A.10 READER ASSISTANCE

Three tools are provided here to facilitate the use of this report: a list of acronyms, a glossary with definitions of scientific and technical terms that might not be familiar or in every day usage, and some background information on water quality impairments found in the Big Darby Creek watershed.

A.10.1 List of Acronyms and Abbreviations

ALU	aquatic life use
AWS	Agricultural Water Supply
BDC	Big Darby Creek
BMP	best management practices
BNA	base neutral and acid extractable compounds
BW	Bathing Water
CFR	Code of Federal Regulations
CRP	Conservation Reserve Program
CWA	Clean Water Act
CWH	Cold Water Habitat
D.O.	dissolved oxygen
DNAP	Division of Natural Areas and Preserves (part of ODNR)
DOW	Division of Wildlife (part of ODNR)
DSWC	Division of Soil and Water Conservation (part of ODNR)
ECBP	Eastern Corn Belt Plains (ecoregion)
EQIP	Environmental Quality Incentive Plan (USDA program)
EWH	Exceptional Warmwater Habitat
FSA	Farm Service Agency
gpd	gallons per day
HELP	Huron Erie Lake Plain (ecoregion)
I/I	infiltration and inflow
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IWS	Industrial Water Supply
l	liter
LEL	lowest effect level
LRW	Limited Resource Water
mg	milligram
MHP	mobile home park
MIwb	Modified Index of well being
ml	milliliter
MOR	monthly operating report
MORPC	Mid-Ohio Regional Planning Commission
MWH	Modified Warmwater Habitat

n	number (of data points in a grouping)
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OSC	onsite coordinator
OSUE	Ohio State University Extension
PCB	polychlorinated biphenyls
PCR	Primary Contact Recreation
PEC	probable effect concentration
PWS	Public Water Supply
QCTV	Qualitative Community Tolerance Value
QHEI	Qualitative Habitat Evaluation Index
RM	river mile
SCR	Secondary Contact Recreation
SEL	severe effect level
SMP	sludge management plan
SRW	State Resource Water
SSH	Seasonal Salmonid Habitat
SWCD	Soil and Water Conservation District
TEC	threshold effect concentration
TKN	total kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
UAA	Use Attainability Analysis
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound
WASCOBS	water and sediment control basins
WAU	watershed assessment unit
WPCLF	Water Pollution Control Loan Fund
WQS	water quality standards
WRP	Wetland Reserve Program
WTP	water treatment plant
WWH	Warm Water Habitat
WWTP	wastewater treatment plant

A.10.2 Glossary

Many of the definitions of the terms came directly from Armantrout, 1998.

A

Aerobic	A process conducted in the presence of oxygen which facilitates the reduction of wastewater pollutants.
Alluvial	Related to material deposited by running water.
Alluvial deposit	Clay, sand, silt, gravel or other sediment carried by flowing waters and deposited when the water velocity drops below that required to keep the material in suspension or move the bed load. Synonymous with alluvial fill.
Ambient	Refers to general conditions in the environment.
Anaerobic	(1) Environmental conditions where free oxygen is absent. (2) Life processes that occur in the absence of molecular oxygen.
Anoxic	Lack of oxygen.
Aquatic	Term applied to growing, living in, frequenting or pertaining to water.
Aquatic ecosystem	Any body of water, such as a wetland, stream, lake, reservoir or estuary that includes all organisms and nonliving components, functioning as a natural system.
Aquatic habitat	A specific type of area with environmental (i.e., biological, chemical or physical) characteristics needed and used by an aquatic organism, population or community.
Assimilation	Ability of a water body to absorb materials and substances to purify itself.
Assimilation capacity	(1) Capacity of a natural water body to receive wastewaters, without deleterious effects or toxic materials, without damage to the environment or humans who consume the water. (2) To incorporate and convert waste waters without deleterious effects. (3) Biological Oxygen Demand (BOD), within prescribed dissolved oxygen limits.
Association	(1) Plant and animal communities of a particular kind that are consistently found together. (2) A group of plants and animal species.

B

Backwater	(1) A pool formed by water backing upstream from an obstruction, such as narrowing of the channel by a bedrock or boulder constriction. (2) Abandoned channel that remains connected to the active main stem river. (3) Secondary channel in which the inlet becomes blocked with substrate deposition when water velocities decrease as the river subsides but the outlet remains connected with the active channel.
Bank	Ground bordering a channel above the stream bed and below the level of rooted vegetation that often has a gradient steeper than 45 and exhibits a district break in slope from the stream bottom. The portion of the channel cross section that restricts lateral movement of water during normal stream flow. Right and left banks are determined while looking downstream.

Bank erosion	Erosion of bank material caused by water current, wave action or surface erosion.
Bank-full depth	Depth of water measured from the surface to the channel bottom when the water surface is even with the top of the stream bank.
Bank-full discharge	Maximum stream flow that can be accommodated within the channel without overtopping the banks and spreading onto the flood plain. Generally the level associated with two- or three-year stream flow events.
Bank-full stage	Stream stage where stream reaches bank-full depth.
Bank-full width	Channel width between the tops of the most pronounced banks on either side of a stream reach.
Bank height	Distance between the channel bed and the top of the bank.
Bar	A submerged or exposed ridge-like accumulation of sand, gravel, or other alluvial material formed in the lake, or in the channel, along the banks, or at the mouth of a stream, where a decrease in velocity induces depositon.
Bedrock	Rock outcrop or rock covered by a thin mantle (less than 10 cm) of consolidated material.
Bioaccumulation	The net accumulation of a substance by an organism as a result of uptake from all environmental sources.
Bioconcentration	The net accumulation of a substance by an aquatic organism as a result of uptake directly from the ambient water through gill membranes or other external body surfaces.

C

Carbonaceous	The portion of the total biochemical oxygen demand that is from materials composed primarily of carbon (as opposed to being composed primarily of nitrogen).
$cBOD_5$	The analytical result for carbonaceous biochemical oxygen demand of the wastewater after 5 days.
Coldwater fish	Those species of fish that thrive in relatively cold water. These species include, but are not limited to, salmon and trout (Salmonidae), and may include sculpins (Cottidae) and certain minnow (Cyprinidae) species.
Comminutor	A pump or grinder that shreds inorganic material, generally located at the influent end of a wastewater treatment plant.
Confluence	The point where two or more bodies of water flow together.
Channel	A natural or artificial waterway that periodically or continuously contains moving water, has a definite bed, and has banks that serve to confine water at low to moderate stream flows.
Channelization	Deepening an existing stream channel or creating new stream channel by human activity to increase the rate of runoff or to lower the water table.
Clarifier	A tank that allows settling of solids, providing a “clear” overflow of wastewater.
Criteria	Elements of water quality standards, expressed as constituent concentrations, levels or narrative statements, representing a quality of water that supports a particular designated use.

D

Decant	The removal of the clearest portion of wastewater or sludge.
Degradation	Lowering of the existing water quality in the surface waters of the state.
Deposit	An accumulation of organic or inorganic material resulting from naturally occurring biological, chemical or physical processes.
Demand (as in oxygen)	The amount of oxygen needed to reduce wastewater pollutants over a period of time.
Designated use	A use of the surface waters of the state, established by the water quality standards, Chapter 3745-1 of the Administrative Code.
Dessication	Process of dehydration or drying up.
Detention	The amount of time that wastewater remains in the treatment system.
Detritus	A non-dissolved product of disintegration or wearing away. Pertains to small organic particles like leaves and twigs. Detritus may pertain to material produced by erosion, such as soil, sand, clay, gravel and rock, carried down a watercourse, and deposits on an outwash fan or floodplain.
Diatom	Microscopic algae with a siliceous skeleton that occurs as plankton or attaches to the substrate.
Diel	Pertaining to a 24-hour period or a regular occurrence in every 24-hour period.
Director	The director of the Ohio Environmental Protection Agency.
Dissolved oxygen	Concentration of oxygen dissolved in water, where saturation is the maximum amount of oxygen that can theoretically can be dissolved in water at a given altitude and temperature. Expressed as milligrams liter or percent saturation.
Discharge	The addition of any pollutant to the waters of the state from a point source.
Distribution	Occurrence, frequency of occurrence, position or arrangement of animals or plants within an area. May also be applied to a rate such as the number per unit of area or time.
Disturbance	A force that causes changes in habitat or community structure and composition through (a) natural events such as fire, flood, wind or earthquake; (b) mortality due to insect or disease outbreaks; or (c) human activities such as agriculture, grazing, logging, mining, road construction, etc.
Ditch	A long narrow excavation in the ground (usually an open and unpaved channel, trench or waterway smaller than a canal) for conveying water to or from a specific location for purposes such as drainage or irrigation.
Diversity	Variation that occurs in plant and animal taxa (i.e., species composition), habitats or ecosystems within a given geographic location.

E

E. coli	A specific bacterial species included in the fecal coliform bacteria group, the presence of which in surface waters has been correlated with gastrointestinal illness in swimmers.

Ecosystem	Any complex of living organisms interacting with nonliving chemical and physical components that form and function as a natural environmental unit.
Eddy	Circular movement of water, sometimes quite strong, diverging from and initially flowing against the main current in streams. Eddies are usually formed where water flows past some obstruction or on the inside of river bends. Eddies often form backwater pools, alcove pools or pocket water in rapids or cascades.
Effluent	(1) Discharge of liquid into a water body or emission of a gas into the environment. Usually composed of waste material. For example, emission of combustion gases into the atmosphere from industry or manufacturing. (2) May also be used to describe a stream flowing out of a lake or reservoir.
Embeddedness	Degree that gravel and larger sizes of particles (boulders, cobble or rubble) are surrounded or covered by fine sediment (e.g., less than 2mm.).
Emergent vegetation	Rooted aquatic plants with some herbaceous vegetative parts that project above the water surface. Also referred to as emersed vegetation.
End moraine	A ridge of glacial till that remains in equilibrium at the terminus of a valley glacier or at the margin of an ice sheet.
Endemic	Species that is unique or confined to a specific locality.
Enrichment	Process where discharges or runoff carries nutrients into a waterbody, enhancing the growth potential for bacteria, algae and aquatic plants.
Entrenchment	Stream channel incision from fluvial processes.
Environment	Combination of physical, chemical, climatic and biotic conditions that influence the development, growth, structure and vigor of an organism, population or community.
Ephemeral	Short lived or transitory.
Ephemeral flows	Stream flows in channels that are short-lived or transitory and occur from precipitation, snow melt or short-term water releases.
Erosion	(1) Process of weathering or wearing away of streambanks and adjacent land slopes by water, ice, wind or other factors. (2) Removal of rock and soil from the land surfaces by a variety of processes including gravitational stress, mass wasting or movement in a medium.

F

Facultative	Capable of living under varying conditions.
Fecal	A bacteria "fecal coliform" that indicates feces has contaminated the water.
Fecal coliform	The portion of the coliform group of bacteria which is present in the intestinal tract of warmblooded animals and is evidence of the presence of human or animal wastes.
Fines	Particulate material, less than 2 mm in diameter, including sand silt, clay and fine organic material.

Fish habitat	Aquatic and riparian habitats that provide the necessary biological, chemical and physical (i.e., environmental) requirements of fish species at various life stages.
Flood plain	(1) Area adjoining a water body that becomes inundated during periods of overbank flooding and that is given rigorous legal definition in regulatory programs. (2) Land beyond a stream channel that forms the perimeter for the maximum probability flood. (3) Strip of land bordering a stream that is formed by substrate deposition. (4) Deposit of alluvium that covers a valley flat from lateral erosion of meandering streams and rivers.
Fluvial	Pertaining to or living in streams or rivers or produced by the action of flowing water.
Fork	The point at which a stream branches into two channels that may be of similar size and flow.
Free-flowing	Stream or stream reach that flows unconfined and naturally without impoundment, diversion, straightening, rip-rapping or other modification of the waterway.

G

Geomorphology	Study of the origin of landforms, the processes that form them, and their material composition.
Glide	A shallow stream reach with a maximum depth that is 5% or less of the average stream width, a water velocity less than 20 cm (8 in) per second and without surface turbulence.
Gradient	(1) General slope or the change in vertical elevation per unit of horizontal distance, of the water surface in a flowing stream. (2) Rate of change of any characteristic per unit of length.
Gravel	Substrate particle size between 2 and 64 mm (0.1 and 2.5 in.) In diameter.
Ground moraine	Thin deposits left underneath a retreating glacier that may have a gently rolling or hummock-like appearance.
Ground water	(1) Water located interstitially in the substrate of the earth that is recharged by infiltration and enters streams through seepage and springs. (2) Subsurface water in a zone of saturation, standing in or passing through (ground water flow) the soil and the underlying strata.

H

Habitat	Specific type of place within an ecosystem occupied by an organism, population or organism that contains both living and nonliving components with specific biological, chemical and physical characteristics including the basic life requirements of food, water and cover or shelter.
Habitat component	Single element (such as velocity, depth or cover) of the habitat or area where an organism lives or occurs. Component is synonymous with attribute.
Habitat diversity	Number of different types of habitat within a given area.

Hardness	Total concentration of calcium and magnesium ions expressed as milligrams per liter (mg/L) of calcium carbonate. Synonymous with total hardness.
Hardpan	A layer of earth that has become relatively hard and impermeable, usually through mineral deposits. A chemically hardened layer where the soil particles are cemented together with organic matter of SiO_2, sesquioxides or $CACO_3$.
Homogeneous	Refers to a waterbody that has a uniform chemical composition throughout.
Hummock	Rounded, undefined or chaotic pattern of steep-sided low hills and hollows.

I

Impermeable	Refers to a layer of material of sufficient composition, density, thickness that is does not permit passage of a liquid or a gas.
Impervious	Refers to material through which water cannot pass or passes with great difficulty.
Impoundment	Natural or artificial body of water that is confined by a structure such as a dam to retain water, sediment or wastes.
Indicator organisms	(1) Organisms that respond predictably to various environmental changes and whose presence, absence and abundance are used as indicators of environmental conditions. (2) Any plant or animal that, by its presence, its frequency or its vigor, indicates any particular property of a site.
Indigenous	A fish or other aquatic organism native to a particular water body, basin or region.
Indirect toxicity	Toxicity that affects organisms by interfering with their food supply or modifying their habitat instead of acting directly on the organisms.
Infiltration	(1) Process by which water moves from the earth or surface water into the ground water system. (2) Clean water that enters the wastewater treatment system through cracks in the pipes and/or equipment.
Inflow	(1) Location where water from one source enters another water body. Also, the movement of water from one source into another water body. (2) Clean water entering the wastewater treatment system through a direct connection.
Instream	Within the wetted perimeter of the stream channel.
Instream cover	Area with structure (e.g., boulders, rocks, logs, etc.) in a stream channel that provide aquatic organisms with shelter or protection from predators or competitors. Also a place with low water velocity where organisms can rest and conserve energy.
Intermittent	(1) Alternately starting and stopping. (2) Water that flows or exists sporadically or periodically.
Intermittent flow	Flows that occur at certain times of the year only when ground water levels are adequate but may cease entirely in low flow years or be reduced to a series of separated pools.

J

Jam	Wholly or partially submerged accumulation of woody debris from winds, water currents or logging activities that partially or completely blocks the stream channel and obstructs streamflow.

K

Kame	A ridge-like or hilly local glacial deposit of coarse alluvium formed as a delta at the front of glaciers by meltwater streams.

L

Leachate	Soluble substance that has been removed from other material by water percolation.
Lentic	An aquatic system with standing or slow flowing water (e.g., lake, pond, reservoir, swamp, marsh and wetland). Such systems have a non-directional net flow of water.
Loadings	The mass, typically in kilograms per day, of a pollutant delivered to stream.
Longitudinal profile	A plot of elevations with distances to depict stream channel characteristics.
Losing stream	Stream or stream reach that contributes water to the zone of saturation.
Lotic	Aquatic system with rapidly flowing water such as a brook, stream or river where the net flow of water is unidirectional from the headwaters to the mouth.
Low-head dam	A low barrier that is placed in a waterway to retain or redirect flows.

M

Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 0.595 mm (U.S. # 30) screen.
Macrophyte	A plant that can be seen without the aid of optics.
Main stem	Principal, largest or dominating stream or channel in any given area or drainage system.
Meander	Sinuous course of a river having specific geometric dimensions that describe the degree of curvature. More particularly, one curved portion of a sinuous or winding stream channel, consisting of two consecutive loops, one turning clockwise and the other counterclockwise.
Mean high water	Average height of the high water over 19 years.
Mean low water	Average height of the low water over 19 years.
Mesic	(Ecology) Moderately moist: said of a habitat.
Mitigation	(1) Action taken to alleviate or compensate for potentially adverse effects on aquatic habitat that have been modified through anthropogenic actions. (2) In-kind mitigation may be substituted for compensation to replace a resource that has been negatively impacted with a similar resource (e.g., a stream for a stream). (3) Out-of-kind mitigation refers to replacement of one resource with another (e.g., a lake for stream).

Moraine	Irregular, surficial deposit of sand, rock and debris left by a retreating glacier.
Morphology	Physical attributes of a waterbody and the methods for measuring those attributes.
Muck	Soft fine-grained soil composed of silt, clay or organic substrate material, typically dark in color, that consists of 20-50% highly decomposed organic matter with intermingled silt and clay.

N

Native species	Plant and animal species that occur naturally in aquatic and terrestrial habitats.
Nitrogenous	The nitrogen portion of the total biochemical oxygen demand in the wastewater.
Non-contact cooling water	Water that cools without coming into contact with the item to be cooled.
Nonpoint source	Usually applied to pollutants entering a waterbody in a diffuse pattern rather than from a specific, single location that includes land runoff, precipitation, atmospheric deposition or percolation.
Nutrient	Element or compound essential for growth, development and life for living organisms such as oxygen, nitrogen, phosphorus and potassium.
Nutrient cycling	Circulation of nutrient elements and compounds in and among the atmosphere, soil, parent rock, flora and fauna in a given area such as a water body.
Nutrient loading	Addition of nutrients into the water column via runoff, discharge, internal re-circulation, ground water or atmosphere.
Nutrient spiraling	Cycling and downstream transport of nutrients from physical and biological activities in a stream.

O

Organic debris	Material of organic origin that ranges in size from fine particulate matter large trees.
Organism	Any individual animal or plant having diverse organs and parts that function together as a whole to maintain life and its activities.
Outfall	Outlet of a water body, drain, culvert or other structure.
Overflow channel	Abandoned channel in a floodplain that carries water during periods of high runoff.
Overhang	Organic or inorganic materials that project over a waterbody.
Overhead cover	Plant foliage or overhanging material that provides protection to fish or other aquatic animals.

P

Parameter	Any quantitative characteristic that describes an individual, population or community or that describes the biological, chemical and physical components of an ecosystem.

Parent material	Unconsolidated (more or less) weathered material or organic matter from which soil is developed.
Particle	Individual fragment of organic or mineral material.
Particle size	Linear dimension, usually designated as "diameter," that characterizes the size of a particle.
Particle size distribution	Frequency distribution (expressed as d_n) of the relative amounts of particles in a sample that are within a specified size range or a cumulative frequency distribution of the relative amounts of particles that are coarser or finer than a specified size.
Peat	Unconsolidated, partially decomposed organic - mainly plant - material deposited under waterlogged, oxygen-poor conditions. A layer of organic material containing plant residues that have accumulated in a very wet environment.
Pebble	Small (2-64 mm.), gravel-sized stone with rounded edges, especially one smoothed by the action of water.
Perennial	Stream, lake or other water body with water present continuously during a normal water year.
Perennial flow	Flows that are continuous throughout the year.
Periphyton	Attached microflora growing on the bottom or on other submerged substrates, including higher aquatic plants.
Pesticide	Any chemical used to control populations of organisms that are undesirable to humans. The term "pesticide" is a generic term that is applied to chemicals used to control animals. More specific terms include "herbicide" (to control plants), "insecticide" (to control insect) and "lampricide" (to control sea lampreys).
pH	Measure of the acidity and alkalinity of a solution, expressed as the negative $\log_{10}$ of the hydrogen-ion concentration on a scale of 0 (highly acidic) to 14 (highly basic). A pH of 7 is neutral.
Plain	Any flat or gently sloping (elevation differences of less than 150 m [500 ft]) area formed from deposition of eroded substrates at low elevations and that may be forested or bare of trees.
Photosynthesis	The production of organic substances, chiefly sugars, from carbon dioxide and water occurring in green plant cells supplied with enough light to allow chlorophyll to aid in the transformation of the radiant energy into a chemical form.
Plankton	Small animals and plants, generally smaller than 2 mm and without strong locomotive ability, that are suspended in the water column and carried by currents or waves that may make daily or seasonal movements in the water column.
Polishing	Continued reduction of pollutants from the effluent.
Pool	Aquatic habitat in a stream with a gradient less than 1% that is normally deeper and wider than aquatic habitats immediately above and below it.
Point source	Any discernible, confined or discrete conveyance from which a pollutant is or may be discharged to the surface waters of the state.

Pollutant	Sewage, industrial waste or other waste as defined by divisions (B) to (D) of Section 6111.01 of the Revised Code.
Pollute	To contaminate land, water, air, plants, animals or microorganisms with substances considered objectionable or harmful to the health of living organisms.
Pollution	Presence of matter or energy, usually of human origin, whose nature, location or quantity produces undesired environmental effects on natural systems.
Pool	Small depression with standing water such as found in a marsh or on a floodplain. Aquatic habitat in a stream with a gradient less than 1% that is normally deeper and wider than aquatic habitats immediately above and below it.
Pretreatment	Wastewater that has been treated to reduce the pollutants, generally prior to reaching a wastewater treatment plant.
Protozoan	One type of microorganism(s) found within the biomass (sludge) that metabolizes the wastewater pollutants.

R

Receiving waters	The surface waters of the state into which point and nonpoint sources flow.
Relicts	(Geology) A physical feature, structure, etc. that remains after other components have wasted away or been altered.
Respiration	Process by which a living organism or cell takes in oxygen from the air or water, distributes and utilizes it in oxidation, and gives off products of oxidation, especially carbon dioxide.
Riffle	Shallow reaches with low sub-critical flow (1-4% gradient) in alluvial channels of finer particles that are unstable, characterized by small hydraulic jumps over rough bed material, causing small ripples, waves and eddies, without breaking the surface tension. Stable riffles are important in maintaining water level in the pool immediately upstream of the riffle.
Riparian area	(1) Of, pertaining to, situated or dwelling on the margin of a river or other water body. (2) Also applies to banks on water bodies where sufficient soil moisture supports the growth of mesic vegetation that requires moderate amount of moisture. Also referred to as riparian zone, riparian management area or riparian habitat.
Riparian vegetation	Vegetation growing on or near the banks of a stream or other waterbody that is more dependent on water than vegetation that is found further upslope.
Riprap	Hard materials, such as logs, rock or boulders (often fastened together) used to protect a bank or another important feature of a stream, lake, reservoir or other waterbody.
River	Large natural or human modified stream that flows in a defined course or channel or a series of diverging and converging channels.

River continuum	Ecological succession that occurs from the headwaters to the mouth in a river and that is associated with an increase in nutrients and organic matter.
Riverine (riverain)	(1) Habitats that are formed by or associated with a river or stream. (2) Wetlands and deeper water habitats within a channel that are influenced strongly by the energy of flowing water. (3) Also applied to vegetation growing in a floodplain, in close proximity to water courses with flowing water or on islands in a river.
Rootwad	Root mass from a tree. Synonymous with butt ends.
Run	Swiftly flowing stream reach with a gradient greater than 4%, little or no surface agitation, waves or turbulence, no major flow obstructions, approximately uniform flow, substrates of variable particle size, and water surface slope roughly parallel to the overall stream gradient.

S

(sic)	Used within brackets "[sic]," to show that a quoted passage, especially one containing some error or something questionable, is precisely reproduced.
Sludge	A concentration of biological organisms that metabolize the wastewater pollutants.
Solids	A small portion of the biomass or sludge.
Stream	Natural watercourse containing flowing water, at least part of the year, together with dissolved and suspended materials, that normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Storm event	Major episode of atmospheric disturbance that often is associated with heavy precipitation.

T

Terminal moraine	Geologic deposits at the front lobe or foot of a glacier that marks the furthest point reached by a glacier.
Threatened or endangered species	Those species of the state's biota which are threatened with statewide extirpation or national extinction, as listed in rule 1501:31-23-01 of the Administrative Code or 50 C.F.R. 17 or that are listed as endangered or threatened under section 4 of the Endangered Species Act, 16 U.S.C. 1531 *et seq.* (as amended).
Toxicity	Acute toxicity: Adverse effects that result from an acute exposure and occur within any short observation period which begins when the exposure begins and usually does not constitute a substantial portion of the life span of the organism. Chronic toxicity: Concurrent and delayed adverse effects that occur only as a result of a chronic exposure. Chronic exposure is exposure of an organism for any long period or for a substantial portion of its life span.

U

Uptake	The acquisition of a substance from the environment by an organism as a result of any active or passive process.
Use attainability analysis	A structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological and economic factors.

W

Wasting (sludge)	Removal of sludge from the treatment system to a holding tank, another treatment unit or another WWTP.
Water quality standards	The rules set forth in Chapter 3745-1 of the Administrative Code establishing stream use designations and water quality criteria protective of such uses for the surface waters of the state.
Warmwater fish	Those species of fish that inhabit relatively warmwater. These species include, but are not limited to, bass, crappies and sunfish (Centrachidae) and catfish (Ictaluridae), and may include certain suckers (Catostomidae), minnows (Cyprinidae) and perch and darter (Percidae) species.
Wastewater	Water that has been contaminated with pollutants.
Wetland	Areas of land where the water table is at, near or above the land surface long enough each year to result in the formation of characteristically wet (hydric) soil types and support the growth of water-dependent (hydrophytic) vegetation. Wetlands include, but are not limited to marshes, swamps, bogs and other such low lying areas.
Woody debris	Collection of materials in the water or substrate on the bank or shoreline that is primarily composed of wood.

Z

Zone of saturation	The soil zone that is located below the permanent water table.

A.10.3 Mechanisms for Water Quality Impairment

The following paragraphs present causes of impairment that were encountered during the 2001/2002 survey. While the various perturbations are presented separately, it is important to remember that they are often interrelated and cumulative in impact.

A.10.3.1 Habitat and Flow Alterations

Habitat alterations impact biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Habitat and flow alterations include channelization (the straightening and deepening of a stream) and the installation of field tiles to facilitate drainage. The removal of trees on the stream bank usually accompanies this action.

In tiled fields, after a rain event most of the water quickly drains rather than filtering through the soil and recharging the ground water and reaching the stream at a lower volume and more sustained rate. As a consequence, small streams in watersheds predominated by tiled fields more frequently go dry or become intermittent.

Shading of the stream channel by trees is important because it limits the amount of sunlight reaching the water's surface reducing instream photosynthesis (i.e., algal production) and reduces temperature swings of the water column. Removal of the riparian tree canopy 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 trap sediments 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 re-aeration of the stream and promotion of algal productivity. 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.

A.10.3.2 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 and permitted for the deposition of sediment outside of the 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 macroinvertebrates is reduced. Silt can also clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding sight 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 varied 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 adsorbed 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.

A.10.3.3 Nutrients

The element of greatest concern is phosphorus because it is critical for plant growth and it 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 great 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.

Phosphorus originates from both point and nonpoint sources of pollution. Most of the phosphorus discharged by point sources is soluble. Point sources, for example, municipal sewage treatment plants, tend to have a continuous impact on the streams that receive them. The contribution from failed on-lot septic systems can also be significant, especially if many are located in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l; after secondary treatment, generally 4-6 mg/l. Further removal requires the added cost of chemicals such as lime or alum to form a precipitate; most phosphorus (80%) ends up in the sludge. Phosphorus discharged by nonpoint sources is usually delivered intermittently; e.g., associated with storm water runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban storm water is more of a concern if combined sewer overflows are involved.

The impact from rural storm water 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 can be more pronounced in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels may also be affected because phosphorus is released from sediment at higher rates under anoxic (oxygen-starved) conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion stating that phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). An Ohio EPA study found significant correlation between phosphorus and the health of aquatic communities (Association Between Nutrients, Habitat and Aquatic Biota in Ohio Rivers and Streams, MAS/1999-1-1). Biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. The lowest phosphorus concentrations were associated with the highest quality habitats, indicating 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).

A.10.3.4 Organic Enrichment and Low Dissolved Oxygen

The amount of oxygen soluble in water is low and 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 quickly depleted unless it is replenished from the air. Sources of organic matter include inadequately treated waste water, sewage bypasses and 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 aquatic life use designations (Administrative Code 3745-1-07, Table 7-1).

A.10.3.5 Ammonia

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 (*Nitrosomonas*) and then to nitrate (*Nitrobacter*). Nitrate can then be reduced by the de-nitrification process (*Pseudomonas*) 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).

A.10.3.6 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 fetuses. 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.

A.10.3.7 Bacteria

High levels of indicator bacteria (fecal coliform and E. coli) in streams are a concern because of human health. People can be exposed to contaminated water while wading, swimming and fishing. Fecal coliform and E. coli 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 a skin rash, sore throat or ear infection to a more serious flu-like symptoms. Some types of bacteria that are a concern include *Escherichia*, which cause diarrhea and urinary tract infections, *Salmonella*, which can cause typhoid fever and gastroenteritis (food poisoning) and *Shigella*, which causes 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 (i.e., rain or snow storms). Animal sources are usually a more intermittent problem and are also associated with rainfall, except when 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 (i.e., applied on frozen ground or ground without vegetation to incorporate the nutrients) and it sometimes seeps into field tiles.

Bacterial 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 recreational 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, Part F).

A.10.3.8 Sediment Contamination

The 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 can cause skin cancer and tumors with sufficient exposure. 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 most physically, chemically and biologically reactive at the sediment-water interface because this is where it is affected by sunlight, current, wave action and benthic organisms. Assessment of the chemical nature of this layer can be used to predict ecological impact.

The Ohio EPA evaluation of sediment chemistry results are evaluated using a dual approach, first by ranking relative concentrations based on a system developed by Ohio EPA (1996) and then by determining the potential for toxicity based on guidelines developed by MacDonald *et al.* (2000). The Ohio EPA system was derived from samples collected at ecoregional reference sites. Classes are grouped in ranges that are based on the median analytical value (non-elevated) plus 1 (slightly elevated), 2 (elevated), 4 (highly elevated), and 8 (extremely elevated) inter-quartile values. The MacDonald guidelines are consensus-based using previously developed values. The system predicts that sediments below the threshold effect concentration (TEC) are absent of toxicity and those greater than the probable effect concentration (PEC) are toxic.

Sediment samples collected by Ohio EPA are measured for a number of physical and chemical properties. Physical attributes included % particle size distribution (sand $\geq$60 μ, silt 5-59 μ, clay $\leq$4 μ), % solids and % organic carbon. Due to the dynamics of flowing water, most streams do not contain a lot of sediment and samples often consist mostly of inert sand. This scenario changes if the stream is impounded by a dam or channelized. Chemical attributes measured include concentration of metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCBs).