State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Vermilion River Watershed

Vermilion River near Birmingham in Erie County

Draft Report for Public Review
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1.0 Introduction

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize 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 and 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 identified as impaired on the Section 303(d) lists.

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 waterbody can receive and still meet water quality standards, including 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.

The Ohio Environmental Protection Agency (Ohio EPA) has traditionally listed impaired waters and developed TMDLs on a watershed basis, organizing on the 11-digit Hydrologic Unit Code (HUC) system. The Ohio EPA identified the Vermilion River (assessment units 04100012 050 and 04100012 060) as impaired on the 2004 303(d) list (Ohio EPA, 2004). The Vermilion River basin is located in north central Ohio in portions of Ashland, Erie, Huron, Lorain and Richland counties. The total drainage area of the watershed is approximately 268 mi^2. For this report the two assessment units within the Vermilion River basin have been further divided into 14-digit subwatershed hydrological units (HUC) as presented in the watershed map in Figure 1.1.

Ohio EPA surveyed the status of the water quality in the Vermilion River watershed during 2002. The results of the study, on which the 2004 303(d) listing is based, were published by Ohio EPA in October 2004. The report, *Biological and Water Quality Study of the Vermilion River, Old Woman Creek, Chappel Creek, Sugar Creek, and Select Lake Erie Tributaries, 2002. Ashland, Huron, Erie, Richland and Lorain Counties, Ohio*, is available at http://www.epa.state.oh.us/dsw/document_index/psdindx.html. The study found impairment of the Aquatic Life Use and impairment of the designated or recommended Recreation Use. The main causes of impairment along with associated sources from the 2004 Integrated Report for the two assessment units are listed in Tables 1.1 and 1.2.

The primary causes of impairment in the Vermilion River watershed are nutrient/organic enrichment, siltation, habitat alteration, flow alteration and pathogens. Figure 1.1 shows the study area and summarizes the attainment status for the Aquatic Life Use. Tables 1.1 and 1.2 also summarize the Aquatic Life Use attainment status along with the status of the Recreation Use of the two assessment units. A schematic representation of the Vermilion River watershed is provided in Figure 1.2.

This report summarizes the water quality and habitat condition of the Vermilion River basin, quantitatively assesses the factors causing the impairment, provides for tangible actions to restore and maintain the streams, and specifies monitoring to ensure actions are carried out to measure the success of the actions taken.

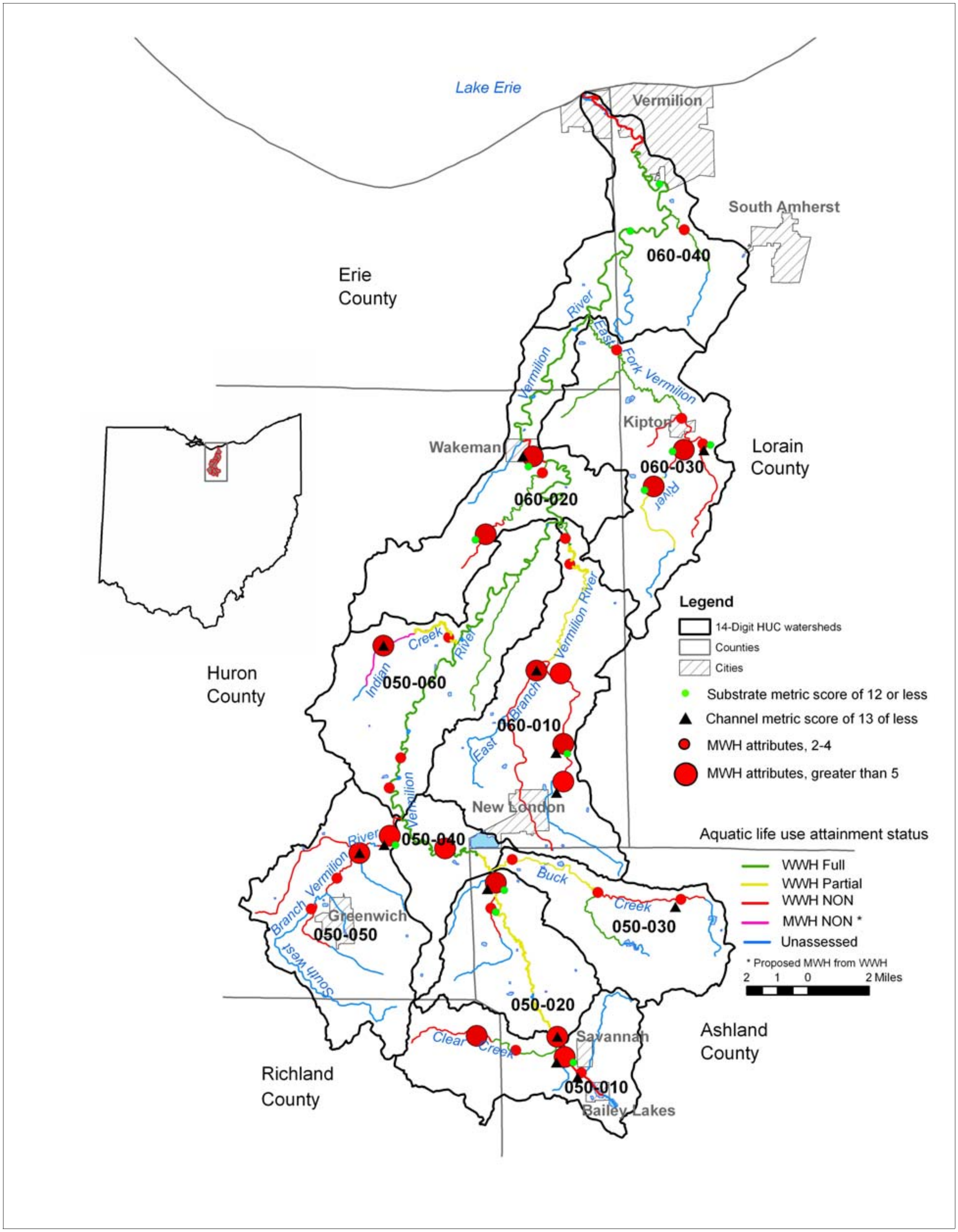


Figure 1.1 Assessment units 04100012 050 & 04100012 060 study area and attainment status

Table 1.1 Attainment Status for Assessment Unit 04100012 050					
Stream/14-Digit HUC & Use Designations **River Mile**	**Attainment Status**	**QHEI**	**Impairment Cause**	**Impairment Source**	**Cause Addressed in TMDL?**
Vermilion River/HUC 04100012 050-010 (headwaters to below Clear Ck.) Aquatic Life Use: WWH Recreational Use: PCR					
63.8 63.85	**(NON)** Threatened		Habitat alteration Nutrient enrichment Pathogens	Channelization Agriculture Development/ WWTP	Yes Yes Yes
63.0 62.88	**NON** Threatened	45.0	Habitat alteration Pathogens	Channelization Agriculture	Yes Yes
Trib. to Vermilion River (63.52) Aquatic Life: WWH Recreational: None					
0.2/0.3	**NON**	38.0	Habitat alteration Nutrient enrichment	Channelization Development	Yes Yes
Clear Creek Aquatic Life Use: WWH Recreational Use: PCR					
4.0 3.99	**(NON)**	52.0	Siltation/flow alteration Pathogens	Natural (drought) Pasture Septic system	Yes Yes
1.8/2.1	FULL	71.0			
Vermilion River/HUC 04100012 050-020 (below Clear Ck. to above Buck Ck.) Aquatic Life: WWH Recreational: PCR					
62.1/62.0	PARTIAL	62.5	Siltation Organic enrichment	Septic system Channelization Agriculture	Yes Indirectly
54.0/56.2	PARTIAL	59.0	Siltation Organic enrichment	Septic system Channelization Agriculture	Yes Indirectly
Trib. to Vermilion River (54.62) Aquatic Life: WWH Recreational: None					
0.5	**(NON)**	67.0	Flow alteration	Natural (drought)	No

Table 1.1 Attainment Status for Assessment Unit 04100012 050					
Stream/14-Digit HUC & Use Designations **River Mile**	**Attainment Status**	**QHEI**	**Impairment Cause**	**Impairment Source**	**Cause Addressed in TMDL?**
Buck Creek/HUC 04100012 050-030 Aquatic Life: WWH Recreational: PCR					
8.2/8.1	**NON**	44.0	Siltation Nutrient enrichment	Pasture Septic system	Yes Yes
5.0	**(NON)**	74.0	Flow alteration	Natural (drought)	No
3.2 3.21	PARTIAL Threatened	75.0	Flow alteration Pathogens	Natural (drought) Pasture Septic system	No Yes
1.1/1.0 1.06	PARTIAL Threatened	66.0	Flow alteration Pathogens	Natural (drought) Septic system	No Yes
Trib. to Buck Creek (4.92) Aquatic Life: WWH Recreational: None					
0.1	Full	64.0			
Vermilion River/HUC 04100012 050-040 (below Buck Ck. to above Southwest Branch) Aquatic Life: WWH Recreational: PCR					
50.7/50.6	FULL	68.0			
Southwest Branch Vermilion River/HUC 04100012 050-050 Aquatic Life: WWH Recreational: PCR					
5.6	PARTIAL	62.5	Siltation	Agriculture	Yes
3.9 3.81	**NON** Threatened	65.0	Nutrient enrichment Organic enrichment Pathogens	Pasture Greenwich CSOs	Yes Indirectly Yes
2.5 2.53	PARTIAL Threatened	65.5	Siltation Pathogens	Non-irrigated crops Pasture	Yes Yes
1.0 0.94	**NON** Threatened	47.5	Siltation Pathogens	Non-irrigated crops Pasture	Yes Yes

Table 1.1 Attainment Status for Assessment Unit 04100012 050					
Stream/14-Digit HUC & Use Designations **River Mile**	**Attainment Status**	**QHEI**	**Impairment Cause**	**Impairment Source**	**Cause Addressed in TMDL?**
Trib. to Southwest Branch (2.3) Aquatic Use: WWH Recreational: None					
0.7 0.57	**(NON)** Threatened		Nutrient enrichment Organic enrichment Pathogens	Non-irrigated crop Pasture	Yes Indirectly Yes
Trib. to Southwest Branch (5.35) Aquatic: WWH Recreational: None					
0.6	**(NON)**		Flow alteration	Natural (drought)	No
Vermilion River/HUC 04100012 050-060 (below Southwest Branch to above East Branch) Aquatic Life: WWH Recreational: PCR					
44.5	FULL	79.0			
33.6 33.5	FULL Threatened	80.5	Pathogens	Septic system	Yes
Trib. to Vermilion River (32.98) Aquatic Life: WWH Recreational: None					
1.0	(FULL)				
Indian Creek Aquatic Life: WWH existing/propose MWH Recreational: PCR					
3.5	**NON**	36.0	Habitat alteration	Channelization Agriculture	Yes
0.4	PARTIAL	71.5	Siltation/flow alteration	Agriculture	Yes

Parentheses ( ) in the attainment column, e.g. (NON), indicate only one metric (fish or macroinvertebrates) was used as the attainment determinate.

Table 1.2 Attainment Status for Assessment Unit 04100012 060					
Stream/14-Digit HUC & Use Designations **River Mile**	**Attainment Status**	**QHEI**	**Impairment Cause**	**Impairment Source**	**Cause Addressed in TMDL?**
East Branch Vermilion River/HUC 04100012 060-010 Aquatic Life: WWH Recreational: PCR					
8.6/8.3 8.31	**NON** Threatened	62.0	Siltation Pathogens	Channelization Agriculture Pasture/Septic system	Yes Yes
2.7/3.6 3.6	PARTIAL Threatened	66.0	Nutrient enrichment Pathogens	Non-irrigated crops Pasture/Septic system	Yes Yes
1.4 1.02	FULL Threatened	77.0	 Pathogens	 Pasture/Septic system	 Yes
Trib. to East Branch (8.2) Aquatic Life: WWH Recreational: None					
5.8	**(NON)**	43.5	Nutrient enrichment Organic enrichment Habitat alteration	Pasture	Yes Indirectly Yes
4.0 4.03	**(NON)** Threatened	40.5	Nutrient enrichment Organic enrichment Habitat alteration Pathogens	Septic systems Pasture	Yes Indirectly Yes Yes
1.1/1.0	**NON**	56.0	Organic enrichment Habitat alteration	Septic systems	Yes Yes
Skellinger Creek Aquatic Life: WWH Recreational: SCR					
0.8/1.0 0.95	**NON** Threatened	48.5	Nutrient enrichment Organic enrichment Siltation Pathogens	Non-irrigated crops New London WWTP Pasture CSOs	Yes Indirectly Yes Yes
Vermilion River/HUC 04100012 060-020 (below East Branch to above East Fork) Aquatic Life: WWH Recreational:					
29.2	FULL	80.0			
23.9 23.69	**NON** Threatened	48.5	Flow alteration Pathogens	Impoundment Septic system	No Yes
22.5	FULL	79.0			

Table 1.2 Attainment Status for Assessment Unit 04100012 060

Stream/14-Digit HUC & Use Designations River Mile	Attainment Status	QHEI	Impairment Cause	Impairment Source	Cause Addressed in TMDL?
Trib. to Vermilion River (24.35) Aquatic Life: WWH Recreational: None					
5.5	**NON**	55.5	Organic enrichment Siltation	Pasture	Indirectly Yes
0.2 0.2	FULL Threatened	71.0	 Pathogens	 Pasture/Septic system	 Yes
East Fork Vermilion River/HUC 04100012 060-030 Aquatic Life: WWH Recreational: PCR					
10.9 10.87	PARTIAL Threatened	58.0	Siltation Pathogens	Channelization Agriculture Pasture/septic system	Yes Yes
8.9/9.1 9.04	**NON** Threatened	67.0	Nutrient enrichment Organic enrichment Pathogens	Industrial point source (Green Circle Growers) Pasture/Septic system	Yes Indirectly Yes
7.4 7.41	**NON** Threatened	68.0	Nutrient enrichment Organic enrichment Pathogens	Industrial point source (Green Circle Growers) Septic system (Kipton)	Yes Indirectly Yes
2.3	FULL	64.0			
Trib. to East Fork (8.47) Aquatic Life: WWH Recreational: None					
0.7	**NON**	53.3	Nutrient enrichment Organic enrichment	Industrial point source (Green Circle Growers)	Yes Indirectly
Frankenburg Creek Aquatic Life: WWH Recreational: None					
0.2	FULL	77.0			
Vermilion River/HUC 04100012 060-040 (below East Fork to Lake Erie) Aquatic Life: EWH existing/propose WWH Recreational: PCR					
14.5	PARTIAL	81	EWH existing/WWH proposed-FULL attainment		
10.7	PARTIAL	75.5	EWH existing/WWH proposed-FULL attainment		
6.4	FULL	71.5			

Table 1.2 Attainment Status for Assessment Unit 04100012 060					
Stream/14-Digit HUC & Use Designations **River Mile**	**Attainment Status**	**QHEI**	**Impairment Cause**	**Impairment Source**	**Cause Addressed in TMDL?**
1.4/1.1	**NON**		Siltation Nutrient enrichment	Agriculture Development	Yes Yes
0.8	**(NON)**		Siltation Nutrient enrichment	Dnst Vermilion WWTP	Yes Yes
0.1	**(NON)**		Siltation Nutrient enrichment	Agriculture Development	Yes Yes
Trib. to Vermilion River (12.0) Aquatic Life: WWH Recreational: None					
1.5 1.99	FULL Threatened		Pathogens	Septic system	Yes
Trib. to Vermilion (8.29) Aquatic Life: WWH Recreational: None					
5.5	(FULL)				
1.93	Threatened		Pathogens	Septic system	Yes
1.0/0.9	FULL	63.0			

Parentheses ( ) in the attainment column, e.g. (NON), indicate only one metric (fish or macroinvertebrates) was used as the attainment determinate.

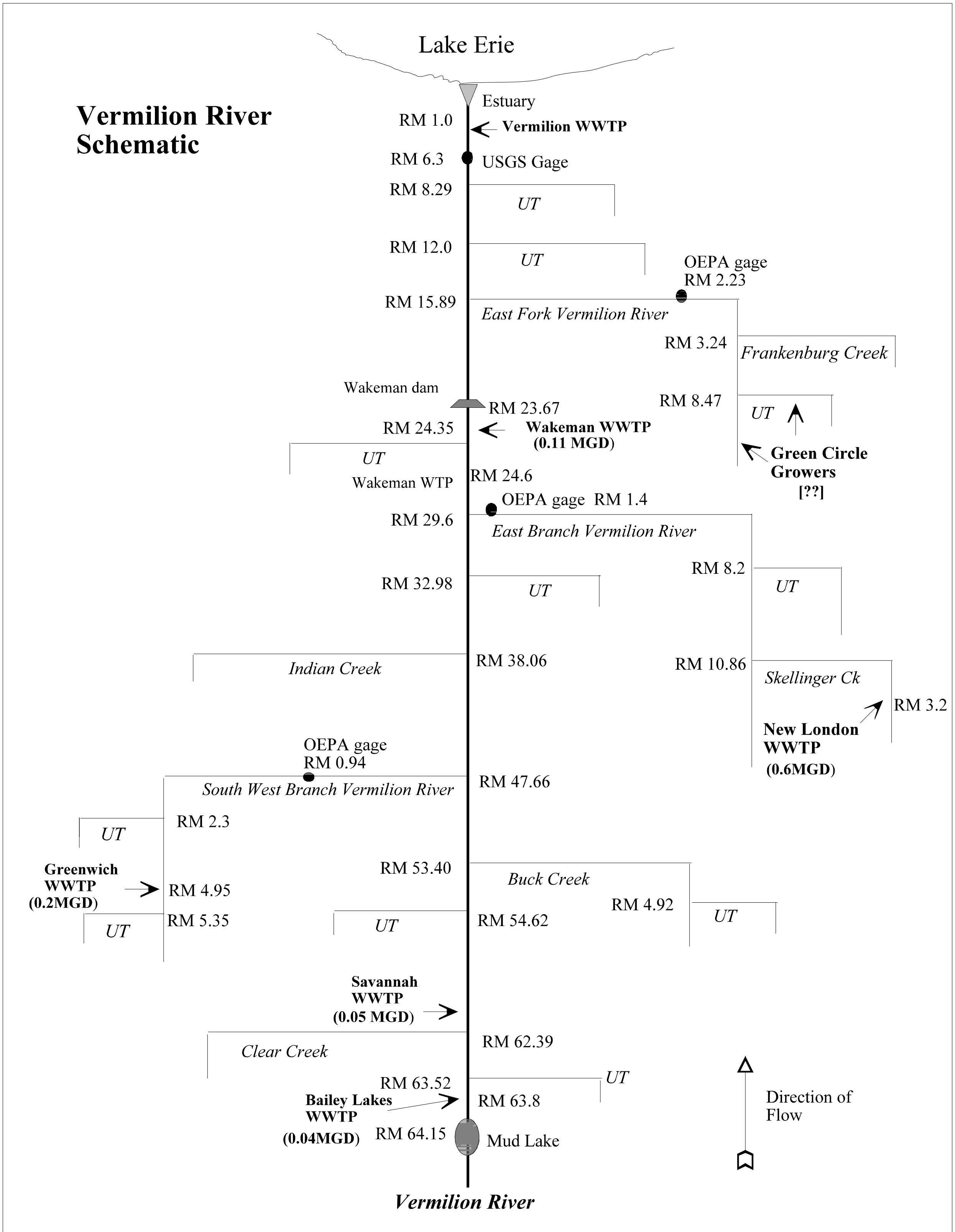


Figure 1.2 Schematic representation of the Vermilion River

2.0 Waterbody Overview

2.1 Description of the Study Area

The Vermilion River basin is located in north-central Ohio in portions of Ashland, Erie, Huron, Lorain and Richland counties. The watershed flows to the north to Lake Erie. Assessment unit 04100012 050 consists of the upper portion of the Vermilion River Basin from upstream of the East Branch Vermilion River to the headwaters near the community of Bailey Lakes, including Indian Creek, Southwest Branch Vermilion River, Buck Creek, Clear Creek and tributaries. Assessment unit 04100012 060 consists of the Vermilion River mainstem upstream of the East Branch Vermilion River downstream to Lake Erie, East Branch Vermilion River, East Fork Vermilion River and tributaries. The total drainage area of the two assessment units is approximately 268 mi^2. For this report the two assessment units within the Vermilion River basin have been divided into 14-digit subwatershed hydrological units (HUC) as presented in Figure 1.1.

2.1.1 Ecoregion and Geological Characteristics

The upper portion of Vermilion River and its tributaries originate in the Erie/Ontario Drift and Lake Plain (EOLP) ecoregion consisting of low rolling hills and end moraines blanketed with low line drift and lacustrine deposits. Soils are less fertile than other ecoregions in Ohio, but support farming activities such as raising livestock, corn and soybeans. The mid-section of the watershed in Erie, Huron and Lorain counties flows through the Eastern Corn Belt Plains (ECPB) ecoregion which is characterized by rolling till plains and end moraines. Rich and well drained glacier deposits of the Wisconsinan age support extensive production of livestock, corn and soybeans. The lower portion of the watershed is located in the EOLP ecoregion. In contrast to the upper watershed, this portion of the ecoregion is characterized by nearly level coastal lacustrine land with beach ridges and swales. The lacustrine deposits and lake effected climate support the production of fruit/vegetables and nursery crops.

2.1.2 Land Use

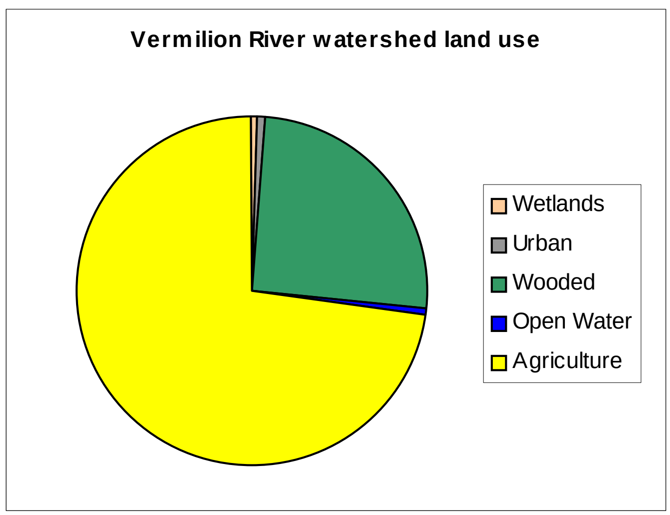
The predominant land use within the Vermilion River basin is agriculture, at 72.8%, followed by wooded lots at 25.3%. The remaining 1.9% of the land is occupied by wetlands, open water and urban areas. Basic land use in each of the14-digit subwatershed HUCs within the Vermilion River watershed is presented in Table 2.1. Total land use by acres within the watershed is displayed in Figure 2.1. Visual representation of land use is provided by the watershed map (Figure 2.2).

Table 2.1 Land use based on 14 - digit HUC

HUC 14	Total Area	Urban		Agriculture		Wooded		Open Water		Wetlands	
	Acres	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
050 010	14471	81	0.6	10935	75.6	3297	22.8	88	0.6	72	0.5
~020	12768	0	0.0	8779	68.8	3893	30.5	32	0.3	63	0.5
~030	13321	71	0.5	9920	74.5	3191	24.0	104	0.8	35	0.3
~040	7146	5	0.1	4913	68.7	1990	27.9	231	3.2	6	0.1
~050	19836	258	1.3	15700	79.1	3827	19.3	33	0.2	18	0.1
~060	22134	82	0.4	15940	72.0	6067	27.4	25	0.1	20	0.1
060 010	23992	418	1.7	17409	72.6	6008	25.0	68	0.3	89	0.4
~020	18127	170	0.9	13151	72.5	4762	26.3	8	0.0	36	0.2
~030	22239	49	0.2	17628	79.3	4360	19.6	48	0.2	155	0.7
~040	17258	583	3.4	10339	59.9	6031	34.9	84	0.5	220	1.3

Figure 2.1 Total land use within the Vermilion River watershed

Vermilion River watershed land use		
Wetlands	715	ac
Urban	1716	ac
Wooded	43425	ac
Open Water	721	ac
Agriculture	124716	ac



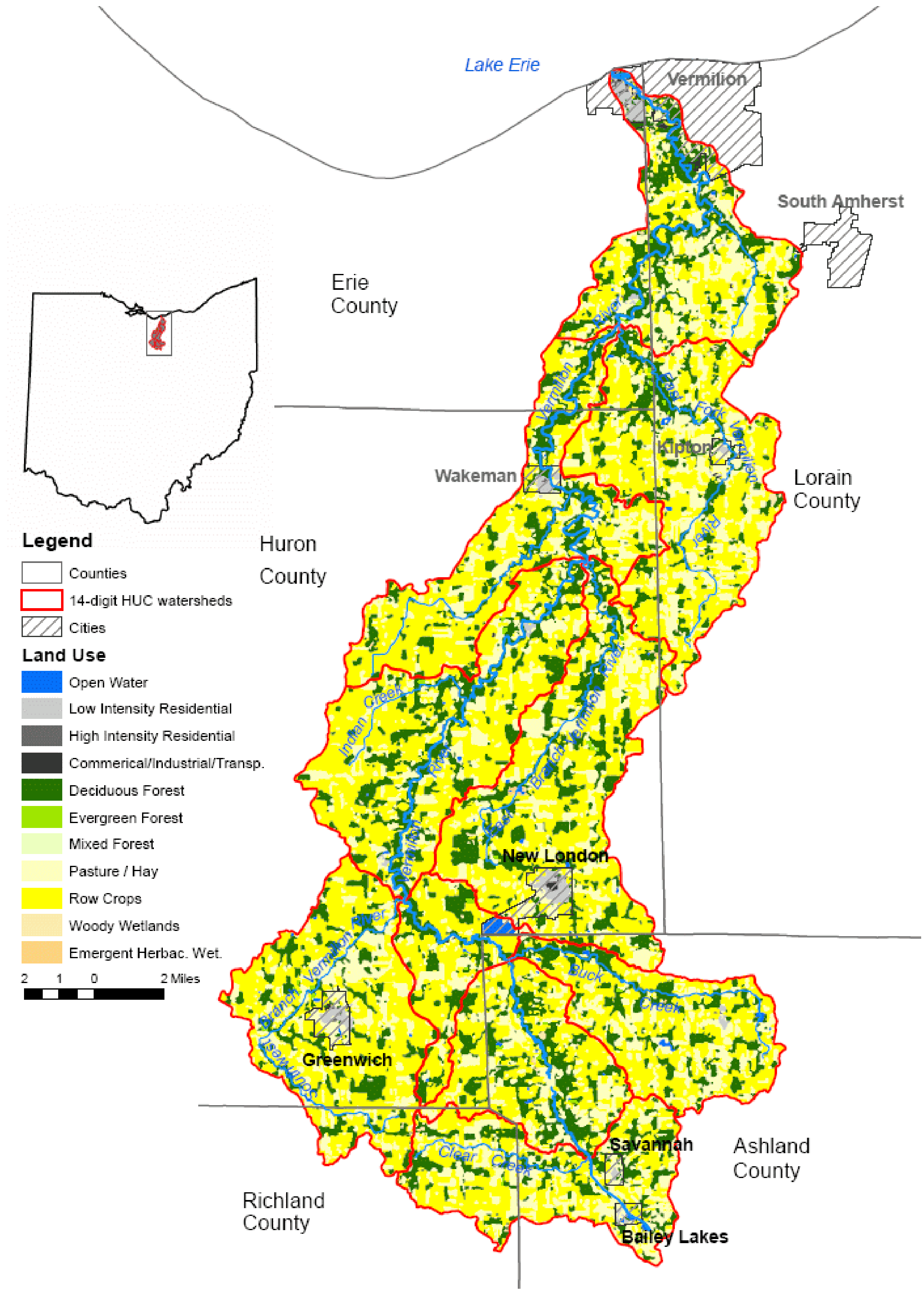


Figure 2.2 Vermilion River watershed land use map

2.1.3 Regulated Point Source Discharges

Ohio EPA has the authority to regulate the discharge of pollutants to waters of the state from municipal, commercial, and industrial facilities. Chapter 6111 of the Ohio Revised Code requires these discharges to have a National Pollutant Discharge Elimination System (NPDES) permit that limits the types and loads of pollutants entering the streams, lakes, and groundwater of Ohio. Permits are classified as Individual and General.

Individual permits are unique to each facility. The discharge limits imposed in the permit are based on the type of operation, volume of discharge, receiving stream characteristics, and other factors.

General permits are designed so that one permit is appropriate for facilities that have similar operations. Types of wastewater covered include industrial stormwater, construction site stormwater, municipal separate storm sewer systems (MS4), non contact cooling water, petroleum corrective action sites, small sanitary sources, and coal mines. An MS4 is any public entity (city, village, transportation department, university, military base, etc.) that owns or operates a separate storm sewer system. In December 1999, USEPA promulgated Phase II stormwater rules that required designated MS4 entities to submit permit applications. No entities met this criteria in the Vermilion River watershed, but Phase II also required Ohio EPA to develop criteria to determine if MS4 entities with a population of 10,000 or more or a population density of 1,000/mi.^{2} must obtain permit coverage. The City of Vermilion and portions of Erie and Lorain counties have been designated as Phase II MS4. A list of Individual and general permits within each 14 - digit HUC is presented in Table 2.2.

Table 2.2 Permitted Dischargers in the Vermilion River Watershed		
Entity (Ohio EPA Permit No.)	**Receiving Stream (Location of Discharge)**	**Type of Discharge**
Vermilion River/HUC 04100012 050-010 (headwaters to below Clear Ck.)		
Bailey Lakes WWTP (2PR00028001)	Vermilion River (RM 64.0)	Two parallel extended aeration units with polishing ponds
Savannah WWTP (2PA00086001)	Vermilion River (RM 62.0)	Series of two aerated lagoons with controlled discharge
Buck Creek/HUC 04100012 050-030		
ODOT District 3 (OHR112283)	Buck Creek	Storm Water
ODOT District 3 (2GC00364)		Construction Storm water
Tory Twp. WW District (2PH00019001)	Unnamed tributary to Buck Creek	3 Lagoons with control discharge
Tory Twp. WW District (OHC000002)	Unnamedtributary to Buck Creek	Storm Water
Southwest Branch Vermilion River/HUC 04100012 050-050		
Greenwich WWTP (2PB00059001)	Southwest Branch Vermilion R. (RM 5.0)	Series of two aerated lagoons with controlled discharge
(2PB00059002)	Southwest Branch Vermilion R. Tributary # 2 West of Townsend St	Combined sewer overflow
(2PB00059003)	Southwest Branch Vermilion R. Tributary # 2 South of East Union St.	Combined sewer overflow
(2PB00059012)	Southwest Branch Vermilion R. Tributary # 1 East of N. Kniffin St.	Combined sewer overflow
(2PB00059013)	Southwest Branch Vermilion R. Tributary # 2 East of NE. S. Kniffin St.	Combined sewer overflow
(2PB00059014)	Southwest Branch Vermilion R. Tributary # 2 East of outfall 013	Combined sewer overflow
(2PB00059015)	Southwest Branch Vermilion R. Tributary # 2 Southeast of S. Kniffin St.	Combined sewer overflow
(2PB00059016)	Southwest Branch Vermilion R. Southwest of S. Kniffin St.	Combined sewer overflow

Table 2.2 Continued.		
Entity (Ohio EPA Permit No.)	**Receiving Stream (Location of Discharge)**	**Type of Discharge**
(2PB00059017)	Southwest Branch Vermilion R. Tributary # 2 North of outfall 016	Combined sewer overflow
(2PB00059018)	Southwest Branch Vermilion R. Tributary # 4 West of New St.	Combined sewer overflow
(2PB00059019)	Southwest Branch Vermilion R. Tributary # 4 South of Main St.	Combined sewer overflow
(2PB00059020)	Southwest Branch Vermilion R. Tributary # 4 North of Main St.	Combined sewer overflow
(2PB00059021)	Southwest Branch Vermilion R. Tributary # 4 Southwest of Seminary St	Combined sewer overflow
(2PB00059022)	Southwest Branch Vermilion R. Tributary # 4 North of outfall 21	Combined sewer overflow
(2PB00059023)	Southwest Branch Vermilion R. Tributary # 3 West of N. Pleasant St.	Combined sewer overflow
Central Plastics Company (2GR00362)	Unnamed tributary . to Vermilion R.	Industrial Stormwater
East Branch Vermilion River/HUC 04100012 060-010		
New London WWTP (2PB00058001)	Skellinger Creek (RM 3.2)	Trickling filter system
(2PB00058002)	Skellinger Creek	Equalization basin overflow
BP Exploration & Oil Inc. (2GU00042)	Vermilion River	Petroleum Corrective Action
Norfolk & Western Railway (2GU00038)		Petroleum Corrective Action
Vermilion River/HUC 04100012 060-020 (below East Branch to above East Fork)		
Wakeman WWTP (2PA00014001)	Vermilion River 24.0	Series of two lagoons followed by a polishing with controlled discharge
Firelands Manor MHP (2PY00017001)	Ditch #237 (Vermilion River)	Extended aeration unit with sand filter

Table 2.2 Continued.

Entity (Ohio EPA Permit No.)	Receiving Stream (Location of Discharge)	Type of Discharge
Riverview MHP (2PY0020001)	Vermilion River	Extended aeration unit with sand filter, Cl-deCl with sludge holding
Vermilion River/HUC 04100012 060-040		
M.A. Harrison Mfg., Inc. (2IS00069001)	Hunters Ditch	Extended aeration unit with sand filter
(2IS00069601)	Hunters Ditch	Chemical treatment and carbon filtration of process water
(2GR00357)	Vermilion River	Industrial Stormwater
Bettcher Ind., Inc. (2IN00159001)	Hunters Ditch	Extended aeration unit with sand filter
Vermilion WWTP (2PD00032001)	Vermilion River (RM 1.0)	Conventional activated sludge
Valley Harbor Marina	Vermilion River	Industrial Stormwater
Lithonia Lighting (2GR00368)	Vermilion River	Industrial Stormwater
Hull Builders Supply, Inc. (2GG00010)	Vermilion River	Industrial Stormwater
Moes Marine, Inc. (2GR00215)	Vermilion River	Industrial Stormwater
Don Parsons, Inc. (2GR00046)	Vermilion River	Industrial Stormwater
Petroleum Systems, Inc. (2GU00029)	Vermilion River	Petroleum Corrective Action
BP Oil Company (2GU00010)		Petroleum Corrective Action
PC Campana, Inc. (3GR00272)	Shady Lake	Industrial Stormwater
Marios Landing, Inc. (3GR00346)	Vermilion River	Industrial Stormwater
Best Oil Company (3GU00075)	Vermilion River	Petroleum Corrective Action
Cassell Realty (3GC00029)	Vermilion River	Construction Stormwater

2.1.4 Unsewered Areas

Home sewage treatment systems are found mainly in rural areas and small villages. One common system employs a septic tank followed by a leaching tile field. The septic tank is a concrete box that provides primary treatment. It allows solids to settle and also promotes some decomposition. Solids will eventually fill the tank and routine cleaning is necessary. Water that overflows from the septic tank is distributed to a leaching tile field. This consists of pipe laid in trenches of gravel and sand that the wastewater slowly seeps into. Tile fields require a sufficient land area with well drained soils for them to operate effectively and they have a short life span. Home sewage treatment systems have minimal surface water impact if they are properly designed, installed, and maintained. Sometimes failed tile fields are bypassed into a storm sewer system or the nearest stream to prevent backing-up in yards and basements. This results in the presence of raw and poorly treated sewage in the stream and can be a major source of impairment, especially in larger communities and subdivisions. A list of unsewered villages located in the Vermilion River watershed is presented in Table 2.3.

Table 2.3 Unsewered Communities in the Vermilion River Watershed

Stream / 14 - HUC	**Community**
Vermilion River/HUC 04100012 050-010 (headwaters to below Clear Ck.)	NA
Vermilion River/HUC 04100012 050-020 (below Clear Creek to above Buck Ck.)	Ruggles
Buck Creek/HUC 04100012 050-030	Nova PTI issued/construction proposed spring 2005
Vermilion River/HUC 04100012 050-040 (below Buck Ck. to above Southwest Branch)	NA
SW Br. Vermilion R./HUC 04100012 050-050	NA
Vermilion River/HUC 04100012 050-060 (below Southwest Branch to above East Branch)	Fitchville, West Clarksfield, Clarksfield
East Br. Vermilion R./HUC 04100012 060-010	NA
Vermilion River/HUC 04100012 060-020 (below East Branch to above East Fork)	Hartland
East Fk. Vermilion R./HUC 04100012 060-030	Kipton
Vermilion River/HUC 04100012 060-040 (below East Fork to Lake Erie)	Birmingham

2.2 Water Quality and Biological Assessment

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters. Table 2.4 provides a brief description of Ohio's water quality standards. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (OAC) (http://www.epa.state.oh.us/dsw/wqs/criteria.html).

In the Vermilion River study area, the aquatic life use designations that apply to various segments are Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH). Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms (note: a Coldwater Habitat is a trout stream). Waters designated as EWH are capable of supporting "exceptional or unusual" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly pollutant intolerant and/or are rare, threatened, or endangered.

Attainment of aquatic life uses is determined by directly measuring fish and aquatic insect populations to see if they are comparable to those seen in least impacted areas of the same ecological region and aquatic life use. Attainment benchmarks from these least impacted areas are established in the WQS in the form of "biocriteria," which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic insects: Invertebrate Community Index (ICI)), the stream is considered in "non attainment." If the stream measurements achieve some of the biological criteria, but not others, the stream is said to be in "partial-attainment." A stream that is in "partial attainment" is not achieving its designated aquatic life use, whereas a stream that meets all of the biocriteria benchmarks, is said to be in full attainment.

Another type of use in the WQS is for recreational purposes. The recreational use for the majority of the Vermilion River study area is Primary Contact Recreation (PCR). The criterion for the PCR designation is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion, the Secondary Contact Recreation (SCR) use applies. The attainment status of PCR and SCR is determined using bacterial indicators; the criteria for each are specified in the Ohio WQS.

Table 2.4 Summary of the Components and Examples of Ohio's Water Quality Standards

<table>
<tr><th>WQS Components</th><th>Examples</th><th>Description</th></tr>
<tr><td>Beneficial
Use Designation</td><td>1. Water supply
• Public (drinking)
• Agricultural
• Industrial

2. Recreational contact
• Beaches (Bathing waters)
• Swimming (Primary Contact)
• Wading (Secondary Contact)

3. Aquatic life habitats (partial list):
• Exceptional Warmwater (EWH)
• Warmwater (WWH)
• Modified Warmwater (MWH)
• Limited Resource Water (LRW)

• State Resource Water</td><td>Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (they are water body specific).

Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent (lower) allowable concentrations of pollutants than would the average stream.

Recreational uses indicate whether the water can potentially be used for swimming or if it may only be suitable for wading.</td></tr>
<tr><td rowspan="4">Numeric Criteria</td><td>1. Chemical</td><td>Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.</td></tr>
<tr><td>2. Biological
Measures of fish health:
• Index of Biotic Integrity
• Modified Index of Well Being
Measure of bug (macroinvertebrate) health:
1. Invertebrate Community Index</td><td>Indicates the health of the instream biological community by using these 3 indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites. These criteria are the basis for determining aquatic life use attainment.</td></tr>
<tr><td>3. Whole Effluent Toxicity (WET)</td><td>Measures the harmful effect of an effluent on living organisms (using toxicity tests).</td></tr>
<tr><td>4. Bacteriological</td><td>Represents the level of bacteria protective of the potential recreational use.</td></tr>
<tr><td>Narrative Criteria

(Also known as 'Free Froms')</td><td colspan="2">General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, and nutrients in concentrations that may cause algal blooms.</td></tr>
<tr><td>Antidegradation Policy</td><td colspan="2">This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to http://www.epa.state.oh.us/dsw/wqs/wqs.html for more information.</td></tr>
</table>

For the Vermilion River TMDL, Ohio EPA conducted a detailed assessment of chemical (water column, effluent, sediment), physical (flows, habitat), and biological (fish and aquatic insect) conditions in order to determine if streams and rivers in the study area were attaining their designated uses. The basis for the listing of the Vermilion River on the 303(d) list is the measurements that were obtained in an assessment conducted in 2002 (OEPA, 2004). An aquatic life and recreational use attainment table for the Vermilion River study area is provided in Chapter 1, Table 1.1 of this report. The table is arranged from upstream to downstream and includes sampling locations indicated by river mile (RM), the use attainment status (i.e., full, partial, non or threatened), the Qualitative Habitat Evaluation Index (QHEI) (an indicator of habitat quality), and comments for the sampling location. Where the aquatic life use designation (WWH or EWH) is determined to be different than the existing use designation, Table 1.1 provides the attainment status for both the existing and the recommended use designation.

Assessment Unit Scores

Assessment unit scores are used to grade aquatic life use status within an 11 digit HUC. Scores are determined using a combination of spatial and linear analysis. A score of 100 is possible if all monitored sites meet designated aquatic life uses. Data is grouped according to the watershed size at the point of sampling: sites with drainage areas $\leq$5 mi.^{2}; sites with drainage areas >5 mi.^{2} and $\leq$20 mi.^{2}; sites with drainage areas >20 mi.^{2} and $\leq$50 mi.^{2}; and sites with drainage areas >50 mi.^{2}. Within each assessment unit a "linear" attainment score is calculated for the stream segments with drainage areas >50 mi.^{2} in the fashion described above for large rivers. A separate "spatial" attainment score is calculated for each assessment unit using information about the fraction or proportion of sites within data groups that demonstrated full aquatic life use attainment. To correct a bias in biosurvey design that generates a larger number of data points from small watersheds, the following formula was used to give more weight in the final spatial score to results from larger streams.

Data Group 1		Data Group 2		Data Group 3		
$\leq$5 mi.^{2}		>5 mi.^{2} to $\leq$20 mi.^{2}		>20 mi.^{2} to $\leq$50 mi.^{2}		Spatial Score
[(a/b	+	a/b)/2	+	(a/b)]/2 x 100	=	c

where

a= number of sites in full attainment
b= number of sites in data group
c= spatial attainment score for assessment unit

Assessment unit scores 80-99 generally indicate a localized water quality issue and are considered medium priority for TMDL development, since a targeted fix might address the problem better than a complete watershed effort. Assessment unit scores 40-79 indicate a problem of such a scale that make them good candidates for a traditional TMDL and make them a high priority. Assessment unit scores 0-39 indicate severe basin wide problems that may require significant time and resources and make them a low priority. Education about how land use affects water quality and encouraging stewardship in these areas may be more effective than a traditional TMDL.

Ohio has developed a point system to prioritize waters identified as impaired and requiring a TMDL. The method is described in the *2004 Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2004). A total of 13 points can be assigned to an assessment unit. Impairment of the recreation use is more heavily weighted (7 points) compared to the aquatic life use (4 points) and fish consumption advisories (2 points).

The assessment unit score for the upper Vermilion watershed (04100012 050) is 51; the lower part of the watershed (04100012 060) scored 39. Priority points are 8 and 5, respectively. The assessment summaries included in the 2004 integrated report are presented in Appendix A.

2.3 Causes and Sources of Impairment

The determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiter of aquatic life use attainment and impairment. The rationale for using biocriteria has been extensively discussed elsewhere (Karr, 1991; OEPA, 1987a, b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991).

Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent and land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g., agricultural runoff, municipal point sources, septic systems) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear on the section 303(d) list do not necessarily represent a true "cause and effect" relationship. Rather they represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

2.3.1 Causes of Impairments

The following paragraphs are provided to present the varied causes of impairment that were encountered during the Vermilion study. While the various perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

Habitat and Flow Alterations

Habitat alteration, such as channelization, impacts biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include the removal of riparian trees and field tiling to facilitate drainage. Following a rain event, most of the water is quickly removed from tiled fields rather than filtering through the soil, recharging groundwater, and reaching the stream at a lower volume and more sustained rate. As a result, small streams more frequently go dry or become intermittent.

Tree shade is important because it limits the energy input from the sun, moderates water temperature, and limits evaporation. Removal of the tree canopy further degrades conditions because it eliminates an important source of coarse organic matter essential for a balanced ecosystem. Erosion impacts channelized streams more severely due to the lack of a riparian buffer zone to slow runoff, trap sediment and stabilize banks. Additionally, deep trapezoidal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses.

The lack of water movement under low flow conditions can exacerbate impacts from organic loading and nutrient enrichment by limiting relegation of the stream. The amount of oxygen soluble in water decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion, but channelization eliminates turbulence produced by riffles, meanders, and debris snags. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Oxygen is also used by bacteria that decay dead organic matter. Nutrient enrichment can promote the growth of nuisance algae that subsequently dies and serves as food for bacteria. Under these conditions, oxygen can be depleted unless it is replenished from the air.

Siltation and Sedimentation

Whenever the natural flow regime is altered to facilitate drainage, increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosional process. Channelization keeps all but the highest flow events confined within the artificially high banks. As a result, areas that were formerly flood plains that allowed for the removal of sediment from the primary stream channel no longer serve this function. As water levels fall following a rain event, interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macro invertebrates is reduced. Silt also can clog the gills of both fish and macro invertebrates, reduce visibility thereby excluding site feeding fish species, and smother the nests of lithophilic fishes.

Lithophilic spawning fish require clean substrates with interstitial voids in which to deposit eggs. Conversely, pioneering species benefit. They are generalists and best suited for exploiting disturbed and less heterogeneous habitats. The net result is a lower diversity of aquatic species compared with a typical warmwater stream with natural habitats.

Sediment also impacts water quality, recreation, and drinking water. Nutrients absorbed to soil particles remain trapped in the watercourse. Likewise, bacteria, pathogens, and pesticides which also attach to suspended or bedload sediments become concentrated in waterways where the channel is functionally isolated from the landscape. Community drinking water systems address these issues with more costly advanced treatment technologies.

Nutrient Enrichment

The element of greatest concern is phosphorus because it is critical for plant growth and is often the limiting nutrient. The form that can be readily used by plants, and therefore can stimulate nuisance algae blooms, is orthophosphate (PO_4^{-3}). The amount of phosphorus tied up in the nucleic acids of food and waste is actually quite low. This organic material is eventually converted to orthophosphate by bacteria. The amount of orthophosphate contained in synthetic detergents is a greater concern however. It was for this reason that the General Assembly of the State of Ohio enacted a law in 1990 to limit phosphorus content in household laundry detergents sold in the Lake Erie drainage basin to 0.5 % by weight. Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Another characteristic of point sources is they have a continuous impact and are human in origin, for instance, effluents from municipal sewage treatment plants. The contribution from failed on-lot septic systems can also be significant, especially if they are concentrated in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l and after secondary treatment is generally 4-6 mg/l. Further removal requires the added cost of chemical addition. The most common methods use the addition of lime or alum to form a precipitate, so most phosphorus (80%) ends up in the sludge.

A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and associated with stormwater runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban stormwater is more of a concern if combined sewer overflows are involved. The impact from rural stormwater varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills. Land management is an issue because erosion is worse on streams without any riparian buffer zone to trap runoff.

The impact is worse in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, (E)). Phosphorus loadings from large volume point source dischargers in the Lake Erie drainage basin are regulated by the National Pollutant Discharge Elimination System (NPDES). The permit limit is a concentration of 1.0 mg/l in final effluent. Research conducted by the Ohio EPA indicates that a significant correlation exists between phosphorus and the health of aquatic communities (Miltner and Rankin, 1998). It was concluded that biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. It was also determined that the lowest phosphorus concentrations were associated with the highest quality habitats, supporting the notion that habitat is a critical component of stream function. The report recommends WWH criteria of 0.08 mg/l in headwater streams (<20 mi^2 watershed size), 0.10 mg/l in wadeable streams (>20-200 mi^2) and 0.17 mg/l in small rivers (>200-1000 mi^2).

Organic Enrichment and Low Dissolved Oxygen

The amount of oxygen soluble in water is low and it decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion. Drainage practices such as channelization eliminate turbulence produced by riffles, meanders, and debris snags. Although plant photosynthesis produces oxygen by day, it is consumed by the reverse process of respiration at night. Oxygen is also consumed by bacteria that decay organic matter, so it can be easily depleted unless it is replenished from the air. Sources of organic matter include poorly treated waste water, livestock waste, sewage bypasses, dead plants and algae.

Dissolved oxygen criteria are established in the Ohio Water Quality Standards to protect aquatic life. The minimum and average limits are tiered values and linked to use designations (Administrative Code 3745-1-07, Table 7-1).

Ammonia

Ammonia enters streams as a component of fertilizer, manure run-off and wastewater effluent. Ammonia gas (NH_3) readily dissolves in water to form the compound ammonium hydroxide (NH_4OH). In aquatic ecosystems an equilibrium is established as ammonia shifts from a gas to undissociated ammonium hydroxide to the dissociated ammonium ion (NH_4^{+1}). Under normal conditions (neutral pH 7 and 25°C) almost none of the total ammonia is present as gas, only 0.55% is present as ammonium hydroxide, and the rest is ammonium ion. Alkaline pH shifts the equation toward gaseous ammonia production, so the amount of ammonium hydroxide increases. This is important because while the ammonium ion is almost harmless to aquatic life, ammonium hydroxide is very toxic and can reduce growth and reproduction or cause mortality.

The concentration of ammonia in raw sewage is high, sometimes as much as 20-30 mg/l. Treatment to remove ammonia involves gaseous stripping to the atmosphere, biological nitrification and de-nitrification, and assimilation into plant and animal biomass. The nitrification process requires a long detention time and aerobic conditions like that provided in extended aeration treatment plants. Under these conditions, bacteria first convert ammonia to nitrite and then to nitrate. Nitrate can then be reduced by bacteria through the de-nitrification process and nitrogen gas and carbon dioxide are produced as by-products.

Ammonia criteria are established in the Ohio Water Quality Standards to protect aquatic life. The maximum and average limits are tiered values based on sample pH and temperature and linked to use designations (Administrative Code 3745-1-07, Tables 7-2 through 7-8).

Metals

Metals can be toxic to aquatic life and hazardous to human health. Although they are naturally occurring elements many are extensively used in manufacturing and are by-products of human activity. Certain metals like copper and zinc are essential in the human diet, but excessive levels are usually detrimental. Lead and mercury are of particular concern because they often trigger fish consumption advisories. Mercury is used in the production of chlorine gas and caustic soda and in the manufacture of batteries and fluorescent light bulbs. In the environment it forms inorganic salts, but bacteria convert these to methyl-mercury and this organic form builds up in the tissues of fish. Extended exposure can damage the brain, kidneys, and developing fetus. The Ohio Department of Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under not to eat more than one meal per week of any species of fish from waters of the state because of mercury. Lead is used in batteries, pipes, and paints and is emitted from burning fossil fuels. It affects the central nervous system and damages the kidneys and reproductive system. Copper is mined extensively and used to manufacture wire, sheet metal, and pipes. Ingesting large amounts can cause liver and kidney damage. Zinc is a by-product of mining, steel production, and coal burning and used in alloys such as brass and bronze. Ingesting large amounts can cause stomach cramps, nausea, and vomiting.

Metals criteria are established in the Ohio Water Quality Standards to protect human health, wildlife, and aquatic life. Three levels of aquatic life standards are established (Administrative Code 3745-1-07, Table 7-1) and limits for some elements are based on water hardness (Administrative Code 3745-1-07, Table 7-9). Human health and wildlife standards are linked to either the Lake Erie (Administrative Code 3745-1-33, Table 33-2) or Ohio River (Administrative Code 3745-1-34, Table 34-1) drainage basins. The drainage basins also have limits for additional elements not established elsewhere that are identified as Tier I and Tier II values.

Pathogens

High concentrations of either fecal coliform bacteria or *Escherichia coli* (E. coli) in a lake or stream may indicate contamination with human pathogens. People can be exposed to contaminated water while wading, swimming, and fishing. Fecal coliform bacteria are relatively harmless in most cases, but their presence indicates that the water has been contaminated with feces from a warm-blooded animal. Although intestinal organisms eventually die off outside the body, some will remain virulent for a period of time and may be dangerous sources of infection. This is especially a problem if the feces contained pathogens or disease producing bacteria and viruses. Reactions to exposure can range from an isolated illness such as skin rash, sore throat, or ear infection to a more serious wide spread epidemic. Some types of bacteria that are a concern include *Escherichia*, which cause diarrhea and urinary tract infections, *Salmonella*, which cause typhoid fever and gastroenteritis (food poisoning), and *Shigella*, which cause severe gastroenteritis or bacterial dysentery. Some types of viruses that are a concern include polio, hepatitis A, and encephalitis. Disease causing microorganisms such as cryptosporidium and giardia are also a concern.

Since fecal coliform bacteria are associated with warm-blooded animals, there are both human and animal sources. Human sources, including effluent from sewage treatment plants or discharges by on-lot septic systems, are a more continuous problem. Bacterial contamination from combined sewer overflows are associated with wet weather events. Animal sources are usually more intermittent and are also associated with rainfall, except when domestic livestock have access to the water. Large livestock farms store manure in holding lagoons and this creates the potential for an accidental spill. Liquid manure applied as fertilizer is a runoff problem if not managed properly and it sometimes seeps into field tiles.

Bacteria criteria are established in the Ohio Water Quality Standards to protect human health. The maximum and average limits are tiered values and linked to use designation, but only apply during the May 1-October 15 recreation season (Administrative Code 3745-1-07, Table 7-13). The standards also state that streams must be free of any public health nuisance associated with raw or poorly treated sewage during dry weather conditions (Administrative Code 3745-1-04, (F)).

Sediment Contamination

Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles and are persistent in the environment. Some of these compounds accumulate in the aquatic food chain and trigger fish consumption advisories, but others are simply a contact hazard because they cause skin cancer and tumors. The physical and chemical nature of sediment is determined by local geology, land use, and contribution from manmade sources. As some materials enter the water column they are attracted to the surface electrical charges associated with suspended silt and clay particles. Others simply sink to the bottom due to their high specific gravity. Sediment layers form as suspended particles settle, accumulate, and combine with other organic and inorganic materials. Sediment is the most physically, chemically, and biologically reactive at the water interface because this is where it is affected by sunlight, current, wave action, and benthic organisms.

Fish Consumption Advisories

Ohio does not include fish consumption among the codified beneficial uses, so no criteria exist and attainment status cannot be assessed. However, the Ohio Department of Health issues a sport fish consumption advisory in cooperation with the Ohio EPA and Ohio Department of Natural Resources.

A statewide/nationwide advisory for mercury has been issued since 1997 to protect women of child bearing age and children under the age of six. These sensitive populations are advised not to eat more than one meal per week of any species of fish caught from any body of water in Ohio. Mercury is a human health concern because extended exposure can damage the brain, kidneys, and developing fetus. Elemental mercury forms inorganic salts when it enters the aquatic environment, but bacteria convert these to methyl-mercury. It is this organic form of mercury that bioaccumulates in the aquatic food chain.

2.3.2 Sources

Sources of pollution are usually classified as either point or non-point. The location of point sources is easy to identify at the end of a pipe and most are regulated by a permit to control quality of effluent. The location of non-point sources is difficult to identify because they come from all land uses. They are difficult to control and not often regulated, but have a major impact on water quality. Section 319 of the CWA was ratified in 1987 to require states to develop non-point source management programs.

Nonpoint Sources

Nonpoint sources of pollution to a water resource are a direct function of surrounding land use. All land use contributes to nonpoint sources of pollution that impair Ohio watersheds. Since agriculture occupies 72.8% of the land area in the Vermilion River watershed, agricultural land uses are responsible for much of the nonpoint source pollution in area streams (Huron SWCD, 2004 and Erie SWCD, 2004). Agricultural land use is a source of nonpoint source pollution as it may increase habitat alteration, nutrient enrichment, siltation, pathogens and flow alteration.

Cultivation of land for crop production makes the soils susceptible to water and wind erosion and this increases the amount of sediment in streams. It also increases the amount of nutrients, especially phosphorus, and pesticides that are applied to crops to increase yield. Nitrates pass easily thorough soil and contribute to pollution problems because they enter the streams through field tiles installed to improve drainage.

A major concern with livestock production is the management of manure. Confined feeding areas usually require the collection and storage of manure and this creates the potential for spills. Pasture land contributes to pollution too, especially if the livestock have unrestricted access to the stream.

Stormwater runoff can be a significant source of impairment. Runoff from lands modified by human activities can harm surface water resources in several ways, including the changing of natural habitat and hydrologic patterns and elevating pollutant concentrations and loadings. Storm water runoff may contain or mobilize high levels of contaminants, such as sediment, nutrients, heavy metals, pathogens, toxins, oxygen-demanding substances, and floatable debris.

Hydromodification includes activities like channelization, removal of riparian vegetation, and dam construction. Channelization redefines the natural structure and form of a stream to make it straight, wide, and deep. This is done to increase capacity and flow rate and improve the operation of internal drainage systems. The removal of riparian vegetation is often conducted as a part of channelization projects. This practice reduces friction, allows farming closer to the channel, and facilitates maintenance activities. Most dams were constructed for flood control, but some were intended to enhance navigation, recreation, and water supplies.

Septic systems are used to treat sanitary sewage in areas where no municipal facilities exist. These systems usually employ a settling tank followed by either a leaching field or sand filters. They have a finite life span and require routine maintenance to operate properly. When poorly designed or neglected, they contribute loads of organic matter, nutrients, and pathogens. Another problem that occurs in small towns is cross connecting failed systems to storm sewers. This solves the problem of sewage backing up in yards and basements, but severely impacts stream quality.

Nonpoint source pollution and land use impacts on water resources in the Vermilion River watersheds include the following:

- Nitrate concentrations often exceed drinking water standards
- Seasonally elevated herbicide levels

- High concentrations of suspended solids during runoff events
- Failure to attain aquatic life uses set by Ohio Water Quality Standards
- Fish and wildlife kills due to spills
- Sedimentation impairment to in-stream habitat for fish and macro invertebrates
- Primary and Secondary Contact Recreation Uses limited by high bacteria events
- Fish consumption advisory for the entire Vermilion River watershed
- Aesthetic impairment from sediment and algal blooms
- Phosphorus loading
- Suspended sediment degradation to Vermilion River habitat
- Pesticides, nitrates, and other organic chemical pollutants transported by sediment
- Impervious surfaces cause accelerated runoff volume to the river
- Failing septic systems
- Contaminated storm runoff

Point Sources

Point sources include municipal and industrial types. The wastewater they discharge can contain a wide variety of pollutants, but of particular concern are organic matter and nutrients. Organic enrichment contributes to dissolved oxygen sags and is usually measured with the BOD test. Nutrient enrichment can stimulate plants and algae to grow to the point where they are a nuisance and detrimental to the environment. The compounds ammonia, nitrate, and phosphorus are measured to evaluate the extent of enrichment.

Sewage treatment plants are designed to provide conditions suitable for microbes to convert organic compounds into stable inorganic compounds. Two components that are important for a system to operate efficiently are a long retention time and oxygen. These conditions stimulate bacterial respiration, which converts organic carbon to carbon dioxide and water. Another important process performed by bacteria involves the nitrogen cycle, which converts organic nitrogen and ammonia to ammonium, then nitrite, and finally nitrate. The treatment of phosphorus usually requires the addition of chemicals to encourage particles to adsorb to their surface and coagulate in masses heavy enough to precipitate out of the wastewater. This is why most phosphorus ends up in sludge, making it an attractive fertilizer.

Combined Sewer Overflows

These types of sewer systems carry both sanitary waste and stormwater runoff. They are not a problem during dry weather, because treatment plants are designed to handle these flows. It is during wet weather that CSOs and bypasses become a concern, because they activate to prevent flooding of the sewer system. Since this wastewater is not treated it contains a high amount of organic matter, nutrients, and pathogens. It can also contain a high amount of metals and oily waste.

3.0 Problem Statement

The goal of the TMDL process is full attainment of the Water Quality Standards established for aquatic life and recreation uses summarized in Table 2.4. These beneficial uses are impaired in some portions of the Vermilion River watershed. The major causes of non-attainment for aquatic life uses are organic enrichment, excessive nutrients, sedimentation, habitat degradation, and flow alteration. The specific nutrients are mentioned below. The major cause of non-attainment for recreation uses are elevated fecal coliform counts. Low summer streamflows provide little dilution for many point sources in the watershed.

Although nutrients and sediments are listed as causes of aquatic life impairment in this watershed, data collected by Heidelberg College's Water Quality Laboratory indicates that the unit area loads for those parameters are fairly low compared to several other monitored watersheds in Ohio. Table 3.1 shows the unit area loads for suspended solids, total and dissolved phosphorus, nitrate and chloride for the Vermilion and 10 other watersheds for which daily monitoring has been conducted by Heidelberg College for extended periods (Loftus et al., 2005). This comparison indicates that nutrient and sediment loads in the Vermilion are less significant at the watershed outlet, when compared to other watersheds in Ohio. Most water quality and habitat problems were observed close to the headwaters of the Vermilion River and its major tributaries.

Table 3.1 Average annual unit area discharges and unit area loads for indicated water years for tributaries monitored by Heidelberg College Water Quality Lab

River	Year	Discharge (inches)	TSS*	Total P*	SRP*	Nitrate*	Chloride*
Raisin	94-03	9.92	221	0.43	0.06	10.7	84
Maumee	94-03	11.56	435	0.98	0.17	16.9	76
Sandusky	94-03	11.4	483	1.00	0.12	17.5	74
Honey Ck.	94-03	11.18	371	0.98	0.15	15.9	58
Rock Ck	94-03	11.23	717	1.21	0.11	10.4	59
Vermilion	**01-03**	**9.58**	**370**	**0.60**	**0.09**	**8.7**	**77**
Cuyahoga	94-03	17.56	911	1.08	0.15	7.1	557
Grand	94-03	17.67	478	0.49	0.04	2.3	143
Muskingum	96-03	-	284	0.59	0.10	5.9	114
Scioto	97-03	12.8	330	0.94	0.34	12.8	125
Great Miami	97-03	14.36	366	1.22	0.49	15.1	148

* All loads are in lbs/acre

Poor quality habitat with reduced or debilitated riparian zones and channelized streams intensify the impact of nutrients by reducing the riparian uptake and conversion of nutrients, by increased retention time due to widened channel, and by allowing full sunlight to stimulate nuisance growths of algae. These factors also interact to increase the retention of nutrients in the most available dissolved forms, attached to fine sediments (especially clays and silts) and in planktonic and attached algae (OEPA, 1999).

The habitat quality in the Vermilion River watershed was excellent at most mainstem sites, but tended to be below target in many of the tributaries, as drainage area decreased. (The habitat targets are identified in Section 3.1). Most of the habitat problems are related to agricultural activities, since more than 70% of the watershed is devoted to agriculture, although suburban development is affecting small parts of the watershed.

The parameters selected for Total Maximum Daily Load development are sediment, habitat, total phosphorus, and bacteria. Organic enrichment is identified as a cause of impairment in some areas (see Tables 1.1 and 1.2), but is dealt with indirectly in this report. Implementation actions to alleviate the other impairments should be adequate to eliminate organic enrichment as a cause of impairment. Instead of trying to develop sediment mass loadings, the Qualitative Habitat Evaluation Index (QHEI) will be used as a surrogate. Specifically, the substrate, channel and riparian scores (which are components of the QHEI) are used to indicate siltation problems. Ohio EPA used a watershed model to estimate phosphorus loads basinwide, and a spreadsheet model to perform fecal coliform bacteria modeling for several assessment units known to be impaired. More details about the phosphorus and bacteria modeling are available in Chapter 4.

3.1 Target Identification

The establishment of instream numeric targets is a significant component of the TMDL process. The numeric targets serve as a measure of comparison between observed instream conditions and conditions that are expected to restore the designated uses of the segment. The TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in the attainment of applicable water quality standards.

3.1.1 Total Phosphorus

Ohio EPA currently does not have statewide numeric criteria for nutrients, but potential targets have been identified in a technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). This document provides the results of a study analyzing the effects of nutrients on the aquatic assemblages of Ohio streams and rivers. The study reaches a number of conclusions and stresses the importance of habitat and other factors, in addition to instream nutrient concentrations, as having an impact on the health of biologic communities. The study also includes proposed targets for nitrate+nitrite concentrations and total phosphorus concentrations based on observed concentrations at reference sites. Reference sites are relatively unimpacted sites that are used to define the expected or potential biological community within an ecoregion. The total phosphorus targets are shown in Table 3.2. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL.

Table 3.2 Total Phosphorus Target Values

Statewide (WWH)	
Watershed Size	**TP (mg/l)**
Headwaters (H)- drainage area < 20 mi^2	0.08
Wadeable (W)- drainage area 20-200 mi^2	0.10
Small Rivers (SR)- drainage area 200-1000 mi^2	0.17

Ohio's water quality standards also include narrative criteria which limits the quantity of nutrients which may enter waters. Specifically, OAC 3745-1-04 states that all waters of the state shall be free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae.

Figure 3.1 shows the total phosphorus concentrations measured in the Vermilion River mainstem during Ohio EPA surveys conducted between June and October of 2002. Most results were below the target values of 0.1 (wadeable streams) and 0.17 (small rivers). The impact of point sources is evident in the graph.

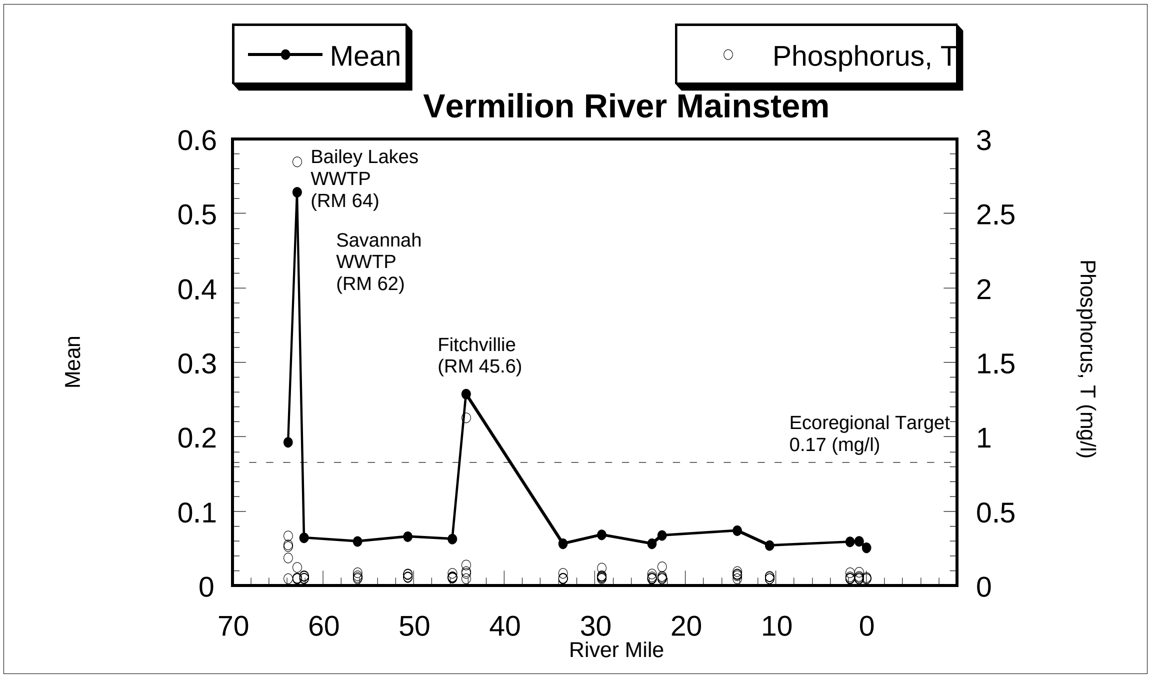


Figure 3.1 Average Total P concentrations in Vermilion River mainstem, June-Oct 2002

3.1.2 Habitat

The QHEI is a quantitative index that combines the scores given to six physical stream/riparian variables, thus yielding a numeric value for a stream's habitat. The variables included in the index are: substrate, instream cover, riparian characteristics, channel characteristics, pool/riffle quality, and gradient/drainage area. The QHEI can be used to assess a stream's habitat and determine which of the six variables needs to be improved to reach the target score. Figure 3.2 shows the QHEI (habitat) index scores versus drainage area for each of the Vermilion watershed sites where the index was measured. Most of the sites not meeting the habitat targets have drainage areas less than 30 mi^2, thus indicating where remediation efforts should be focused. Note that of all the sites that were assessed, only one was recommended to be classified as Modified Warmwater Habitat (MWH, with an applicable QHEI target of $\geq$45). All other sites are considered as Warmwater Habitat (WWH), with a QHEI goal of $\geq$60.

In addition to the QHEI measurements and related stream variables, each site is also assessed for presence of characteristics that are typical of natural habitats as well as modified habitats. Table 3.3 shows the characteristics of modified streams that Ohio EPA uses to help classify a reach as leaning closer to Modified Warmwater Habitat than to Warmwater Habitat. The number of these characteristics present in a reach provides another quantitative tool to evaluate habitat degradation, and is also used as part of TMDL development.

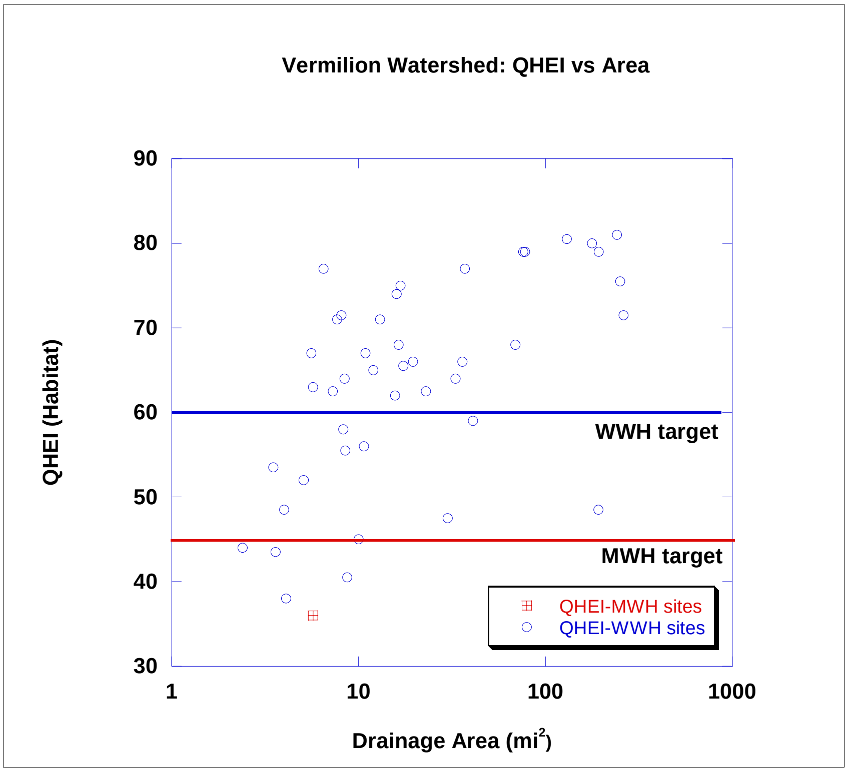


Figure 3.2 Habitat (QHEI) Scores versus Drainage Area

Table 3.3 Habitat Characteristics of Modified Warmwater Streams

High Influence	*Moderate Influence*
Channelized; little or no recovery	Channelized, but recovering
Silt or muck substrates	Heavy to moderate substrate embeddedness
Low or no sinuosity (headwaters)	Hardpan substrate origin
Cover sparse to none	Low or no sinuosity
Max. pool depth < 40 cm (wading)	Only 1 or 2 cover types
	Max. pool depth < 40 cm (headwater)
	Fair or poor channel development
	No fast current
	Sand substrate (boat sites)
	Intermittent or interstitial with poor pools

Source: Rankin, 1991

The attributes shown in Table 3.3 are modifications of natural habitat and were classified as high-influence or moderate-influence attributes based on the statistical strength of the relationships against biological index (IBI) scores. The presence of these modified attributes can strongly influence aquatic biology to a degree that the QHEI score itself may not reflect. The analysis indicates that a stream with more than one high-influence or more than four moderate-influence attributes will not typically achieve WWH biocriteria (using an IBI of 40 as a representative WWH biocriterion). Therefore, it is possible that a stream segment can be impaired even with a QHEI score above 60. For example, the positive effects of a good riparian zone and high sinuosity may be overwhelmed by the negative impact of muck substrate. In this hypothetical situation, the QHEI may exceed 60 because some high-quality habitat features are in place; however, the stream is impaired because it is limited by a very poor substrate. For this reason, the number of high and moderate influence modified habitat attributes, in combination with the QHEI scores, are used for habitat TMDL development in this report. Table 3.4 shows the target scores for each habitat variable.

Table 3.4 Target Values For Habitat Condition (WWH)

Type of Habitat Index (QHEI)Variable	Target Score
QHEI Score	≥ 60
Number of High Influence Attributes	< 2
Total # of Modified Habitat Attributes	< 5

3.1.3 Sedimentation

Sedimentation was identified as a major cause of impairment. OAC 3745-1-04 states that all waters of the state shall be free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. Although total suspended solids (TSS) were measured at most sites, Ohio currently has no statewide numeric criteria that can be used to assess the observed TSS concentrations. Several variables within Ohio EPA’s QHEI (Qualitative Habitat Evaluation Index) scores for the 2002 Vermilion River watershed sites can be used as surrogates for sedimentation.

The substrate variable includes an assessment of sediment quality and quantity, thus providing a numeric target for sedimentation. The substrate score is available for each site that received a QHEI evaluation. A target score of 13 or higher (of a maximum score of 20) is recommended for Warmwater Habitat (WWH) sites. The channel morphology variable evaluates channel sinuosity (meanders), development (presence of pools/riffles), channelization (man-induced), and stability (stable/eroded banks). A score of 14 or higher (out of twenty) is recommended for WWH sites. The riparian variable emphasizes the quality of the riparian buffer zone and of the flood plain vegetation, including riparian zone width, flood plain quality and extent of bank erosion. A score of 5 or greater (out of 10) is recommended for WWH sites.

Table 3.5 shows the targets for the substrate, channel and riparian scores, which are used as surrogates for sediments. The scores for these indices at each assessed site are used to determine sediment TMDLs in Chapter 4.

Table 3.5 Target Values For Sediment Surrogate Variables

Type of Habitat Index (QHEI)Variable	Target Score
Substrate	$\geq$ 13
Channel	$\geq$14
Riparian	$\geq$5

Figure 3.3 shows which of the sites assessed in the Vermilion watershed had poor substrate channel variable scores. It also shows the sites that had the higher numbers of modified habitat characteristics mentioned in Table 3.3. The streams are color coded to indicate which reaches are attaining the WWH or MWH use designation.

3.1.4 Biocriteria

The biocriteria are the definitive measure of attainment of the Aquatic Life use designation. After the control strategies have been implemented, biological measures including the IBI, ICI, QHEI and MIwb will be used to validate biological improvement and biocriteria attainment. The current attainment status of biocriteria in the Vermilion watershed is listed in the Vermilion and Old Woman Creek Technical Support Document. Applicable criteria are available in OAC Chapter 3745-1. Figure 3.3 shows the approximate extent of use attainment for the main water bodies in the watershed.

3.1.5 Bacteria

Bacteria samples were collected at numerous sites throughout the watershed during the summer of 2002. The statewide numerical and narrative criteria for primary contact recreational use designation requires that for each designation at least one of the two bacteria standards (fecal coliform or E. coli) must be met. These criteria apply outside the mixing zone and for fecal coliform state; the geometric mean content (either MPN or MF), based on not less than five samples within a thirty-day period, shall not exceed 1,000 per 100 ml and shall not exceed 2,000 per 100 ml in more than 10 percent of the samples taken during any thirty-day period. Since fewer than 5 samples were taken at each site, the data results could not be used to determine if a site was violating the WQS. The available data was pooled by 14 digit HUC assessment unit to evaluate which of them were considered impaired due to bacteria.

Bacteria modeling was performed only for those assessment units shown to be impaired. The target selected for use in the bacteria modeling is the WQS used to compare to the geometric mean of the sample values (1000 counts or MPN/100 ml). It was assumed that meeting the 1000 counts/100 ml standard would also result in meeting the other half of the standard (not to exceed 2000 counts/100 ml in more than 10% of the samples).

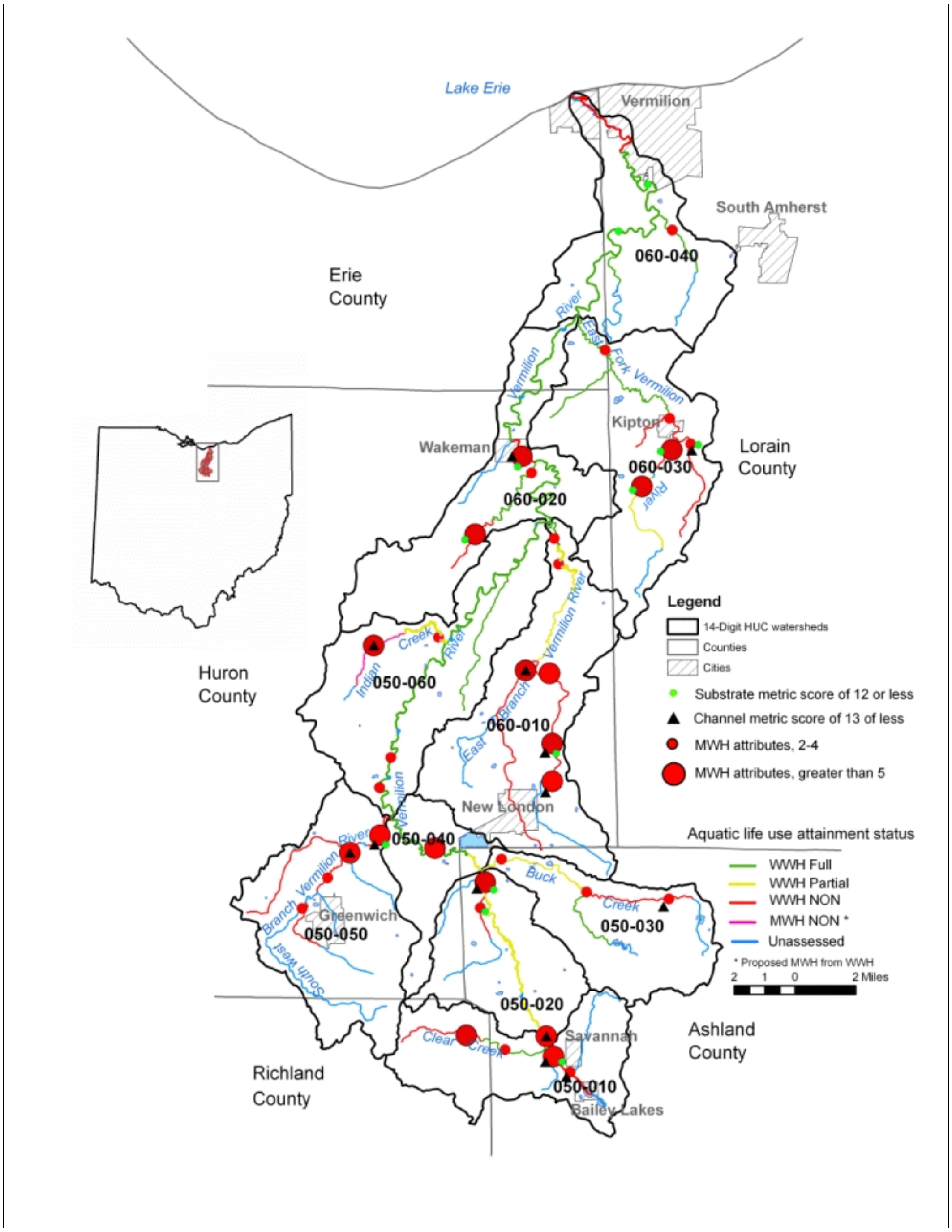


Figure 3.3 Location of Sites with Poor Habitat and Sediment Scores in the Vermilion Watershed

3.2 Current Deviation from Target

3.2.1 Nutrients (Total P)

As described in the preceding section, target values for total phosphorus vary with the drainage area of a given stream segment. Table 3.6 illustrates the median concentrations compared to the target values for total phosphorus arranged by assessment unit (HUC) and drainage area size. The phosphorus TMDLs are based on the "% reduction needed to meet the target "data shown below.

Table 3.6 Comparison of total phosphorus concentrations to target values in Vermilion River assessment units by drainage area

HUC 14 Assessment Unit	Watershed Size	Total P Target (mg/l)	Total P Median (mg/l)	% Reduction Needed to Meet target
HUC 04100012-050-010				
Vermilion River Headwaters to below Clear Creek	Headwater	0.08	0.059	None
Clear Creek	Headwater	0.08	0.179	55%
HUC 04100012-050-020				
Vermilion River below Clear Creek to above Buck Creek	Wadeable	0.10	0.05	None
HUC 04100012-050-030				
Buck Creek: Headwaters to RM 4.93 (County Rd 1181)	Headwater	0.08	0.09*	10%
Buck Creek: Downstream RM 4.93 to mouth (including tributaries)	Headwater	0.08	0.05	None
HUC 04100012-050-040				
Vermilion River below Buck Creek to above Southwest Branch	Wadeable	0.10	0.06	None
HUC 04100012-050-050				
Southwest Branch: Headwater to RM 3.8 (Greenwich-Angling Rd)	Headwater	0.08	0.14	44%
Southwest Branch: Downstream RM 3.8 to mouth	Wadeable	0.10	0.10	None
HUC 04100012-050-060				
Vermilion River below Southwest Branch to above East Fork	Wadeable	0.10	0.05	None
Indian Creek	Headwater	0.08	0.05	None
HUC 04100012-060-010				
East Branch: Headwaters to RM 8.31 (Vesta Rd)	Headwater	0.08	0.26	69%
East Branch: Downstream RM 8.3 to mouth	Wadeable	0.10	0.16	37%

Table 3.6 Comparison of total phosphorus concentrations to target values in Vermilion River assessment units by drainage area

HUC 14 Assessment Unit	Watershed Size	Total P Target (mg/l)	Total P Median (mg/l)	% Reduction Needed to Meet target
East Branch trib at RM 8.2	Headwater	0.08	0.26	69%
Skellinger Creek	Headwater	0.08	1.9*	96%
HUC 04100012-060-020				
Vermilion River below East Branch to above East Fork	Wadeable	0.10	0.06	None
Vermilion tributary at RM 24.3	Headwater	0.08	0.07*	None
HUC 04100012-060-030				
East Fork: Headwaters to RM 10.87 (State Road 303)	Headwater	0.08	0.11*	25%
East Fork: Downst. RM 10.8 to RM 7.4 (State Road 511)	Headwater	0.08	0.62	87%
East Fork: Downstream RM 7.4 to mouth	Wadeable	0.10	0.18	45%
East Fork trib at RM 12.64	Headwater	0.08	0.40*	80%
East Fork trib at RM 8.47	Headwater	0.08	0.59*	86%
Frankenburg Creek (RM 3.24)	Headwater	0.08	0.07*	None
HUC 04100012-060-040				
Vermilion R: Below East Fork to N Ridge Rd	Small River	0.17	0.05	None
Vermilion: Downst. N. Ridge Rd to mouth	Small River	0.17	0.05	None
Vermilion River trib at RM 12.1	Headwater	0.08	0.13*	38%
Vermilion River trib at RM 8.29	Headwater	0.08	0.07	None

*Average value was determined if <10 samples were available

The water quality data collected by Ohio EPA was grouped by HUC 14 assessment unit, according to the location of each monitoring site. Within each assessment unit, the 50^{th} percentile concentration of total phosphorus was used to help characterize the degree of phosphorus enrichment of each reach or major tributary. The average value was determined for reaches with fewer than 10 samples available. The purpose of segregating the data by reach or tributary is to provide enough detail about conditions in each of them, which will be useful when implementation priorities are established.

In this TMDL report the “percent reduction needed to reach target” is used as the basis to recommend load reductions for point sources (including failing septic systems) located within each reach where the phosphorus target is not being met. Most of the chemistry data collected by Ohio EPA was collected under summer low flow conditions, therefore it is appropriate to assume that runoff from agricultural activities had low influence on most of these results (except for sites impacted by livestock with free access to streams). Additional details about the justification for selected load reductions for point and nonpoint sources are explained in Section 4.4.2.

3.2.2 Sedimentation, Habitat, and Biocriteria

The biological criteria scores for each monitoring site are available in the report based on the 2002 studies of the Vermilion River (Ohio EPA, 2004). Figures 3.4, 3.5 and 3.6 show the substrate, channel and riparian scores for each monitored site within the Vermilion watershed, compared to the recommended target for each. These variables are used as surrogates for siltation. The sites are arranged by drainage area. The scores for the substrate, channel and riparian variables are shown in Chapter 4 with more details (at HUC-14 assessment unit level), when the sediment TMDLs are determined.

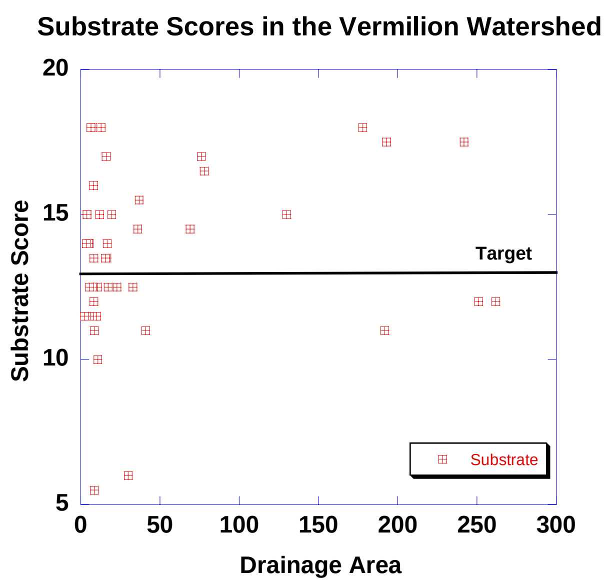


Figure 3.4 Substrate Scores versus Drainage Area

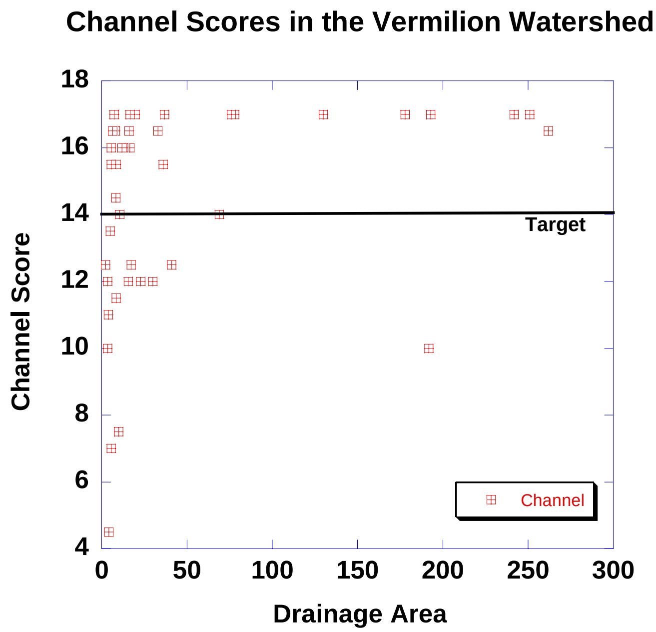


Figure 3.5 Channel Scores versus Drainage Area

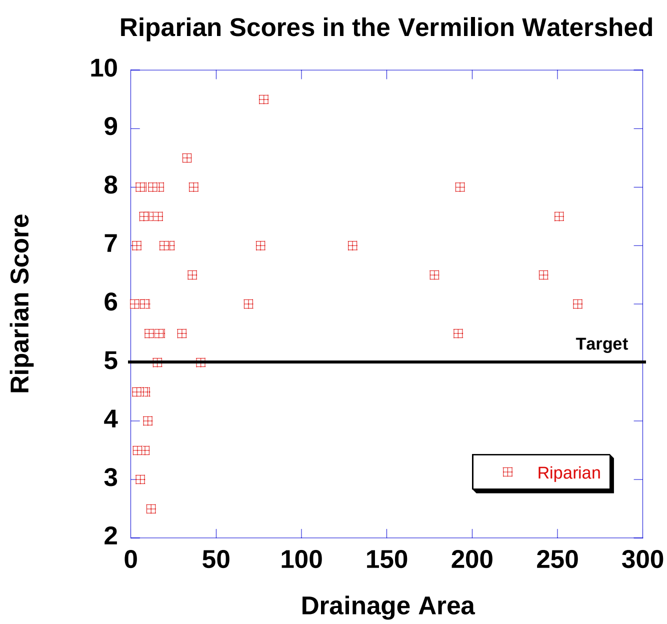


Figure 3.6 Riparian Scores versus Drainage Area

3.2.3 Bacteria

The results of the bacteria data analysis performed by Ohio EPA showed that five of the 10 HUC-14 assessment units within the Vermilion watershed had one or more segments that were not attaining their recreational use designation. Bacteria modeling was only performed for those five subwatersheds.

To determine the deviation from target, the geometric mean of fecal coliform concentration data was compared to the Fecal Coliform WQS at all sites that were exceeding the target value. Refer to Table 3.7 for a list of the selected sites, the deviation from target, and the percent reduction needed to achieve the target. Chapter 4 offers details about the procedure followed to estimate bacteria loads for the assessment units where the impaired sites are located.

Table 3.7 Bacteria Target Deviation*

Stream	Assessment Unit # 04100012-	RM at site	Geometric mean count from field samples	Deviation from Fecal Coliform WQS
			(counts/100 ml)	(percent)
Clear Creek @ Townline Rd	050-010	3.99	3526	72%
Vermilion River @ Clear Creek Rd	050-010	62.9	1381	28%
Buck Creek at TR 1281	050-030	3.21	1200	17%
Southwest Branch @ Greenwich/Angling Rd	050-050	5.6	1500	33%
Southwest Branch @ SR 13	050-050	0.94	4400	77%
East Branch @ Vesta Rd	060-010	8.31	5654	82%
East Branch @ Zenobia Rd	060-010	3.6	2383	58%
Skellinger Ck at Fayette Rd	060-010	0.95	1524	34%
East Fork Vermilion at SR 511	060-030	9.0	1945	49%

***** Deviation from the Fecal Coliform WQS of 1000 counts/100 ml

3.3 Source Identification

Nonpoint sources contribute the largest portion of the nutrient loads in the Vermilion watershed. However, the loads from home sewage treatment systems (HSTS) and sanitary wastewater treatment plants constitute a significant percentage of the total load during the critical low flow summer period. Figure 3.7 shows the average daily total phosphorus loads measured at the Vermilion gauge, compared to the point source loads and to the estimated HSTS loads. The WWTP loads are based on data reported by major dischargers in the watershed from 2000-2003. The average daily load was determined for each month to show the seasonal variations. During the summer months (mainly July through August) the point source loads are a larger proportion of the total load, due to typically lower stream flows during those months. The point source loads are small compared to what originates from nonpoint sources, but cause problems in the vicinity of the point source discharge whenever the upstream flows are low. The loads shown in Figure 3.7 exclude the load from the Vermilion WWTP (about 4.5 lbs/day), because it is located downstream of the USGS gage.

During storm events and other periods of high flow, nonpoint sources are the predominant source of nutrients on a yearly average basis, and are the largest source of sediment resulting in siltation and sedimentation. Lack of riparian cover and channelization, particularly in the upper reaches, also contributes to non-attainment.

Livestock with free access to streams (as shown in Figure 3.8) and failing home sewage treatment systems (HSTS) are significant sources of bacteria impairment in various subwatersheds in the Vermilion watershed. Allocation of loads follows in Chapter 4.

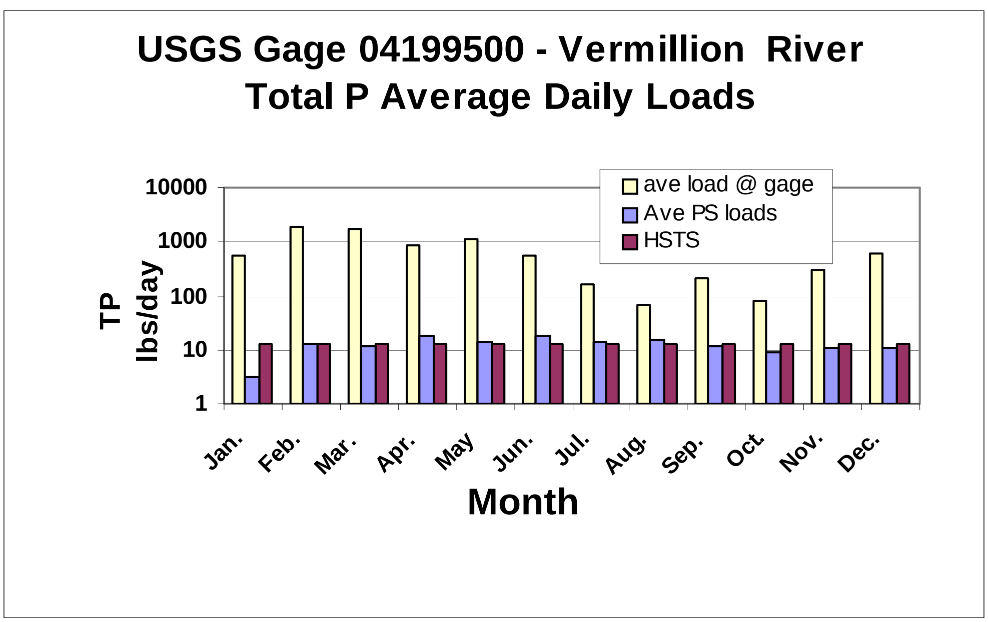


Figure 3.7 Total P Measured at Vermilion USGS gauge compared with Load Estimates from WWTPs and Septic Systems

Figure 3.8 Livestock with Access to the Stream in SouthWest Branch Vermilion River

4.0 Total Maximum Daily Loads

The TMDL is the sum of the wasteload allocations for the point sources and the load allocations for natural background and nonpoint sources in a watershed. Also included in TMDL calculations is a margin of safety (implicit or explicit) to account for any uncertainty regarding the relationship between pollutant load and water quality. Habitat degradation issues in this watershed dictate that several non-load TMDLs be developed to address impaired segments affected by habitat modification. Attainment of water quality standards (WQS) may require a combination of pollutant load reductions and improvement of other conditions (such as instream and riparian habitat, cropland and livestock management practices, dam removal, low-flow augmentation, etc.) if they have been identified as causes of impairment.

In the Vermilion River watershed, most of the impaired or partially impaired sites are located near headwater areas (with drainage area < 20 mi^2) where low background streamflows aggravate the impact of relatively minor pollutant sources. The installation of drainage tiles and the maintenance of ditches (designed to quickly drain agricultural lands) may contribute to the desiccation of headwater streams during periods of low precipitation. The results of the biological surveys and the use attainment status for this watershed are detailed in a separate report (Ohio EPA, 2004).

The attainment of WQS in Ohio requires meeting criteria based on the health of the aquatic biological community (biocriteria). Chemical water quality criteria are established as a surrogate for direct measurement of the aquatic biological community to allow a determination if a particular pollutant is present in amounts that are projected to cause impairment in an aquatic biological community. A similar linkage between biocriteria and habitat condition can also be used to recommend habitat goals that are deemed favorable for full attainment of the stream's designated aquatic life use.

In the Vermilion River watershed, total phosphorus was subject to load reductions in several subwatersheds because its existing concentration is exceeding Ohio EPA guidelines (as seen in Section 3.2). In most cases, the phosphorus problems are seasonal. Although nitrate concentrations are somewhat high during a few months in this watershed, total phosphorus is typically considered the limiting factor among nutrients, and is also more cost effective to control than nitrate (which is mostly in dissolved form and cannot be filtered or settled out). A nitrate TMDL was not performed, however, information about dissolved nitrogen loads in the watershed is provided in Section 4.2. The information provided will be beneficial to counties and citizens in the watershed that are concerned about reducing the concentration of nitrate in their water supply.

As reported in Chapter 3, the major causes of non-attainment of the aquatic life use are organic enrichment, excessive nutrients, sedimentation, habitat degradation and flow alteration. Bacteria are impairing the recreational use in several tributaries. Various approaches are followed for TMDL development for each of them, and are described in Section 4.1.

4.1 Method of Calculation

Different modeling approaches were used to quantify and determine TMDLs for the Vermilion watershed. These approaches are summarized in Table 4.1.

The Vermilion River watershed assimilates a large portion of the nutrients generated in the upper parts of the watershed. Instream chemistry and biological results indicate that most of the mainstem is in full attainment of the aquatic life use designation. Due to the variety of conditions that are affecting the streams, several approaches were used to determine the TMDLs for this report:

1. Study the long term hydrologic regime and seasonal flow distribution to determine if streamflow is a limiting factor.

2. Determine the nonpoint and point source loading contributions to the stream network. This method determined the annual phosphorus load to the stream. Information about seasonal variations is also provided. Total phosphorus is used as the indicator for excessive nutrients.

3. Establish current habitat and substrate conditions and quantify desired habitat and substrate goals. This method quantifies sedimentation and habitat degradation.

4. Estimate bacteria loads for the assessment units that were determined to be impaired by bacteria. Due to the small number of bacteria samples collected in the watershed, the model used to get these estimates is not calibrated. The bacteria load information includes estimates of livestock and failing septic system contributions.

Table 4.1 Modeling Approach Summary

Model or Method	**Parameters Analyzed**	**Goals**	**How was it used?**
Flow and Load Duration Curves and Continuous Stream Gauge Monitoring data	- Phosphorus - TSS - Nitrogen - Streamflow	Examine streamflow variation Quantify the total nutrient load in the Vermilion River and major tributaries. Evaluate and compare nutrient loadings among sub-watersheds	- Quantify the existing loads based on stream water quality data. -Establish percent load reduction goals based on meeting nutrient targets linked to biological index attainment. -Examine seasonal variations and recommend minimum streamflow
Watershed Model (Generalized Watershed Loading Functions)	- Dissolved P - Sediments - Dissolved N (no TMDL)	Quantify nutrient & sediment loads by subwatershed & sources Quantify background loads Evaluate impact of management practices Quantify septic systems loads	- Estimate loads at subwatershed level to help prioritize implementation - Show effects of various management practices scenarios - Provide seasonal load estimates
Bacterial Indicator Tool	- Fecal Coliforms	Quantify bacteria loads in impaired tributaries	- Quantify the existing loads and recommend percent load reductions using targets based on the fecal coliform WQS.
Ecological Assessment Techniques and Models	- Phosphorus - TSS - QHEI 1. Substrate 2. Channel 3. Riparian quality	Establish targets for parameters with no criteria. Evaluate parameters which are not directly incorporated in the other models. Directly address the biocriteria impairment issues.	- Determine numeric targets for phosphorus and habitat where no criteria exists - Compare attaining reference sub-watersheds to impaired sub-watersheds in the Vermilion River basin. Assist in determining needed changes in the impaired subwatersheds

4.1.1 Hydrologic Regime

Vermilion Watershed Streamflow Gaging Sites

Table 4.2 shows information about the USGS gauging site and three other temporary streamflow gauges established by Ohio EPA. The table also shows the percentage of the watershed drainage area measured by the gauge, and the total phosphorus targets that apply at those sites, based on their drainage area. A map depicting the gauge locations is shown in Chapter 3.

Table 4.2 USGS and Ohio EPA Streamflow Gauges in the Vermilion Watershed and the Applicable Total Phosphorus Targets

Location	Drainage Area (mi^2)	% Watershed Area	Total P Target (mg/l)
Vermilion River near Vermilion	262	98%	0.17
East Fork at Green Road	33	12%	0.10
East Branch at Townline Road	37	14%	0.10
Southwest Branch at SR 13	30	11%	0.10

Flow Duration Analysis

The availability of daily flow and water quality data at the Vermilion USGS gauge from November 2000 through November 2004 made it possible to develop flow and load duration curves for the Vermilion River near the mouth. The information collected there and at other Ohio EPA gauges was used to determine the percent load reductions (if needed) for Total Phosphorus. A flow duration curve for the Vermilion gauge was developed combining historical flow data (1950-1981) with recent data (2000-2004). "Flow duration analysis looks at the cumulative frequency of historic flow data over a specified period. The duration analysis results in a curve, which relates flow values to the percent of time those values have been met or exceeded. Thus, the full range of stream flows is considered. Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently. Duration curve analysis identifies intervals, which can be used as a general indicator of hydrologic condition (i.e., wet versus dry and to what degree). This indicator, when combined with other basic elements of watershed planning, can help point problem solution discussions towards relevant watershed processes, important contributing areas, and key delivery mechanisms. These are all major considerations when identifying those controls that might be most appropriate and under what conditions. Duration curves also give a context for evaluating both monitoring data and modeling information." (Cleland, 2003).

The first step of the load duration curve method is to calculate and develop a **flow** duration curve using continuous flow data record at the gauge site of interest. Figure 4.1 shows a flow duration curve for the Vermilion River at the Vermilion USGS gauge. It compares the flow duration interval (FDI) - the percent of time a particular flow value is met or exceeded, to that flow value. A FDI is also referred to as a flow recurrence interval. The right side of the curve ("drought side") drops quickly toward zero, and is typical of "flashy" streams. In flashy streams the flows rise and drop quickly during storms.

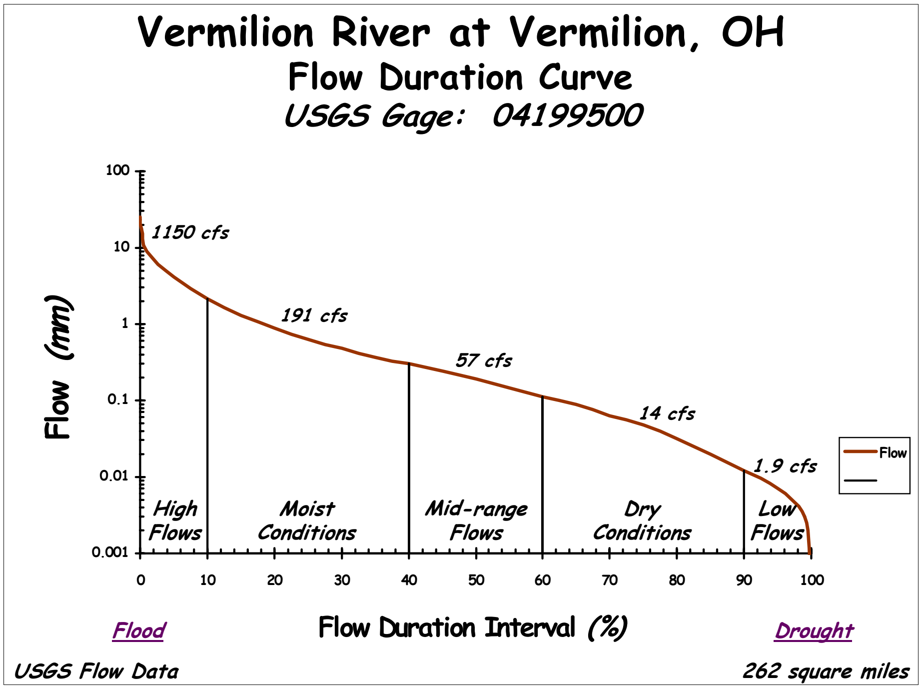


Figure 4.1 Flow Duration Curve for the Vermilion River at Vermilion

Extremely high flows are rarely exceeded and have low FDI values; very low flows are often exceeded and have high FDI values. The flow duration curve includes all flows observed at the gauge for the applicable period of record. The Vermilion River watershed shows very low flows (less than 2 cfs) during 10% of the time, based on measurements during the period of record. **Low streamflow constitutes a serious constraint to attainment of water quality and biological quality targets in the Vermilion River watershed, particularly during the warmer summer months.**

Table 4.3 shows the monthly flow variations measured at the Vermilion USGS gauge. The table depicts the percentage of time that a particular streamflow value is equaled or exceeded. Thus, the September flow of 89 cfs is at or below that value 90% of the time, and exceeded 10% of the time. For the same month, the streamflow is less than 1 cfs during 10% of the time, and ≥ 1 cfs during 90% of the time. This information can be used to determine minimum recommended flows if low flow augmentation is considered as a feasible management alternative.

Table 4.3 Streamflow Equaled or Exceeded Each Month for the Indicated Percentage of Time at the Vermilion USGS Gauge

	Monthly Flow Variation (cfs)				
Month	**90%**	**75%**	**50%**	**25%**	**10%**
Sept	89	21	7	2	1
Oct	63	25	9	3	2
Nov	259	89	29	9	4
Dec	668	250	80	30	12
Jan	800	250	88	32	17
Feb	1223	433	145	65	24
Mar	1588	757	298	139	81
Apr	1100	458	203	105	67
May	524	231	96	45	27
June	272	101	41	19	9
July	155	49	18	7	3
Aug	87	29	10	3	1

4.1.2 Loads to the Stream

The Vermilion River has one USGS gauge near its outlet, near the city of Vermilion. Water quality samples are collected and analyzed by staff from Heidelberg College's Water Quality Laboratory near the outlets of several Lake Erie tributaries, including the Vermilion River at that gauge. **That data indicates that the Vermilion River's annual unit area export rates of total phosphorus, suspended solids and nitrate nitrogen are low compared to other agricultural watersheds in the Lake Erie basin, but higher than the rates for the Grand River (where forest is the predominant land use**) (Loftus, 2005). The Vermilion River's export rates and time-weighted mean concentrations are compared to other tributaries in Figures 4.2 through 4.7.

The average total phosphorus concentration in the Vermilion River (shown in Figure 4.2) is well below the recommended target concentration of 0.17 mg/l for this size watershed, and is lower than the concentration observed in the Sandusky River but higher than that observed in the Grand River. The phosphorus load per unit area in Figure 4.3 is similar to that of the Grand River during 2001 (a low flow year), and ranks between the Grand and the Sandusky for 2002 and 2003 (high flow years). The increase in loads and concentrations for 2002 and 2003 is most probably due to high streamflows and associated impact from increased runoff and erosion.

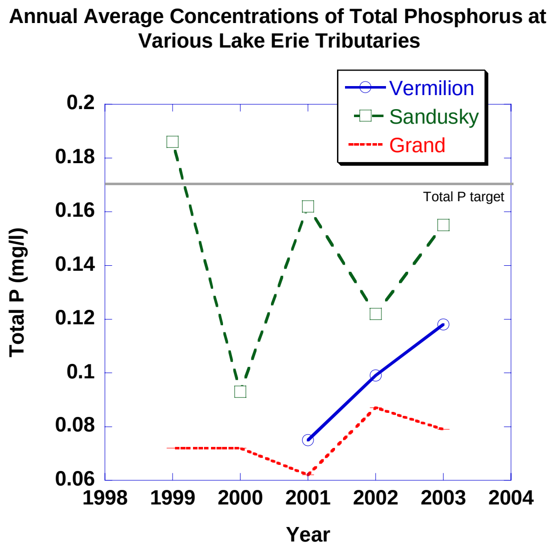


Figure 4.2 Annual Total P Concentration in Various Lake Erie Watersheds

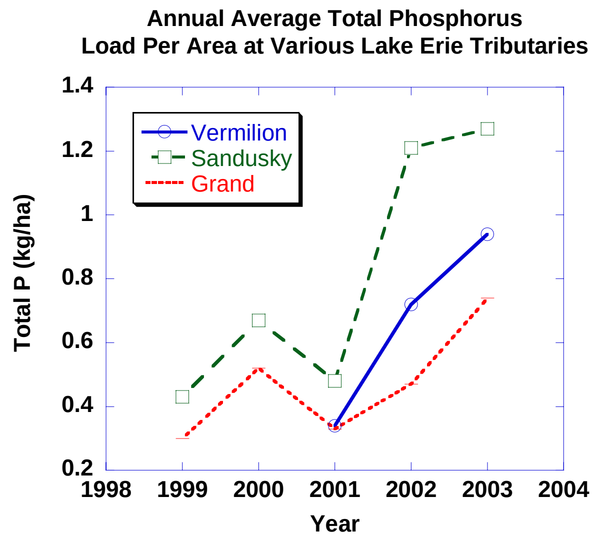


Figure 4.3 Annual P load/unit area in Various Lake Erie Watersheds

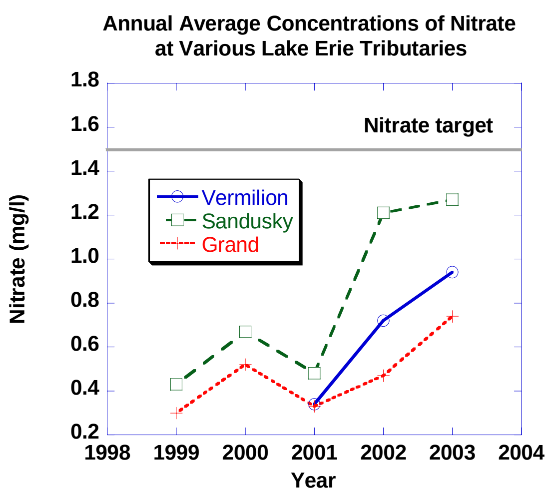


Figure 4.4 Annual NO_3 Concentration in Various lake Erie Watersheds

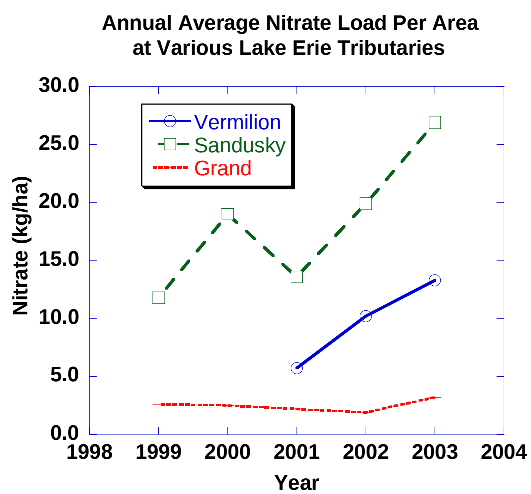


Figure 4.5 Annual NO_3 Load/unit Area in Various Lake Erie Watersheds

Figure 4.4 shows the average nitrate-N concentration in the Vermilion and two other watersheds, based on data collected at the USGS gauges near the watershed outlet. A target concentration of 1.7 mg/l is shown to illustrate that on an annual basis the nitrate concentrations in the Vermilion River are within target. The nitrate load per unit area is significantly lower than the load for the Sandusky watershed, as shown in Figure 4.5.

The total suspended solids concentrations are seen in Figure 4.6, compared against a reference concentration of 20 mg/l (Ohio has no aquatic life water quality criterion for TSS). The Vermilion watershed TSS concentrations are close to those observed for the Grand River, a highly forested watershed, and lower than the Sandusky. The loads per unit area are similar for the three watersheds for most of the period examined, as shown in Figure 4.7.

These charts illustrate that, at the watershed outlet, the Vermilion concentrations and loading rates for phosphorus, nitrate and TSS are reasonably low on an annual basis. Additional analyses and simulations in this chapter provide details about seasonal variations and relative loads from various subwatersheds within the basin.

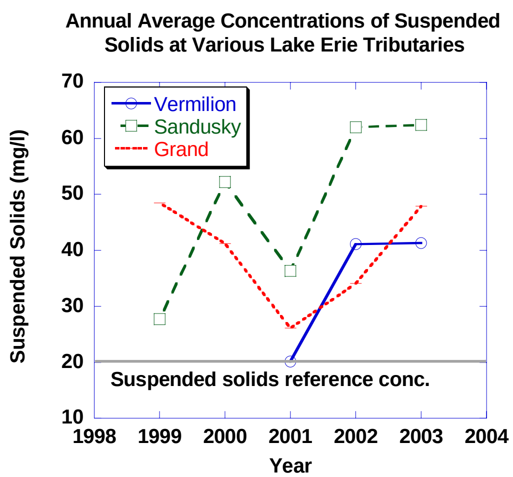


Figure 4.6 Annual TSS Concentration in Various Lake Erie Watersheds

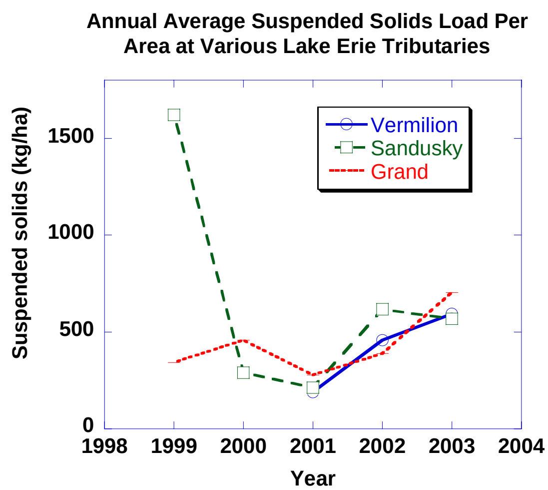


Figure 4.7 Annual TSS Loads/unit Area in Various Lake Erie Watersheds

Load Duration Curves

A load duration curve is created by multiplying the flow duration curve flow values by the applicable water quality criterion or target (shown in Table 4.2) and a conversion factor. The independent x-axis remains as the Flow Duration Interval (FDI), and the dependent y-axis depicts the load at that point in the watershed. The curve represents the allowable load (or the TMDL) at each flow condition. Depicting flows as intervals ranging from drought to flood may be easier to understand by citizens in the watershed. By comparing the load duration curve to the loads from samples collected over a wide range of flow conditions, it is possible to estimate the percent load reductions needed to meet the TMDL target under each flow interval, and determine which conditions are more critical at this location. The points above the LDC (Load Duration Curve) show values that exceed the target load, and points on or below the curve indicate when the target is being met.

Figure 4.8 shows the total phosphorus load duration curve for the Vermilion River at Vermilion. The graph shows that the total phosphorus TMDL is being met under the Low Flow, Dry Conditions, Mid-Range and Moist Conditions flow intervals on the graph, but is exceeded under High Flows (flows exceeded only 10% of the time). The load duration curve is based on water quality data collected by the Water Quality Laboratory at Heidelberg College in Tiffin, Ohio from November 2000 through November 2004. These samples were typically collected daily, or more frequently during periods of high streamflow. The existing nutrient loads at the USGS gauge were used to calibrate a watershed model (GWLF) for the Vermilion River watershed.

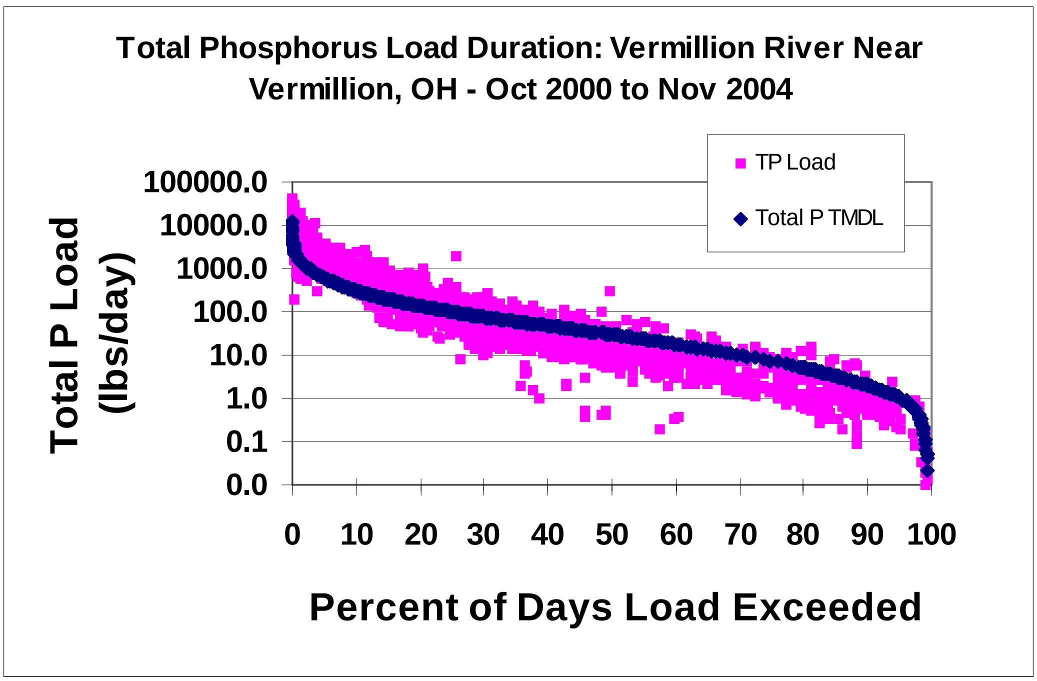


Figure 4.8 Total Phosphorus Load Duration Curve for Vermilion gauge

Figure 4.9 is similar to the previous figure but shows the percentage of time that the target phosphorus concentration (0.17 mg/l) is being exceeded at the Vermilion USGS gauge. The target concentration is consistently exceeded only during periods of high flows (extreme flow events that occur less than 10% of the time).

The duration curves shown in the Figures 4.8 and 4.9 reinforce Ohio EPA's belief that phosphorus concentrations and loads at the basin outlet are within TMDL goals, except during very high flows or excessive runoff events.

Data collected at the USGS gauge was supplemented with samples collected at three temporary gaging stations installed by Ohio EPA throughout the watershed. Although additional temporary gauges had been installed, these three sites are the only ones that had sufficient streamflow during 2002, a drought year during which the biological surveys were performed. These 3 gauges provided additional details about the variations in pollutant concentration observed in smaller subwatersheds within the Vermilio River basin. The location of the USGS and Ohio EPA gauges are shown in Figure 4.10.

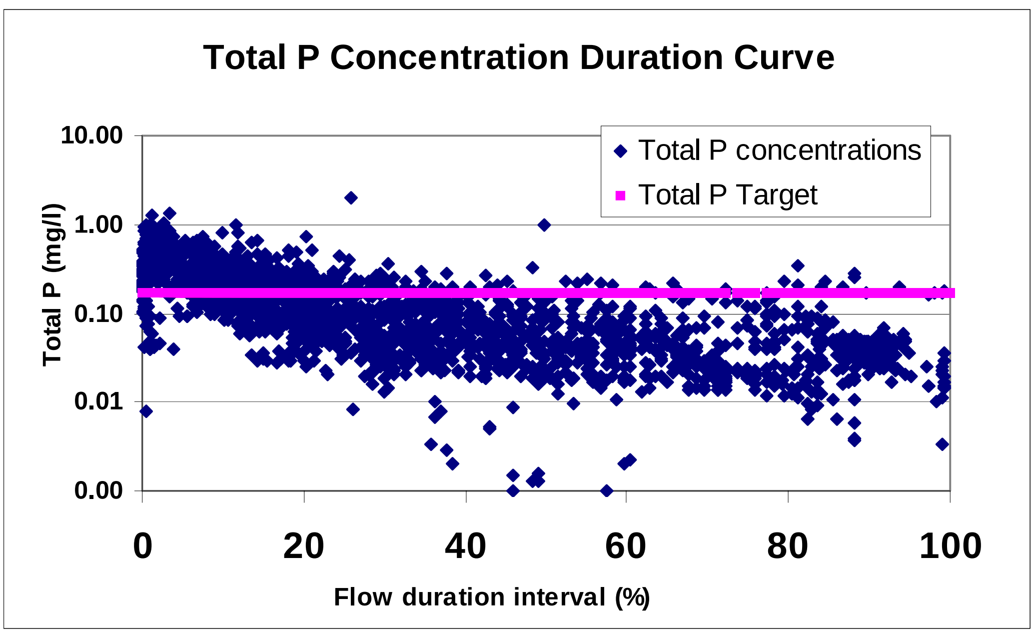


Figure 4.9 Total Phosphorus Concentration Duration Curve for Vermilion Gauge

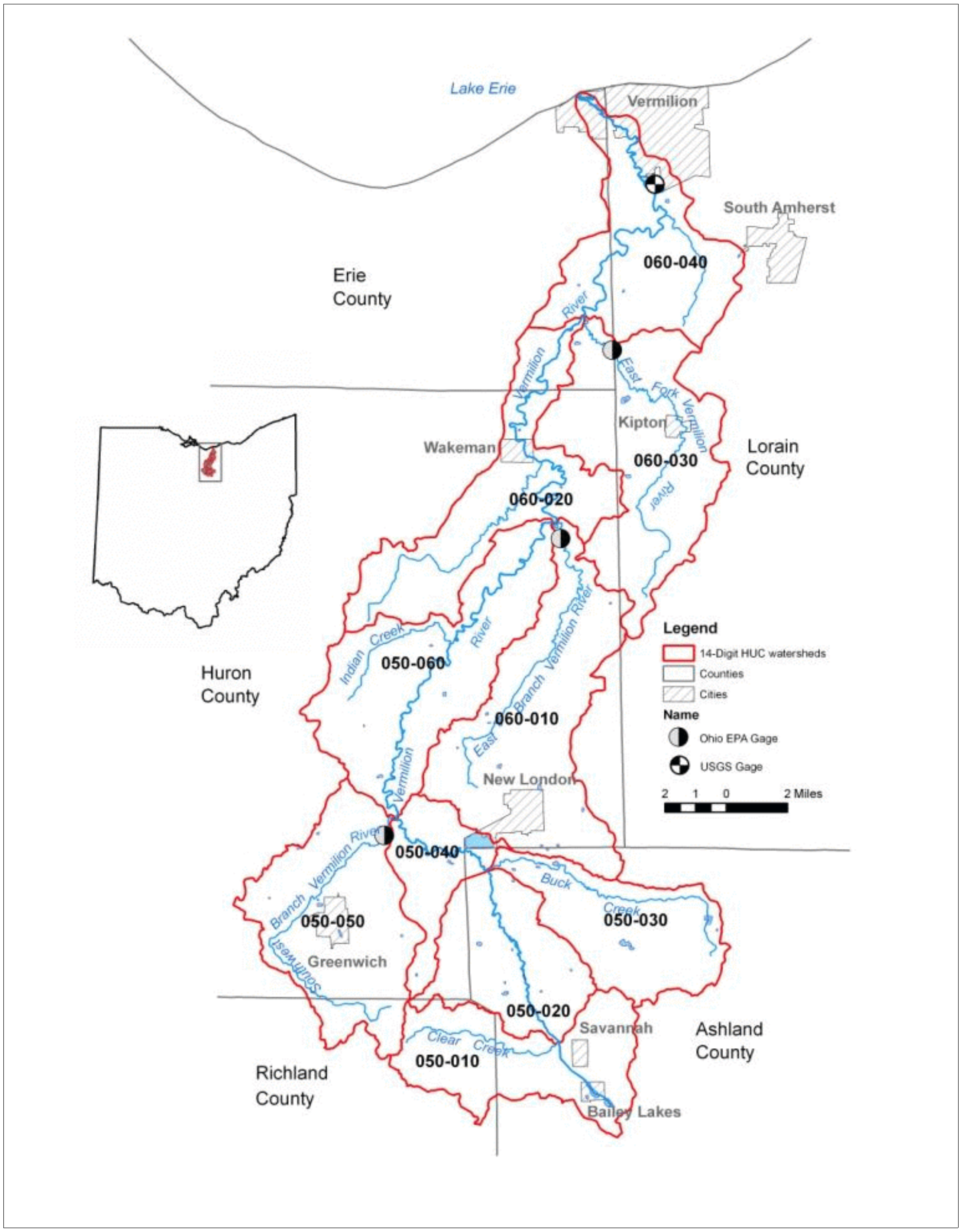


Figure 4.10 Location of USGS Gauge and OEPA Temporary Gauges

4.1.3 Habitat and Sediment Goals

Physical habitats were evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin, 1989, 1995). The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar.

The results of the 2002 surveys indicated that most sites in the Vermilion watershed were meeting their habitat target, with some exceptions. If the survey's habitat results had been grouped by subwatershed, the good scores would cancel out the poor ones, giving the impression that the whole subwatershed is meeting its habitat goals. For that reason the results for each individual site are itemized, rather than averaged by subwatershed. This provides local stakeholders with site specific information about the type and magnitude of habitat impairment.

To decide if a site was meeting its target Habitat score, the scores obtained from the surveys were compared to the appropriate habitat (QHEI) target (60 for Warmwater habitat streams and 45 for Modified warmwater). Only one site in the whole watershed was recommended for the Modified Warmwater habitat classification. In addition to the QHEI score, the number of "High Influence" and "Moderate Influence" modified habitat attributes shown in Table 3.3 was used to quantify habitat TMDLs, as shown in Section 4.4.2.

Sediments were evaluated quantitatively by comparing to target scores shown in Table 3.5 for the surrogate indices of Substrate, Channel and Riparian condition, measured as part of the QHEI assessment. The sediment TMDLs are shown in Section 4.4.3.

4.1.4 Linkages among Biological Scores, Sedimentation and Habitat Indices

For use in TMDL development, a target QHEI of 60 was selected for warmwater habitat sites. The target was determined by statistical analysis of a statewide database of paired QHEI and IBI (Index of Biotic Integrity) scores. Linear and exponential regressions and frequency analyses of combined and individual components of the QHEI in relation to the IBI were examined (Ohio EPA, 1999). The regressions indicated the QHEI is significantly correlated with the IBI with the exponential model providing a better fit to the data than the linear. Sites with QHEI scores greater than or equal to 60 were generally associated with IBI scores supportive of a WWH use designation.

Analyses of several of the other QHEI components (substrate, channel condition, number of modified attributes) versus the IBI scores were used to establish the targets for each component at which attainment of the biological goals was expected.

4.1.5 Bacteria Assessment

The land accumulation, or build-up, of fecal coliform in each 14-digit HUC is estimated using the U.S. EPA's Bacteria Indicator Tool (BIT). The tool estimates the accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland). The inputs for BIT include, for each HUC, the area for the four land-use type (in acres) and the number of various livestock. Also the density of various wildlife (in animals per square mile) is required for each land-use type for all the Vermilion HUCs combined. The tool also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems (USEPA, 2000).

4.2 Critical Conditions and Seasonality

Streamflow and water quality data collected at the USGS and Ohio EPA gaging sites were examined to look for seasonal patterns and critical conditions. The seasonal flow variations were studied by determining the monthly percentile flows for the Vermilion gauge's period of record. Figure 4.11 shows how the flows measured at this gauge are particularly low, especially during the summer, with 50th percentile flows of 10 cfs or less during August, September and October. These low flows measured near the mouth indicate that there is very little dilution flow available during an average summer for point sources located in headwater streams, and very restrictive effluent limits would be required to meet instream targets. Thus, the summer season is considered to be the critical condition regarding streamflow.

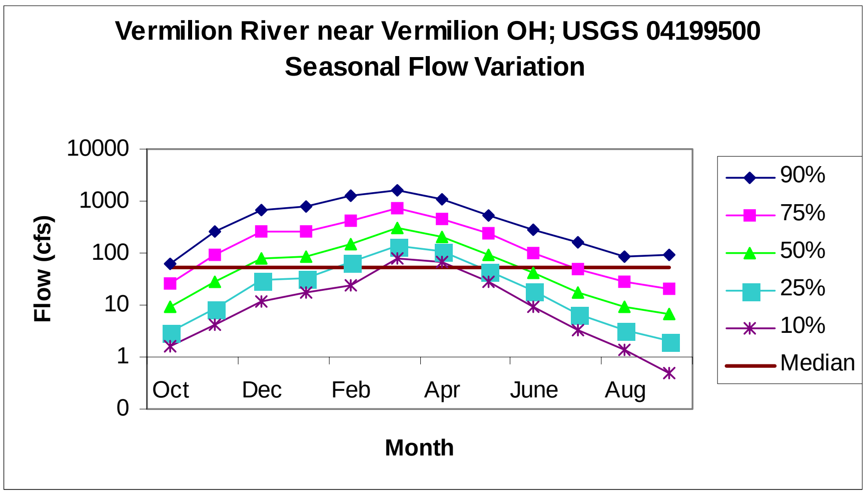


Figure 4.11 Seasonal Flow Variation: Vermilion USGS Gauge

The critical condition for instream nutrient concentrations was determined by examining the monthly concentrations measured at the USGS gauge, as well as the percentile statistics for data collected by Ohio EPA at the three temporary gauging sites. Although point sources contribute a much smaller proportion of nutrients than nonpoint sources, the summer low flow and high stream temperatures make the streams more susceptible to nutrient enrichment during that season. Figure 4.12 shows the range of total phosphorus concentrations measured at the USGS gauge near the mouth of the

Vermilion River, and at three temporary gaging sites set-up by Ohio EPA. The horizontal line crossing each box & whisker figure is the 50th percentile concentration value for that site. The USGS gauge site shows the lowest concentration, well below the target level of 0.1 mg/l (recommended for drainage areas 20 to 200 mi^2; the target at the USGS gauge site is 0.17 mg/l). The 50th percentile concentrations at the Southwest Branch, East Branch and East Fork exceed the recommended target by varying magnitudes.

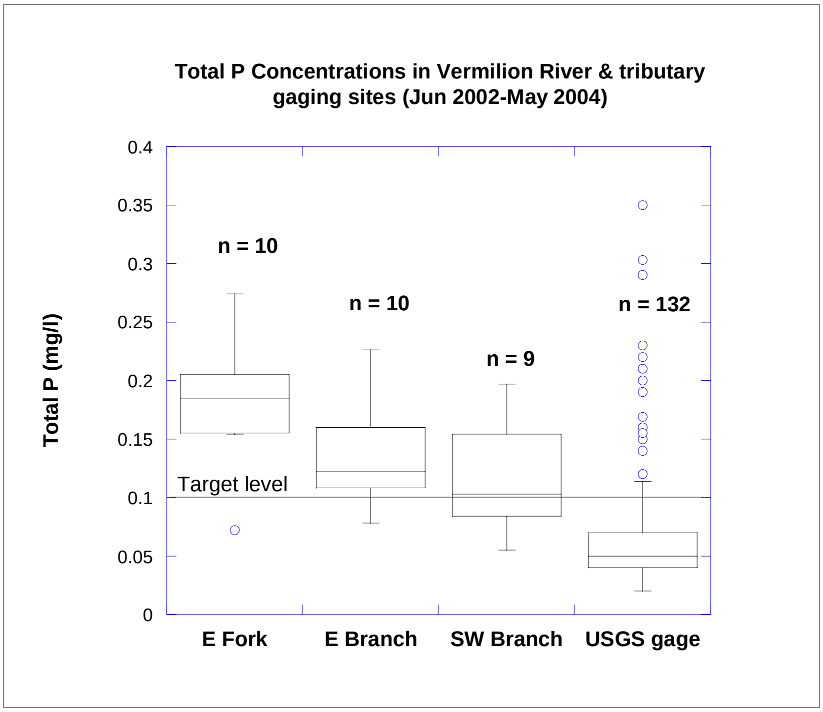


Figure 4.12 Range of Total P Concentrations Observed at Vermilion River Gauging Sites

Most of the water quality samples collected at the Ohio EPA gauging sites were collected during summer months, indicating that the summer low flow period is the critical condition for many Vermilion River subwatersheds, particularly those with smaller drainage areas. The low concentrations measured at the Vermilion USGS gauge indicate that most instream phosphorus has already been assimilated by the time it reaches the mouth.

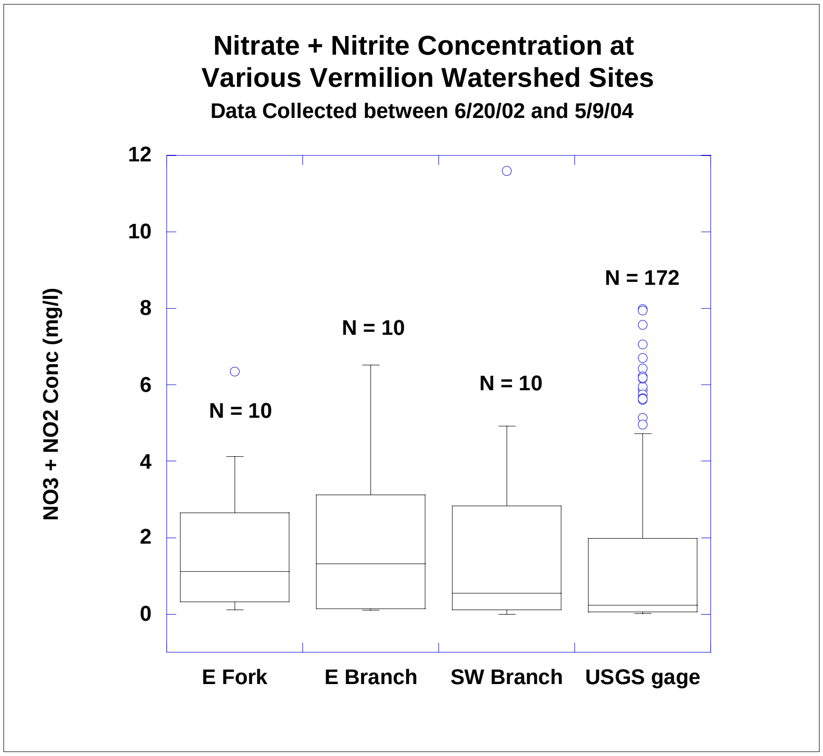


Figure 4.13 Range of NO_3 + NO_2 Concentrations Observed at Vermilion River Gauging Sites

Although no TMDLs are proposed for nitrate, the range of concentrations measured at the Ohio EPA and USGS gauges is shown in Figure 4.13 for informational purposes.

Additional insight into seasonal variations is shown in Figure 4.14, in which the total phosphorus concentrations measured daily at the Vermilion gauge between 2001 and 2003 are arranged by percentile for each month. The median concentrations are usually lower during July through November.

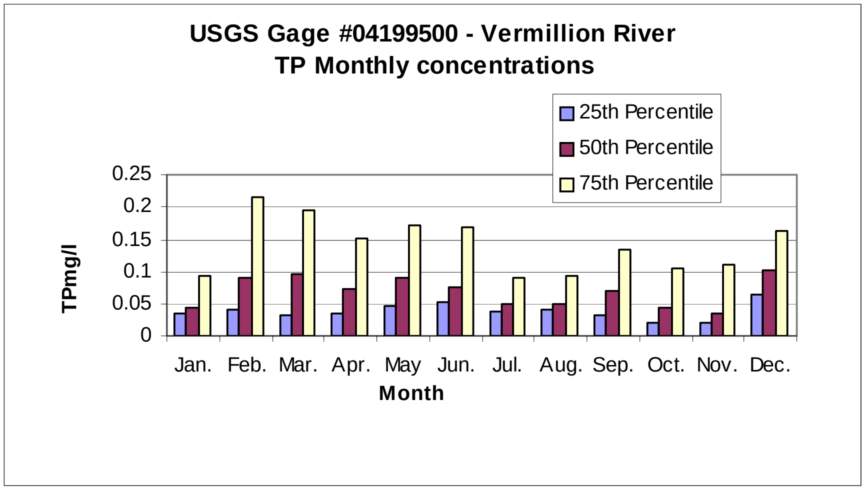


Figure 4.14 Total Phosphorus Monthly Concentrations at Vermilion USGS Gauge

4.3 Allocation Methods

The seasonal streamflow patterns observed in the Vermilion watershed penalize point sources located near headwaters, due to the low volume of streamflow available for wastewater assimilation during typical summers. The data presented so far indicates that minimal phosphorus load reductions are needed at the basin outlet, because the TMDL targets are being met except under very high flows. Thus, the focus of the required TMDLs should be reducing the phosphorus concentrations for those subwatersheds found to be exceeding the target. However, high sediment and phosphorus loads transported during storm events may also be affecting use attainment, therefore a watershed model (GWLF) was used to estimate nutrient contributions from overland runoff, while taking into account loads form point sources and failing septic systems. The following categories of sources were assessed for this TMDL report:

- Nonpoint sources based on over land runoff
- Groundwater
- Point sources
- Combined sewer overflows
- Septic systems
- Atmospheric deposition

Each of these sources receives an allocated portion of the total allowable load. Another allocated category includes margin of safety to account for uncertainty in the analysis.

No reserve for future growth was allocated because census data indicates negligible population growth during the last few decades for most of the counties in the study area. The method to determine the load estimates for each of these sources and categories varied and is discussed more fully below.

Nonpoint sources

In order to provide more detailed information, the Vermilion watershed was assessed based on 10 subwatersheds, corresponding to 14-digit HUC (Hydrologic Unit Code) assessment units. The sub-watershed boundaries were already shown in Figure 4.10. The hydrology for the GWLF nonpoint source model was calibrated against streamflow data from the Vermilion USGS gauge, collected from October 2000 through October 2004. Total and dissolved phosphorus loadings for the model were calibrated based on data collected by Heidelberg College at the Vermilion USGS gauge for the same time period. The GWLF model yielded annual estimates of total and dissolved phosphorus loads for each land use.

Groundwater

The groundwater contribution of dissolved phosphorus was estimated by the GWLF model as follows. The baseflow for the Vermilion USGS gauge was estimated based on the flow duration curve data as the flows equal to or below 13 cfs. The 50^{th} percentile values of the dissolved phosphorus concentrations measured under those flow conditions were assumed to be the baseflow contributions of dissolved phosphorus and were entered into GWLF as an input parameter.

Point Sources

Point source loads of total phosphorus and other nutrients were determined using dischargers' monitoring data. Total phosphorus load data from 1999 through 2003 was usually available. Monthly average loads were determined for the permitted dischargers (based on self-monitoring data submitted to Ohio EPA) and entered as point source load inputs in the GWLF model runs for the appropriate HUC-14 assessment unit. For those dischargers that don't monitor total phosphorus (because the discharge is very small) their flow information was used to estimate the annual phosphorus load by assuming an effluent concentration of 1 mg/l for wastewater treatment plants.

Combined Sewer Overflows

For CSOs, there was no information regarding the total phosphorus concentration in CSO discharge. In addition, only one discharger (the New London WWTP) has CSO data available. The following procedure was used to estimate the phosphorus concentration for the New London CSO discharge. A previous report done for a nearby watershed used a total P concentration of 0.52 mg/l as representative of CSO concentrations based on data collected under storm flow conditions at a gauge influenced by CSO events (Ohio EPA, 2004). That value was multiplied by the CSO discharge volume reported by the New London WWTP outfall to estimate the total P CSO loads. The estimated annual load of total phosphorus from the New London CSO is 16 kg/yr. Due to the small size of the facility (0.6 MGD), even if the estimate is too low, the load would be insignificant compared to the annual phosphorus load for the assessment unit where the New London WWTP is located. No data was available for the Greenwich CSO discharges, so the same loads as New London CSOs were used.

Septic Systems
Census data and estimates provided by the Huron, Erie, Lorain, Ashland and Richland counties' Health Departments were used to determine the number of home sewage treatment systems (HSTS) in each county, and the percentage of defective systems. GIS (Geographic Information System) tools were also used to determine the percentage area of each county within each subwatershed. Using census housing and population data, the number of persons per household was estimated, which in combination with the number of defective HSTS, was used to determine the population contributing phosphorus loads to the stream from defective septic systems. The septic system phosphorus concentrations were based on values recommended by Haith et al. (1996). These estimates are considered adequate because the population density of the study area is low, and the phosphorus load from defective septic systems is small compared to the total nonpoint source load.

Atmospheric Deposition
To estimate atmospheric deposition, a rate of 0.2 kg/ha/year of total phosphorus based on textbook values was assumed (Thomann and Mueller, 1987). The rate was applied as direct input over the area comprised by water bodies within each assessment unit, based on land use data.

4.4 Margin of Safety

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C), 40 CFR § 130.7(c)(1)). EPA guidance explains that the margin of safety (MOS) may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be quantified.

An explicit margin of safety of 5% was included for the Vermilion watershed phosphorus TMDLs. The availability of daily samples collected at the Vermilion USGS gauge from October 2000 through October 2004 allows for a reliable quantification of existing loads, therefore the 5% MOS is adequate. In addition, there are several areas where an implicit margin of safety is incorporated including the 303(d) listing process and the pollutant target development process. An explanation for each of these areas is provided below.

4.4.1 TMDL Priority 303(d) List Development

It is important to keep in mind during the evaluation of the TMDL that there is a major difference in Ohio's program from other state programs. In Ohio, one way a stream segment is listed on the 303(d) list is for failure to attain the appropriate aquatic life use as determined by direct measurement of the aquatic biological community. Many state programs rely solely on chemical samples, and compare them with chemical criteria to determine water quality and designated use attainment. However, relying solely on chemical data does not take into account any of the parameters or other factors for which no criteria exist but that may have an impact on stream biology nor does it 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. Ohio's approach incorporates an increased level of assurance that Ohio's water quality problems are being identified. Likewise, delisting requires attainment of the aquatic life use determined by the direct measurement of the aquatic biological community. This provides a high level of assurance (and an implicit margin of safety) that if the TMDL allocations do not lead to sufficiently improved water quality then the segments remain on the list until true attainment is achieved.

4.4.2 Target Development

The use of nutrient targets that are based on data from relatively unimpacted reference sites provides an additional implicit safety factor. These data constitute a background concentration of nutrients in a stream; unimpacted streams generally have nutrient levels well below those needed to meet biological water quality standards. As the stream becomes impacted, nutrient levels can rise, but the stream can still meet the water quality standards based on other factors such as the presence of good habitat. Once the nutrient levels rise high enough or other factors change which no longer mitigate the effects of nutrients then the biological community is impacted, and the stream is impaired. By using nutrient targets based on data from relatively unimpacted sites (or sites that are conservatively in attainment of biological water quality criteria) the targets themselves are set at a conservative level. In other words, water quality attainment is likely to occur at levels higher than these targets and the difference between this actual level where attainment can be achieved and the selected target is an implicit margin of safety.

4.5 TMDL Calculations

4.5.1 Load-based Calculations: Total Phosphorus Point Source Allocations

The recommended phosphorus reductions were determined after examination of the load duration curve (LDCs) for the Vermilion USGS gage, as well as the range of loads observed at the temporary USGS gages. The LDC confirmed that the target phosphorus load was only being exceeded under high flows. Under lower flows, the recommended load reductions were determined based on water quality data collected at each subwatershed (mainly under low flow conditions), and vary according to drainage area (headwater, wadeable or small river) and the deviation from the phosphorus target concentration observed at each group of monitoring sites for the streams in each assessment unit. The recommended point source load reduction for each assessment unit was based on the percent deviation from the target for each unit's headwater or wadeable streams. The median of the total phosphorus concentrations measured in each assessment unit during 2002 was compared to the appropriate target to determine the percentage load reduction. Table 3.6 in Chapter 3 showed the phosphorus targets, median concentrations observed, and percent deviation from target for each assessment unit.

The load duration curve analyses performed for the Vermilion USGS gauge indicates that the total phosphorus target loads at the basin outlet are being met under most flow conditions, being exceeded only during high flows (streamflows exceeded 5 percent of the time) in the mainstem. Data from the temporary gaging sites set up by Ohio EPA show excessive phosphorus concentrations during low flow periods, and support the need for measures to control CSOs, septic systems, and point source nutrient loads. The magnitude of the deviation from the phosphorus target is proportional to the streamflow available upstream of the point sources, therefore the small WWTPs in the watershed may benefit from controlled discharge as a management option, if feasible. **The recommended point source percent load reductions are based on the data collected in each assessment unit and are summarized in Table 4.4.**

4.5.2 Total Phosphorus Allocation for Nonpoint Sources

Export rates for total phosphorus in the Vermilion River watershed have been shown to rank among the lowest compared to other Ohio watersheds. Therefore the focus during consideration of management alternatives should be to reduce the instream concentrations of total phosphorus, rather than significantly lowering the existing loads, which are already at target levels on an annual basis.

Table 4.4 shows the recommended phosphorus TMDLs for the Vermilion watershed (by assessment unit). All segments in the study area are included in one of these 10 assessment units. Unlisted and attaining stream segments are also included because they are sources of load whether they are locally impaired or not. The table lists the existing point source and nonpoint source loads, needed reductions, and the total phosphorus allocations for each assessment unit. The existing NPS category includes agricultural, groundwater/natural background, air deposition, failing septic systems, and storm runoff. The Point Source category includes wastewater treatment plants. The TMDL loads include the background conditions (natural), waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint sources.

In most assessment units, point source loads and failing septic systems represent a small fraction of the existing total phosphorus load, hence any significant load reductions require nonpoint source controls. Data presented elsewhere in this document indicate that large phosphorus load reductions are not needed in this watershed. However, the point sources and failing septic systems have a greater impact on aquatic life use attainment in several Vermilion subwatersheds during typical summers, due to extremely low upstream flows. The lack of streamflow to sustain a viable biological community severely limits the streams' ability to assimilate nutrients. Any small discharges (such as failing septic systems, livestock with stream access and combine sewer overflows) have a short term impact in water quality (both bacteria and nutrients) under low flow conditions and should be corrected.

Table 4.4 TMDLs and Total Phosphorus Allocations for the Vermilion River Watershed (kg/year)

Stream Name (HUC 14 Code)	Existing Load Conditions			Percent Reduction		TMDL Loads	Margin of Safety	TMDL Allocations		
	NPS	PS	Total	NPS	PS			Natural	WLA	LA
Assessment Unit: 04100012-050										
Vermilion: Headwaters (010)	5978	68	6047	15	50	5116	256	254	34	4572
Vermilion: above Buck Ck (020)	5538	0	5538	15	none	4707	235	188	0	4284
Buck Creek (030)	5415	0	5415	15	none	4603	230	169	0	4204
Vermilion: above SW Branch (040)	3504	0	3504	15	none	2979	149	113	0	2717
Southwest Branch (050)	9499	465	9963	15	45	8329	416	350	256	7307
Vermilion: above E. Branch (060)	10984	0	10984	15	none	9337	467	436	0	8434
Assessment Unit: 04100012-060										
East Branch (010)	9845	1574	11419	15	75	8761	438	370	393	7560
Vermilion: above E. Fork (020)	7516	73	7589	15	none	6462	323	294	73	5772
East Fork (030)	10035	0	10035	15	50	8529	426	360	0	7743
Vermilion: below E. Fork (040)	5777	728	6504	15	10	5565	278	329	655	4303

* The % point source reduction applies to phosphorus load from main outfall, not to CSO discharges.

Table 4.5 Estimated Annual Loads (kg/yr) of Total Phosphorus by Source for Vermilion River Assessment Units[A]

Source	Vermilion Headwaters & Clear Ck 04100012-050-010	Vermilion Above Buck Ck 04100012-050-020	Buck Creek 04100012-050-030	Vermilion Below Buck Ck 04100012-050-040	South West Branch 04100012-050-050	Vermilion Below SW Branch 04100012-050-060
Point Sources	68	0	0	0	465	0
CSOs	0	0	0	0	16	0
Unregulated Runoff	5300	4921	4513	3138	8479	9791
Stormwater	6	0	6	2	30	8
Septic Systems	12	28	318	28	21	314
Background/ groundwater	653	586	571	316	951	869
Air Deposition	7	3	9	21	3	2

[A] The magnitude of nonpoint source loads fluctuates widely every year depending on precipitation amount and intensity, fertilizer application rates, crop rotations, etc. This table is based on average conditions and is meant to illustrate relative loads from each source. The point source loads represent the maximum allowable under existing permits, prior to TMDL load reductions.

Table 4.5 Estimated Annual Loads (kg/yr) of Total Phosphorus by Source for Vermilion River Assessment Units[A] (cont)

Source	East Branch 04100012-060-010	Vermilion Above East Fork 04100012-060-020	East Fork 04100012-060-030	Vermilion Below East Fork 04100012-060-040
Point Sources	1574	73	0	728
CSOs	16	0	0	0
Unregulated Runoff	8721	6643	8549	4323
Stormwater	50	13	8	120
Septic Systems	81	54	652	663
Background/ groundwater	973	806	823	664
Air Deposition	5	1	4	7

[A] The magnitude of nonpoint source loads fluctuates widely every year depending on precipitation amount and intensity, fertilizer application rates, crop rotations, etc. This table is based on average conditions and is meant to illustrate relative loads from each source. The point source loads represent the maximum allowable under existing permits, prior to TMDL load reductions.

4.5.3 Habitat Calculations for Aquatic Life

The habitat TMDL equation presented in Table 4.6 shows the relationship between the QHEI score, modified-habitat attributes, and aquatic community performance. It is based upon a target of three (3), and is the sum of three component scores. Individual component scores exist for the observed QHEI score to target QHEI score ratio, and for the presence or absence of high and moderate influence attributes. A QHEI score lower than 60 or the presence of more than one high-influence attribute or more than four moderate influence attributes will prevent a stream segment from achieving its TMDL target.

Table 4.6 shows the Habitat TMDLs, which incorporate both the QHEI target of 60 and the targets for modified habitat attributes. This table indicates how far each assessment unit is from meeting a recommended habitat score. Except for one segment of Indian Creek (HUC 04100012-050-060) classified as Modified Warm Water habitat, all other sites have a proposed use designation of WWH. This table is useful for the stakeholders to prioritize which assessment units need habitat improvements.

Table 4.6 Habitat TMDL Equation for Warm Water Habitats

Component Measure	Score
QHEI score is greater than 60	+1
Less than 2 high-influence modified-habitat attributes	+1
Less than 5 moderate-influence modified-habitat attributes	+1
Total TMDL Score:	3

Table 4.7 QHEI Assessment Results and Habitat TMDL Scores

River	**River Mile**	**Assessment Results**			**Component Scores**			**TMDL Score**
		QHEI Score	High Influence	Moderate Influence	QHEI Score	High Influence	Moderate Influence	
WWH Targets:		*>60*	*<2*	*<5*	*+1*	*+1*	*+1*	*3*
HUC 04100012-050-010								
Vermilion R.	63	45	❸❹❺	①②③④⑤⑦⑧⑩	0	0	0	0
Clear Cr.	4	52	❸❺	④⑤⑥⑦⑧⑩	0	0	0	0
Clear Cr.	1.8	71		③⑤⑥⑦	1	1	1	3
Trib. to Vermilion R. (RM 63.52)	0.2	38	❶❸❹❺	①④⑤⑦⑩	0	0	0	0
HUC 04100012-050-020								
Vermilion R.	62.1	62.5	❸	②③④⑤⑦⑧⑩	1	1	0	2
Vermilion R.	54	59		②③④⑤⑦⑧⑨	0	1	0	1
Trib. to Vermilion R. (RM 54.62)	0.5	67		③④⑤⑥⑦	1	1	0	2
HUC 04100012-050-030								
Buck Cr.	8.2	44	❹❺	③④⑤⑥⑦⑩	0	0	0	0
Buck Cr.	5	74		⑤⑦	1	1	1	3
Buck Cr.	3.2	75		⑤⑦	1	1	1	3
Buck Cr.	1.1	66		⑤⑥⑦⑩	1	1	1	3
Trib. to Buck Cr. (RM 4.92)	0.1	64		②③④⑤⑦⑨	1	1	0	2
HUC 04100012-050-040								
Vermilion R.	50.7	68	❸	②⑤⑦⑧⑨	1	1	0	2
04100012-050-050								
SW Br.Vermilion R.	5.6	62.5		②⑤⑥⑦⑧⑨	1	1	0	2
SW Br.Vermilion R.	3.9	65	❹	②⑤⑧⑨	1	1	1	3
SW Br.Vermilion R.	2.5	65.5	❸	②③④⑤⑦⑧⑨	1	1	0	2
SW Br.Vermilion R.	1	47.5	❸	③④⑤⑦⑧⑨	0	1	0	1
HUC 04100012-050-060								
Vermilion R.	45.7	79		②⑦⑨	1	1	1	3
Vermilion R.	44.5	79		③⑤⑦	1	1	1	3
Vermilion R.	33.6	80.5		⑤	1	1	1	3
Indian Cr. (MWH)	3.5	36	❶❸❹❺	①②④⑤⑦⑧⑨	-	-	-	N.A.
Indian Cr.	0.4	71.5		③⑤⑥⑦	1	1	1	3

Table 4.7 QHEI Assessment Results and Habitat TMDL Scores

River	River Mile	Assessment Results			Component Scores			TMDL Score
		QHEI Score	High Influence	Moderate Influence	QHEI Score	High Influence	Moderate Influence	
WWH Targets:		*>60*	*<2*	*<5*	*+1*	*+1*	*+1*	*3*
HUC 04100012-060-010								
East Branch Vermilion R.	13	48.5	❸❹	④⑤⑦⑨	0	0	1	1
East Branch Vermilion R.	8.6	62		②③④⑤⑦⑧⑨	1	1	0	2
East Branch Vermilion R.	2.7	66	❸	⑦⑤⑨	1	1	1	3
East Branch Vermilion R.	1.4	77		⑤⑦⑧⑨	1	1	1	3
Trib. to E. Br. Ver. R. (RM 8.20)	5.8	43.5	❸❹❺	②④⑤⑥⑦⑩	0	0	0	0
Trib. to E. Br. Ver. R. (RM 8.20)	4	40.5	❸	③④⑤⑥⑦⑧⑩	0	1	0	1
Trib. to E. Br. Ver. R. (RM 8.20)	1.1	56		③④⑤⑥⑦⑩	0	1	0	1
HUC 04100012-060-020								
Vermilion R.	29.2	80		⑤⑦	1	1	1	3
Vermilion R.	23.9	48.5	❸❹	②④⑤⑦⑧⑩	0	0	0	0
Vermilion R.	22.5	79			1	1	1	3
Trib. to Vermilion R. (RM 24.35)	5.5	55.5		②③④⑤⑥⑦⑧⑩	0	1	0	1
Trib. to Vermilion R. (RM 24.35)	0.2	71		④⑥⑦⑩	1	1	1	3
HUC 04100012-060-030								
E. Fork Vermilion R.	10.9	58		②④⑤⑦⑧⑨⑩	0	1	0	1
E. Fork Vermilion R.	8.92	67		③④⑤⑦⑧⑨	1	1	0	2
E. Fork Vermilion R.	7.4	68		②④⑤⑦⑧⑨	1	1	0	2
E. Fork Vermilion R.	2.3	64		⑦⑤⑨	1	1	1	3
Trib. to E. Fk. Ver. R. (RM 8.47)	0.7	53.5	❸	③④⑤⑥⑦⑩	0	1	0	1
Frankenburg Creek	0.2	77			1	1	1	3
HUC 04100012-060-040								
Vermilion R.	14.5	81			1	1	1	3
Vermilion R.	10.7	75.5		⑤	1	1	1	3
Vermilion R.	6.4	71.5			1	1	1	3
Trib. to Ver. R. (RM 8.29)	1	63		④⑤⑦⑨	1	1	1	3

4.5.4 Sediment TMDLs

The substrate, channel and riparian condition subscores from the Habitat (QHEI) assessment are being used as a surrogate for sediments. The sediment TMDL equation presented in Table 4.8 shows the recommended targets for each component. The sum of the recommended targets yields the TMDL value of 32 for streams classified as WWH. Table 4.9 shows the sediment TMDLs, including the TMDL scores achieved by each site, and indicates the percent deviation from the recommended TMDL value. The scores of each component are also shown, and the value that showed the largest deviation relative to its recommended score is highlighted in bold characters, as an indication of which is the main impaired category. The numerical targets provide a framework for tracking improvements in the stream in response to sediment load reductions. This table should be used in conjunction with the phosphorus and habitat TMDL tables to prioritize the assessment units that have the greatest need for restoration/intervention.

Table 4.8 Sediment TMDL Equation for Warmwater Habitats

Component Measure	**Score**
Substrate score is ≥ 13	13
Channel score is ≥ 14	14
Riparian score is ≥ 5	5
Total TMDL Score:	32

Table 4.9 Assessment Results and Sediment TMDL Scores

River	RM	Assessment Results			Sediment TMDL	% Deviation
		Substrate	Channel	Riparian		
WWH Targets:		*≥13*	*≥14*	*≥5*	*≥32*	*n/a*
HUC 04100012-050-010						
Vermilion River	63[1]	11.5	**7.5**	4.0	23.0	39%
Clear Creek	4[1]	14.0	13.5	4.5	32.0	-
Clear Creek	1.8[1]	18.0	17.0	7.5	42.5	-
Trib. to Vermilion R. (RM 63.52)	0.2[1]	15.0	**4.5**	3.5	23.0	39%
HUC 04100012-050-020						
Vermilion River	62.1[2]	12.5	**12.0**	7.0	31.5	2%
Vermilion River	54[2]	**11.0**	12.5	5.0	28.5	12%
Trib. to Vermilion R. (RM 54.62)	0.5[1]	11.5	15.5	6.0	33.0	-
HUC 04100012-050-030						
Buck Creek	8.2[1]	**11.5**	12.5	6.0	30.0	7%
Buck Creek	5[2]	17.0	16.5	7.5	41.0	-
Buck Creek	3.2[2]	14.0	17.0	8.0	39.0	-
Buck Creek	1.1[2]	15.0	17.0	7.0	39.0	-
Trib. to Buck Creek (RM 4.92)	0.1[1]	13.5	14.5	7.5	35.5	-
HUC 04100012-050-040						
Vermilion River	50.7[3]	14.5	14.0	6.0	34.5	-
HUC 04100012-050-050						
Southwest Branch Vermilion	5.6[1]	12.5	17.0	4.5	34.0	-
Southwest Branch Vermilion	3.9[2]	15.0	16.0	2.5	33.5	-
Southwest Branch Vermilion	2.5[2]	12.5	**12.5**	5.5	30.5	5%
Southwest Branch Vermilion	1[3]	**6.0**	12.0	5.5	23.5	36%
HUC 04100012-050-060						
Vermilion River	45.7[3]	17.0	17.0	7.0	41.0	-
Vermilion River	44.5[3]	16.5	17.0	9.5	43.0	-
Vermilion River	33.6[4]	15.0	17.0	7.0	39.0	-
Indian Creek	3.5[1]	12.5	**7.0**	3.0	22.5	42%
Indian Creek	0.4[1]	16.0	16.5	6.0	38.5	-

Table 4.9 Assessment Results and Sediment TMDL Scores

River	RM	Assessment Results			Sediment TMDL	% Deviation
		Substrate	**Channel**	**Riparian**		
WWH Targets:		*≥13*	*≥14*	*≥5*	*≥32*	*n/a*
HUC 04100012-060-010						
East Branch Vermilion River	13[1]	15.0	11.0	**3.5**	29.5	8%
East Branch Vermilion River	8.6[2]	13.5	**12.0**	5.0	30.5	5%
East Branch Vermilion River	2.7[3]	14.5	15.5	6.5	36.5	-
East Branch Vermilion River	1.4[3]	15.5	17.0	8.0	40.5	-
Trib. to E. Br. Verm. R. (RM 8.20)	5.8[1]	14.0	**10.0**	4.5	28.5	12%
Trib. to E. Br. Verm. R. (RM 8.20)	4[1]	**5.5**	11.5	4.5	21.5	49%
Trib. to E. Br. Verm. R. (RM 8.20)	1.1[2]	12.5	14.0	7.5	34.0	-
HUC 04100012-060-020						
Vermilion River	29.2[5]	18.0	17.0	6.5	41.5	-
Vermilion River	23.9[5]	11.0	**10.0**	5.5	26.5	21%
Vermilion River	22.5[5]	17.5	17.0	8.0	42.5	-
Trib. to Vermilion R. (RM 24.35)	5.5[1]	11.0	15.5	6.0	32.5	-
Trib. to Vermilion R. (RM 24.35)	0.2[2]	18.0	16.0	8.0	42.0	-
HUC 04100012-060-030						
East Fork Vermilion River	10.9[1]	12.0	14.5	**3.5**	30.0	7%
East Fork Vermilion River	8.9[2]	**10.0**	14.0	5.5	29.5	8%
East Fork Vermilion River	7.4[2]	13.5	16.0	5.5	35.0	-
East Fork Vermilion River	2.3[3]	12.5	16.5	8.5	37.5	-
Trib. to E. Fk. Vermilion R. (RM	0.7[1]	11.5	**12.0**	7.0	30.5	5%
Frankenburg Creek	0.2[1]	18.0	16.5	8.0	42.5	-
HUC 04100012-060-040						
Vermilion River	14.5[6]	17.5	17.0	6.5	41.0	-
Vermilion River	10.7[6]	12.0	17.0	7.5	36.5	-
Vermilion River	6.4[6]	12.0	16.5	6.0	34.5	-
Trib. to Vermilion R. (RM 8.29)	1[1]	14.0	16.0	8.0	38.0	-

4.5.5 Bacteria Assessment

As mentioned in earlier chapters, the bacteria assessment was performed based on a limited data set, but the statistical analysis of the pooled data indicated that the streams included in Table 4.10 are exceeding bacteria WQS.

The bacteria load estimates took into account estimated loads from wildlife, failing home sewage treatment systems, wastewater treatment plants, surface runoff, and livestock with access to streams. The target bacteria load (TMDL) for a subwatershed was calculated by multiplying the fecal coliform WQS (1000 counts/100 ml) by the estimated flow at the subwatershed outlet.

The results of bacteria modeling performed for those sites is shown in Table 4.10. The recommended % reduction represents the load reduction needed to meet the fecal coliform water quality standard. It is recommended that the information provided below be used to prioritize the sites for which bacteria load abatement may be most urgently needed, in case grants are available for septic system upgrades or for livestock exclusion/confinement. Livestock with access to the streams are a major bacteria source.

Based on the bacteria modeling, direct animal inputs, CSOs, and septic systems are the largest contributors of fecal coliform bacteria that can be managed. The existing WWTP bacteria loads are currently complying with bacteria WQS, therefore no point source reductions are recommended. The large bacteria loads calculated by the bacteria simulations for rural nonpoint sources are possibly an overestimate due to the large areas assumed to be devoted to livestock grazing and manure application in this watershed, which is primarily agricultural.

Table 4.10 Fecal Coliform Bacteria TMDL (May-October)

Vermilion R. headwaters to below Clear Creek *HUC 050-010*							
	Total (TMDL)	Septic (Directs)	CSO	Point Source WWTPs	Margin of Safety	Total Nonpoint Sources	
						Rural	Direct Animal Inputs
Allowable	4.0E+13	3.24E+10	none	5.85E+11	Implicit	2.8E+13	1.15E+13
Existing	5.68E+15	1.08E+11	none	3.47E+11	0	4.52E+15	1.15E+15
% Reduction	99%	70%	0%	0%	--	99%	99%
Buck Creek *HUC 050-030*							
	Total (TMDL)	Septic (Directs)	CSO	Point Source WWTPs	Margin of Safety	Total Nonpoint Sources	
						Rural	Direct Animal Inputs
Allowable	3.67E+13	1.82E+12	none	none	Implicit	1.71E+13	1.78E+13
Existing	5.00E+15	2.27E+12	none	none	0	3.22E+15	1.78E+15
% Reduction	99%	20%	0%	0%	--	99%	99%
Southwest Branch Vermilion River *HUC 050-050*							
	Total (TMDL)	Septic (Directs)	CSO	Point Source WWTPs	Margin of Safety	Total Nonpoint Sources	
						Rural	Direct Animal Inputs
Allowable	5.48E+13	6.58E+10	5.35E+10	1.27E+12	Implicit	4.24E+13	1.11E+13
Existing	1.29E+16	3.29E+11	1.07E+12	1.70E+11	0	5.76E+15	7.11E+15
% Reduction	99%	80%	95%	0%	--	99%	99%
East Branch Vermilion River *HUC 060-010*							
	Total (TMDL)	Septic (Directs)	CSO	Point Source WWTPs	Margin of Safety	Total Nonpoint Sources	
						Rural	Direct Animal Inputs
Allowable	6.60E+13	2.24E+11	1.42E+11	3.82E+12	Implicit	1.59E+13	4.59E+13
Existing	8.52E+15	7.46E+11	2.85E+12	9.78E+11	0	4.52E+15	4.59E+15
% Reduction	99%	70%	95%	0%	--	99%	99%
East Fork Vermilion River *HUC 060-030*							
	Total (TMDL)	Septic (Directs)	CSO	Point Source WWTPs	Margin of Safety	Total Nonpoint Sources	
						Rural	Direct Animal Inputs
Allowable	6.13E+13	2.75E+12	none	none	Implicit	4.04E+13	1.82E+13
Existing	3.34E+15	5.50E+12	none	none	0	4.52E+15	1.82E+15
% Reduction	98%	50%	0%	0%	--	99%	99%

5.0 Public Participation

The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency with the development of the TMDL program in Ohio. The EAG met multiple times over eighteen months and in July 2000 issued a report to the Director of Ohio EPA on their findings and recommendations. The Vermilion River TMDL has been completed using the process endorsed by the EAG.

Ohio EPA involved the partners and public stakeholders in the Vermilion River TMDL project by soliciting input and recommendations for action in a series of annual meetings in 2003, 2004 and 2005 (see Table 5.1). The Huron Soil and Water Conservation District (SWCD) is the grant sponsor for a Section 319 watershed implementation grant in the Vermilion River watershed. There is not an active local watershed group in the watershed.

Public stakeholder information meetings were held in March, 2003 in New London and Wakeman. Ohio EPA presented a summary of the TMDL process, and heard of local funding opportunities available from the Huron County SWCD through the Section 319 grant, and other traditional farming assistance programs.

The Ohio EPA Division of Surface Water was invited to present a follow-up TMDL presentation in March, 2004 which highlighted what we found in our 2002 water quality assessment. This second meeting invited broader representation from local agencies, conservation organizations, and academic researchers working in the watershed area.

A third public participation meeting was held on April 26, 2005 with about two dozen people representing broad interests in the watershed, to solicit feedback on recommended solutions for restoration and protection of the watershed resources. Specifically, ideas to eliminate impairments and encourage voluntary actions to reduce nonpoint sources of pollution were discussed with local officials and landowners.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report will be public noticed in July, 2005 and a copy of the draft report posted on Ohio EPA's web page (www.epa.state.oh.us/dsw/tMDL/index.html). In addition, copies of the report will be distributed to local libraries. A summary of the comments received and the associated responses will be completed after the public comment period and included in Appendix B (to be included in the final report).

Public involvement is key 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 and agency partners to bring the Vermilion River watershed into attainment.

Table 5.1 Vermilion River Watershed Public Involvement

Date	Time	Subject(s)
3/6/03	6:30 - 8:30 PM	Local Stakeholders meeting in New London to introduce TMDL process
3/12/03	6:30 - 8:30 PM	Local Stakeholders meeting in Wakeman to introduce TMDL process
3/29/04	6:30 - 8:30 PM	Public Information Meeting on Vermilion River water quality status
4/26/05	10:00 -12:30 PM	Meeting to discuss Draft TMDL Report with local stakeholders
July 2005	-	Public notice of the Vermilion River TMDL Report

6.0 Implementation and Monitoring Recommendations

Restoration methods to bring an impaired water body into attainment with water quality standards generally involve an increase in the water body's capacity to assimilate pollutants, a reduction of pollutant loads, or some combination of both. As described in Chapter 3, the causes of impairment of the Aquatic Life Use in the Vermilion River are organic enrichment, excessive nutrients, sedimentation, habitat degradation, and flow alteration. In addition, elevated bacteria caused impairment for Recreation Use. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads, potentially combined with some additional means of increasing the assimilative capacity of the stream.

Potential restoration strategies used to achieve the TMDL restoration targets might include:

- Public education and awareness of watersheds and water quality
- Riparian buffer initiatives
- Wetlands creation and protection
- Natural stream management principles
- Corridor protection ordinances
- Dam evaluation and removal
- Flood plain management
- Flow augmentation
- Evaluation of irrigation withdrawals
- Sediment and erosion control practices in agricultural and urban areas
- Post-construction storm water management practices
- Reduction of the use of residential fertilizers and pesticides
- Proper use and storage of fertilizers and pesticides
- Conservation farming practices
- Comprehensive nutrient management plans
- Livestock waste management plans
- Home sewage treatment system management and maintenance
- Planned growth/development strategies
- Phase I and II Storm Water Pollution Prevention Plans (SWP3s) and Storm Water Management Programs (SWMPs)
- Reduction and reuse of point source discharge water
- NPDES program - permit limitations and compliance schedules
- Elimination/control of combined sewer overflows (CSOs)
- Municipal pretreatment programs
- Centralized treatment for unsewered communities

6.1 Vermilion River TMDL Implementation Strategy

Ohio EPA is taking an iterative, adaptive approach to implementation of this TMDL project. Point source reductions will be achieved through effluent limitations, compliance schedules, special conditions in existing dischargers' NPDES permits, and the designation of additional MS4s for NPDES permit coverage. A schedule will be developed for issuance of NPDES permits consistent with implementing the TMDL recommendations. Permits will be issued such that:

- a new discharge will not exceed the loading capacity of the receiving stream in relation to phosphorus and ammonia
- stormwater management programs (SWMPs) will be developed and implemented which address the causes of impairment;
- trends in in-stream concentrations will be tracked, and the NPDES permits will include an option for permit modifications should data indicate in-stream total phosphorus, ammonia and D.O. levels have achieved stable and desirable levels or the use designations are being fully met.

Implementation of nonpoint source reduction measures may be achieved through a locally adopted implementation strategy built around non-regulatory and voluntary incentive programs. Local input to the implementation strategy will result in a planning and decision-making process that leads to reasonable and sustainable actions that will be the most effective in restoring water resources in the watershed.

Ohio EPA recommends an approach that directs resources to improve the overall habitat and physical stability of streams throughout the watershed. Often, Ohio EPA noted that impaired stream function was not the result of one discrete source, such as a wastewater discharge or runoff from a single feedlot. The cumulative effect of multiple impairments like sediment and habitat degradation in the lacustuary (river/lake) area, or excess nutrients in a small stream with little or no flow, appeared to work in concert to degrade the chemical water quality and aquatic communities.

A two-tiered approach that prescribes land management practices and promotes natural channel stability will be most effective in achieving nutrient and sediment load reductions. Traditional BMPs (best management practices) and barriers should be targeted at the stream segments most vulnerable to erosion during high flow storm events. Restoring stream habitat and maintaining channel stability will increase the nutrient and sediment assimilative capacity of streams during normal and lower flow conditions. In particular, phosphorus strategies will need to be targeted for implementation in the smaller drainage areas in order to achieve the recommended reductions.

6.1.1 Resource Conservation Programs

The local implementation strategy will evaluate existing conservation programs and seek opportunities for new funding sources for landowners willing to try innovative practices. Several existing voluntary nonpoint source control programs available in this watershed are highlighted below.

The 2002 USDA Farm Bill provides funding for several programs including the Environmental Quality Incentive Program (EQIP), and the Conservation Reserve Program (CRP) which have reduced agricultural contributions of nutrients and sediment in this watershed. In addition, Lake Erie CREP, an enhanced conservation Reserve program is available in all Lake Erie watersheds. Continued adoption of these conservation practices on new farmland acres in the smaller tributary streams and the headwaters of the Vermilion will contribute to water quality improvements in the whole watershed.

The Ohio Lake Erie CREP is a special conservation program to create 67,000 acres of riparian area and upland practices to reduce sediment pollution in Lake Erie and its watersheds. This voluntary program will improve the water quality of streams and increase wildlife habitat by reducing sediment transport to the lake. The Ohio Lake Erie CREP is a Federal-State agreement to commit environmentally sensitive agricultural land through the Conservation Reserve Program to a conserving use, through installation of filter strips, riparian buffers, wetlands, hardwood tress, wildlife habitat, and field windbreaks. More information on Lake Erie CREP can be found at the following web site: http://www.dnr.state.oh.us/soilandwater/crephome.htm

A new incentive based program, the Conservation Security Program (CSP), was first available in 2004 for landowners in the Auglaize River and St Joseph River watersheds. In October 2004, it was announced that $28.4 million in CSP funds would be available for five priority watersheds, including the Huron and Vermilion Rivers in Ohio, with sign-up of participants during 2005. This voluntary program will support ongoing conservation stewardship of agricultural working lands by rewarding producers who maintain and enhance the condition of natural resources in these watersheds. A limited number of participants will be considered on the basis of past conservation efforts and willingness to perform additional conservation activities during their five to ten year contracts. More information on the 2002 Farm Bill and Conservation Security Program is available at the following web site: http://www.nrcs.usda.gov/programs/csp.

6.1.2 Stream Restoration and Protection Programs

There is a FY02 Section 319 Nonpoint Source grant funded project being implemented in this watershed until the end of 2005. The Vermilion River Water Quality Project provides cost share funds for landowners to implement best management practices in the watershed. There was funding for nine (9) pieces of manure handling equipment, up to 100 acres of grass or wooded riparian buffers, twelve (12) livestock exclusion fencing and intensive grazing management projects, eight (8) agri chemical mixing pads, and fifty four (54) home sewage system upgrades or replacements. The Huron SWCD and project partners were required to define critical implementation areas, and to refine those designations when more stream assessment information became available. The Village of New London drinking water supply intake has been identified as a protection goal of the grant. The project also includes funding for public information on the TMDL process, field days and other educational activities. Partners providing local match commitment to the project include the SWCDs in Ashland, Erie, Lorain, and Richland counties, the local Health Departments from Huron, and Erie counties, OSU Extension, Village of New London, and Rural Lorain County Water Authority.

The Vermilion River watershed will be considered a priority watershed for TMDL implementation funding in FY2006 and beyond. Local partners will be encouraged to submit proposals that implement recommendations of the TMDL plan. Ohio EPA will be especially interested in funding projects that reduce or eliminate the habitat degradation and sedimentation impairments in this watershed. Fundable projects could include removal of the dam at Wakeman, stream re-naturalization to restore natural stream ecology, flow and flood plain function, or demonstration of a two stage channel on a maintained drainage ditch. Other projects that will protect and help prevent NPS pollution threats to the already attaining mainstem of the Vermilion River could include riparian wetland restorations or permanent riparian easements. Additional information on the Nonpoint Source Program and 319 grants is available on Ohio EPA's web site at: http://www.epa.state.oh.us/dsw/nps/index.html

Ohio's Water Pollution Control Loan Fund (WPCLF) has two funding sources for nonpoint source pollution control available through the Ohio EPA Division of Environmental and Financial Assistance (DEFA). The Linked Deposit Loan Program provides low interest loans through local banks to aid landowners in implementing nonpoint source reduction projects such as residential on-lot septic system repair or replacement, agricultural BMPs, stream corridor restoration, and sanitary sewer connections.

The other WPCLF funding mechanism, the Water Resource Restoration Sponsor Program (WRRSP), is a unique opportunity for municipalities and local partners to work together on a stream restoration project. When a publicly owned wastewater treatment system obtains a WPCLF loan for plant expansion or other improvements, the reduction in interest on the loan repayment can be used to "sponsor" a smaller local watershed project. There is an additional discounted loan rate for municipalities who enter these partnerships. Some uses of WRRSP could be to finance riparian easement purchase, stream channel and wetland restoration and protection, and match monies for other funding sources such as Section 319 grants. Additional information on Linked Deposit loans and WRRSP is available on the Ohio EPA web site at http://www.epa.state.oh.us/defa/wpclf.html.

6.1.3 Harbor Dredging Programs

The US Army Corps of Engineers (ACOE) is responsible for maintaining sufficient water depths within the Great Lakes shipping ports. Vermilion Harbor is a shallow-draft harbor with an identified problem of shoaling of the Federal navigation channels and subsequent reduction in navigable depths within the harbor. Dredging restores the harbor navigation channels to their authorized depths, which facilitates safe recreational navigation and its associated benefits.

Maintenance dredging in the Vermilion Harbor is conducted approximately once every five to ten years. In 2004, ACOE received authorization to dredge 60,000 cubic yards from the Federal Navigation Channel in Vermilion Harbor. Sediment analysis in 2003 indicated a large percentage of the material consists primarily of silt, with variable amounts of sand and clay. Approximately 20,000 cubic yards of sediment dredged from the River Channel was discharged into an existing open-lake disposal site. The remaining 40,000 cubic yards of dredged material from the Entrance and Lake Approach Channels was discharged into the Huron Harbor Confined Disposal Facility (CDF) because contaminant levels were found to be above open-lake reference.

Recognizing that reducing the frequency or amount of dredging will result in an economic benefit, traditional funding sources, such as the USDA Farm Bill, should be targeted towards highly erodible lands to reduce sedimentation in the watershed. As part of Phase I and Phase II of the Storm Water Program, storm water controls must be implemented that address sediment reduction, such as in the areas of construction activity, post-construction storm water management, and pollution prevention/good housekeeping for municipal operations.

6.2 Reasonable Assurances

As part of an implementation strategy, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The local stakeholders will develop and document a list that differentiates the enforceable and non-enforceable selected actions necessary to achieve the restoration targets. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, will be fulfilled through a schedule for implementation of planned NPDES permit actions. For non-enforceable actions (certain nonpoint source activities), assurances must include: 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with those governmental entities that have jurisdiction and programs in place to implement the nonpoint source actions (e.g., county soil and water conservation district offices, county health departments, local Natural Resource Conservation Service offices of the U.S. Department of Agriculture, municipalities and local governmental offices).

6.2.1 Minimum Elements of an Implementation Plan

Whether an implementation plan is for one TMDL or a group of TMDLs, it should include at a minimum the following eight elements:

- Implementation actions/management measures
- Time line
- Reasonable assurances
- Legal or regulatory controls
- Time required to attain water quality standards
- Monitoring plan
- Milestones for attaining water quality standards
- TMDL revision procedures

6.2.2 Reasonable Assurances Summary

This is a summary of the regulatory, non-regulatory and incentive-based actions applicable to or recommended for the Vermilion River watershed. Many of these activities deal specifically with the point source discharge regulatory actions. Non-regulatory and incentive-based programs are currently delivered through existing local conservation authorities and nonpoint source reduction activities:

Regulatory:

- NPDES permit renewal with compliance schedule for additional monitoring or permit limits for phosphorus at the Village of Bailey Lakes WWTP and the Village of Savannah WWTP
- NPDES permit schedules for CSO elimination or Long Term Control Plans for villages of Greenwich and New London
- Statewide Rules for Home Sewage Treatment/Disposal
- Enforcement of Storm Water Phase I and II regulations
- Sediment and erosion control practices for construction projects
- Implementation of post-construction storm water controls on construction projects
- Implementation of the 208 Water Quality Plan in regards to development and sewer extensions.
- Enforcement of Section 404/401 of the Clean Water Act and Ohio Isolated Wetland Permit issues

Non-regulatory/Incentive based:

- Evaluation of dam(s) for removal
- Explore criteria for Scenic River Designation
- Flow augmentation in headwater streams or near point source discharges and irrigation withdrawals
- Periodic stream monitoring to measure progress
- Development and local acceptance of an implementation plan which includes:
  - Watershed awareness education activities
  - Storm water management programs

- Source protection of ground and surface drinking water supplies (SWAP)
- Septic system improvements
- Agricultural conservation practices
- Riparian buffer initiatives
- Manure nutrient management plans
- Urban nutrient (fertilizer) management plans
- Water table management/controlled drainage
- Restoration of natural stream and flood plain function
- Encourage local health departments to implement Home Sewage Treatment System (HSTS) Plans in watershed

Potential Funding Sources:

- Section 319 grant opportunities for implementation projects that support the strategy and goals of this TMDL
- USDA Farm Bill programs for agricultural BMPs, including the new Conservation Security Program (CSP) incentives
- Lake Erie CREP for buffer practices throughout the Lake Erie watersheds
- Clean Ohio Grant Fund opportunities for natural resource protection and improvement and farmland BMPs
- Various loan opportunities for WWTP improvements
- Low interest loan opportunities through WPCLF Linked Deposit program
- Funding opportunities through WRRSP program for riparian/habitat improvements
- USDA Rural Development Fund grants and WPCLF loan opportunities for centralized wastewater treatment in small communities
- Ohio Environmental Education Fund administered by Ohio EPA
- Lake Erie Protection Fund and Great Lakes Commission grant opportunities
- Ohio Coastal Nonpoint Source grant funding through ODNR/NOAA

6.2.3 Point Source Controls

Implementation of the TMDL for the Vermilion River watershed NPDES permit holders will result in language in the Schedule of Compliance for NPDES permits and new limits for phosphorus.

Village of Bailey Lakes WWTP: Phosphorus in the form of nutrients is listed as a cause of impairment in Table 1.1, so a TMDL for phosphorus was done for the Vermilion River in the vicinity of the Village of Bailey Lakes WWTP. A target load of 0.08 mg/l was calculated for this section of the river. Since the current load of 0.059 mg/l is less than the target, no reduction is needed for the Bailey Lakes WWTP. Phosphorous monitoring will be included in the renewal of the Village's NPDES permit to quantify the amount of phosphorous the plant is discharging. If it is found that the values exceed the target load, the Bailey Lakes NPDES permit will likely be modified to add a compliance schedule to meet the TMDL phosphorus load. The compliance schedule is expected to extend beyond the expiration date of the permit and be carried over to any renewal NPDES permit until the final compliance date is achieved.

For the benefit of readers who may be unfamiliar with how such a permit condition could be structured, the following is an example compliance schedule:

Part I, C - Schedule of Compliance
A. Vermilion TMDL Phosphorus Reduction Implementation Schedule
As soon as possible, but not later than the dates developed in accordance with the following schedule, the permittee shall achieve an allowable total phosphorus load of 0.08 kg/day. The permittee may achieve the allowable phosphorus load by reducing phosphorus loads discharged through wastewater treatment plant station number 2PR00028001 and/or by implementing alternative load reduction projects that are reviewed by and are acceptable to Ohio EPA.

1. The permittee shall immediately begin an evaluation of the capability of its existing treatment facilities to reduce the effluent loadings of total phosphorus. Operational procedures, unit process configuration, and any other measures shall be evaluated as appropriate.

2. Not later than 24 months from the effective date of this permit, the permittee shall submit to the Ohio EPA Northwest District Office a report on the capability of its existing treatment facilities to reduce the effluent loadings of total phosphorus and a summary of other projects, initiatives or activities the permittee proposes to take to achieve the loading reductions necessary to meet the final allowable phosphorus load of 0.08 kg/day.

3. Not later than 30 months from the effective date of this permit, the permittee shall initiate implementation of any projects, initiatives or activities that the permittee has proposed to take to meet the final allowable phosphorus load of 0.08 kg/day.

4. Not later than 30 months from the effective date of this permit, the permittee shall operate the existing treatment facilities to the best of its capability to reduce the effluent loading of total phosphorus.

5. Not later than 48 months from the effective date of this permit, the permittee shall submit a general plan for achieving the loading reductions necessary to meet the final allowable phosphorus load of 0.08 kg/day. In developing the plan, the permittee shall evaluate various alternatives for achieving the necessary loading reduction. The alternatives may include, but are not limited to: implementation of nonpoint source loading reduction projects; implementation of projects that increase the capacity of the receiving waters to assimilate total phosphorus loads; entering into cooperative agreements with other parties to implement projects that will achieve the point source loading reductions identified in the report "Total Maximum Daily Load for the Vermilion River Basin"; and/or upgrading the existing wastewater treatment facilities (Event Code 1299). Any alternative load reduction projects or other initiatives identified and undertaken by the permittee to achieve the phosphorus loading reductions must comply with the wasteload allocations (WLA) and load allocations (LA) assigned in the Vermilion River Basin TMDL report. Loading reductions achieved by the permittee must be applied to meeting the point source WLA for phosphorus. After review and acceptance by Ohio EPA, any portion of loading reductions achieved by one stakeholder may be credited to it or to another stakeholder(s) so long as such credit is not duplicated. The general plan for achieving the loading reductions shall address,at a minimum, the following:
a. The alternative(s) chosen to achieve the loading reductions.

b. Cost estimates of implementing the chosen alternatives, including any applicable operation, maintenance, and replacement costs.
c. A fixed date compliance schedule for meeting the reduction targets for total phosphorus. At a minimum, this schedule should include dates for: submission of approvable detail plans (if applicable); completion of implementation/construction; attainment of operational level; notification of the Ohio EPA Northwest District Office within 14 days of attaining operational level (if applicable); and the achievement of the loading reductions required by Schedule of Compliance Item A.6 not later than 84 months from the effective date of this permit.
d. The financial mechanism to be used to fund the required improvements, operation, maintenance, and replacement costs (if applicable).
e. For alternatives other than upgrading the existing wastewater treatment facilities, demonstration of reasonable assurance by providing information that: the proposed projects are technically feasible based on accepted modeling, data from similar projects, and commonly accepted professional expectations; a reasonable expectation that the proposed controls will be implemented; and other appropriate measures identified by the permittee.

6. The permittee shall achieve the final allowable total phosphorus load of 0.08 kg/day not later than 84 months from the effective date of this permit. (Event Code 5699).
This NPDES permit, Ohio EPA permit number 2PR00028* expires on _________. This Schedule of Compliance includes an item that extends beyond the term of the permit. Any requirements of this Schedule of Compliance that have not been met, including the compliance dates, will be included in the permit when it is renewed. In the event that evidence becomes available demonstrating to the Director's satisfaction that biological indices applicable to the Vermilion River Basin are in full attainment, or that monitoring data collected at appropriate locations within the TMDL study area show that the median total phosphorus concentration measured at those locations is less than or equal to the instream target for two consecutive years, the Director will evaluate any proposed modification of the TMDL Implementation Schedule included in this NPDES permit. This permit may be modified or revoked and reissued for the following reasons:
- To include new or revised conditions based on new information resulting from implementation of the TMDL recommendations.
- To include new or revised conditions based on plans submitted by the permittee to upgrade the existing wastewater treatment facilities to achieve the allowable total phosphorus load of 0.08 kg/day.

7. Not later than June 30 of each year, after the effective date of this permit, the permittee shall submit to the Ohio EPA Northwest District Office a status report that includes the following:
a. A summary of changes in operational procedures, unit process configuration, and other measures taken to maximize the ability of its treatment facilities to achieve an allowable total phosphorus load of 0.08 kg/day.
b. The phosphorus load discharged from station number 2PR00028001 during each calendar year since the effective date of this permit.
c. A summary of any projects, initiatives or activities the permittee has taken to achieve the loading reductions necessary to meet the final allowable phosphorus load of 0.08 kg/day.

Village of Savannah WWTP: Phosphorus in the form of nutrients is listed as a cause of impairment in Table 1.1, so a TMDL for phosphorus was done for the Vermilion River in the vicinity of the Village of Savannah WWTP. A target load of 0.10 mg/l was calculated for this section of the river. Since the current load of 0.05 mg/l is less then the target, no reduction is needed for the Savannah WWTP. Phosphorous monitoring will be included in the renewal of the Village's NPDES permit to quantify the amount of phosphorous the plant is discharging. If it is found that the values exceed the target load, the Savannah NPDES permit will likely be modified to add a compliance schedule to meet the TMDL phosphorus load. The compliance schedule is expected to extend beyond the expiration date of the permit and be carried over to any renewal NPDES permit until the final compliance date is achieved.

Troy Township WWTP (Village of Nova): Pathogens and Phosphorous were listed in Table 1.1 as sources of impairment in the Buck Creek watershed. During the sampling period for the TMDL development the Village of Nova was an unsewered community. Ohio EPA has approved plans for a central sanitary sewerage system and wastewater treatment lagoons to serve the Village. The completion of this project should improve the water quality in this tributary.

TMDL Re-opener Language

Re-opener language will be included in the renewal of NPDES permits in the Huron River watershed which will explicitly allow Ohio EPA to modify, revoke, or reissue a permit based upon requirements of the approved TMDL. Changes to a permit could include new or revised effluent limits, revised monitoring requirements, and/or other conditions which would be necessary for TMDL implementation.

Stormwater Discharges

Currently, there are nine regulated Municipal Separate Storm Sewer Systems (MS4s) in the TMDL area. Six have obtained permit coverage while three were granted a waiver (see the Stormwater Management discussion in Section 6.2.6). There are also many sites with coverage under the NPDES General Permit for Storm Water Discharges Associated with Construction Activities or under the NPDES General Permit for Storm Water Discharges Associated with Industrial Activities (see Table 2.3).

6.2.4 Source Water Protection Recommendations

The only public water supply that receives water directly from surface waters within the Vermilion River basin is the Village of New London. According to the Drinking Water Source Assessment for the Village of New London, the Village operates a community public water system that serves a population of approximately 3,200 (plant #1) and 10,000 (plant #2) people. The source is surface water pumped from Buck Creek. The water system has a combined treatment capacity of approximately 1.42 million gallons per day.

Water quality criteria established for a public water supply (OAC 3745-1-33) apply within 500 yards of an intake pipe. Though no chemical sampling completed during the 2002 sampling season was this close to an intake, 10 sites within the Corridor Management Zone (CMZ) were sampled. The CMZ is an area bordering streams and tributaries within the source water assessment area that warrants delineation, inventory and management for drinking water protection.

Results of sampling within the CMZ showed frequent low levels of dissolved oxygen, below the Ohio EPA water quality criteria (OAC 3745-1) in an unnamed tributary of the Vermilion River (RM 54.62). Manganese levels in nearly all the samples exceeded the Water Quality Criterion established for the protection of human health in drinking water. In addition, Ohio EPA's Pesticide Special Study (1995-1999) showed that low levels of nitrate and several pesticides (alachlor, atrazine, metolachlor, metribuzin, simazine and cyanazine) had been detected in the finished water, indicating an impact from land use activities within the Village of New London's protection area.

Strategies for protecting Buck Creek, Clear Creek, and the headwaters of the Vermilion River in northwestern Ashland County and southeastern Huron County should include

- controlling soil and nutrient runoff from agricultural areas
- reducing fertilizer and pesticide application on crop fields
- restricting livestock access to the streams
- establishment of an early warning and emergency response plan for spills
- repairing or eliminating discharges from failing home and commercial septic systems
- coordination with local emergency response agencies
- evaluation of the potential impact from municipal sewage sludge application within the water supply protection area.

Additional information regarding New London's public water supply can be obtained from the Ohio EPA report "Drinking Water Source Assessment for the Village of New London" November, 2003. A copy of the report can be obtained from the Village's Water Department or from the Ohio EPA, Northwest District Office, 347 North Dunbridge Road, Bowling Green, Ohio 43402 or by calling 419-352-8461. For more information on the Ohio EPA's Source Water Assessment and Protection program (SWAP), please visit the agency website at http://www.epa.state.oh.us/ddagw/pdu/swap.html

6.2.5 Unsewered Areas Recommendations

In small towns and unincorporated areas, water quality and public health can be severely impacted when multiple homes bypass failed systems into the storm sewers or local streams. This contributes to water quality degradation and recreational impairment of streams in the Vermilion River watershed. As discussed previously, it is recommended that unsewered communities in the watershed work toward implementing the Section 208 Sewerage Facilities Plan to provide permanent solutions for areas such as Birmingham, Clarksfield, Fitchville, Hartland, Kipton, Ruggles, and West Clarksfield.

6.2.6 Nonpoint Source Controls

Agricultural Nutrient Enrichment and Sedimentation
The Vermilion River watershed is a predominately agricultural area used mostly for row crop production and, to a smaller degree livestock production, although that sector of agriculture is growing in the southern (headwater) areas of the watershed. In the past ten to fifteen years, conservation efforts by farmers, local partnerships and units of government have reduced non-point sources of pollution significantly, and efforts in this direction continue. However, agricultural contributions of sediment and nutrients continue to be problematic in the smaller tributary and headwater streams.

The following streams need restoration projects that will reduce or eliminate nutrient impairment, especially from phosphorus. Please refer to Table 3.6 for estimates of the total phosphorus reductions needed to bring these streams into attainment:
- Clear Creek, entire stream
- Southwest Branch from the headwaters to RM 3.8 (Greenwich-Angling Road), is also affected by Greenwich WWTP
- Tributary to East Branch at RM 8.20 (entire length)
- East Branch, entire stream
- Skellinger Creek, entire stream (is also affected by New London WWTP)
- East Fork for entire length plus two tributaries
- Tributary of Vermilion River at RM 12.1 (upstream State Route 113 for entire length)

The following streams need restoration projects that will reduce or eliminate sediment impairments. Please refer to table 4.10 for estimates of sediment loading reductions needed to bring these streams into attainment:
- Vermilion River at RM 63 (headwaters upsteam of Clear Creek Road)
- Tributary to Vermilion River at RM 63.52 (State Route 60/250)
- Southwest Branch in the last mile before confluence of Vermilion River
- Indian Creek headwaters
- Tributary to East Branch at RM 8.20 (upstream of Fayette road)

As discussed previously, landowners can take advantage of several incentive programs that will cover significant costs of adopting Best Management Practices on farmland, while educational initiatives exist to boost participation in these programs. The Livestock Environmental Assurance Program (LEAP), the Environmental Quality Incentives Program (EQIP) for livestock exclusion and waste management practices, the Lake Erie Conservation Reserve Enhancement Program (CREP), and many other 2002 Farm Bill programs are available through the Farm Service Agency and Soil and Water Conservation Districts in each county of the watershed.

Partners in the Vermilion River watershed will again be eligible for Section 319 grant funds beginning in FY 2006. The priority focus for funding will be projects that eliminate water quality impairments from nonpoint sources, or restore a stream segment to the aquatic use designation specified in a TMDL report.

Habitat Degradation and Flow Alteration

A lack of instream and riparian habitat, and low water levels in small tributary streams and maintained channels caused multiple impairments in the Vermilion watershed. In this study, the difference between small streams that were attaining their aquatic use designations and streams that were not, appeared to be related to the amount of nutrient enrichment and the presence or absence of continuous stream flow. In other words, the impacts of sediment and nutrients are magnified by poor physical habitat or intermittent flow. Conversely, good physical habitat and adequate flow can be effective in assimilating these pollutants.

Habitat improvements are recommended throughout the watershed with special effort directed at the following non-attaining stream segments:

- Vermilion River headwaters
- Clear creek headwaters
- Tributary to Vermilion River at RM 63.52 (State Route 60/250)
- Vermilion River at RM 54 (downstream US Route 250)
- Buck Creek headwaters
- Southwest Branch in the last mile before confluence of Vermilion River
- East Branch at RM 13 (Fayette Road)
- Tributary to East Branch at RM 8.20 (whole length upstream of Chenango Road)
- Vermilion River at RM 23.9 (upstream of the Wakeman dam)
- Tributary to East Fork at RM 8.47 (whole length upstream of US Route 20)

Restoration projects that yield an increase in the Habitat (QHEI) score to an average of 60 for WWH and 45 for MWH are desired. The target for the QHEI provides a means for evaluating success for any activities performed in terms of how likely it is for an aquatic life use to be restored. When QHEI values begin to exceed 60 for WWH and 45 for MWH, the likelihood that a warmwater aquatic fauna will be supported is greater than when the scores are lower. In these stream segments, all aspects of the habitat including substrate, instream cover, riparian and channel characteristics, and pool riffle quality need improvement.

Habitat Protection and Restoration

Preservation of natural habitat is key to maintaining the existing level of assimilative capacity of the watershed. Actions such as preserving natural drainage features, restoring and maintaining riparian areas, reconnecting riparian floodplains, minimizing impervious surface areas, and installing post-construction structural storm water management practices are recommended.

Unlike the standard practices for reducing sediment and nutrient runoff from crop land, the solutions for habitat and flow-impaired streams will not be familiar BMPs that have well-established incentive programs. Improved habitat will rely on long term changes and social acceptance of new trends in agricultural drainage practices. Implementation actions could include:

- Adopt riparian protection ordinances that prevent flood plain encroachment and riparian removal

- Protect riparian areas with conservation easements and/or buffer establishment
- Stabilize severely eroding stream banks with bio-engineering techniques
- Reconnect stream channels with active natural floodplains
- Promote riparian wetlands to provide flood water storage and enhance groundwater recharge, and seasonal flow augmentation
- Demonstrate drainage water management practices on agricultural fields with subsurface drainage systems
- Promote natural stream management and filter strips to reduce the frequency of maintenance on petition ditches
- Restore severely impaired waters using two-stage channel design
- Evaluate the dam at Wakeman for modification or removal
- Reduce drainage maintenance assessment if filter strips are established and maintained

Bacteria/Recreation Impairment
Septic systems impact water quality in the Vermilion River watershed through both point and nonpoint discharges from failed, inadequately designed, or discharging systems in small unincorporated villages and rural areas. Individual sewage systems are used to treat household sanitary waste in areas where no municipal treatment facilities exist. When poorly designed or neglected, they contribute loads of organic matter, nutrients, and pathogens. Site limitations such as lot size, soil type and depth to bedrock or groundwater further reduce effectiveness and increase system failures leading to surface or groundwater contamination.

Livestock access to streams is also a source of elevated bacteria in streams, when animals use the stream for watering.

The streams that were identified as bacteria impaired are:
- Clear Creek at Townline Road
- Vermilion River at Clear Creek Road
- Buck Creek at Township Road 1281
- Southwest Branch at Greenwich/Angling Road
- Southwest Branch at State Route 13
- East Branch at Vesta Road
- East Branch at Zenobia Road
- Skellinger Creek at Fayette Road
- East Fork at State Route 511

Specific sampling results for these site that exceeded Ohio Water Quality Standards are listed in Table 3.7.

Implementation actions to address these sources of pollution would include, exclusion fencing and alternative watering systems to keep livestock out of the streams, identification and replacement of faulty septic systems, elimination of on-site septic systems through extension of municipal sanitary sewers, and public education on septic system maintenance. Section 319 grant funds have in the past assisted homeowners with repair or replacement of failed septic systems in critical areas of the watershed.

Although this funding is no longer available, the Ohio Department of Health is developingrules that will bring all local health department sewage programs up to a statewide standard. County Home Sewage Treatment System (HSTS) plans have been developed and approved for Huron and Erie County.

Storm Water Management

In the Vermilion River watershed, sources of stream impairment may include discharges from urban storm runoff and storm water discharges from Phase I and II Industrial, Construction, and Municipal activities. Those industrial facilities with NPDES permit coverage for storm water discharges associated with industrial activities must develop and implement a Storm Water Pollution Prevention Plan (SWP3) which identifies potential sources of pollution. The SWP3 must also describe and ensure the implementation of practices to reduce pollutants in storm water discharges. It is recommended that these facilities review their SWP3s during their annual comprehensive site compliance evaluation to ensure that appropriate BMPs are implemented that address the causes of impairment for this watershed, including habitat alteration, organic and nutrient enrichment, siltation, flow alteration, and bacteria.

Phase II Storm Water regulations now require that prescribed management practices for construction activities be described in a site's SWP3 including :

- Installation and maintenance of sediment and erosion control practices for construction projects which, either by themselves or as part of a total common plan of development or sale, collectively disturb one acre or more
- Implementation of post-construction storm water controls on construction projects which, either by themselves or as part of a total common plan of development or sale, collectively disturb one acre or more

So that a receiving stream's physical, chemical, and biological characteristics are protected and stream functions are maintained, the post-construction storm water practices shall provide perpetual management of runoff quality and quantity. To meet the post-construction requirements of the NPDES Construction General Permit, the SWP3 must contain a description of the post-construction BMPs that will be installed during construction for the site and the rationale for their selection. The rationale must address the anticipated impacts on the channel and floodplain morphology, hydrology, and water quality. To this end, appropriate BMPs are to be considered and implemented that address the causes of impairment for this watershed, including habitat alteration, nutrient enrichment, siltation, flow alteration, and bacteria. The post-construction BMP(s) chosen must be able to detain storm water runoff for protection of the stream channels, stream erosion control, and improved water quality.

The regulated small MS4s in the Vermilion River watershed must either obtain NPDES permit coverage for their storm water discharges or request a waiver. The City of Vermilion and Erie County currently are Co-Permittees (Ohio EPA Number 2GQ00027) with coverage under the Baseline NPDES General Permit for Small MS4s. The Ohio Department of Transportation (Ohio EPA Number 4GQ00000) and the Lorain County

Metropolitan Park District (Ohio EPA Number 3GQ00013) also have this type of permit coverage. Under this permit, entities are required to have a Storm Water Management Program (SWMP) implemented by March 2008 for all areas served by their MS4 within the Elyria/Lorain Urbanized Area (UA). In the SWMP, BMPs addressing six Minimum Control Measures are implemented to minimize and to prevent storm water pollution. The six Minimum Control Measures are: Public Outreach and Education, Public Participation, Illicit Discharge Detection/Elimination, Sediment and Erosion Control (construction site program), Post-Construction Storm Water Management, and Pollution Prevention for Municipal Operations. Lorain County (Ohio EPA Number 3GQ10012) has permit coverage under the Alternative General Permit for MS4s Located within Rapidly Developing Watersheds. Under this permit, Lorain County is required to develop an SWMP addressing the six Minimum Control Measures, however implementation of the Construction and Post-Construction Minimum Control Measures is required by March 2006.

For all of the regulated small MS4s, it is recommended that BMPs are considered and are implemented that address the causes of impairment for this watershed, including habitat alteration, organic and nutrient enrichment, siltation, flow alteration, and bacteria.

Under the Phase II Storm Water Regulations and Ohio Administrative Code Chapter 3745-39, those regulated small MS4s with populations less than 1000 inside a UA may be eligible for a waiver from NPDES MS4 permitting. Portions of Brownhelm Township (Lorain County), New Russia Township (Lorain County), and Vermilion Township (Erie County) are within an Urbanized Area in the watershed, but applied for and received a waiver from the program in 2003. Such waivers must be re-evaluated every 5 years. It is recommended that Ohio EPA reconsider the waiver from NPDES Small MS4 General permit coverage currently granted to Vermilion, Brownhelm, and New Russia Townships. As development progresses adjacent to the City of Vermilion, it is important to have programs already in place to mitigate the impacts of development as it occurs.

Under OAC Chapter 3745-39, a small MS4 shall be designated by the director to obtain Ohio NPDES permit coverage for discharges when a storm water discharge from the small MS4 results in or has the potential to result in an exceedance of Ohio water quality standards, including impairment of a designated use, or other significant water quality impacts including habitat and biological impacts to surface waters of the state. The 2002 water quality study of the Vermilion Watershed (Ohio EPA, 2004, Figure 12, Table 2, and Table 10) shows channelization due to development and development as the primary sources of impairment for the Vermilion at River Mile 63.8 and for the tributary to the Vermilion at River Mile 63.98. Due to this, it is recommended that the Village of Bailey Lakes, Village of Savannah, and portions of Ashland County tributary to the Vermilion be considered for designation. Any Small MS4 notified to obtain NPDES permit coverage will have 180 days from designation in which to apply.

It should be noted that while the Ohio Turnpike Commission is a permittee and has developed a SWMP, their permit coverage does not extend to, nor is required for, portions of their system outside the UA. So, while the Ohio Turnpike passes through this watershed, their SWMP is not required to be implemented in this area. Erie County, Lorain County, the City of Vermilion, ODOT, the Ohio Turnpike, and the Lorain County Metropolitan Park District should evaluate extending their Storm Water Management Programs in this watershed to areas outside the UA. The formation of a stakeholder based advisory group to guide the development of a Storm Water Management Program in a Watershed Implementation Plan would be an important first step. Implementation actions could include drafting ordinances for storm water and sediment and erosion control, and expanding existing programs (i.e., Soil and Water Conservation Districts (SWCDs) to include storm water monitoring. Public education, such as developing an adult education program about storm water pollution, would be an important and necessary part of the implementation plan.

Public Education
The Lorain County Park District, Firelands Land Conservancy, and Oberlin College have staff and volunteers that deliver programs and information to help local landowners and public officials understand the value of water and land resources. Education materials can be updated to include information on causes, sources and solutions to nonpoint pollution in the Vermilion watershed. The primary focus would be building public awareness about the value of a healthy watershed and the importance of reducing/eliminating these sources of pollution. Funding for nonpoint source (NPS) education is available through competitive grants from ODNR Division of Soil and Water Conservation and the Ohio Environmental Education Fund administered by Ohio EPA.

6.3 Process for Monitoring and Revision

An initial monitoring plan to determine whether the TMDL has resulted in attainment of water quality standards and to support any revisions to the TMDL that might be required begins with in-stream water quality chemical monitoring. This sampling will be done at a minimum by those permit holders with individual NPDES permits at locations upstream and downstream of their outfalls and at ambient monitoring stations to be collected by Ohio EPA.

A more detailed and inclusive monitoring plan could be developed by a local watershed group which would describe steps in a monitoring program, including timing and location of monitoring activities, parties responsible for monitoring, and quality assurance and quality control procedures. It may include a method to determine whether actions identified in the implementation plan are actually being carried out and criteria for determining whether these actions are effective in reaching the TMDL targets.

Although this watershed does not currently have a full time watershed coordinator that would be able to help organize a local watershed group and develop a monitoring program, there are several organizations, interested citizens, and landowners that have indicated such an interest. Heidelberg Water Quality Lab is conducting ongoing monitoring of water quality at the USGS gauge station on the Vermilion River. It is recommended that these local groups work together, with the Ohio EPA, OSU Extension and other local partners, such as Oberlin College, to develop a monitoring plan and locate resources to establish and maintain a volunteer monitoring program throughout their watershed.

The Firelands Land Conservancy, in partnership with Oberlin College has involved citizens and student volunteers in river protection and education projects over the last four years. In addition, there has been recent effort to recruit and train volunteers through an organization called Vermilion On The Lake. Ohio EPA should support efforts by these local partners to compete for funding of an expanded water quality monitoring program. Please visit the websites for Vermilion-on-the-Lake at www.volohio.org, Firelands Land Conservancy at www.firelandslc.org, or Oberlin College at http://www.oberlin.edu/nav/community.html.

A biological and water quality study of the Vermilion River, similar to that conducted by the Ohio EPA in 2002 will be scheduled when indications suggest that major changes in the watershed have occurred. In addition, interim and/or surrogate measures that document progress in water quality improvement are recommended. Consideration must be given to the lag time between source control actions (habitat improvements and loading reductions) and observable/measurable instream effects, especially for nonpoint sources.

A tiered approach to monitoring progress and validating the TMDL will be followed;. The tiered progression includes:

1. Confirmation of completion of implementation plan activities
2. Evaluation of attainment of chemical water quality criteria
3. Evaluation of biological attainment.

A TMDL revision will be triggered if any one of these three broad validation steps is not being completed, or if the WQS are not being attained after an appropriate time interval. If the implementation plan activities are not being carried out within a reasonable time frame as specified in the implementation plan then an intercession by a local watershed group or other appropriate parties would be needed to keep the implementation activities on schedule. Once the majority of (or the major) implementation plan items have been carried out and/or the chemical water quality has shown consistent and stable improvements, then a full scale biological and chemical watershed assessment would be completed to evaluate attainment of the use designations. If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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Appendix A

Assessment Unit Summaries from 2004 Integrated Report

HUC11	WAU Description	WAU Size (mi^2): 140.3
04100012 050	Vermilion River (headwaters to upstream East Branch)	

Integrated Report Assessment Category: 5 **Priority Points: 8**

Next Scheduled Monitoring: 2011

Aquatic Life Use Assessment

Subcategories of ALU: WWH Sampling Year(s): 2002

Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	% Attainment: Full	% Attainment: Partial	% Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	2 Sites	0 Sites						
5-20 mi^2	14 Sites	2 Sites	7.1	67.9	25.0			
20-50 mi^2	3 Sites	0 Sites				51	36	13
Large (Linear)	4 Sites							
50-500 mi^2	23.8 Miles	22.6 Miles	95.0	5.0	0.0			

High Magnitude Causes

- Nutrients
- Siltation
- Flow Alteration
- Other Habitat Alterations
- Organic Enrichment/D.O.
- Natural Limits (Drought)

High Magnitude Sources

- Channelization-Development
- Channelization-Agriculture
- Onsite Wastewater Systems (Septic Tanks)
- Hydromodification-Agriculture
- Pasture Land
- Nonirrigated Crop Production
- Minor Municipal Point Source
- Natural

Recreation Use Assessment

Subcategory of Use: Primary Contact

Impairment: Yes

Geometric Mean: 380

No. Ambient Sites: 6 No. Ambient Sampling Records: 59 75^{th} %ile: 1200

No. of NPDES MOR Sites: 1 No. of NPDES MOR Records: 7 90^{th} %ile: 1950

Other:

Fish Consumption Advisory (FCA) Assessment

Waters Within the WAU Sampled and Assessed: Yes

FCA Issued: Yes

(See the 2004 Ohio FCA for more detailed information at "www.epa.state.oh.us/dsw/fishadvisory/index.html")

Impairment Due to FCA: No Pollutant (Waterbody):

Comments

Development of TMDLs for pollutants impairing beneficial uses is underway. Biological and water quality monitoring in support of the TMDLs was conducted in 2002. Principal streams sampled included the Vermilion River, Southwest Branch Vermilion River, Buck Creek, and Clear Creek.

HUC11	WAU Description	WAU Size (mi^2): 127.7
04100012 060	Vermilion River (upstream East Branch to mouth)	

Integrated Report Assessment Category: 5 **Priority Points: 5**

Next Scheduled Monitoring: 2011

Aquatic Life Use Assessment

Subcategories of ALU: EWH,WWH Sampling Year(s): 2002

Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	% Attainment: Full	% Attainment: Partial	% Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	8 Sites	3 Sites						
5-20 mi^2	10 Sites	3 Sites	50.2	21.7	28.1	39	39	22
20-50 mi^2	3 Sites	2 Sites						
Large (Linear)	11 Sites							
50-500 mi^2	29.7 Miles	8.1 Miles	27.3	56.9	15.8			

High Magnitude Causes

Flow Alteration
Siltation
Organic Enrichment/D.O.
Nutrients
Natural Limits (Drought)

High Magnitude Sources

Flow Regulation/Modification-Development
Channelization-Agriculture
Nonirrigated Crop Production
Industrial Point Source
Minor Municipal Point Source
Onsite Wastewater Systems (Septic Tanks)
Natural

Recreation Use Assessment

Subcategory of Use: Primary Contact

Impairment: Yes

Geometric Mean: 157

No. Ambient Sites: 23 No. Ambient Sampling Records: 92 75^{th} %ile: 400

No. of NPDES MOR Sites: 1 No. of NPDES MOR Records: 60 90^{th} %ile: 2200

Other:

Fish Consumption Advisory (FCA) Assessment

Waters Within the WAU Sampled and Assessed: Yes

FCA Issued: Yes

(See the 2004 Ohio FCA for more detailed information at "www.epa.state.oh.us/dsw/fishadvisory/index.html")

Impairment Due to FCA: No Pollutant (Waterbody):

Comments

Development of TMDLs for pollutants impairing beneficial uses is underway. Biological and water quality monitoring in support of the TMDLs was conducted in 2002. Principal streams sampled included the Vermilion River, East Fork Vermilion River, and East Branch Vermilion River.