APPENDIX C

IMPLEMENTATION AND REASONABLE ASSURANCES
LOWER LITTLE MIAMI RIVER WATERSHED

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C1 Agricultural Best Management Practices

Much of the following information was adapted from the National Resource Conservation Service (NRCS) Electronic Field Office Technical Guide (http://www.nrcs.usda.gov).

C1.1 Farmland

Cover/manure crops (NRCS 340)

DEFINITION: Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes.

PURPOSES
- Reduce erosion from wind and water.
- Increase soil organic matter content.
- Capture and recycle or redistribute nutrients in the soil profile.
- Promote biological nitrogen fixation.
- Increase biodiversity.
- Weed suppression.
- Provide supplemental forage.
- Soil moisture management.
- Reduce particulate emissions into the atmosphere.
- Minimize and reduce soil compaction.

Conservation tillage practices

NRCS 329: residue and tillage management – no till / strip till / direct seed
DEFINITION: Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

PURPOSES
This practice may be applied as part of a conservation system to support one or more of the following:
- Reduce sheet, rill and wind erosion.
- Improve soil organic matter content.
- Reduce soil particulate emissions.
- Reduce CO_2 losses from the soil.
- Increase or conserve plant-available soil moisture.
- Provide food and escape cover for wildlife.

NRCS 344: residue management, seasonal
DEFINITION: Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed.

PURPOSES
This practice may be applied as part of a conservation management system to support one or more of the following:

- Reduce sheet and rill erosion.
- Reduce soil erosion from wind and air soil particulates.
- Provide food and escape cover for wildlife.

NRCS 345: residue and tillage management – mulch till
DEFINITION: Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow crops in systems where the entire field surface is tilled prior to planting.

PURPOSES
This practice may be applied as part of a conservation system to support one or more of the following:

- Reduce sheet, rill and wind erosion.
- Reduce soil particulate emissions.
- Maintain or improve soil condition.
- Increase or conserve plant-available soil moisture.
- Provide food and escape cover for wildlife.

NRCS 346: residue and tillage management – ridge till
DEFINITION: Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while growing crops on pre-formed ridges alternated with furrows protected by crop residue.

PURPOSES
This practice may be applied as part of a conservation system to support one or more of the following:

- Reduce sheet, rill and wind erosion.
- Maintain or improve soil condition.
- Reduce soil particulate emissions.
- Modify cool, wet soil conditions.
- Provide food and escape cover for wildlife.

<u>Grass/legume rotations (NRCS 328: conservation crop rotation)</u>
DEFINITION: Growing crops in a recurring sequence on the same field.

PURPOSES
This practice may be applied as part of a conservation management system to support one or more of the following:

- Reduce sheet and rill erosion.
- Reduce soil erosion from wind.
- Maintain or improve soil organic matter content and tilth.
- Manage deficient or excess plant nutrients.
- Manage plant pests (weeds, insects, and diseases).
- Provide food for domestic livestock
- Provide food and cover for wildlife.

NRCS 590 (nutrient management) also discusses the use of certain crops to uptake residuals.

Permanent hayland (NRCS 512: pasture and hay planting)

DEFINITION: Establishing and re-establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants. (Includes pasture and hayland renovation. Does not include grassed waterway or outlet on cropland.)
PURPOSE
To reduce erosion, produce high quality forage and adjust land use.

Grassed waterways (NRCS 412)

DEFINITION: A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

PURPOSES
This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To convey runoff from water concentrations without causing erosion or flooding.
- To reduce gully erosion.
- To protect/improve water quality.

Vegetated buffer areas/strips and location-specific conservation buffers

NRCS 393: filter strips
DEFINITION: A strip or area of herbaceous vegetation situated between cropland, grazing land or disturbed land (including forest land) and environmentally sensitive areas.

PURPOSES

- To reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in runoff.
- To reduce dissolved contaminant loadings in runoff.
- To restore, create or enhance herbaceous habitat for wildlife and beneficial insects.
- To maintain or enhance watershed functions and values.

NRCS 391: riparian forest buffer
DEFINITION: An area of trees and/or shrubs located adjacent to and up-gradient from water bodies.

PURPOSES

- Create shade to low water temperatures to improve habitat for fish and other aquatic organisms.
- Provide a source of detritus and large woody debris for fish and other aquatic organisms and riparian habitat and corridors for wildlife.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.

The forest riparian buffer will be most effective when used as a component of a total resource management system including nutrient management, pest management, erosion, runoff and sediment control practices as well as non-riparian wildlife habitat management.

Wetlands

NRCS 656: constructed wetland
DEFINITION: An artificial ecosystem with hydrophytic vegetation for water treatment.

PURPOSE
- For treatment of wastewater and contaminated runoff from agricultural processing, livestock, and aquaculture facilities.
- For improving the quality improvement of storm water runoff or other water flows lacking specific water quality discharge criteria.

NRCS 657: wetland restoration
DEFINITION: The construction or restoration of a wetland facility to provide the hydrological and biological benefits of a wetland.

SCOPE: This practice applies to structural and nonstructural facilities as needed, to establish or restore wetlands.

PURPOSE
- To establish or reestablish wetlands for the benefit of wildlife, to reduce flooding, to provide off-site water quality benefits and to provide ground water recharge of acceptable water quality.

NRCS 658: wetland creation
DEFINITION: The creation of a wetland on a site that was historically non-wetland.

PURPOSE
- To create wetland functions and values.

NRCS 659: wetland enhancement
DEFINITION: The rehabilitation or re-establishment of a degraded wetland, and/or the modification of an existing wetland, which augments specific site conditions for specific species or purposes; possibly at the expense of other functions and other species.

PURPOSES
To provide specific wetland conditions to favor specific wetland functions and targeted species by:
- hydrologic enhancement (depth duration and season of inundation, and/or duration and season of soil saturation).
- vegetative enhancement (including the removal of undesired species, and/or seeding or planting of desired species).

C1.2 Nutrients / Agricultural Chemicals

Soil testing
Generally soil testing is included as part of a certified nutrient management plan.

NRCS 590: practice nutrient management
DEFINITION: Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

PURPOSES

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To maintain or improve the physical, chemical and biological condition of soil.

Nitrogen reduction practices

Generally nitrogen reduction is included as part of a certified nutrient management plan (see NRCS practice 590 above).

Nutrient management (NRCS 590)

See description of NRCS 590 above under "Soil Testing."

C1.3 Drainage

Install sinkhole stabilization structures (NRCS 527: sinkhole and sinkhole area treatment)

DEFINITION: The treatment of sinkholes and/or sinkhole areas to reduce contamination of ground water resources and/or improve farm safety.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- Improve water quality.
- Improve farm safety.

Controlled drainage system (NRCS 587: structure for water control)

See description of drainage water management (below).

Drainage water management (NRCS 554)

DEFINITION: Control of water surface elevations and discharge from surface and subsurface drainage systems.

PURPOSES

- Improve water quality.
- Improve the soil environment for vegetative growth.
- Reduce the rate of oxidation of organic soils.
- Prevent wind erosion.
- Enable seasonal shallow flooding.
- Prevent discharge of manure or nutrient laden water carried through subsurface drainage into waters of the State.

Construct overwide ditch (currently no NRCS practice established)

DEFINITION: Ditches are open channel conveyances used to provide outlets for surface and sub-surface drainage and to expedite downstream flow. An overwide ditch is a modified version of the traditional ditch in which the primary purpose is to develop and/or enhance floodplain

functions that are otherwise absent in drainage ditches. This is accomplished when the ditch is constructed or modified to be much wider than necessary to accommodate the typical design flow. This additional width is needed for sediment deposition that leads to the formation of small floodplain-like features termed benches.

PURPOSES

- Reduce stream power and channel erosion.
- Store sediment.
- Reduce need for more rigorous channel/riparian maintenance.
- Improve water quality.
- Improve flow conditions and habitat quality.

Construct 2-stage channel (currently no NRCS practice established)

DEFINITION: Ditches are open channel conveyances used to provide outlets for surface and sub-surface drainage and to expedite downstream flow. A two-stage ditch is a modified version of the traditional ditch in which the primary purpose is to provide floodplain functions that are otherwise absent in drainage ditches. This is accomplished by constructing a much wider channel than necessary to accommodate the typical design flow. Additionally, low benches that act like floodplains are also constructed. The primary difference between an overwide ditch and a two-stage ditch is that the overwide uses elements of self-design (*i.e.*, benches build themselves) while the two-stage is initially constructed with the benches. Overwide ditches may be more generally preferred to constructed two-stage ditches because performance in sequestering upland sediment loading and nutrient processing may be superior. Additionally, the use of self-design principles typically reduces the risk of failure or ineffectiveness of the system's performance.

PURPOSES

- Reduce stream power and channel erosion.
- Store sediment.
- Reduce need for more rigorous channel/riparian maintenance.
- Improve water quality.
- Improve flow conditions and habitat quality.

C1.4 Livestock

Prescribed grazing practices

NRCS 528A: prescribed grazing (also referred to as conservation grazing)
DEFINITION: Managing the harvest of vegetation with grazing and/or browsing animals.

PURPOSES
This practice may be applied as a part of conservation management system to achieve one or more of the following:

- Improve or maintain desired species composition and vigor of plant communities.
- Improve or maintain quantity and quality of forage for grazing and browsing animals' health and productivity.
- Improve or maintain surface and/or subsurface water quality and quantity.
- Improve or maintain riparian and watershed function.

- Reduce accelerated soil erosion, and maintain or improve soil condition.
- Improve or maintain the quantity and quality of food and/or cover available for wildlife.
- Manage fine fuel loads to achieve desired conditions.

Livestock exclusion fencing (NRCS 382)

DEFINITION: A constructed barrier to animals or people.

PURPOSES
This practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals and people, including vehicles. It includes:

- exclude livestock from areas that should be protected from grazing.
- control livestock where permanent fencing is installed as a component of a rotational grazing system.
- confine livestock on an area.
- control domestic livestock while permitting wildlife movement.
- regulate access to areas by people, to prevent trespassing, or for purposes of safety.

Livestock crossings (NRCS 578: stream crossing)

DEFINITION: A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.

PURPOSES

- Improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream.
- Reduce streambank and streambed erosion.
- Provide crossing for access to another land unit.

Alternative water supplies (NRCS 614: watering facility)

DEFINITION: A device (tank, trough, or other watertight container) for providing animal access to water.

PURPOSES
To provide watering facilities for livestock and/or wildlife at selected locations in order to:

- Protect and enhance vegetative cover through proper distribution of grazing.
- Provide erosion control through better grassland management.
- Protect streams, ponds and water supplies from contamination by providing alternative access to water.
- Provide improved watering places to increase the range or improve the habitat of wildlife.

Livestock access lanes (NRCS 560: access road)

DEFINITION: A roadway constructed as part of a conservation plan.

PURPOSE
To provide a fixed route of travel for moving livestock, produce, equipment, and supplies; and to provide access for proper operation, maintenance, and management of livestock or conservation enterprises while controlling runoff to prevent erosion or improve water quality.

C1.5 Manure

Implement manure management practices (NRCS 633: waste utilization)

DEFINITION: Using agricultural wastes such as manure and wastewater or other organic residues.

PURPOSES
- Protect water quality.
- Provide fertility for crop, forage, fiber production.
- To provide nutrients for the production of forest products.
- Improve or maintain soil structure.
- Provide feedstock for livestock.
- Provide a source of energy.

Animal waste storage structures (NRCS 313: waste storage facility)

DEFINITION: An impoundment made by constructing an embankment and/or excavating a pit, or by fabricating a manmade structure.

PURPOSE
To store or settle agricultural by-products in order to maximize their use as soil amendments in an environmentally safe manner.

Manure transfer practices (NRCS 634)

DEFINITION: A manure conveyance system using structures, conduits, or equipment.

PURPOSE
To transfer animal manure (bedding material, spilled feed, process and wash water, and other residues associated with animal production may be included) through a hopper or reception pit, a pump (if applicable), a conduit, or hauling equipment to:
- A manure storage/treatment facility.
- A loading area.
- Agricultural land for final utilization.

Grass manure spreading strips (NRCS 635: wastewater treatment strip)

DEFINITION: Conservation Cover is a component of an agricultural waste management system, consisting of an area of permanent vegetation used for agricultural wastewater treatment.

PURPOSE
To improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with animal manure and other contaminated runoff and process generated water from livestock, poultry, and other agricultural operations.

C1.6 Miscellaneous Infrastructure and Management

Install chemical mixing pads (NRCS 702: agrichemical handling facility)

DEFINITION: The Agrichemical Handling Facility (AHF) is a permanent structure providing an environmentally safe area for storage, handling and mixing of on-farm liquid agrichemicals, such as fertilizers and pesticides.

PURPOSE
To protect the environment by containing, collecting and storing on-farm agrichemicals during mixing, loading, unloading and rinsing operations.

Install heavy use feeding pads (NRCS 561: heavy use area protection)

DEFINITION: Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing needed structures. This standard also includes protecting areas used for livestock feeding and watering, loafing, exercising, or confinement by surfacing with suitable materials, and installing control structures, if necessary.

PURPOSE
This practice may be used as a part of a conservation management system to support one or more of the following resource concerns.

- Improve soil quality.
- Reduce soil erosion.
- Improve water quantity and quality.
- Stabilize pastures, feeding areas, loafing areas, exercise corrals, livestock traffic lanes or facility areas frequently or intensely used by livestock.
- Improve air quality.
- Improve aesthetics.

Install erosion & sediment control structures (NRCS 350: sediment basin)

DEFINITION: A basin constructed to collect and store debris or sediment.

PURPOSES

- To preserve the capacity of reservoirs, ditches, canals, diversions, waterways and streams.
- To prevent undesirable deposition on bottom lands and developed areas.
- To trap sediment originating from construction sites.
- To reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes and other detritus.

Install roof water management practices (NRCS 558)

DEFINITION: Structures that collect, control, and transport precipitation from roofs.

PURPOSES
This practice may be applied as a part of a resource management system to support one or more of the following purposes:

- Improve water quality.
- Reduce soil erosion.
- Increase infiltration.
- Protect structures.
- Increase water quantity.

Install milkhouse waste treatment practices (NRCS 591: amendments for treatment of agricultural waste)

DEFINITION: Treatment of manure, process wastewater, storm water runoff from lots or other high intensity areas, and other wastes, with chemical or biological additives.

PURPOSES
To alter the physical and/or chemical characteristics of the waste stream to facilitate the implementation of a waste management system to:

- Improve or protect air quality.
- Improve or protect water quality.
- Improve or protect animal health.
- Alter the consistency of the waste stream to facilitate implementation of a waste management system.

Develop whole farm management plans (NRCS-NEDC-000019: Conservation Planning)

DEFINITION: Apply the current NRCS conservation planning policy, the procedures and guidelines in the National Planning Procedures Handbook, the supporting technology and tools to carry out the planning process, and the locally-led concept for managing farmland.

PURPOSE: Assist clients in developing complete, comprehensive, conservation plans considering all of the resources (soil, water, air, plants, and animals) and the human concerns (economic and social) so as to make decisions that result in conservation plans that protect, conserve, and enhance the resources.

C1.7 BMP Effectiveness

Potential effectiveness of various best management practices applicable

BMP	Description and Removal Mechanism	Estimated Removal Rate			
		Sediment/ TSS	TN	TP	Fecal
Nutrient management plan	Site specific guidance on appropriate fertilization rates, methods of application, and timing. Appropriate application rates for optimized crop yield reduce loading from excessive nutrient application.	Minimal	Minimal based on SWAT modeling	Approximately 20 percent based on SWAT modeling	Minimal
Conservation tillage	Reduced tillage practice with a minimum of 30 percent cover of crop residuals. Reduces erosion rates and phosphorus losses. Increases soil quality by providing organic material and nutrient supplementation.	75 to 88 percent reduction in soil loss rates [1; 2, respectively]	Minimal based on SWAT modeling	30 to 40 percent based on SWAT modeling	Minimal

BMP	Description and Removal Mechanism	Estimated Removal Rate			
		Sediment/ TSS	TN	TP	Fecal
Manure composting	Composting is the biological decomposition and stabilization of organic material. The process produces heat that, in turn, produces a final product that is stable, free of pathogens and viable plant seeds, and can be beneficially applied to the land.	Application of composted manure improves soil infiltration and reduces sediment loss by 68 percent [3]	30 to 75 percent due to volatization that occurs during storage	Minimal	Reductions of up to 99% in fecal coliform concentrations have resulted from composted manure [4]
Providing alternative sources of water for cattle	Providing water sources for cattle away from streams. Reduces streambank trampling and deposition of fecal matter in the stream.	90 percent reduction in direct deposition of fecal matter [1]	90 percent reduction in direct deposition of fecal matter [1]	90 percent reduction in direct deposition of fecal matter [1]	90 percent reduction in direct deposition of fecal matter [1]
Cattle exclusion from streams	Placement of fencing between the cattle grazing area and stream channel. Reduces streambank trampling and deposition of fecal matter in the stream.	Theoretically, 100 percent reduction in direct deposition of fecal matter	15 percent reduction in nitrogen loading [1]	15 percent reduction in phosphorus loading [1]	Theoretically, 100 percent reduction in direct deposition of fecal matter
Grazing land protection	Use of cover crop or rotational grazing patterns to maximize ground cover and reduce soil compaction.	88 percent reduction in sediment loading assuming increased ground cover from 60 percent to 95 percent [5]	60 percent reduction in nitrogen loading [1]	49 to 60 percent reduction in phosphorus loading [1]	29 to 46 percent reduction in fecal coliform loading [1]
Precision feeding	Feeding strategies designed to reduce nitrogen (N) and phosphorus (P) losses include more precise diet formulation, enhancing the digestibility of feed ingredients, genetic enhancement of cereal grains and other ingredients resulting in increased feed digestibility, and improved quality control.	Minimal	20 to 30 percent reduction in nitrogen loading [6]	20 to 30 percent reduction in phosphorus loading [6]	Not Available
Controlled drainage	This practice involves placing simple water control structures at various locations in the tiling system to raise the water elevation. Decreases in nitrate losses have been attributed primarily to reductions in the volume of water drained and, to a somewhat lesser extent, by increased denitrification in the soil. If managed properly, controlled drainage has the potential to improve crop yields by making more water available to plants.	Minimal	40 to 50 percent reduction in nitrogen loading compared to conventionally drained fields	Minimal	Minimal

BMP	Description and Removal Mechanism	Estimated Removal Rate			
		Sediment/ TSS	TN	TP	Fecal
Cover crop	Use of ground cover plants on fallow fields. Reduces erosion, provides organic materials and nutrients to soil matrix, reduces nutrient losses, suppresses weeds, and controls insects.	88 percent reduction in soil erosion [3]	30 percent reduction in nitrogen loading rates [5]	70 to 85 percent removal of total phosphorus [3]	Variable
Filter strips	Placement of vegetated strips in the path of field drainage to treat sediment and nutrients.	60 to 65 percent reduction in sediment [1]	70 percent reduction in total nitrogen [1]	~ 65 percent removal of total phosphorus [7; 8]	55 percent reduction in fecal coliform [1]
Grass swales	A runoff conveyance that provides storage for approximately 24 hours. Removes pollutants by sedimentation and plant uptake. Reduces peak flow velocities and subsequent erosion.	93 percent reduction of TSS [7]	92 percent removal of total nitrogen [7]	83 percent removal of total phosphorus [7]	Minimal
Conservation Easements	Conversion of highly erodible land or land near nutrient sensitive waterbodies to grass or forest cover. Reduces loading rates to natural conditions.	98 percent reduction in sediment loading rates [5]	92 percent reduction in nitrogen loading rates [5]	90 percent reduction in phosphorus loading rates [5]	Variable impacts depending on presence of cattle and wildlife in the area
Restoration of Riparian Buffers	Conversion of land adjacent to stream channels to vegetated buffer zones. Removes pollutants by sedimentation and plant uptake. Provides stream bank stability, stream shading, and aesthetic enhancement.	97 percent removal of sediment from treated area, assuming a 90 ft buffer width [9]	80 percent removal of total nitrogen from treated area, assuming a 90 ft buffer width [9]	78 percent removal of total phosphorus from treated area, assuming a 90 ft buffer width [9]	Variable impacts depending on presence of cattle and wildlife in the area
Proper use of onsite wastewater disposal systems.	Includes periodic maintenance (e.g., pumping every 3 to 5 years) and inspection of all onsite wastewater disposal systems in the watershed. Requires immediate repairs (or replacement) of malfunctioning systems as well as disconnection of direct discharges to tile drainage systems.	Variable depending on the degree and type of failure as well as type of onsite system used	Variable depending on the degree and type of failure as well as type of onsite system used	Variable depending on the degree and type of failure as well as type of onsite system used	Variable depending on the degree and type of failure as well as type of onsite system used

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C2 Acid Mine Drainage Abatement

Active treatment technologies (such as limestone dosing and limestone dumping) address pH problems; however, they traditionally do not address metal precipitants. In addition, active treatments usually require routine operation and maintenance at minimum to restock the neutralizing agent. Passive treatment techniques, on the other hand, are designed to be more self-sufficient and are typically designed for a 20-30 year project life. Examples include anaerobic wetlands and open limestone channels. Unlike active treatments, passive treatments require minimal operation and maintenance and are designed to eliminate precipitating metals in addition to raising pH. General descriptions of remediation technologies are described below.

- Limestone Dosing (Active): A process where limestone is introduced into a stream in regular increments. The limestone particles may be in a large hopper or from a plant-type operation. The doser can be electric or water-driven. Maintenance, weather, regular access, vandalism, and the lack of variability in dosing are concerns. While dosing can be effective treatment for low pH, dosing does not address metal precipitants.

- Limestone Dumping (Active): Similar to limestone dosing where limestone fines are added directly into a stream. Unlike dosing where the limestone is released incrementally, limestone dumping is when an entire truck's worth of limestone is literally dumped into the stream. Additional limestone is dumped after the previous dump has dissolved.

- Anoxic Limestone Drain (ALD) (Passive): An ALD is an adequately-sized buried channel containing limestone that is designed to limit oxygen contact with the mine discharge. An ALD requires relatively low metal concentration and low dissolved oxygen. Typically, an ALD is used in conjunction with aeration and a wetland system of settling ponds to allow for metal precipitation reactions. If the acidity or dissolved oxygen is very high, pretreatment may be provided by a compost wetland to reduce one or both of these parameters.

- Compost or Anaerobic Wetland (Passive): The wetlands are usually 1 to 6 acres in size. Some limestone can be added to the organics. A compost wetland generates alkalinity through a combination of bacterial activity and limestone dissolution. In some cases, an aerobic settling pond may be needed for metal precipitation reactions before the compost wetland.

- Aerobic Wetland (Passive): The wetlands are usually 1 to 6 acres in size. It typically requires pretreatment such as an ALD to raise the pH above 4. Aerobic wetlands are

typically designed to promote precipitation of iron hydroxide and thus often require periodic dredging.

- Open Limestone Channels (OLC) (Passive): An adequately sized open channel containing large limestone that carries and treats the mine discharge. Sizing takes into account expected armoring (from metal precipitation). The OLC must be on a fairly steep slope (greater than 10 percent) to ensure sufficient amount of oxygen necessary to precipitate metals and to transport the metal precipitates down the channel. An OLC is suited for AMD with high dissolved oxygen and metal concentrations and low pH.

- Successive Alkalinity Producing Systems (APS or SAPS) (Passive) combine the use of an ALD and an anaerobic wetland. Oxygen concentrations are often a design limitation for ALDs. They are generally ineffective where dissolved oxygen (DO) concentrations are greater than 1 or 2 mg/l. In situations where the DO concentrations are above 1 or 2 mg/l, the water can be introduced into a pond. In APS and SAPS, a drainage system is installed in the bottom of the pond. The drainage pipes are overlain by limestone that is then overlain by organic material. Four to eight feet of water are ponded on top of the organic layer. The principle is to introduce the semiaerated water into the pond and cause the water to move down through the organic matter to filter out ferric iron or reduce it by microbial iron reduction to ferrous iron. The reduced water then continues downward into the limestone, picking up additional alkalinity by limestone dissolution. The water then discharges through the drainage system in the bottom of the pond, having a pH of 6.0 and a much higher level of alkalinity in the water. The treated water is then aerated and the metals precipitate in a sedimentation pond, aerobic wetland, or anaerobic wetland.

- Limestone Ponds (LSPs) (Passive): LSPs are a new passive treatment idea in which a pond is constructed at the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond and the water flows upward through the limestone.

- Limestone Leach Bed (LLB) (Passive): The purpose of these leach beds is to provide alkalinity to fresh water streams upstream of any AMD sources.

- Slag Leach Beds (SLB) (Passive): Steel-making slags are often locally available in large quantities at low cost. When fresh, they have neutralization potentials ranging from 45 to 90 percent. Studies indicate that columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate (>1,000 mg/l as $CaCO_3$). Steel slag can be used as an alkaline amendment as well as a medium for alkaline recharge trenches. Slags are produced by a number of processes so care is needed to ensure that candidate slags are not prone to leaching metal ions such as Cr, Mn, Ni, or Pb.

- Diversion (Passive): Diverting surface water upstream of AMD sites to decrease the amount of water entering the mined area is highly recommended in acid-producing areas. Channeling surface waters or mine waters to control volume, direction, and contact time can be used to minimize the effects of AMD on receiving streams. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the site before infiltration occurs, or to limit its movement into the backfill. The diversion is accomplished either by ditching on the

uphill side of surface mines or by providing impervious channels for existing surface streams to convey water across the disturbed area.

Alternatively, pyritic material can be placed where it will be rapidly and permanently inundated, thereby preventing or minimizing oxidation of acid-forming materials. Inundation is recommended only where a water table may be reestablished to cover acid-producing materials (such as below drainage deep mines) and has not been recommended for surface mined lands or above drainage deep mines in the mountainous Appalachian United States region. Complete inundation has been used successfully in other areas where acid-producing materials are submerged in lakes or other permanent impoundments. Other methods of water management involve alkaline loading of water upgradient of mined areas to buffer the effects of subsequent acid water, and alkaline loading of the backfill with structured alkaline recharge systems.

- Inundation (Saturation) (Passive): The physical restriction of waters by constructing impoundments within an isolated area of a surface mine has been used to minimize or eliminate AMD. Inundation of acid-producing materials may be a less expensive reclamation technique in some areas than traditional reclamation by backfilling and planting, although the latter are typically required by law. Improvements in the quality of impounded waters flowing from acid areas have not always been the result. While pH has not always shown marked improvement, there has been some reduction in total acid and iron. Even in the less satisfactory cases, the drainage has had a less deleterious effect on downstream water quality than that from unreclaimed areas. The creation of an impoundment in the final cut of a surface mine not only lowers the cost of reclamation, but also has several other advantages. It forms recreation areas, aids in recharging the water table in the local area, and can eliminate or greatly reduce the amount of pollution from AMD and silt. By carefully designing the impoundment size and depth so the body of water formed will cover all acid-producing and carbonaceous materials, and also completely flood any intercepted deep mine workings or auger mining holes, the pyrite oxidation process will be stopped and thus the formation of acid will cease. Field studies have confirmed this action, and have also shown that the resulting impoundment quickly flushes the oxidized acid salts from the contacted area and produces a body of water of near neutral to alkaline quality.

- Underground Mine Sealing (Passive): Deep mine sealing is defined as closure of mine entries, drifts, slopes, shafts, boreholes, barriers, outcrops, subsidence holes, fractures, and other openings into underground mine complexes. Deep mine seals are constructed to achieve one or more functional design goals including (1) eliminate potential access to the abandoned mine works following closure; (2) minimize AMD production by limiting infiltration of air and water into the deep mine; (3) minimize AMD production by maximizing inundation of the mine works; (4) minimize AMD exfiltration through periphery barriers to surface water systems; and (5) develop staged internal mine pools to regulate maximum hydraulic head and pressure.

- Low Head Dams (Passive): The purpose of these low head dams is to aerate the stream and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The limestone, or any other non-acid producing rock, used to build these dams should have a diameter no less than 20% of the total stream width.

- Stream Subsidence Closures (Passive): The goal of stream subsidence closure is to restore positive drainage to the stream and reduce AMD generation by preventing contact between

stream water and pyritic minerals. Restoring positive drainage to the affected streams will improve the long-term performance of the other AMD treatment systems and should reduce human and animal hazards.

C3 Voluntary Storm Water Best Management Practices

The Ohio Department of Natural Resources (ODNR) developed a manual to describe in detail storm water practices that result in improved water quality: the *Rainwater and Land Development Manual* (2006 Edition). In many cases, practices listed below or examples of practices under some categories can be explored in more detail in the ODNR Rainwater Manual (http://www.dnr.state.oh.us/tabid/9186/default.aspx#Manual).

C3.1 Planning

Local comprehensive land use plan
Comprehensive land use planning is specialized planning that deals with how land is used in the planning area. A comprehensive land use plan addresses housing, utilities, transportation, economic growth and agricultural, natural, and cultural resources. It sets goals for development and preservation, helping to promote balanced growth. There are multiple reasons to utilize comprehensive land use planning locally:

- It provides legal justification for zoning laws.
- It helps a community define itself.
- In the face of growth, it can help a community maintain the character or quality of life desired by residents.
- In the face of population decline, it can help a community inventory its assets and serve as a springboard for economic development strategy.
- It gives a community the power to chart its own future.
- It can help leverage federal grant dollars.
- It provides a critical link between land use and water quality.

Local ordinances/resolutions
A local ordinance is a law enacted by the legislative body of a village or a municipality, and usually found in a municipal code. These laws are enforced locally in addition to state law and federal law. In counties and townships, the equivalent is a resolution. A resolution is a written motion adopted by a deliberative body. The substance of the resolution can be anything that can normally be proposed as a motion. Both ordinances and resolutions can be used locally to plan for future development in ways that will help protect water resources. Possible ordinances/resolutions include: an illicit discharge ordinance and/or home sewage treatment system rules that prevent non-storm water connections to storm sewer systems and surface waters unless covered by an NPDES permit; a construction site ordinance that ensures the use of sediment and erosion controls during construction; a riparian/wetland setback resolution that requires structures and certain land uses be kept back a certain distance from waterbodies in order maintain their function; or post construction storm water ordinances that require runoff treatment for water quality and encourage low impact development techniques or compact development. For further information on these practices and model ordinances, please see Cleveland State University's Countryside Program (http://urban.csuohio.edu/planningcenter/countryside/) and the Ohio Lake Erie Commission's Balanced Growth Program (http://www.lakeerie.ohio.gov/BalancedGrowth.aspx).

C3.2 Construction Practices

Erosion controls
Erosion controls are practices that prevent the transport of soil by wind or water. Typically they function by providing cover or by slowing the velocity of wind and/or water. Examples may be maintaining riparian areas, phasing earthwork to limit the amount of exposed soil at any given time, applying a temporary cover of mulch, seeding with mulch, installing stone check dams, or installing velocity dissipation devices at storm water outfalls. Information on these and other erosion control practices can be found in ODNR's Rainwater and Land Development Manual.

Sediment controls
Sediment controls are structural (physically engineered and created) controls that remove sediment once it has become suspended in runoff. Typically the removal mechanism is settling, but it may include chemical treatment and/or filtration. Information on specific practices, such as sediment settling ponds, silt fence, filter socks, and inlet protection, and their design can be found in ODNR's Rainwater and Land Development Manual.

Non-sediment controls
Non-sediment controls prevent or reduce the presence of pollutants other than sediment (e.g., metals, oils, organic/inorganic chemicals) in storm water discharges. They may be structural or non-structural best management practices (BMPs). For construction sites, examples are: secondary containment around fuel tanks and other liquid storage areas, rinse pits to collect and contain concrete rinse water, covered dumpsters, and a strong spill response plan.

C3.3 Post-Construction Storm Water Management Practices

Post-construction controls are permanent controls that are constructed while a facility is being built. They are installed to perpetually manage pollutants in the runoff that occurs after construction activities cease and the facility assumes its intended land use. They also address impacts to the receiving waters' morphology and hydrology. The goal is to protect the physical, biological, and chemical characteristics of those water resources receiving storm water discharges. This is achieved through the use of treatment and flow/volume management controls.

Treatment controls
Storm water treatment controls are practices that are designed to remove pollutants from runoff. Often this is accomplished through physical and biological processes. Chemical treatment is also possible but may require an NPDES permit for the discharge. Common controls are: bioretention cells/rain gardens, water quality swales, sand filters, infiltration trenches and hydrodynamic separators. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

Flow/volume management controls
Flow/volume management controls are BMPs that manage runoff frequency, volume, and energy to protect water resources. Runoff flow/volume may be used as a surrogate parameter for some pollutants of interest. In this approach, pollutant reduction is achieved by decreasing the amount of runoff generated and by providing extended detention to reduce downstream erosive energy. Runoff reduction is achieved by reducing the amount of imperviousness, encouraging infiltration and evapotranspiration. Extended detention is provided for the water quality volume generated during each storm. Examples of runoff reduction controls include disconnecting impervious surfaces, maintaining the natural hydrology, using rain barrels,

encouraging infiltration by directing flow to vegetated areas or infiltration trenches, and providing riparian setbacks. Controls that provide extended detention when designed properly include bioretention cells, water quality swales, and retention ponds with extended detention. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

C3.4 Post-Development / Storm Water Retrofit

Post-development/storm water retrofit controls are permanent improvements made at existing sites where storm water management for water quality purposes is absent or poor. They are installed to manage pollutants in the runoff that occurs while a facility continues its intended land use. Often, there are opportunities to improve water quality at existing facilities. They can be as simple as re-establishing vegetation or a riparian area, adding extended detention to an existing storm water basin, or something a little more elaborate such as making curb cuts and placing a bioretention area in a parking lot island or a cul-de-sac.

Erosion controls
Erosion controls are practices that prevent the transport of soil by wind or water. Typically they function by providing cover or by slowing the velocity of wind and/or water. In the post-development context, examples may be: establishing vegetation on bare areas, installing porous pavement on a dirt parking lot, covering erodible materials, laying stone drive in equipment traffic areas, diverting flow around erodible areas, and using stone aprons or level spreaders at outfalls.

Non-sediment controls
Non-sediment controls prevent or reduce the presence of pollutants other than sediment (e.g., metals, oils, organic/inorganic chemicals) in storm water discharges. They may be structural or non-structural BMPs. Examples include: secondary containment around liquid material storage, covered material/waste storage, dumpster management, a strong spill response plan, a pesticide/fertilizer application plan, good housekeeping and routine maintenance activities.

Treatment controls
Storm water treatment controls are practices that are designed to remove pollutants from runoff. Often this is achieved through physical and biological processes. Chemical treatment is also possible but may require an NPDES permit for the discharge. Common controls are: bioretention cells/rain gardens, water quality swales, retention ponds with extended detention, sand filters, infiltration trenches, and hydrodynamic separators. Many of these practices function to remove sediment as well. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

Flow/volume management controls
Flow/volume management controls are BMPs that manage runoff frequency, volume, and energy to protect water resources. Runoff flow/volume may be used as a surrogate parameter for some pollutants of interest. In the flow/volume management approach, pollutant reduction is achieved by decreasing the amount of runoff generated and by providing extended detention to reduce downstream erosive energy. Runoff reduction is accomplished by restoring pervious surfaces, encouraging infiltration and evapotranspiration. Extended detention is provided for the water quality volume generated by each storm. Examples of runoff reduction controls include: disconnecting impervious surfaces, using rain barrels, encouraging infiltration by directing flow to vegetated areas or infiltration trenches, and providing riparian setbacks. Controls that provide extended detention when designed properly include bioretention cells, water quality

swales and retention ponds with extended detention. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

C4 Regulatory Storm Water Best Management Practices

C4.1 Planning

Local ordinances/resolutions
A local ordinance is a law enacted by the legislative body of a village or a municipality, and usually found in a municipal code. These laws are enforced locally in addition to state law and federal law. In counties and townships, the equivalent is a resolution. A resolution is a written motion adopted by a deliberative body. The substance of the resolution can be anything that can normally be proposed as a motion. Both ordinances and resolutions can be used locally to plan for future development in ways that will help protect water resources. Possible ordinances/resolutions include: an illicit discharge ordinance and/or home sewage treatment system rules that prevent non-storm water connections to storm sewer systems and surface waters unless covered by an NPDES permit; a construction site ordinance that ensures the use of sediment and erosion controls during construction; a riparian/wetland setback resolution that requires structures and certain land uses be kept back a certain distance from waterbodies in order maintain their function; or post construction storm water ordinances that require treatment for water quality or encourage low impact development techniques or compact development. For further information on these practices and model ordinances, please see Cleveland State University's Countryside Program (http://urban.csuohio.edu/planningcenter/countryside/) and the Ohio Lake Erie Commission's Balanced Growth Program (http://www.lakeerie.ohio.gov/BalancedGrowth.aspx).

Water quality management/208 plans
Ohio EPA oversees the State Water Quality Management (WQM) Plan. The State WQM Plan is like an encyclopedia of information used to plot and direct actions that abate pollution and preserve clean water. A wide variety of issues is addressed and framed within the context of applicable law and regulations.

C4.2 Construction Practices

Permits and permit limits
National Pollutant Discharge Elimination System (NPDES) permit coverage is required for storm water discharges from construction activities that will (collectively) disturb one acre or more in the total common plan of development or sale. Sites may be covered by either an individual or general NPDES permit. Most sites are covered by the statewide NPDES Construction General Permit. The permit outlines a minimum set of best management practices that are appropriate to protect water quality during most construction activities. In situations where the conditions of the site or of the receiving waters require different controls to protect or restore water quality, an individual or watershed-specific NPDES permit may be issued.

Erosion controls
Erosion controls are practices that prevent the transport of soil by wind or water. Typically they function by providing cover or by slowing the velocity of wind and/or water. Examples may be maintaining riparian areas, phasing earthwork to limit the amount of exposed soil at any given time, applying a temporary cover of mulch, seeding with mulch, installing stone check dams, or

installing velocity dissipation devices at storm water outfalls. Information on these and other erosion control practices can be found in ODNR's Rainwater and Land Development Manual.

Sediment controls
Sediment controls are structural (physically engineered and created) controls that remove sediment once it has become suspended in runoff. Typically the removal mechanism is settling, but it may include chemical treatment and/or filtration. Information on specific practices, such as sediment settling ponds, silt fence, filter socks, and inlet protection, and their design can be found in ODNR's Rainwater and Land Development Manual.

Non-sediment controls
Non-sediment controls prevent or reduce the presence of pollutants other than sediment (e.g., metals, oils, organic/inorganic chemicals) in storm water discharges. They may be structural or non-structural BMPs. For construction sites, examples are secondary containment around fuel tanks and other liquid storage areas, rinse pits to collect and contain concrete rinse water, covered dumpsters, and a strong spill response plan.

C4.3 Post-Construction Storm Water Management Practices

Post-construction controls are permanent controls that are constructed while a facility is being built. They are installed to perpetually manage pollutants in the runoff that occurs after construction activities cease and the facility assumes its intended land use. They also address impacts to the receiving waters' morphology and hydrology. The goal is to protect the physical, biological, and chemical characteristics of those water resources receiving storm water discharges. This is achieved through the use of treatment and flow/volume management controls.

Permits and permit limits
NPDES permit coverage is required for storm water discharges from construction activities that will (collectively) disturb one acre or more in the total common plan of development or sale. Sites may be covered by either an individual or general NPDES permit. Most sites are covered the statewide NPDES Construction General Permit. The permit outlines a minimum set of post-construction storm water management practices appropriate to protect water quality and their design criteria. In situations where the conditions of the site or of the receiving waters require different controls to protect or restore water quality, an individual or watershed specific NPDES permit may be issued.

Treatment Controls
Storm water treatment controls are practices that are designed to remove pollutants from runoff. Often this is accomplished through physical and biological processes. Chemical treatment is also possible but may require a separate NPDES permit and permit to install for the treatment system and discharge. Common controls are retention ponds with extended detention, bioretention cells/rain gardens, water quality swales, sand filters, oil/water separators infiltration trenches and hydrodynamic separators. Information on the use of some of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

Flow/volume management controls
Flow/volume management controls are BMPs that manage runoff frequency, volume, and energy to protect water resources. Runoff flow/volume may be used as a surrogate parameter for some pollutants of interest. In this approach, pollutant reduction is achieved by decreasing the amount of runoff generated and by providing extended detention to reduce downstream

erosive energy. Runoff reduction is achieved by reducing the amount of imperviousness, encouraging infiltration and evapotranspiration. Extended detention is provided for the water quality volume generated during each storm. Examples of runoff reduction controls include disconnecting impervious surfaces, maintaining the natural hydrology, using rain barrels, encouraging infiltration by directing flow to vegetated areas or infiltration trenches, and providing riparian setbacks. Controls that provide extended detention when designed properly include bioretention cells, water quality swales, and retention ponds with extended detention. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

C4.4 Post-Development / Storm Water Retrofit

Post-development/storm water retrofit controls are permanent improvements made at existing sites where storm water management for water quality purposes is absent or poor. They are installed to manage pollutants in the runoff that occurs while a facility continues its intended land use. Often, there are opportunities to improve water quality at existing facilities. They can be as simple as re-establishing vegetation or a riparian area, adding extended detention to an existing storm water basin, or something a little more elaborate, such as making curb cuts and placing a bioretention area in a parking lot island or a cul-de-sac.

Permits and permit limits
Post-development runoff may be addressed through an NPDES permit for storm water discharges associated with industrial activities or with Municipal Separate Storm Sewer Systems (MS4s). The director may also designate for NPDES permit coverage dischargers that impair or have the potential to significantly impact water quality. In situations where the conditions of the site or of the receiving waters require different or additional controls to protect or restore water quality, a facility may be required to obtain individual NPDES permit coverage, monitor discharges, meet permit limits, meet benchmarks (action levels), or implement additional BMPs.

Erosion controls
Erosion controls are practices that prevent the transport of soil by wind or water. Typically they function by providing cover or by slowing the velocity of wind and/or water. In the post-development context, examples may be establishing vegetation on bare areas, installing porous pavement on a dirt parking lot, covering erodible materials, laying stone in equipment traffic areas, diverting flow around erodible areas, using stone aprons or level spreaders at outfalls.

Non-sediment controls
Non-sediment controls prevent or reduce the presence of pollutants other than sediment (e.g., metals, oils, organic/inorganic chemicals) in storm water discharges. They may be structural or non-structural BMPs. Examples include secondary containment around liquid material storage, covered material/waste storage, dumpster management, a strong spill response plan, a pesticide/fertilizer application plan, and good housekeeping and routine maintenance activities.

Treatment controls
Storm water treatment controls are practices that are designed to remove pollutants from runoff. Often this is achieved through physical and biological processes. Chemical treatment is also possible but may require a separate NPDES permit and a permit to install for the discharge. Common controls are bioretention cells/rain gardens, water quality swales, retention ponds with extended detention, sand filters, infiltration trenches, and hydrodynamic separators. Many of

these practices function to remove sediment as well. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

Flow/volume management controls

Flow/volume management controls are BMPs that manage runoff frequency, volume, and energy to protect water resources. Runoff flow/volume may be used as a surrogate parameter for some pollutants of interest. In the flow/volume management approach, pollutant reduction is achieved by decreasing the amount of runoff generated and by providing extended detention to reduce downstream erosive energy. Runoff reduction is accomplished by restoring pervious surfaces, encouraging infiltration and evapotranspiration. Extended detention is provided for the water quality volume generated by each storm. Examples of runoff reduction controls include disconnecting impervious surfaces, restoring natural hydrology, using rain barrels, encouraging infiltration by directing flow to vegetated areas or infiltration trenches, and providing riparian setbacks. Controls that provide extended detention when designed properly include bioretention cells, water quality swales, and retention ponds with extended detention. Information on the use of these and other BMPs can be found in ODNR's Rainwater and Land Development Manual.

Reduce volume and pollutant loading to CSOs

Combined sewers were built to collect sanitary and industrial wastewater, as well as storm water runoff, and transport this combined wastewater to treatment facilities. During dry weather and small wet weather events (*i.e.*, rainfall and snowmelt), combined sewers are designed to transport all flows to a treatment plant. During larger wet weather events the volume of storm water entering the combined sewer system may exceed the capacity of the combined sewers or the treatment plant. When this happens, combined sewers are designed to allow a portion of the untreated combined wastewater to overflow into the nearest ditch, stream, river or lake. This prevents the rupturing of pipes, backing up of sewage into basements, and/or flooding of streets. The locations where these discharges of untreated combined wastewater occur, as well as the discharge events themselves, are known as combined sewer overflows (CSOs).

CSOs contain not only storm water but also untreated human and industrial waste, toxic materials, and debris. This is a major water pollution concern for cities with combined sewer systems. CSOs are among the major sources responsible for beach closings, shellfishing restrictions, aesthetic impairments and other water body impairments. Additionally, contact with discharges from CSOs can have adverse effects on human health.

Storm water BMPs (such as flow/volume reduction, extended detention and treatment controls) can be used in cities with combined sewers to reduce the frequency of CSO discharges and overflow pollutant levels.

C5 Reasonable Assurances

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

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

C5.1 Ohio EPA

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

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

Combined Sewer Overflow Program
Ohio EPA implements CSO controls through provisions included in NPDES permits and by using orders and consent agreements when appropriate. The NPDES permits for CSO communities require the implementation of nine minimum control measures (http://cfpub1.epa.gov/npdes/cso/ninecontrols.cfm?program_id=5). Requirements to develop and implement Long Term Control Plans are also included where appropriate. Through the CSO program, the Ohio EPA will use its authority to ensure that recommended control activities are conducted by the permit holders within the watershed.

Storm Water Program
Ohio EPA implements the federal regulations for storm water dischargers (http://cfpub1.epa.gov/npdes/home.cfm?program_id=6). The following fact sheet describes which discharges are regulated: http://www.epa.ohio.gov/portals/35/storm/phase2factsheet.pdf. Both general and individual permits can be used for coverage of storm water effluent. The following website provides a list of Ohio EPA permitted storm water discharges: http://www.epa.ohio.gov/dsw/permits/gplist.aspx.

Through the Storm Water Program, the Ohio EPA will ensure that the storm water permit related recommendations of this TMDL are applied. Staff within the Storm Water Program provides technical assistance to permitted entities when needed. District Office staff within the Storm Water Program respond to and investigate complaints received by individuals and organizations.

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

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

Currently there are proposed rules changes to the 401 Program that are designed to provide a more scientific basis for determining appropriate criteria for 401 permit decisions (i.e., acceptance or denial) as well as mitigation stipulations for the respective projects (http://www.epa.ohio.gov/dsw/401/indeEaspx). These rule changes are expected to be finalized in 2008. Ohio EPA staff will conduct reviews and issue permits to provide the most reasonable protections and improvements, where possible, of surface waters in the watershed.

Wetland Protection Program
House Bill 231 established a permanent permitting process for isolated wetlands. Reviewers in the 401 Water Quality Certification Section are responsible for the isolated wetland permits required by this state law. Ohio EPA staff will conduct reviews and issue permits to provide the most reasonable protections and improvements of surface waters in the watershed.

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

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

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

In addressing sources of impairment related to agricultural activities, NPS staff will correspond with Ohio DNR to promote BMPs as well as cost-share and incentive based conservation programs. In particular, Ohio EPA will encourage the Ohio DNR to continue to work with Farm Service Agency personnel and staff from local SWCD and NRCS offices. NPS staff will also provide assistance to agencies and groups actively promoting conservation as well as direction to other appropriate resources within the Ohio EPA.

NPS staff will continue to work with any watershed groups active in the basin. Local NPS implementation is critical to achieving state environmental targets. Additionally, there is a reliance on watershed management plans to identify and outline actions to correct water quality problems caused by NPS pollution.

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

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

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

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

C5.2 Ohio Department of Natural Resources

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

The following are programs and divisions within the Ohio DNR that are particularly instrumental in protecting and improving water resources within the watershed.

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

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

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

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

Urban Storm Water Program
Ohio DNR staff provides technical expertise regarding storm water management and controls as well as administers urban storm water-related grants. The Urban Storm Water Program has been responsible for the development and maintenance of the Rainwater Manual for the State of Ohio which provides guidance regarding storm water management and sediment and erosion control measures.

Staff from the Urban Storm Water Program will be an important resource for communicating with the development community and promoting storm water management that is consistent with recommendations and goals of this TMDL report.

Scenic River Program
The Scenic River Program is administered within the Division of Natural areas and Preserves (DNAP) and functions according to the Scenic Rivers Act of 1968. By statute, Ohio DNR has

the authority to approve or disapprove any publicly funded projects on streams with a Scenic River designation that lie outside of municipal boundaries. Decisions are based on the potential impact that such projects may have on stream quality. An appointed citizens' advisory council, representing local officials, landowners and conservation organizations, provides advice regarding local river preservation and protection concerns.

Staff within the Scenic River program communicates with private citizens, businesses, local governments, watershed groups, and other organizations in regards to streamside preservation and other actions that protect and/or improve water quality. Scenic River coordinators will be useful resources in communicating with the development community in this part of the watershed and advancing appropriate planning, setbacks, preservation, and management strategies.

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

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

Division of Mineral Resource Management – Acid Mine Drainage Abatement Program
AMD set aside program
The Ohio legislature established the Acid Mine Drainage Abatement and Treatment (AMDAT) fund in March 1995. The Division transfers up to 30% of the annual federal Abandoned Mine Land (AML) grant into the AMDAT fund. Based upon projected AML grant levels, the Division will transfer an average of $4.2 million into the fund annually through 2017. Grant moneys placed into the AMDAT fund pursuant to ORC 1513.37 (E) are utilized to abate mine drainage problems within watersheds that have been approved as hydrologic units. Priority will be given to the expenditure of AMDAT funds whenever other sources of funding can be leveraged through the expenditure of AMDAT moneys (the AMDAT funds are considered “state money” and can therefore be used to match federal funds from other programs). It is the purpose of the AMDAT fund to provide for the long-term clean up of watersheds impacted by AMD in accordance with the criteria established in ORC 1513.37 (E) for hydrologic units.

Local community watershed groups and other governmental agencies may request assistance from the Division in developing watershed abatement plans, such that AMDAT funds can be expended for AMD abatement. The Division of Mineral Resource Management (DMRM) can provide assistance in the form of subsurface drilling, development of watershed monitoring plans, laboratory analysis of water samples, matching funding for water monitoring, hydrology and engineering technical assistance, construction contract administration, and construction oversight. Once watershed restoration plans are developed for a hydrologic unit or for a subwatershed within a hydrologic unit, the Division may also provide matching funding for the purpose of construction of an abatement project. Individual projects are eligible to receive matching funds through AMDAT if such projects are within an approved hydrologic unit and the project has been demonstrated to be a priority component of a watershed restoration plan.

State-funded AML program

The mission of the state-funded AML program is to address environmental problems associated with abandoned mines affected prior to April 10, 1972. The program is funded through a state severance tax on coal and other minerals which generates revenue for use in the state AML program. Funds from this program are matched with outside resources in order to leverage additional total dollars for a specific project. The DMRM may also fund AMD abatement projects, monitoring, site assessment and subsurface investigative work on a case-by-case basis.

Appalachian clean streams initiative

The Appalachian Clean Streams Initiative (ACSI) is a broad-based program to eliminate acid drainage from coal mines. The mission of the ACSI is to facilitate and coordinate citizen groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that are involved in cleaning up streams polluted by acid drainage. The program was initiated by the U.S. Office of Surface Mining (OSM) and the U.S. EPA Region 3; numerous participants and sponsors have joined these agencies through the signing of the "Statement of Mutual Intent" over the past several years. The DMRM is one such agency. OSM provides seed money to watershed groups and other non-profit organizations in the form of challenge grants. ACSI project selection criteria include:

- The presence of partnerships that will provide significant local support in the form of leveraged funding or in-kind services;
- The use of proven or innovative technology with a high probability of success;
- Projects with quantifiable environmental benefits resulting in restored stream miles, fisheries, or aquatic life uses.

Remining

The division recognizes that remining can result in a significant contribution to the restoration of watersheds impacted by acid mine drainage. In watersheds targeted for restoration, the DMRM will examine the potential for remining, and will offer incentives to encourage remining if technologically and economically feasible. The objectives of using remining incentives will be the same as the overall AMD program—the restoration of streams biologically impaired by drainage from abandoned mines.

C5.3 Agricultural Services and Programs

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

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

The close working relationships that SWCD and NRCS staffs typically maintain with local land owners and producers make them well suited for promoting both widely used conservation practices as well as some that are more innovative.

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

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

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

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

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

Watershed Conservation Reserve Enhancement Program
The Conservation Reserve Enhancement Program (CREP) is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. The program is a partnership among producers; tribal, state, and federal governments; and, in some cases, private groups. CREP is an offshoot of the country's largest private-lands environmental improvement program, the Conservation Reserve Program (CRP; see above).

Like CRP, CREP is administered by USDA's Farm Service Agency (FSA). By combining CRP resources with state, tribal, and private programs, CREP provides farmers and ranchers with a sound financial package for conserving and enhancing the natural resources of farms.

CREP addresses high-priority conservation issues of both local and national significance, such as impacts to water supplies, loss of critical habitat for threatened and endangered wildlife species, soil erosion, and reduced habitat for fish populations such as salmon. CREP is a community-based, results-oriented effort centered around local participation and leadership.

A specific CREP project begins when a state, Indian tribe, local government, or local nongovernment entity identifies an agriculture-related environmental issue of state or national significance. These parties and FSA then develop a project proposal to address particular environmental issues and goals. In Ohio, there are three CREP programs: one in the Scioto River basin; one in the upper Big Walnut Creek basin; and one in the Western Lake Erie basin.

Like CRP, CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. CREP provides payments to participants who offer eligible land. A federal annual rental rate, including an FSA state committee-determined maintenance incentive payment, is offered, plus cost-share of up to 50 percent of the eligible costs to install the practice. Further, the program generally offers a sign-up incentive for participants to install specific practices.

FSA uses CRP funding to pay a percentage of the program's cost, while state, tribal governments or other non-federal sources provide the balance of the funds. States and private groups involved in the effort may also provide technical support and other in-kind services.

C5.4 Extension and Development Services

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

C5.5 Agricultural Organizations and Programs

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

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

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

C5.6 Local Health Departments

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

C5.7 Local Zoning and Regional Planning

Local zoning is typically controlled at the county or municipality level. Local zoning can be a useful tool for implementing some recommendations of the TMDL, such as streambank setbacks for developing land.

Local governments typically conduct planning to meet the sewage disposal needs of the community. Ohio EPA has established guidelines for planning that are useful in the context of Section 208 and the State Water Quality Management Plan. Local governments that follow these guidelines are more likely to have the results of their planning work incorporated into the State 208 plan prepared by Ohio EPA. The Areawide Planning Agencies have established their own operating protocols, committees and processes to involve local governments in shaping their 208 plans.

Planning should account for long range sewer and treatment needs by looking at projections for community growth and development. Comprehensive land use planning, where available, is an excellent tool that can help those assessing the sewage disposal needs of a community or group of communities. In highly populated areas regional solutions involving several communities have proven to be a cost-effective means to solve sewage disposal problems in urban and suburban areas.

C5.8 Regulated Storm Water Communities

Regulated storm water communities must develop storm water management programs that include controls for the six minimum control measures outlined by the U.S. EPA (http://www.epa.ohio.gov/dsw/storm/ms4_indeEaspx). Local areas that fall within the municipal separate storm sewer system (MS4) program are regulated under the general storm water permit for the State of Ohio.

C5.9 Easements and Land Preservation

A conservation easement is a voluntary agreement that allows a landowner to limit the type or amount of development on their property while retaining private ownership of the land. The

easement is signed by the landowner, who is the easement donor, and the party receiving the easement. The receiving party accepts the easement with understanding that it must enforce the terms of the easement in perpetuity. After the easement is signed, it is recorded with the County Register of Deeds and applies to all future owners of the land (landtrust.org/). Easements and preservation agreements can be excellent tools to preserve high quality or particularly diverse areas within a watershed. Frequently such agreements will include streams, riparian areas and/or wetlands.

C6 Process for Evaluation and Revision

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

This section of the report provides a general strategy for continued monitoring and evaluation and lists parties who can potentially carry out such work. It highlights past efforts and those planned to be carried out in the future by the Ohio EPA and others. It also outlines a process by which changes to the implementation strategy can be made if needed.

C6.1 Evaluation and Analyses

Aquatic life and recreational uses are impaired in the watershed, so monitoring that evaluates the river system with respect to these uses is a priority to the Ohio EPA. The degree of impairment of aquatic life use is exclusively determined through the analysis of biological monitoring data. Recreational use impairment is determined through bacteria counts from water quality samples. Ambient conditions causing impairment are discussed in the main text of the report. This report sets targets values for these parameters, which should also be measured through ongoing monitoring.

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

Recommended Approach for Gathering and Using Available Data
Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Through this, areas of overlap should be identified and ways to make all parties research efforts more efficient should be discussed. Ultimately important questions can be addressed by working collectively and through pooling resources, knowledge, and data.

C6.2 Revision to the Implementation Approach

An adaptive management approach will be taken in the watershed. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack et al., 1999) and this approach is applied on federally-owned lands. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current

strategy is inadequate or ineffective. The recommendations put forth for the watershed are discussed in the last chapter of the main report. 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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