STREAM CORRIDOR MASTER PLAN

A COMPREHENSIVE PLAN TO HELP OUR STREAMS REACH THEIR FULL POTENTIAL

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Executive Summary

The City of Lancaster has not treated its water resources well throughout its history. Industrial activities so polluted the streams that early Ohio EPA water quality studies document the Hocking River through Lancaster as one of the most severely degraded segments of river statewide. Then, in the late 1980s, improvements to the Waste Water Treatment Plant led the way towards the upper Hocking River today being considered one of the most improved rivers in the state for its water quality. Multiple large scale restorations and Combined Sewer Overflow removal/improvements in the early 2000s have continued the trend of improving water quality. Moving forward, this plan addresses the preferred management methods for each stream within the city, determined by walking each stream and qualitatively evaluating the stream environment. Each stream plan acts as a stand-alone document designed to help City officials make informed choices on the management plan of any given parcel of land adjacent to or containing a stream.

Stream Corridor Master Plan Overview

Introduction

The Stream Corridor Master Plan for the City of Lancaster is designed to give City officials guidance on how to manage parcels of land containing and/or adjacent to our City's streams. Historically, the City and its inhabitants have neglected our streams, consistently polluting them with debris and industrial runoff while ignoring their recreational value. The quality of the water was generally poor, as was the quality of the habitat provided by our streams. Biological and water quality studies from the early 1990's document "severe" conditions on the Hocking River and its tributaries and identifies point sources of pollution from within Lancaster, mainly the effluent of the Waste Water Treatment Plant (WWTP) and Combined Sewer Overflows (CSO's), as the main source of impairment. It became clear that changes would be needed if the City were to achieve attainment with state-wide water quality standards.

Subsequent Ohio EPA water quality studies began to show improvements in the Hocking River watershed around Lancaster due to efforts made by City officials. It began with improvements to the WWTP made in the late 1980's and the incorporation of a pretreatment program, both of which made small impacts in the early 1990's but were fully realized by the end of the decade. Improvements have been continuing over the years with the removal and/or modification of CSO's in order to reduce the number of overflow events. Of the initial 33 CSO's within the City, only nine remain today with more improvements coming in the near future. The upper Hocking River watershed was named one of the most improved water bodies by the Ohio EPA in the 1997 publication titled "Biological and Water Quality Study of the Upper Hocking River and Selected Tributaries".

With the expansion of the City and the development of stream-adjacent recreational opportunities, primarily the Fairfield Heritage Trail, came an increased awareness for the aesthetic and water quality attributes of our City's water resources. This is a testament to the efforts of the City to improve its streams that are now being considered recreational resources, valued and appreciated by Lancaster residents. It is also motivation to continue making improvements to our water resources. The City completed stream restorations in the late 2000's and early 2010's on the Hocking River and Baldwin Run, respectively. Two construction projects restored wetlands along the banks of the Hocking River, one at the River Valley Mall and one at Deeds Wetland on Sugar Grove Road. Various projects along the banks of Baldwin Run restored most of the stream throughout the same period, most recently in the area immediately north of Main Street. Continued restoration projects, stream cleanups, and minor but important management actions will be vital in conserving and building upon previously completed work.

This document will help give City officials the insight needed to make important decisions concerning our City's water resources set in the greater context of the watershed as a whole. Each stream was taken into consideration separately using a qualitative approach while keeping in mind the needs of neighboring streams and all other adjoining water bodies. Each stream has its own background based on available information, a short summary of existing conditions, a plan containing the most-needed management actions, and an appendix with maps and any other related information. In total there are 11 water bodies included in this plan, each of which act as a stand-alone document that can be used to inform decisions based on that stream.

Ohio EPA Studies

The Ohio EPA monitors the Hocking River watershed as part of ongoing biological and water quality studies as well as Total Maximum Daily Load (TMDL) studies. Each year, the Ohio EPA studies water bodies in different areas of the state looking at chemical content, fish and insect counts, and other water quality measures. These measures are documented in a year-end report and eventually inform the TMDL report and help the EPA set and assess measureable goals for a watershed's management. These studies are divided into major watersheds and involve data points taken from throughout the watershed. The Hocking River watershed contains all of Lancaster's streams, but only five of those streams, six including the Hocking River, are directly measured through the studies.

The Ohio EPA published two biological and water quality studies for the Hocking River watershed and its tributaries during the 1990's. The first was published in 1991 and documented poor conditions in the Hocking River watershed, indicative of the lack of emphasis on water quality by the City of Lancaster as well as other communities on the Hocking River prior to that period. The only section in this study that consistently achieves full attainment with warmwater habitat criteria is an approximately 20 mile section from west Logan to just upstream of Monday Creek, near Nelsonville. The rest of the watershed is in either non-attainment or partial attainment with warmwater habitat criteria. The second water quality study, published in 1997, documented an upward trend in biological and water quality throughout the Hocking River, though most data points through Lancaster document only partial attainment with warmwater habitat criteria. This study also provided details from a 1982 Ohio EPA study in which most of the Hocking River between Lancaster and Logan was in non-attainment with warmwater habitat criteria. Maps showing attainment status can be found in **Appendix 1**, taken from the 1997 water quality study from the Ohio EPA.

The 2009 TMDL Report documented further improvements to biological and water quality. Qualitative Habitat Evaluative Index (QHEI) scores were generally higher, and many areas throughout the watershed achieved two out of three or better on their total habitat score, which is a combination of QHEI scores, the amount of modified attributes on the channel, and the number of high-influence modifying attributes on the channel. The second metric that is used in determining attainment with warmwater habitat criteria is the bedload rating. Three specific metrics taken from the QHEI study determine the bedload rating: channel, substrate, and riparian. The study explores the categories together for their overall health as well as documenting individual ratings for each category to determine which category is most impaired in the sample location. Excerpts from the TMDL study can be found in the appendices of each stream, if relevant.

Sinuosity

Sinuosity is a measure of the amount a stream meanders through its environment. The higher the sinuosity, the greater the distance a stream travels for the same decrease in elevation, or the more curves there are in the stream channel. Natural-state streams resting on flatter ground will have higher sinuosity and those resting in areas of high relief have less sinuosity. Sinuosity is measured using a metric known as the sinuosity index, which is formed by dividing the distance along the channel by the distance down-valley, or perpendicular to elevation contour lines. Indices range from 1 at the low end to around 4 among natural-state streams, though there is no theoretical maximum sinuosity index a stream can have. Lancaster's streams range from Baldwin Run at 1.04 to Lateral D at 2.04 overall, though localized areas of channelized streams exist in every stream. A table containing all of Lancaster's sinuosity ranges can be found in **Appendix 2.**

River Mile

The river mile system was developed in order to more accurately identify locations within a stream or along its banks. It is commonly seen in studies involving stream health, including those published by the Ohio EPA. The river mile measurement represents the distance from the mouth of the river along its centerline. For most of the streams within Lancaster, that means the distance from the Hocking River as measured along the centerline of the stream. Lancaster has not yet adopted this practice for its own streams, but adopting this system would allow for more accurate descriptions of stream issues, including those associated with Illicit Discharge Detection and Elimination.

Stream Maintenance

Streams are similar to infrastructure in that they need constant upkeep in order to maintain maximum effectiveness. Stream maintenance can take the form of stream cleanup activities, invasive species removal, or the removal of sand/silt from the substrate. Streams in an urban environment receive unnatural trash and debris. Regularly clearing out this trash would benefit every stream by allowing natural structures to develop as opposed to unnatural debris, and can be implemented with relative ease. Invasive species removal, likewise, is easy to implement and requires neither entering the stream nor heavy machinery. Invasive species can be manually removed or, if a specialist with a pesticide certification is available, removed through pesticide application taking care to use pesticides that will not affect stream quality. Removing sand/silt from the channel substrate requires more action and may require outsourcing to a contractor. The "Sand Wand" operation would accomplish this, and is discussed in more detail in the Stream Restoration Techniques section.

Project Initiation Team and Technical Assistance

Project initiation will be conducted by meeting with all departments with an interest in the project. Department representatives will discuss known issues among Lancaster streams and use a collective approach to finalize the project location. Location decision will involve all departments who may be involved in the implementation or maintenance of the project, including but not limited to:

- Superintendent of Water/Water Pollution Control or their designee.
- Superintendent of Transportation or their designee
- Stormwater Management, or their designee
- Superintendent of Parks and Recreation or their designee

The members of the project initiation team will also help provide technical guidance on how to proceed with stream restorations and which restoration techniques to pursue. This team will be supplemented by professional consultants when necessary as well as all relevant environmental regulatory agencies and/or money grantors.

Scheduling and Milestones

Stream restoration in Lancaster began in 2005 in coordination with the Anchor Hocking Brownfield project with bank stabilizations along Baldwin Run. In the decade following the project, restorations were also conducted along the Hocking River as well as along Baldwin Run. Stream restorations will continue under capital improvement and maintenance projects as money becomes available with a goal to complete all major restorations by 2035.

At the end of summer each year, the Stormwater Specialist or other responsible official will present a report on the status and progress of the plan to the Stormwater Utility Committee, which meets on the 4th Thursday of each month. Every 5th year, set to coincide with the renewal of the City of Lancaster Water Pollution Control NPDES Permit renewal, an in-depth report on the status and progress of the plan and a review of the plan will be conducted by the Stormwater Specialist or other responsible official. The 5th year report will be accompanied by the results of monitoring results required under the NPDES Permit. This includes sampling events upstream and downstream of both the Lawrence Street Water Pollution Control Facility and the Upper Hocking Water Pollution Control Facility effluent, testing total suspended solids, nitrogen, phosphorous, and other water quality metrics. The monitoring also involves both chronic and acute bioassays to measure toxicity both upstream and downstream of each WPCF.

In addition to Water Pollution Control testing, Qualitative Habitat Evaluative Index tests will be conducted in fixed locations every five years as well as in project areas, both before and after project construction. Fixed locations are upstream on the Hocking River near the Lancaster Corporation Boundary (LCB), downstream on the Hocking River near the LCB, and on the Hocking River near the Miller Park Water Plant. The tests will be conducted by the Stormwater Specialist or other qualified individual.

Stream Restoration Techniques

Techniques Overview

Techniques for stream restoration are both numerous and diverse. Any particular stream issue will have more than one potential way to restore it. These techniques vary in associated cost, maintenance required, expertise needed for installation, and effectiveness. Each technique should be evaluated for their suitability on the stream in question. This section covers preferred stream restoration techniques that have either been used previously by the City of Lancaster in stream restoration projects or would be well-suited for the type of streams within Lancaster. Specific techniques for each stream are discussed in their individual reports. **Appendix 3** contains detailed schematics for each of the stream restoration techniques discussed below.

The first step in restoring a stream channel is to evaluate the local health of the stream. The individual stream reports contain overview reports for the stream's health, but the evaluation of the specific project location is important to producing lasting effects from a stream restoration. The primary stream evaluation index used by the Ohio EPA is called the Qualitative Habitat Evaluative Index (QHEI). The index combines substrate, instream cover, channel morphology, bank erosion, and other metrics to evaluate the health of the stream. The Ohio EPA QHEI and Use Assessment Field Sheet is attached in **Appendix 4.** When evaluating stream segments for a potential restoration, this metric may be helpful in the final decision on location.

Load reductions were calculated for each stream within the individual reports. They were calculated based on an average per lineal foot reduction per year for the expected restoration extent. The estimated reduction per foot is as follows:

Nitrogen:	0.02 lb/ft/yr
Phosphorous:	0.0025 lb/ft/yr
Suspended Solids	2 lb/ft/yr

Sediment Removal Maintenance

Sediment removal is a maintenance-type operation which would benefit many of the streams throughout Lancaster. Multiple contracting companies throughout Ohio offer a sediment removal service, most notably Streamside Environmental out of Findlay. While the periodic removal of sediment will maintain habitat for local fauna, restoring stream channel stability through restorations would reduce the need for sediment removal maintenance activities and is a more effective long-term control strategy. Stabilizing banks, restoring floodplain, and utilizing in-stream structures would restore the stream's natural ability to regulate local sediment import and export.

Floodplain Reconnection & Restoration

A properly developed floodplain would reduce bank erosion during high-flow events and can even allow some self-maintenance for a dynamic stream channel, re-stabilizing banks and restoring the natural channel. A proper floodplain can also help to regulate the entrance of pollutants, allowing them to settle out of surface flow before entering the stream. Pollutants could be debris, trash, or even chemicals involved in the land use surrounding the stream. Streams throughout the City would benefit from being reconnected to their floodplain. Adequate floodplain area exists for many of these streams, but steep banks or modified attributes prevent the floodplain from acting as it should. Regrading the banks, or reshaping the stream channel in severe situations, would aid the stream control high-water flow events.

Lancaster also has streams throughout the City that lack appropriate areas of the floodplain. Appropriate floodplain often means expanses of land adjacent to the stream containing trees and other vegetation that would decrease floodwater velocity. Decreasing floodwater velocity allows more water to soak into the ground as opposed to eroding streambank or potentially damaging infrastructure. The City should restore floodplain as land becomes available to them to do so.

Root Wads & Toe Wood

Root Wads are a type of natural bank stabilization that involve burying the root mass of a tree into meander bends in the stream channel. They reduce the rate of stream bank erosion while also providing habitat for local fauna and are also able to utilize any trees removed from the project area by turning them into restoration aids. They can be installed with a point drive method that reduces soil disturbance and is faster and cheaper than a trenching method. Toe Wood is very similar to Root Wad installation but is typically more extensive as it covers an entire meander bend. Toe Wood is better able to protect the bank but is also more expensive and will disturb more soil during installation.

Vortex Rock Weirs

The term "vortex rock weirs" refers generally to a group of structures that seek to control the direction of stream travel and create pools. These include cross vanes, W-weirs, and J-hooks, among others. Cross Vanes are typically U-shaped or V-shaped structures used on smaller streams that divert all streamflow into the center of the channel, protecting both banks and creating a pool in the middle of the channel. The W-weir vortex is similar to the Cross Vane, but is W-shaped and creates a second pool in the channel. These are typically installed on larger, wider streams. J-hooks are J-shaped structures that divert energy away from only one stream bank and do not produce any pools in the channel but provide bank protection for one bank. These are typically implemented near meander bends in order to prevent excess erosion on sharp turns. All three structures are able to utilize natural stream materials such as large woody debris and in addition to large boulders in order to operate properly.

Armorflex Matting

Armorflex matting is an unnatural stream bank stabilization method that has been utilized by the City of Lancaster in previous stream restoration projects. Armorflex is an effective measure for protecting infrastructure or any stream bank that needs particular protection. It consists of linking together concrete blocks and laying them over the surface in need of protection. Designs are available that allow small vegetation to develop in the slight voids between cells as well as through openings within each cell.

Boulders & Rock Eddies

In-stream boulders are typically larger than the surrounding material and are able to provide multiple benefits to the stream. Rock eddies are similar to boulders, but are smaller and more numerous. Both can be utilized to control the velocity of the stream and create pools and other habitat for local fauna. Deep pools created by in-stream boulders are prime habitat for fish as they produce overhead cover and with it, shade. In-stream boulders are able to alleviate issues from a lack of riparian corridor or provide temporary benefits while restored riparian corridors develop. They will also improve the aesthetics of the stream.

Riparian Corridor Plantings

The riparian corridor is an often overlooked but crucial part of a stream ecosystem. A well-developed riparian corridor will protect the stream from debris and trash, provide shade from the sun, stabilize the bank, and deciduous trees will be able to provide organic material to the stream each fall. They are also important in flood mechanics, protecting the stream by reducing the amount of debris picked up by floodwaters and protecting local property by reducing floodwater velocity. Restoring the riparian corridor involves removing invasive species and old, failing vegetation from the immediate reaches of the stream and replacing them with seed mixes and live plantings. Small shrubs and grasses would stabilize local soils and reduce the rate of invasive species' return while allowing the larger species to grow to maturity. Riparian corridor plantings require upkeep following project completion to ensure that vegetation succeeds and that invasive species have not overwhelmed the area.

Associated with the theme of the riparian corridor, the City should consider a stream setback ordinance. A stream setback ordinance would limit the options for developing within a set distance from the stream. This could either be a distance adjusted according to the stream's specific needs, or could even have different levels of restrictions depending on the distance from the stream. This management technique would need support from the community, as the restrictions would apply to many private and commercial properties across the City. Without seeking the proper public involvement, a stream setback ordinance could upset many of the City's inhabitants who own property along one of our streams.

Home Sewage Treatment System Removal

The Hocking River TMDL and other associated water quality studies from the Ohio EPA have identified HSTS's as one of the primary sources of degradation in streams throughout Lancaster. A map of these HSTS's can be found in **Appendix 5.** The Lancaster Codified Ordinance 912.02 states that as long as there is a public sewer system available for use near your establishment, you must connect to the public system rather than building or maintaining a private facility intended or used for the disposal of sewage. Over time this will reduce and eventually eliminate HSTS's in Lancaster and improve overall water quality.

Stream Cleanup

Stream cleanup activities involve entering the stream to remove any trash and debris that has entered. Given that all of our streams contain trash throughout, activities that involve the removal of trash should involve all streams throughout the community. The Hocking River is currently cleaned out each year through a community care day in association with United Way, but other streams are largely ignored. A second day could be added in addition to the community care day, allowing City volunteers to clean out a second stream each year, which would rotate each year it is completed. This, however, would require volunteers from the community as well as access to heavy machinery to haul trash away but would benefit the stream environment in general.

Sources Cited

Czarnezki, Jim and Brown, Danny. Missouri Stream Team. *Missouri Streams Fact Sheets: Monitoring Stream Conditions.* Web.

Endreny, T. "Compute River Reach Sinuosity Exercise." *Fluvial Geomorphology.* Department of Environmental Resources Engineering. Web. 16 December 2015. <http://www.fgmorph.com/fg_2_22.php>

Femmer, Suzanne and Lobb, Del. Missouri Stream Team. *Missouri Streams Fact Sheets: Riparian Corridors.* Web.

Femmer, Suzanne and Lobb, Del. Missouri Stream Team. *Missouri Streams Fact Sheets: Stream Habitat.* Web.

North Carolina Stream Restoration Institute. North Carolina Sea Grant. *Stream Restoration: A Natural Channel Design Handbook.* Web.

State of Ohio Environmental Protection Agency. Division of Surface Water. *Total Maximum Daily Loads for the Hocking River Watershed.* 27 August 2009. Web.

State of Ohio Environmental Protection Agency. Division of Water Quality. *Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries.* 25 October 1991. Web.

State of Ohio Environmental Protection Agency. Division of Surface Water. *Biological and Water Quality Study of the Upper Hocking River and Selected Tributaries.* 31 December 1997. Web.

"Statewide Biological and Water Quality Monitoring and Assessment". *Ohio Environmental Protection Agency.* Ohio Environmental Protection Agency. Web. 13 January 2016. <http://www.epa.ohio.gov/dsw/bioassess/ohstrat.aspx>

United State Fish and Wildlife Service. National Marine Fisheries Service. United States Army Corps of Engineers. United States Environmental Protection Agency. *Sediment Removal from Active Stream Channels in Oregon: Considerations for Federal Agencies for the Evaluation of Sediment Removal Actions from Oregon Streams.* N.P. 1 March 2006. Web.

Vermont Watershed Division. Vermont River Programs. *An Introduction to River Channel Evolution.* 12 April 2011. Web.

Virginia Department of Environmental Quality. Department of Conservation & Recreation, Division of Soil and Water Conservation. *The Virginia Stream Restoration & Stabilization Best Management Practices Guide.* 2004. Web.

Appendix 1

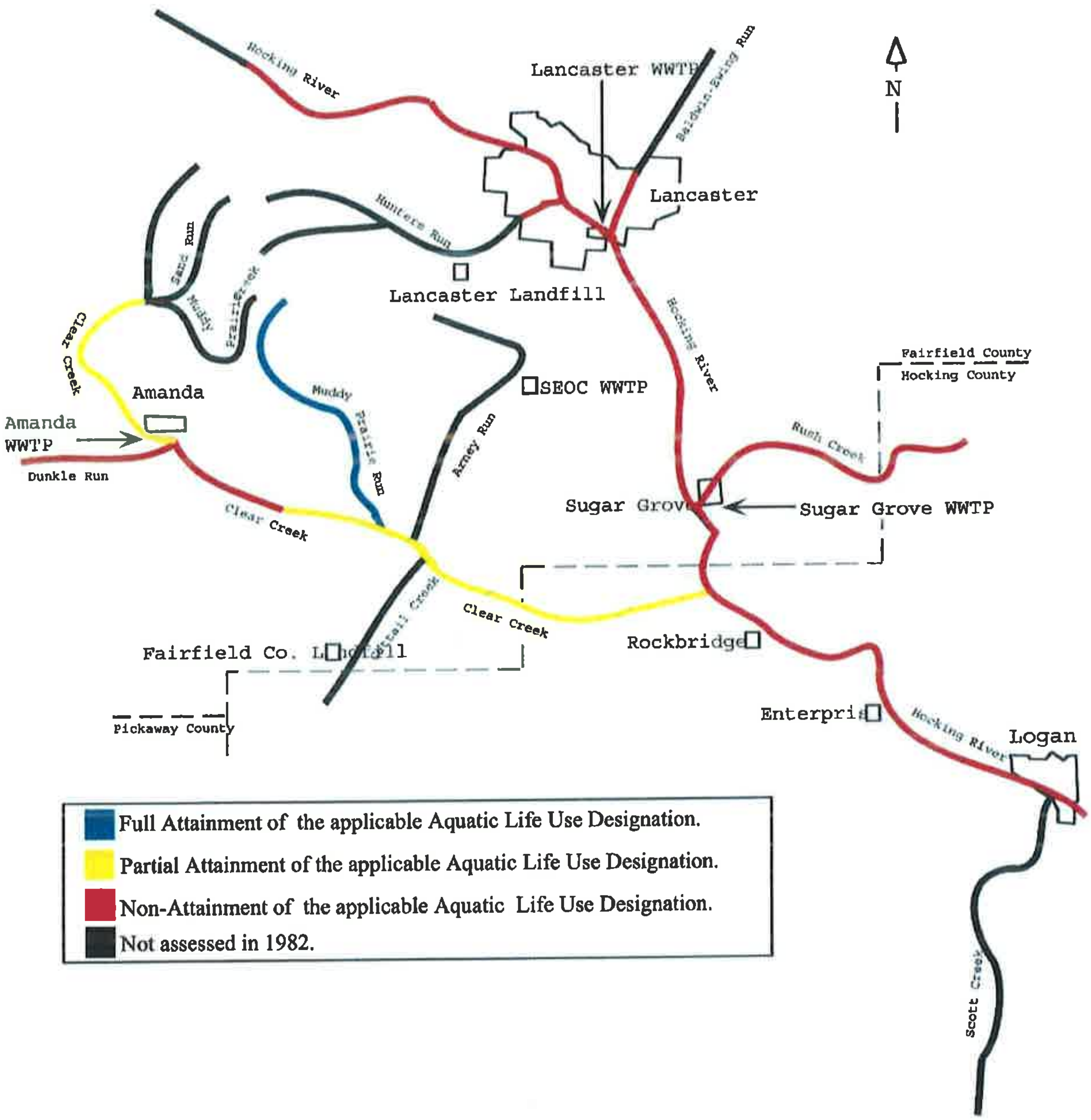


Figure 3. Attainment status of the applicable aquatic life use designations for the principal drainage network of the upper Hocking River study area, 1982.

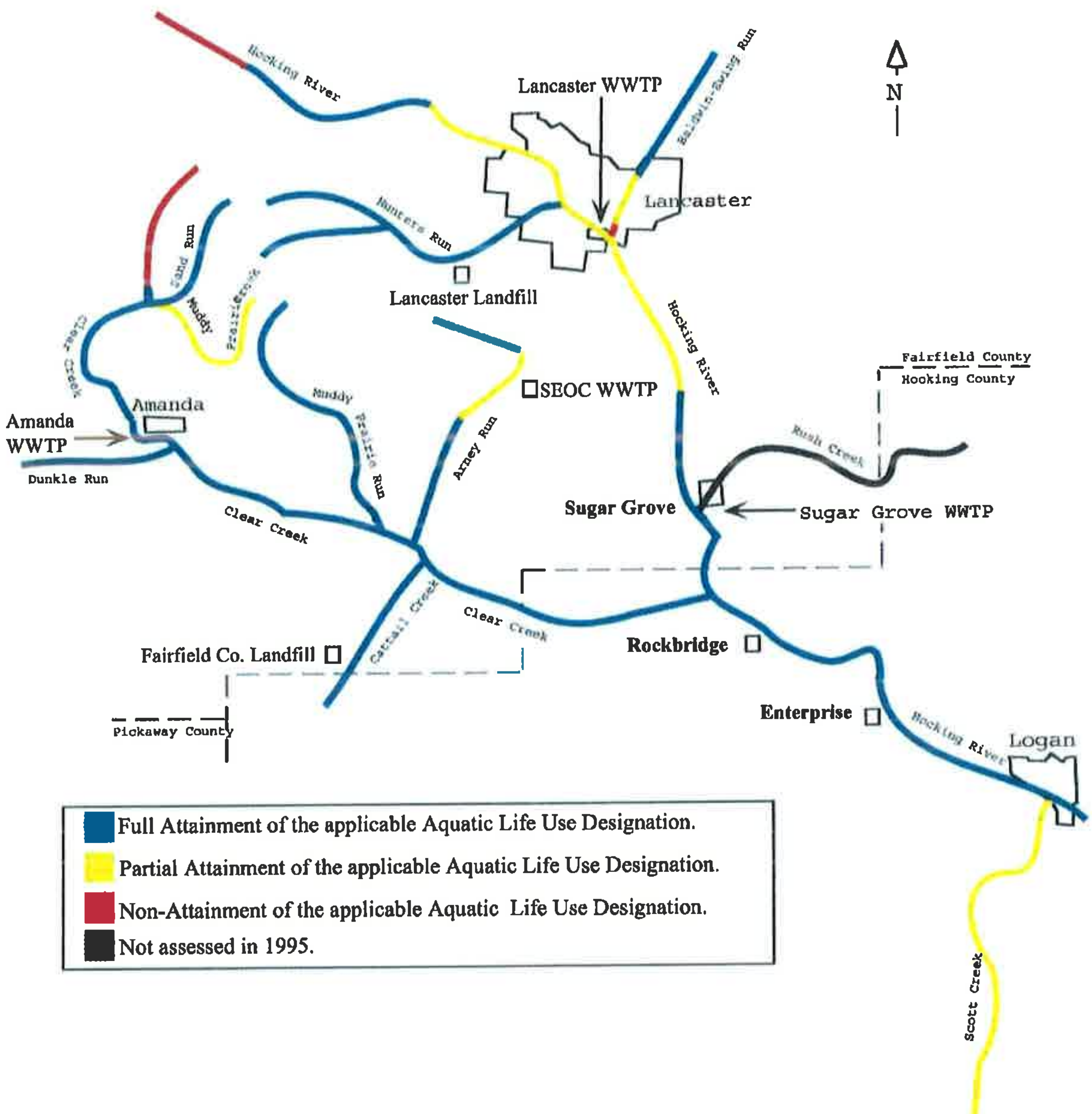


Figure 2. Attainment status of the applicable aquatic life use designations for the principal drainage network of the upper Hocking River study area, 1995.

Appendix 2

Stream	Sinuosity Index
Baldwin Run	1.04
Ewing Run	1.18
Fetter's Run	1.35
Hocking River	1.39
Hunter's Run	1.47
Lateral A	1.37
Lateral B	1.45
Lateral C	1.37
Lateral D	2.04
Pleasant Run	1.45
Tarhe Run	1.30

Average	1.401
Average (without Lateral D)	1.34
Median	1.37

Categories	Index Range
Straight	<1.05
Winding	1.06-1.25
Twisting	1.26-1.49
Meandering	>1.50

Appendix 3

PRACTICE 1.2: ROOTWAD REVETMENTS

Rigid lower bank and toe protection measure for outer meander bends

DESCRIPTION

A rootwad revetment consists of the lower trunk and root fan of a tree (rootwad), a footer log, and large boulders or graded riprap. Individual rootwads are placed in series along the outer meander bend in the lower portion of the streambank and provide immediate bank protection.

APPROPRIATE USES

- In outer mender bends where a rigid protection strategy is needed that also has high habitat value.
- When on-site materials are available for making rootwad revetment.
- Used as a component of an integrated bank treatment for rigid stabilization of the toe and lower bank region.
- Used in combination with a vane device such as PRACTICE 4.1: Rock Vanes and PRACTICE 4.2: J-Hook Vanes.
- Often used to repair streams after major floods, as trees are readily available.

LIMITATIONS

- Site must be accessible to heavy equipment.
- Structures can degrade after 5-15 years. Long-term stability depends on establishment of woody vegetation. Species selection can increase life of structure.
- Rootwads collect litter in urban areas and can cause public perception problems.
- Rootwad revetments can be very expensive if onsite materials are not available.
- Not well suited for smaller, headwater streams.
- May be undermined or flanked if the channel is still experiencing plan form or vertical adjustments. Ensuring the upstream meander bend is stable minimizes risk of failure.
- Not suitable for highly sandy banks (<15% silt and clay).

DESIGN REQUIREMENTS AND PROCEDURES

- The bottom of the footer log and root fan must extend slightly below the design scour depth.
- Effective design hinges on determining a stable meander radius of curvature.
- Length of the rootwad trunk determined by anticipated scour behind the rootwad. Size trunk so that 3/4 of its length remains embedded in bank at maximum anticipated scour.
- Spacing and orientation of rootwads to flow is highly variable in practice and in the literature. Designer must ensure that velocity current is deflected away from the

streambank along the outer meander bend. Some suggestions and ranges are given below:

  - Spacing: Rootwads can be placed along the banks so the root fans overlap. This is sometimes called root wrap and provides the most complete bank protection. At a maximum, rootwads can be spaced at radius of curvature to top widths (Rc/W) of greater than 3.0. At less than 2.5, the rootwads no longer deflect flow. A general rule is that the rootwads should be spaced 3-4 times the length they extend past the bank.
  - Orientation: Typically, the face of a single root fan is positioned at 90 degrees to the incoming flow, but can be rotated as much as 15 degrees toward the stream channel (away from the streambank). In root wrap, the orientation is parallel to the bank.
- Thresholds and allowable stress guidelines have not been developed. A hydraulic analysis of near bank erosional forces can minimize risk.
- Erosion most often occurs in unprotected or poorly compacted soil around roodwad. Design should address need for bank stability behind Rootwad.
- If Qcf elevation provides less than 1.5 feet of cover over the trunk of the rootwad, the placement of bracing boulders on top of the rootwad will improve stability and counter buoyancy of rootwad.

MATERIAL SPECIFICATIONS

- <u>Rootwad:</u> Lower portion of a preferably rot-resistant tree species consisting of a root fan and a trunk. The root fan shall have a diameter roughly equal to the vertical distance from the design scour depth to the Qcf elevation. Root fans shall have relatively few broken branches and be securely attached to the trunk. Trunks shall be relatively straight and free of breaks, and splits. Trunks shall be long enough so that 3/4 of their length is securely embedded in the bank at maximum scour. A minimum length of 10 feet and a maximum length of 20 feet are recommended. Trunks should have a minimum diameter of 12 inches.
- <u>Footer Logs:</u> Minimum of 12-inch diameter log meeting the same specifications as the rootwad trunk above. Length is determined by overall design of structure.
- <u>Boulders and Riprap:</u> Used as anchors and backfill. Size and material choice vary.

CONSTRUCTION RECOMMENDATIONS

- Requires use of track hoe with pneumatic or mechanical thumb to place rootwads.
- Trees used for rootwads can consist of any species that provides a dense, flattened root mass, although hardwoods are preferred. Trees with a deep tap-root are not generally suitable for rootwads.
- Backfill material should be relatively free-draining and should not create high pore water pressures that could cause the slope to fail.

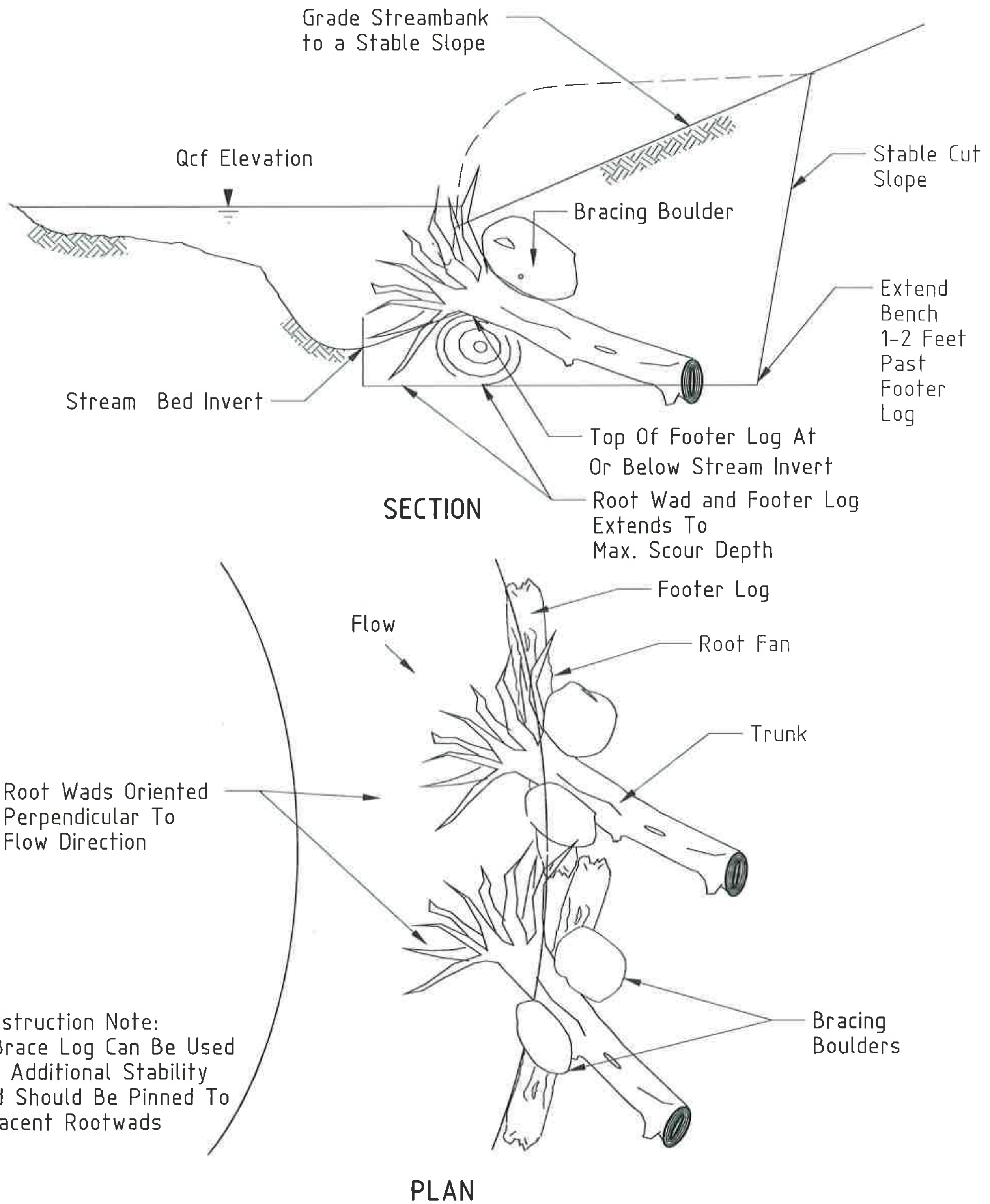
INSTALLATION GUIDELINES

There are two basic methods of installing rootwads. The preferred method pushes or drives the trunk into the bank. This approach minimizes excavation, and reduces disturbance to the bank and floodplain. If site conditions do not allow for this approach, the trunk can be trenched into the bank. This approach requires additional attention to compacting the backfill around the trunk and controlling sedimentation into the stream channel.

- Excavate a trench along the streambank toe for the footer logs. Excavate slightly below the design scour depth and to a length 1-2 feet longer than the length of the footer logs.
- Starting at the downstream end, place footer logs parallel to the streambank. Ensure that the bottom of the footer log is placed slightly below the design scour depth.
- Either drive the rootwad into the bank with track hoe, or trench it into the bank. If driving the rootwad into the bank, sharpen the trunk end to a point.
- Place the rootwad so that the back of the root fan rests against the front of the footer log and the bottom of the root fan is placed slightly below the design scour depth. Ensure that the rootwad is oriented properly with the flow.
- Moving upstream, the next footer log is placed in the trench with its downstream end extending behind the first footer log and the next root wad is put in place. This process continues until all rootwads have been installed.
- Large boulders are placed on the top and sides of the footer log and rootwad to hold them in place. Boulders can be placed as an even course across the whole bench or in strategic locations on the front and back ends of the footer log. Boulders placed in between rootwads limits lateral movement. Header or cut-off logs meeting the same specifications as footer logs can be placed on top of the rootwads from the front of one rootwad to the front of the adjacent rootwad or from front to back for added stability.
- Backfill with fill, riprap or aggregate as needed to achieve a stable, free draining streambank. Compact fill with bucket of excavator.

The Virginia Stream Restoration & Stabilization Best Management Practices Guide

DETAIL 1.2: ROOT WAD REVETMENT



Section & Plan Views Adapted From Rosgen (1999)

BANK PROTECTION GUIDELINES	DECEMBER 2003	VIRGINIA DEPARTMENT OF CONSERVATION RECREATION

PRACTICE 3.1: ROCK CROSS VANES

In-stream rock structure for directing erosional forces away from the streambanks and establishing grade control

DESCRIPTION

A rock cross vane is a stone structure consisting of footer and vane rocks constructed in a way that provides grade control and reduces bank erosion. The vane is composed of a center section perpendicular to the streambanks joined to two arms that extend into the streambank at the Qcf height. The rock cross vane accumulates sediment behind the vane arms, directs flow over the cross vane, and creates a scour pool downstream of the structure.

APPROPRIATE USES

- Where stabilization of a vertically unstable stream bed requires grade control.
- To direct erosional forces away from the streambanks and to the center of the channel.
- When fish habitat enhancement and grade control are both desired.
- For bridge protection, cross vanes provide grade controls, prevent lateral migration of channels, increase sediment transport capacity and competence, and reduce footer scour.
- To enhance or create recreational paddling opportunities.
- Most suitable for rapid-dominated stream systems (Rosgen Class B) with gravel/cobble substrate.

LIMITATIONS

- The Qcf height must be accurately located for the stream as the vane arm is set into the streambank at the Qcf elevation.
- Rock cross vanes used in streams with a significant portion of sand, silt or clay in their beds must be sealed using filter fabric and/or a properly sized and placed open class aggregate.
- Large rock size requirements make it difficult to use in small streams.
- Requires heavy equipment and skilled operators to place rock correctly.
- Rock may sink or subside in streams with sand and clay beds, which makes proper construction difficult. Additional foundation design may be required.

DESIGN REQUIREMENTS AND PROCEDURES

- Vane arms should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the vane intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.
- Vane arm slopes range from 2-15 percent. The center vane is flat (no slope). When designing cross vanes in larger systems, a 2-7 percent slope can result in excessive

vane arm lengths. The designer can choose a steeper slope for the vane arms when practical. However, steeper vanes tend to be less stable.

- Specify elevation and offset values for both ends of the vane arms. This ensures exact placement of the structure by the contractor.
- Always use at least two vane rocks for the middle 1/3 of the structure. Streams have a tendency to erode around a single vane rock in the middle of the structure.
- Rock cross vanes may create blockages to fish migration. Vane rocks in the center 1/3 of the structure can be gapped to allow fish passage. However, when rocks are gapped, it is important to understand that the top of the footer rock becomes the invert elevation for grade control, not the top of the vane rocks.
- Designer must specify a design depth for the scour pool immediately downstream of the cross vane. A scour depth analysis is recommended to aid in specifying the depth.
- Cross vane arms must terminate at the Qcf elevation. If the top of bank is above Qcf elevation, then a floodplain bench should be created at the Qcf elevation.
- Rock cross vanes should be designed for a maximum vertical drop (protrusion height) of 6 inches. If more than 6 inches of drop is required over a short section of stream, use a series of step pools per PRACTICE 3.4: Step Pools.
- For designs using multiple cross vanes to achieve grade control the following rule of thumb can be used to determine spacing of structures along the stream channel:

  $P_s=8.2513S^{-0.9799}$

  Where P_s=the ratio of pool to pool spacing/Qcf width
  S=Channel slope in percent

This relationship is derived from data on natural streams and rivers with slope generally greater than 2% (Rosgen 2001).

MATERIAL SPECIFICATIONS

- Rock: Footer and vane rocks must be large enough to achieve the design height and appropriately sized to resist movement due to stream flow characteristics. Rocks shall be relatively rectangular in shape, uniform in size, and have a minimum intermediate (b) axis greater than 1.5 feet (0.5 meters) at a minimum. An example of rock size as a function of Qcf shear stress is given below:

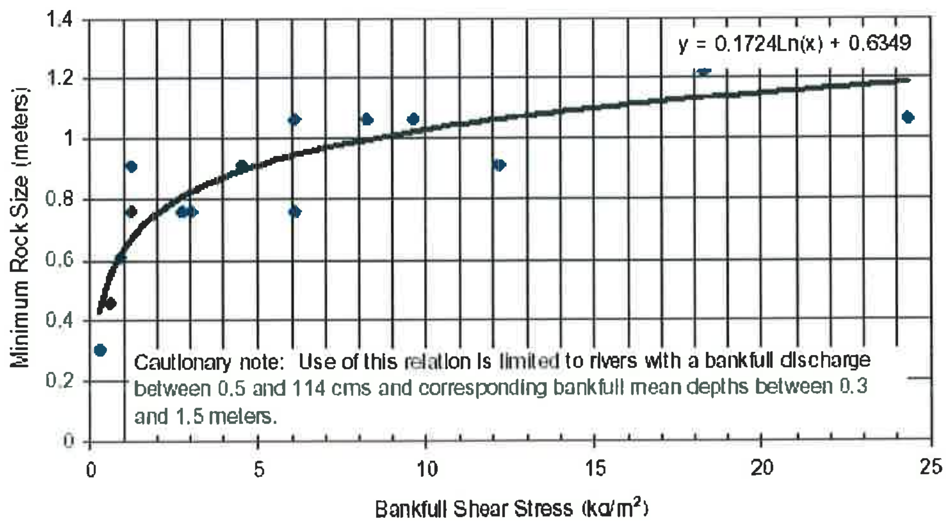


Figure 3.1: Minimum Rock Size for Rock Cross Vane's as a function of Qcf shear stress. Source: Rosgen 2001.

- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook for sill rocks, bank armoring, and toe protection.
- Open Class Aggregate: If used for sealing behind structure, should be properly sized to be minimally mobilized and displaced in supercritical flow events. Salvaged alluvial channel material can be substituted for aggregate if properly sized.
- Filter Fabric: If used for sealing the structure, filter fabric shall consist of a material meeting the *requirement for filter fabric used with riprap* as detailed in Table 3.19 D in section 3.19 of the Virginia Erosion and Sediment Control Handbook Third Edition, 1992, page III-171. A granular filter may be substituted for or used with filter fabric. See Standard and Specification 3.19: Riprap for granular filter material specifications.

CONSTRUCTION RECOMMENDATIONS

- Placement of rock requires a track hoe with a hydraulic thumb.
- Require an inspection of the rock material before it is placed. Rock size and shape requirements are specific and often inappropriate material is installed and must be removed or ultimately leads to structural failure.
- Rock cross vanes must be sealed with filter fabric, a properly sized and placed open class filter aggregate, and/or riprap if the channel bed material is fine enough to pass the structure. This is especially true in sand, silt, and clay stream beds. Material passing through the structure can fill the scour pool. In addition, passing of bed material undermines one of the key benefits of the structure, which is the accumulation of sediment behind the rock cross vane.
- Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.

INSTALLATION GUIDELINES

- Excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the center section and arms of the cross vane. The trench should be perpendicular to the streambanks in the middle 1/3 Qcf width for the center section and excavated to the design angle in the 1/3 Qcf width for each arm. The vane arms should be properly tied into the bank at the Qcf elevation. Excavate a Qcf bench if the top of bank is not at the Qcf elevation. The trench shall be excavated to the minimum footer rock depth (see description below).
- Place one or two courses of footer rocks to the minimum footer rock depth. The minimum footer rock is measured from the stream bed invert and is equal to a depth 3 times the protrusion height of the vane rock for cobble and gravel bed streams and 6 times the protrusion height for sand bed or finer streams (see detail 3.1). Be sure to leave space above the footer rocks for the below invert portion of the vane rocks
- Place vane rocks on top of footer rocks so that each half of the vane rock rests on one half of a footer rock below. Offset the vane rock in the upstream direction and place so they slope slightly against the flow direction. A portion of the vane rocks should be below the stream bed invert with a portion above the invert to the specified protrusion height. The maximum protrusion height is 6 inches.
- Extend the structure into the bank a minimum of 2 feet at the Qcf elevation, and armor with riprap upstream and downstream as needed for stability.
- At the Qcf elevation, create a sill of placed rock perpendicular to the streambank extending away from the end of the vane arm. Construct the sill per PRACTICE 4.5: Cut-Off Sills and Linear Deflectors. The rock should be smaller than the vane and footer rocks but large enough to resist displacement during high flow events.
- Seal the structure on the upstream side for streams with a high proportion of sand, clay, and silt bed material. The detail below (figure 3.2) shows a typical sealing scenario for rock cross vanes.
- Excavate the scour pool to the design depth.

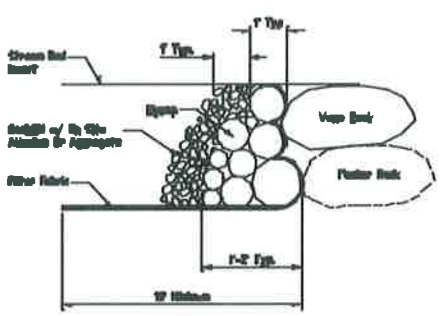


Figure 3.2. Typical sealing detail for rock grade control structures. Adapted from Buck Engineering.

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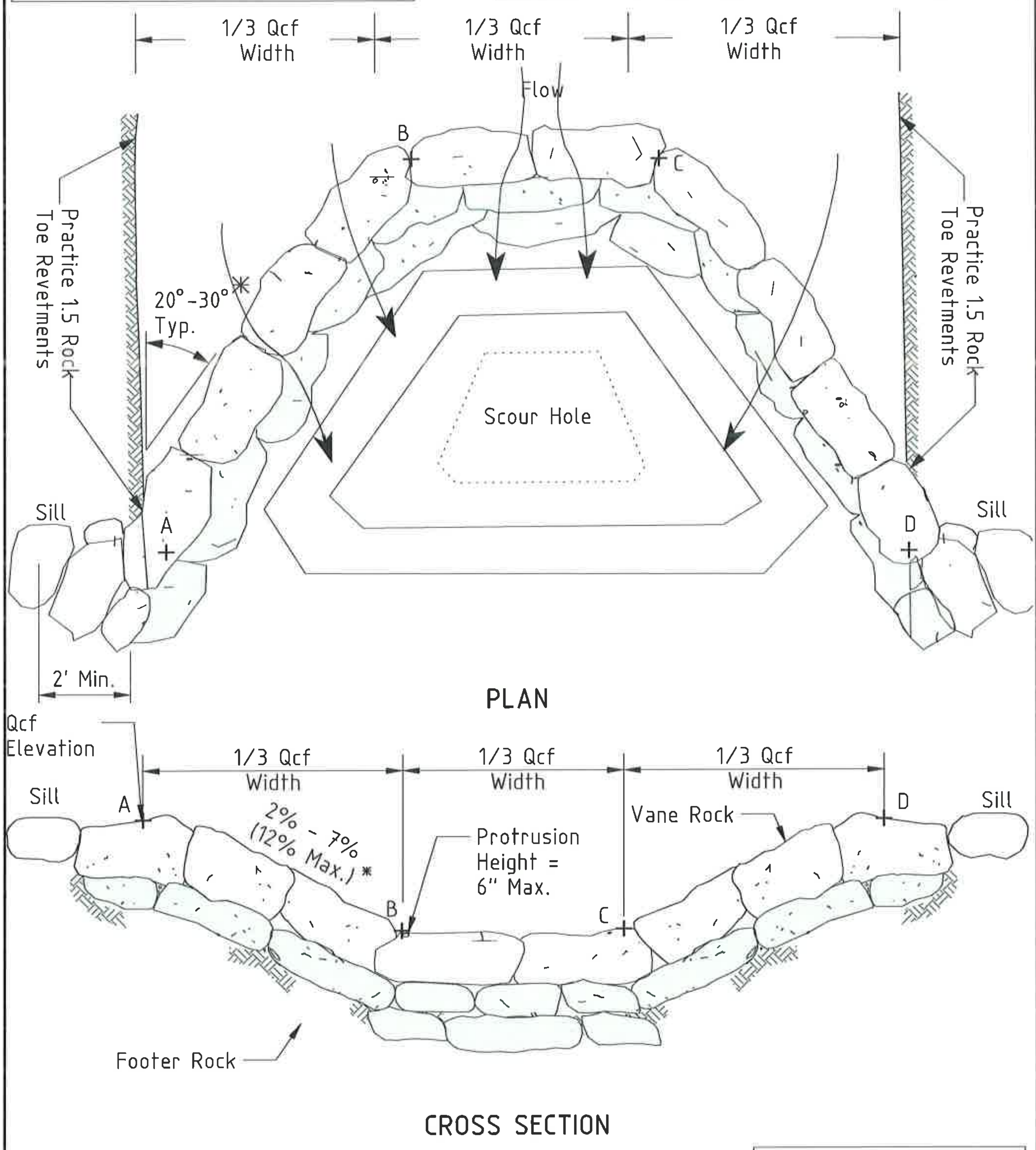
DETAIL 3.1(a): ROCK CROSS VANES

*Provide Elevation & Offset Information for Points A, B,C,D

Seal All Structures per Fig. 3.2 In Streams w/ Sand portion in the bed



Source: Rosgen, 2001

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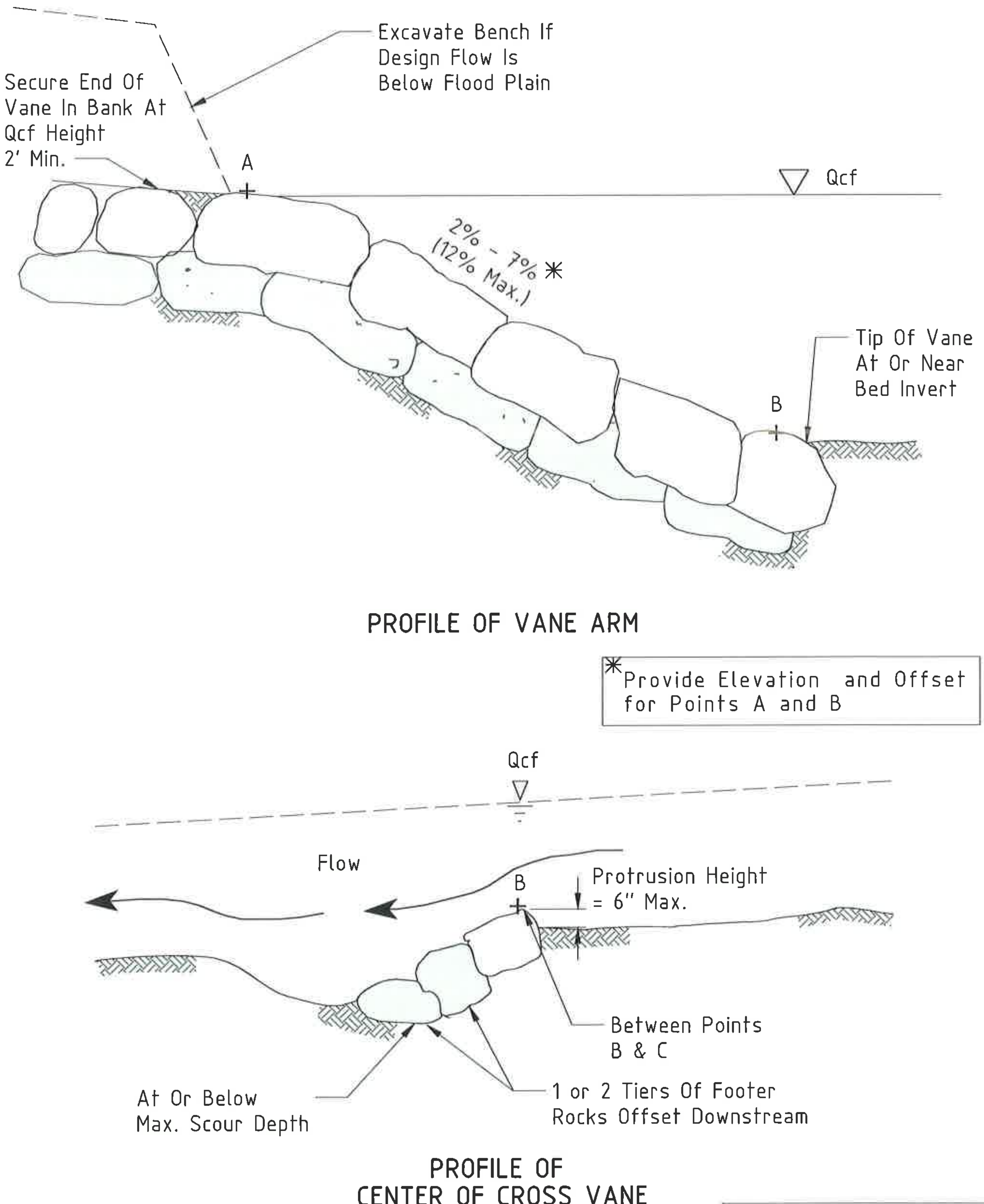
DETAIL 3.1(b): ROCK CROSS VANES



Source: Rosgen, 2001

PRACTICE 3.2: ROCK W-WEIRS

In-stream rock structure for directing erosional forces away from the streambanks and establishing grade control. Rock W-Weirs are similar to Rock Cross Vanes with the W shape pointing upstream and creating two scour pools.

DESCRIPTION

A rock W-weir is a stone structure consisting of footer and vane rocks that provides grade control and reduces bank erosion. The weir consists of four weir arms arranged in a "W" fashion across the channel. The weir accumulates sediment behind the weir arms and creates two scour pools downstream of the structure.

APPROPRIATE USES

- W-weirs are best used in streams with Qcf widths greater than 40 feet.
- Where restoration of an unstable stream bed requires a fixed stream bed elevation.
- To direct erosional forces away from the streambank and to the center of the channel.
- When fish habitat enhancement and/or grade control are desired.
- For protection of 3 cell/two pier bridge. W-weirs provide grade control, prevent lateral migration of channels, increase sediment transport capacity and competence, and reduce footer scour.
- To enhance or create recreational paddling opportunities.

LIMITATIONS

- The Qcf height must be accurately located for the stream as the vane arm is set into the streambank at the Qcf elevation.
- W-weirs used in streams with a significant portion of sand, silt or clay in their beds must be sealed using filter fabric or a properly sized and placed open class aggregate.
- Large rock size requirements and the W-shaped pattern make it difficult to use in smaller streams (less than 40 foot width).
- Requires heavy equipment and skilled operators to place rock correctly.
- Rock may sink or subside in streams with sand and clay beds, which makes proper construction difficult.

DESIGN REQUIREMENTS AND PROCEDURES

- Weir arm should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the weir intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.
- Weir arm slopes are typically 2-15 percent. When designing W-weirs in larger systems, a 2-7 percent slope can result in excessive weir arm lengths. The designer

can choose a steeper slope for the weir arms when practical. However, steeper weirs tend to be less stable, and protect less of the bank.

- Specify elevation and offset values for both ends of all four weir arms. This ensures exact placement of the structure by the contractor.
- W-weirs may create blockages to fish migration. Weir rocks in the center 1/2 of the structure can be gapped to allow fish passage. However, when rocks are gapped, it is important to understand that the top of the footer rock becomes the invert elevation for grade control, not the top of the vein rocks.
- Designer must specify a design depth for the two scour pools immediately downstream of the W-weir. A scour depth analysis is recommended to aid in this effort.
- The outer two weir arms must terminate at the Qcf elevation. If the top of bank is above Qcf, the outer weir arms must be properly connected or entrenched into the bank at the Qcf elevation and a Qcf bench must be created at the Qcf elevation.
- Rock W-weirs should be designed for a maximum vertical drop (protrusion height) of 6 inches. If more than 6 inches of drop is required over a short section of stream, use a series of step pools with 6 inch drops per PRACTICE 3.4: Step Pools.
- For designs using multiple W-weirs to achieve grade control, the following rule of thumb can be used to determine spacing of structures along the stream channel:

  $P_s=8.2513S^{-0.9799}$

  Where P_s=the ratio of pool to pool spacing/Qcf width
  S=Channel slope in percent

This relationship is derived from data on natural streams and rivers with slope generally greater than 2% (Rosgen 2001).

MATERIAL SPECIFICATIONS

- Rock: Footer and weir rocks must be large enough to achieve the design height and appropriately sized to resist movement due to stream flow characteristics. Rocks shall be relatively rectangular in shape, uniform in size, and have a minimum intermediate axis greater than 1.5 feet. An example of rock size as a function of Qcf shear stress is given in Figure 3.1 of PRACTICE 3.1: Rock Cross Vanes.
- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook as needed for sill rocks, bank armoring, and toe protection.
- Open Class Aggregate: Used for sealing behind structure. Should be properly sized to be minimally mobilized and displaced in supercritical flow events. Salvaged alluvial channel material can be substituted for aggregate if properly sized.
- Filter Fabric: If used for sealing the structure, filter fabric shall consist of a material meeting the *requirement for filter fabric used with riprap* as detailed in Table 3.19 D in section 3.19 of the Virginia Erosion and Sediment Control Handbook Third Edition, 1992, page III-171. A granular filter may be substituted for or combined with filter fabric. See Standard and Specification 3.19: Riprap for granular filter material specifications.

CONSTRUCTION RECOMMENDATIONS

- Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.
- Placement of rock may require a track hoe with a hydraulic thumb.
- Require an inspection of the rock material before it is placed. Rock size and shape requirements are specific and often inappropriate material is installed and must be removed or ultimately leads to structural failure.
- Rock W-weirs must be sealed with filter fabric, a properly sized and placed open class aggregate, and/or riprap if a significant portion of channel bed material is fine enough to pass the structure. This is especially true in sand, silt, and clay bed streams. Material passing through the structure can fill the scour pool. In addition, passing of bed material undermines one of the key benefits of the structure, which is the accumulation of sediment behind the rock W-weir.

INSTALLATION GUIDELINES

- Installation will depend in part on how stream flow is maintained around the site and how much of the site, if any, is de-watered during construction. Within the work area, excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the four arms of the rock W-weir. Excavate a Qcf bench if the top of bank is not at the Qcf elevation. The trench shall be excavated to the minimum footer rock depth (see description below). The weir arms should be properly tied into the bank at the Qcf elevation.
- Place one or two courses of footer rocks to the minimum footer rock depth. The minimum footer rock is measured from the stream bed invert and is equal to a depth 3 times the protrusion height of the two apex weir rocks for cobble and gravel bed streams and 6 times the protrusion height for sand bed or finer streams (see detail 3.1). Be sure to leave space above the footer rocks for the below invert portion of the weir rocks.
- Place weir rocks on top of footer rocks so that each half of the weir rock rests on one half of a footer rock below. Offset the weir rock in the upstream direction and place so they slope slightly against the flow direction. A portion of the weir rocks should be below the stream bed invert with a portion above the invert to the specified protrusion height. The maximum protrusion height is 6 inches.
- Extend the structure into the bank a minimum of 2 feet and armor upstream and downstream as needed for stability with riprap.
- At the Qcf elevation, create a sill of placed rock perpendicular to the streambank extending away from the end of the vane arm. Construct the sill per PRACTICE 4.5: Cut-Off Sills and Linear Deflectors. The rock should be smaller than the vane and footer rocks but large enough to resist displacement during high flow events.
- Seal the structure on the upstream side for streams with a high proportion of sand, clay, and silt bed material. See Figure 3.2 of PRACTICE 3.1: Rock Cross Vanes for a typical sealing scenario.
- Excavate the scour pools to the design depth.

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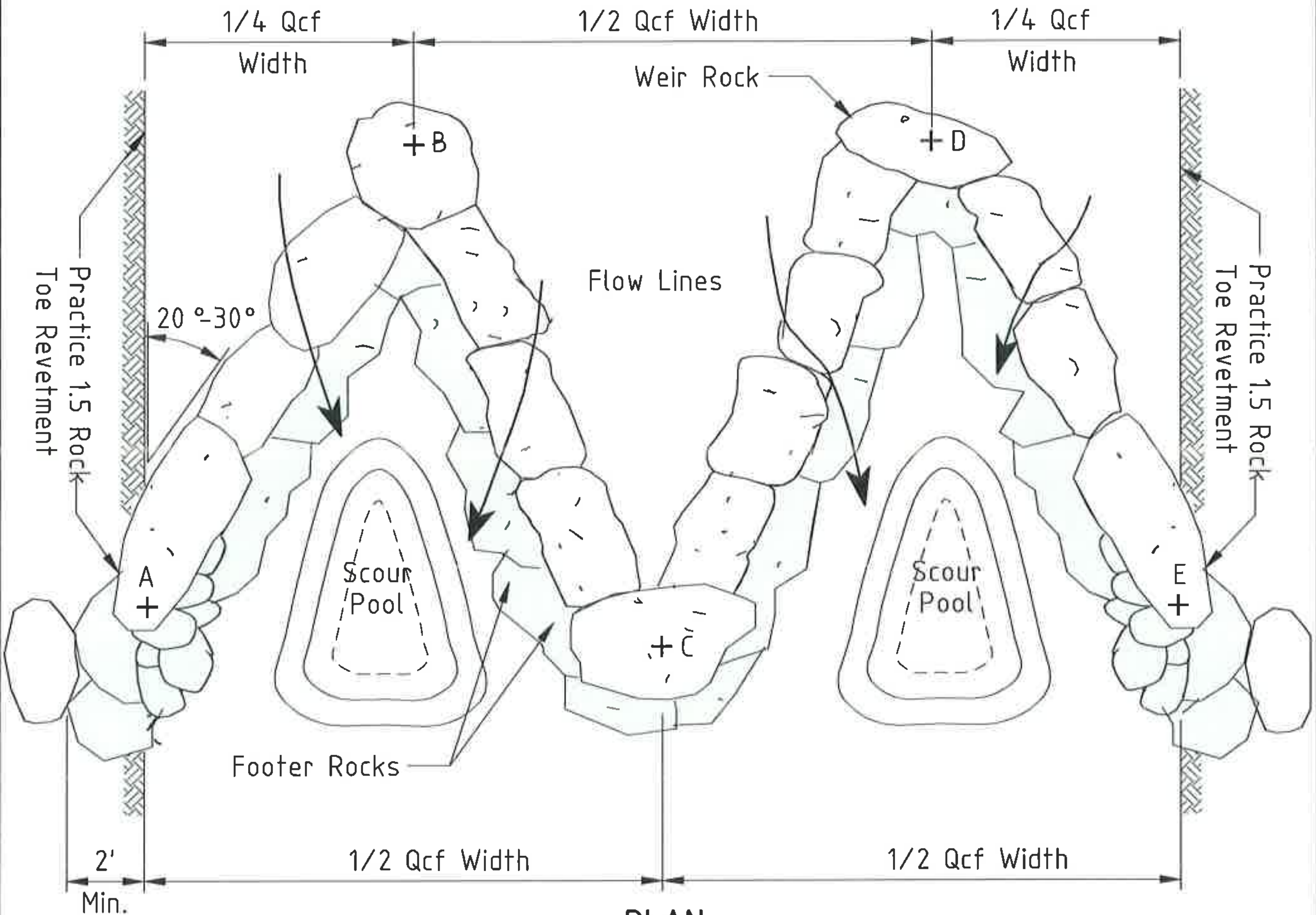
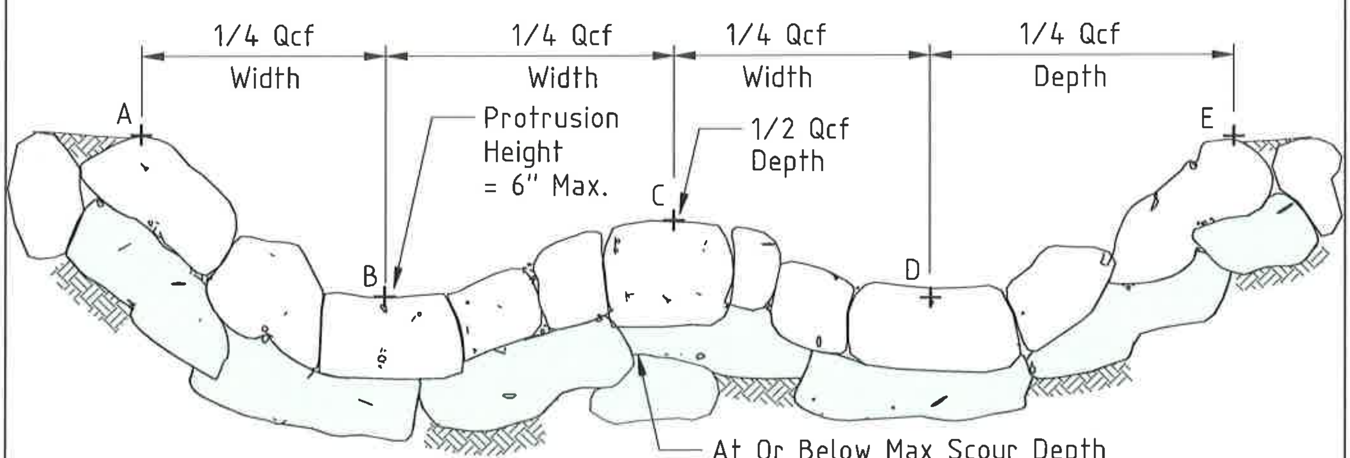
DETAIL 3.2(a): ROCK W-WEIRS

Seal All Structures per Fig. 3.2 for Streams w/ a Sand portion in the bed.

Provide Elevation and Offset for Points A, B, C, D and E



PLAN



SECTION

Section & Plan Views Adapted From Rosgen (1999)

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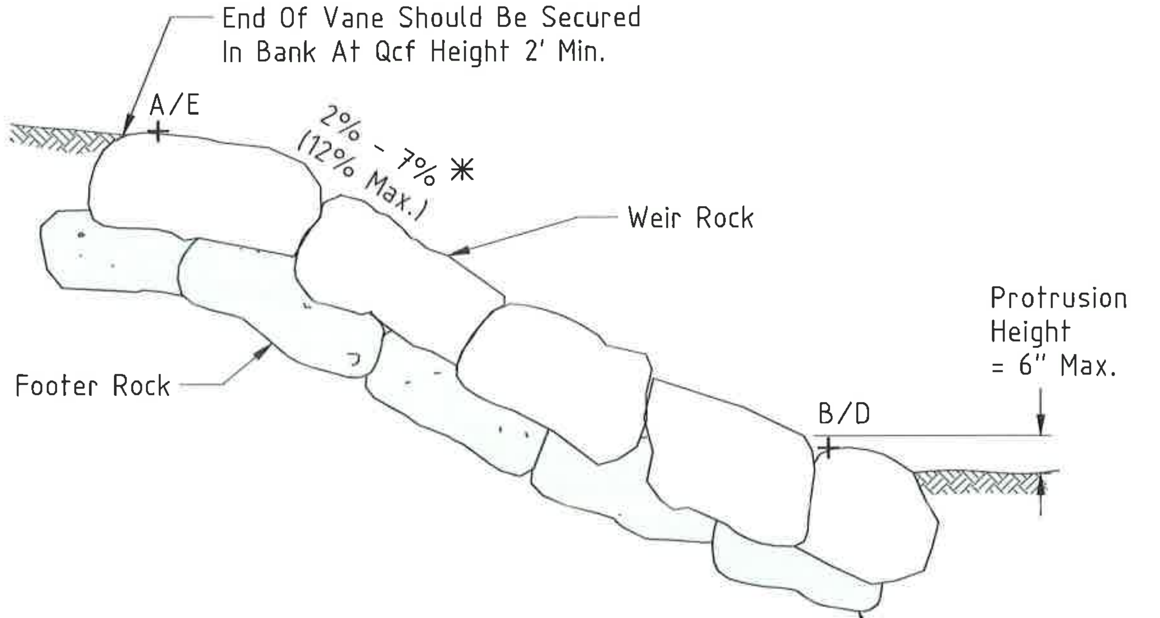
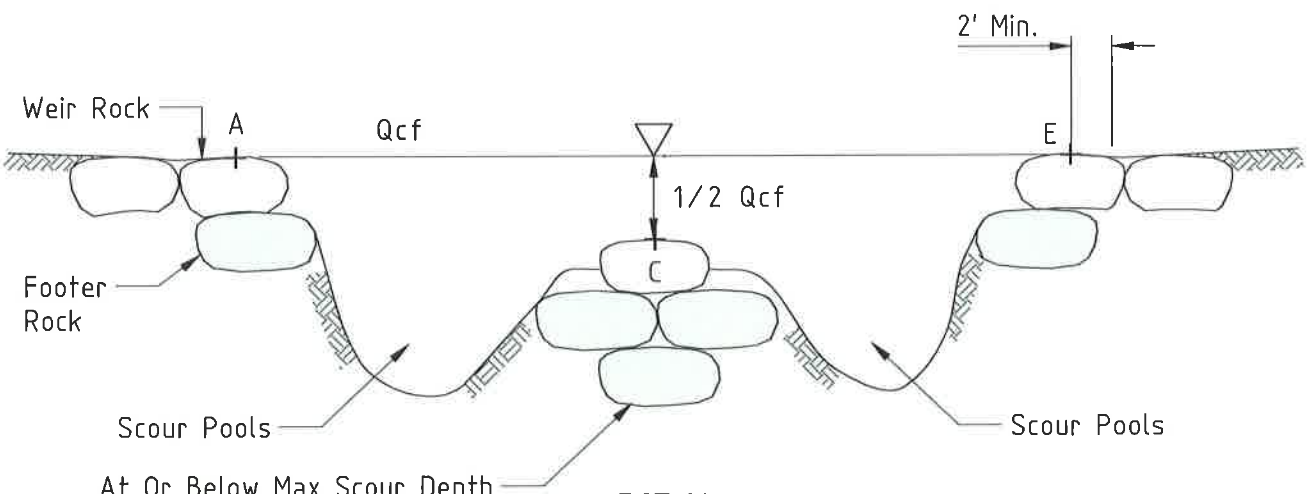
DETAIL 3.2(b): ROCK W-WEIRS



*Provide Elevation and Offset for Points A and B

PROFILE
A → B
E → D



SECTION
A - C - E

Adapted From Rosgen 2001

PRACTICE 3.3: ROCK VORTEX WEIRS

In-stream rock structure for directing erosional forces away from the streambanks and establishing grade control. Rock vortex weirs are similar to rock cross vanes but have a parabolic form and open gaps in structure.

DESCRIPTION

A rock vortex weir consists of footer and vane rocks arranged to provide grade control, provide scour hole, and reduce bank erosion. The form of the rock vortex weir is parabolic and spans the Qcf channel width. The rock vortex weir accumulates sediment behind the weir arms and creates a scour pool downstream of the structure.

APPROPRIATE USES

- Can be used in larger systems but also in smaller streams where the Qcf width limits the use of a rock cross vane.
- Where stabilization of an unstable stream bed requires providing a fixed stream bed elevation.
- To direct erosional forces away from the streambank and to the center of the channel.
- When fish habitat enhancement and grade control are both desired.

LIMITATIONS

- Vortex weirs can be used in place of cross vanes, but are more difficult to construct correctly, due to the critical spacing of the gaps in the structure.
- The Qcf height must be accurately located for the stream, as the weir is set into the streambank at the Qcf elevation.
- Vortex weirs used in streams with a significant portion of sand, silt or clay in their beds must be sealed using filter fabric or a properly sized and placed open class aggregate.
- Smaller rock sizes may be used due to size constraints of the stream, however, rock must be sized to withstand anticipated flow conditions as well as movement by the public.
- Rock may sink or subside in streams with sand and clay beds, which makes proper construction difficult.
- In urban watersheds and smaller streams, litter and debris may clog the gaps in the structure.

DESIGN REQUIREMENTS AND PROCEDURES

- Vortex weirs should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the weir intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.

- Weir arm slopes are typically 2-7 percent. The designer can choose a steeper slope for the weir arms when practical. A higher slope can be used, but the structure will be less stable.
- Specify elevation and offset values for both ends and the center of the structure. This ensures exact placement of the structure by the contractor.
- Designer must specify a design depth for the scour pool immediately downstream of the vortex weir. A scour depth analysis is recommended to aid in this effort.
- The vortex weir must terminate at the Qcf elevation. If the top of bank is above Qcf, the weir arms should be properly tied into the bank at the Qcf elevation and a Qcf bench must be created at the Qcf elevation.
- Rock vortex weirs should be designed for a maximum vertical drop of 6 inches. If more than 6 inches of drop is required over a short section of stream, use a series of step pools with 6 inch drops per PRACTICE 3.4: Step Pools.
- For designs using multiple vortex weirs to achieve grade control, the following rule of thumb can be used to determine spacing of structures along the stream channel.

  $P_s = 8.2513S^{-0.9799}$

  Where P_s=the ratio of pool to pool spacing/Qcf width
  S=Channel slope in percent

This relationship is derived from data on natural streams and rivers with slope generally greater than 2% (Rosgen 2001).

MATERIAL SPECIFICATIONS

- Rock: Footer and weir rocks must be large enough to achieve the design height and appropriately sized to resist movement during storm events.
- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook as needed for bank armoring, and toe protection.
- Open Class Aggregate: Used for sealing behind structure. Should be properly sized to be minimally mobilized and displaced in supercritical flow events. Salvaged alluvial channel material can be substituted for aggregate if properly sized.
- Filter Fabric: If used for sealing the structure, filter fabric shall consist of a material meeting the *requirement for filter fabric used with riprap* as detailed in Table 3.19 D in section 3.19 of the Virginia Erosion and Sediment Control Handbook Third Edition, 1992, page III-171. A granular filter may be substituted for or combined with filter fabric. See Standard and Specification 3.19: Riprap for granular filter material specifications.

CONSTRUCTION RECOMMENDATIONS

- Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.

- Require an inspection of the rock material before it is placed. Rock size and shape requirements are specific and often inappropriate material is installed and must be removed or ultimately leads to structural failure.

INSTALLATION GUIDELINES

- Excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the vortex weir. The trench shall be excavated to the minimum footer rock depth (see description below). Excavate a Qcf bench if the top of bank is not at the Qcf elevation.
- Place one or two courses of footer rocks to the minimum footer rock depth. The minimum footer rock is measured from the stream bed invert and is equal to a depth 3 times the protrusion height of the apex weir rock for cobble and gravel bed streams and 6 times the protrusion height for sand bed or finer streams (see Detail 3.1). Be sure to leave space above the footer rocks for the below invert portion of the weir rocks.
- Place weir rocks on top of footer rocks so that each half of the weir rock rests on one half of a footer rock below. Offset the weir rock in the upstream direction and place so the weir rock slopes slightly against the flow direction. A portion of the weir rocks should be below the stream bed invert with a portion above the invert to the specified protrusion height, typically $1/10^{th}$ the Qcf depth.
- Gap the weir rocks in the middle third of the structure. Ensure the middle third of the structure is properly shaped to direct the flow into the center of the channel.
- Extend the structure into the bank a minimum of 2 feet at the Qcf elevation, and armor upstream and downstream with PRACTICE 1.5: Rock Toe Revetment.
- At the Qcf elevation, create a sill of placed rock perpendicular to the streambank extending away from the end of the vane arm. Construct the sill per PRACTICE 4.5: Cut-Off Sills and Linear Deflectors. The rock should be smaller than the vane and footer rocks but large enough to resist displacement during high flow events.
- Seal the structure on the upstream side for streams with a high proportion of sand, clay, and silt bed material. See Figure 3.2 of PRACTICE 3.1: Rock Cross Vanes for a typical sealing scenario.
- Excavate the scour pool to the design depth.

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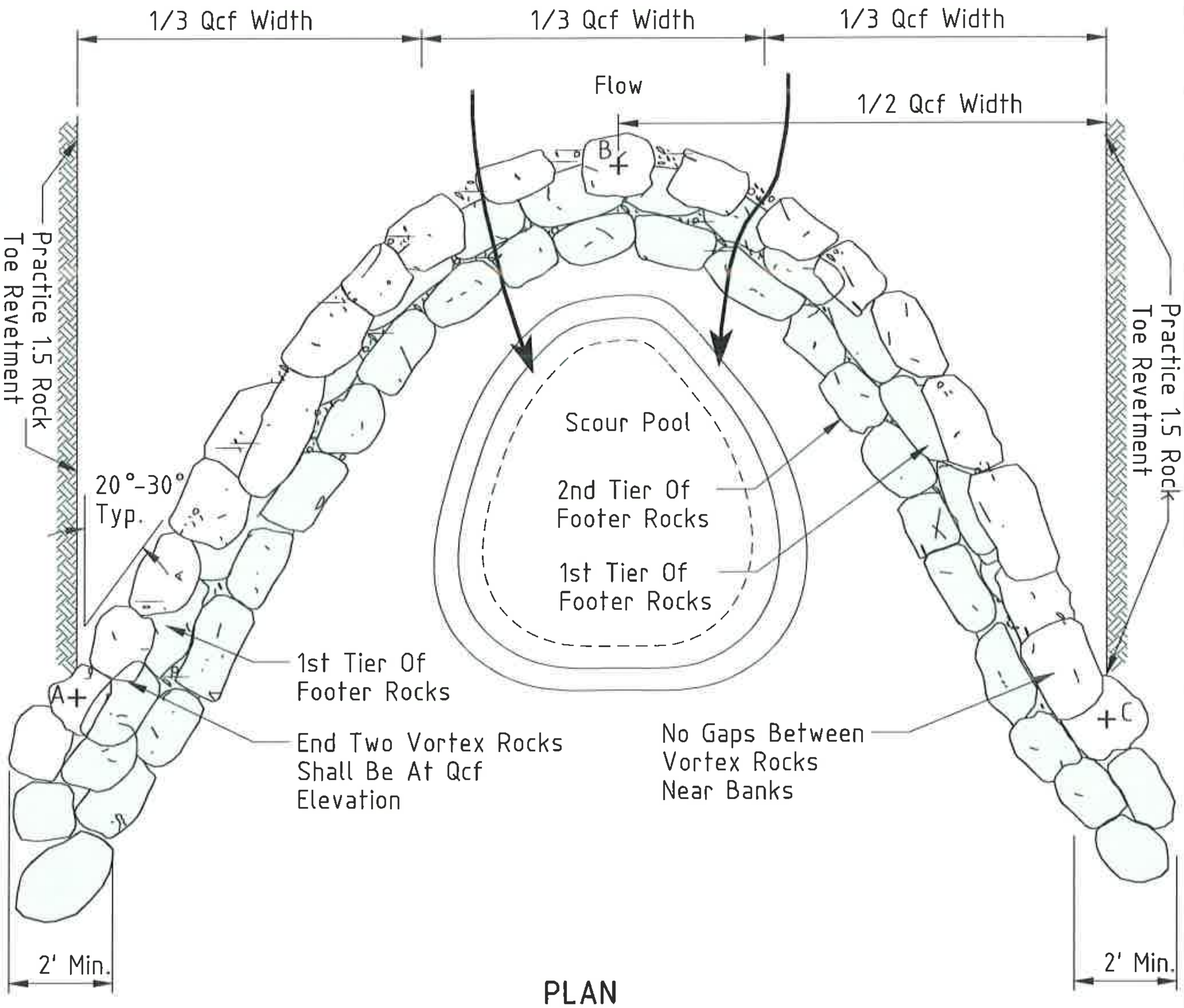
DETAIL 3.3(a): ROCK VORTEX WEIRS

Provide Elevation and Offset for Points A, B and C

Seal All Structures per fig 3.2 For Streams w/ a Sand portion in the bed.



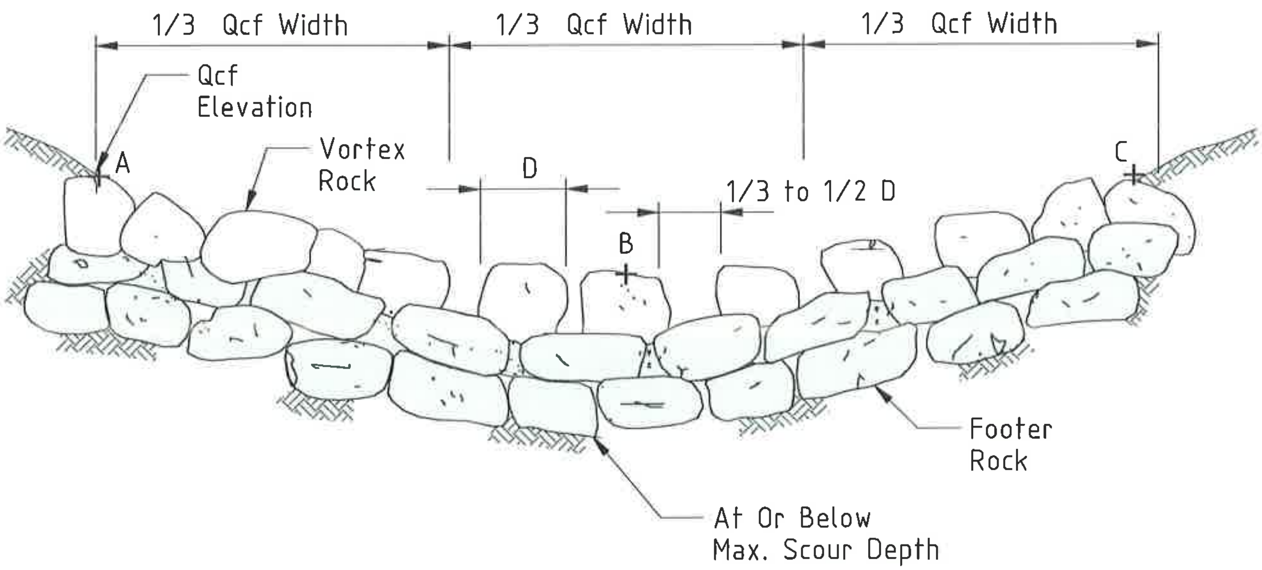
PLAN

Adapted From Rosgen (1999)

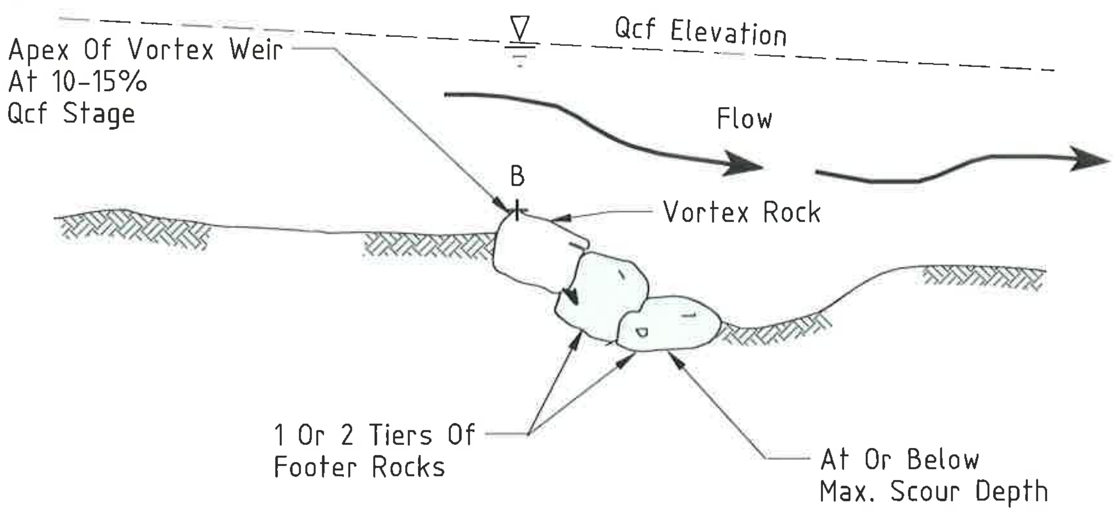
The Virginia Stream Restoration & Stabilization Best Management Practices Guide

DETAIL 3.3(b): ROCK VORTEX WEIRS

Provide Elevation and Offset for Points A, B and C



SECTION



PROFILE

Section & Plan Views Adapted From Rosgen (1999)

PRACTICE 4.1: ROCK VANES

In stream rock structure designed to direct near bank erosional forces away from streambank

DESCRIPTION

Rock vanes are used to deflect near-bank erosional forces away from unstable streambanks and to improve/create aquatic habitat through the formation of scour pools.

APPROPRIATE USES

- To deflect erosional forces away from the streambank at the upstream end of the outer mender bend or other unstable areas.
- Rock vanes are most appropriate in streams with gravel or larger substrate. In low gradient coastal streams, or sand-bed streams, consider use of log vanes.
- When fish habitat enhancement and/or flow deflection are desired.

LIMITATIONS

- The Qcf height must be accurately located for the stream as the vane is set into the streambank at the Qcf elevation.
- Rock vanes used in streams with a significant portion of sand, silt or clay in their beds must be sealed using filter fabric or a properly sized and placed open class aggregate. PRACTICE 4.4: Log Vanes may be more appropriate for these conditions.
- Large rock size requirements may make it difficult to use in small streams.
- May require heavy equipment and skilled operators to place rock correctly.
- Rock may sink or subside in streams with sand and clay beds, which makes proper construction difficult.
- Vanes should not be used in stream reaches with channel slopes greater than 3%.

DESIGN REQUIREMENTS AND PROCEDURES

- Vane arm should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the vane intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.
- Vane arm slopes are typically 2-15 percent. When designing Rock Vanes in larger systems, a 2-7 percent slope can result in excessive vane arm lengths. The designer can choose a steeper slope for the vane arms when practical. However, steeper vanes tend to be less stable, and protect less of the bank.
- Specify elevation and offset values for both ends of the vane arm. This ensures exact placement of the structure by the contractor.
- Horizontal placement is typically along the outer bank on the upstream end of a meander bend. This placement reduces bank erosion along the outer meander.

- Designer must specify a design depth for the scour pool immediately downstream of the rock vane. A scour depth analysis is recommended to aid in this effort.
- The rock vane must terminate at the Qcf elevation. If the top of bank is above the Qcf elevation, the rock vane arms must be properly connected or entrenched into the bank and a floodplain bench must be created at the Qcf elevation.

MATERIAL SPECIFICATIONS

- Rock: Footer and vane rocks must be large enough to achieve the design height and appropriately sized to resist movement due to stream flow characteristics. Rocks shall be relatively rectangular in shape, uniform in size, and have a minimum intermediate axis greater than 1.5 feet. An example of rock size as a function of Qcf shear stress is given in Figure 3.1 of PRACTICE 3.1: Rock Cross Vanes.
- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook for bank armoring and toe protection.
- Open Class Aggregate: Used for sealing behind structure. Should be properly sized to be minimally mobilized and displaced in supercritical flow events. Salvaged alluvial channel material can be substituted for aggregate if properly sized.
- Filter Fabric: If used for sealing the structure, filter fabric shall consist of a material meeting the *requirement for filter fabric used with riprap* as detailed in Table 3.19 D in section 3.19 of the Virginia Erosion and Sediment Control Handbook Third Edition, 1992, page III-171. A granular filter may be substituted for or combined with filter fabric. See Standard and Specification 3.19: Riprap for granular filter material specifications.

CONSTRUCTION RECOMMENDATIONS

- Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.
- Placement of rock may require a track hoe with a hydraulic thumb.
- Require an inspection of the rock material before it is placed. Rock size and shape requirements are specific and often inappropriate material is installed and must be removed or ultimately leads to structural failure.
- Rock vanes must be sealed with filter fabric, open class aggregate, and/or riprap if a significant portion of channel bed material is fine enough to pass the structure. This is especially true in sand, silt, and clay bed streams. Material passing through the structure can fill the scour pool.
- The vane arm should span a maximum of 1/3 of the Qcf width. The larger the channel, the shorter the vane should be relative to the channel width.

INSTALLATION GUIDELINES

- Excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the rock vane. Excavate a Qcf bench if the top of bank is not at the Qcf elevation. The trench shall be excavated to the minimum footer rock depth (see description below). The rock vane arms should be properly tied into the bank at the Qcf elevation.
- Place one or two courses of footer rocks to the minimum footer rock depth. The minimum footer rock is measured from the stream bed invert and is equal to a depth 3 times the protrusion height of the apex rock for cobble and gravel bed streams and 6 times the protrusion height for sand bed or finer streams (see detail 3.1). Be sure to leave space above the footer rocks for the below invert portion of the vane rocks.
- Place vane rocks on top of footer rocks so that each half of the vane rock rests on one half of a footer rock below. Offset the vane rock in the upstream direction and place so they slope slightly against the flow direction. A portion of the vane rocks should be below the stream bed invert with a portion above the invert to the specified protrusion height. The maximum protrusion height is 6 inches.
- Extend the structure into the bank a minimum of 2 feet and armor upstream and downstream as needed for stability with riprap.
- At the Qcf elevation, create a sill of placed rock perpendicular to the streambank extending away from the end of the vane arm. Construct the sill per PRACTICE 4.5: Cut-Off Sills and Linear Deflectors. The rock should be smaller than the vane and footer rocks but large enough to resist displacement during high flow events.
- Seal the structure on the upstream side for streams with a high proportion of sand, clay, and silt bed material. See Figure 3.2 of PRACTICE 3.1: Rock Cross Vanes for a typical sealing scenario.
- Excavate the scour pools to the design depth.

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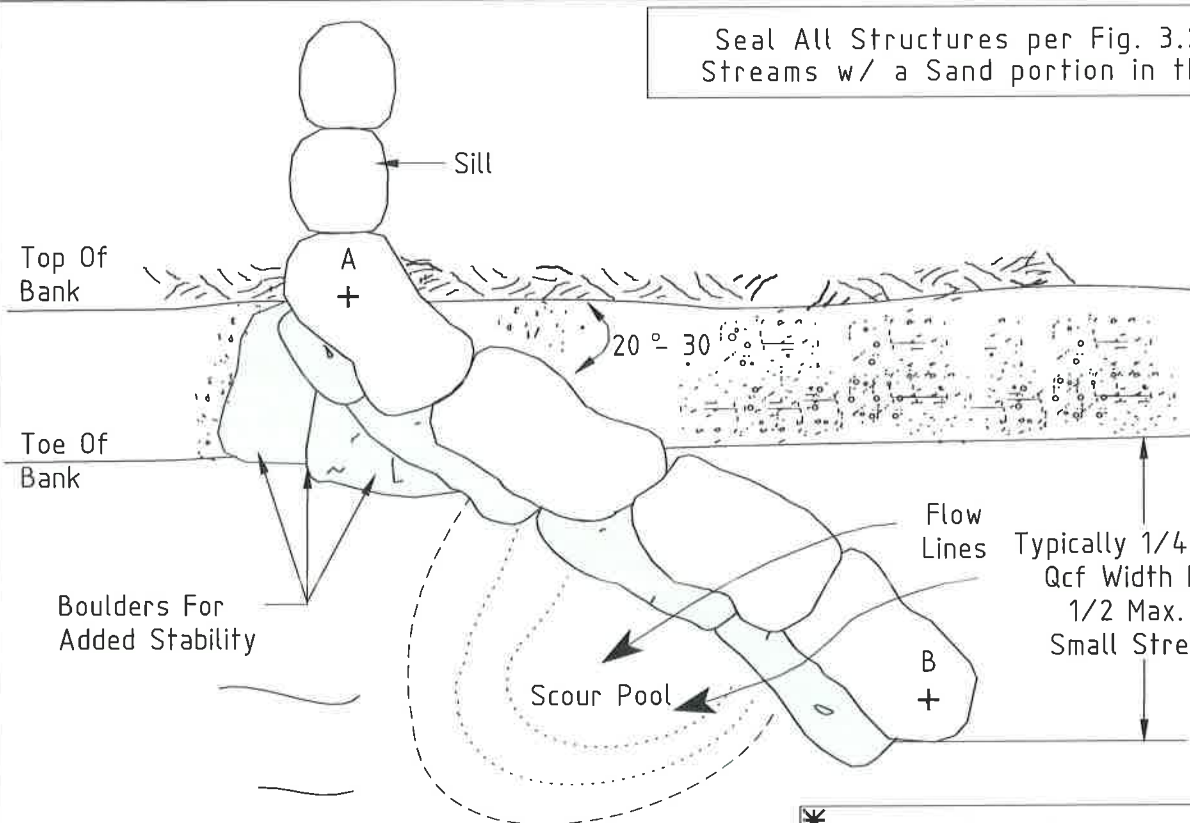
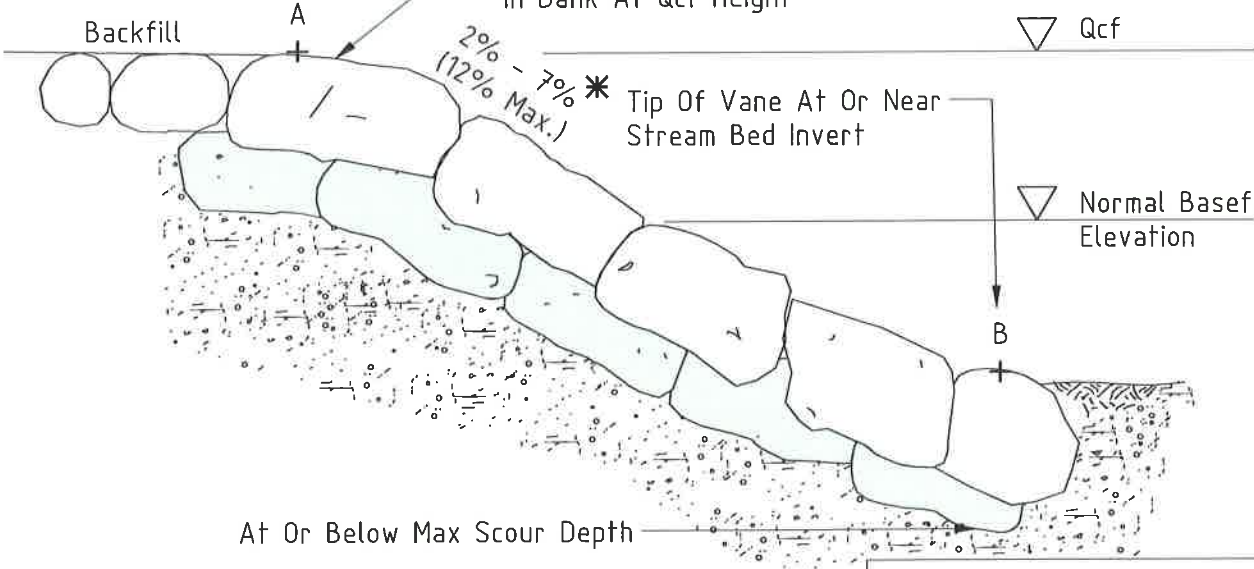
DETAIL 4.1: ROCK VANES

Seal All Structures per Fig. 3.2 For Streams w/ a Sand portion in the bed.



*Provide Elevation and Offset for Points A and B

PLAN



PROFILE

Section & Plan Views Adapted From Rosgen (2001)

FLOW DEFLECTION CONCENTRATION GUIDELINES	DECEMBER 2003	VIRGINIA DEPARTMENT OF CONSERVATION RECREATION

PRACTICE 4.2: J-HOOK VANES

In stream rock structure similar to a rock vane designed to direct near bank erosional forces away from streambank

DESCRIPTION

J-hook vanes are used to deflect near-bank erosional forces away from unstable streambanks and to improve/create aquatic habitat through the formation of scour pools. The structure is identical to a rock vane (as described in PRACTICE 4.1:Rock Vanes) with the addition of several gapped rocks placed in the middle third of the channel in a parabolic arc. The additional "J-rocks" create a scour pool with moderate to high fish habitat value.

APPROPRIATE USES

- To deflect erosional forces away from the streambank at the upstream end of the outer mender bend.
- J-Hook vanes are most appropriate in streams with gravel or larger substrate. In low gradient coastal streams, or sand-bed streams, consider use of log vanes or combination of log and rock to create J-Hook Vane.
- When fish habitat enhancement and/or flow deflection are desired.
- Compatible with recreational boating in medium to large rivers.

LIMITATIONS

- The Qcf height must be accurately located for the stream as the top of the streambank must be at Qcf height or a Qcf bench must be created for use with J-hook vanes. The vane is set into the streambank at the Qcf elevation.
- J-hook vanes used in streams with a significant portion of sand, silt or clay in their beds must be sealed using filter fabric or a properly sized and placed open class aggregate. PRACTICE 4.4: Log Vanes may be more appropriate for these conditions.
- Large rock size requirements may make it difficult to use in small streams.
- May require heavy equipment and skilled operators to place rock correctly.
- Rock may sink or subside in streams with sand and clay beds, which makes proper construction difficult.
- J-hook vanes should not be used in stream reaches with channel slopes greater than 3%.

DESIGN REQUIREMENTS AND PROCEDURES

- Vane arm should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the vane intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.

- On large rivers, it is impractical to extend the vane to the 1/3 Qcf width, so a specific angle is selected.
- Vane arm slopes are typically 2-15 percent. When designing J-hook Vanes in larger systems, a 2-7 percent slope can result in excessive vane arm lengths. The designer can choose a steeper slope for the vane arms when practical. However, steeper vane arms tend to be less stable, and protect less bank.
- Specify elevation and offset values for both ends of the vane arms and the terminal "J-rock." This ensures exact placement of the structure by the contractor.
- Designer must specify a design depth for the scour pool immediately downstream of the rock vane. A scour depth analysis is recommended to aid in this effort.
- The J-hook vane must terminate at the Qcf elevation. If the top of bank is above Qcf, the J-hook vane must be properly connected or entrenched into the bank and a Qcf bench must be created at the Qcf elevation.
- Gap the "J-rock" 1/3 to 1/2 of the diameter of the rock.

MATERIAL SPECIFICATIONS

- Rock: Footer and vane rocks must be large enough to achieve the design height and appropriately sized to resist movement due to stream flow characteristics. Rocks shall be relatively rectangular in shape, uniform in size, and have a minimum intermediate axis greater than 1.5 feet. An example of rock size as a function of Qcf shear stress is given in Figure 3.1 (PRACTICE 3.1: Rock Cross Vanes).
- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook for bank armoring and toe protection.
- Open Class Aggregate: Used for sealing behind structure. Should be properly sized to be minimally mobilized and displaced in supercritical flow events. Salvaged alluvial channel material can be substituted for aggregate if properly sized.
- Filter Fabric: If used for sealing the structure, filter fabric shall consist of a material meeting the *requirement for filter fabric used with riprap* as detailed in Table 3.19 D in section 3.19 of the Virginia Erosion and Sediment Control Handbook Third Edition, 1992, page III-171. A granular filter may be substituted for or combined with filter fabric. See standard and specification 3.19: Riprap for granular filter material specifications.

CONSTRUCTION RECOMMENDATIONS

- Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.
- Placement of rock requires a track hoe with a hydraulic thumb.
- Require an inspection of the rock material before it is placed. Rock size and shape requirements are specific and often inappropriate material is installed and must be removed or ultimately leads to structural failure.
- J-hook vanes must be sealed with filter fabric, open class aggregate, and/or riprap if a significant portion of channel bed material is fine enough to pass the structure.

This is especially true in sand, silt, and clay bed streams. Material passing through the structure can fill the scour pool.
- The vane arm should span a maximum of 1/3 of the Qcf width and the J-hook rocks should span the center 1/3 of the Qcf width. The larger the channel, the shorter the vane should be relative to the channel width.

INSTALLATION GUIDELINES

- Excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the j-hook vane. The vane arms should be properly tied into the bank at the Qcf elevation and a Qcf bench should be excavated if the top of bank is not at the Qcf elevation. The trench shall be excavated to the minimum footer rock depth (see description below).
- Place one or two courses of footer rocks to the minimum footer rock depth. The minimum footer rock is measured from the stream bed invert and is equal to a depth 3 times the protrusion height of the apex rocks for cobble and gravel bed streams and 6 times the protrusion height for sand bed or finer streams (see detail 3.1). Be sure to leave space above the footer rocks for the below invert portion of the vane rocks.
- Place vane rocks on top of footer rocks so that each half of the vane rock rests on one half of a footer rock below. Offset the vane rock in the upstream direction and place so they slope slightly against the flow direction. A portion of the vane rocks should be below the stream bed invert with a portion above the invert to the specified protrusion height. The maximum protrusion height is 6 inches.
- Extend the structure into the bank a minimum of 2 feet and armor upstream and downstream as needed for stability with riprap.
- At the Qcf elevation, create a sill of placed rock perpendicular to the streambank extending away from the end of the vane arm. Construct the sill per PRACTICE 4.5: Cut-Off Sills and Linear Deflectors. The rock should be smaller than the vane and footer rocks but large enough to resist displacement during high flow events.
- Seal the structure on the upstream side for streams with a high proportion of sand, clay, and silt bed material. See Figure 3.2 of PRACTICE 3.1: Rock Cross Vanes for a typical sealing scenario.
- Excavate the scour pools to the design depth.

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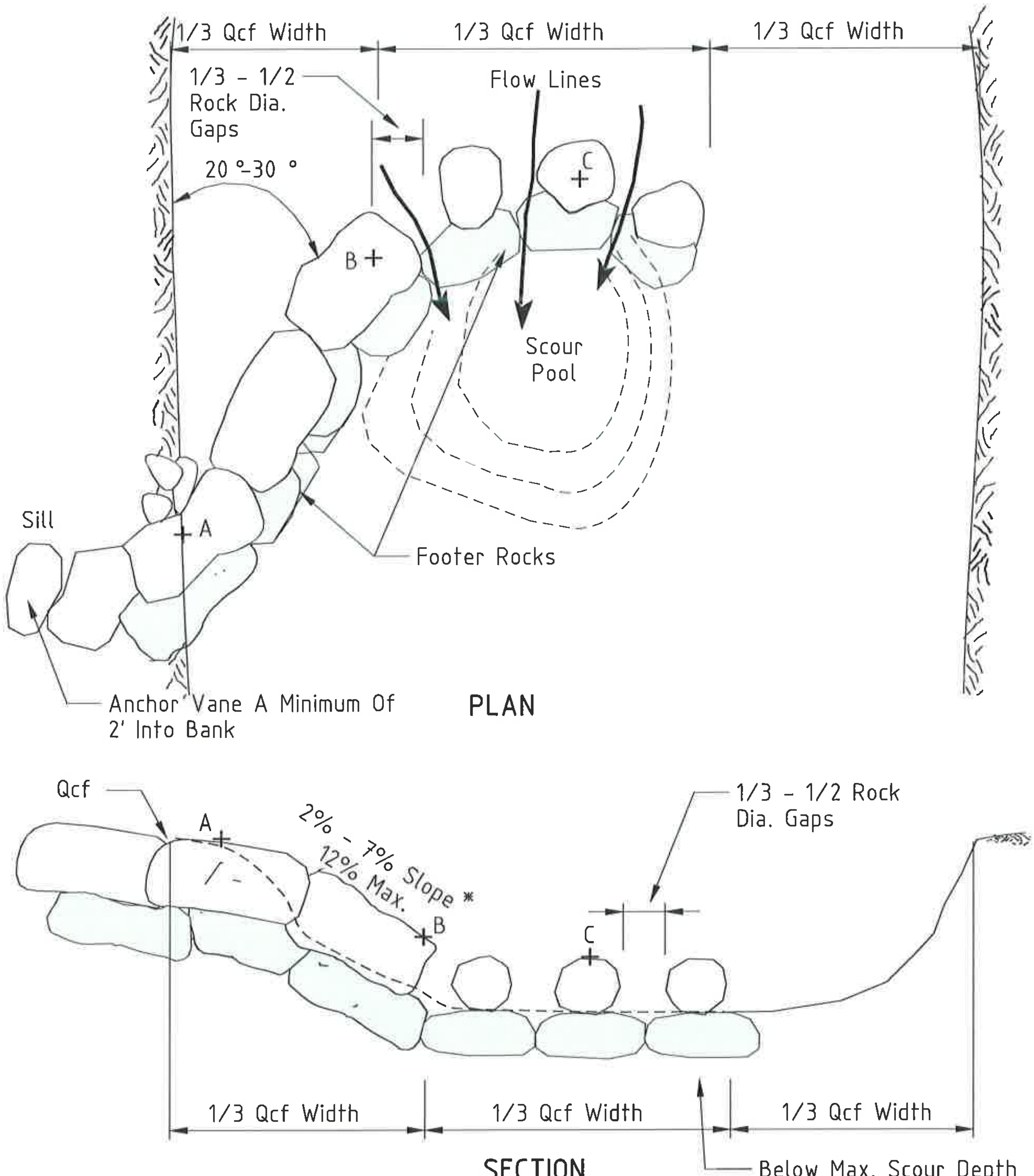
DETAIL 4.2(a): J-HOOK VANES



* Designer to Provided Offset and Elevation for Points A,B,C

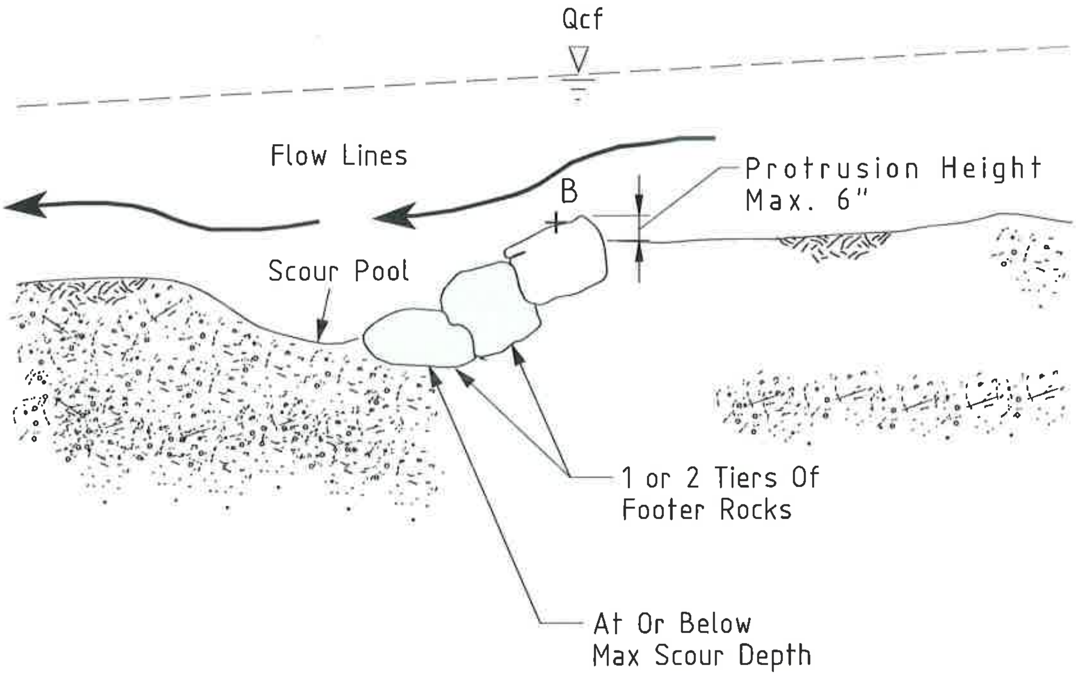
Seal All Structures per Fig. 3.2 For Streams with a Sand portion in the bed.

Section & Plan Views Adapted From Rosgen (2001)

FLOW DEFLECTION CONCENTRATION GUIDELINES	DECEMBER 2003	VIRGINIA DEPARTMENT OF CONSERVATION RECREATION

The Virginia Stream Restoration & Stabilization Best Management Practices Guide

DETAIL 4.2(b): J-HOOK VANES



PROFILE
B-C

Section & Plan Views Adapted From Rosgen (2001)

PRACTICE 4.4: LOG VANES

In-stream wood structure designed to direct near bank erosional forces away from streambank

DESCRIPTION

Log vanes are used to deflect near bank erosional forces away from unstable streambanks and to improve/create aquatic habitat through the formation of scour pools.

APPROPRIATE USES

- To deflect erosional forces away from the streambank at the upstream end of the outer mender bend or other unstable areas.
- In sand, silt, and clay bed streams or in streams where a design preference for woody material is expressed.
- When fish habitat enhancement or flow deflection are desired.

LIMITATIONS

- The Qcf height must be accurately located for the stream as the vane is set into the streambank at the Qcf elevation.
- Vanes should not be used in stream reaches with channel slopes greater than 3%.
- Log vanes have limited lengths, so may not be suitable for large rivers.
- Logs degrade over time and may need to be periodically maintained or replaced.

DESIGN REQUIREMENTS AND PROCEDURES

- Log Vanes should intersect the bank at an angle between 20 and 30 degrees. The angle is measured upstream from the tangent line where the vane intercepts the bank. A smaller angle produces a longer arm. A longer arm provides more linear feet of bank protection.
- Log Vane slopes are typically 2-15 percent. Slopes are constrained by length of available logs. The steeper the slope of the vane, the less stable it may be.
- Specify elevation and offset values for both ends of the vane arms. This ensures exact placement of the structure by the contractor.
- Designer must specify a design depth for the scour pool immediately downstream of the log vane. A scour depth analysis is recommended to aid in this effort.
- The log vane must terminate at the Qcf elevation. If the top of bank is above Qcf, a Qcf bench must be created. The log vane must be properly connected or entrenched into the bank at the Qcf elevation.

MATERIAL SPECIFICATIONS

- Logs: 8 inches to 12+ inches in diameter rot-resistant logs.
- Anchors: 1/4 inch minimum diameter, 3 foot long rebar or drift pins for anchoring and connecting logs.
- Support Pilings: 3 inches to 6 inches in diameter logs with one angled and one flat end. Long enough to extend from the normal baseflow elevation to a minimum of one foot below the design scour depth.
- Riprap: Riprap per Standard and Specification 3.19: Riprap of the Virginia Erosion and Sediment Control Handbook for bank armoring and toe protection.

CONSTRUCTION RECOMMENDATIONS

Ensure no leakage/flow under or around the structure by properly grading, sealing, and compacting under and around the structure.

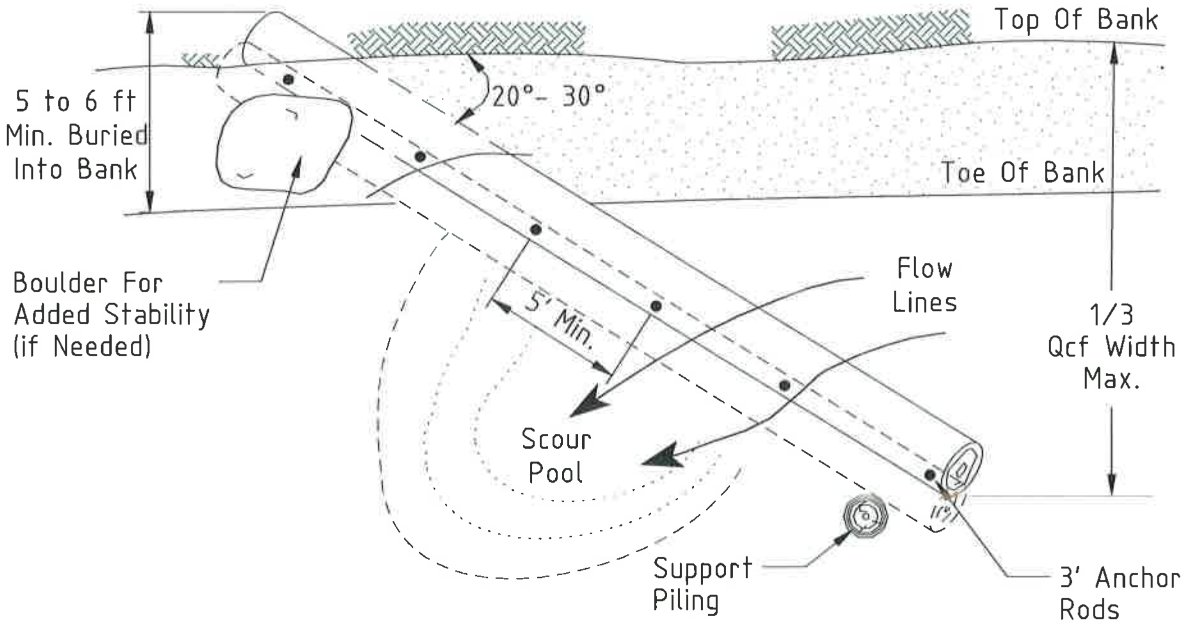
- After installation, check proper function/flow path by observing flow over structure. Repair as needed to ensure proper function.
- The log vane should span a maximum of 1/3 of the Qcf width.

INSTALLATION GUIDELINES

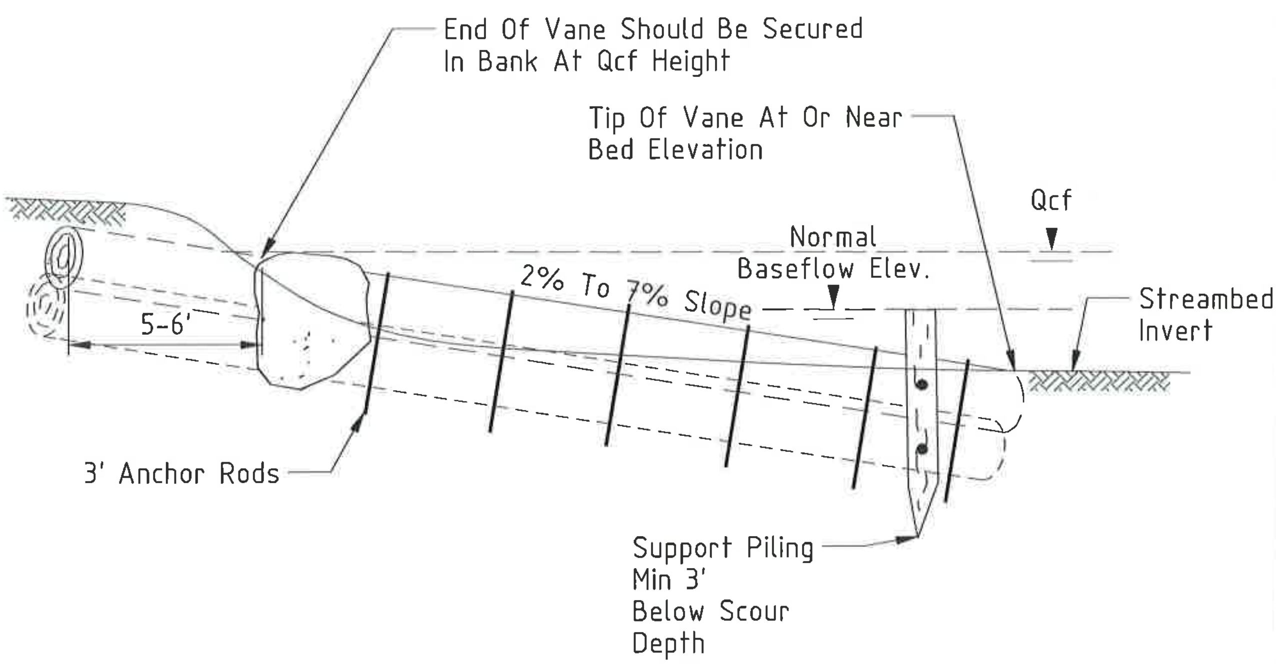
- Excavate a trench along the bottom of the stream bed and to the Qcf elevation in the streambank for the log vane. Excavate a Qcf bench if the top of bank is not at the Qcf elevation. The log vane must be properly connected or entrenched into the bank at the Qcf elevation.
- Anchor logs into the stream bed to a depth below the design scour depth. Logs should be anchored together with anchor rods at a spacing of 5 feet on center. Place an anchor on both sides of the support piling at the streamside end of the structure.
- Place the support piling on the downstream side of the log. The support piling should be driven into the bottom below the anticipated scour depth. Anchor the support piling to the log vane with one anchor per log comprising the vane.
- The log vane should extend into the bank a minimum of 5 to 6 feet. Riprap may be needed upstream and downstream of where the log vane enters the bank to enhance stability. If riprap is used, it should be designed and constructed per Standard and Specification 3.19 of the Virginia Erosion and Sediment Control Handbook.
- Excavate the scour pools to the design depth.

The Virginia Stream Restoration & Stabilization Best Management Practices Guide

DETAIL 4.4: LOG VANES



PLAN



SECTION

Source

KCI Technologies

FLOW DEFLECTION CONCENTRATION GUIDELINES	DECEMBER 2003	VIRGINIA DEPARTMENT OF CONSERVATION RECREATION

Appendix 4

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet **QHEI Score:** [ ]

Stream & Location: ________________ *RM:* _ _ _ . _ *Date:* _ _ / _ _ / 06

________________ *Scorers Full Name & Affiliation:* ________________

River Code: _ _ - _ _ _ - _ _ _ *STORET #:* _ _ _ _ _ _ *Lat./ Long.:* (NAD 83 - decimal °) _ _ . _ _ _ _ _ /8_ . _ _ _ _ _ *Office verified location* ☐

1] *SUBSTRATE* Check *ONLY* Two substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]	___	___	☐☐ HARDPAN [4]	___	___
☐☐ BOULDER [9]	___	___	☐☐ DETRITUS [3]	___	___
☐☐ COBBLE [8]	___	___	☐☐ MUCK [2]	___	___
☐☐ GRAVEL [7]	___	___	☐☐ SILT [2]	___	___
☐☐ SAND [6]	___	___	☐☐ ARTIFICIAL [0]	___	___
☐☐ BEDROCK [5]	___	___	(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

Comments

Check ONE (*Or 2 & average*)

ORIGIN
☐ LIMESTONE [1]
☐ TILLS [1]
☐ WETLANDS [0]
☐ HARDPAN [0]
☐ SANDSTONE [0]
☐ RIP/RAP [0]
☐ LACUSTURINE [0]
☐ SHALE [-1]
☐ COAL FINES [-2]

QUALITY
SILT:
☐ HEAVY [-2]
☐ MODERATE [-1]
☐ NORMAL [0]
☐ FREE [1]

EMBEDDEDNESS:
☐ EXTENSIVE [-2]
☐ MODERATE [-1]
☐ NORMAL [0]
☐ NONE [1]

Substrate [ ] *Maximum 20*

2] *INSTREAM COVER*

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT
Check ONE (*Or 2 & average*)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover [ ] *Maximum 20*

3] *CHANNEL MORPHOLOGY* Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel [ ] *Maximum 20*

4] *BANK EROSION AND RIPARIAN ZONE* Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐ ☐ NONE / LITTLE [3]	☐ ☐ WIDE > 50m [4]	☐ ☐ FOREST, SWAMP [3]	☐ ☐ CONSERVATION TILLAGE [1]
☐ ☐ MODERATE [2]	☐ ☐ MODERATE 10-50m [3]	☐ ☐ SHRUB OR OLD FIELD [2]	☐ ☐ URBAN OR INDUSTRIAL [0]
☐ ☐ HEAVY / SEVERE [1]	☐ ☐ NARROW 5-10m [2]	☐ ☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐ ☐ MINING / CONSTRUCTION [0]
	☐ ☐ VERY NARROW < 5m [1]	☐ ☐ FENCED PASTURE [1]	
	☐ ☐ NONE [0]	☐ ☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian [ ] *Maximum 10*

5] *POOL / GLIDE AND RIFFLE / RUN QUALITY*

MAXIMUM DEPTH
Check ONE (*ONLY!*)
☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH
Check ONE (*Or 2 & average*)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☐ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY
Check ALL that apply
☐ TORRENTIAL [-1]
☐ VERY FAST [1]
☐ FAST [1]
☐ MODERATE [1]
☐ SLOW [1]
☐ INTERSTITIAL [-1]
☐ INTERMITTENT [-2]
☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current [ ] *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*).

☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
☐ BEST AREAS > 10cm [2]
☐ BEST AREAS 5-10cm [1]
☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
☐ MAXIMUM > 50cm [2]
☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
☐ STABLE (e.g., Cobble, Boulder) [2]
☐ MOD. STABLE (e.g., Large Gravel) [1]
☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
☐ NONE [2]
☐ LOW [1]
☐ MODERATE [0]
☐ EXTENSIVE [-1]

Comments

Riffle / Run [ ] *Maximum 8*

6] *GRADIENT* (ft/mi)

DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: [ ] %GLIDE: [ ]
%RUN: [ ] %RIFFLE: [ ]

Gradient [ ] *Maximum 10*

A] SAMPLED REACH
Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE (1st -sample pass- 2nd)
- ☐ HIGH ☐
- ☐ UP ☐
- ☐ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☐ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_______ meters

CLARITY (1st --sample pass-- 2nd)
- ☐ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

pass 1st_________ cm
2nd_________ cm

CANOPY
- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

C] RECREATION
AREA DEPTH
POOL: ☐ >100ft² ☐ >3ft

D] MAINTENANCE
Circle some & *COMMENT*

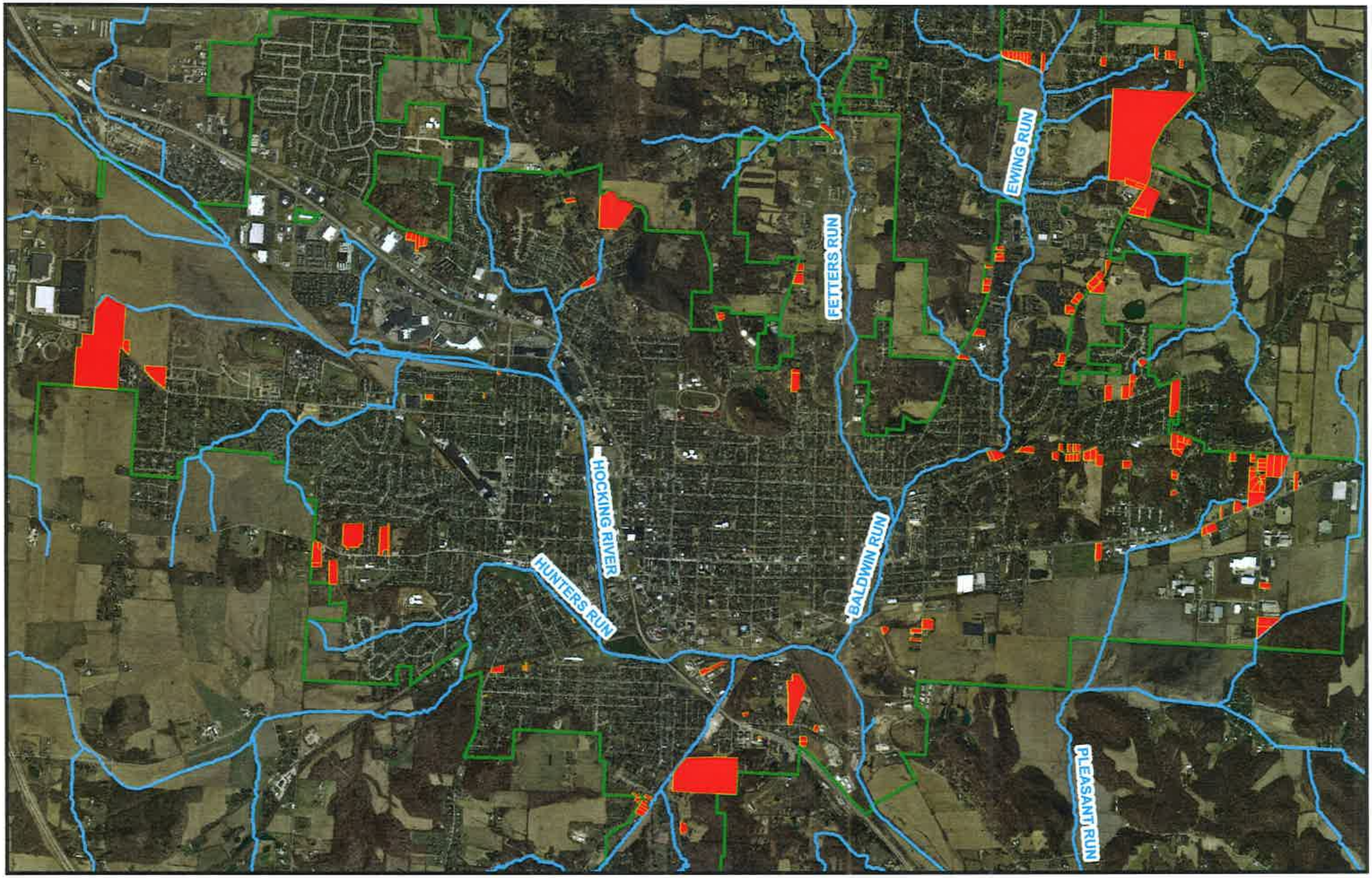
PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES
WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS
$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio
Legacy Tree:

Stream Drawing:

Appendix 5



Lancaster Home Sewage Treatment Systems

0 2,000 4,000 8,000 Feet

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data -North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet.
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology
Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

Hocking River Corridor Plan

Hocking River Background

Background & Literature Review

The Hocking River watershed is a major watershed in southeastern Ohio with a total drainage area of 1,200 square miles over portions of six southeast Ohio counties. Its headwaters are located to the west of Lancaster, near Hocking Run Street and south of Lithopolis Road. It is the final destination into which all of Lancaster's water resources flow. The Hocking River then crosses through Fairfield County followed by two additional counties, Hocking and Athens, before discharging into the Ohio River. Lancaster contains 5.5 miles of river out of the total 100 miles.

Early settlers identified the Hocking River as a resource to fulfill needs including drinking water, agriculture, and transport, making the area an attractive one for settlement. Lancaster and Athens are the two largest cities located along the banks of the Hocking River, with Logan being a third city of relative size. This extensive development includes multiple land uses including agricultural, residential, commercial, and industrial uses throughout its length. The Hocking River is the primary recipient of multiple water pollution control facility discharges from Lancaster and other cities as well as CSO overflows, home sewage treatment system seepage, Municipal Separate Storm Sewer Systems (MS4), and discharges associated with mobile home parks.

Major floods have occurred in the Hocking River watershed at least three times since the beginning of the 20th century. In 1907, spring showers coalesced into flood waters across the southern portion of the state. Areas of the state received more than six inches of water in a 2-3 day period. The result was 32 total deaths, 15 of which occurred in the Hocking River watershed, and thousands left homeless. The water reaching the Ohio River resulted in a 30-foot rise in river levels and immeasurable damage to infrastructure. More flooding during the 1930s lead to conditions where multiple streams throughout Lancaster and the Hocking River watershed became channelized.

Flooding also affected the Hocking River through Athens County in 1968. The event became national news after four inches of rain fell in 24 hours, raising water levels in the Hocking River to eight feet above flood stage and forcing Ohio University students as well as local residents to evacuate the area. The floods in Athens County resulted in 8.9 million dollars in damages, one million dollars to Ohio University alone. This flood, in combination with previous moderate flooding in 1963 and 1964, prompted a project to relocate the Hocking River to reduce flood damages. The project relocated five miles of the river to avoid sensitive infrastructure, resulting in an estimated 48 million dollars of flood damage prevention in the time since completion of the project in 1971.

The Ohio EPA monitors water quality on the Hocking River as one of the major watersheds for the state and one of the major tributaries to the Ohio River itself.

The 1991 Ohio EPA publication entitled "Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries" identified improved water quality conditions when compared to conditions in the early 1980s. The report considered water quality "good" upstream of Lancaster, but beginning around RM 92, near Lancaster, water quality "gradually declined" until exiting Lancaster, despite the improved water quality. The Hocking River through Lancaster received only partial attainment with WWH criteria at one of four locations. The other three locations were considered in nonattainment with habitat criteria. All Lancaster locations were in exceedance of the criteria for fecal coliform, with two of these locations also exceeding the criteria for dissolved oxygen and one exceeding the criteria for iron in acceptable water conditions.

A similar publication in 1997 entitled "Biological and Water Quality Study of the Upper Hocking and Selected Tributaries" documented further improvements in water quality in the river. The Hocking River achieved partial to full attainment for WWH criteria in all locations taken across the City. Water quality parameters and heavy metal levels were consistent with WWH usage.

In 2009, the Ohio EPA publication entitled "Total Maximum Daily Loads for the Hocking River Watershed" sampled both the Hocking River and major tributaries assessing water quality, habitat quality, and channel-modifying attributes. The Ohio EPA retrieved samples at many locations in and around Lancaster and scores from each of these locations varied greatly. Samples taken upstream of Lancaster achieved QHEI scores varying between 41 and 73, but all three locations, located at RM 100.2, 96.8, and 91.9, contained modified attributes and high-influence modified attributes. Three samples taken from within Lancaster located at RM 89.4, 88.9, and 87.3 scored between 55 and 69, only one of which was under the threshold for the requisite number of high-influence modifications. The channel is cited as the main impaired category through Lancaster. The nearest sample location downstream is at RM 81.9, and achieved full attainment with OEPA's thresholds for WWH and a QHEI score of 77.

The City of Lancaster completed a restoration of a portion of Hocking River in 2011, resulting in the addition and/or restoration of 25 acres of wetlands. In 1986, Glimcher Realty began development of the River Valley Mall complex. Glimcher Realty excavated the current wetland site for fill material to elevate the mall property and prevent flood damage. The now low-lying land was consistently inundated with water, and water-tolerant species of plants and animals moved into the area. In 2008 River Valley Associates donated the site to the City of Lancaster. The City applied for and received a $362,077 grant under the American Recovery and Reinvestment Act in 2010 to perform stream and wetlands restoration. The project involved riparian corridor improvements along 4,000 feet of stream bank and the previously mentioned 25 acres of wetland restoration. Shortly after construction, the City enacted conservation easements to ensure the longevity of the project. Late-2011 and early-2012 flooding demonstrated the effectiveness of the newly-constructed wetlands as they stored floodwaters while preventing infrastructure damage downstream.

Observations

The Hocking River floodplain is extensive throughout the City, putting infrastructure across town at risk for flood damage. It extends 1,500 feet west of the river for most of its length within the City, which puts residential properties at risk while the eastern portion of the floodplain extends past numerous commercial properties, primarily along Memorial Drive.

The overall sinuosity of the Hocking River through Lancaster is average for a stream within the Lancaster Corporation Boundary. However, channelized sections of the stream reflect flood damages while other sections are wide and shallow. One such area lies between the confluence with Hunter's Run to West Fair Avenue as well as next to the Hocking River Wetland. Wide, shallow stream channels are not optimal for supporting local organisms.

The Ohio EPA announced through the 2009 TMDL Report that the Hocking River is the most-improved watershed in the state in terms of water quality. With the implementation of stream and wetland restorations completed in 2011 and annual stream cleanups, future projects on the Hocking River would include small-scale improvements in specific locations that are highly impaired. Localized areas have channel substrates primarily composed of sand and silt and other areas would require bank stabilization and riparian corridor restoration and re-planting. Therefore, channel enhancements, bank stabilization, and riparian corridor plantings are the primary restoration techniques suggested for the Hocking River.

Hocking River Master Plan

The Hocking River corridor plan addresses issues associated with channel and bank degradation as well as inadequate riparian corridor vegetation. These issues are causing the stream to receive below average TMDL scores that narrowly comply with WWH criteria set by the Ohio EPA. QHEI scores from within Lancaster were similar to those upstream and downstream of the City, but the number of modifying attributes and high-influence modifying attributes lead to low habitat scores for the Hocking River through Lancaster.

This plan will cover the entirety of the Hocking River as it travels through Lancaster. The City has previously restored portions of the stream such as the development of wetlands and bank stabilization south of the River Valley Mall and two more wetlands near the southern reaches of the City. The remainder of the stream will be managed as needed and/or as land becomes available to the City.

One section of the stream to highlight is the section of the river between Cenci Lake Park and where Tarhe Run discharges into the Hocking River. This section is wide and shallow with localized openings in riparian vegetation. Bank erosion has led to failing banks and a substrate composed of sand and silt. This area is adjacent to the bike trail, and is included in the river cleanup process that takes place each fall. The area represents an optimal area for a restoration due to its current upkeep and its proximity to a recreational opportunity in the bike trail.

The following categories within the corridor plan are arranged from highest priority to lowest:

Channel Enhancements/Bank Stabilization

The Hocking River's channel is in poor condition over most of its length through Lancaster. Sinuosity is low, the substrate is made up of sand and silt, and the river is generally wide and shallow. Development along the riverbanks limits the options for incorporating sinuosity into the stream channel. Adding j-hooks and point bars would divert the stream from one bank to the other, and over time a more natural stream channel would develop. The stream channel could be altered in those areas in which the City already owns the land or as land becomes available, evaluated for their value in adding sinuosity to the stream. The "Sand Wand" operation would also provide maintenance for the degraded channel substrate and bring the local environment to a state able to support biodiversity.

To prevent the incorporation of unnatural bank stabilization techniques such as rock channel protection or similar devices, bank stabilization can take the form of toe wood and/or cross vanes wherever possible. This would reduce the amount of soil to be transported and deposited downstream and reduce the risk of flooding. Following the reshaping of the channel, in-stream structures could be installed to develop streambed diversity and more habitat for local fauna. Bank stabilization such as Armorflex matting would be installed as needed to prevent any damage to infrastructure where natural stabilization techniques are not feasible.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Flood Prevention Dike Installation

The City of Lancaster is planning three flood prevention dikes, one of which would be on the Hocking River. These dikes are intended to contain a 100-year storm event with 2-feet of freeboard. It would, however, require the taking of homes. The section placed on the Hocking River would be installed between Broad Street and the abandoned railroad just north of Cenci Lake Park, a total distance of 0.36 miles.

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources while the aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor plan is designed to improve stream habitat that is currently degraded due to channelization and erosion. The design would also create visual interest that can be enjoyed by the properties surrounding the stream and enhance the enjoyment of the bike trail. Load reductions from restorations between Cenci Lake Park and Tarhe Run would result in a reduction of 48 lbs/yr of nitrogen, 6 lbs/yr of phosphorous, and 2.4 tons/yr of suspended solids. This restoration is anticipated to cost $480,000 in total.

The goal for this stream plan is to achieve a healthy WWH and a healthy habitat TMDL rating. The highly urbanized stream environment leads to highly degraded streams with a sand-based substrate and steep, eroded banks. The Hocking River was considered the most improved watershed in the state by the Ohio EPA in the 2009 TMDL Report, and further improvements would continue the trend in water quality improvement.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Rain Garden/Riverside Park

In the section of stream right along Canal Street (between High Street and the railroad track) with the bike trail nearby, opportunity exists for a riverside park. Two of the intended parcels are already owned by the City and the addition of a third property would increase the possibilities, such as the development of a rain garden adjacent to the river and the bike trail. Associated signage would help the general public to understand the intention and purpose of a rain garden and the park would provide recreation along the bike trail.

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include an electronic version of the project fact sheet. The webpage would detail the project process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Informational Kiosk

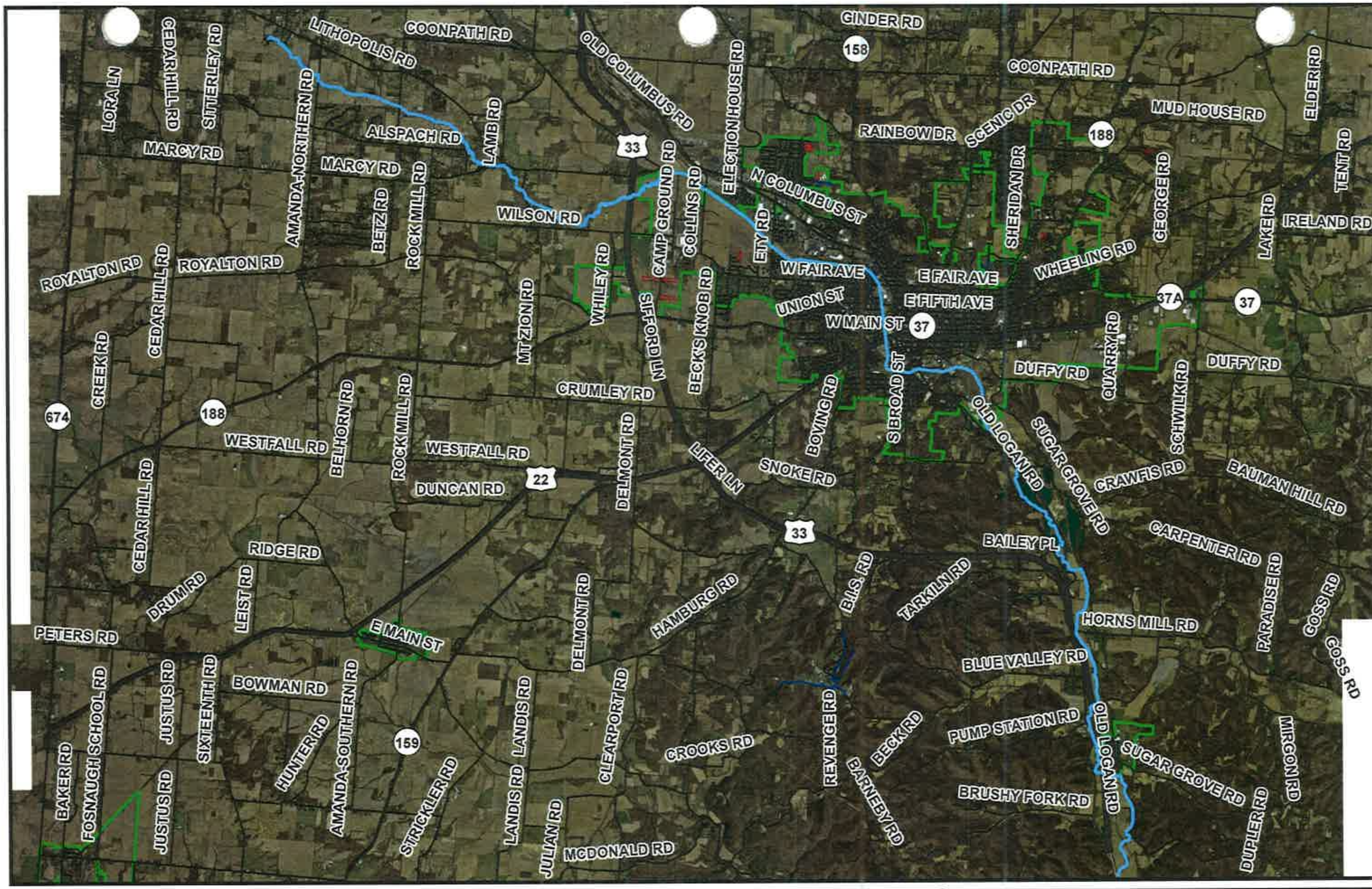
The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on the Hocking River, the Stormwater Department could aid the Parks Department and install a kiosk at Cenci Lake Park, Miller Park, or any other park near the Hocking River, or add signage if the kiosk has been previously installed in either location.

Signage

Signs are a staple in the field of public outreach due to their versatility. They can offer educational information, places to go for more information, public awareness announcements, or diagrams on how certain processes take place in relation to how we utilize a certain resource. The Hocking River has a publicly accessible location at which to places signs, including anywhere along the Lancaster bike trail or within Cenci Lake Park, Miller Park, or any other park near the Hocking River.

Appendix

Aerial Maps



CITY OF LANCASTER, OHIO — SPIRIT 1800 PRIDE

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data -North American Datum Vertical Datum (NAVD) 88
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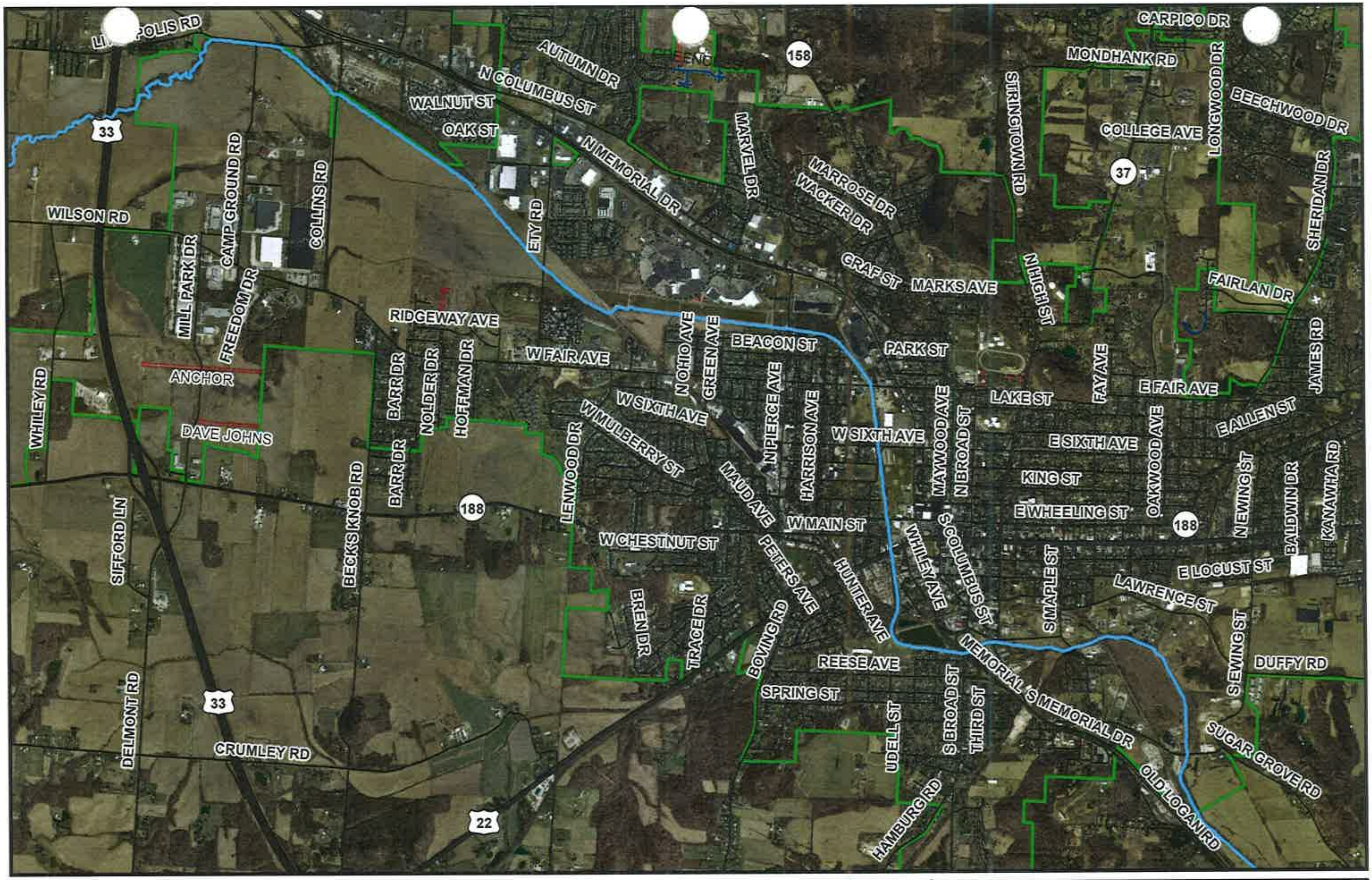
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology
Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Hocking River

0 1.25 2.5 5 Miles



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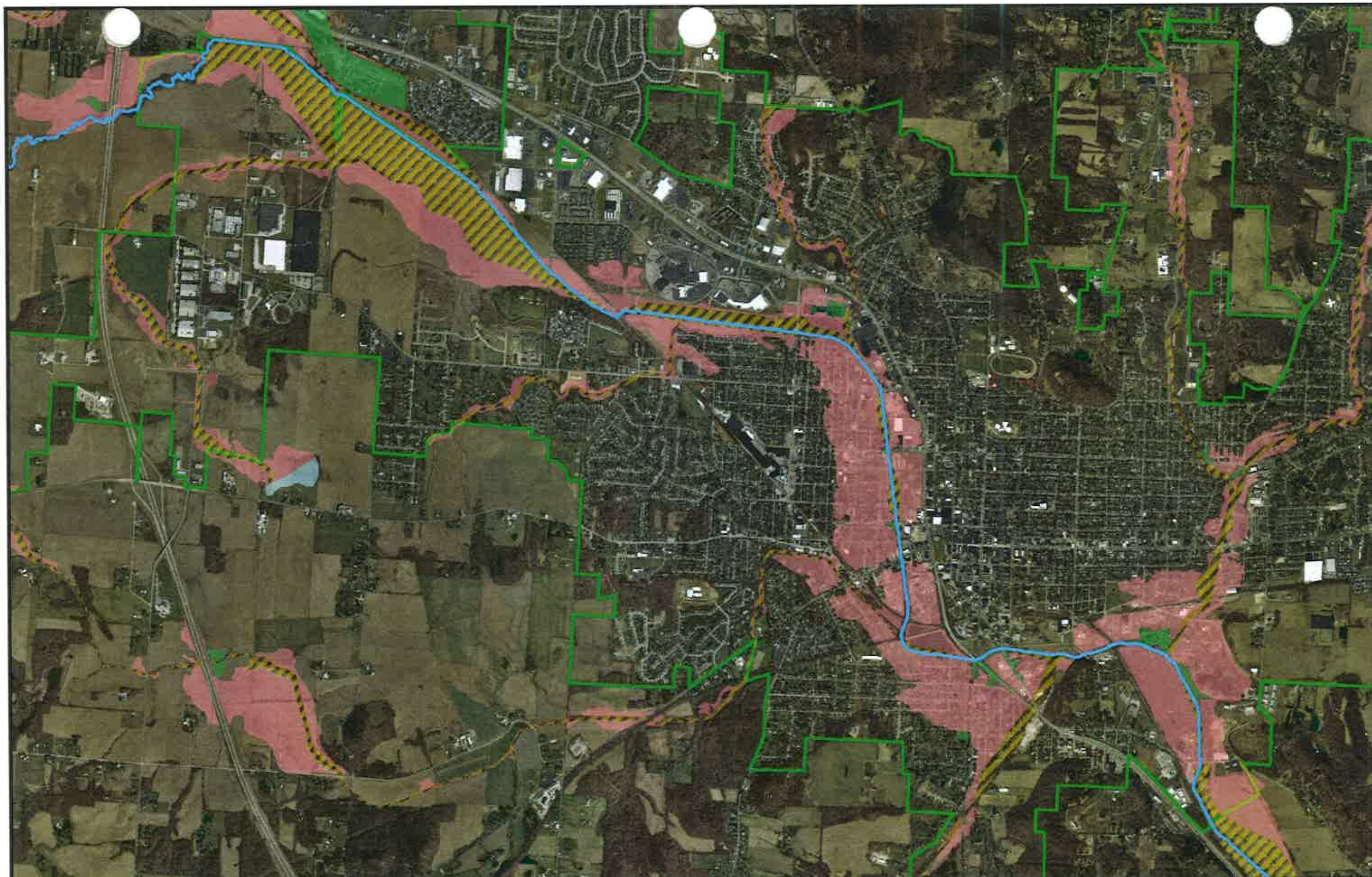
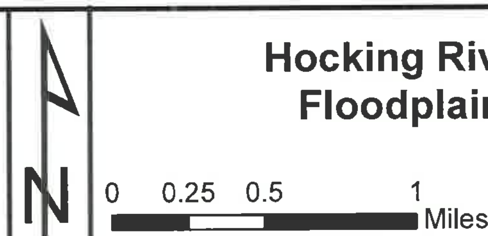
N

Hocking River Within LCB

0 0.25 0.5 1 Miles





Hocking River Floodplain

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Vertical data -North American Datum Vertical Datum (NAVD) 88
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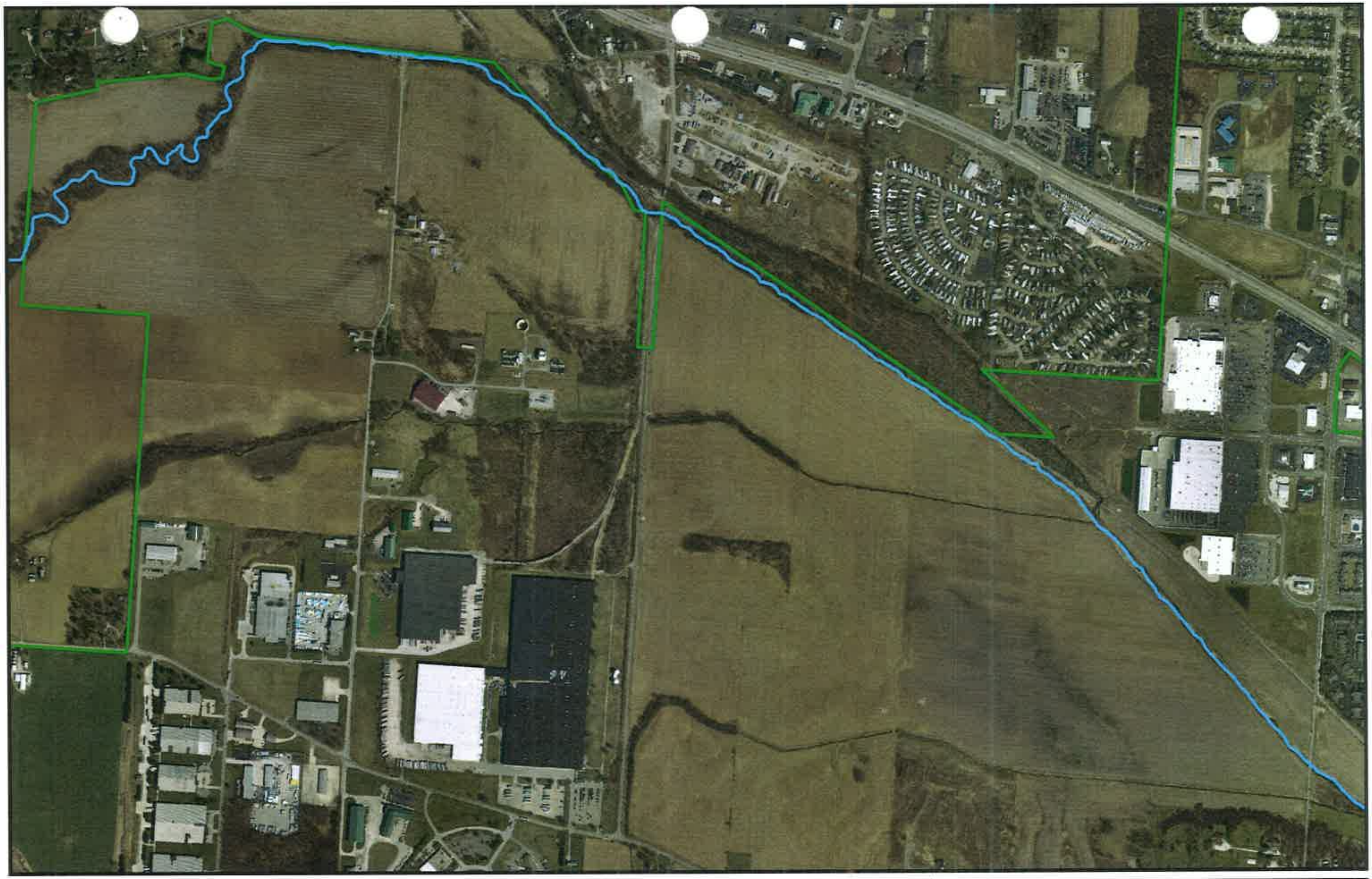

Hocking River Upper 1/3

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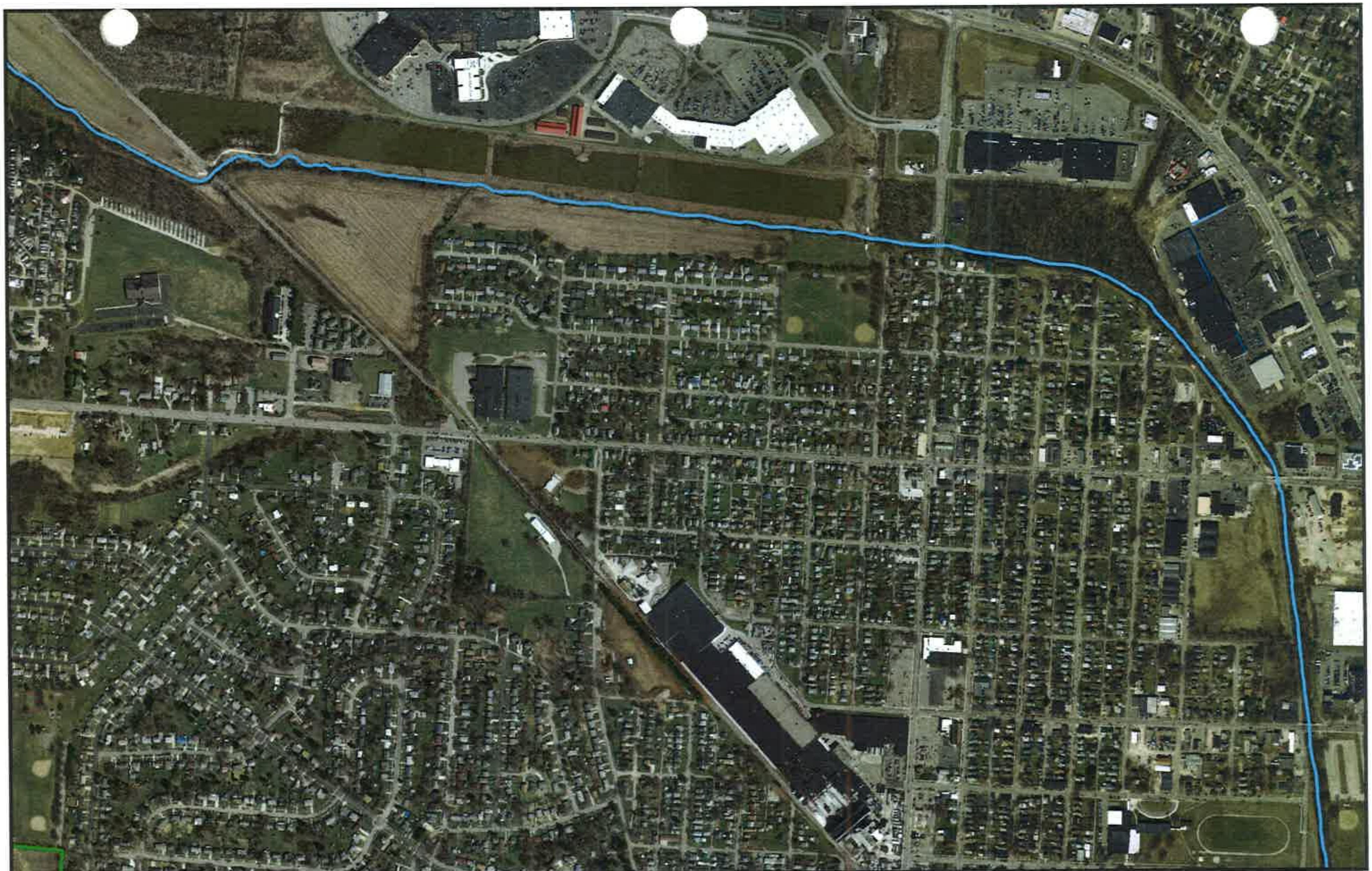

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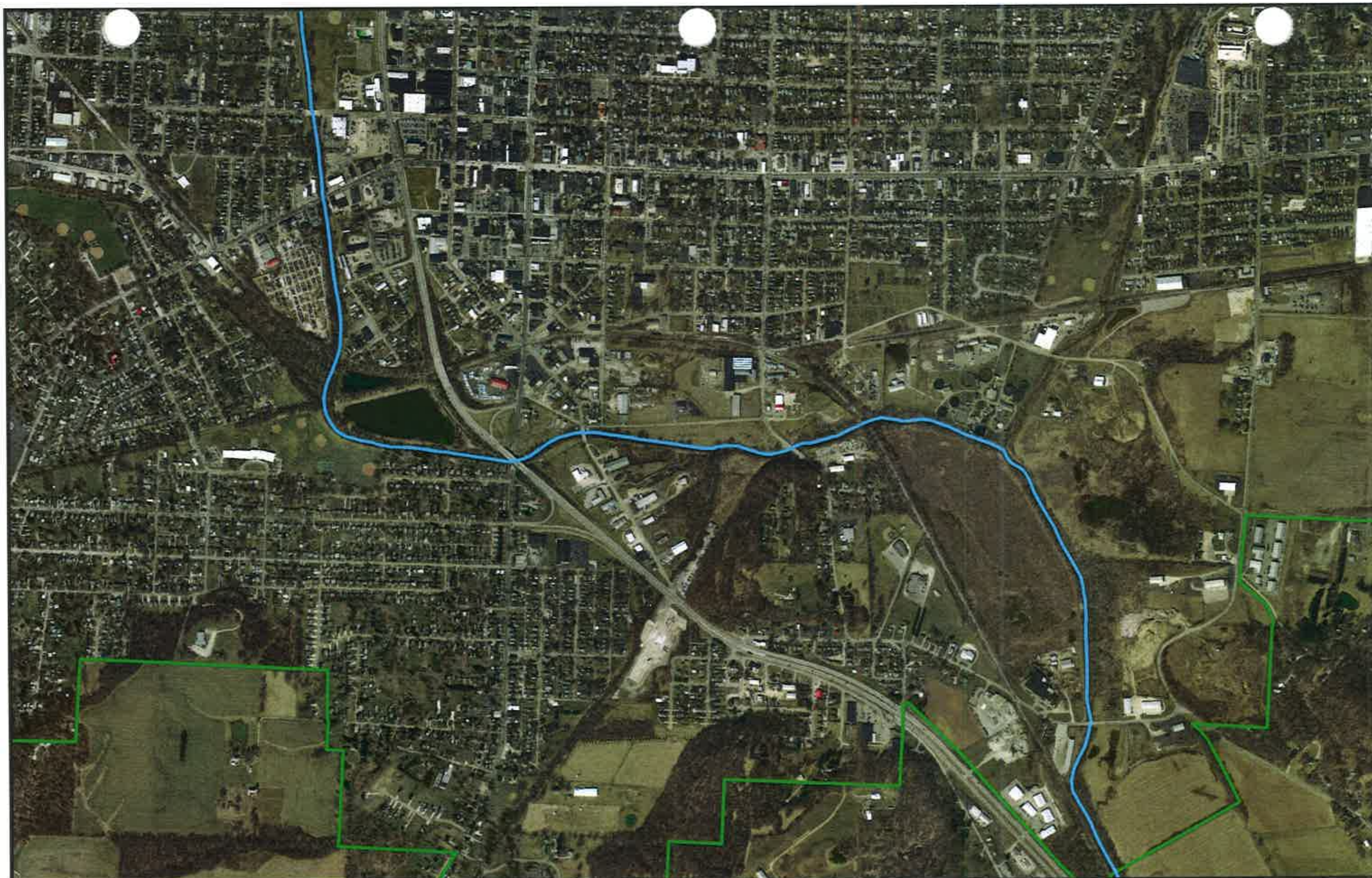
N

Hocking River Middle 1/3

0 0.1 0.2 0.4 Miles



Hocking River
Lower 1/3

0 0.125 0.25 0.5 Miles

N

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Vertical data -North American Datum Vertical Datum (NAVD) 88
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CITY OF LANCASTER, OHIO
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Pictures







Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed "high influence modified attributes".

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	Substrate	+	Channel Morphology	+	Riparian Zone/Bank Erosion	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories									Subscore			
		Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

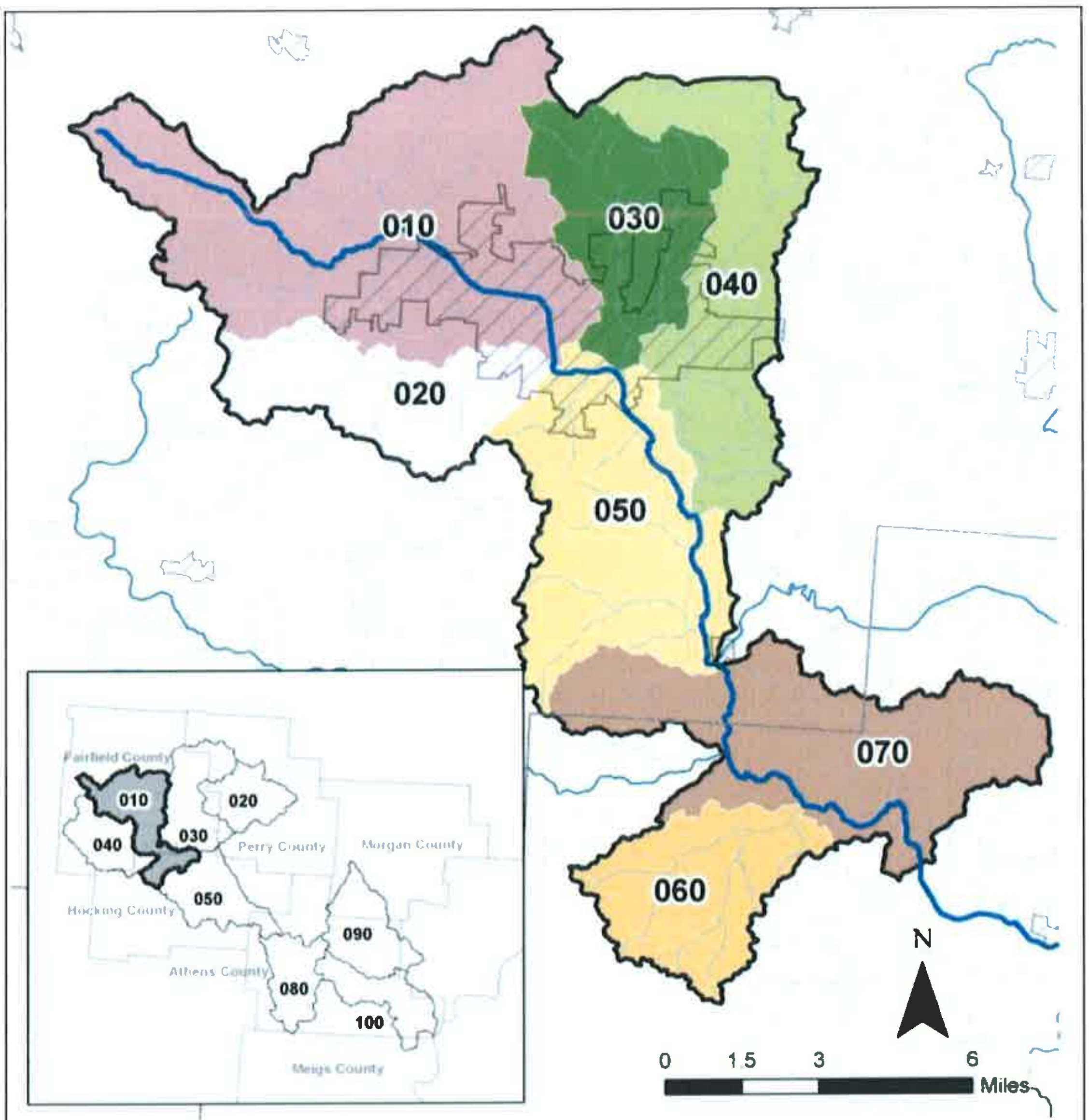

Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
	05030204-010- **Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	X					X	X
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	X					X	X
Stream Restoration		Restore flood plain	X					X	X
		Restore stream channel	X					X	X
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	X					X	X
		Restore natural flow	X					X	X
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	X						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	X	X	X	X	X	X	
		Inspect HSTS	X	X	X	X	X	X	
		Repair or replace traditional HSTS	X	X	X	X	X	X	
		Repair or replace alternative HSTS	X	X	X	X	X	X	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
		Construction BMPs: erosion control							
		Construction BMPs: runoff control							
		Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
		Develop and/or implement long term control plan (CSOs)	X	X	X	X	X		
		Eliminate SSOs/CSOs/by-passes	X	X	X		X		
	storm water	Implement an MS4 permit	X	X	X	X	X		
		Implement an industrial permit							
		Implement a construction permit	X	X	X	X	X		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
		Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
		Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	X				X		
		Implement conservation tillage practices	X				X		
		Implement grass/legume rotations	X				X		
		Convert to permanent hayland							
		Install grassed waterways	X				X		
		Install vegetated buffer strips	X				X		
		Install / restore wetlands	X				X		
	nutrients / agro-chemicals	Conduct soil testing	X				X		
		Install nitrogen reduction practices	X				X		
		Develop nutrient management plans	X				X		
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system	X				X		
		Implement drainage water management	X				X		
		Construct overwide ditch	X				X		
		Construct 2-stage channel	X				X		
	livestock	Implement prescribed & conservation grazing practices							
		Install livestock exclusion fencing							
		Install livestock crossings							
		Install alternative water supplies							
		Install livestock access lanes							
	manure	Implement manure management practices	X				X		
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

Table A.3 **Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**

		WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Table A.3 (con't) **Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**

		WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]																																
Hocking River (MWH)																																
89.4	69.0		■		■		■	■	■	■		6				■		1	■				■	■					■		4	○
Hocking River (WWH)																																
88.9	55.5		■							■	■	3	■			■		2	■	■			■	■			■	■	■		7	○
87.3	65.0		■		■	■		■	■	■	■	7				■		1	■	■			■	■				■	■		6	◑
81.9	77.0	■	■		■	■	■	■	■	■	■	9						0					■								1	○
Trib. to Hocking R. (RM 84.38) (WWH)																																
0.2	47.0										■	1			■	■	■	3	■	■			■				■	■			5	◑
Trib. to Hocking R. (RM 82.57) (WWH)																																
1.1	54.0	■						■	■	■		4			■	■		2					■						■		2	◑
05030204-010-060 - Buck Run																																
Buck Run (WWH)																																
2.8	57.5	■		■		■				■		4			■	■		2	■				■				■	■	■		5	○
0.9	61.5				■	■	■			■	■	5						0	■				■				■	■	■		5	◑
East Branch Buck Run (WWH)																																
0.1	56.0	■			■	■				■		4				■		1		■			■				■	■	■		5	◑

Baldwin Run Corridor Plan

Baldwin Run Background

Background & Literature Review

Fetter's Run and Ewing Run combine to form Baldwin Run just east of King Street, which then flows through the near east side of Lancaster. The stream is around 0.7 miles in length, all of which is within the LCB. The run flows south until emptying into the Hocking River on the south side of town.

The Ohio EPA monitors Baldwin Run as part of Hocking River Watershed Water Quality Studies and TMDL reports. The two monitoring stations for Baldwin Run are upstream on Ewing Run near Tiki Lane and downstream near the Hocking River and Lancaster WWTP.

The 1991 Ohio EPA publication entitled "Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries" identified poor but improving water quality conditions when compared to the early 1980s. The study deemed Baldwin-Ewing Run as non-compliant with WWH criteria following sampling events near the WWTP discharge.

The 1997 Ohio EPA publication entitled "Biological and Water Quality Study of the Upper Hocking and Selected Tributaries" documented further improvements to the stream's water quality. The publication designated the upstream habitat unimpaired by local development, i.e., having all the necessary components for WWH designation. The study assigned a QHEI of 74.5 to Baldwin-Ewing upstream while sections near the WWTP scored as low as 57.6. The Agency attributes improvements to the removal of the Anchor Hocking discharge in 1978 and upgrades to the Water Pollution Control Facility in 1985/6, which were not yet evident in the 1991 study.

The 2009 Ohio EPA publication entitled the "Total Maximum Daily Loads for the Hocking River Watershed" determined the stream compliant with WWH criteria following samples taken near Tiki Lane. The study assigned a QHEI score of 65.5, while nearby Fetter's Run was assigned a QHEI score of 70, both surpassing the 60 required for compliance.

The City of Lancaster completed the first phase of the Baldwin Run Stream Restoration from Main Street to the Hocking River in 2005, in coordination with the Anchor Hocking Brownfield Project. This project provided channel restoration, bank stabilization and stream plantings along approximately 2,000 feet of stream channel. In 2009 and 2010 bank stabilization near storm outlets was performed as part of nearby projects. The second phase of Baldwin Run Restoration occurred in early 2015 from Main Street to the confluence of Ewing Run and Fetter's Run. This project provided debris removal, invasive species management, channel enhancements, and bank stabilization along 960 feet of stream channel.

Observations

Development around Baldwin Run has involved multiple land uses including commercial, residential, industrial, and recreational. The source of the stream is adjacent to the Kroger parking lot and the hospital, which prevents the floodplain from acting as it should. Further downstream, the stream flows through residential properties and City-owned Mary Burnham Park. The final section of the stream, nearest the Hocking River, flows through an industrial section of town with the WWTP and the sewage disposal plant.

Flooding in the 1930s channelized streams around Lancaster, resulting in a loss of flood capacity as well as natural, ecological habitat. Despite floodplain degradation, the floodplain overall is extensive and puts local infrastructure at risk including private homes, commercial businesses, and public utility services. The non-natural state of the floodplain limits its effectiveness in providing relief for the stream during high-water events. The sinuosity of Baldwin Run is the lowest among the City's streams. At a sinuosity index of 1.04, it is the only stream in Lancaster classified as "straight" under the conventional classification system while most others are classified as "twisting".

The primary concern on Baldwin Run is a lack of sinuosity as well as channel degradation, bank erosion, and poor riparian corridor. The lack of sinuosity exacerbates other issues throughout the stream, as the quick-moving water results in high levels of bank erosion and potential issues with loss of riparian corridor plantings. Channel enhancements and bank stabilization would mitigate these issues and improve habitat quality within the stream while riparian corridor restoration is suggested to provide shade and vital nutrients to the local environment for the stream.

Channel enhancements, bank stabilization, and riparian corridor plantings are the primary restoration techniques suggested for Baldwin Run. Channel enhancements would be focused on providing more sinuosity to the stream in the form of J-hooks and cross vanes. Bank stabilization and riparian corridor plantings both provide protection from flood waters and aid the production of WWH and prevent further degradation. Riparian corridor plantings would also aid those areas that have previously been restored but lack the vegetation required for WWH designation.

Baldwin Run Master Plan

The Baldwin Run corridor plan addresses issues associated with a lack of suitable WWH, channelization, bank erosion and inadequate riparian vegetation. Two major restorations have already been conducted on Baldwin Run that included many of these same enhancements, but other sections of the stream would benefit from improvements. This plan describes management techniques for the entirety of Baldwin Run, including those areas previously restored.

A critical section of Baldwin Run to highlight is on the southeast corner of Mary Burnham Park, near the railroad crossing. The stream here is in poor condition, notably eroding around the base of the railroad crossing. The stream channel expands into a wide, shallow state with no riparian corridor vegetation to provide shade to the stream. The banks through this section are stable with the exception of a sharp turn just south of the railroad crossing, which is being undercut by the stream.

The following categories within the corridor plan are arranged from highest priority to lowest:

Channel Enhancements

Channel enhancements on Baldwin Run would include the installation of J-hooks and cross vanes that would redirect the stream channel away from any erodible banks and would also help maintain the stream channel depth and slow downcutting. Improving the sinuosity of the stream would be a major benefit to the stream, but infrastructure on either side of the stream limits the options available for improvement. Rock vortex weirs would create additional wildlife habitat while supplying visual interest to the area. Installation of eddy rocks in the stream channel would help dissipate high-flow energy, improve the appearance of the channel, and provide suitable habitat.

One of the major degrading attributes on this stream is the railroad crossing near the southeast corner of Mary Burnham Park. Despite being previously restored, this portion of the stream channel is eroding away the base of the railroad as well as the immediate area. The piers for the railroad are currently exposed and the condition is degrading over time. In order to fix this issue fully, the stream needs to be re-aligned in relation to the railroad line. Erosion in this case is caused by the stream's energy striking the railroad piers at an angle, so re-aligning the stream such that it flows perpendicular to the railroad line would alleviate issues associated with erosion as well as prevent downstream erosion by removing the sharp curve just south of the railroad line. The City of Lancaster does own the land surrounding the stream at this point, but the re-alignment would require moving both the bike path and one of the baseball fields within Mary Burnham Park.

Baldwin Run, having been previously restored, would now benefit from maintenance type projects such as the Sand Wand operation or other similar channel enhancement projects. The Sand Wand operation would remove aggregate silt and sand from the streambed and allow previously installed in-stream devices such as boulders and rock vortex weirs to work as intended. In an urban environment, silt and sand are a common problem that are unlikely to ever be removed completely as an issue, meaning maintenance projects are suggested to upkeep previous restorations and improve water quality.

Bank Stabilization

Regrading steep sections and installing Armorflex concrete block mats would stabilize and reinforce sections of Baldwin Run within the riparian reach. The installation would prevent undercutting and protect the infrastructure running parallel to or having outlets on Baldwin Run. In-stream structures such as J-hooks, cross vanes, or toe wood would also provide a natural form of bank stabilization. These bank stabilization techniques would also incorporate sinuosity into the stream channel by diverting energy towards one of the stream banks to begin developing a natural form of sinuosity. Land at Mary Burnham Park and/or the Lawrence Street Wetland could provide land necessary to incorporate more sinuosity into Baldwin Run, though each of these provide their own obstacles to this form of restoration.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources while the aesthetic value gained from a restored stream adds value to local properties and to the City itself.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor plan is designed to improve stream habitat that is currently degraded due to channelization and bank instability. Load reductions resulting from restorations ranging from the bike path bridge at Mary Burnham Park down to Lawrence Street would be a total of 28 lbs/yr of nitrogen, 3.5 lbs/yr of phosphorous, and 1.4 tons/yr of suspended solids. The restoration is estimated to cost $280,000 for the full section previously noted, possibly more depending upon the ease with which the stream can be realigned.

The goal for this stream plan is to achieve a healthy WWH and a healthy habitat TMDL rating. The previous restorations offer an opportunity for small scale projects to benefit the ecosystem as a whole. The stream releases into the Hocking River, which has been noted as being one of the most improved rivers in the state. This restoration would only further that improvement and help keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to informing the public and seeking funding. The presentation could then be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet explaining the project. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Signage

Signs are a staple in the field of public outreach due to their versatility. They can offer educational information, places to go for more information, public awareness announcements, or diagrams on how certain processes take place in relation to how we utilize a certain resource. Baldwin Run has a publicly accessible location at which to places signs, including anywhere along the bike trail or within Lanreco Park or Mary Burnham Park.

Informational Kiosk

The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on Baldwin Run, the Stormwater Department could aid the Parks Department and install a kiosk at Lanreco Park or Mary Burnham Park, or add signage if the kiosk has been previously installed in one of those parks.

Lancaster Eagle Gazette

With larger projects, the submission of a story to the Lancaster Eagle Gazette could be made in order to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Library Books/Display

The library is a great public arena that could get information out to the public through posters/signage, as well as a great place to offer brochures or book-related information on stream dynamics and restorative efforts implemented in our City's streams.

Appendix

Aerial Maps

Baldwin Run

0 150 300 600
Feet

N

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology.
Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

Baldwin Run
Phase 1 2000

0 100 200 400 Feet

N

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
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N

Baldwin Run
Phase 1 2015

0 100 200 400 Feet

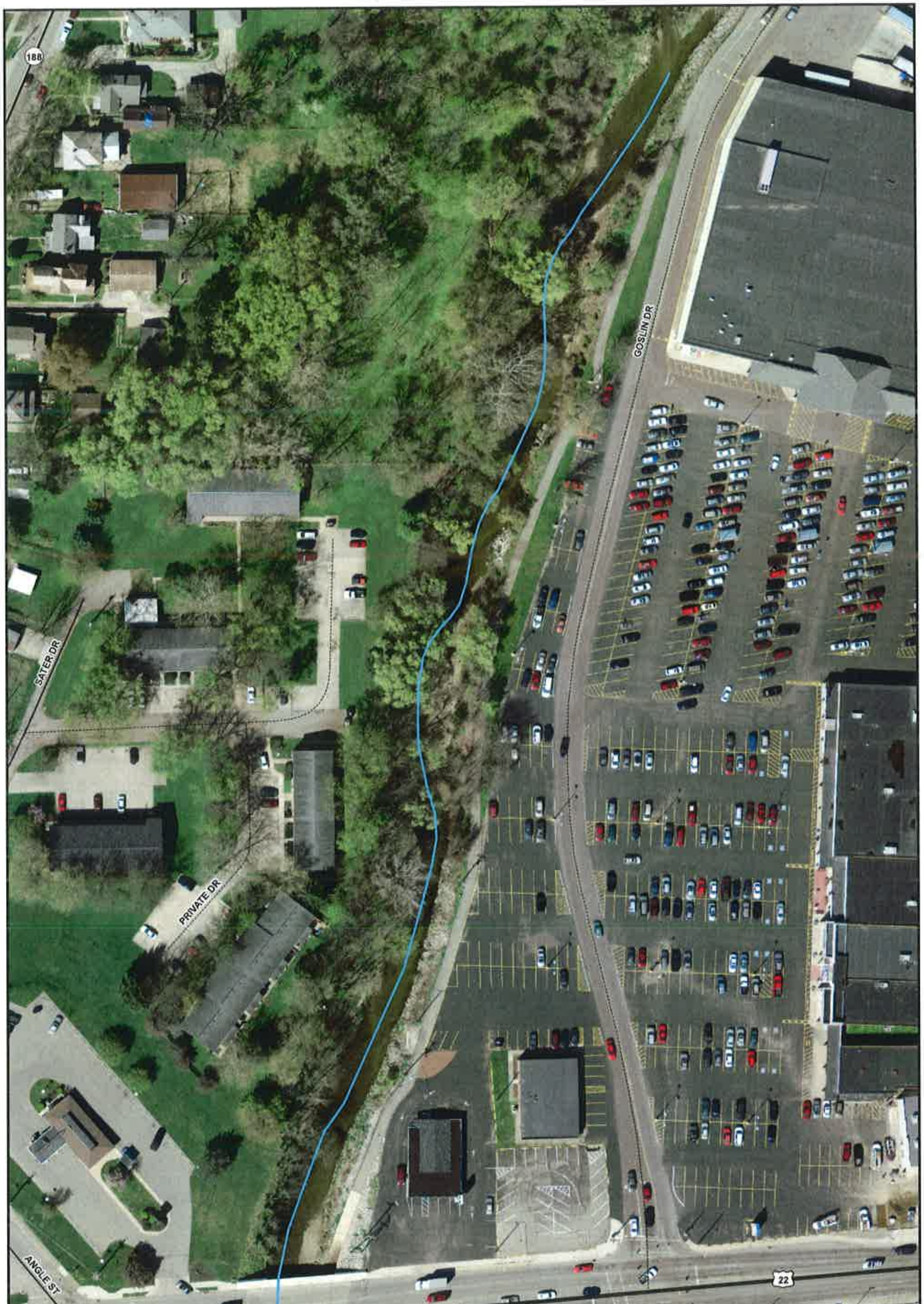
DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology. Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Baldwin Run
Phase 2 2000

0 50 100 200 Feet



DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet.
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
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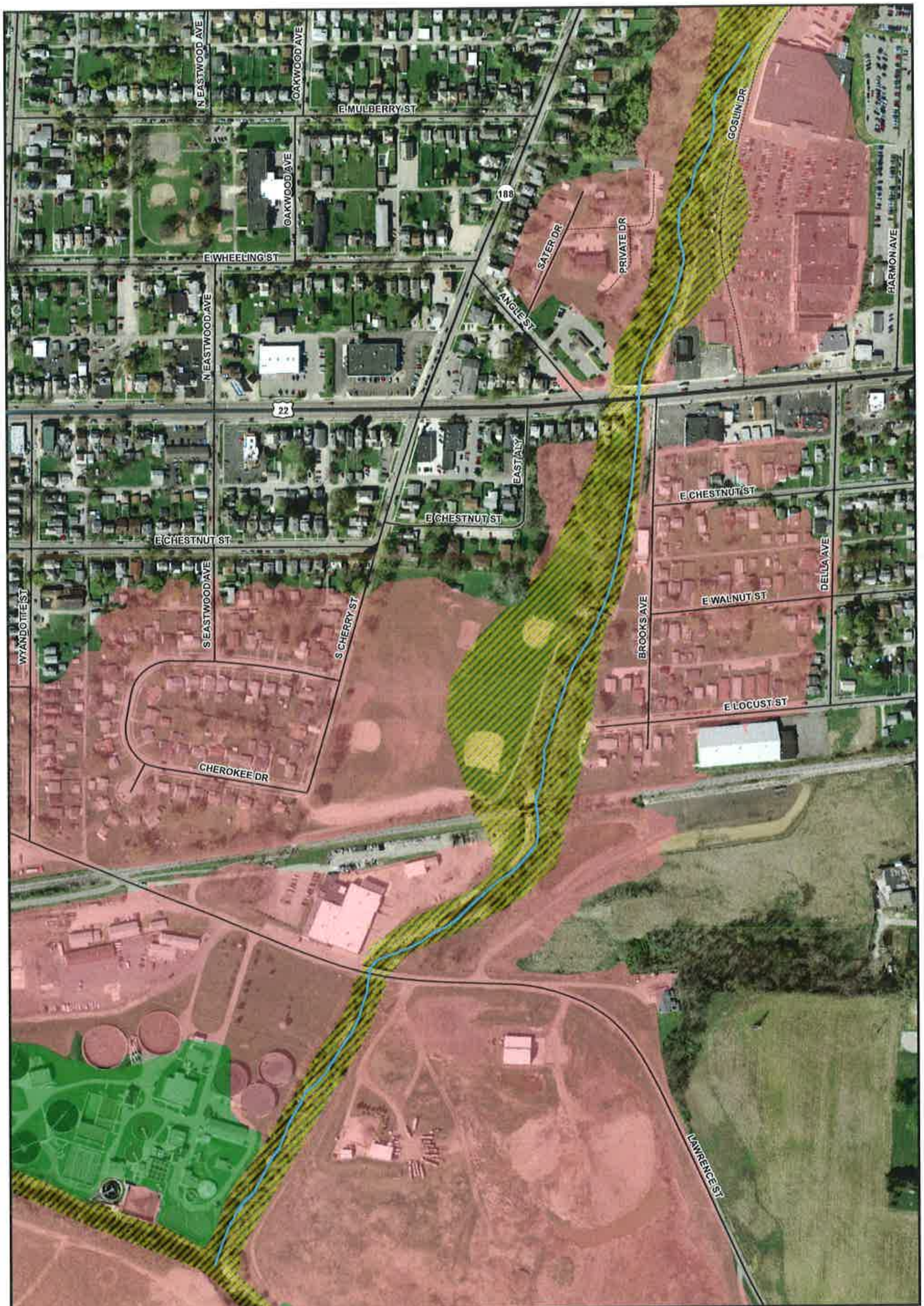
N

Baldwin Run
Phase 2 2012

0 50 100 200 Feet



DISCLAIMER

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Horizontal - North American Datum (NAD) 83 (95)
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N

Baldwin Run Floodplain

0 150 300 600 Feet

Pictures


05/14/2015


05/14/2015


05/14/2015


05/14/2015

Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed "high influence modified attributes".

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	Substrate	+	Channel Morphology	+	Riparian Zone/Bank Erosion	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 7.8. Bacteria waste load allocations by assessment unit.

05030204		Sources	Fecal Coliform Load (count/day*10^7)		Reduction Required	Comments
			Existing	Allowable		
010	010	**Hocking River from headwaters to Rock Mill Dam**				Direct HSTS connections are illegal and the only known sources of significance in this subwatershed, and need to be eliminated.
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	
		Direct HSTS	24888	0	100%	Elimination of illegal direct HSTS reduce the load below the TMDL. The difference between this load reduction and the TMDL is the MOS.
		Total Point Source (Wasteloads)	*24888*	*0*	*100%*	
	010	**Hocking River from Rock Mill Dam to below the Ohio and Erie Canal**				Failing and direct HSTS pose the major sources of concern in this area.
		Air Products & Chemicals	-	-	-	
		Lancaster MS4	0.228	0.224	2%	
		Direct HSTS	14210	0	100%	Air Products & Chemicals does not discharge fecal coliform
		Total Point Source (Wasteloads)	*14210*	*0*	*100%*	
	010 & 050	**Hocking River from Rock Mill Recreation Area to Ety Road**				The Lancaster Long Term CSO Control Plan should achieve a 95% reduction in fecal coliform load once it is fully implemented.
		Lancaster WPCF	3785	3785	0%	
		CSO	20264	1013	95%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Lancaster MS4	46	15	66%	
		Direct HSTS	10013	0	100%	
		Total Point Source (Wasteloads)	*34108*	*4814*	*86%*	Manure management and limiting livestock access are areas that need attention in this subwatershed.
	020	**Hunter's Run**				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Stonewall Landfill	-	-	-	
		CSO	20264	0	100%	
		Lancaster MS4	7	3	55%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Direct HSTS	6005	0	100%	
		Total Point Source (Wasteloads)	*26276*	*3*	*100%*	
						Manure management and limiting livestock access are areas that need attention in this subwatershed.
						Stonewall Landfill does not discharge fecal coliform
	030	**Baldwin Run**				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		No NPDES facilities	-	-	-	
		CSO	45085	0	100%	
		MS4	31	31	0%	A new WWTP for Lancaster will eliminate some of the direct HSTS.
		Direct HSTS	10766	0	100%	
		Total Point Source (Wasteloads)	*55882*	*31*	*100%*	The elimination of the CSOs through the Lancaster LTCP and the elimination of direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL: QHEI Categories: Substrate	BEDLOAD TMDL: QHEI Categories: Channel	BEDLOAD TMDL: QHEI Categories: Riparian	BEDLOAD TMDL: Total Bedload Score	BEDLOAD TMDL: % Deviation from Target	BEDLOAD TMDL: Main Impaired Category	HABITAT TMDL: QHEI Score	HABITAT TMDL: # High influence Attributes	HABITAT TMDL: Total # Modified Attributes	HABITAT TMDL: Subscore: QHEI	HABITAT TMDL: Subscore: High Influence	HABITAT TMDL: Subscore: # Modified Attributes	HABITAT TMDL: Total Habitat Score
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

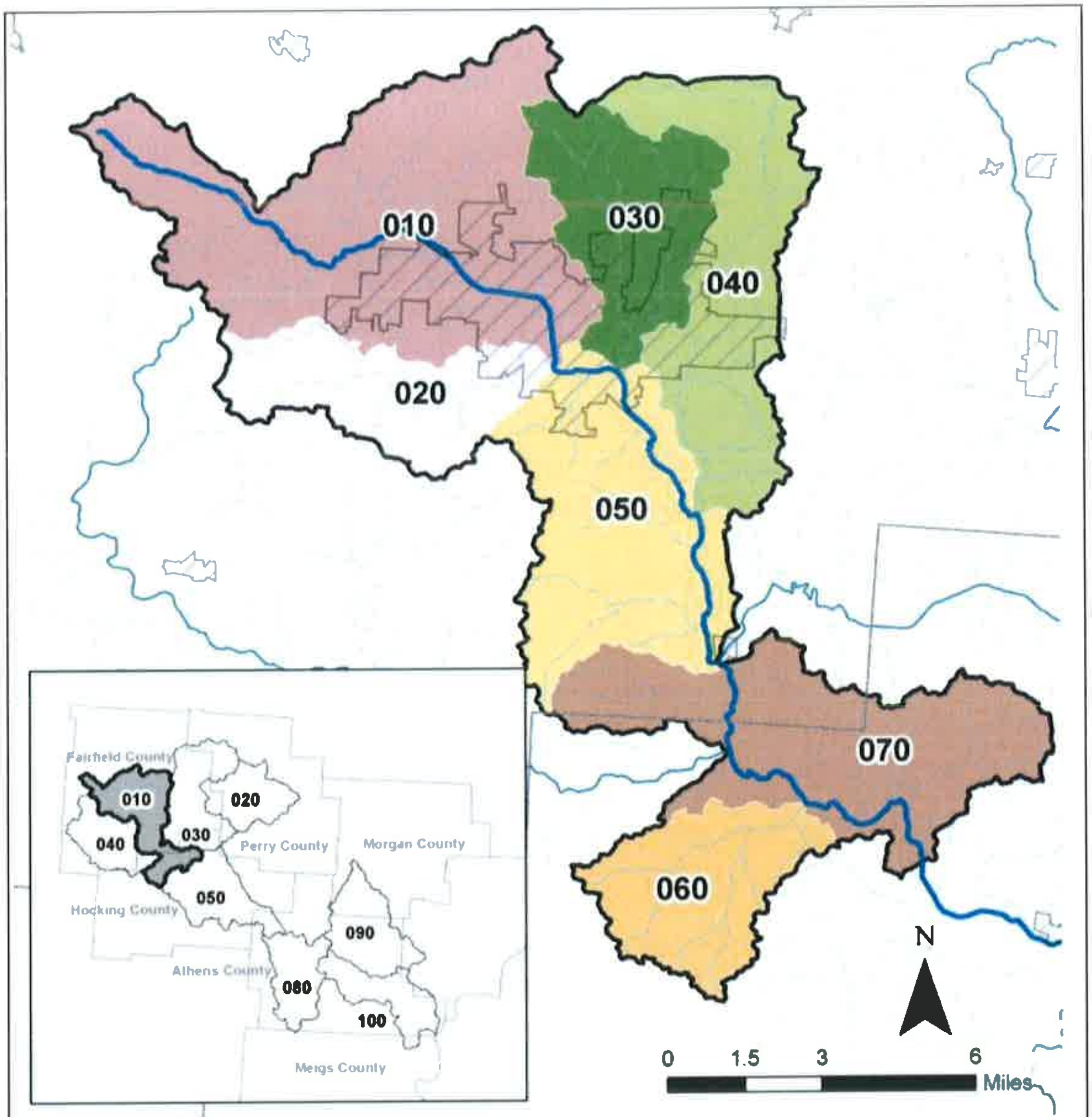


Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
05030204-010- Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])	
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	X					X	X
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	X					X	X
Stream Restoration		Restore flood plain	X					X	X
		Restore stream channel	X					X	X
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	X					X	X
		Restore natural flow	X					X	X
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	X						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	X	X	X	X	X	X	
		Inspect HSTS	X	X	X	X	X	X	
		Repair or replace traditional HSTS	X	X	X	X	X	X	
		Repair or replace alternative HSTS	X	X	X	X	X	X	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
		Construction BMPs: erosion control							
		Construction BMPs: runoff control							
		Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
		Develop and/or implement long term control plan (CSOs)	X	X	X	X	X		
		Eliminate SSOs/CSOs/by-passes	X	X	X		X		
	storm water	Implement an MS4 permit	X	X	X	X	X		
		Implement an industrial permit							
		Implement a construction permit	X	X	X	X	X		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
		Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
		Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	X				X		
		Implement conservation tillage practices	X				X		
		Implement grass/legume rotations	X				X		
		Convert to permanent hayland							
		Install grassed waterways	X				X		
		Install vegetated buffer strips	X				X		
		Install / restore wetlands	X				X		
	nutrients / agro-chemicals	Conduct soil testing	X				X		
		Install nitrogen reduction practices	X				X		
		Develop nutrient management plans	X				X		
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system	X				X		
		Implement drainage water management	X				X		
		Construct overwide ditch	X				X		
		Construct 2-stage channel	X				X		
	livestock	Implement prescribed & conservation grazing practices							
		Install livestock exclusion fencing							
		Install livestock crossings							
		Install alternative water supplies							
		Install livestock access lanes							
	manure	Implement manure management practices	X				X		
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

Table A.3 Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])

		WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◐ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Fetter's Run Corridor Plan

Fetter's Run Background & Existing Conditions

Background & Literature Review

Originating in the fields north of town, Fetter's Run flows through the near east side of Lancaster. The stream is approximately five miles in length in its entirety, two miles of which lie inside the LCB. The run flows south until it converges with Ewing Run to form Baldwin Run. Baldwin Run then continues into the Hocking River.

In 1988, the John Bright No. 2 covered bridge was moved from its original location on Poplar Creek to Fetter's Run just east of Ohio University Lancaster (OUL) campus. John Bright No. 1 was similarly moved to Fetter's Run in 1999 from its original location, also along Poplar Creek. Both bridges were added to the National Register of Historic Places during the late 1970s. They provide a recreational opportunity for the community as part of the Lancaster Festival and their placement along the bike trail. On each Saturday of the festival, concerts are held on Festival Hill, on the east side of Fetter's Run, with people using the bridges as travel from the parking lot across the stream.

The Ohio EPA monitors nearby Baldwin Run as part of Water Quality Studies and TMDL reports. The two monitoring stations occur upstream on Ewing Run near Tiki Lane and downstream on Baldwin Run near the Hocking River. Baldwin-Ewing Run conditions can indicate water quality in Fetter's Run due to their locations within Lancaster and similar conditions along the stream banks.

The 1991 Ohio EPA publication entitled "Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries" identified poor but improving water quality conditions when compared to the early 1980s. The study deemed Baldwin-Ewing Run as non-compliant with WWH criteria following sampling events near the WWTP discharge.

The 1997 Ohio EPA publication entitled "Biological and Water Quality Study of the Upper Hocking and Selected Tributaries" documented further improvements to the stream's water quality. The publication designated the upstream habitat unimpaired by local development, i.e., having all the necessary components for WWH designation. The study assigned a QHEI of 74.5 to Baldwin-Ewing upstream while sections near the WWTP scored as low as 57.6. The Agency attributes improvements to the removal of the Anchor Hocking discharge in 1978 and upgrades to the Water Pollution Control Facility in 1985/6, which were not yet evident in the 1991 study.

A 2009 Ohio EPA publication entitled "Total Maximum Daily Loads for the Hocking River Watershed" sampled upstream near Tiki Lane and determined the stream in compliance with WWH criteria. Baldwin Run was given a QHEI score with this study at 65.5, while Fetter's Run was assigned a QHEI score of 70, both surpassing the 60 required for compliance.

Observations

Agricultural practices are the most common land uses surrounding Fetter's Run in the area of its headwaters. These practices introduce sediment and nutrients to the stream channel that are transported downstream. Within the LCB, residential and commercial development are most common near the stream. Development has resulted in limitations in the floodplain for the stream. From Sixth Avenue to the south up to an area just north of Lancaster High School, Fetter's Run has a limited area designated as

100-year floodplain. The removal of this floodplain has occurred gradually over time, in particular by the development of the current Lancaster High School building and Fulton Field in 1963 and Thomas Ewing Junior High School.

North of Lancaster High School the riparian corridor is degraded from local development. The Ohio University Lancaster campus opened for classes in the fall of 1968 with an addition occurring around 1978. While this did not remove area designated as floodplain, the building and adjacent parking lot limit its effectiveness and all riparian corridor in the area has been removed. Further still to the north, the riparian corridor is well established, but floodplain area is lacking.

The primary concern on Fetter's Run is bank erosion. Around OUL and LHS, downed trees in the stream channel and landslides along the bank result in floodplain disconnection. Trees and trash account for debris throughout the stream. Localized areas of the stream lack a riparian corridor, particularly west of Thomas Ewing Junior High and east of OUL. In this same area, near LHS, invasive species exist in abundance along the stream banks. In residential sections of the stream, the two main issues are channelization and debris.

Bank stabilization and riparian corridor plantings are the primary restoration techniques suggested for Fetter's Run. Bank stabilization would include regrading the bank to reconnect the floodplain and prevent landslides that may remove riparian corridor vegetation. The riparian corridor would be restored in places where vegetation is absent to shade the stream and allow in-stream structures to work as intended.

Fetter's Run Master Plan

The Fetter's Run corridor plan addresses problem areas with eroded banks and a lack of riparian corridor vegetation and is designed to get the stream into compliance with WWH requirements and the habitat TMDL requirements set by the Ohio EPA. The stream has areas of aggregation and erosion that should be fixed to maintain a healthy and stable stream corridor.

A critical section of Fetter's Run to highlight is from Thomas Ewing Junior High School to the Forest Rose School. This reach is channelized by local development and generally lacks riparian corridor vegetation with localized bank instability. It also travels along the Lancaster bike trail and flows by Thomas Ewing Junior High School, LHS, and OUL, making this section of stream highly visible to the public. The habitat for local organisms is limited here by the narrow channel and the lack of riparian corridor vegetation, leaving the channel vulnerable to sunlight and lacking organic nutrients from fallen leaves.

A second section to highlight is the section of stream that runs through Lanreco Park. Near the upstream limit of the park is a CSO, which will be modified to reduce the number of overflow events in the summer of 2017. The downstream limit of the park is bound by a bridge which is not aligned properly in relation to the stream. Within the park there are sections of aggregation, an eroded streambank near a storm outfall, and a sandstone wall constricting the southern bank of the stream. Since this section of stream runs through public land, it is a prime location for a restoration.

The following categories within the corridor plan are arranged from highest priority to lowest:

Bank Stabilization

Bank stabilization on Fetter's Run would prevent silt and sediment from entering the stream while also developing and protecting riparian corridor vegetation. J-hooks and cross vanes would help to redirect energy away from the banks while regrading the bank and planting vegetation would provide a natural approach to bank protection. Land availability may constrain bank protection options, requiring Armorflex matting with inter-planted vegetation or rock channel protection to stabilize critical banks rather than regrading.

Channelizing features such as artificially constructed walls would ideally be removed from the stream's banks. A sandstone wall in Lanreco Park constricts the natural streamflow while the stream is undercutting the wall. The wall is likely to fail unless a solution is applied in the near future. This area would be suitable for a toe wood structure installation. The turn is sharp enough to require protection that toe wood would provide protection in addition to habitat for local fauna. By combining toe wood with J-hooks to redirect the stream away from the south/west bank, the stream would benefit in the short term from bank protection and habitat generation and benefit in the long term from the abatement of the sharp turn.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Channel Enhancements

Fetter's Run overall is considered a "winding" stream, with a sinuosity index of only 1.18. Channelization affects two segments of the stream in particular, but infrastructure exists on both sides of the stream that limits development options. The first segment is at the property of 1061 East Fifth Avenue and the second segment is from the bridge at Sixth Avenue to the bridge at Fair Avenue. The first segment is behind a private residence and has been modified to channelize the stream. The solution to this channelizing feature is discussed in the bank erosion section. The second segment is constrained by private property to either side of the stream so options are limited. The bed is uniform and lacks the diversity which would allow fauna diversity. In-stream structures such as large boulders and rock vortex weirs would create additional wildlife habitat and supply visual interest to the area. Boulders placed in portions of the stream would likewise alter flow dynamics and create deeper pools to support local fauna. J-hooks would help to add sinuosity to the stream to slow down water, further improve the habitat, and prevent bank erosion.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor plan is designed to improve stream habitat that is currently degraded due to siltation and channelization. Load reductions resulting from restorations through Lanreco Park should be 14lbs/yr of nitrogen, 1.75lbs/yr of phosphorous, and 0.7 tons/yr of suspended solids. The total cost for the Lanreco Park Stream Restoration is anticipated to be ~$270,000, which is more expensive per foot than the average restoration. The higher price reflects a section of ArmorFlex matting to provide bank stabilization. ArmorFlex matting is an expensive but effective option for protecting critical stream banks. The section from Thomas Ewing Junior High to Forest Rose is a mile in total length, but much of this has seen some restoration work and all of this land lies on private property. If a focus is placed on the northern quarter of this section, nitrogen could be reduced by 30lbs/yr, phosphorous by 3.75lbs/yr, and suspended solids by 1.5 tons/yr. This section is anticipated to cost $300,000 to restore.

The goal is to achieve a healthy WWH and a healthy Habitat TMDL rating. The current state of Fetter's Run is stable and relatively diverse compared to other streams in Lancaster. This stream also lets out at Baldwin Run, which was previously restored, so the improved health of Fetter's Run directly affects the health of Baldwin Run. By restoring Fetter's Run, Baldwin Run would continue to be positively affected and contribute to the previous restoration efforts.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet explaining the project. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Signage

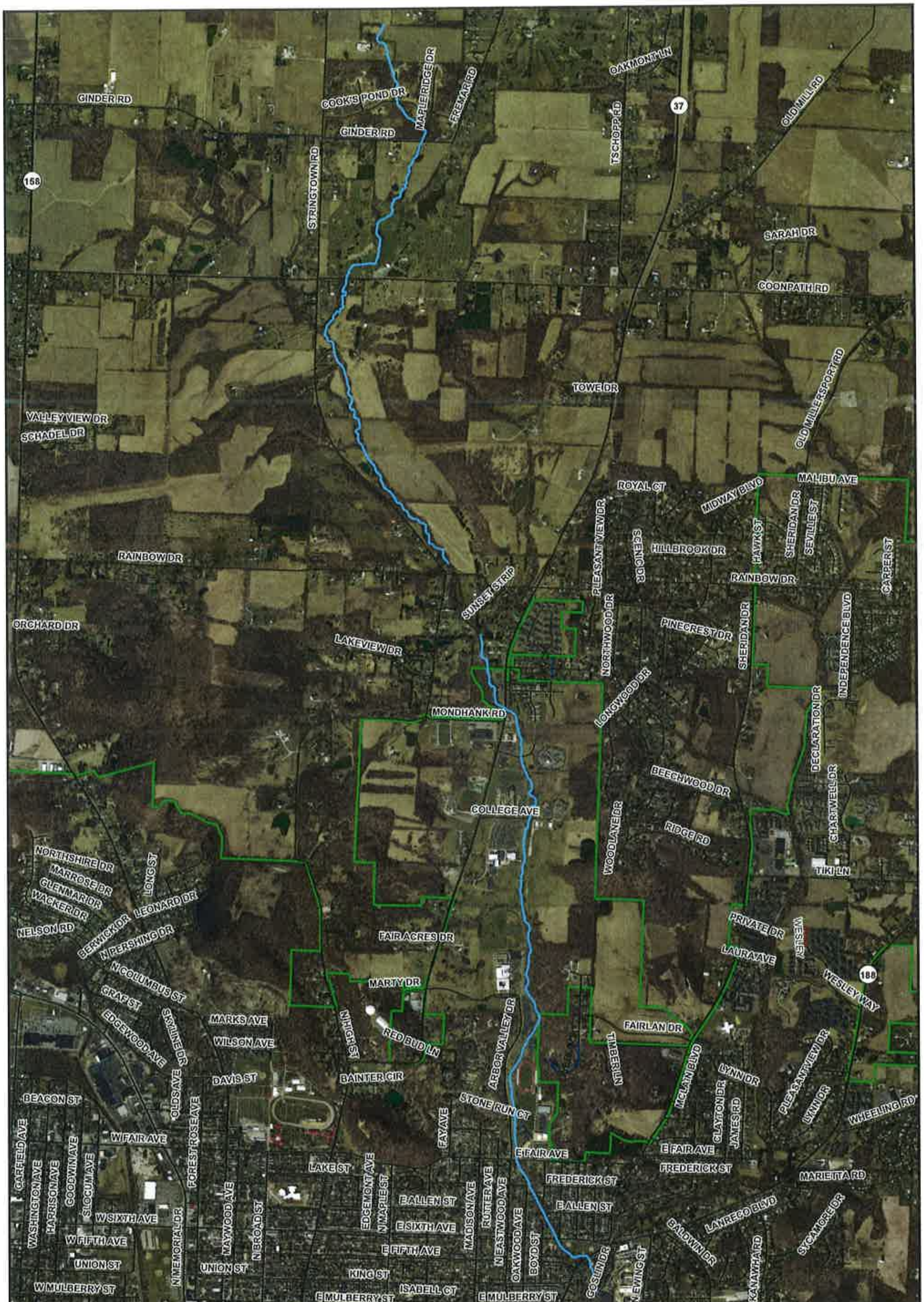
Signs are a staple in the field of public outreach due to their versatility. They can offer educational information, places to go for more information, public awareness announcements, or diagrams on how certain processes take place in relation to how we utilize a certain resource. Fetter's Run has a publicly accessible location at which to places signs, including anywhere along the Lancaster bike trail or within Lanreco Park.

Informational Kiosk

The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on Fetter's Run, the Stormwater Department could aid the Parks Department and install a kiosk at Lanreco Park, or add signage if the kiosk has been previously installed near Fetter's Run.

Appendix

Aerial Maps



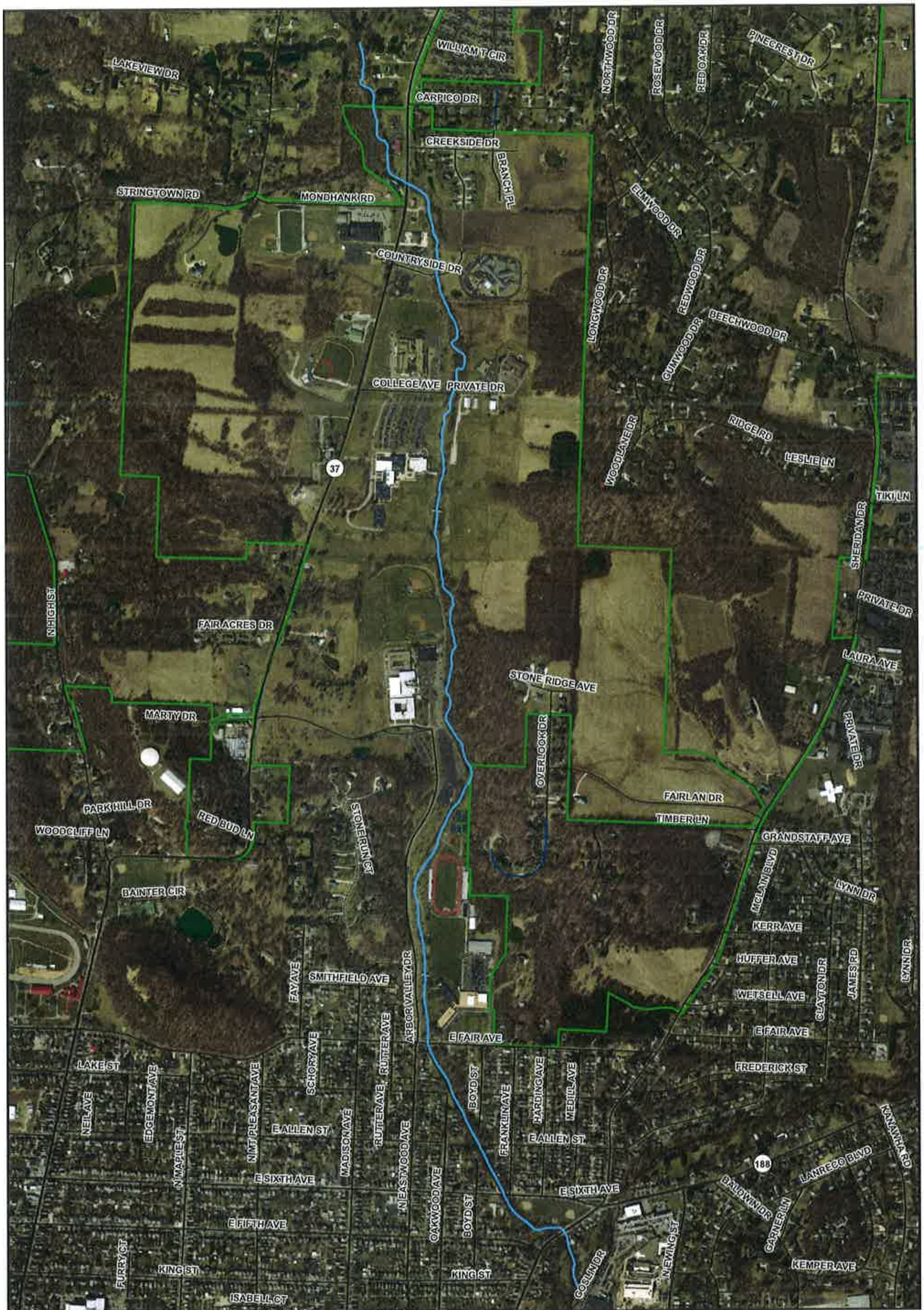
DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology. Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Fetter's Run

0 1,000 2,000 4,000 Feet



DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (91)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
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N

Fetter's Run Within LCB

0 500 1,000 2,000 Feet

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
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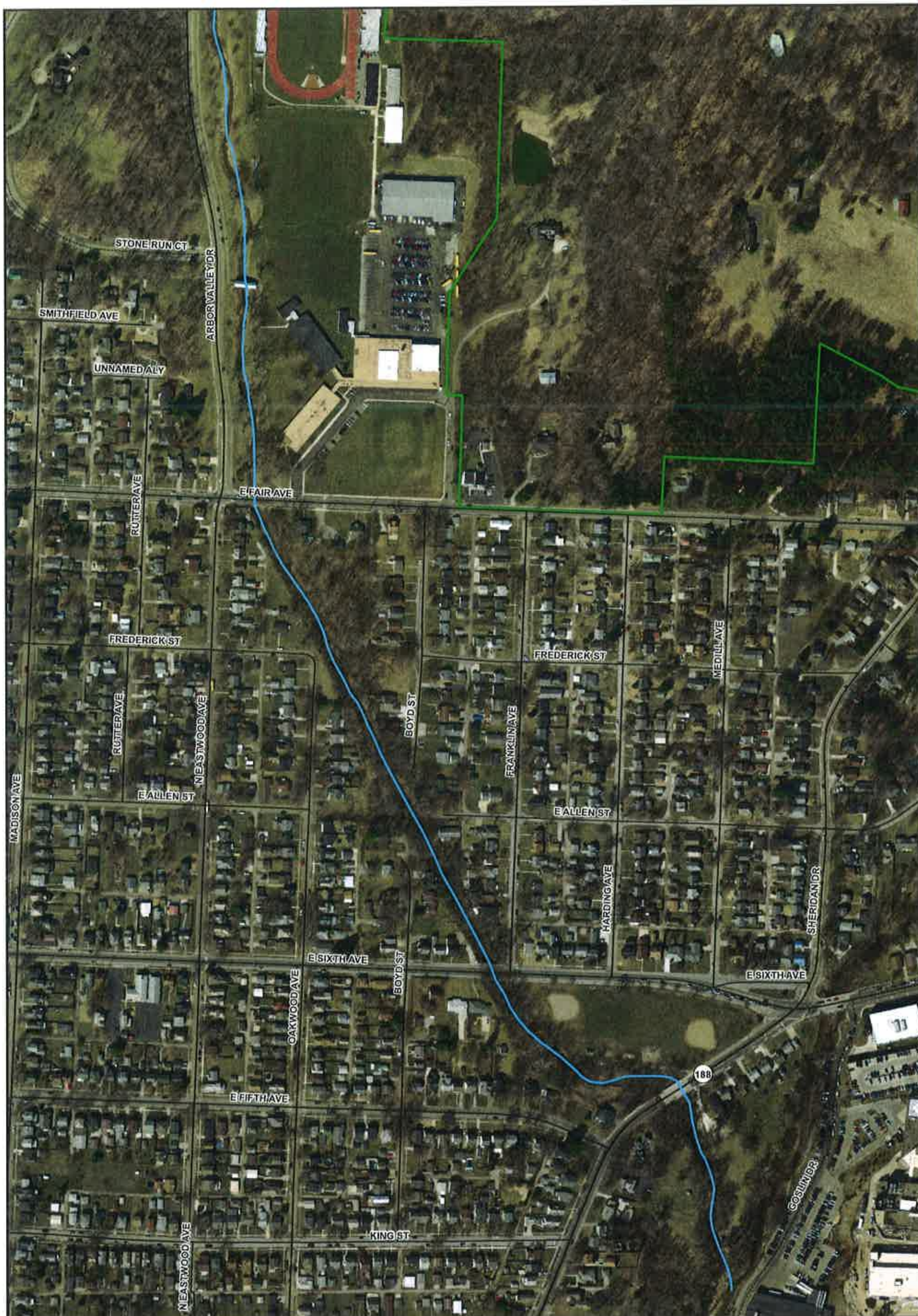
N

Fetter's Run Floodplain

0 500 1,000 2,000 Feet



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Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
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N

Fetter's Run
Lower 1/3

0 150 300 600 Feet

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet

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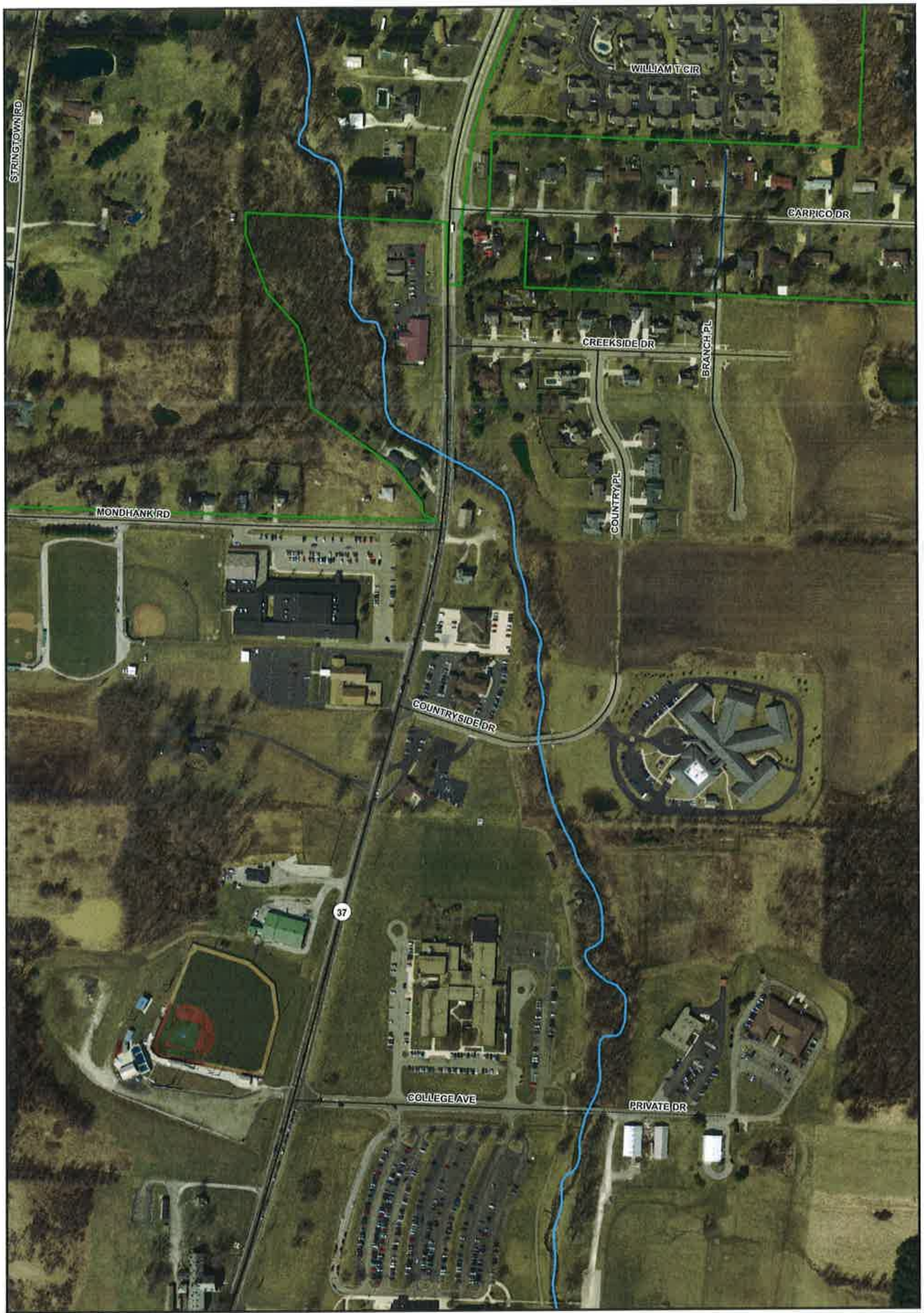
N

Fetter's Run
Middle 1/3

0 150 300 600 Feet



DISCLAIMER

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Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose. If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology. Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Fetter's Run
Upper 1/3

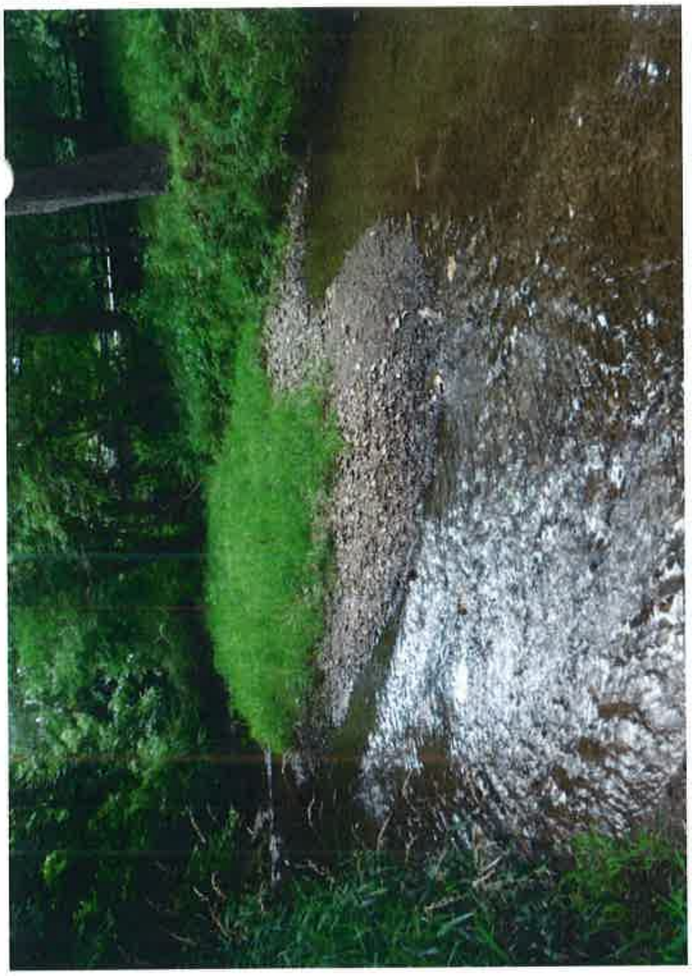
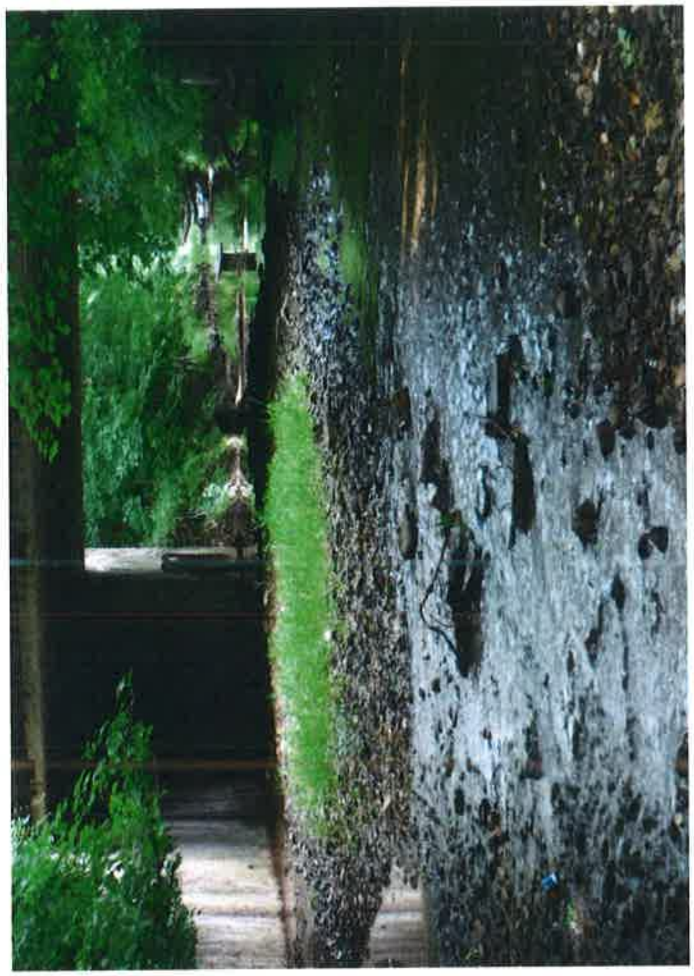
0 150 300 600 Feet

Pictures










Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed "high influence modified attributes".

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	**Substrate**	**+**	**Channel Morphology**	**+**	**Riparian Zone/Bank Erosion**	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories									Subscore			
		Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table A.3 Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])

		WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Hunter's Run Corridor Plan

Hunter's Run Background & Existing Conditions

Background & Literature Review

Hunter's Run flows through the southwest side of Lancaster, originating from the fields west of town. The stream is approximately nine miles in length in its entirety, one mile of which lie within the LCB. The run flows east until converging with the Hocking River near Cenci Lake Park.

Hunter's Run has been included in multiple Ohio EPA studies spanning the past 25 years as part of the Hocking River Watershed.

The 1991 Ohio EPA publication entitled "Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries" identified improved water quality conditions when compared to conditions in the early 1980s. This study sampled at RM 0.5 and determined the stream as compliant with all the requirements of a WWH despite achieving a QHEI score of 50.5. The study does note, however, that Hunter's Run is channelized and shows degradation common amongst urban streams. It also states that soils are oilier than expected, possibly due to an oil spill at the Lancaster Electroplating Plant in early 1991.

The 1997 Ohio EPA publication entitled "Biological and Water Quality Study of the Upper Hocking and Selected Tributaries" documented further improvements in water quality in the stream. From three sampling stations, located at RM 0.5, 2.5, and 3.5, results were consistently in compliance with WWH in all categories including fish, benthic macroinvertebrates, nutrient loadings, and dissolved oxygen. The only non-compliant metric was fecal coliform, which was highest in the urbanized sample location. Due to the absence of CSOs on Hunter's Run, exceedances originate from nonpoint source pollutants such as home sewage treatment system leakages. The Agency attributes improvements to the removal of the Anchor Hocking discharge in 1978 and upgrades to the Water Pollution Control Facility in 1985/6, which were not yet evident in the 1991 study. The closure of the Stonewall Landfill is also cited as a reason for the improved conditions in Hunter's Run itself.

The 2009 Ohio EPA publication entitled "Total Maximum Daily Loads for the Hocking River Watershed", determined the stream still compliant with WWH criteria following sampling events at RM 2.5 and RM 4.9. The study assigned QHEI scores of 60.5 and 53, respectively. The main impaired category as identified in the report is Hunter Run's riparian corridor.

Observations

Agricultural practices are the most common land uses surrounding Hunter's Run in the area of its headwaters. The agricultural practices introduce sediment and nutrients to the stream channel which migrate downstream. The Stonewall Landfill site is just outside the LCB, which previously affected the stream but has since been capped with clay and land. Any discharges from the site are collected and treated before leaving the site. City of Lancaster-related development near Hunter's Run includes residential properties as well as a City-owned park. Most of the stream has retained its natural sinuosity despite the urbanization of its surroundings. The most channelized sections lie within the LCB, particularly where the stream approaches Cenci Lake. While this section does not have walls bordering the channel, both banks are steep, eroded, and remove the stream from its floodplain. This section represents a critical segment for flood management as many private residences and commercial properties are subject to flooding.

The primary concerns on Hunter's Run within the LCB are the riparian corridor, debris, and bank erosion. Debris in the stream consists of man-made materials: lawn mowers, trash, utensils and cutlery, clothing, and a few failed attempts at bank stabilization as well as fallen trees and branches that are collecting along the banks. Bank erosion has created steep sections along the entire stream, the worst of which are closest to the Hocking River. The stream has undercut the bank through this section as well.

Debris removal, riparian corridor plantings, and bank stabilization constitute the restoration techniques suggested for Hunter's Run. Stabilizing the bank would decrease the amount of sediment entering the stream. It would also prevent undercutting along the bank and decrease the number of fallen trees and aggregation. Removing debris would return the stream to a natural state while removing trees that are causing blockages would allow the stream to flow normally and prevent sharp turns. Channel modifications would recover natural stream mechanics by diverting stream energy away from the banks and create a natural-state channel.

Hunter's Run Master Plan

The Hunter's Run corridor plan addresses issues caused by channelization including erosion and a lack of a diverse habitat as well as debris in the channel. QHEI scores from Ohio EPA studies were high, but sampling locations were far upstream of the most critical stretches of Hunter's Run. The stream is in unstable condition with eroded stream banks, soil and cobble sedimentation, and a stream bed inundated with sediment. The eroded stream banks have exposed root structures and washed away vegetation.

This plan describes management techniques for Hunter's Run within the LCB, emphasizing two sections. One section to highlight is an approximately 600 foot stretch on a large parcel to the south of Arney Avenue, west of Marten's Park (PID: 0536161600). The area has two sewers running through it, one storm and one sanitary, which limit development options. The land is well-suited for a small greenspace area along the bike trail should the City be able to acquire the land. The second section of stream to highlight is the section flowing through Marten's Park. A stream restoration could be completed in multiple small projects as funds become available, or as a large restoration. Restorative efforts could be appreciated by visitors of the park as well as bike trail users without interfering with current uses of either facility.

The following categories within the corridor plan are arranged from highest priority to lowest:

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Channel Enhancements/Bank Stabilization

Hunter's Run is in a relatively favorable state when compared to other streams in Lancaster. However, there are local areas in need of restoration and/or maintenance activities. South of Arney Avenue sinuosity is adequate, but erosion and a lack of riparian corridor both exist. To fit a natural and stable bank, the bike trail would be relocated further away from the stream to regrade the bank and plant vegetation. Regrading and reseeding the bank would improve stability. In-stream structures such as vortex rock weirs would be installed to create pools and more diverse habitats for local fauna. Cross vanes would provide both habitat and bank stabilization by diversifying the stream bed and redirecting energy towards the center of the stream.

Similar to the previous section, the stream section around Marten's Park has adequate sinuosity but the riparian corridor is lacking. There is no tree growth and limited understory vegetation near the foot bridge across Hunter's Run. Regrading and replanting vegetation would improve the riparian corridor and attract the park's visitors to the site. Adding in-stream structures like eddy rocks, cross vanes, and rock vortex weirs would enhance habitat and dissipate stream energy.

Channel enhancements and bank stabilization are most important for the channelized area from Marten's Park to Cenci Lake Park. This section has eroded banks that are undercutting the bank and increasing the risk of bank failure which would remove riparian vegetation. Ideally, the natural sinuosity would be restored by installing J-hooks and other channel deflectors to introduce meander within the stream. The flow of water would erode and curve portions of the banks over time, creating a more sinuous stream. Plants would be installed in the new curves while rocks and other bank stabilization techniques would be placed at eroded walls to avoid re-channelization. This redirection and restoration would occur naturally following a few installations by the City. When the natural stream flow is restored, a second restoration could occur with improvements to the channel substrate and bank stabilization to solidify restoration efforts.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Flood Prevention Dike Installation

The City of Lancaster may install three flood prevention dikes, one of which would be on Hunter's Run. It would, however, require the taking of homes. The section placed on Hunter's Run would be installed between the abandoned railroad and Lincoln Avenue, a total distance of 0.31 miles.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor plan is designed to improve stream habitat that is currently degraded due to channelization and erosion. Load reductions from restoration activities near Arney Avenue would result in a reduction of 12 lbs/yr of nitrogen, 1.5 lbs/yr of phosphorous, and 0.6 tons/yr of suspended solids. This restoration is anticipated to cost $120,000 in total, plus the cost of installing a potential public art project. Restoration activities near Marten's Park would result in a reduction of 20 lbs/yr of nitrogen, 2.5 lbs/yr of phosphorous, and 1 ton/yr of suspended solids. A project through Marten's Park would cost a total of $200,000 for the degraded section.

The goal for this stream plan is to achieve a healthy WWH and a healthy habitat TMDL rating. The current state of the run is unstable and does not support a healthy population of aquatic life. The highly urbanized stream environment leads to degraded streams with sand-based substrates and steep, eroded banks. A river cleanup would provide a great opportunity to rid the stream of unwanted debris prevalent through the residential section of the stream.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Public Art Display

In the greenspace near Hunter's Run just south of Arney Avenue, opportunity exists for a public art display installed by the Stormwater Department. Associated signage could indicate how and when the piece was installed, while the piece itself could be decided upon through public participation or be picked by the department so that it relates to stormwater management.

Rain Garden

A rain garden would be a useful installation at multiple places along Hunter's Run, most notably on the plot of land south of Arney Avenue (PID 0536161600). A storm sewer runs through this land. Depending on the depth of the sewer, a depression could be made in the land and filled with native plants that are fed by the water coming from the storm sewer and treating that water before reaching Hunter's Run.

Webpage

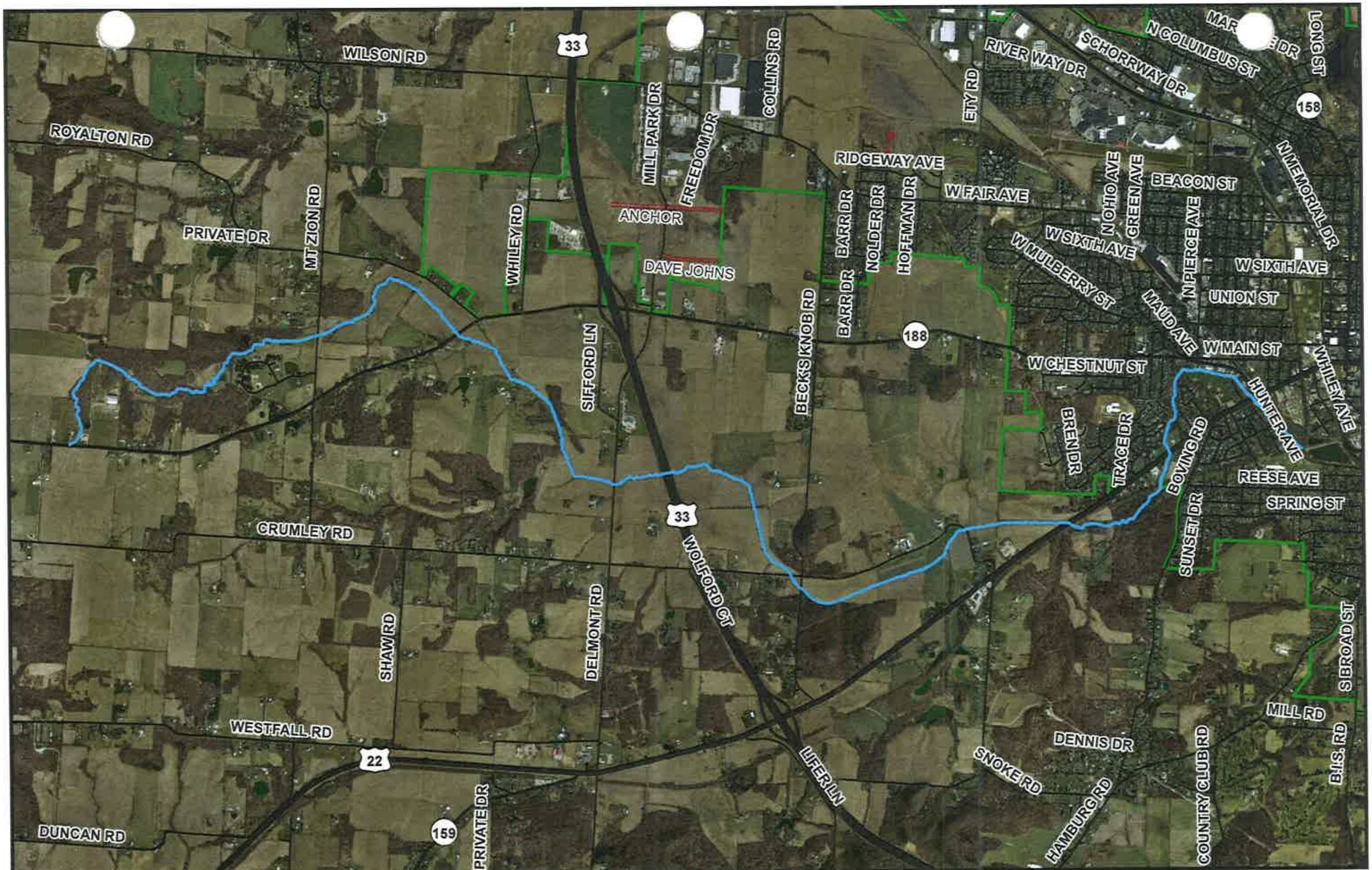
The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet explaining the project. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Signage

Signs are a staple in the field of public outreach due to their versatility. They can offer educational information, places to go for more information, public awareness announcements, or diagrams on how certain processes take place in relation to how we utilize a certain resource. Fetter's Run has a publicly accessible location at which to places signs, including anywhere along the Lancaster bike trail or within Marten's Park.

Appendix

Aerial Maps



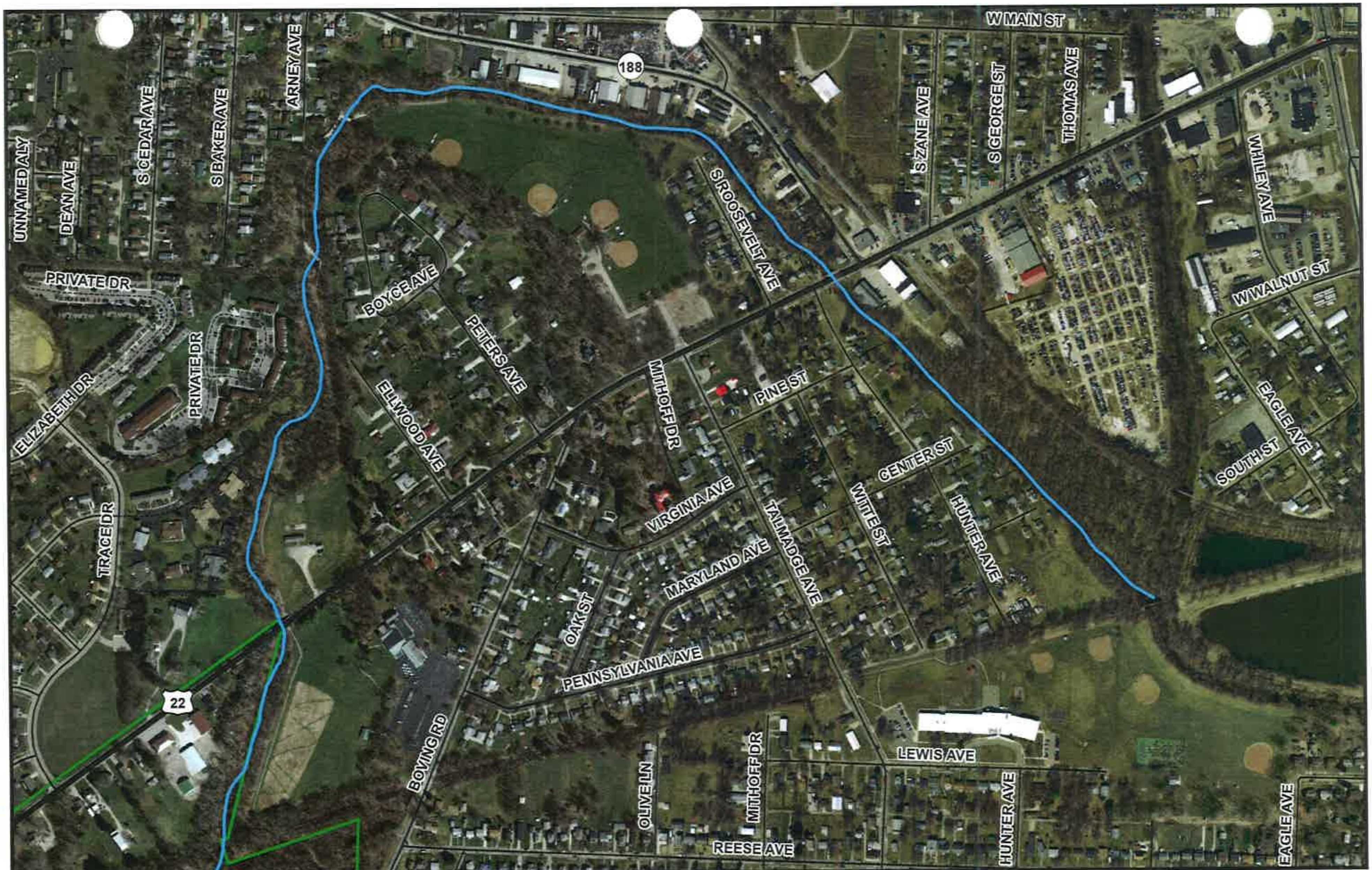
DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data -North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet.
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.
If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology
Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Hunter's Run

0 0.375 0.75 1.5 Miles



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N

Hunter's Run Within LCB

0 0.05 0.1 0.2 Miles

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data -North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet.
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Hunter's Run Within LCB

0 0.05 0.1 0.2 Miles

Pictures










Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed "high influence modified attributes".

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	All Other Modified Attributes
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	**Substrate**	**+**	**Channel Morphology**	**+**	**Riparian Zone/Bank Erosion**	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,
- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 7.8. Bacteria waste load allocations by assessment unit.

05030204		Sources	Fecal Coliform Load (count/day*10^7)		Reduction Required	Comments
			Existing	Allowable		
	010	Hocking River from headwaters to Rock Mill Dam				Direct HSTS connections are illegal and the only known sources of significance in this subwatershed, and need to be eliminated.
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	
		Direct HSTS	24888	0	100%	Elimination of illegal direct HSTS reduce the load below the TMDL. The difference between this load reduction and the TMDL is the MOS.
		Total Point Source (Wasteloads)	*24888*	*0*	*100%*	
	010	Hocking River from Rock Mill Dam to below the Ohio and Erie Canal				Failing and direct HSTS pose the major sources of concern in this area.
		Air Products & Chemicals	-	-	-	
		Lancaster MS4	0.228	0.224	2%	
		Direct HSTS	14210	0	100%	Air Products & Chemicals does not discharge fecal coliform
		Total Point Source (Wasteloads)	*14210*	*0*	*100%*	
	010 & 050	Hocking River from Rock Mill Recreation Area to Ety Road				The Lancaster Long Term CSO Control Plan should achieve a 95% reduction in fecal coliform load once it is fully implemented.
		Lancaster WPCF	3785	3785	0%	
		CSO	20264	1013	95%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Lancaster MS4	46	15	66%	
		Direct HSTS	10013	0	100%	
		Total Point Source (Wasteloads)	*34108*	*4814*	*86%*	Manure management and limiting livestock access are areas that need attention in this subwatershed.
010						
	020	Hunter's Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Stonewall Landfill	-	-	-	
		CSO	20264	0	100%	
		Lancaster MS4	7	3	55%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Direct HSTS	6005	0	100%	
		Total Point Source (Wasteloads)	*26276*	*3*	*100%*	
						Manure management and limiting livestock access are areas that need attention in this subwatershed.
						Stonewall Landfill does not discharge fecal coliform
	030	Baldwin Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		No NPDES facilities	-	-	-	
		CSO	45085	0	100%	
		MS4	31	31	0%	A new WWTP for Lancaster will eliminate some of the direct HSTS.
		Direct HSTS	10766	0	100%	
		Total Point Source (Wasteloads)	*55882*	*31*	*100%*	The elimination of the CSOs through the Lancaster LTCP and the elimination of direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories									Subscore			
		Substrate	Channel	Riparian	Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	QHEI	High Influence	# Modified Attributes	Total Habitat Score
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

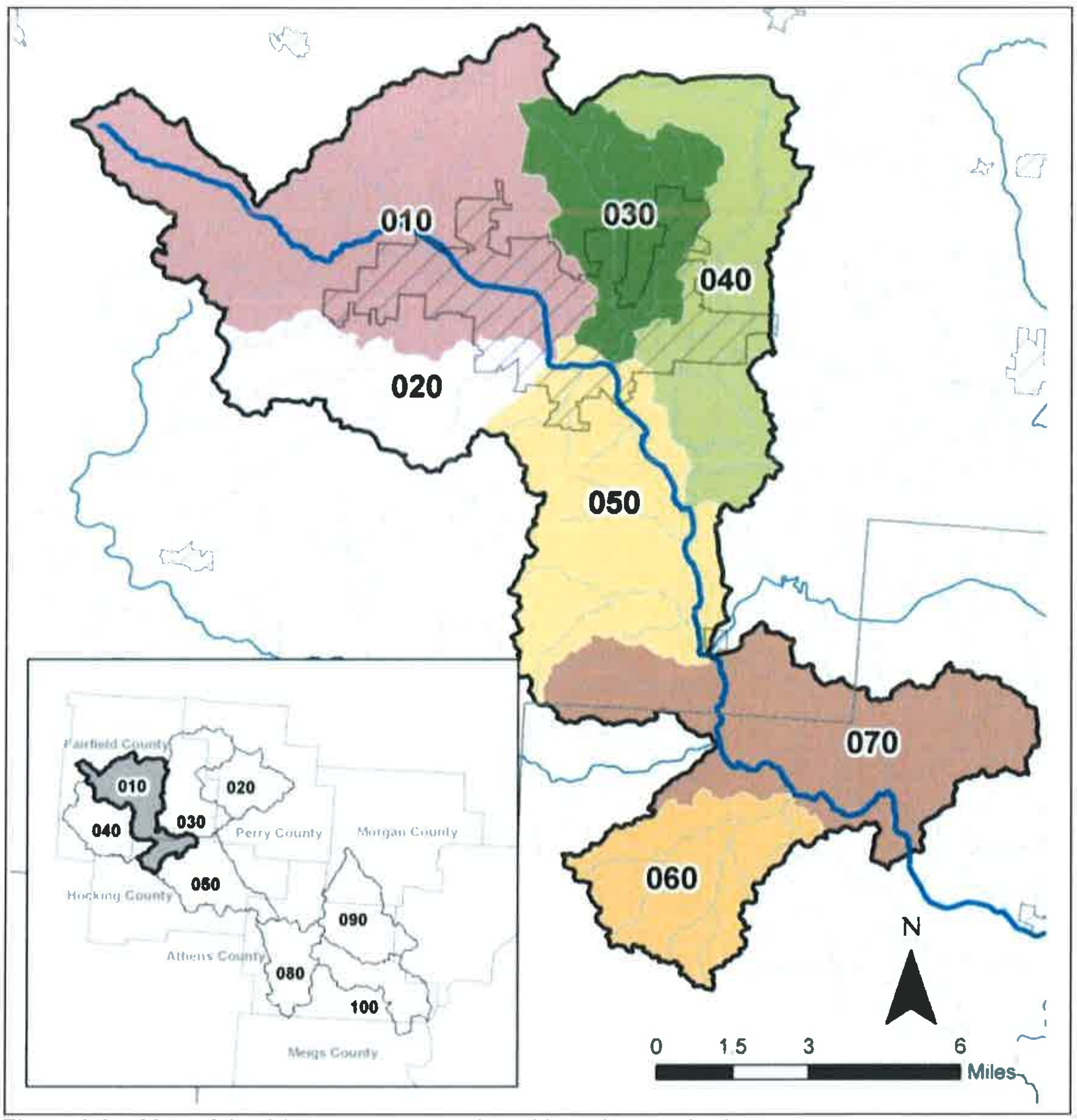


Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
	05030204-010- **Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	x					x	x
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	x					x	x
Stream Restoration		Restore flood plain	x					x	x
		Restore stream channel	x					x	x
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	x					x	x
		Restore natural flow	x					x	x
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	x						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x	x	
		Inspect HSTS	x	x	x	x	x	x	
		Repair or replace traditional HSTS	x	x	x	x	x	x	
		Repair or replace alternative HSTS	x	x	x	x	x	x	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
		Construction BMPs: erosion control							
		Construction BMPs: runoff control							
		Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
		Develop and/or implement long term control plan (CSOs)	x	x	x	x	x		
		Eliminate SSOs/CSOs/by-passes	x	x	x		x		
	storm water	Implement an MS4 permit	x	x	x	x	x		
		Implement an industrial permit							
		Implement a construction permit	x	x	x	x	x		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
		Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
		Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x				x		
		Implement conservation tillage practices	x				x		
		Implement grass/legume rotations	x				x		
		Convert to permanent hayland							
		Install grassed waterways	x				x		
		Install vegetated buffer strips	x				x		
		Install / restore wetlands	x				x		
	nutrients / agro-chemicals	Conduct soil testing	x				x		
		Install nitrogen reduction practices	x				x		
		Develop nutrient management plans	x				x		
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system	x				x		
		Implement drainage water management	x				x		
		Construct overwide ditch	x				x		
		Construct 2-stage channel	x				x		
	livestock	Implement prescribed & conservation grazing practices							
		Install livestock exclusion fencing							
		Install livestock crossings							
		Install alternative water supplies							
		Install livestock access lanes							
	manure	Implement manure management practices	x				x		
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

Table A.3 Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])

		WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Ewing Run Corridor Plan

Ewing Run Background & Existing Conditions

Background & Literature Review

Originating in the fields north of town, Ewing Run flows through the near east side of the City of Lancaster. The stream is around 5.5 miles in length in its entirety, three miles of which lie within the LCB. The run flows south until converging with Fetter's Run to form Baldwin Run. Baldwin Run then flows into the Hocking River.

The Ohio EPA monitors water and habitat quality in Ewing Run due to its association with Baldwin Run and the Hocking River. The two monitoring stations occur upstream near Tiki Lane and downstream near the Hocking River and Lancaster WWTP.

The 1991 Ohio EPA publication entitled "Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries" identified poor but improving water quality conditions when compared to the early 1980s. The study deemed Baldwin-Ewing Run as non-compliant with WWH criteria following sampling events near the WWTP discharge.

The 1997 Ohio EPA publication entitled "Biological and Water Quality Study of the Upper Hocking and Selected Tributaries" documented further improvements to the stream's water quality. The publication designated the upstream habitat unimpaired by local development, i.e., having all the necessary components for WWH designation. The study assigned a QHEI of 74.5 to Baldwin-Ewing upstream while sections near the WWTP scored as low as 57.6. The Agency attributes improvements to the removal of the Anchor Hocking discharge in 1978 and upgrades to the Water Pollution Control Facility in 1985/6, which were not yet evident in the 1991 study.

The 2009 Ohio EPA publication entitled the "Total Maximum Daily Loads for the Hocking River Watershed" determined the stream compliant with WWH criteria following samples taken near Tiki Lane. The study assigned a QHEI score of 65.5, surpassing the 60 required for compliance.

Observations

Agricultural practices are the most common land uses surrounding Ewing Run in the area of its headwaters. The agricultural practices introduce sediment and nutrients to the stream channel, which are then transported downstream. City of Lancaster-related development surrounds Ewing Run within the LCB. The stream travels through residential property within Lancaster. Private-property owners channelized the stream by constructing walls near the confluence with Fetter's Run. Bank erosion in this same area exposed multiple sewer manholes and encroached on private property. The lower portion of the stream shows evidence for degradation common to urbanized streams, including bank erosion, sedimentation, and poor floodplain conditions. Steeply eroded banks and artificially-walled banks have disconnected the stream from its floodplain. Local walling protects local infrastructure, but increases the degradation rate in other areas of the stream through the floodplain removal.

The primary concern on Ewing Run is bank erosion due to its connection to other stream issues. The water has undercut the bank, leaving roots exposed and public infrastructure exposed and/or damaged. Banks along the upper portion of the stream have collapsed, and with them trees have fallen into the stream. Trees and sediment in the middle of the channel cause streamflow alteration and downstream sedimentation. Urban sources, such as rock channel protection and concrete blocks, create permanent streamflow alteration, at least until the sources are removed. Orange bacteria from an unknown source has seeped into the stream and stained tree roots in areas throughout the stream.

Bank stabilization and debris removal constitute the restoration techniques suggested for Ewing Run. Stabilizing the bank decreases the amount of sediment entering the stream. It also prevents undercutting along the bank and decreases the number of downed trees and aggregation. Removing debris would return the stream to a natural state while removing trees that are causing blockages allows the stream to flow normally and prevent sharp turns. Channel modifications divert stream energy away from the banks and creates a natural-state channel.

Ewing Run Master Plan

The Ewing Run corridor plan addresses problem areas with eroded stream banks and exposed public infrastructure. The Ohio EPA's water quality and TMDL reports assigned Ewing Run high QHEI scores, but local areas exhibit instability that puts both private and public infrastructure at risk. The lower reaches that are channelized through constructed walls are also wide and shallow, neither of which are suitable conditions for proper water or habitat quality.

This plan describes management techniques for Ewing Run within the LCB, emphasizing two sections. The first section is one mile Baldwin Run to Huffer-Durdin Park. This section flows through private property, which limits general public access to the stream but is of concern to the owners. Bank erosion has exposed two manholes, one of which lies near the middle of the stream. Risk to both public and private infrastructure is prevalent throughout the section. The second section to emphasize is a half-mile stretch centered on Rainbow Drive. This area sets on private property and has been disconnected from its floodplain through eroded stream banks.

The following categories within the corridor plan are arranged from highest priority to lowest:

Bank Stabilization/ Channel Enhancements

Ewing Run overall is considered a "twisting" stream, with a sinuosity index of 1.35. However, channel modifications in the first river mile create local channelization. From Pleasantville Road to Huffer-Durdin Park, large walls have been constructed along the north/west bank of the stream, including 8-10 foot high walls of wood and metal and shorter walls made up of wooden boards held in place with wire. The south/east bank through this section has eroded banks, poor riparian vegetation, and exposed manholes. The most effective plan would be to remove the wall and install Armorflex matting with inter-planted vegetation or a similar bank stabilization technique, but this would require the cooperation of private property owners. If the local residents are not willing to have the wall removed which may put their property at risk, a compromise could be to install toe wood at critical points in the stream. The natural material from toe wood would prevent bank erosion while avoiding unnatural and permanent bank erosion techniques like rock channel protection or Armorflex matting. A sod-mat placed on top of a toe wood structure could alleviate local property owners' concern over the loss of the wall to protect their property. In this section there is also a concrete stream crossing that is obstructing stream flow and creating further erosional issues through this section. Due to its private ownership, coordinating its removal would require the support of the land owner.

Following the removal of modifying attributes, the banks would be reshaped into a natural slope leading to the water's edge and planted with native vegetation and large canopy trees. The channel itself would be compressed into a deeper and narrower state. The removal of the wall would decrease the Total Number of Modified Attributes indicated in the Habitat TMDL and the stream would achieve a healthy Habitat Score of three. Removing aggregate soil and silt along Ewing Run would increase the flow of the stream and reduce the risk of the channel being blocked in the future. This would reduce the amount of soil to be carried away by water and deposited downstream.

If the removal of the wall is not possible due to cost or property issues, then in-stream structures could be installed to create a more dynamic bed. J-hooks and cross vanes could divert the stream away from the wall as well as develop a deeper channel. Rock vortex weirs and boulders would create pools and other local habitat features. Another solution would be to construct a two-stage channel such that the stream itself would be narrower but deeper, have more room in which to move, and have more floodplain available.

Upstream from Huffer-Durdin Park, there are localized areas of heavy erosion and one area where the stream has been divided into two channels. At least two sections of the stream contain recently collapsed banks that fell due to undercut banks. These banks deposited sediment into the stream that is being washed downstream while also diverting stream energy away from the middle of the stream and compounding erosional issues. One such of these areas lies just west and north of Redeemer Lutheran Church. Aerial photography reveals that this section of stream has shifted location through erosion over the past fifteen years. This section would benefit from bank stabilization through regrading, riparian corridor vegetation planting, or armoring through Armorflex matting or rock channel protection.

The northern section of the stream, near Rainbow Drive, would benefit from bank stabilization through regrading. The stream bank through this section is steep on the west side of the stream. Regrading the bank would allow for floodplain reconnection and development as well as limit future bank erosion. Should the regrading of the west bank not be possible, the east bank could be used to develop the floodplain while using J-hooks and/or bank protection to prevent further degradation of the west bank.

Typical restoration techniques would be implemented in other areas of the stream to provide local habitat and improve stream quality. Toe wood would be installed at critical points throughout the stream to protect failing banks. J-hooks and cross vanes would also protect stream banks and create pools, while rock vortex weirs and rock eddies would provide local habitat.

Infrastructure Protection

Protecting infrastructure could occur through the bank stabilization process. J-hooks would redirect water away from the structures while adding soil and bank protection would protect the structure itself until the J-hook begins to work. The manhole in the middle of the stream would require the cooperation of two property owners in order to resolve the issue efficiently. The stream could be re-routed through Parcel #0534006600 and Parcel #0534081000 and avoid the manhole altogether. Following the adjustment, bank protection would be installed to prevent re-exposure through erosion.

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City itself.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor plan is designed to improve stream habitat that is currently degraded due to bank erosion, siltation and channelization. Load reductions resulting from restorations in the southern reaches of the stream would ideally span the section from Pleasantville Road to the concrete crossing just south of Huffer-Durdin Park. This 3,500 foot section would result in load reductions of 70 lbs/yr of nitrogen, 8.75 lbs/yr of phosphorous, and 3.5 tons/yr of suspended solids. This restoration would likely occur over time in smaller restoration projects, as time and money allows. The total section is expected to cost $700,000, plus another $100,000 for the removal of the low head dam in this section. The northern section around Rainbow Drive would provide load reductions of 56 lbs/yr of nitrogen, 7 lbs/yr of phosphorous, and 2.8 tons/yr if the full half-mile section were to be restored, though this would be completed in smaller projects as well. The total cost for this section is anticipated to be $560,000 in total, spread among small scale projects as time and money allow.

The goal is to achieve a healthy WWH and a healthy Habitat TMDL rating. The current state of Ewing Run is stable when compared to other streams in Lancaster and the restoration of this stream segment would require the cooperation of the current land owners and easements. This stream lets out at Baldwin Run, which was previously restored, so the improved health of Ewing Run directly affects the health of Baldwin Run. By restoring Ewing Run, Baldwin Run would continue to be positively affected and contribute to the previous restoration efforts.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the restoration public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet explaining the project. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Informational Kiosk

The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on Ewing Run, the Stormwater Department could aid the Parks Department and install a kiosk at Huffer-Durdin Park, or add signage if the kiosk has been previously installed near Ewing Run.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made in order to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Library Books/Display

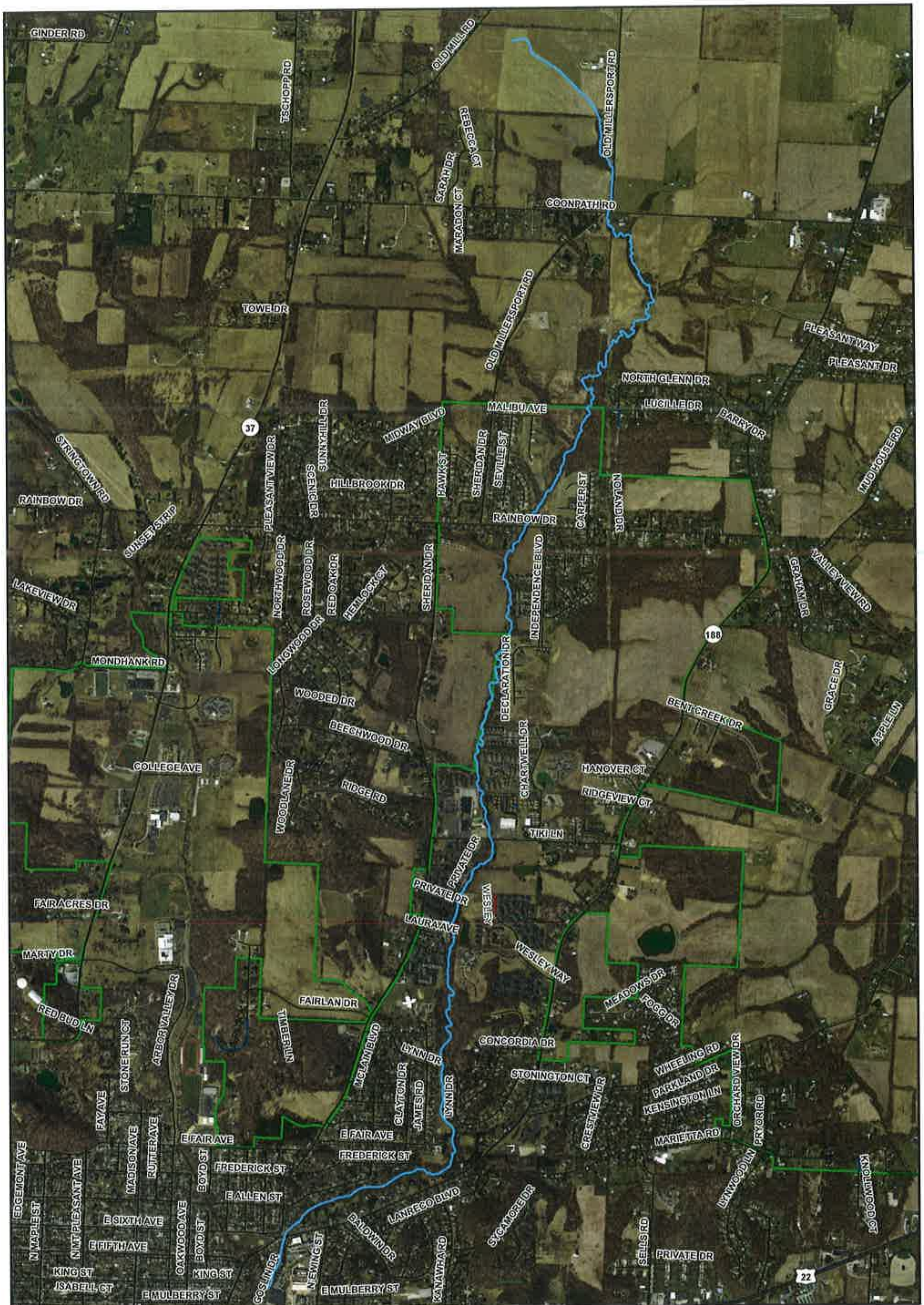
The library is a great public arena that could get information out to the public through posters/signage, as well as a great place to offer brochures or book-related information on stream dynamics and restorative efforts implemented in our City's streams.

Other

With efforts for this plan primarily located on private land, the department may need to use alternative forms of public outreach than typical on-site practices. Nearby Fetter's Run and Baldwin Run both run along the Lancaster bike trail and have much higher visibility than Ewing Run. Signs could be installed near the point where the three runs meet and contain information about how stream health is related amongst waters connected to one another.

Appendix

Aerial Maps



DISCLAIMER

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Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose. If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology. Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Ewing Run

0 750 1,500 3,000 Feet

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N

Ewing Run Within LCB

0 500 1,000 2,000 Feet

Ewing Run Floodplain

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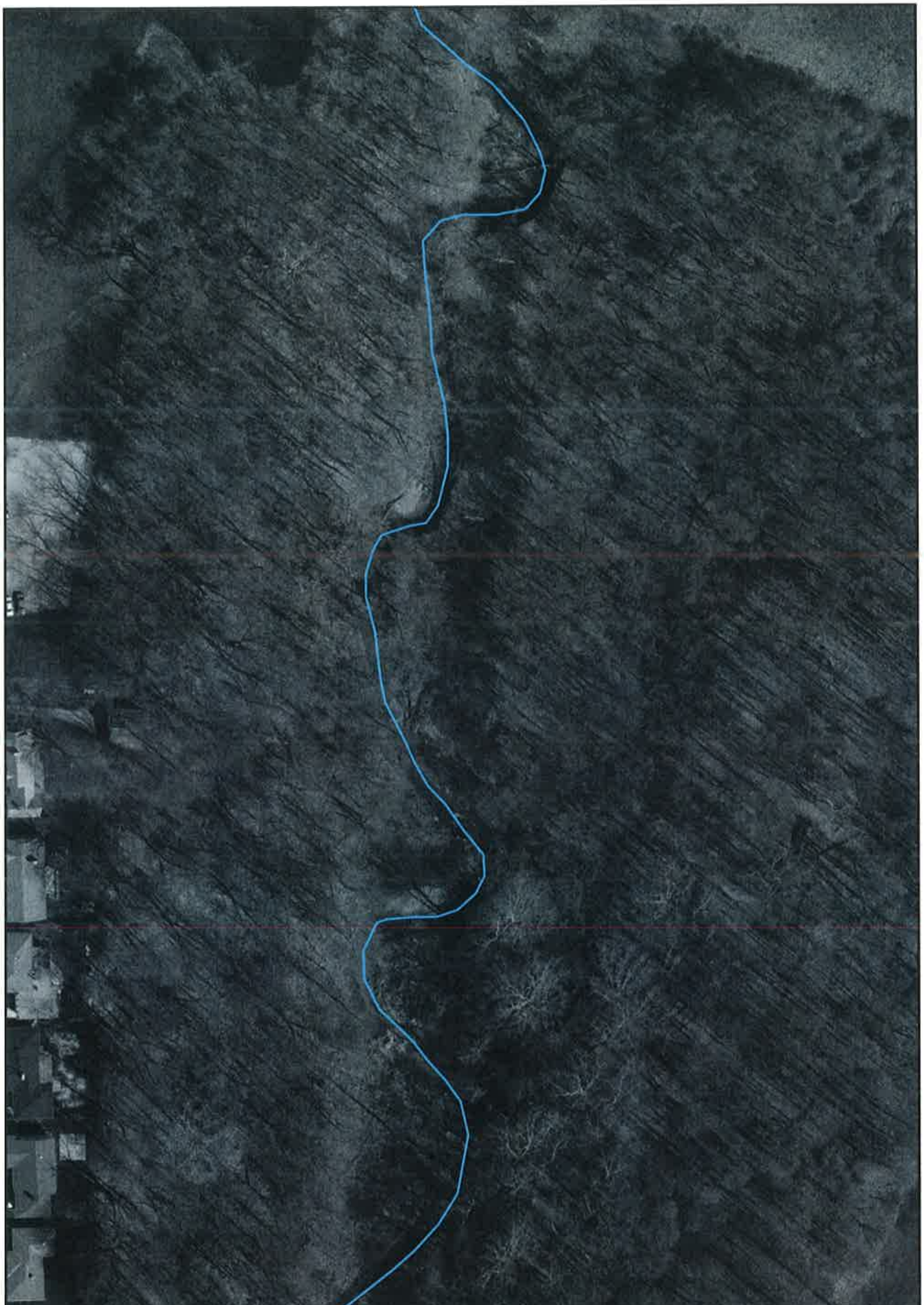
N

0 500 1,000 2,000
Feet



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N

Ewing Run Channelized Section 2015

0 37.5 75 150 Feet

DISCLAIMER

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N

Ewing Run Channelized Section 2015

0 37.5 75 150 Feet

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N

Ewing Run
Lower 1/3

0 250 500 1,000 Feet

DISCLAIMER

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N

Ewing Run
Middle 1/3

0 200 400 800 Feet

DISCLAIMER

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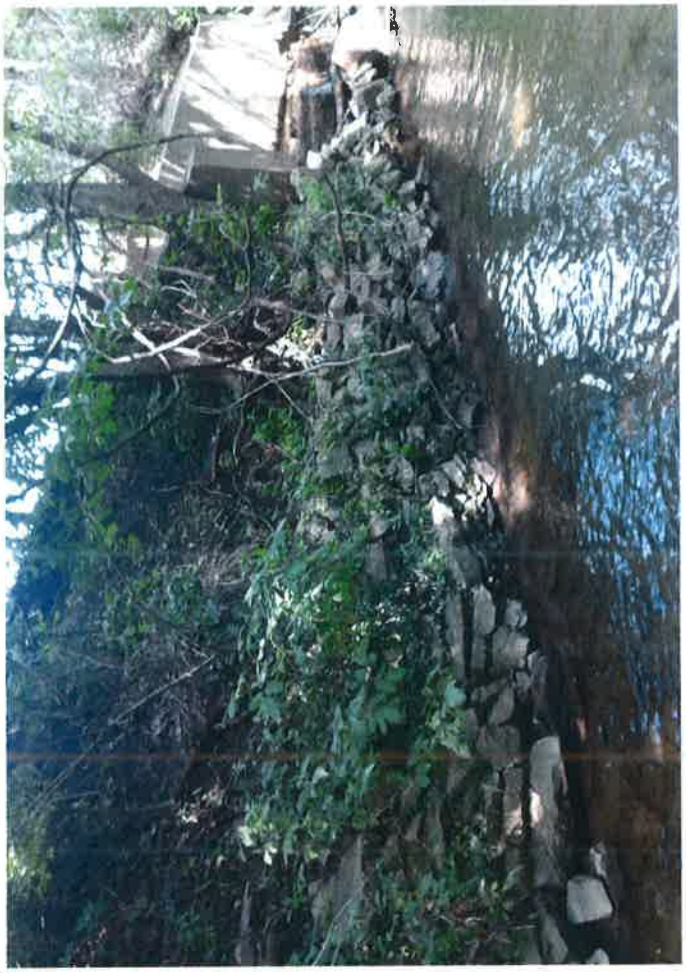
N

Ewing Run
Upper 1/3

0 250 500 1,000 Feet

Pictures



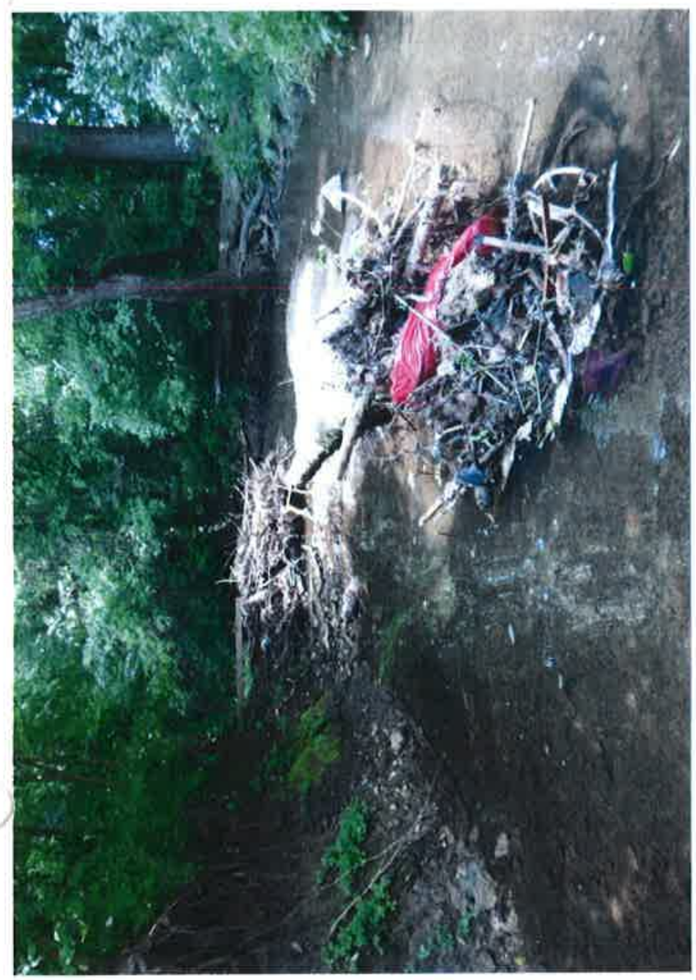












Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed "high influence modified attributes".

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	**Substrate**	**+**	**Channel Morphology**	**+**	**Riparian Zone/Bank Erosion**	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

Table 7.8. Bacteria waste load allocations by assessment unit.

05030204		Sources	Fecal Coliform Load (count/day*10^{7}) Existing	Allowable	Reduction Required	Comments
010	010	Hocking River from headwaters to Rock Mill Dam				Direct HSTS connections are illegal and the only known sources of significance in this subwatershed, and need to be eliminated.
		No NPDES facilities	-	-	-	
		No CSO or MS4s	-	-	-	
		Direct HSTS	24888	0	100%	Elimination of illegal direct HSTS reduce the load below the TMDL. The difference between this load reduction and the TMDL is the MOS.
		Total Point Source (Wasteloads)	*24888*	*0*	*100%*	
	010	Hocking River from Rock Mill Dam to below the Ohio and Erie Canal				Failing and direct HSTS pose the major sources of concern in this area.
		Air Products & Chemicals	-	-	-	
		Lancaster MS4	0.228	0.224	2%	
		Direct HSTS	14210	0	100%	Air Products & Chemicals does not discharge fecal coliform
		Total Point Source (Wasteloads)	*14210*	*0*	*100%*	
	010 & 050	Hocking River from Rock Mill Recreation Area to Ety Road				The Lancaster Long Term CSO Control Plan should achieve a 95% reduction in fecal coliform load once it is fully implemented.
		Lancaster WPCF	3785	3785	0%	
		CSO	20264	1013	95%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Lancaster MS4	46	15	66%	
		Direct HSTS	10013	0	100%	
		Total Point Source (Wasteloads)	*34108*	*4814*	*86%*	Manure management and limiting livestock access are areas that need attention in this subwatershed.
	020	Hunter's Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		Stonewall Landfill	-	-	-	
		CSO	20264	0	100%	
		Lancaster MS4	7	3	55%	A new WWTP is proposed for Lancaster which would tie in many of the direct and failing HSTS.
		Direct HSTS	6005	0	100%	
		Total Point Source (Wasteloads)	*26276*	*3*	*100%*	
						Manure management and limiting livestock access are areas that need attention in this subwatershed.
						Stonewall Landfill does not discharge fecal coliform
	030	Baldwin Run				The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented.
		No NPDES facilities	-	-	-	
		CSO	45085	0	100%	
		MS4	31	31	0%	A new WWTP for Lancaster will eliminate some of the direct HSTS.
		Direct HSTS	10766	0	100%	
		Total Point Source (Wasteloads)	*55882*	*31*	*100%*	The elimination of the CSOs through the Lancaster LTCP and the elimination of direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

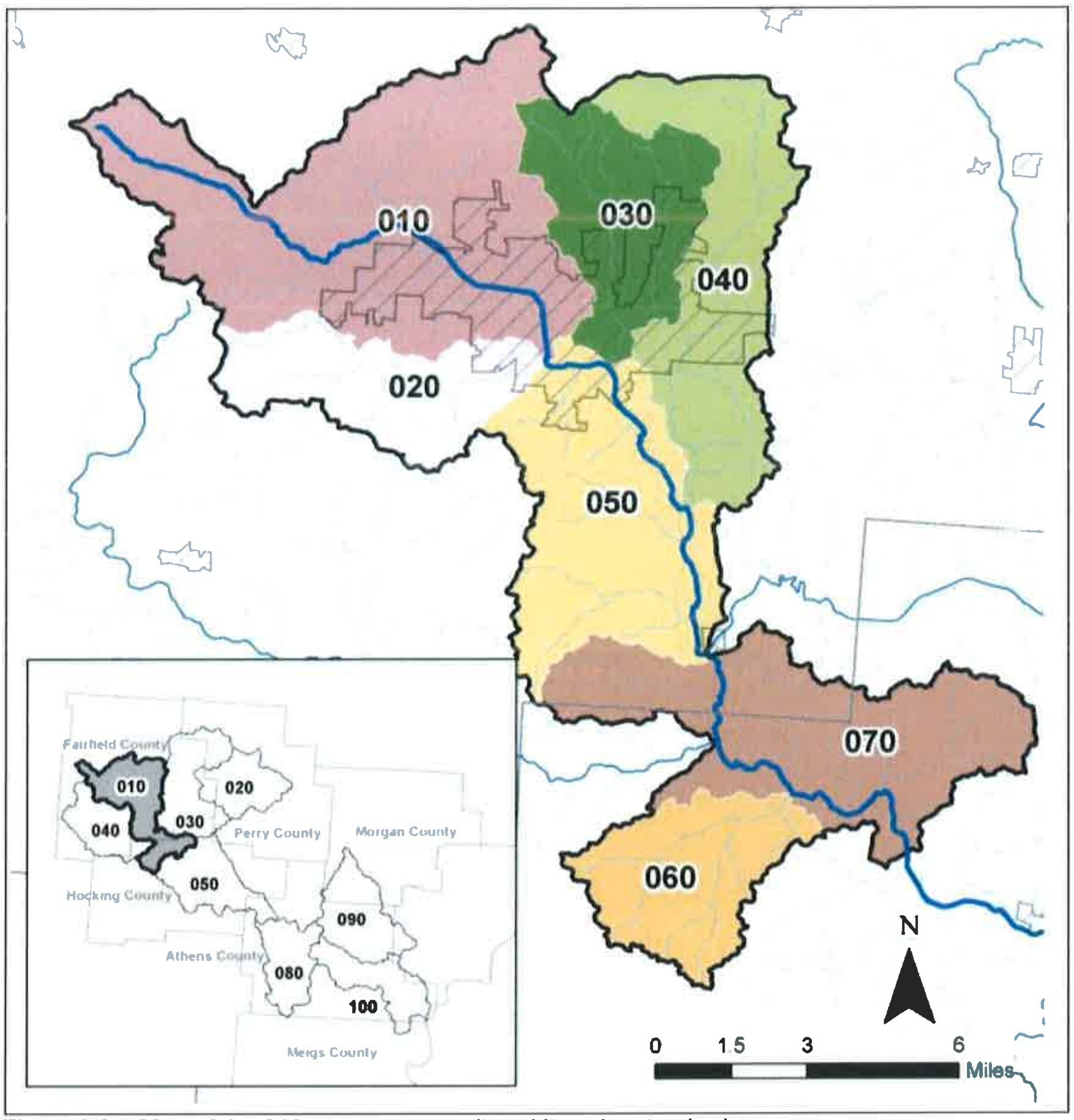


Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
	05030204-010- **Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	x					x	x
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	x					x	x
Stream Restoration		Restore flood plain	x					x	x
		Restore stream channel	x					x	x
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	x					x	x
		Restore natural flow	x					x	x
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	x						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x	x	
		Inspect HSTS	x	x	x	x	x	x	
		Repair or replace traditional HSTS	x	x	x	x	x	x	
		Repair or replace alternative HSTS	x	x	x	x	x	x	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010 010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
	quality controls	Construction BMPs: erosion control							
	quality controls	Construction BMPs: runoff control							
	quality controls	Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
	collection and new treatment	Develop and/or implement long term control plan (CSOs)	x	x	x	x	x		
	collection and new treatment	Eliminate SSOs/CSOs/by-passes	x	x	x		x		
	storm water	Implement an MS4 permit	x	x	x	x	x		
	storm water	Implement an industrial permit							
	storm water	Implement a construction permit	x	x	x	x	x		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
	enhanced treatment	Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
	monitoring	Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x				x		
	farmland	Implement conservation tillage practices	x				x		
	farmland	Implement grass/legume rotations	x				x		
	farmland	Convert to permanent hayland							
	farmland	Install grassed waterways	x				x		
	farmland	Install vegetated buffer strips	x				x		
	farmland	Install / restore wetlands	x				x		
	nutrients / agro-chemicals	Conduct soil testing	x				x		
	nutrients / agro-chemicals	Install nitrogen reduction practices	x				x		
	nutrients / agro-chemicals	Develop nutrient management plans	x				x		
	drainage	Install sinkhole stabilization structures							
	drainage	Install controlled drainage system	x				x		
	drainage	Implement drainage water management	x				x		
	drainage	Construct overwide ditch	x				x		
	drainage	Construct 2-stage channel	x				x		
	livestock	Implement prescribed & conservation grazing practices							
	livestock	Install livestock exclusion fencing							
	livestock	Install livestock crossings							
	livestock	Install alternative water supplies							
	livestock	Install livestock access lanes							
	manure	Implement manure management practices	x				x		
	manure	Construct animal waste storage structures							
	manure	Implement manure transfer practices							
	manure	Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010 010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

Table A.3 Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])

River Mile	QHEI	WWH Attributes: No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	MWH Attributes – High Influence: Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	MWH Attributes – Moderate Influence: Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Pleasant Run Corridor Plan

Pleasant Run Background & Existing Conditions

Background & Literature Review

Pleasant Run flows through the east side of Lancaster, originating in the fields north of town. The stream is approximately 12 miles in length in its entirety, two miles of which lie within the LCB. The run flows south until emptying into the Hocking River south of town, near the U.S. 33 and Logan-Lancaster Road intersection.

In 2009, the Ohio EPA publication entitled the "Total Maximum Daily Loads for the Hocking River Watershed" sampled four streams in Lancaster as well as the Hocking River. Pleasant Run received the highest scores of all five bodies of water sampled during this study. All three sampling locations achieved WWH target standards for QHEI scores and all three were either close to or achieved all subcategory targets for total bedload and total habitat score. Pleasant Run had the only two sections to achieve 3/3 on the total habitat section.

Observations

Development surrounding Pleasant Run has been limited. For most of its great length, Pleasant Run makes its way through agricultural fields, golf courses, and forested areas. Agricultural practices are the most common land uses surrounding Pleasant Run in the area of its headwaters. The agricultural practices introduce sediment and nutrients to the stream channel which migrate downstream. Lancaster City-related development around Pleasant Run includes residences, a gas station, an automotive repair service, and a church. The stream flows through privately owned parcels of land within the LCB. The Shelly Company operates near the confluence of Pleasant Run and the Hocking River. Just north of Shelly Company, evidence found in aerial photos of changes in the route of Pleasant Run indicate an attempt to control the amount of water reaching local farms. Sharp turns and unnaturally straight segments in the stream channel suggest human-induced changes in stream history. These changes occurred between 1938 and 1980, according to aerial photography.

The floodplain for Pleasant Run is extensive, unhampered by local development and conflicting interests. The floodplain to the east of the stream where it flows through Lancaster has been used for commercial development, but effects on the stream are low. The sinuosity of the stream is high compared to other streams in Lancaster. Pleasant Run has a sinuosity index of 1.45 and is only surpassed in the category by Hunter's Run at 1.47. Both streams are near "meander" status, the highest conventional class of sinuosity a stream can achieve.

The primary concerns on Pleasant Run are unnaturally occurring debris associated with an urbanized stream and localized bank erosion, as well as localized openings in the riparian corridor vegetation. Car tires around the gas station and armoring the banks around agricultural fields as well as concrete blocks exist throughout the stream. Collapsed trees are also affecting streamflow in multiple locations. Bank erosion is severe in certain areas of the stream with steep, non-vegetated banks and failing vegetation. Local areas lack riparian corridor vegetation, and in others modified structures channelize the stream.

Bank stabilization and regrading, riparian corridor revitalization, and a river cleanup are the forms of restoration suggested for this stream. Stabilizing the bank would decrease the amount of sediment in the stream, prevent undercutting along the bank, and reduce the number of modified attributes along the channel. It would also reduce the amount of fallen trees resulting in less aggregation and fewer pieces of debris affecting the channel. Clearing out accumulated debris and removing fall trees would both help to restore natural streamflow mechanics.

Pleasant Run Master Plan

The Pleasant Run corridor plan addresses issues caused by a lack of vegetation and urban debris within the LCB. Pleasant Run is documented as having all the components necessary for a healthy environment for local flora and fauna. Sinuosity is high, the riffle to run to pool ratio adequate, and the substrate made of gravel to cobble sized rocks. The riparian area is well developed through most of the stream with the exception of the area around Kumler Automotive and Collision and near East Main Street, where no riparian corridor exists. The lack of vegetation, along with debris and channelization through walling, is the primary issue with Pleasant Run.

This plan describes management techniques for Pleasant Run within the LCB, emphasizing two sections of the stream. The first section is from east of Kumler Automotive and Collision to East Main Street. This area lacks riparian corridor, has multiple modified attributes, contains large woody debris, and with non-natural debris. This area is the only section missing multiple characteristics of a healthy stream according to the Ohio EPA. The second section to emphasize is the section just west of East Main Street. This section is behind commercial properties along Main Street, which is evident within the stream. Multiple tires exist through this section and steeply eroded banks on the north side of the stream, near the commercial properties.

The following categories within the corridor plan are arranged from highest priority to lowest:

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Channel Enhancements/Bank Stabilization

The Pleasant Run stream channel is in favorable condition when compared to other streams around the City. The issues are large woody debris and a retaining wall on the north side of the stream north of East Main Street. The large woody debris should be removed so that the stream could either return to its original path or incise a new, natural channel. The retaining wall would ideally be removed, but given its location that solution is unlikely. The retaining wall shows evidence for multiple rounds on maintenance on it, so it may beneficial to involve the owner in the planning process to develop a longer lasting approach that is beneficial for everyone.

Bank stabilization on Pleasant Run would include regrading and armoring the banks with Armorflex matting or a more natural protection method such as toe wood and/or riparian vegetation installation. The two sections most in need of bank stabilization are the section behind commercial properties along East Main Street and the section east of Kumler Automotive and Collision.

Stream Setback Ordinance

A stream setback ordinance would limit the options for developing within a certain distance from the stream. This could include different levels of limitation based on the distance from the stream or, if implemented City-wide, limitations specific to each stream. The ordinance option is easily adaptable to fulfill a stream's needs, but previous development and public support may prevent a stream setback from achieving its full potential. If properly implemented, a stream setback ordinance should provide protection for the stream from urban activities and protect local infrastructure from flood damage.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This corridor is designed to improve stream habitat that is currently degraded due to debris in the channel and lack of riparian vegetation. Load reductions resulting from restorations from Kumler Automotive and Collision to East Main Street should be 40 lbs/yr of nitrogen, 5 lbs/yr of phosphorous, and 2 tons/yr of suspended solids. The restoration project through this section is anticipated to cost $400,000 in total. The section west of East Main Street could be restored in order to reduce nitrogen by 20 lbs/yr, phosphorous by 2.5 lbs/yr, and suspended solids by 1 ton/yr. This section is anticipated to cost $200,000 in total to restore.

The goal of the corridor plan for Pleasant Run is to achieve a healthy WWH and a healthy Habitat TMDL. With the current state of Pleasant Run, smaller, less intensive projects would benefit the stream and its habitat quality. The stream releases into the Hocking River, which has been noted as being one of the most improved rivers in the state. This restoration would only further that improvement and help keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Library Books/Display

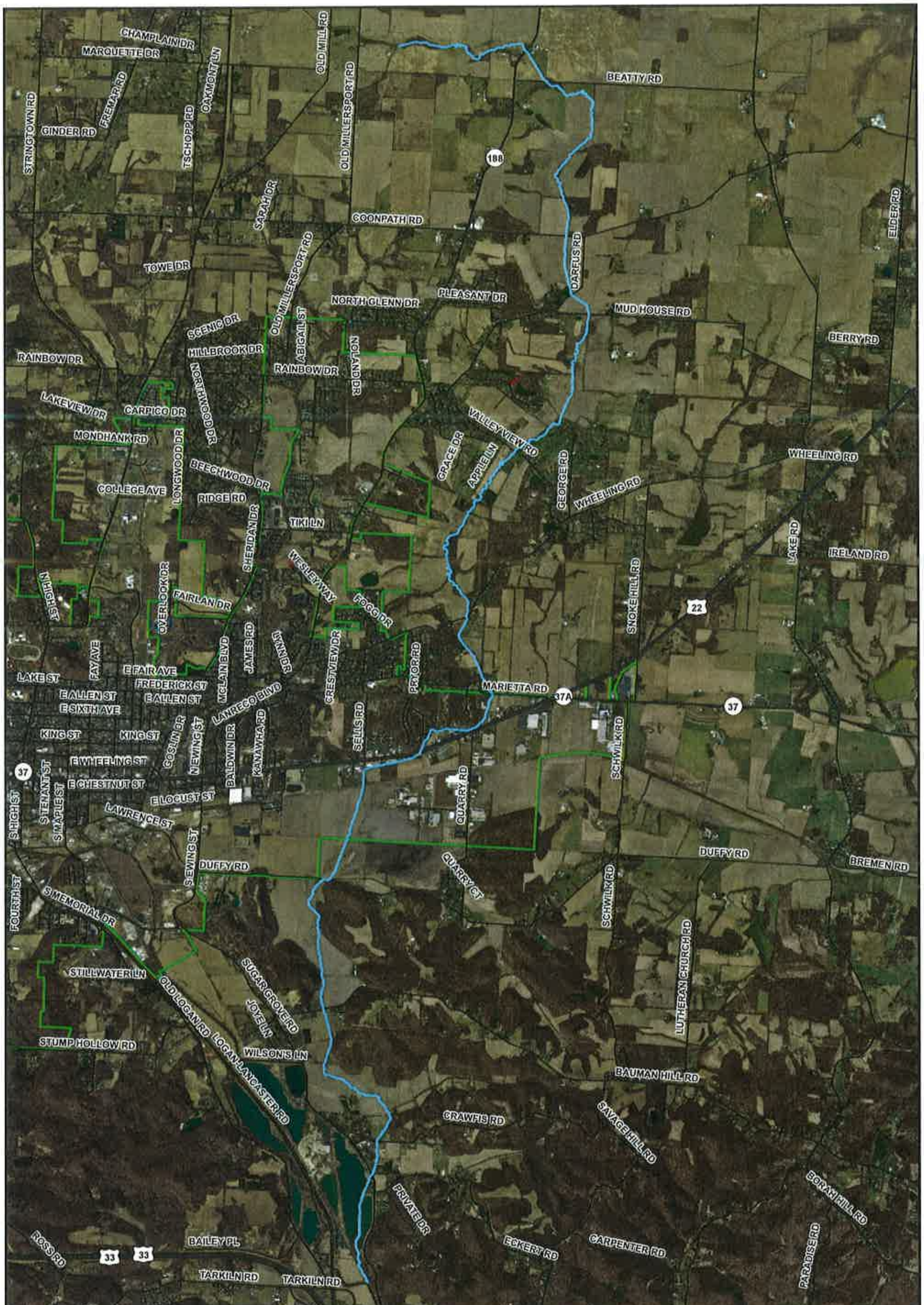
The library is a great public arena that could get information out to the public through posters/signage, as well as a great place to offer brochures or book-related information on stream dynamics and restorative efforts implemented in our City's streams.

Other

With efforts for this plan primarily located on private land, the department may need to use alternative forms of public outreach than typical on-site practices. Public arenas such as the library, parks, or public events provide grounds that would get information to the public.

Appendix

Aerial Maps



DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose. If detailed information is required for data layers shown, please contact the City of Lancaster Department of Information Technology. Please notify the City of Lancaster Department of Information Technology with any discrepancies.

N

Pleasant Run

0 0.25 0.5 1 Miles

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Horizontal - North American Datum (NAD) 83 (90)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
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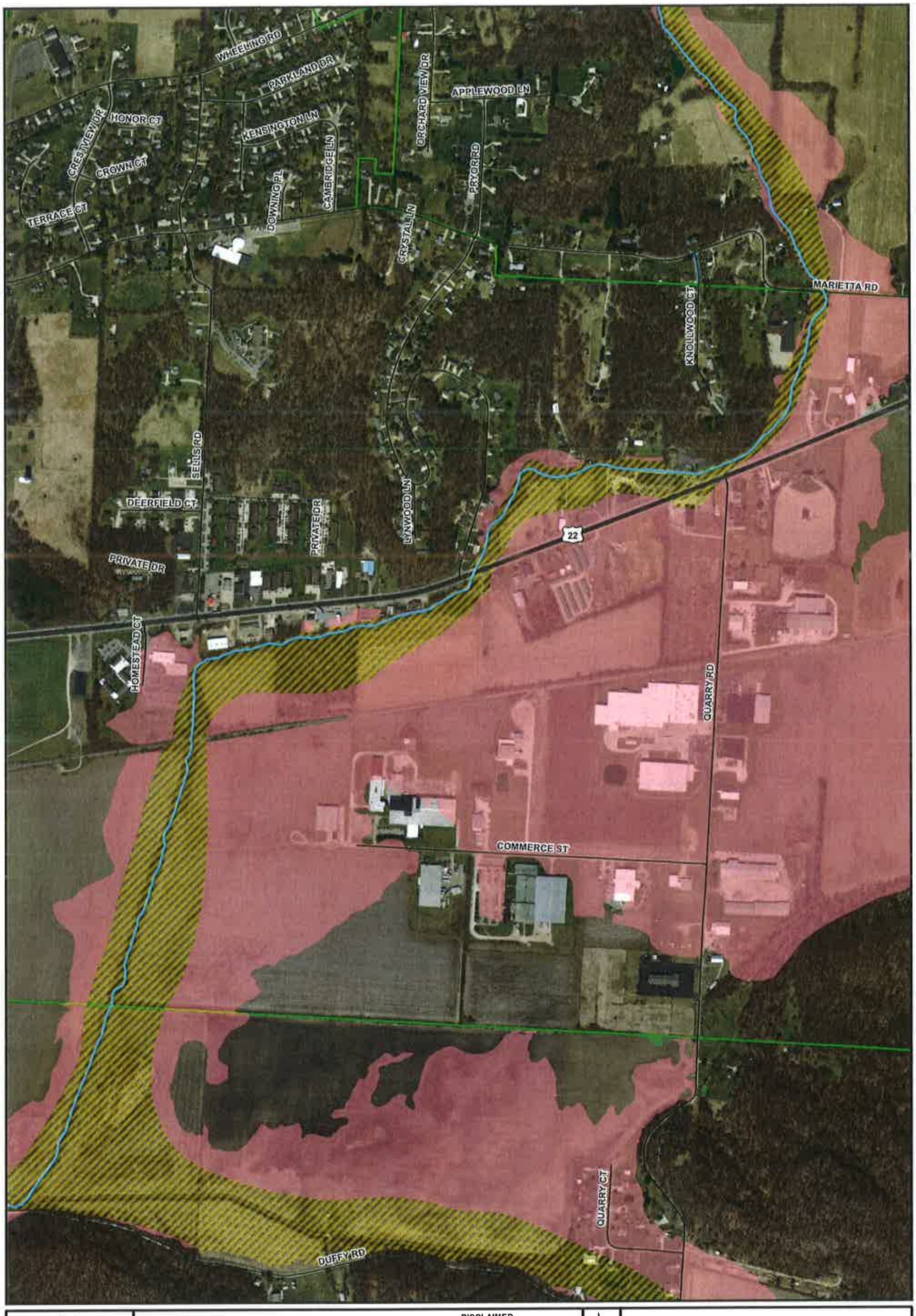
Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Pleasant Run Within LCB

0 0.05 0.1 0.2 Miles



DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal : North American Datum (NAD) 83 (95)
Vertical data : North American Datum Vertical Datum (NAVD) 88
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Please notify the City of Lancaster, Department of Information Technology with any discrepancies

N

Pleasant Run Floodplain

0 0.05 0.1 0.2 Miles

DISCLAIMER
All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (90)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
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N

Pleasant Run
Lower 1/2

0 125 250 500 Feet

DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System.
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
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Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Pleasant Run Upper 1/2

0 125 250 500 Feet

Pictures













Hocking River TMDL Excerpts

5.2 Fecal Coliform

Fecal Coliform (FC) is a measure of the number of organisms in the water column within the fecal coliform sub-group of bacteria. FC bacteria are largely non-pathogenic organisms naturally found in the intestinal tracts of warm-blooded animals. FC is used as an indicator of pathogen contamination because most pathogenic organisms are found in the ambient environment in numbers too small and variable to directly quantify.

The numeric targets for fecal coliform are derived directly from WQS. The PCR fecal-coliform geometric-mean criterion of 1,000 counts per 100 ml is the target for the average condition. The PCR ten-percent exceedance criterion of 2,000 counts per 100 ml is the target for the acute condition. These targets are also applied to SCR waters to protect for downstream use.

5.3 QHEI Targets for Sediment and Habitat TMDLs

The Qualitative Habitat Evaluation Index (QHEI) is a tool developed and used by the Ohio EPA to assess stream habitat quality. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-streamcover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these categories or metrics, points are assigned based on the ecological utility of specific stream features as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

Strong correlations exist between QHEI scores and some its component metrics and metrics and the biological indices such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 has been shown to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 for modified warm water habitat (MWH) streams.

Strong negative correlations exist between the number of “modified attributes” and the IBI scores. Modified attributes are features or conditions that have low or negative value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger negative impact on biological performance; these are termed “high influence modified attributes”.

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 5.2 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a “1”, if not, it is assigned a “0”. To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 5.2. QHEI targets for the habitat TMDL.

	Overall QHEI Score	All Modified Attributes	
		High Influence Modified Attributes	**All Other Modified Attributes**
Range of Possibilities	12 to 100 points	- Channelized or No Recovery - Silt/Muck Substrate - Low Sinuosity - Sparse/No Cover - Max Pool Depth < 40 cm (wadeable streams only)	- Recovering Channel - Sand Substrate (boat sites) - Hardpan Substrate Origin - Fair/Poor Development - Only 1-2 Cover Types - No Fast Current - High/Moderate Embeddedness - Ext/Mod Riffle Embeddedness - No Riffle
Target	Overall score ≥ 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)
The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 5.3 lists targets for each of these metrics.

- The substrate metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- The channel morphology metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone metric also reflects the likely degree of in-streamsediment sources. The evaluation of floodplain quality is included in this metric which is related to the capacity of the system to assimilate sediment loads.

Table 5.3. QHEI targets for the sediment TMDL.

Sediment TMDL =	Substrate	+	Channel Morphology	+	Riparian Zone/Bank Erosion	
For WWH >=	13	+	14	+	5	>= 32

5.4 Acid Mine Drainage

Indicators of AMD used in this analysis are acidity, total aluminum, total iron, total manganese, and total sulfate as these parameters are commonly associated with AMD. The Ohio EPA does not currently have statewide numeric criteria for any of these parameters; however, narrative criteria related to the effects of acid mine drainage exist. These criteria are:

- Waters of the state shall be free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance (OAC 3745-1-04 C); and,

- Waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone (OAC 3745-1-04 E).

Numeric targets for these parameters were developed using the water-chemistry sample results collected by the Ohio EPA for this TMDL project. Only non-impacted sites in the Western Alleghany Plateau ecoregion of the watershed were used to develop the targets as the vast majority of mining operations exist in this ecoregion. Impacted sites are defined as those immediately downstream a major point source or those in a known AMD receiving stream. High TSS in a sample can be a confounding factor when evaluating AMD impacts. Samples with TSS in the fourth quartile were removed to avoid this bias.

This edited database was analyzed to determine the median and 90th percentiles for each of the target parameters. The median statistic is used as the target to represent the desirable average condition. The 90th percentile is used as the target to represent the allowable instantaneous maximum. Results of the water-chemistry dataset are presented in Table 5.4.

05030204		Sources	Fecal Coliform Load (count/day*10^7) Existing	Fecal Coliform Load (count/day*10^7) Allowable	Reduction Required	Comments
	040	Pleasant Run				Colony Village MHP will need to have a fecal coliform permit limit of 1000 counts/100ml.
		Bay Packing Co.	0.07	0.07	0%	
		Venture Industries	-	-	-	
		Diamond Power	-	-	-	Direct HSTS are the major source of fecal coliform in this subwatershed. These illegal sources need to be eliminated.
		Lakeside Estates	3	3	0%	
		Fairfield County Subdivision	15	15	0%	
		South Central Power Co.	1	1	0%	The elimination of illegal direct HSTS will reduce the load below the TMDL. The difference between these load reductions and the TMDL is the MOS.
		Colony Village MHP	38	4	90%	
		MS4	38	38	0%	
		Direct HSTS	20271	0	100%	
		Total Point Source (Wasteloads)	*20366*	*61*	*100%*	
	050	Hocking River from Pleasant Run to above Rush Creek				Failing and direct HSTS pose the major sources of concern in this area.
		Hillview MHP	8	8	0%	
		Rustic Ridge MHP	189	189	0%	
		Brookdale MHP	8	8	0%	
		Presbytery of Scioto	3	3	0%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	17076	0	100%	
		Total Point Source (Wasteloads)	*17283*	*207*	*99%*	
	060	Buck Run				Failing and direct HSTS pose the major sources of concern in this area.
		No NPDES facilities	-	-		
		No CSO or MS4 areas	-	-		
		Direct HSTS	1073	0	100%	
		Total Point Source (Wasteloads)	*1073*	*0*	*100%*	
020	020	Center Branch				**Implementation Focus**: Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed. Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed. The Somerset STP NPDES permit will need to have a 1.3 mg/l total phosphorus limit and monitoring requirements.
		Somerset STP	95	95	0%	
		No CSO or MS4 areas	-	-	-	
		Direct HSTS	9797	0	100%	
		Total Point Source (Wasteloads)	*9892*	*95*	*99%*	
030	040	Rush Creek below Little Rush Creek to mouth (except Raccoon Run)				Direct HSTS and livestock in the streams are the major sources of fecal coliform in this subwatershed.
		Sugar Grove STP	26	26	0%	
		Bremen STP	127	127	0%	
		No CSO or MS4 areas	-	-	-	Fencing pastures to limit domestic animal access to the streams and eliminating direct HSTS are areas to focus on in this subwatershed.
		Direct HSTS	29696	0	100%	
		Total Point Source (Wasteloads)	*29823*	*127*	*100%*	
050	050	Fivemile Creek				Direct HSTS pose the major source of concern in this area.
		Union Furnace Elementary	1.1	1.1	0%	
		No CSO or MS4 areas	-	-	-	

Table 7.10. Overview of existing conditions, allocations, TMDLs, and calculated reductions for habitat and bedload within the entire TMDL project area.

Stream name (aquatic life use)	River mile	BEDLOAD TMDL						HABITAT TMDL						
		QHEI Categories			Total Bedload Score	% Deviation from Target	Main Impaired Category	QHEI Score	# High influence Attributes	Total # Modified Attributes	Subscore			Total Habitat Score
		Substrate	Channel	Riparian							QHEI	High Influence	# Modified Attributes	
05030204-010-010 - Hocking River headwaters to above Hunters Run														
Hocking River (WWH)	100.2	6	7	4	17	47%	substrate	41	4	10	0	0	0	0
	96.8	17.5	10	9.5	37	—	channel	72.5	2	6	1	0	0	1
Hocking River (MWH)	91.9	15.5	7	5	27.5	n/a	n/a	52	2	7	n/a	n/a	n/a	n/a
Claypool Run (WWH)	0.4	9.5	5.5	4.5	19.5	39%	channel	38.5	3	8	0	0	0	0
05030204-010-020 - Hunters Run														
Hunters Run (WWH)	4.9	15.5	10	2.5	28	13%	riparian	53	3	7	0	0	0	0
	2.5	15	13	4.5	32.5	—	riparian	60.5	1	5	1	1	0	2
05030204-010-030 - Baldwin Run														
Baldwin Run (WWH)	2.7	7	15	4.5	26.5	17%	substrate	65.5	0	5	1	1	0	2
Fetters Run (WWH)	2.2	16	14.5	6.5	37	—	—	70	1	5	1	1	0	2
05030204-010-040 - Pleasant Run														
Pleasant Run (WWH)	8.4	14.5	9	4.5	28	13%	channel	60	1	6	1	1	0	2
	5.6	11	16	7	34	—	substrate	67.5	0	3	1	1	1	3
	0.6	15.5	10.5	5	31	3%	channel	65	1	4	1	1	1	3
05030204-010-050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]														
Hocking River (MWH)	89.4	15.5	9.5	6	31	n/a	n/a	69	1	5	n/a	n/a	n/a	n/a
Hocking River (WWH)	88.9	13.5	7	5	25.5	20%	channel	55.5	2	9	0	0	0	0
	87.3	14.5	10.5	4	29	9%	channel	65	1	7	1	1	0	2
	81.9	15.5	14.5	6	36	—	—	77	0	1	1	1	1	3
Trib. to Hocking R. (RM 84.38) (WWH)	0.2	9.5	9.5	3	22	31%	riparian	47	3	8	0	0	0	0
Trib. to Hocking R. (RM 82.57) (WWH)	1.1	12	11	6	29	9%	channel	54	2	4	0	0	1	1
05030204-010-060 - Buck Run														
Buck Run (WWH)	2.8	11.5	9	7	27.5	14%	channel	57.5	2	7	0	0	0	0
	0.9	10.5	11.5	4	26	19%	riparian	61.5	0	5	1	1	0	2
East Branch Buck Run (WWH)	0.1	11	16	6	33	—	substrate	56	1	6	0	1	0	1

Table 8.2. Overview of the types of restoration actions that are recommended throughout the entire TMDL project area.

Watershed	Sources of impairment (causes of impairment associated with the source)	Bank & riparian restoration	Stream restoration	Wetland restoration	Conservation easements	Home sewage planning & improvement	Education & outreach	Point source controls (regulatory programs)	Agricultural best management practices	Mine drainage abatement
05030204 010 - Hocking River (headwaters to Enterprise [except Rush and Clear Creeks)										
010 - Hocking River headwaters to above Hunter's Run										
	row crop (sediment, nutrients)				x				x	
	channelization (poor habitat)		x							
	riparian disturbance (sediment, DO)	x								
	HSTS (bacteria)					x				
	natural conditions (sediment)									
020 - Hunters Run										
	failed HSTS (bacteria)					x				
030 - Baldwin Run										
	failed HSTS (bacteria)					x				
040 - Pleasant Run										
	failed HSTS (bacteria)					x				
050 - Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]										
	channelization (poor habitat, sediment, DO)		x							
	row crop production (nutrients, organic enrichment)								x	
	riparian disturbance (sediment, DO)	x								
	failed HSTS (bacteria, nutrients)					x				
	natural conditions (poor habitat)									
060 - Buck Run										
	channelization (poor habitat)		x							
	failed HSTS (bacteria)					x				
	natural conditions (sedimentation)									
070 - Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]										
	channelization (poor habitat)		x							
	natural conditions (sedimentation)									

8.2.1. Hocking River (headwaters to Enterprise [except Rush and Clear Creeks]) - 010

The most widely recommended abatement actions for this assessment unit deal with controlling pollution and/or stressors from row crop production, drainage improvements, home sewage systems, and point sources (primarily combined sewer overflows). Nutrients derived from cropland runoff are causing problems in the 010 and 050 HUC -14 subwatersheds and cropping, tillage and nutrient application (including manure management) oriented conservation practices are recommended. Alternatives to typical channel maintenance for drainage are recommended to foster some level of floodplain function (two-stage channel shape or stream restoration) in HUCs 010, 060 and 070.

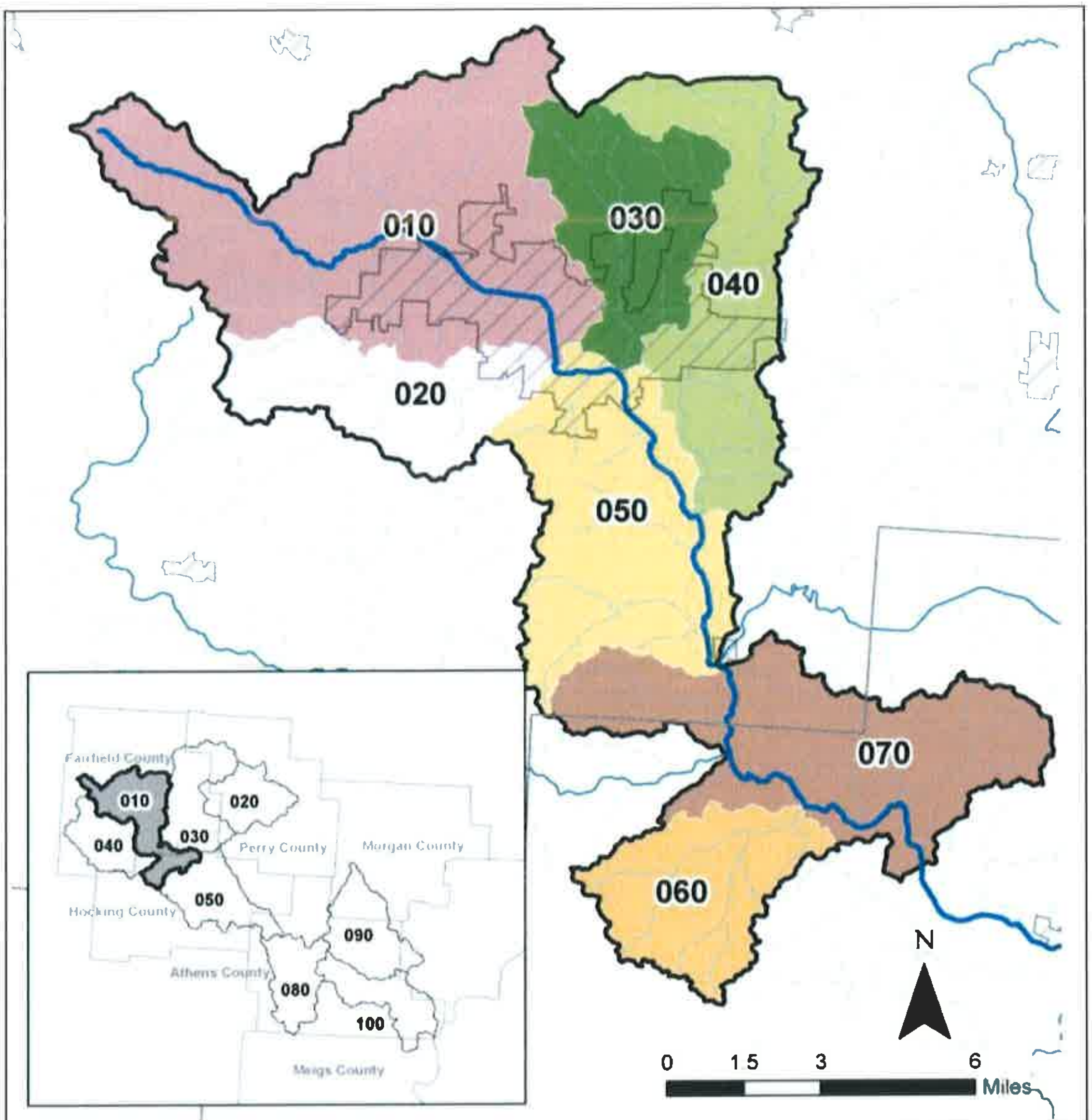


Figure 8.2. Map of the 010 assessment unit and its subwatersheds.

Table 8.3. Narrative descriptions of each of the subwatersheds in the 010 assessment unit.

14-digit HUC	Narrative Description
	05030204-010- **Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])**
010	Hocking River headwaters to above Hunters Run
020	Hunters Run
030	Baldwin Run
040	Pleasant Run
050	Hocking River below Hunters Run to above Rush Cr. [except Baldwin Run and Pleasant Run]
060	Buck Run
070	Hocking River below Rush Cr. to Enterprise [except Clear Cr. and Buck Run]

Table 8.4. Restoration and abatement actions that are recommended for the 010 assessment unit.

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering							
		Restore streambank by recontouring or regrading							
	planted	Plant grasses in riparian areas							
		Plant prairie grasses in riparian areas	X					X	X
		Remove/treat invasive species							
		Plant trees or shrubs in riparian areas	X					X	X
Stream Restoration		Restore flood plain	X					X	X
		Restore stream channel	X					X	X
		Install in-stream habitat structures							
		Install grade structures							
		Construct 2-stage channel	X					X	X
		Restore natural flow	X					X	X
Wetland Restoration		Reconnect wetland to stream							
		Reconstruct & restore wetlands							
		Plant wetland species							
Conservation Easements		Acquire agriculture conservation easements	X						
		Acquire non-agriculture conservation easements							
Home Sewage Planning and Improvement		Develop HSTS plan	X	X	X	X	X	X	
		Inspect HSTS	X	X	X	X	X	X	
		Repair or replace traditional HSTS	X	X	X	X	X	X	
		Repair or replace alternative HSTS	X	X	X	X	X	X	
Education and Outreach		Distribute educational materials							
		Host meetings, workshops and/or other events							
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs							
		Post-construction BMPs: infiltration							
		Post-construction BMPs:							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
		retention/detention							
	quality controls	Post-construction BMPs: filtration							
		Construction BMPs: erosion control							
		Construction BMPs: runoff control							
		Construction BMPs: sediment control							
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities							
		Develop and/or implement long term control plan (CSOs)	X	X	X	X	X		
		Eliminate SSOs/CSOs/by-passes	X	X	X		X		
	storm water	Implement an MS4 permit	X	X	X	X	X		
		Implement an industrial permit							
		Implement a construction permit	X	X	X	X	X		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)							
		Improve quality of effluent							
	monitoring	Establish ambient monitoring program							
		Increase effluent monitoring							
	alternatives	Establish water quality trading							
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	X				X		
		Implement conservation tillage practices	X				X		
		Implement grass/legume rotations	X				X		
		Convert to permanent hayland							
		Install grassed waterways	X				X		
		Install vegetated buffer strips	X				X		
		Install / restore wetlands	X				X		
	nutrients / agro-chemicals	Conduct soil testing	X				X		
		Install nitrogen reduction practices	X				X		
		Develop nutrient management plans	X				X		
	drainage	Install sinkhole stabilization structures							
		Install controlled drainage system	X				X		
		Implement drainage water management	X				X		
		Construct overwide ditch	X				X		
		Construct 2-stage channel	X				X		
	livestock	Implement prescribed & conservation grazing practices							
		Install livestock exclusion fencing							
		Install livestock crossings							
		Install alternative water supplies							
		Install livestock access lanes							
	manure	Implement manure management practices	X				X		
		Construct animal waste storage structures							
		Implement manure transfer practices							
		Install grass manure spreading strips							

Restoration Categories		Specific Restoration Actions	05030204 - 010						
			010	020	030	040	050	060	070
	misc. infra-structure and mgt	Install chemical mixing pads							
		Install heavy use feeding pads							
		Install erosion & sediment control structures							
		Install roof water management practices							
		Install milkhouse waste treatment practices							
		Develop whole farm management plans							

8.2.2 Rush Creek (headwaters to above Little Rush Creek) & Rush Creek (above Little Rush Creek to Hocking River) – 020 & 030

The most widely recommended abatement actions for these assessment units deal with controlling pollution and/or stressors from home sewage systems, row crop production, and acid mine drainage. Streamside protection is also widely recommended. Reestablishment of floodplain connection is also recommended in some areas to abate the disturbed hydrology due to upland drainage efficiencies. The need for continued vigilance regarding compliance with storm water permits is pointed out in the recommendations, which is in reference to industrial storm water that formerly had a high concentration of biological oxygen demand in its discharge. Additionally, Ohio EPA staff is aware of a discrete storm water issue within a separate storm sewer area in New Lexington. These issues are to be handled though inspection and compliance work on the part of Ohio EPA staff.

Acid mine drainage is particularly problematic in the upper portion of Rush Creek and a number of its small tributary streams. The U.S. Geological Survey has conducted a study to better understand the geographic scope and severity of the mine drainage problems. An acid mine drainage abatement and treatment plan (AMDAT) is in development. Once complete, this document will culminate the most recent water chemistry and other data and expert analyses of the problems and possible abatement strategies. Cost effectiveness and benefit-cost analysis is a large part of the abatement planning. Based on the expertise of the developers of the AMDAT and communications that Ohio EPA has had with them, it is likely that this document will be endorsed by Ohio EPA as the best plan for achieving water quality standards in this part of the Hocking River watershed.

To view the USGS report visit : http://pubs.er.usgs.gov/usgspubs/sir/sir20055196. For more information about the development of the AMDAT visit: http://www.dnr.state.oh.us/mineral/acid/tabid/10421/Default.aspx.

Table A.3 Habitat Assessment Results for WAU 05030204 010: Hocking River (headwaters to Enterprise [except Rush and Clear Creeks])

		WWH Attributes											MWH Attributes																			
													High Influence						Moderate Influence													
River Mile	QHEI	No Channelization or Recovered	Boulder or Cobble or Gravel Substrate	Silt Free Substrate	Excellent or Good Development	Moderate or High Sinuosity	Extensive or Moderate Cover	Fast Velocity or Eddies	Normal or No Substrate Embeddedness	Maximum Pool Depth > 40 cm	Low or No Riffle/Run Embeddedness	**Total WWH Attributes**	Recent Channelization or No Recovery	Silt or Muck Substrate	Low or No Sinuosity and Drainage Area <= 20 sq. mi.	Sparse or Nearly Absent Cover	< 40 cm Max. Pool Depth and Wadeable or Headwater Site	**Total High-Influence MWH Attributes**	Recovering Channelization	Silt Heavy or Silt Moderate	Sand Substrate and Boat Site	Hardpan Substrate Origin	Fair or Poor Development	Low or No Sinuosity and Drainage Area > 20 sq. mi.	Two or Less Cover Types	Intermittent Pools and Max. Pool Depth < 40 cm	No Fast Current Velocity	Extensive or Moderate Substrate Embeddedness	Extensive or Moderate Riffle Embeddedness	No Riffle	**Total Moderate-Influence MWH Attributes**	Current Use Attainment Status (○ = full, ◑ = partial, ● = non)
05030204-010-010 - Hocking River headwaters to above Hunters Run																																
Hocking River (WWH)																																
100	41.0									■		1	■	■	■	■		4	■	■			■				■	■		■	6	●
96.8	72.5		■						■	■	■	4			■	■		2	■	■			■				■				4	○
Hocking River (MWH)																																
91.9	52.0		■						■	■	■	4	■			■		2	■				■	■			■		■		5	○
Claypool Run (WWH)																																
0.4	38.5									■		1	■		■	■		3		■			■				■	■		■	5	○
05030204-010-020 - Hunters Run																																
Hunters Run (WWH)																																
4.9	53.0		■						■		■	3			■	■	■	3	■	■			■				■				4	○
2.5	60.5		■		■	■		■		■		5				■		1	■	■								■	■		4	○
05030204-010-030 - Baldwin Run																																
Baldwin Run (WWH)																																
2.7	65.5	■			■	■	■	■		■		6						0		■		■	■					■	■		5	○
Fetters Run (WWH)																																
2.2	70.0	■	■			■	■	■		■		6			■			1		■			■					■	■		4	○
05030204-010-040 - Pleasant Run																																
Pleasant Run (WWH)																																
8.4	60.0		■				■	■		■		4			■			1	■	■			■					■	■		5	○
5.6	67.5	■	■		■	■	■	■		■	■	8						0		■								■	■		3	○
0.6	65.0		■			■	■		■	■	■	6			■			1	■				■				■				3	○

Tarhe Run Corridor Plan

Tarhe Run Background & Existing Conditions

Background & Literature Review

Tarhe Run flows through the south side of Lancaster, originating in the fields south of town near the B.I.S. Road bridge over SR-33. The stream is approximately three miles in length in its entirety, about half of which lies within the LCB. The run flows north until emptying into the Hocking River near the intersection between Canal Street and Maple Street.

The Tarhe Run Dry Dam was installed in 1994 as a flood control device. It was constructed upstream from Mill Road and designed with a storage volume reserve to reduce sedimentation and flooding and increase safety, and is regularly inspected for proper function. It is a "dry" structure, meaning it impounds water only during periods of high precipitation. The dam has an emergency spillway to prevent overtopping of the earthen structure. The dam regulates flooding on Tarhe Run in conjunction with a nearby diversion ditch and future flood prevention dikes.

Observations

Development surrounding Tarhe Run has been limited. Tarhe Run traverses through agricultural fields, golf courses, and forested areas. What little development has occurred near Tarhe Run is associated with the expansion of Lancaster. Most of the development has been residential, though notable exceptions include a Sonoco Company property, a City-owned park, and the City-owned dry dam.

The floodplain for Tarhe Run is relatively extensive when compared to other streams in the City. Near the Hocking River, the floodway covers multiple private residences while the floodplain, in conjunction with the Hocking River, covers more than 100 acres of private residences and commercial development. This section of the Flood Insurance Rate Map (FIRM) is currently under review for an update in early 2017. Tarhe Run has a sinuosity index of 1.30, which is third lowest among Lancaster streams. What little it had has faded over recent years, with evidence for channelization in the past six years. As determined from City orthophotography in a three year period from 2009 to 2012, an area of the stream just north of the Tarhe Run Dry Dam was reduced from a sinuosity index of 1.25 to 1.03.

The primary concerns on Tarhe Run are flood management, channelization, erosion, and siltation. The Tarhe Run floodplain potentially endangers private homes on the south side of town. The low sinuosity index indicates that channelization is an issue on the run, with few diversions and no turns until the edge of town. Erosion and siltation are an issue in the section between Memorial Drive and Utica Park.

Bank stabilization, channel enhancements, and flood control devices are the forms of management suggested for this stream. Levee installation is currently intended to occur on Tarhe Run, pending both funding and the acquisition of private property necessary for the most effective installation. Channel enhancements would provide variation in the streambed and provide habitat for local flora and fauna. If possible, sinuosity should be incorporated into the channel but is limited by local development. J-hooks and toe wood would establish sinuosity within the channel. Cross vanes and Armorflex matting would be incorporated into the channel and on the streambank to prevent further erosion and siltation.

Tarhe Run Master Plan

The Tarhe Run corridor plan addresses issues associated with flooding, invasive species, bank erosion, and channelization. The run lacks sinuosity, has a sand-based substrate which is indicative of an urban stream, and shows evidence for localized bank erosion. Channel enhancements would help alleviate issues with the channel such as sinuosity and the sand-based substrate while Armorflex matting and cross vanes would prevent further bank erosion. This would also prevent siltation and prevent failing infrastructure from entering the stream. Concrete blocks from failing infrastructure are prevalent throughout the stream.

This plan describes management techniques for Tarhe Run within the LCB, focused around Utica Park. This area would have public visibility and public recreational use. As land becomes available, the management plan for Tarhe Run should be focused around measures to increase sinuosity and bank stabilization within the stream channel, and floodplain management strategies for the banks.

The following categories within the corridor plan are arranged from highest priority to lowest:

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Channel Enhancements/Bank Stabilization

Channel enhancements on Tarhe Run would include in-stream structures such as boulders and vortex rock weirs, eddy rocks, and J-hooks. Boulders and vortex rock weirs would diversify the streambed to create more habitat for local flora and fauna. They would alter flow such that a healthy ratio of riffle to run to pool would be created. Eddy rocks would dissipate high-energy flow, improve the appearance of the channel, and provide more habitat. J-hooks would redirect stream flow away from one bank of the stream and towards the other in an attempt to restore the sinuosity of the channel. This stream would also benefit from the use of a "Sand Wand" treatment. Sand Wand technology would remove all sand and silt while leaving behind larger stones on the substrate. Larger stones would provide habitat for local macroinvertebrates.

Bank stabilization on Tarhe Run would include regrading and armoring the banks with Armorflex matting or a more natural protection method such as toe wood and/or riparian vegetation installation. The section most in need of bank stabilization is the section just south of South Memorial Drive, where failing infrastructure has entered the stream and is impeding flow.

Flood Prevention Dike Installation

The City of Lancaster may install three flood prevention dikes, one of which would be on Tarhe Run. It would, however, require the taking of homes. The section placed on Tarhe Run would be installed on the west side of the stream from Memorial Drive to east of Third Street, a total distance of 0.30 miles.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This plan is designed to improve stream habitat that is currently degraded due to siltation and channelization. Restoration activities around Utica Park would reduce loadings by 16 lbs/yr for nitrogen, 2 lbs/yr for phosphorous, and 3.2 tons/yr for suspended solids. This restoration is anticipated to cost $640,000 in total.

The goal of the corridor plan for Tarhe Run is to achieve a healthy WWH and a healthy Habitat TMDL. The stream releases into the Hocking River, which has been identified as one of the most improved watersheds in the state by Ohio EPA in the 2009 TMDL report, and restoration of Tarhe Run would only further that improvement and keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet explaining the project. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Informational kiosk

The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on Tarhe Run, the Stormwater Department could aid the Parks Department and install a kiosk at Utica Park, or add signage if the kiosk has been previously installed near Tarhe Run.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Library Books/Display

The library is a great public arena that could get information out to the public through posters/signage, as well as a great place to offer brochures or book-related information on stream dynamics and restorative efforts implemented in our City's streams.

Appendix

Aerial Maps

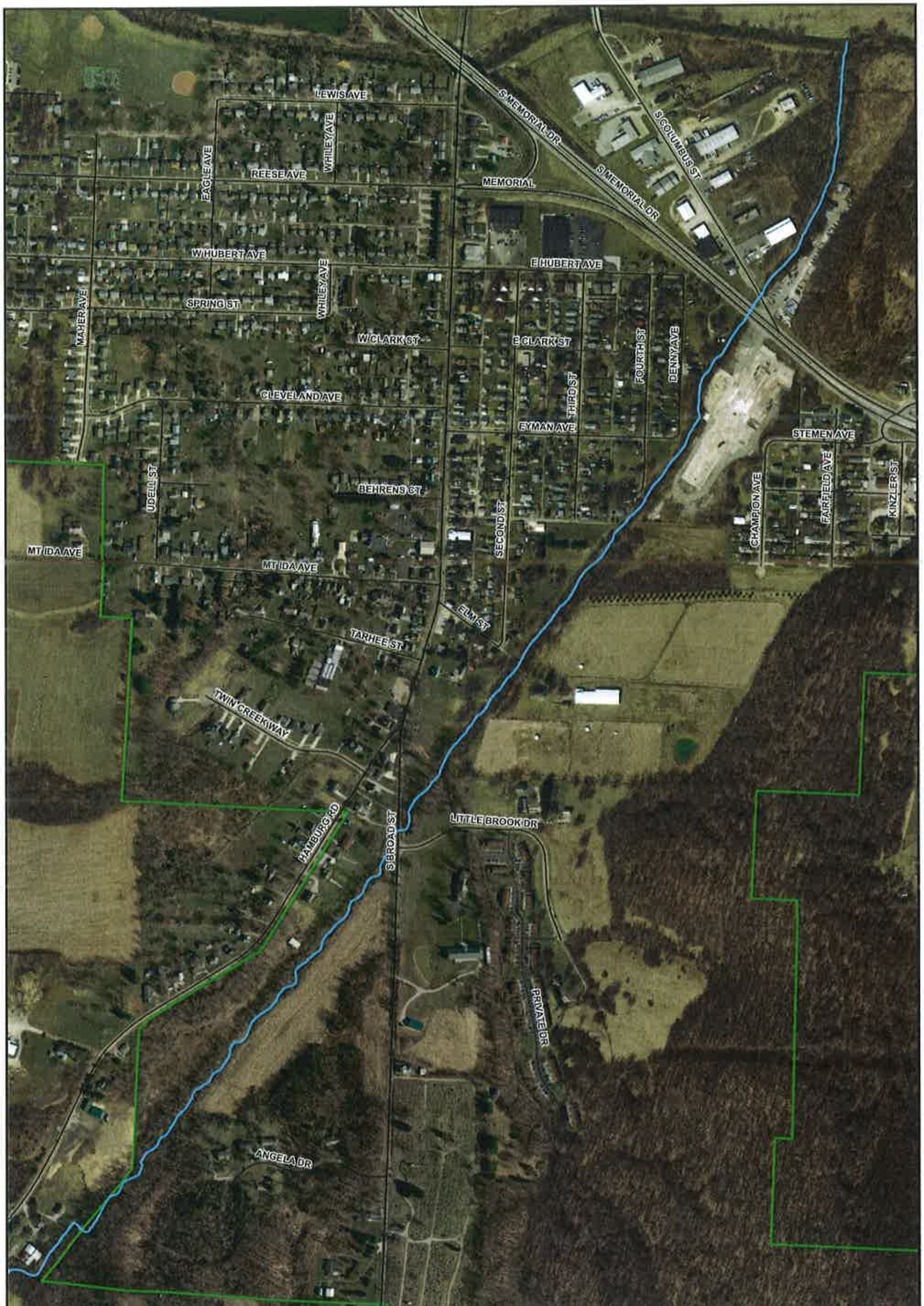
DISCLAIMER

All data created has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System
Horizontal - North American Datum (NAD) 83 (95)
Vertical data - North American Datum Vertical Datum (NAVD) 88
Units - Surveyors Feet
All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. The City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose. If detailed information is required for data layers shown, please contact the City of Lancaster, Department of Information Technology. Please notify the City of Lancaster, Department of Information Technology with any discrepancies.

N

Tarhe Run

0 500 1,000 2,000 Feet



DISCLAIMER

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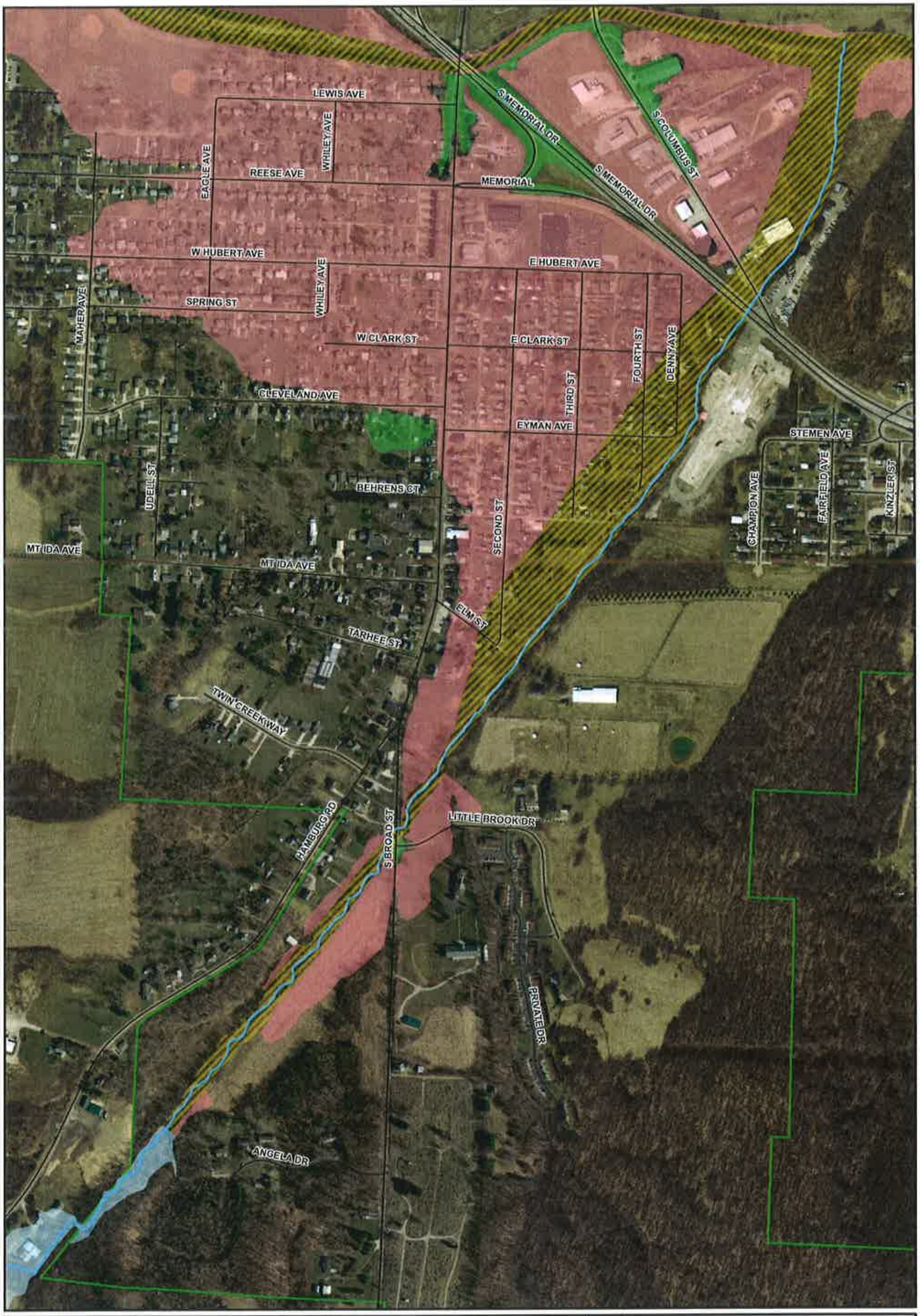
N

Tarhe Run Within LCB

0 250 500 1,000 Feet



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N

Tarhe Run Floodplain

0 250 500 1,000 Feet

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N

Tarhe Run
Lower 1/2

0 125 250 500 Feet

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N

Tarhe Run
Upper 1/2

0 150 300 600 Feet

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N

Tarhe Run Channelization 2015

0 25 50 100 Feet

Pictures







Lateral A Corridor Plan

Lateral A Background

Background & Observations

Lateral A flows through the near west side of Lancaster, originating in the fields north of town. The stream is approximately three miles in length, about half of which lies within the LCB. The run flows south until emptying into the Hocking River southwest of Memorial Drive, north of Goodwin Avenue.

Development surrounding Lateral A has occurred with the expansion of the City of Lancaster. In the area of the Lateral A's headwaters, the surrounding land is composed of agricultural fields with the occasional residential property. As the run continues across the LCB, multiple residential and, closest to the Hocking River, commercial properties surround the stream.

The floodplain for Lateral A is constricted to the area adjacent to the stream, which includes many private residences north of Memorial Drive. Lateral A would also contribute, along with the Hocking River, to floodwaters that could reach commercial areas along Memorial Drive. Near the edge of town, the floodplain expands, though data is not available outside the LCB. Within the city limits, the sinuosity of Lateral A has been decreased and locked by local development. Lateral A still has a sinuosity index of 1.29 within the City and an overall sinuosity index of 1.37, which is similar to streams throughout Lancaster.

The primary concerns on Lateral A are debris, bank erosion, and sedimentation. The stream has in it fallen trees, couches, shopping carts, and large concrete blocks along with trash common among other streams in Lancaster. Bank erosion and sedimentation are consistent with urbanized streams throughout Lancaster. Channelizing features and modified attributes also exist along the banks and in the center of the stream.

Debris removal, bank stabilization, and channel enhancements are the forms of management suggested for this stream. Debris removal could in large part occur as part of river cleanup days, but much of the debris in the stream is too large to remove without the aid of heavy equipment. Large scale debris removal would occur through a restoration process. Bank stabilization would occur by way of regrading and natural stream restoration techniques.

Lateral A Master Plan

The Lateral A corridor plan addresses issues associated with debris in the stream, bank erosion and channelization through modifications. Lateral A is able to support local flora and fauna, though movement throughout the stream is inhibited by trash and debris. The channel substrate is inundated with sand and silt, but has a variety of riffles, runs, and pools and has a well-developed riparian corridor over much of its length.

This plan describes management techniques for Lateral A within the LCB. The need for small, quick projects is low on Lateral A, where long term plans include ways to remove trash and debris and improve the banks and channel in large projects. This stream displays all of the signs of an urbanized stream, and as such should be managed how one would manage any urban stream for water and habitat quality.

The following categories within the corridor plan are arranged from highest priority to lowest:

Debris Removal/Stream Cleanup

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year. Lateral A's location may limit the amount of debris removal that can occur, with many access points to stream located on private land. Access points would be coordinated with local owners to complete a removal activity.

Bank Stabilization/Channel Enhancements

A lack of sinuosity through channelizing modifications would be the first issue dealt with to begin the process of a Lateral A restoration. The stream would then be able to develop a suitable substrate habitat for local fauna through in-stream structures such as vortex rock weirs or in-stream boulders. The addition of J-hooks and toe wood structures would introduce sinuosity while the stream itself would naturally begin to develop sinuosity with the removal of the modifying attributes.

Steep banks and thin stream channels lead to erosional issues and poor water quality. The regrading and reshaping of the channel would be the best management strategy for the stream's water quality and aesthetic appeal. The removal of aggregate soil and silt along Lateral A would increase the flow of the stream and reduce the risk of the channel becoming blocked in the future. In areas with eroded banks, the banks could be built up and protected with properly installed rock channel protection or Armorflex matting to reduce the direct contact of water on the soil banks. This would reduce erosion and aggregation downstream as well as reduce the risk of flooding.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Floodplain Management

Floodplain management would uphold all other improvements to the stream. Development near the stream limits the floodplain which increases flood damages to both to the stream and surrounding property. A well-developed floodplain would help the stream maintain its riparian corridor, channel, and banks. Provided land becomes available near Lateral A, it could be developed into and designated a floodplain zone to maintain conditions on Lateral A. Floodplain restoration involves expanding the riparian corridor and regrading the land either to reconnect the floodplain to the stream or provide more flat, vegetated ground for the stream to expand into during high flow events.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This plan is designed to improve stream habitat that is currently degraded due to degradation common to urban environment streams. Load reductions from restoration activities between the Hocking River and Memorial Drive would result in a reduction of 30 lbs/yr of nitrogen, 3.75 lbs/yr of phosphorous, and 1.5 tons/yr of suspended solids. These restoration activities are anticipated to cost $300,000 to complete.

The goal of the corridor plan for Lateral A is to achieve a healthy stream environment that would lead to improved water quality, macroinvertebrate habitat, and improved aesthetic qualities. This stream releases into the Hocking River, which has been identified as one of the most improved watersheds in the state by Ohio EPA in the 2009 TMDL report, and the restoration of Lateral A would further that improvement and keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet. The webpage would detail the process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made to inform a larger portion of the public and offers an opportunity to receive public comments. Both print versions and online articles could help get information to the public.

Educational Program

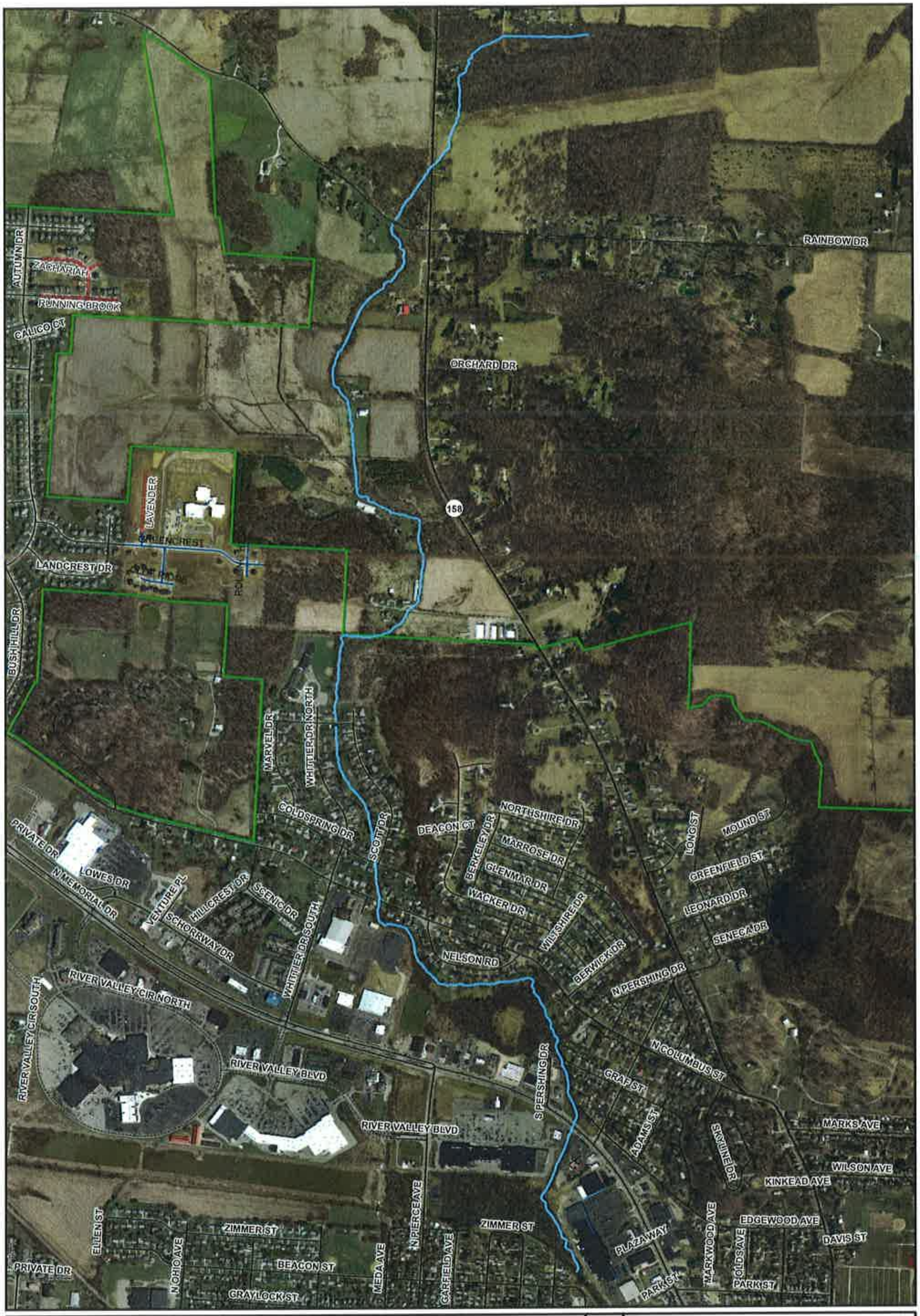
With Fairfield Christian located adjacent to the stream, it would be possible to develop an educational program involving the stream to be incorporated into the school's curriculum. This could take on many forms, ranging from a presentation or guided field trip with a City employee to a program that demonstrates typical stream restoration techniques and those that were implemented on Lateral A.

Other

With efforts for this plan primarily located on private land, the department may need to use alternative forms of public outreach than typical on-site practices. Public arenas such as the library, parks, or public events provide grounds that would get information to the public.

Appendix

Aerial Maps



Lateral A

0 400 800 1,600 Feet

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N

Lateral A
Within LCB

0 250 500 1,000
Feet

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N

Lateral A Floodplain

0 250 500 1,000 Feet

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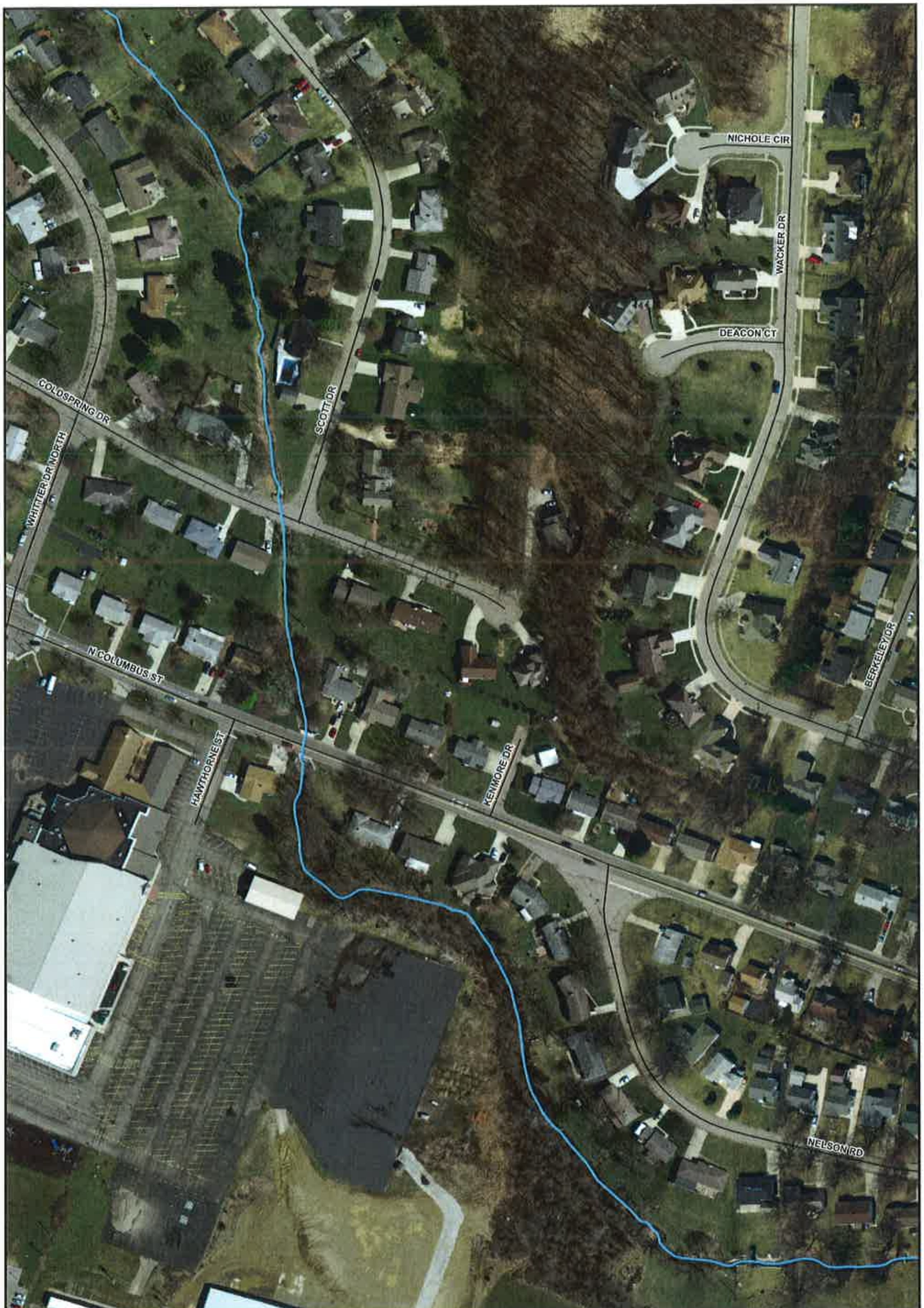
N

Lateral A
Lower 1/3

0 125 250 500 Feet



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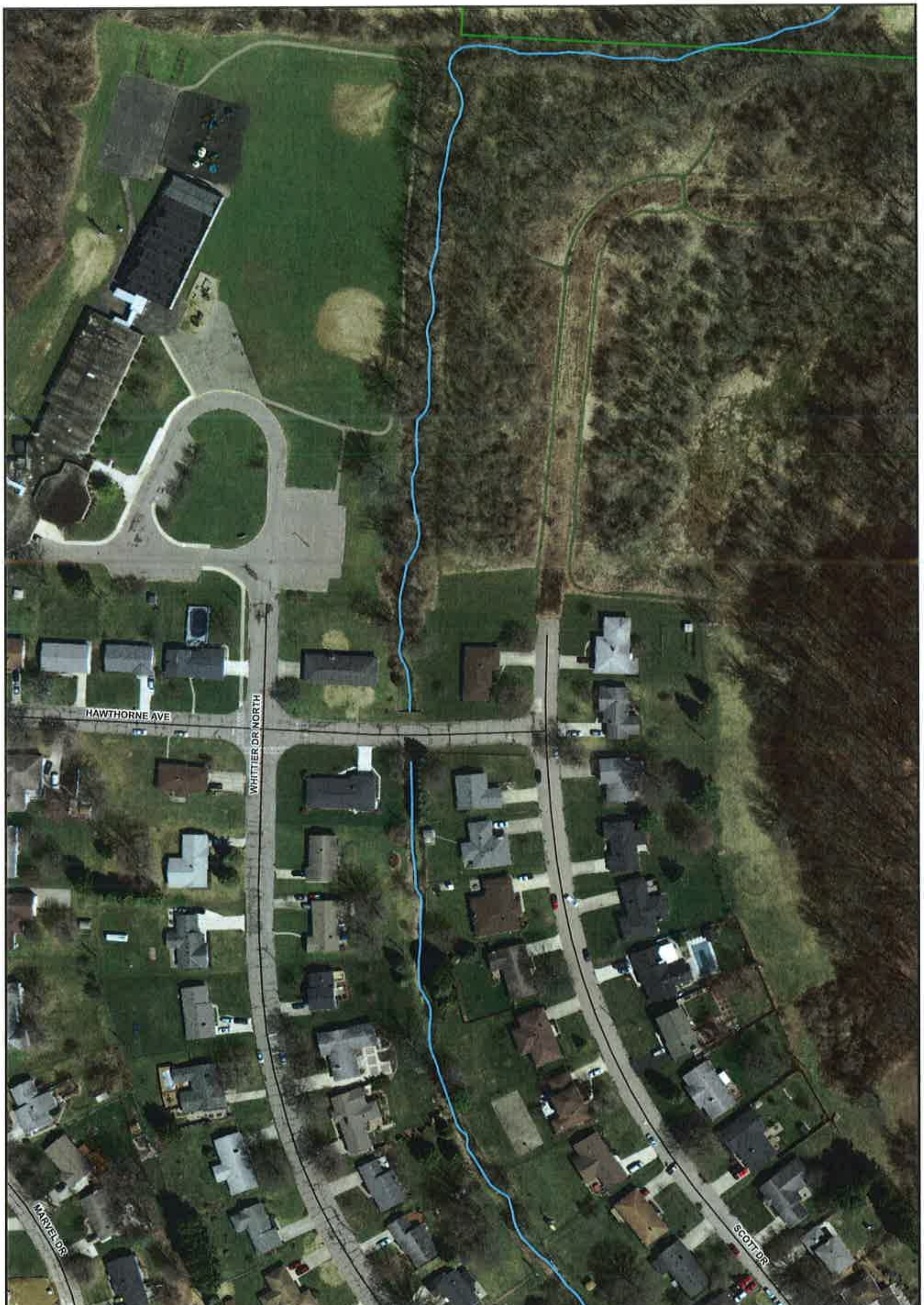
Lateral A
Middle 1/3



N

Lateral A
Upper 1/3

0 75 150 300 Feet

Pictures










Lateral B Corridor Plan

Lateral B Background

Background & Observations

Lateral B flows through the west side of Lancaster, originating south of State Route 188 just east of Barr Drive. The stream is approximately two miles in length, almost all of which are inside the LCB. Lateral B flows across SR 188, then north along Barr Drive, and then east around Roxton Ravines and the Lenmar Subdivision before turning north again to head into the Hocking River.

Development has limited the floodplain where the stream travels between the Lenmar subdivision and Roxton Ravines, and excess water flows onto and through residential properties. In other areas of the stream, floodplain has likewise been limited by local development but is generally in acceptable condition. This puts residential properties at risk for flood damage. There is also a unique drainage issue near Lateral B. When flooding occurs, water flows over Shasta Drive and backwards into the culvert to form a positive feedback cycle into which water aggregates.

Sinuosity has likewise been reduced by local development. Aerial photography shows evidence for stream path alteration, likely with the addition of the Lenmar subdivision, the Lanreco Farm Acres subdivision, and commercial development along West Fair Avenue. An unnaturally sharp turn near the railroad is further evidence of human modification of stream channel morphology. Aerial photography shows that this change occurred prior to 1980. Another sharp turn around the Hocking Meadow subdivision suggests alteration in the recent past.

The primary concerns on Lateral B are inadequate floodplain, localized bank erosion, and large woody debris. Development surrounding the stream limits the ability of the floodplain to act as intended, and flattened vegetation and bank erosion indicate that local flooding occurs frequently. Localized bank erosion associated with any urban stream as well as large woody debris exist throughout the stream. The riparian corridor has been either removed entirely or is lacking in multiple areas along this stream. Pollutants and nutrients from lawn-mowing were in areas of the stream where the riparian corridor was lacking.

Floodplain management and bank improvements are the forms of management suggested for this stream. It would also benefit from removal of large woody debris in the stream bank, particularly in the area just west of Shasta Drive, and the development of vegetation to protect the stream from stormwater runoff and other urban activities.

Lateral B Master Plan

The Lateral B corridor plan addresses issues associated with bank stability and large woody debris within the stream as well as floodplain management. Lateral B's ability to support local flora and fauna is low and it puts local property at risk if it were to flood. Providing bank stability, removing large woody debris, and incorporating riparian corridor vegetation would both create a more suitable environment for macroinvertebrates and fish while reconnecting the stream to its floodplain to protect local property.

This plan describes management techniques for all of Lateral B. Small, easily implemented projects would benefit Lateral B on a short-term scale, but long term plans should be developed to include ways to address the urbanization of this stream and lack of floodplain.

The following categories within the corridor plan are listed from highest priority to lowest:

Floodplain Management

Floodplain management would include similar techniques to general stream restoration. Regrading the bank and providing riparian vegetation would provide both stabilization and protection during flood events, but the stream would benefit from an undeveloped area where water can enter during flood events. Most important to proper floodplain use is to regrade the stream banks and reconnect the stream to its existing floodplain. Riparian corridor vegetation would slow down flood waters and settle out nutrients and pollutants. Parcels of land would be evaluated for their use as a floodplain as they become available. Dike installation may also be used as a management technique, particularly in the section where Lateral B enters the Hocking River. The eastern portion of the floodplain covers a residential section of town, while the western portion is undeveloped land. By expanding upon the western portion and trying to limit eastern flooding, we can limit flood damage to local infrastructure.

Debris Removal

Removing debris and larger trash that is interfering with natural stream dynamics would facilitate the flow of the stream. This removal would include concrete blocks, cement pipes, and other items embedded in the stream channel. Cut logs would also be removed, but naturally occurring fallen logs and branches would be permitted to remain as long as they do not contribute to stream bank instability. It is important that fallen logs are evaluated to determine whether or not they create habitats within the stream. Debris removal would also include the removal of private docks, stepping stones, and other materials placed within the stream corridor by private entities that interfere with natural stream processes. These would be removed by the residents whose property the debris is located on; if not, the debris would be removed by the City to begin the restoration process.

This debris removal could occur as part of a stream cleanup process that occurs each year on the Hocking River. By extending the number of days spent removing debris from the water, we could include more streams in the effort by rotating streams for a second day of cleanup. This second day of cleanup could occur around Earth Day and feature a different stream throughout our community each year. Debris removal on Lateral B would be limited by the availability of equipment, as a stream cleanup limited to manpower would be ineffectual. Large woody debris is the predominant form of trash within the stream and would require specialized equipment to remove from the stream.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Bank Stabilization/Channel Enhancements

The banks along Lateral B should be regraded in multiple areas. Steep banks and thin stream channels lead to erosional issues and poor water quality. The regrading and reshaping of the channel would be the most beneficial management strategy for the stream in terms of water quality and aesthetic quality. Regrading the banks would occur early in the process and complement other proposed improvements such as riparian plantings, floodplain management, and channel enhancements. Stabilization would occur in areas with the highest levels of erosion, particularly where there is a sharp bend in the stream's direction near the railroad.

Lateral B has a narrow, deep channel for most of its length. The stream would be widened where possible and J-hook, cross vanes, rock vortex weirs, and boulders would be installed in the channel. This would help to control water velocity while simultaneously providing habitat for local fauna. The stream channel and water velocity would also be aided by the removal of all of the large woody debris.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This plan is designed to improve stream habitat that is currently degraded due to local development and large woody debris. Load reductions from a project ranging from Shasta Drive to the confluence of streams near Roxton Ravine's retention pond would result in a reduction of 30 lbs/yr of nitrogen, 3.75 lbs/yr of phosphorous, and 1.5 tons/yr of suspended solids. This stream restoration and floodplain preservation is anticipated to cost $325,000 in total.

The goal of the corridor plan for Lateral B is to achieve a healthy stream environment that would lead to improved water quality, macroinvertebrate habitat, and improved aesthetic qualities. This stream releases into the Hocking River, which has been identified as one of the most improved watersheds in the state by Ohio EPA in the 2009 TMDL report, and the restoration of Lateral B would further that improvement and keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking a project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the project fact sheet. The webpage would detail the project process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Library Books/Display

The library is a great public arena that could get information out to the public through posters/signage, as well as a great place to offer brochures or book-related information on stream dynamics and restorative efforts implemented in our City's streams.

Signage

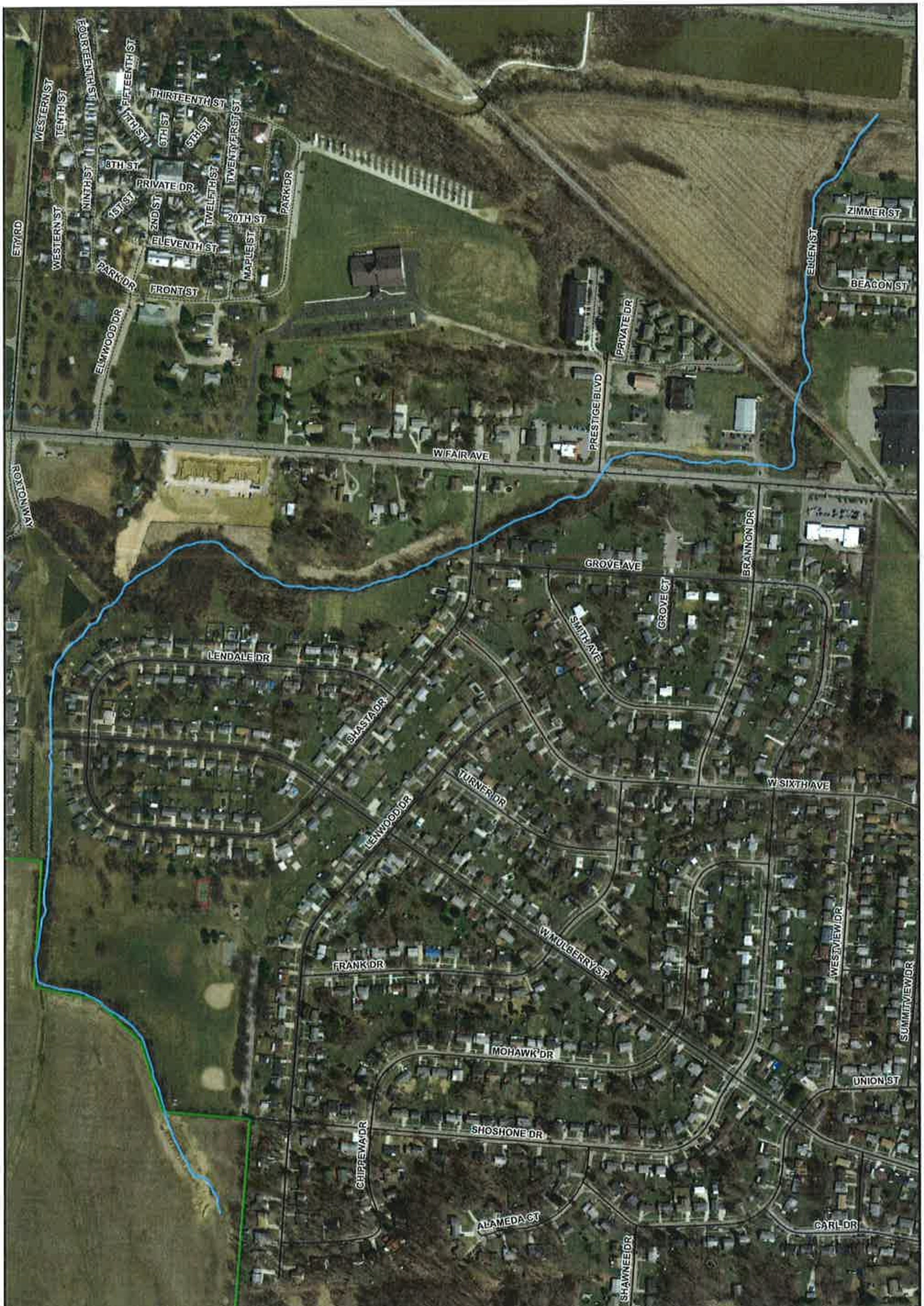
Signs are a staple in the field of public outreach due to their versatility. They can offer educational information, places to go for more information, public awareness announcements, or diagrams on how certain processes take place in relation to how we utilize a certain resource. Lateral B has a publicly accessible location at which to places signs at Cedarlen Park.

Other

With efforts for this plan primarily located on private land, the department may need to use alternative forms of public outreach than typical on-site practices. Public arenas such as the library, parks, or public events provide grounds that would get information to the public.

Appendix

Aerial Maps



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N

Lateral B

0 150 300 600 Feet

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N

Lateral B Floodplain

0 150 300 600 Feet

Pictures







Lateral C Corridor Plan

Lateral C Background

Background & Observations

Lateral C flows through the west side of Lancaster, originating in the fields on the west side of town. The stream is approximately 1.75 miles in length, all of which are inside the LCB. The stream flows through agricultural fields for its entire length, flowing north and then east before emptying into the Hocking River just east of Ety Road.

Development surrounding Lateral C is limited to agricultural fields and a single building. However, the route of the stream was altered during the early 1970s to accommodate local development. An approximately 600-foot section of stream was moved 150 feet to the east near the intersection of West Fair Avenue and Collins Road. The limited development and natural-state stream provide grounds for proper management of the stream and the assets it offers. Along the banks of this stream is a property currently intended for use as a future park, IJ Collins Park.

The floodplain for Lateral C combines with the Hocking River to cover most of the property designated for future development into IJ Collins Park. The remainder of the streams floodplain is separated from the stream by steep walls associated with farming practices. The lack of floodplain would lead to increased bank erosion, especially in those areas with steep turns in the stream path, if not reconnected. Sinuosity is likewise unfavorable. The stream overall achieves a "twisting" status, but has segments of straight, narrow stream channel that neither produces local habitat nor provides conditions for improved water quality.

The primary concerns on Lateral C are the lack of riparian corridor, bank erosion, floodplain management, and channel enhancements. The channel substrate is inundated with agriculture-related sand and silt. These sediments contain nutrients and other pollutants in higher quantities than the average sediment due to their association with agricultural runoff. This, combined with a lack of large riparian corridor vegetation, leads to unfavorable conditions for local fauna. Bank erosion increases the amount of overall sediment entering the stream. The riparian corridor is lacking throughout the stream, allowing sunlight to heat the stream and sediments to enter unimpeded.

Bank stabilization, riparian corridor development, and channel enhancements are the forms of management suggested for this stream. Agricultural runoff creates poor substrate conditions, so developing a more effective means of preventing sediment from entering the stream is critical to returning the stream to a natural state. Channel improvements would reinforce floodplain management while also providing suitable habitat for local fauna. A stream setback ordinance that prevents development along this stream as the City expands and develops into these kinds of areas would preserve the natural state of the stream.

Lateral C Master Plan

The Lateral C corridor plan addresses issues associated with channel substrate insufficiency as well as floodplain management techniques. Lateral C's ability to support local flora and fauna is impeded by runoff from local agricultural practices. The potential for this stream is high given its relatively undisturbed local environment and planned implementation of IJ Collins Park. This plan includes management techniques for all of Lateral C.

The following categories within the corridor plan are arranged from highest priority to lowest:

Channel Enhancements/Bank Enhancements

A lack of floodplain and sinuosity, combined with a large amount of agricultural runoff, leads to a channel that has up to 12 inches of sand and silt in areas of Lateral C. The degraded habitat and elevated pollutant levels are poor conditions for local fauna. Redeveloping and regrading the stream banks, including installation of vegetation, would alleviate the problem over time and prevent excess sediment from entering the stream. The "Sand Wand" operation would be able to remove the existing sand and silt. Following the "Sand Wand" operation, typical stream restoration techniques such as vortex rock weirs or mid-stream boulders could be utilized to develop substrate habitat for local fauna. The regrading and reshaping of the channel would prepare the stream for other proposed improvements such as riparian plantings and floodplain management.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Floodplain Management

Floodplain management would include similar techniques to general stream restoration. Most important to proper floodplain use is to regrade the stream banks and reconnect the stream to its existing floodplain.

Regrading the bank and providing riparian vegetation would provide both stabilization and protection during flood events. Riparian corridor vegetation would also slow down flood waters and settle out nutrients and pollutants. Parcels of land would be evaluated for their use as a floodplain as they become available.

Stream Setback Ordinance

A stream setback ordinance would limit the options for developing within a certain distance from the stream. This could include different levels of limitation based on the distance from the stream or, if implemented City-wide, limitations specific to each stream. The ordinance option is easily adaptable to fulfill a stream's needs, but previous development and public support may prevent a stream setback from achieving its full potential. If properly implemented, a stream setback ordinance should provide protection for the stream from urban activities and protect local infrastructure from flood damage.

Closing

Stormwater management provides restoration and upkeep for our streams. Pollution, vegetation removal, CSOs, erosion, floodplain removal, and channelization have all degraded our streams throughout the last century. Healthy streams provide a natural filtering system that removes harmful nutrients and pollutants from City water resources. The aesthetic value gained from a restored stream adds value to local properties and to the City as a whole.

Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This plan is designed to improve stream habitat that is currently degraded due to agricultural development and riparian zone removal. A restoration project on Lateral C with the introduction of a new City park near Ety Road could reduce loads by 40 lbs/yr for nitrogen, 5 lbs/yr for phosphorous, and 2 tons/yr for total suspended solids. The stream restoration portion of the IJ Collins Park is anticipated to cost $400,000 in total.

The goal of the corridor plan for Lateral C is to achieve a healthy stream environment that would lead to improved water quality, macroinvertebrate habitat, and improved recreational opportunities along with the planned park, IJ Collins Park. This stream releases into the Hocking River, which has been identified as one of the most improved watersheds in the state by Ohio EPA in the 2009 TMDL report and the restoration of Lateral C would further that improvement and keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education:

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the project public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

The webpage would be associated with the City of Lancaster homepage and the Stormwater Department webpage. It could focus on healthy streams and complement both the wetlands webpage and the Long Term Control webpage and would include electronic versions of the fact sheet. The webpage would detail the restoration process and show a timeline of the expected construction dates. After project completion, the webpage would have information of the stream such as the history, flora and fauna, and the importance of healthy streams.

Lancaster Eagle Gazette

With larger projects, the submission of a story into the Lancaster Eagle Gazette could be made to inform a larger portion of the public and offers an opportunity to receive public comments on the project. Both print versions and online articles could help get information to the public.

Information Kiosk

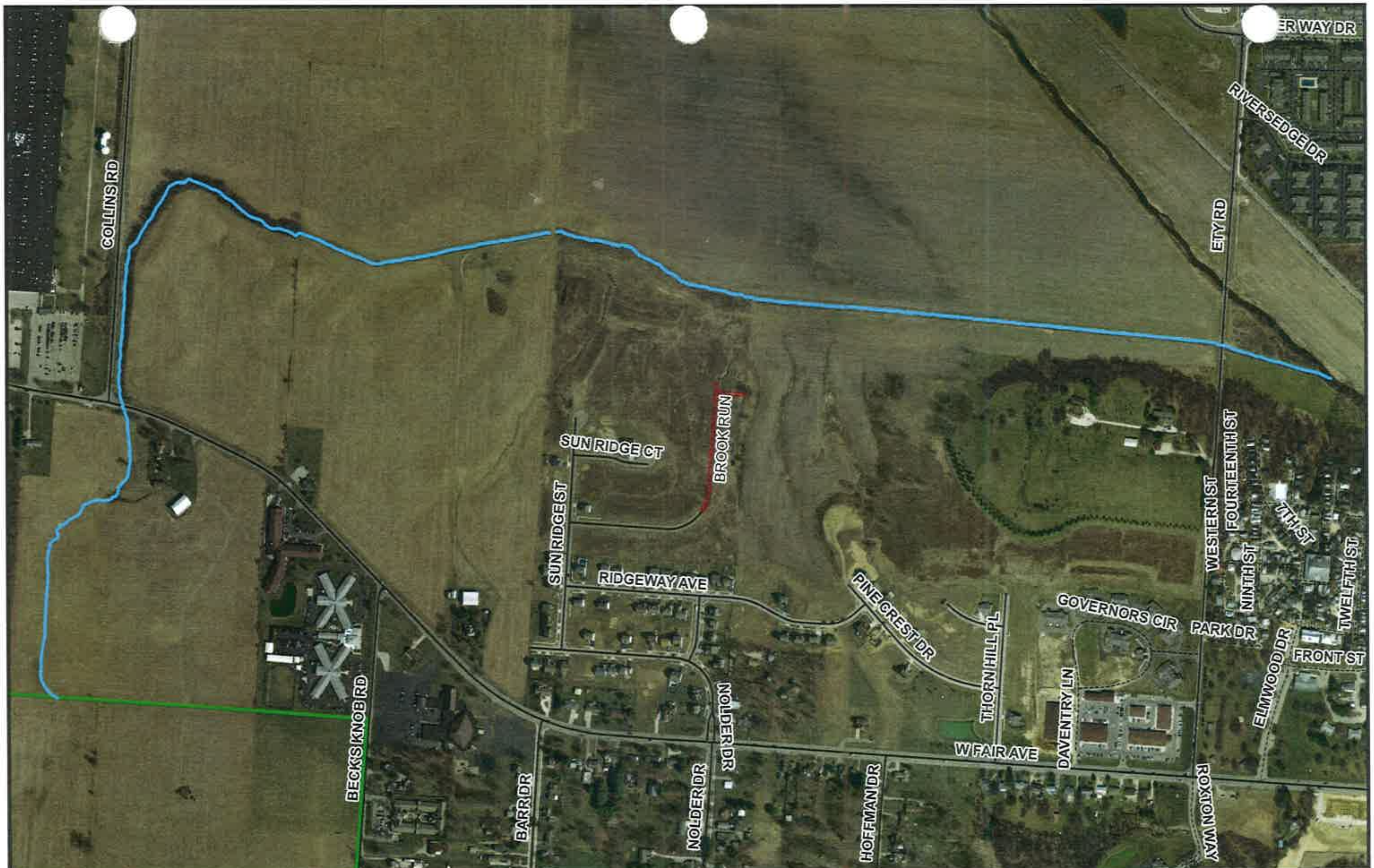
The City of Lancaster Parks and Recreation Department is in the process of designing and implementing a standard kiosk design into all of the City's parks. As part of a project on Lateral C, the Stormwater Department could aid the Parks Department and install a kiosk at the future IJ Collins Park, or add signage if the kiosk has been previously installed near Lateral C.

Other

With efforts for this plan primarily located on private land, the department may need to use alternative forms of public outreach than typical on-site practices. Public arenas such as the library, parks, or public events provide grounds that would get information to the public.

Appendix

Aerial Maps



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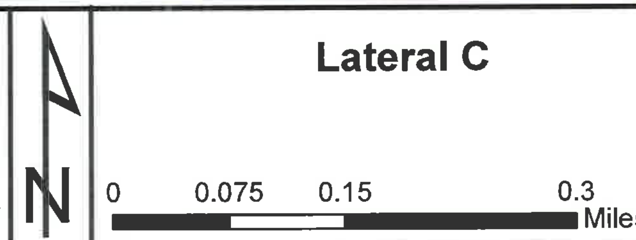
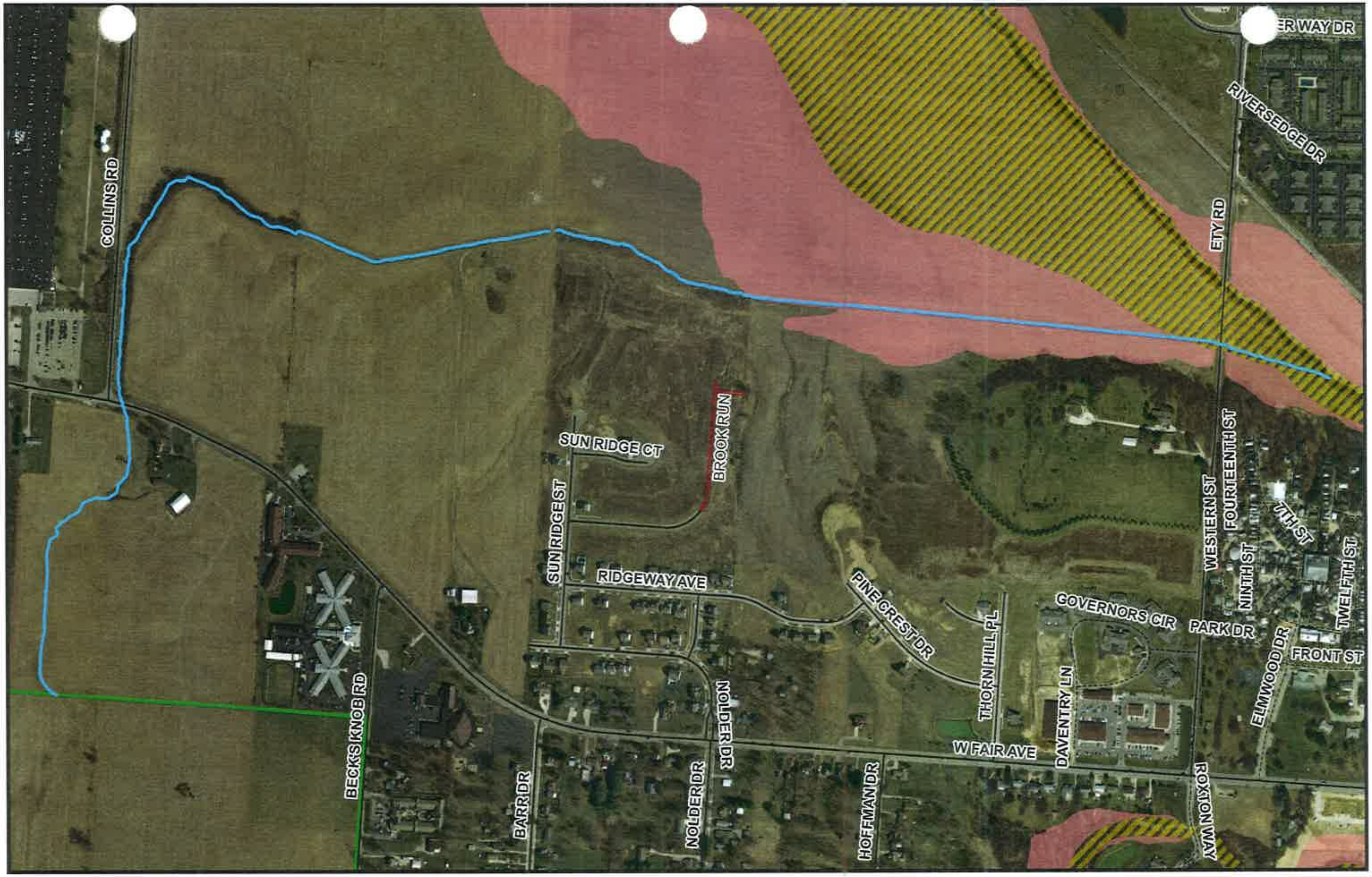
Lateral C





CITY OF LANCASTER, OHIO
SPIRIT 1800 PRIDE

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N

Lateral C Floodplain

0 0.075 0.15 0.3 Miles

Pictures




Lateral D Corridor Plan

Lateral D Background

Background & Observations

Lateral D flows through the west side of Lancaster, originating in the fields on the west side of town. The stream is approximately four miles in length, all of which are inside the LCB. The stream flows through agricultural fields for its entire length. It flows north and then east before emptying into the Hocking River west of Ety Pointe Drive.

Development surrounding Lateral D is limited to agricultural fields and Rock Mill Corporate Park. However, the route of the stream was altered during the early 2000s to accommodate local development. An approximately 0.5 mile section of stream was moved 200 feet to the west near the intersection of Mill Park Drive and Anchor Avenue. A nearby drainage ditch, approximately 1,400 feet in total, was also rerouted to enter Lateral D further south than its original location. The limited development and natural-state stream provide grounds for proper management of the stream.

The floodplain for Lateral D combines with the Hocking River to cover agricultural fields, but does not put infrastructure at risk. The remainder of the stream's floodplain is separated from the stream by steep walls associated with farming practices. The lack of floodplain would lead to increased bank erosion, especially in those areas with steep turns in the stream path. Sinuosity is likewise unfavorable. The stream overall achieves a "meandering" status, the highest among Lancaster's stream. However, the stream has segments of straight, narrow stream channel that neither produces local habitat nor provides conditions for improved water quality.

The primary concerns on Lateral D are the lack of riparian corridor, bank erosion, floodplain management, and channel enhancements. The channel substrate is inundated with agriculture-related sand and silt. These sediments contain nutrients and other pollutants in higher quantities than the average sediment due to their association with agricultural runoff. This, combined with a lack of large riparian corridor vegetation, leads to unfavorable conditions for local fauna. Bank erosion increases the amount of overall sediment entering the stream. The riparian corridor is lacking throughout the stream, allowing sunlight to heat the stream and sediments to enter unimpeded.

Bank stabilization, riparian corridor development, and channel enhancements are the forms of management suggested for this stream. Agricultural runoff creates poor substrate conditions, so developing a more effective means of preventing sediment from entering the stream is critical to returning the stream to a healthy state. Channel improvements would reinforce floodplain management while also providing suitable habitat for local fauna. A stream setback ordinance that prevents development along this stream as the City expands and develops into these kinds of areas would preserve the natural state of the stream.

Lateral D Master Plan

The Lateral D corridor plan addresses issues associated with channel substrate insufficiency as well as floodplain management techniques. Lateral D's ability to support local flora and fauna is impeded by runoff from local agricultural practices. The potential for this stream is high given its relatively undisturbed local environment. This plan includes management techniques for all of Lateral D.

The following improvements are suggested for this stream, listed from highest priority to lowest:

Channel Enhancements/Bank Enhancements

A lack of floodplain and sinuosity, combined with a large amount of agricultural runoff, leads to a channel that has up to 12 inches of sand and silt in areas of Lateral D. The degraded habitat and elevated pollutant levels are poor conditions for local fauna. Redeveloping and regrading the stream banks, including installation of vegetation, would alleviate the problem over time and prevent excess sediment from entering the stream. The "Sand Wand" operation would be able to remove existing sand and silt. Following the "Sand Wand" operation, typical stream restoration techniques such as vortex rock weirs or mid-stream boulders can be utilized to develop substrate habitat for local fauna. The regrading and reshaping of the channel would prepare the stream for other proposed improvements such as riparian plantings and floodplain management.

Invasive Species Management/Riparian Plantings

Removing invasive species includes cutting down and applying herbicide to the stumps of stands of Tree of Heaven, "grapevines", and "honeysuckles" as they occur along the stream. Large canopy trees would be planted in places where necessary following the removal of invasive species. In time, these trees would shade out and limit the extent and reoccurrence of invasive species in the area. Smaller understory trees would be planted to reestablish a more diverse riparian corridor.

A fully developed and diverse riparian corridor is important for providing habitat that is suitable for a wide range of taxa to flourish within the stream. Planting native species along the banks of the stream would eventually shade out the stream, cooling down and providing proper habitat conditions while also protecting the stream from urban pollutants such as sediments, oils, and stormwater from impervious areas. Vegetation also offers nutrients to the stream as leaves fall and introduce organic matter to the stream's surface. Planting would be concentrated in the reach in several areas which contain riprap and bare soils. Areas that have been graded with new slopes would have plantings to help stabilize the soil. Small bare root material would be planted in the spring to avoid frost.

Floodplain Management

Floodplain management would include similar techniques to general stream restoration. Most important to proper floodplain use is to regrade the stream banks and reconnect the stream to its existing floodplain. Regrading the bank and providing riparian vegetation would provide both stabilization and protection during flood events. Riparian corridor vegetation would also slow down flood waters and settle out nutrients and pollutants. Parcels of land would be evaluated for their use as a floodplain as they become available.

Stream Setback Ordinance

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Closing

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Lancaster has taken positive steps toward the goal of improving our stormwater environment and our water quality systems. Through stream restorations, floodplain restorations and management, and the development of a long term control plan for CSOs, including the removal of 24 of the City's 33 CSO points, the City has improved water quality and prevented further degradation to our streams.

This plan is designed to improve stream habitat that is currently degraded due to agricultural development and riparian zone removal. Restoration activities near the confluence with the Hocking River would result in load reductions of 40 lbs/yr of nitrogen, 5 lbs/yr of phosphorous, and 2 tons/yr of total suspended solids. This project is anticipated to cost $400,000 in total.

The goal of the corridor plan for Lateral D is to achieve a healthy stream environment that would lead to improved water quality and macroinvertebrate habitat. This stream releases into the Hocking River, which has been identified as one of the most improved watersheds in the state by Ohio EPA in the 2009 TMDL report and the restoration of Lateral D would further that improvement and keep the Hocking River a clean, high-quality environment for local flora and fauna.

Public Participation and Education:

The public would be kept informed about the project through a number of processes. A public presentation could be made to department heads prior to taking the restoration public and seeking funding. The presentation could be broadcast on local access television with re-broadcasts during the week. Public feedback would be received through oral comments, e-mail, and newspaper blog. It is important that the public remain informed throughout all stages of plan implementation. Suggestions of public education methods are as follows:

Webpage

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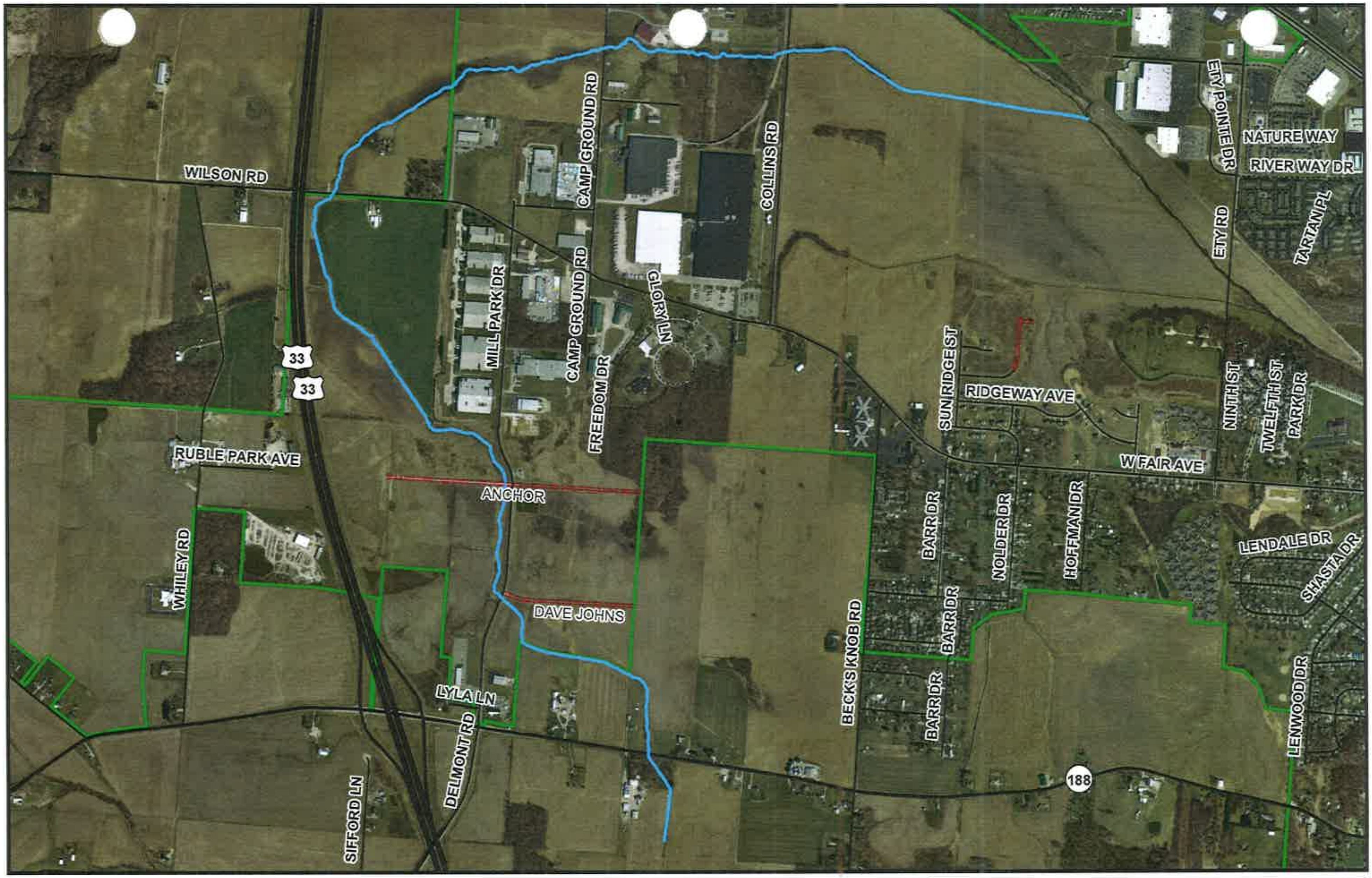

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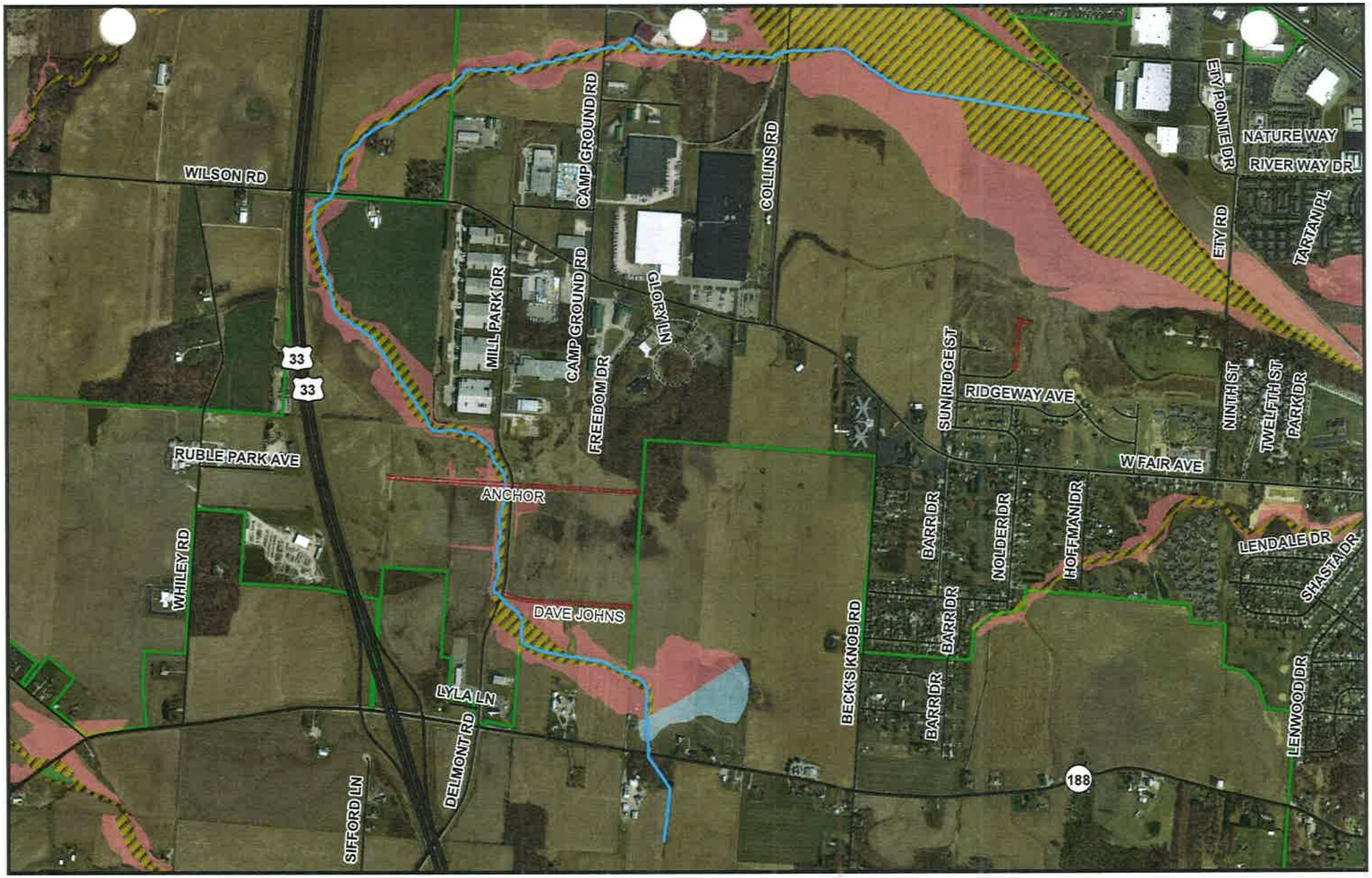
N

Lateral D

0 0.125 0.25 0.5 Miles



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Lateral D Floodplain

0 0.125 0.25 0.5 Miles

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Lateral D
Lower 1/2

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N

Lateral D
Upper 1/2

0 0.125 0.25 0.5 Miles

Pictures