in the watersheds, and it can use the non-point source loads calculated by GWLF.

The GWLF model was chosen because of its widespread use in TMDLs and its ability to simulate important processes, specifically hydrology and nutrient transport. Ten years of actual flow data from USGS record gage and two seasons of chemistry results from the Yellow Creek basin survey were used to calibrate and compare model results. GWLF input parameters were assigned based on available monitoring data, default parameters suggested in the GWLF User's Manual (Haith *et al.,* 1992), and the meteorological record. Default values were used for many parameters due to a lack of local data and also to ensure the modeling results are consistent with previously validated studies. Sediment was not considered a factor in the water quality modeling of nutrients because the majority of each of the lake's watershed is forested and soils are not likely to be very erodible.

Similar to GWLF, BATHTUB was chosen based on the ability to simulate the reservoir conditions without substantial historic data requirements. Site specific morphometric, meteorological, hydrologic, and water quality data of the lakes as well as influent/effluent streams were used to calibrate the coupled modeling effort. Simulated watershed loads and flows from GWLF as well as eutrophication modeling with BATHTUB were completed for the 10 years up to and including the water quality survey years. With these model results, percent reductions of nutrient load to the lakes are proposed to reduce eutrophication to a level that is generally accepted as just below that of nuisance algae conditions. Within the non-nuisance level of in-basin chlorophyll *a*, the effluent is not expected to create nuisance algae conditions. This trophic state level should eliminate the habitat reduction from the algal fines sedimentation found during the watershed survey.

Table 6.2 summarizes the technical approach taken for the total phosphorus TMDLs. Additional detail regarding the models, calibration data, and results of the analysis can be found in Appendix A of this report.

Table 6.2. Summary of total phosphorus TMDL development

Development step	Source	Method
Existing load	surface runoff	GWLF nutrient modeling and field data comparison
	ground-water	GWLF nutrient modeling
	point source	Discharger permit limit used as phosphorus loading
	HSTS	Population served by failing HSTS estimated via GIS and county Health Departments. Phosphorus load based upon population estimate and a per capita loading rate.
Calculation of loading capacity	-	Product of the annual discharge volume from each sub-basin (GWLF hydrology) and the phosphorus target concentration.
Allocation	surface runoff	LA is equal to the sum of all WLAs and the MOS subtracted from the assimilative capacity.
	Point Sources	Product of design flow rate and technology based effluent limitation of 1.0 mg TP/ml (or less depending on plant type).
	natural runoff	The expected background phosphorus load is determined based on running GWLF considering all lands to be unmanaged.
	HSTS	Septic systems are allocated a phosphorus load of zero.
	MS4	MS4s are allocated a portion of the total LA. MS4s allocations are the product of the percentage of the sub-basin area occupied by MS4s and the sub-basin surface runoff allocation.
	MOS	Five percent of the assimilative capacity is reserved for the margin of safety.

6.2.2 Bacteria Indicator Tool (BIT) and SCS Curve Number

The pathogen TMDL was developed at the spatial extent of the HUC 14 subwatershed for all areas impaired by elevated bacteria. The target conditions are based on the concentration of bacteria; therefore both the gross loading of bacteria (measured as a numeric count) to the stream as well as the volume of the stream (expressed as a flow rate at a particular instant in time) is needed.

All the watersheds within the Yellow creek basin were sampled for fecal coliform bacteria during the summer of 2005 (see Tables 4.6, 4.7, and 4.8). The HUC 14 units were selected to be modeled for pathogens based on the number of samples in exceedance of the WQS coupled with the proportion of sites within the HUC 14 that had exceedances. For example, if a HUC unit had numerous sampling locations with multiple samples that exceeded recreational use standards, the entire 14-digit HUC is modeled. All recreational use impaired watersheds are modeled by BIT.

The U.S. EPA Bacteria Indicator Tool (BIT) model was used to estimate the existing gross coliform loading to the streams within these HUC units. BIT estimates the amount of bacteria that accumulates on the landscape, which is then available for transport in runoff to surface waters. Runoff is simulated using the SCS curve number method (SCS, 1986) and total instream flow rates are determined using this and the USGS gage flow separation methods which determines groundwater contributions. Daily runoff volumes were calculated for ten recreational seasons.

Table 6.3 summarizes the technical approach taken for the pathogen TMDLs. More detail regarding the models used, calibration data, and results of the analysis can be found in Appendix C of this report.

Table 6.3. Summary of pathogen TMDL development

Development step	Source	Method
Existing load	Surface runoff	BIT tool with spreadsheet runoff model
	Point source	No Point Source Discharges within the Impaired HUC Units
	HSTS	Population served by failing HSTS estimated via GIS and county Health Departments. Fecal coliform load based upon population census and growth/decline estimates and BIT Model per capita loading rate
Calculation of loading capacity	-	Product of the recreation season discharge volume from each sub-basin (SCS CN hydrology and USGS gage Base flow separation) and the allowable fecal coliform geometric mean concentration
Allocation	Point sources	Village of Salineville NPDES permit limit allocated
	Surface runoff	Total Allowable Load Allocation is equal to the sum of all WLAs subtracted from the assimilative capacity.
	HSTS	Septic systems are allocated a bacteria concentration and subsequent load in compliance with Individual HSTS NPDES permit

6.2.3 Comparative Analysis for Acid Mine Drainage (AMD)

The purpose of this analysis is to identify streams in the Yellow Creek watershed that are not meeting their potential attainment status as listed in Rule OAC 3745-01 because of impacts from acid mine drainage (AMD). It should be noted that this analysis is not a TMDL; however, targets and associated reductions for the concentration of problematic AMD parameters are proposed. This constitutes initial steps towards TMDL development but fall short by not estimating existing loads, calculating loading capacities, or making allocations.

The targets are developed through a statistical comparison between AMD receiving streams that fully meet the biocriteria and those that are impaired (i.e., non/partial biological attainment). The survey sites used in the analyses are also stratified according to stream size as measured by drainage area.

A preliminary screening process was used to ensure that biologically impaired sites are likely to be impacted by AMD. Additionally differences in habitat quality were tested between the groups to determine if habitat quality is responsible for the differences in biological performance between the attaining and impaired sets of survey sites. After satisfying the criteria of the statistical analyses, the resulting target values for the various AMD parameters are based on the median values for the group fully meeting the biocriteria (i.e., despite receiving AMD from upstream sources). Deviations from these established target values are determined on a site-by-site and parameter-by-parameter basis through simple arithmetic operations.

Appendix B provides the details of the methods used in this statistical analysis as well as the resulting targets that were established.

7.0 WATERSHED SOURCE SUMMARY

This chapter discusses the sources of impairment to Yellow Creek and Little Yellow Creek watersheds and is organized by assessment unit and the major source categories. Each section begins with a brief summary of the geographic extent of the watershed and those major sources that are impacting it.

7.1 Upper Yellow Creek Watershed (HUC 180)

The upper Yellow Creek watershed corresponds with the hydrologic unit 05030101-180. This watershed marks the origin of Yellow Creek and ends just above the confluence of Town Fork. Aquatic life attainment in the upper Yellow Creek watershed meets or exceeds use designation in most of the watershed, with the exception of Cox Creek. Causes of aquatic life impairment in Cox Creek can be attributed to organic enrichment and low dissolved oxygen. Recreational use impairment is pervasive in this watershed. The sources for impairment of recreational use include some streams with cattle access and discharging home septic systems in Amsterdam and Bergholz, as well as some scattered residential development outside of these villages. There is only one NPDES discharger, Elkhorn Valley Christian Service Camp (permit # 3PR00454), that is contributing a fecal coliform waste load in a HUC 14 watershed impaired for recreational uses.

7.1.1 Home Sewage Treatment Systems

Pollutant wasteloads contributed to the upper Yellow Creek watershed from HSTSs are presented in Table 8.3. Failing HSTSs are one of the largest sources of bacterial contamination in the watershed. HSTSs are distributed throughout the entire area, but clusters of residences often constitute the largest problem, especially within the villages of Amsterdam and Bergholz, and the adjacent, more populated areas. These areas are described below.

The Village of Amsterdam is located in Springfield Township of Jefferson County at the intersection of SR 43 and SR 164. Amsterdam has approximately 251 housing units located near the headwaters of Yellow Creek. It is just west of this village where the confluence of Elk Fork and Elk Lick merge to form Yellow Creek. Cox Creek enters Yellow Creek just north of the village of Amsterdam.

The Village of Bergholz is also located in Springfield Township of Jefferson County, approximately 2.5 miles north of Amsterdam. SR 524 intersects with SR 164, inside the corporation limits. Bergholz has 317 housing units within its corporation. The mainstem of Yellow Creek flows through this village, and Upper North Fork has confluence with the mainstem of Yellow Creek within this village. Elkhorn Creek flows into Yellow Creek, just south of Bergholz at RM 25.85.

7.1.2 Cattle Access to Streams

Manure loading to streams from cattle operations is somewhat problematic in this assessment unit and fairly scattered throughout. Areas of particular concern are those which show elevated bacteria concentrations coincident with observed cattle operations, especially those where cattle have free access to streams. Areas that fit the above description are found along Long Run, Ralston Run, Elkhorn Creek, Elk Lick Run, and Gault Run.

7.2 Lower Yellow Creek Watershed (HUC 190)

The lower Yellow Creek watershed begins just below the confluence of Town Fork and ends at the mouth, where it empties into the Ohio River at RM 931. Major tributaries include Town Fork, North Fork Yellow Creek, Brush Creek, and Hollow Rock Run. Aquatic life attainment shows impairment at some select locations. The lower segment of Yellow Creek shows impairment at RM 3.3, just downstream North Fork Yellow Creek, probably due to a large AMD discharge near the mouth of North Fork. Also showing impairments were Town Fork, below Jefferson Lake, due to this impoundment; Riley Run; North Fork Yellow Creek tributaries at RM 9.65 and RM 6.08; and Salisbury Run, all attributed to mining, with the exception of the unnamed tributary at RM 9.65, which was attributed to natural causes.

Recreational impairment was only noted in one sub unit (190-040). This area includes North Fork Yellow Creek and its tributaries. Salineville, located near the headwaters of North Fork Yellow Creek, has central sewers and a wastewater treatment plant, but Irondale does not. Population is more concentrated in this area of the subwatershed.

7.2.1 Eutrophication from Lakes

Town Fork, below Jefferson Lake, showed aquatic life impairments. See Table 7.1. Town Fork is a small stream (total length 12.4 miles; drainage area 26 square miles, average fall of 43.7 feet per mile) that flows into the mainstem of Yellow Creek at RM 8.75 near New Somerset, Ohio. Land use is mostly agricultural and forested.

Jefferson Lake

The discharge from Jefferson Lake comes from the epilimnion, or the upper stratum of the lake, as it flows over a concrete ogee type spillway. Figure 7.1 is a photograph taken on September 1, 2006, of Jefferson Lake from the location of the spillway. Subsurface drainage of the dam structure is discharged at the base of the dam to Town Fork.

The algae biomass was significantly elevated within the mixed layer of Jefferson Lake and the increase in chlorophyll a was carried over into Town Fork by discharge over the spillway and into the stream channel below. Dilution of the chlorophyll a in Town Fork could have occurred from lower strata lake water flowing downstream through dam seepage discharges observed at the base of the dam from the dam drainage system.

Figure 7.1. Jefferson Lake photo taken from spillway 9/1/06 (beach in background).

7.2.2 Acid Mine Drainage

Impairment of aquatic life use as a result of acid mine drainage was noted at four sites within this AU. Both current mining and historic mining remnants can be seen within the basins. The sites with aquatic life impairments are North Fork Yellow Creek tributary at RM 6.08, Riley Run, and Salisbury Run. Salisbury Run showed significant impact from historic coal mining activity. This stream also was stained with a bright orange floc of ferric hydroxide, which is a violation of OAC section 3745-1-04(C), which states that all waters of the state shall be “Free from materials entering the waters as a result of human activity producing color, odor, or other conditions in such a degree to create a nuisance”. Also, pH levels were well below the minimum 6.5 water quality criterion. Riley Run also had similar issues, with elevated mine drainage parameters. Riley Run was considered in non-attainment for WWH.

7.2.3 Sewage Treatment Systems

Only HUC 14 subwatershed 05030101-190-040 showed impairment of recreational use designation. This area includes the North Fork Yellow Creek subwatershed. One direct discharger, the village of Salineville, is located in the headwaters. The village of Irondale, and the unincorporated area of Hammondsville are both unsewered, but have a slightly higher population density. Failing HSTSs contribute to the recreational use impairment.

The village of Salineville holds an NPDES discharge permit (3PB00026) for their treated sanitary waste. Some NPDES permit violations occurred during the time of sampling, but corrections have been made to bring the facility back into compliance. Salineville is located in Washington Township of Columbiana County at the intersection of SR 39 and SR 164. Salineville’s wastewater treatment plant discharges to North Fork Yellow Creek at RM 10.32, just downstream from the confluence of Nancy Run and Riley Run. Nancy Run and Riley Run merge within the corporation to form the headwaters of North Fork Yellow Creek. Salineville has approximately 594 housing units, with a population of 1354.

Irondale is a small, incorporated village, located in Knox Township, Jefferson County, and is located near RM 2.0 on North Fork Yellow Creek just north of SR 213. Irondale has approximately 167 housing units with a population of 408 (U.S. Census Bureau). Hammondsville is located directly south of Irondale, very near the confluence of North Fork with Yellow Creek. This is an unincorporated area with several homes and few small businesses.

Figure 7.2. Homes along a tributary to North Fork Yellow Creek in the unsewered community of Irondale (left). Storm sewer with a suspected sewage discharge (right).

7.2.4 Cattle Access to Streams

Recreational use impairments are restricted to one 14 digit HUC in this assessment unit and sources are primarily related to inadequate sewage treatments systems. However manure contributions from cattle are also a concern in some relatively discrete areas which found along Town Fork above Jefferson Lake and in a tributary of Riley Run (confluence with Riley Run at RM 3.75).

7.3 Little Yellow Creek Watershed and Ohio River tributaries (HUC 100)

Little Yellow Creek is a direct tributary to the Ohio River, and several smaller, direct tributaries are also included in this HUC unit. These include Carpenter Run, Jethro Run, Wells Run, and McQueen Run. This HUC unit had the most concentrated area of biological impairment, mostly due to poor fish scores. Many of the small, high gradient streams are clustered along the Ohio River corridor and tend to reflect impairment associated with urban runoff, highway construction, and mining. Steep slopes prevent fish migration upstream from the Ohio River. Highlandtown Lake and Wellsville Reservoir are both on Little Yellow Creek, and biological impairments are found below both of these impoundments.

Recreational impairment is likely along Jethro Run and on Little Yellow Creek at RM 6.7; however only two samples were collected, so attainment status cannot be determined. Future sampling will occur to determine if there is impairment, and an attempt will be made to investigate the suspected sources (failing HSTS or cattle). Full attainment of recreational use was recorded at all other sites.

7.3.1 Eutrophication from Lakes

Little Yellow Creek is not meeting aquatic life use designations, believed to be the result of two impoundments located on this stream. The impoundments are barriers to fish passage which limits colonization to upstream habitats that have been temporarily disturbed (e.g., from a flood). However, water quality is also impacted due to the accumulation of nutrients and subsequent algal production resulting from the relatively long residence time. The algal production impacts downstream habitat and water quality.

Wellsville Reservoir
Two reservoirs impound the Little Yellow Creek mainstem. The most downstream is the Wellsville Reservoir with a dam structure at RM 4.20 (dam constructed in 1926). Bailey Run also flows into this reservoir from the north at about RM 4.40. During the 2005 and 2006 survey this reservoir was utilized by the Buckeye Water District as a primary source of public drinking water. About 0.768 MGD of reservoir water was diverted to the Buckeye Water District-Wellsville plant for treatment [Source Water Assessment Plan (2003) for the Wellsville Reservoir]. The intake structure located near the dam and the orifices were located at multiple depths. Wellsville Reservoir and the intake structure can be viewed in Figure 7.2.

Although the reservoir is drawn from for drinking water at various depths, the receiving stream flow occurs by overtopping of the spillway. Therefore, the receiving stream obtains water from the epilimnion only. Other discharges to Little Yellow Creek downstream of the dam observed during the September, 2006, field visits were dam seepage as well as water treatment plant backflush washwater batch discharge. Samples of lake discharge, flow data, and data sonde investigations were completed in Little Yellow Creek upstream of the WTP discharge outfall.

The algae biomass was significantly elevated within the epilimnion and the increase in chlorophyll *a* was carried over into Little Yellow Creek by discharge over the spillway and into the stream channel below. Chlorophyll a concentrations from the feeder streams are several times lower than what is found in the epilimnion (nearly six times lower for Little Yellow Creek) and four times lower than stream values down from the spillway. Dilution of the chlorophyll *a* in Little Yellow Creek could have occurred from deeper lake water that discharges downstream via dam seepage. Such seepage has been observed at the mid-dam height and evidenced at the base

Highlandtown Reservoir
The upstream impoundment on Little Yellow Creek is Highlandtown Reservoir (dam constructed in 1968) maintained by the Ohio Department of Natural Resources for public boating and fishing. An un-named tributary enters from the north into this lake at RM 10.15. The dam structure is located at RM 8.10 on Little Yellow Creek. Morphometric data for this reservoir can be viewed in the BATHTUB model section of this report. Figure 7.3 is a photograph of Highlandtown Reservoir taken from the spillway and looking upstream toward the Little Yellow Creek inlet of the dam from the dam drainage system.

Figure 7.3. Wellsville Reservoir and Buckeye Water District intake photo taken from spillway 9/6/06.

Figure 7.4. Highlandtown Reservoir photo taken from dam on 9/6/06

Bracket sampling of chlorophyll *a* from influent, reservoir, and effluent data is presented. Results show that both the epilimnion of the Highlandtown Reservoir and Little Yellow Creek downstream of the spillway have chlorophyll a concentrations that are nearly twice as high as what is found in Little Yellow Creek upstream of the reservoir.

A water quality survey of Highlandtown Reservoir was also conducted in 2005 at a single sampling location near the dam and showed that algal production was significantly lower than it had been in 1978. The authors hypothesize that the population of algae eating zooplankton has been increasing and therefore consuming more algae. This may be caused by a decline in zooplankton eating fish due to predation by managed game fish species. More detail regarding the results of the initial survey are discussed in the TSD report. (Ohio EPA, 2008).

7.3.2 Acid Mine Drainage

Two streams within HUC 05030101-100 showed aquatic life use impairment, due to acid mine drainage. These streams include Alder Lick Run, a tributary of Little Yellow Creek, and Wells Run, a direct tributary of the Ohio River. Along with high conductivity and TDS, elevated levels of sulfates and manganese were also noted. The surrounding area was historically mined. Wells Run, on the other hand, was found to be significantly impacted by upstream mine drainage, with pH levels below the minimum WQS of 6.5 S.U. Orange floc was also noted to be covering the stream bed, a violation of statewide “free from” narrative criteria (OAC section 3745-1-04).

8.0 TMDLs and Allocations

This chapter of the report provides the results of the TMDL analyses. Also included are factors that, as per federal requirements, must be accounted for when developing TMDLs. Namely, the allocation of the TMDLs to the respective sources including both load and wasteload allocations, an added margin of safety, an explanation on how seasonality and critical conditions have been handled and/or acknowledged in developing the TMDLs.

The TMDLs and subsequent allocation found herein provide the basis for states to establish water quality-based controls. These calculated values should provide the pollution reduction necessary for a waterbody to meet water quality standards.

8.1 Phosphorus-based TMDLs

Total phosphorus TMDLs were developed for the areas draining to Jefferson Lake on Town Fork, Highlandtown Reservoir and Wellsville Reservoir on Little Yellow Creek. Each of the lakes experience high algal production that contributes to the aquatic life use impairment downstream largely because of impact to habitat quality (i.e., fine algal material causes embeddedness in stream bed substrates).

The total phosphorus TMDLs were established based on the response of the three reservoirs to total phosphorus loading. Specifically, a target was established for the trophic status of the reservoir based on the Carlson Index. BATHTUB was used to model the trophic response to the total phosphorus loading from tributary sources. Iterations of the model were made using different total phosphorus loading rates to determine acceptable loading from upstream sources (i.e., those that do not result in exceeding the target). This resulting total phosphorus load is the TMDL.

8.1.1 Summary of Results

Highlandtown Reservoir
The existing average yearly loading for total phosphorus in the Highlandtown Reservoir was calculated at 77.04 kg. The majority of this loading is from failing septic systems (61.3 kg) with small fractions from runoff (10.2 kg).

Results of BATHTUB modeling and 2006 data for in-lake chlorophyll *a*, total phosphorus, Secchi depth visibility, and Carlson's trophic state index are presented in Appendix A in Figures A16 to A19, respectively. For each of these data sets, the real data compares well with modeled data, while some of the modeled data perfectly corresponds to the actual data.

BATHTUB predicted a range of seasonal in-lake chlorophyll *a* concentrations from 13 to 52 ug/L. Eight of the ten modeled years, the chlorophyll *a* was above the 20 ug/L target. This result was duplicated in the BATHTUB modeling of the Carlson's trophic state index. Eight years were found to be greater than the target of 60, with a range of 63 to 68. Reduction of total influent phosphorus is needed to attain the non-nuisance conditions.

Jefferson Lake
The average seasonal (May-September) loading for total phosphorus in Jefferson Lake was calculated at 164.9 kg. The majority of this loading is from failing septic systems (142.2 kg) with small fractions from runoff (20.7 kg).

Results of BATHTUB modeling and 2006 data for in-lake chlorophyll a, total phosphorus, Secchi depth visibility, and Carlson's trophic state index are presented in Appendix A. For each of these data sets, the real data compares well with modeled data, while some of the modeled data perfectly corresponds to the actual data.

BATHTUB predicted a range of seasonal in-lake chlorophyll *a* concentrations from 26 to105 ug/L. All of the ten modeled years, the chlorophyll *a* was well above the target of 20 ug/L. This result was duplicated in the BATHTUB modeled Carlson's trophic state index. All ten years were found to be greater than the target of 60, with a range of 64.5 to 76.5. Reduction of total influent phosphorus is needed to attain the non-nuisance conditions.

Wellsville Reservoir

The existing average seasonal (May-September) loading for total phosphorus in the Wellsville Reservoir was calculated at 418.7 kg. The majority of this loading is from failing septic systems (350.7 kg) with small fractions from runoff (78.0 kg).

Results of BATHTUB modeling and actual 2006 data for in-lake chlorophyll *a*, total phosphorus, Secchi depth visibility, and Carlson's trophic state index are presented. For each of these data sets, the real data compares well with modeled data except Secchi depth visibility. Some of the modeled data perfectly corresponds to the actual data.

As shown, BATHTUB predicted a range of seasonal in-lake chlorophyll *a* concentrations from 18 to 142 ug/L. For nine of the ten modeled years, the chlorophyll *a* was well above the 20 ug/L target. This result was duplicated in the BATHTUB modeled Carlson's trophic state index. Nine years were found to be greater than the target of 60, with a range of 71.0 to 79.0. Reduction of total influent phosphorus is needed to attain the non-nuisance conditions.

8.1.2 Allocation of the Total Phosphorus Load

Allocations for total phosphorus for each of the reservoirs are presented in Table 8.1. In general, reductions for total phosphorus are required for runoff and septic systems for Jefferson Lake and Wellsville Reservoir; whereas, Highlandtown Reservoir would need only septic system loading reduced. Forested area runoff loadings are not proposed to be reduced because it is not considered practical. No reduction of nitrogen is proposed because BATHTUB modeling was completed without changes of original nitrogen loadings while completing the load allocation determinations. Without change to nitrogen, the goal of an in-lake Carlson's trophic state index of 60 was achieved.

Current estimated septic system loading rates by major subwatershed are also presented in Table 8.1.The table also indicates the proposed reduction percentages of total phosphorus load to the influent streams of each lake. These reductions include septic waste elimination or significant reduction. As can be seen in this table, the majority of total phosphorus in the areas analyzed emanate from failing septic systems. Phosphorus loads from properly performing septic systems are very near zero because the septic adsorption fields retain nearly all phosphorus. Therefore, a one-hundred percent total phosphorus reduction is an achievable goal if all septic systems are made to perform properly.

8.1.3 Critical Condition and Seasonality

The critical condition for total phosphorus loading to the lakes is the summer months when algae production is at its peak. The residence time of phosphorus in Jefferson and Wellsville Reservoirs is less than a month each, meaning that spring and summertime phosphorus loading is most damaging. However, this value is well over ten months for the Highlandtown Reservoir, which means that phosphorus loading can lead to excessive algae production in the summer almost irrespective of the time of year it occurs.

In terms of seasonality, phosphorus loading from cropland is typically at its greatest when soils are most erodible (facilitating transport of particulate phosphorus) and when nutrient uptake by plants (i.e., dissolved form of phosphorus) is at its lowest. Both of these conditions are satisfied in the non-growing season if cover cropping is not used on cropland. HSTS sources of phosphorus are typically constant throughout the year for direct discharge systems. For soil absorption field systems, loading is greatest when surface ponding and run-off occur most, therefore the winter and spring months typically yield higher loading rates.

8.1.4 Margin of Safety

The margin of safety (MOS) accounts for uncertainty in the TMDL calculations. Both an implicit and explicit MOS are incorporated into the phosphorus analysis. The implicit MOS is incorporated into the process for listing impaired waters and the selection of total phosphorus targets.

In terms of the listing of impaired waters, Ohio uses biological criteria in determining the status of aquatic life uses. In order for a waterbody to be removed from an impaired status in the 303(d) reporting it must demonstrate an appropriate level of biological integrity as determined through biological sampling. This approach provides a high level of certainty that aquatic life uses are met, which far exceeds reliance on surrogate measures such as chemical or other physical parameters to indicate the attainment status of aquatic life uses. For example, relying solely on chemical data does not account for factors for which no criteria exist but do in fact impact stream biology. Additionally such an approach does not account for multiple stressor situations. Therefore, the chemical specific approach misses many biologically impaired streams and may not detect a problem until it is severe.

A margin of safety was incorporated implicitly into the total phosphorus TMDLs through the target development process. A conservative assumption implicit in target development lies in the selection of the median statistic used to represent the phosphorus targets for the WWH streams and the 75th percentile for EWH streams that corresponds to an unimpaired biological community. Since Ohio EPA's evaluation of data for generating target values is based on measured performance of aquatic life and since full attainment can be observed at concentrations above these targets (reinforcing the concept that habitat and other factors play an important role in supporting fully functioning biological communities), water quality attainment can occur at levels higher than the targets. The difference between the actual level where attainment can be achieved and the selected target is an implicit margin of safety.

Table 8.1. Existing loads, TMDLs and load allocations distributed across all applicable land covers for total phosphorus entering Jefferson Lake, Highlandtown Reservoir, and Wellsville Reservoir. Note that there are no wasteload allocations due to an absence of point sources dischargers in these subwatersheds.

Impacted Stream	AU (14-digit HUC)		Total Phosphorus Existing and TMDL Point and Non-Point Source Loads (kg/season)[1]									
			Atmospheric	Cropland	Pasture	Forest	Urban	Groundwater	Point Source	Septic Systems	5% MOS	Total
Town Fork (Jefferson Lake)	190-010	Existing	0.01	1.42	4.73	11.68	2.93	1.94	0	142.2	---	164.9
		Allocation	0.01	0.07	0.24	11.68	0.15	1.94	0	0.00	0.74	14.84
		% Reduction	0%	95%	95%	0%	95%	0%	0%	100%	---	91%
Little Yellow Creek (Highlandtown Reservoir)	100 -260	Existing	0.12	0.73	3.85	2.14	3.51	5.36	0	61.3	---	77.04
		Allocation	0.12	0.73	3.85	2.14	3.51	5.36	0	12.82	1.50	30.04
		% Reduction	0%	0%	0%	0%	0%	0%	0%	79%	---	61%
Little Yellow Creek (Wellsville Reservoir)	100 -260	Existing	0.15	4.68	29.86	5.39	11.57	16.28	0	350.7	---	418.7
		Allocation	0.15	1.42	9.05	5.39	3.50	16.28	0	0.00	1.88	37.67
		% Reduction	0%	70%	70%	0%	70%	0%	0%	100%	---	91%

[1] To determine daily loads dived the values presented in this table by 153 (algae growing season) for the Jefferson Lake and Wellsville Reservoirs and by 365 (the entire year) for the Highlandtown Reservoir.

8.2 Pathogen TMDLs

Pathogen TMDLs have been developed for four HUC 14 subwatersheds that contain impaired streams. Impairment is determined if concentrations of fecal coliform bacteria exceed the WQS.

Existing bacteria loading from the relevant source was simulated using multiple tools. Namely the accumulation of bacteria on the landscape was calculated using the U.S. EPA tool BIT, while runoff and stream hydrology was simulated using the SCS curve number method and USGS low separation methods.

8.2.1 Summary of Results

The reductions in bacteria loading needed to the meet the TMDLs ranged from 26.3 to 88.5 percent. By far the largest source of bacteria were HSTS in which loading was at least an order of magnitude greater than other sources. Direct animal input from manure dropping in surface waters was the second highest source of bacteria loading followed by runoff. Natural sources of bacteria loading were estimated to be the smallest source in each of the modeled areas.

8.2.2 Allocation of Pathogen Loads

Existing modeled fecal coliform loads are allocated for each watershed to meet the seasonal TMDL. Bacteria loading from forest, green space, water bodies, and wetlands were issued full allocations because it is not considered practicable to make reductions on these unmanaged lands. In addition, because the Village of Salineville currently discharges under an NPDES permit, the permitted maximum fecal coliform (equal to the geometric mean fecal coliform standard) was allocated to this discharger.

Conversely, HSTSs are point sources from which no wasteload is expected if elimination of failing systems is completed. Therefore, the HSTS were viewed as needing 100 percent reduction. However, in some HUC 14s modeled, if elimination of this source were completed, large assimilative capacity would become available and could bolster the margins of safety. Allocations were given to HSTS in HUC 14s where something less than a 100 percent reduction was needed to meet the assimilative capacity with five percent margin of safety. This allocation is not permitting the failing HSTS source load, but allows for practicable removal with the expectation that the 100 percent removal rate will be accomplished within all the HUC 14s modeled.

Fecal coliform from cows grazing in streams are also allocated. The practice of allowing livestock access to the stream hinders water quality; however, when the entire HUC 14 was modeled, the current level of bacteria from direct animal input was typically not considered to be significant. However, livestock accessing the stream can create unsanitary conditions within the near reaches of the receiving stream. This issue is not addressed in this TMDL because the modeling was completed on a basin wide scale. Only within HUC 14 subwatershed 50030101-190-040 was a percent reduction of direct animal input of pathogens required for the stream to meet assimilative capacity. The direct animal input pathogens were allocated after failing HSTS. The order of allocation was chosen because failing HSTS are more readily eliminated as a pathogen source than livestock in streams. No other percent reductions were required for any of the HUC-14 units which were modeled.

8.2.3 Critical Condition and Seasonality

The critical condition for pathogens is the summer dry period when flows are lowest, and thus the potential for dilution is the lowest. Summer is also the period when the probability of recreational contact is the highest. For these reasons recreational use designations are only applicable in the period May 1 to October 15. Pathogen TMDLs are developed for the same May to October 15 time period in consideration of the critical condition, and for agreement with Ohio WQS. With regard to pathogens, the TMDL and allocations were completed for this recreational season only.

In terms of seasonality, HSTS lading is typically constant throughout the year for direct discharge systems. For soil absorption field systems, loading is greatest when surface ponding and runoff occur most, therefore, the winter and spring months typically yield higher loading rates.

8.2.4 Margin of Safety

The margin of safety (MOS) accounts for uncertainty in TMDL calculations and results in a lower allocation of pollutant loads to the sources. The MOS was applied both implicitly and explicitly in the fecal coliform analysis.

The fecal coliform load to the streams in each subwatershed was quantified, as was the fecal coliform loading capacity at the outlet of each subwatershed. Loading capacity was calculated as the product of the seasonal flow volume and the fecal coliform target concentration. OEPA did not account for die-off of pathogens in the waterbody, which results in increased reductions in the TMDL (see *EPA's Protocol for Developing Pathogen TMDLs* (EPA 841-R-00-002)). This conservative approach provides an implicit margin of safety.

In addition, an explicit five percent MOS is used in the fecal coliform TMDLs. Use of the geo-mean target (which is a monthly target), as a daily load makes the reductions much higher to achieve the WQS, and is therefore more protective. Based upon this assumption, an explicit 5% MOS could be deemed appropriate.

8.3 Acid Mine Drainage Analysis

AMD is responsible for ALU impairment at six sites and a likely contributor to degraded quality at other sites. AMD can have multiple adverse impacts upon a receiving stream. These impacts commonly include depletion of DO, reduction in pH, depletion of alkaline buffering capacity, elevated heavy-metal concentrations, and degraded stream habitat. The magnitude of the impacts is dependent upon many factors including the AMD seep characteristics and the hydrology as well as geology of the drainage area.

The technical analyses addressing AMD parameters do not produce TMDLs but provide some information that can help guide management decisions for abating the problem. Namely, targets have been established based on basin specific data. This effort is also made in tandem with an Acid Mine Drainage Abatement and Treatment plan (AMDAT) developed by scientists from the Voinovich School for Public Affairs at the Ohio University. The AMDAT is an in-depth study of the sources of AMD and also provides a conceptual plan to abate these sources.

A detailed synopsis of Ohio EPA's technical analyses done to address AMD can be found in Appendix B and the AMDAT report can be found in Appendix E.

Table 8.2. Total existing bacteria load, TMDL, and allocations for Yellow Creek (#cfu/day).

HUC 14	Total Loading		Margin of Safety*	Major Source Allocations (#cfu/day)					Total Reduction (#cfu/day)
				Point Source	Septic	Agricultural Sources		Natural	
						Direct Animal Inputs	Overland Runoff		
5030101-180-010	Allowable	9.23E+13	5.0%	-	4.65E+13	4.53E+13	5.41E+11	8.45E+09	4.09E+14
	Existing	5.02E+14		-	4.56E+14	4.53E+13	5.41E+11	8.45E+09	
	% Reduction	81.6%		-	89.8%	0.0%	0.0%	0.0%	
5030101-180-020	Allowable	1.49E+14	5.0%	3.03E+10	8.71E+13	5.91E+13	2.69E+12	2.94E+10	2.83E+14
	Existing	4.32E+14		3.03E+10	3.70E+14	5.91E+13	2.69E+12	2.94E+10	
	% Reduction	65.5%		0%	76.5%	0.0%	0.0%	0.0%	
5030101-180-040	Allowable	2.84E+14	5.0%	-	2.45E+14	3.61E+13	2.52E+12	7.10E+10	1.21E+14
	Existing	4.05E+14		-	3.66E+14	3.61E+13	2.52E+12	7.10E+10	
	% Reduction	30.0%		-	33.1%	0.0%	0.0%	0.0%	
5030101-190-040	Allowable	5.53E+13	5.0%	1.50E+12	0.00E+00	5.25E+13	1.31E+12	1.74E+10	4.53E+14
	Existing	5.08E+14		1.50E+12	4.50E+14	5.47E+13	1.31E+12	1.74E+10	
	% Reduction	89.1%		0%	100.0%	4.0%	0.0%	0.0%	

8.3.1 Summary of Results

Alkalinity, acidity, aluminum, iron, manganese, total dissolved solids, and conductivity were compared and evaluated on sites which were in full biological attainment with those that were only in partial or non-attainment. Streams were also separated according to headwater streams and wadeable streams. As a result, the percent that the above mentioned parameters exceed the target values was determined.

For headwater streams, acidity exceeded the target value by 100% (abatement requires increasing alkalinity by this amount), aluminum by 147%, iron by 685%, conductivity by 93%, manganese by 7186%, and total dissolved solids by 122%. For wadeable streams, only iron exceeded the target, which was by 244%.

Sample results exceeding the stated statistical targets (median and 90^{th}-precentile) are not proof-positive that an AMD impact exists. Rather, values exceeding the targets are merely intended to be suggestive that an AMD impact probably exists.

8.3.2 Critical Condition and Seasonality

AMD water chemistry constituents are themselves damaging and their negative impacts on aquatic life persists as long as they are present in the system. For this reason it is not appropriate to assign a specific condition as being more or less critical than others. However, several AMD sources increase in their loading following precipitation which results in some degree of seasonality. Namely, the wetter times of the year will result in a greater loading of AMD parameters. Other seasonal effects are associated with temperature since chemical reactions that create AMD are facilitated by the acidophillus spp. bacteria, and warmer months are associated with peak growth rates and higher rates of reaction.

8.3.3 Margin of Safety

Although TMDLs were not developed for these parameters, the analyses incorporated an implicit MOS in the form of conservative assumptions and values selected in performing the analyses. No explicit margins of safety were included.

9.0 WATER QUALITY IMPROVEMENT STRATEGY

This chapter of the report describes actions that will or should be taken to improve water quality in the Yellow Creek watershed. The ultimate goal of the improvement is all streams in this watershed meeting the minimum quality standards.

Many of the streams in the Yellow Creek watershed are of good to exceptional quality with regard to aquatic life uses. Seventy-one percent of the sites evaluated fully met WQS. Of the 29 percent not meeting minimum quality standards, the primary cause of impairment are related to drainage from historically mined areas. Other stressors include impoundments, localized impacts from highway construction, run-off from cropland, and discharges from ineffective home septic systems.

In terms of recreational uses, water quality was somewhat lower. Only 63 percent of the sites met the minimum quality standards. The primary cause of impaired recreational uses is the presence of bacteria associated with human wastes which is due to ineffective or essentially nonexistent home sewage treatment. Other less prevalent sources are manure from livestock. Also, the Salineville WWTP had not been properly disinfecting its discharge at the time of the water quality assessment causing a localized problem with bacteria; however it is now believed to be carrying out adequate treatment.

The following sections describe regulatory actions to be implemented and management practices recommended for improving water quality. All of the water quality stressors and the source of those stressors will be addressed; however certainty about the effectiveness of the recommended actions will vary.

Section 9.1 discusses actions that can be taken under regulatory programs such as lower effluent limits for NPDES permittees that discharge wastewater or enforcement actions. Section 9.2 discusses sources of water quality stressors to be abated through unregulated actions such as land management, and restoration of the stream system itself. Rationale for the recommendations is discussed and consideration is given to economic issues and the efficiency of the actions when possible. Section 9.3 describes organizations and other resources that are available to assist in implementing the recommendations made herein.

9.1 Regulatory Actions

There are 24 permitted dischargers and 45 discharge outlets in the Yellow Creek TMDL project area. Of those, only one is a major discharger (i.e., defined as having a daily discharge of one million gallons of more) and it discharges directly to the Ohio River. More than a third of all discharges go directly to the Ohio River or to tributary streams that are very near their confluence with the Ohio River. Among the other two thirds of the discharges in the watershed that are located further from the Ohio River, most are related to mining while a lesser proportion are for landfills and small wastewater treatment facilities. Figure 9.1 is a map of the TMDL project area and shows the location of each NPDES discharger. There are no Municipal Separate Storm Sewers Systems (MS4) that require NPDES coverage in the TMDL project area.

No impairments to aquatic life have been directly attributable to NPDES dischargers. Elevated bacteria concentrations were caused by inadequate wastewater treatment at the Salineville

WWTP leading to impaired recreational uses along Yellow Creek at RM 10.1. However since the time of the 2005 – 06 water quality survey, the Salineville WWTP has made improvements to their treatment operations to the point of receiving a satisfactory inspection report from Ohio EPA staff.

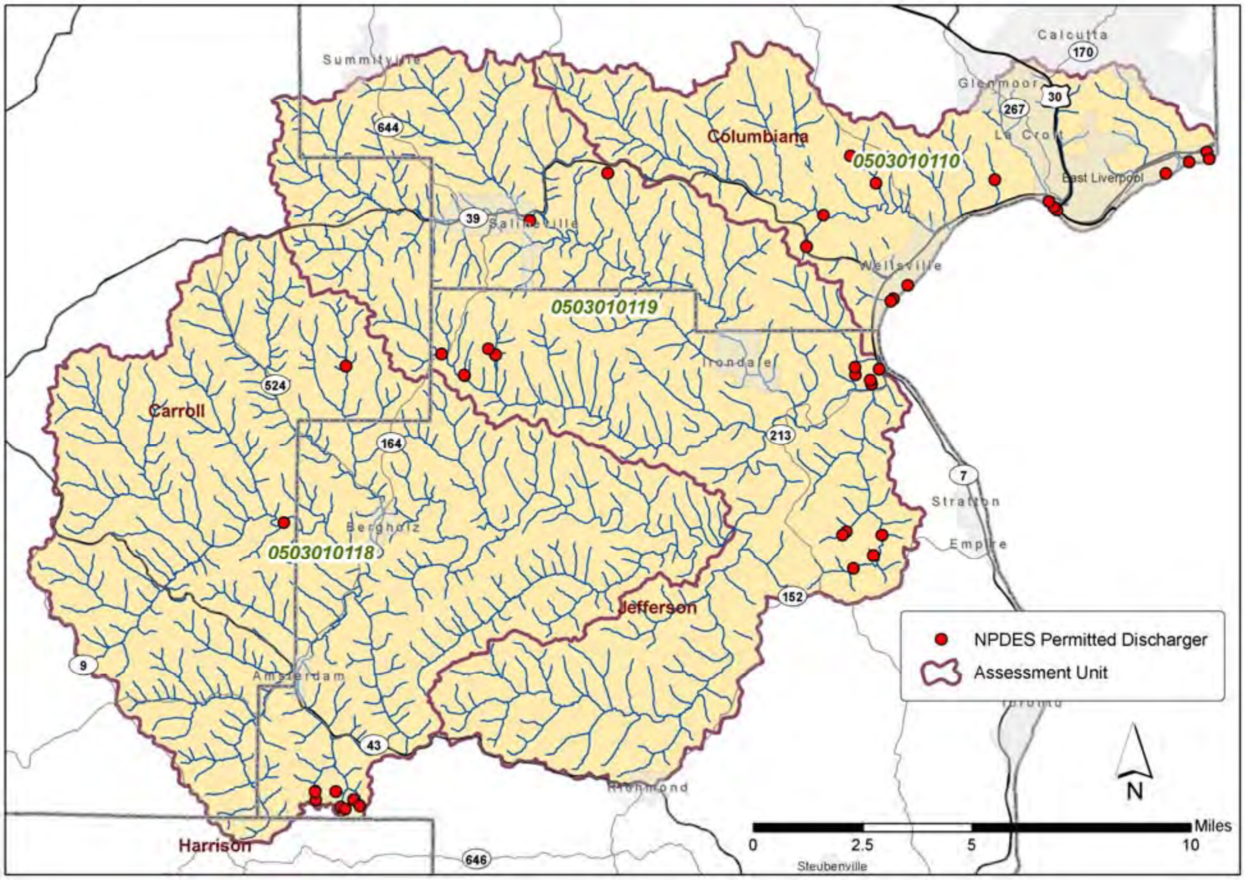

Figure 9.1. Map of the TMDL project area showing the locations of the outfall for all NPDES dischargers.

9.2 Actions to Address Nonpoint Sources

This section will discuss ways to abate nonpoint sources of pollution, and for the most part, the recommendations are not legally required and therefore call for voluntary adoption. The section is organized according to the water quality stressors where the sources of stressors and a general approach to abating the stressors will be discussed. Areas to prioritize are also listed.

9.2.1 Stream Impoundments

Four sites throughout the TMDL project area show adverse impacts to the biological community due to impounded waters associated with three reservoirs. One impact of impoundment is related to the simplified habitat it causes, which precludes diverse biological communities normally found in free flowing streams. Other impacts include obstruction to fish migration and degraded water quality resulting from releases from dam spillways.

The three reservoirs leading to impaired aquatic life uses are important to the community providing recreational opportunities and a supply of drinking water. For this reason dam removal is not a reasonable recommendation. Significant factors precluding a diverse fish community is the inability of fish to travel up or down stream; however, unlike smaller low-head dams, these impoundments are relatively large, precluding the feasibility of fish ladders or other structures that facilitate fish migration. Restoring the biology of these sites may be achieved if desired fish species are introduced to these otherwise isolated stream reaches.

The Ohio Department of Natural Resources Division of Wildlife (ODNR-DoW) has been involved with the re-introduction of fish species deemed valuable and/or threatened to waters where they had been extirpated or their numbers diminished. ODNR-DSW could be consulted regarding the re-introduction and/or relocation of fish species within the region to the areas that are impacted by isolation.

The low water quality of the release from Jefferson Lake is impairing the biological community on Town Fork. Jefferson Lake is a top release flow structure and consequently large amounts of algae and associated organic matter flows into Town Fork and negatively impacts the aquatic ecosystem. A modification to the release that ultimately reduces the amount of near-surface algae exported from the lake is recommended.

Areas to Prioritize

For native fish species relocations/introductions:
- Little Yellow Creek - Upstream of Highlandtown Reservoir
- Little Yellow Creek - Downstream from Highlandtown Reservoir and upstream from Wellsville Reservoir
- Little Yellow Creek - Downstream from Wellsville Reservoir

For addressing poor water quality related to the type of dam release
- Town Fork – Downstream from Jefferson Lake
- Little Yellow Creek - Downstream from Highlandtown and Wellsville Reservoirs

9.2.2 Home Septic Treatment Systems

Home septic treatment systems (HSTS) are used to treat human wastes in the absence of a centralized sewer collection and treatment systems. Central sewers often are not available to homes that are outside of urban or otherwise more densely populated areas. Home sewage can be extremely damaging to water quality because of the associated bacteria and pathogens making recreation unsafe as well as organic material and nutrients that stress aquatic biological communities.

Four sub-watersheds have been identified as needing reductions in HSTS that are associated with the towns of Amsterdam, Bergholz, and Irondale or areas that are in close proximity to these towns where homes are clustered. The reductions range from approximately 30% to 100% of the existing pollutant loading to these systems. Table 9.1 shows the percent reductions estimated as necessary to meet recreational use attainment goals for these sub-watersheds.

Table 9.1. Bacteria load reductions needed from HSTS based on TMDL analysis.

Sub-watershed (last 6 digits of HUC 14)	Associated town	Estimated number of housing units	Overall load reduction needed (percent)
180-010	Amsterdam	251	93.2
180-020	Bergholz (clustered homes outside of town)	Data not available	78.1
180-040	Bergholz	317	30.5
190-040	Irondale	Data not available	100

Options for addressing ineffective or failed HSTS include providing centralized collection and treatment. However this is a relatively expensive undertaking and sometimes is not financially feasible for small communities especially those with lower median incomes. Less expensive alternatives to typical centralized collection and treatment systems are used in some parts of Ohio and throughout the country. These alternatives include trickle type systems such those installed in Amesville in Athens County, Ohio. There are resources available to explore cost-effective alternatives for wastewater treatment for small unsewered communities provided by the U.S. EPA. Grant money and other funding assistance are also available to offset financial burdens imposed on the local citizens.

Ohio EPA recommends that county health departments, particularly the Jefferson County General Health District, work with the communities listed below under “Areas to Prioritize” in identifying cost effective options to manage waste water emanating from those homes.

In the absence of centralizing waste water collection and treatment, improvements to existing HSTSs, including better operation and maintenance, is a means for abating the water quality problems found in the priority areas that are identified. Local health departments are strongly encouraged to ensure that residents in these areas are informed about proper maintenance and care for their HSTSs. In the Yellow Creek watershed most HSTSs are septic tanks with or without leach fields as well as aeration systems. Some basic maintenance practices needed for these systems include:

Leach bed systems

- Inspect septic tanks about every six months to evaluate if clean-out is necessary
- Clean-outs septic tanks as solids accumulate to about 25% of the volume (typically needed every four years)
- Avoid loading the HSTS with oils and solid materials that are difficult to break down
- Resting leach field on a regularly scheduled basis (typically six months)
- Ensure that perimeter drains are working
- Exercise water conservation to avoid over-loading the system

Aeration Systems

- Use the same maintenance for septic tank as above
- Inspect that aerator is working
- Limit shutting down aerator only to occasions when it is necessary for maintenance or repair/replacement

Failed HSTS must sometimes be replaced, and the installation of new systems must be in compliance with applicable regulations (OAC 3701-29). Additionally, any direct routing of septic lines to surface waters, such as by-passing leach fields and/or septic tanks, is an illegal practice (OAC 3701-29) and creates unhealthy and unsafe conditions. These types of connections should be identified and enforcement and/or other actions be taken to correct the situation. Local Health Departments are responsible for responding to complaints issued regarding illicit connections and are expected to be proactive in locating them (OAC 3701-29).

Areas to Prioritize

Water quality data show that the following areas are having a significant impact on water quality due to inadequate performance of HSTSs:

Unsewered communities:

- Bergholz
- Amsterdam
- Hammondsville
- Irondale

Clustered homes:

- Along Cox Creek near Amsterdam (approximately 251 housing units)
- Bergholz area including Yellow Creek, Upper North Fork Yellow Creek, and Elkhorn Creek (approximately 317 housing units)
- Along Jethro Run near East Liverpool

Salineville has had compliance issues in the past due to poor operation of the WWTP. An inspection of the plant in April of 2007 resulted in a satisfactory assessment of operations (Ohio EPA 2007, May 11 letter to the Mayor of Salineville). Continued communications and periodic inspections should be done to ensure treatment remains satisfactory.

9.2.3 Mining

Mining impacts in the Yellow and Little Yellow Creek watersheds are restricted to localized areas that are near the source of AMD. This is due to the overall high buffering capacity of the streams within the watershed which ameliorates the AMD relatively quickly.

An Acid Mine Drainage and Abatement and Treatment Plan (AMDAT) for the Yellow Creek watershed was drafted by scientists from the Voinovich School for Public Affairs at the Ohio University in cooperation with the Jefferson County Soil and Water Conservation District (JCSWCD). AMDATs are in-depth, focused studies conducted by scientists who specialize in AMD related water quality problems.

The Yellow Creek AMDAT was finalized on July 31, 2008 and provides an analysis of the mining-related problems in the Yellow Creek watershed and conceptual plans to abate several of the localized sources of AMD. This AMDAT does not however, cover mining impacts in the Little Yellow Creek watershed (assessment unit 100). Additionally, the problems identified in this AMDAT do not perfectly correspond to Ohio EPA findings, therefore both sets of problem areas are discussed below.

Since this study dealt with locating and measuring the magnitude of the AMD problems, some of the results of that report are summarized in this TMDL report and the AMDAT in its entirety is appended to this document. In general, deference is given to the recommendations of the AMDAT regarding how to abate AMD-caused impairments.

Areas to Prioritize

Table 9.2 below summarizes the locations within the TMDL project area that are impacted by AMD.

Table 9.2. Areas identified as impacted by AMD through both Ohio EPA's 2005 assessment and the assessments performed for development of the AMDAT.

Location Description	AU	Comments
Wolf Run	180	Severe acidity in upper portion of stream that becomes net alkaline near RM 2.5. Problem identified in AMDAT however, OEPA sampling near RM 1.5 showed no biological impairments.
Roach Run	180	Very poor fish community was found at RM 0.1. Two known sources of AMD occur at RMs 0.8 and 0.5 and AMD parameters become significantly elevated as compared to upstream of these sources. AMD sources from Roach Run and another nearby source directly on Yellow Creek (near Co Rd 53 bridge) are adversely impacting Yellow Creek.
Yellow Cr near Co Rd 53 bridge (RM 12)	180	Very high concentration of AMD parameters in the discharge, however impact drastically ameliorated by a high stream flow relative to the AMD discharge. Ohio EPA sampling at RM 11.8 showed no biological impairment.
Salisbury Run	190	Ohio EPA found biological impairments to the LRW use at RM 0.2 and no fish were collected. AMD parameters show severe impact where an instream pH of 3.71 was recorded. It is estimated that Salisbury Run increases acidity loading to North Fork Yellow Creek by 41%.
Randolph Run	190	Ohio EPA only collected macroinvertebrate samples and low stream flows are attributed to impacting that community. AMD parameters were not particularly elevated despite the fact that it may lack the natural buffering capacity seen in most other streams throughout this watershed.
Riley Run	190	Ohio EPA found biological impairments at RM 4.9 due to the poor macroinvertebrate community. Sulfate and manganese concentrations were elevated in this area. Data from the AMDAT showed limited AMD impacts between RMs 3.0 – 3.4 but appears to be ameliorated from RM 2.0 to its mouth.
Hollow Rock Run	190	Elevated conductivity, TDS, sulfate, and strontium indicate mine impacts; however no stress to the biological community was evident. Ohio EPA sampling around RMs 3.0 and 2.2 showed no biological impairment.
Yellow Cr at RM 3.3	190	The Ohio EPA survey determined only partial attainment of WWH at RM 3.3 due to a fair macroinvertebrate community. Increased iron concentrations and the presence of yellow boy down from the confluence of the North Fork suggest AMD impacts coming from this tributary as well as upstream direct sources to Yellow Creek. The Hammondsville source (see below) is likely to be a very significant contributor to this problem.
Wells Run	100	Severe biological impairment was found in the Ohio EPA survey at RM 0.2 with poor fish and macroinvertebrate communities. AMD parameters were elevated and bright orange precipitates were present. The primary source was located near RM 0.5.
Alder Lick Run	100	The Ohio EPA survey showed partial attainment at RM 0.2 due to a fair macroinvertebrate community in which mayflies were not found, as expected in waters with high TDS. Elevated AMD parameters included

Location Description	AU	Comments
		TDS, conductivity, and sulfate.
Bailey Run	100	The Ohio EPA survey showed non attainment of ALU at RM 0.7 due to mining activities coupled with the effects of isolation and wetland conditions in the headwaters. Chemical sampling was conducted above most of the historic mining.
Hammondsville Source (Direct to North Fork YC)	190	A mine source discharges to the North Fork of YC near RM 0.25 resulting in a pH value of 5.0 and a specific conductance of 648 µS/cm. No sites were surveyed for biological attainment on the North Fork of YC downstream from this source; however the macroinvertebrate community was impacted on the mainstem of Yellow Creek at RM 3.3 which is a relatively short distance down from its confluence with the North Fork.
Slayer Source (Direct to YC just down from Wolf Creek confluence)	180	This source occurs opposite of the confluence between Yellow Creek and Wolf Run (RM) and shows seasonal variation in AMD impacts. In April 2006 the pH was 7.0 but in June of that year pH dropped as low as 5.7. Specific conductance was well above 900 µS/cm in both instances.
Irondale Source (Direct to YC)	190	A mine source discharges to the North Fork of YC near RM 1.7 resulting in a pH value of 6.47 and a specific conductance of 1,885 uµµS/cm. Although there is full biological use attainment downstream from this source the biological score drops slightly from upstream sites.

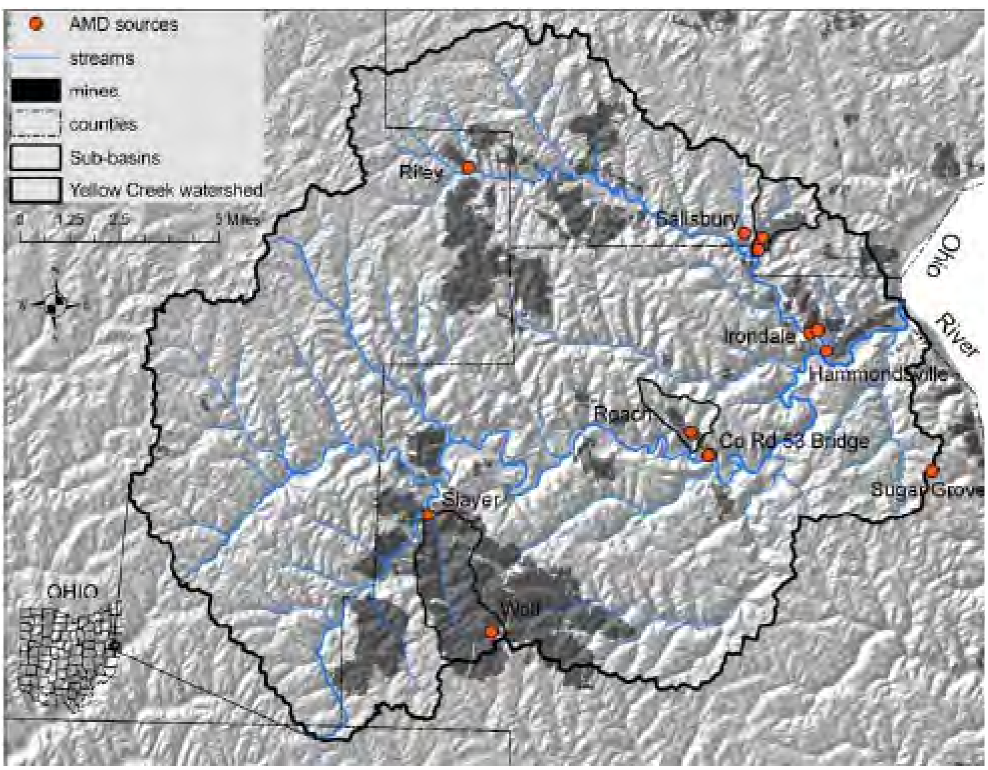

Figure 9.2. Yellow Creek watershed studied for the 2008 AMDAT (Ohio University, 2008) which includes only assessment units 180 and 190. Sources of AMD are shown by red dots and the contributing drainage areas are delineated with a black line. The darker shading indicates historic mines in the watershed.

Specific Recommendations

Recommendations made in the Yellow Creek AMDAT (Ohio University, 2008) focus only on four of the AMD sources, namely Wolf Run, Roach Run, Salisbury Run, and the source along Yellow Creek near the County Road 53 bridge crossing. The rationale for this is that all other sources identified in the AMDAT had very limited impact on the local stream or that constructing a remediation system would be infeasible due space limitations. Ohio EPA feels that AMDAT planning is best suited for determining the best abatement options and therefore encourages similar efforts for the Little Yellow Creek assessment unit (HUC11- 100).

Currently, additional monitoring is being done to better address the AMD source on Wolf Run and Roach Run. The Division of Mineral Resources Management from Ohio DNR had provided cost share assistance for past remediation efforts on Wolf Run and is currently conducting further surface and sub-surface investigation of the Wolf Run site (Route 43 Wash Plant/Jensie Mine) with the installation of a series of monitoring wells, leachate tests, and intense monitoring of water chemistry and volume at the site. Although Phase 1 (Route 43 Washer Reclamation Project) effectively reduced a large amount of sedimentation and chemical loading to Wolf Run, it is expected that the second phase (Phase 2) project will intercept groundwater recharge that continues to flow through the coal waste, or gob, material and eliminate the main AMD (acid mine drainage) source at the headwaters to this stream.

Table 9.3. Summary of the AMD abatement options for sites selected as most feasible and appropriate for remediation as per Yellow Creek AMDAT report (Ohio University, 2008).

Site Name and Alternative Strategy	Remedial Actions	Cost Estimate	Cost Effectiveness (dollars per ton acidity treated)
Wolf Run	Surface reclamation	$973,598	10,806
	Two parallel limestone leach beds with settling wetland and control works	$258,093 (estimated over 15.3 years)	
Roach Run Alt #1	Channel relocation and installation of step-pool limestone channel	$74,540 (estimated over 5 years)	915
Roach run Alt #2	Slag bed to boost alkalinity in tributary	$46,621	679
Roach run Alt #3	Mine seal	No cost estimate	No cost estimate
Salisbury Run Alt #1	Two aerobic wetlands; limestone drain channels; and cross drains	$1,130,654	11,901
Salisbury Run Alt #2	Mine seal	No cost estimate	No cost estimate
Source at County Rd 53 bridge crossing	Limestone leach bed with limestone discharge channel	$266,959 (estimated over 1.6 years)	1,090
	Open limestone diversion channel	$126,244	171

9.2.4 Cattle Access to Streams

The TMDL analysis showed that only one sub-watershed needs to see a load reduction in cattle derived manure in order to meet water quality goals for recreational uses (i.e., bacteria loading). The sub-watershed is shown in Figure 9.3.

Pathogen contamination from livestock manure can be reduced by fencing or other exclusion practices that limit or deny livestock access to streams. Proper manure handling and storage reduces runoff contamination and is achieved through the construction of adequate storage facilities and stormwater controls. Manure that is land applied should be done so according to guidance from the Natural Resource Conservation Service (NRCS) and applicable standards (Standard 633) or a Comprehensive Nutrient Management Plan (CNMP) that is specific to a given operation. Manure discharges occurring through sub-surface drainage tiles following field application can often be avoided if drainage water management control structures are in place. NRCS conservation practices that are appropriate for abating this source of pollution include ***Livestock Use Exclusion (472), Waste utilization (633), Nutrient Management (590), Watering Facility (614), Waste Storage Facility (313) and Drainage Water Management (554).***

Composting manures may also be a viable way to utilize livestock waste and reduce the threat to water quality. The stabilization of the manure materials during the composting process and the proper handling and storage of this material reduces the risk of pollutant loading via storm water run off. More information regarding composting can be found on the Ohio Composting and Manure Management Program's web site (www.oardc.ohio-state.edu/ocamm/).

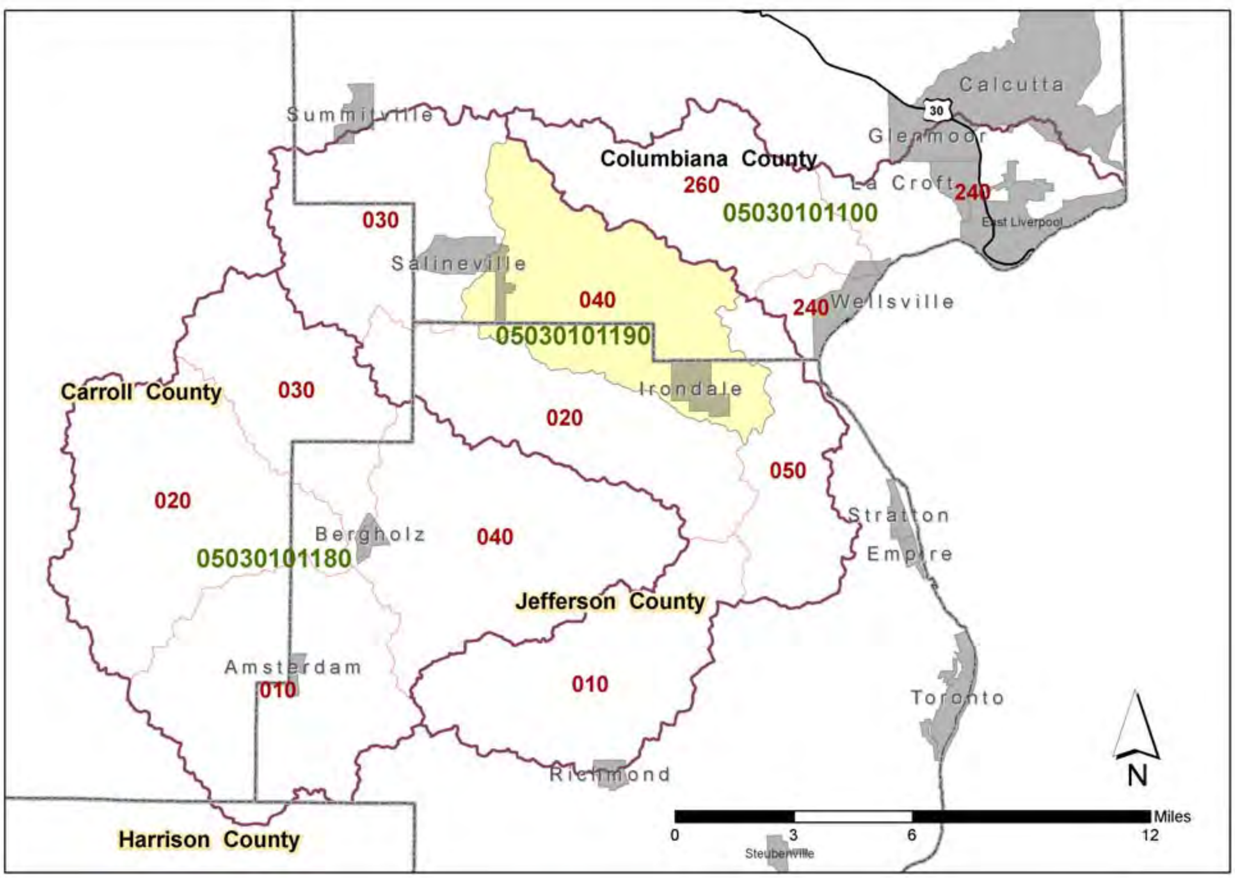

Figure 9.3. Sub-watershed within the Yellow Creek TMDL area where reductions in livestock derived manure is needed in order to meet water quality goals. This sub-watershed (05030100119-04) is highlighted in yellow.

9.2.5 Row Crop Production

Run-off from row crop agriculture contributes nutrient loading to the three reservoirs associated with water quality impairments. Some of the impairment associated with these reservoirs is due to high algae production within the lakes that damages water quality down from the dam release. The high level of algae is caused by excess nutrients in the water column from, in part, nutrient laden run-off from row crop fields.

Row crops constitute a relatively small proportion of the watersheds that drain to these reservoirs however have disproportionately high phosphorus loading. Abating nutrient loading from row crop fields will therefore have a proportionally greater benefit to water quality.

Conservation practices well suited to abate nutrient loading from run-off from farm fields include buffer strips or set-asides along streams, nutrient management, cover cropping, conservation tillage, other practices that limit soil erosion and detain water transported sediment.

Sub-surface drainage is also a significant conduit for nutrient loading from row crop production areas, however due to the high relief in the watershed sub-surface drainage is not believed to be extensively used and therefore unlikely to be an important vehicle for nutrient loading. Nonetheless, water table management allows for control over sub-surface drainage in which discharges can be limited to growing season rather than post-harvest and pre-planting which is when plant utilization of nutrients is at its minimum.

The Natural Resource Conservation Service (NRCS) has defined conservation practices intended to abate nutrient losses to surface and sub-surface waters. The following list is NRCS conservation practices that are well-suited to address nutrient loading to the reservoirs in the Yellow Creek TMDL project area:

- Nutrient management (590)
- Cover and green manure crop (340)
- Conservation cover (327)
- Filter strip (393)
- Riparian forest buffer (391)
- Cover and green manure crop (340)
- Conservation crop rotation (328)
- Mulching (484)
- Residue management (329 A,B,C)
- Pasture and hayland planting (512)
- Grassed waterway (412)
- Diversion (362)
- Water and sediment control basin (638)
- Constructed wetland (656)
- Wetland restoration (657)
- Wetland creation (658)

9.2.6 Summary

The restoration strategies discussed above are summarized in Table 9.4. Involvement from the Ohio EPA in implementing these restoration strategies is also included.

Table 9.4. Summary of implementation recommendations and Ohio EPA programs involved.

Recommendation	Location (AUs)	Ohio EPA Program	Agency Action
Work to improve treatment of home sewage in unsewered communities and clustered homes	180 and 190	Non Point Source NPDES Permits	Provide assessment data to local authorities regarding areas identified as having problems. Provide technical assistance in securing grant funding to address these issues.
Work to better restrict livestock access to streams	190 – 040 (HUC14)	Non Point Source	Provide assessment data to local authorities regarding areas identified as having problems. Provide technical assistance in securing grant funding to address these issues.
Work to abate nutrient loading from row crop production areas.	Sub-watersheds contributing to the three reservoirs in the project area.	Non Point Source	Provide assessment data to local authorities regarding areas identified as having problems. Provide technical assistance in securing grant funding to address these issues.
Implement AMDAT recommendations	Areas identified in Table 9.3 of this report	Non Point Source	Provide assessment data to local authorities regarding areas identified as having problems. Provide technical assistance in securing grant funding to address these issues.

9.3 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation.

The following discusses organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. This section establishes why it is reasonable to be assured of successful implementation.

9.3.1 Ohio EPA

The several programs that Ohio EPA Division of Surface Water (DSW) administers are designed to control pollution from point sources and certain storm water discharges as well as provide assistance for abating nonpoint sources of pollution. Other divisions within the Ohio EPA provide assistance such as funding, technical assistance, and education for water resource related issues. Information regarding the specific programs within the Ohio EPA DSW can be found on the web at www.epa.ohio.gov/dsw/, and information about the Division of Environmental and Financial Assistance (DEFA) at www.epa.ohio.gov/defa/. What follows are programs within the agency that are especially important for the implementation of this TMDL.

NPDES Program
National Pollution Discharge Elimination System (NPDES) permits authorize the discharge of substances at levels that meet the more stringent of technology or water-quality-based effluent limits and establish requirements related to combined sewer overflows, pretreatment, and sludge disposal. All entities that wish to discharge to the waters of the state must obtain a NPDES permit and both general and individual permits are available for coverage. Through the NPDES program (www.epa.ohio.gov/dsw/permits/permits.aspx), the Ohio EPA will use its authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the Yellow Creek watershed. Ohio EPA staff in the NPDES Program can provide technical assistance for permitted entities when needed. Permits issued under the NPDES program must be consistent with the point source recommendations in a TMDL that has been approved by the U.S. EPA.

401 Water Quality Certification Program
In Ohio, anyone wishing to discharge dredged or fill material into the waters of the United States, regardless of whether on private or public property, must obtain a Section 404 permit from the U.S. Army Corps of Engineers (Corps) and a Section 401 Water Quality Certification (WQC) from the state.

Stream and wetland mitigation is used as a condition for granting 401 certificates and is the means of ensuring that water resources do not experience a net decline in quality. When a wetland or stream segment is impacted, an appropriate mitigation is required such that there is no net loss of wetlands or unimpaired stream length. Restoration, creation, or other forms of enhancement is required at a level that depends upon the original quality of the resource.

Currently there are proposed rules changes to the 401 Program that are designed to provide a more scientific basis for determining appropriate criteria for 401 permit decisions (i.e., acceptance or denial) as well as mitigation stipulations for the respective projects (www.epa.ohio.gov/dsw/401/WQC.aspx). Ohio EPA staff will conduct reviews and issue permits to provide the most reasonable protections and improvements, where possible, of surface waters in the Yellow Creek watershed.

Enforcement Program
When Ohio EPA is unable to resolve continuing water quality problems because of violations of permitting rules or laws, the DSW may recommend that enforcement action be taken. The enforcement and compliance staffs work with Ohio EPA attorneys, as well as the Attorney General's Office to resolve these cases. Where possible, an added emphasis and priority is given to actions in sensitive watersheds. All completed enforcement actions are posted on the DSW web page.

208 Program (State Water Quality Management Plans)
Ohio EPA oversees the State Water Quality Management (WQM) Plan. The State WQM Plan is like an encyclopedia of information used to plot and direct actions that abate pollution and preserve clean water. A wide variety of issues is addressed and framed within the context of applicable law and regulations. The Yellow Creek and Little Yellow Creek TMDL becomes a part of the State WQM Plan when it is approved by the U.S. EPA and the recommendations found herein align with and support the state’s overall plan for clean waters. More importantly, the requirement and intention to review and update the State WQM Plan on an annual basis creates an avenue to apply adaptive management and make adjustments in these recommendations as necessary.

Nonpoint Source Program

The Ohio Nonpoint Source (NPS) program focuses on identifying and supporting implementation of management practices and measures that reduce pollutant loadings, control pollution from nonpoint sources and improve the overall quality of these waters. Ohio EPA receives federal Section 319(h) funding to implement a statewide nonpoint source program, including offering grants to address nonpoint sources of pollution. Staff from the NPS program work with state and local agencies, governments, watershed groups, and citizens.

NPS and other Ohio EPA staff will continue to work with the Yellow Creek Watershed Restoration Project. Local NPS implementation is critical to achieving state environmental targets. Additionally, there is a reliance on watershed management plans to identify and outline actions to correct water quality problems caused by NPS pollution.

Section 319(h) grants are expected to be directed to projects that eliminate or reduce water quality impairments caused by nonpoint sources of pollution. Applicants may apply for a maximum of $500,000 for a three year period. Each project funded must provide an additional 40% matching share and the total federally funded share of project costs may not exceed 60%. Because a TMDL exists, grant proposals for work within the Yellow Creek watershed will receive special consideration for funding.

Division of Environmental and Financial Assistance

The Division of Environmental and Financial Assistance (DEFA) provides incentive financing, supports the development of effective projects, and encourages environmentally proactive behaviors through the Ohio Water Pollution Control Loan Fund (WPCLF). Municipal wastewater treatment improvements—sewage treatment facilities, interceptor sewers, sewage collection systems and storm sewer separation projects—are eligible for financing. Nonpoint pollution control projects that are eligible for financing include:

- Improvement or replacement of on-lot wastewater treatment systems
- Agricultural runoff control and best management practices
- Urban storm water runoff
- Septage receiving facilities
- Forestry best management practices

The Water Resource Restoration Sponsor Program (WRRSP) is a part of the WPCLF and directs funding toward stream protection and restoration projects. The primary focus of this program is to improve and protect stream habitat. Like Section 319 (h) grants, proposals for stream improvements within the Yellow Creek watershed will receive special consideration.

9.3.2 Ohio Department of Natural Resources

The Ohio DNR works to protect land and water resources throughout Ohio. A specific objective in regards to water resources is to *"Lead in the development and implementation of stream and wetlands conservation initiatives, applying advanced science, technology and research to restore and protect stream and wetlands habitats."* This commitment attests that the Ohio DNR will be a reliable partner in addressing causes and sources of impairment in the Yellow Creek and Little Yellow Creek watersheds.

An Acid Mine Drainage Abatement and Treatment (AMDAT) report has been prepared for the Yellow Creek Watershed and focuses on problems that are caused by the discharge of acid mine drainage. This report identified sources near the headwaters of streams, very close to the actual source of the problem. A copy of the report is attached in Appendix E.

The following are programs and divisions within the Ohio DNR that are particularly instrumental in protecting and improving water resources within the Yellow Creek and Little Yellow Creek watersheds.

Division of Mineral Resources Management
DMRM administers a federally-funded Abandoned Mine Land (AML) program and a state-funded AML program to reclaim those areas disturbed by mining operations (primarily coal) for which there is no continuing reclamation responsibility by a mine operator. Program staff investigate AML problems, determine their eligibility and priority for the appropriate program, and oversee the design and construction of the selected projects.

The federal AML program includes an emergency program and a non-emergency program. both are funded by a federal fee levied on mined coal. The fee for surface mined coal is thirty-five cents per ton and fifteen cents per ton for underground mined coal. The fees are paid by coal companies to the federal Office of Surface Mining Reclamation and Enforcement (OSM). OSM allocates the monies to eligible states on an annual basis. The monies received from OSM are used to reclaim lands affected by surface mining operations conducted prior to August 3, 1977 and by the surface effects of underground mining prior to September 1, 1982.

The state AML program, funded by severance taxes on coal and industrial minerals currently mined, reclaims lands affected by mining prior to April 10, 1972. This program emphasizes environmental restoration through the reclamation of:

- lands that cause pollution of the waters of the state;
- lands that damage adjacent property;
- lands which, when reclaimed, the public can use for soil, water, forests, wildlife conservation, or public recreation purposes;
- lands which, when reclaimed, will facilitate commercial or industrial site development; and/or
- lands which, when reclaimed, will facilitate the use or improve the enjoyment of nearby public conservation or recreation lands

Pollution Abatement Program
Under Ohio's Pollution Abatement Rules (OAC 1501) the Ohio DNR is required to respond to written and non-written complaints regarding agricultural pollution. As defined by OAC 1501, agricultural pollution is the "failure to use management or conservation practices in farming or silvicultural operations to abate wind or water erosion of the soil or to abate the degradation of waters of the state by animal waste or soil sediment including substances attached thereto." In cooperation with SWCDs, an investigation is begun within five days of receipt of the complaint and a Pollution Investigation Report (PIR) is generated within ten days. Resource management specialists from Ohio DNR within the Division of Soil and Water Conservation (DSWC) typically become involved with pollution abatement cases in their respective areas of the state.

If it is determined necessary, an operation and management plan will be generated to abate the pollution. This plan is to be approved by the SWCD or Ohio DNR and implemented by the landowner. Cost-share funding may be available to assist producers in implementing the appropriate management practices to abate the pollution problems and such practices may be phased in if necessary. If a landowner fails to take corrective action within the required timeframe, the Chief of the Division of Soil and Water Conservation (Ohio DNR) may issue an order such that failure to comply is a first degree misdemeanor. This program safeguards against chronic problems that lead to the degradation of water quality.

SWCD Program
Ohio DNR-DSWC has a cooperative working agreement with the Soil and Water Conservation Districts throughout Ohio and the NRCS. According to the agreement Ohio DNR-DSWC is responsible to “provide leadership to Districts in strategic planning, technical assistance, fiscal management, staffing, and administering District programs.” The Division also provides “training and technical assistance to District supervisors and personnel in their duties, responsibilities, and authorities.” Program Specialists from Ohio DNR work with the SWCDs to identify program needs and training opportunities. Ohio DNR also ensures that program standards and technical specifications are available to SWCDs and NRCS personnel. State matching dollars from the Ohio DNR constitute roughly half of the annual operating budgets of SWCDs.

Through the partnership established by the working agreement and their history of collaboration, Ohio DNR can communicate the goals and recommendations highlighted in this TMDL to SWCDs and provide guidance to actively promote conservation efforts that are consistent with those goals.

Division of Forestry
The mission of the Division of Forestry is to promote sustainable use and protection of forests on public and private lands. The division provides technical expertise and other forms of assistance regarding riparian forest establishment and protection.

Division of Wildlife
Through efforts to increase the amount of habitat for game birds and other forms of wildlife, private lands biologists actively promote the establishment of warm season grass in buffer strips and on cropland set-asides. Private lands biologists come into contact with private landowners and conservation groups to educate, and provide assistance regarding these types of habitat improvements.

9.3.3 Agricultural Services and Programs

Local SWCD, NRCS, and Farm Service Agency (FSA) offices often work to serve the county’s agricultural community. Staffs from these offices establish a working relationship with private landowners and operators within their county, which are often based on trust and cooperation.

SWCD and NRCS staffs are trained to provide sound conservation advice and technical assistance (based on standard practices) to landowners and operators as they manage and work the land. Sediment and erosion control and water quality protections make up a large component of the mission of their work. SWCD and NRCS activities also include outreach and education in order to promote stewardship and conservation of natural resources. SWCD and NRCS staffs also serve county residents not associated with agriculture and some districts have well developed urban conservation programs.

Federal Farm Bill programs are administered by the local NRCS and FSA offices. NRCS is responsible for the Environmental Quality Incentives Program (EQIP), while FSA is responsible for set-aside programs such as the Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), and the Wetland Reserve Program (WRP).

The Jefferson County Soil and Water Conservation District is working with the Jefferson County Health Department to host three septic maintenance workshops each year.

Environmental Quality Incentives Program
Environmental Quality Incentives Program (EQIP) is an incentive-based, voluntary program designed to increase the use of agriculturally-related best management and conservation practices. EQIP is available to operators throughout the entire Yellow Creek watershed irrespective of whether they own or rent the land that they farm. Through this program operators receive cost share and/or incentive payments for employing conservation management practices. Contracts are five years in length.

Eligible conservation practices cover broad categories such as nutrient and pesticide management, conservation tillage, conservation crop rotation, cover cropping, manure management and storage, pesticide and fertilizer handling facilities, livestock fencing, pastureland management, and drainage water management among others. However, funding for these practices is competitive and limited to the allocations made to any respective county in Ohio. Each county in the program receives a minimum of $100,000 per year and may receive more depending on state priorities for that year. More information on this program is available on the NRCS website at www.nrcs.usda.gov.

Conservation Reserve Program and Wetland Reserve Program
The Conservation Reserve and Wetland Reserve Programs (CRP and WRP respectively) are set aside programs much like the CREP (see below), which is the enhanced version of CRP. The goals of these programs are to protect environmentally sensitive lands (e.g., highly erodible soils) and improve water quality and wildlife habitat.

Set aside programs are voluntary and incentive-based and provide compensation to farmers for establishing and maintaining buffers, wetlands, grasslands or woodlands on land that would otherwise be used for agricultural production. Compensation is restricted to the timeframe established in the contract agreement. Incentive payments for these two programs are lower than the enhanced versions (CREP and WREP), which are limited to areas that have been approved by the USDA for the additional funding. These programs can assist in creating land use changes that improve water resource quality in the Yellow Creek watershed.

9.3.4 Extension and Development Services

Each county in Ohio has an extension agent dedicated to agricultural and natural resource issues. The primary purpose of extension is to disseminate up-to-date science and technology so it can be applied for the betterment of the environment and society. Like SWCD and NRCS staff, extension agents provide technical advice to landowners and operators and often develop strong relationships with the local community. Local extension agents are particularly well-suited for promoting innovative conservation measures that have not yet been established in the standard practices developed by NRCS.

Crossroads RC&D provides technical and financial planning support to the Yellow Creek Watershed Restoration Coalition. Staff from Crossroads RC&D will partner with JSWCD and the YCWRC to plan and promote one landowner workshop per year.

9.3.5 Agricultural Organizations and Programs

Agricultural organizations are working to address water quality problems associated with traditional farming practices. The Ohio Farm Bureau Federation (OFBF) seeks to improve water quality through the employment of scientifically-based economically sound conservation management practices (www.ofbf.org). In order to pursue this mission OFBF initiated programs aimed at engaging producers in voluntary water quality protection and improvement efforts. At the local level county Farm Bureau Public Policy Action Teams have the opportunity to administer OFBF programs related to environmental quality. The Public Policy Action Team leader works with the county's Organizational Director, who is a staff member of the OFBF, to implement program initiatives.

OFBF's Agricultural Watershed Awareness and Resource Evaluation (AWARE) program promotes water quality monitoring and education so that producers have more information when making resource conservation decisions regarding their operations. In collaboration with other conservation and commodity organizations OFBF led the development of a producer self-assessment program designed to evaluate the potential for off-site environmental impact and develop strategies to reduce those risks. OFBF also offers assistance to producers to better understand and comply with new and existing environmental regulations.

To help Ohio's livestock, poultry and equine producers identify and address key management issues affecting environmental quality, the Ohio Livestock Coalition (OLC) developed the Livestock Environmental Assurance Program (LEAP). LEAP is a voluntary and confidential environmental assurance program which provides producers the opportunity to take a proactive approach in blending sound production economics with concern about environmental quality. LEAP helps producers profitably manage environmental challenges that are critically important to the success of the business, and effectively assess how farmstead practices affect water quality.

9.3.6 Local Health Departments

Under OAC 3701-29, local health departments are responsible for code enforcement, operational inspections, and nuisance investigations of household sewage treatment systems serving one, two, or three family dwellings. The Ohio Department of Health works with locals health departments and provides technical assistance and training.

9.3.7 Local Watershed Groups

One watershed group exists within this area and is known as the Yellow Creek Watershed Restoration Coalition. Their existence began in 1998, and is comprised of concerned citizens, land owners, business owners, and various government agencies. Their mission statement reads as follows: To improve and protect the environment in the Yellow Creek Watershed. They currently have no involvement with Little Yellow Creek. An Acid Mine Drainage Abatement and Treatment (AMDAT) Plan is included as Appendix F.

9.3.8 Easements and Land Preservation

The Jefferson Soil and Water Conservation District maintains a hold on a wetland easement of thirty acres for the First Energy gypsum landfill. The JSWCD also holds twenty acres of wetland easements associated with Apex landfill.

9.3.9 Other Sources of Funding and Special Projects

Currently, the Jensie Mine site in East Springfield is being monitored for a possible remediation project. The Jensie Mine site pollutes the Wolf Run sub-watershed with acid mine drainage.

Ground water sampling wells were drilled in May 2008 and are monitored monthly along with surface water at the site.

9.4 Process for Evaluation and Revision

The effectiveness of actions implemented based on the TMDL recommendations should be validated through ongoing monitoring and evaluation. Information derived from water quality analyses can guide changes to the implementation strategy to more effectively reach the TMDL goals. Additionally, monitoring is required to determine if and when formerly impaired segments meet applicable water quality standards (WQS).

This section of the report highlights past efforts and those planned to be carried out in the future by the Ohio EPA and others. It also outlines a process by which changes to the implementation strategy can be made if needed.

9.4.1 Evaluation and Analyses

Aquatic life and recreational uses are impaired in the watershed, so monitoring that evaluates the river system with respect to these uses is a priority to the Ohio EPA. The degree of impairment of aquatic life use is exclusively determined through the analysis of biological monitoring data. Recreational use impairment is determined through bacteria counts from water quality samples. Ambient conditions leading to impairment include high bacteria and phosphorus concentrations and AMD parameters (e.g., low pH, elevated TDS). This report sets targets values for these parameters (Chapter 7), which should also be measured through ongoing monitoring.

A serious effort should be made to determine if and to what degree the recommended implementation actions have been carried out. This should occur within an appropriate timeframe following the completion of this TMDL report and occur prior to measuring the biological community, water quality or habitat.

Past and Ongoing Water Resource Evaluation
The Ohio EPA has conducted water quality surveys within the Yellow Creek watershed in 1983, and in 2005 and 2006. The Ohio EPA is scheduled to perform biological, water quality, habitat, and sediment chemistry monitoring in all three assessment units in the basin in 2020 (Ohio EPA, 2008b).

Other water quality data has been collected in support of the AMDAT developed for the Yellow Creek watershed (AUs 180 and 190) and the results are included in the AMDAT report (Ohio University, 2008). These data include biological surveys (fish and macroinvertebrates) and water chemistry sampling. These data result from field work performed in 2005 by staff from the Midwest Biodiversity Institute (MBI), the Voinovich School of Leadership and Public Affairs, and the Ohio Department of Natural Resources. The survey protocols used to evaluate the biological community are consistent with Ohio EPA's protocols. Currently, part of the watershed coordinator's duties for the second half of the semi-annual workplan for 2009 will be to coordinate volunteer monitoring within the watershed.

Recommended Approach for Gathering and Using Available Data
Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Through this, areas of overlap should be identified and ways to make all parties research efforts more efficient should be discussed. Ultimately

important questions can be addressed by working collectively and through pooling resources, knowledge, and data.

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