

APPENDIX 1.1 APPROVED GRANT APPLICATION

FFY 2018 Project Application

Kentucky Nonpoint Source Pollution Control Program

**Refer to the 2018 Grant Guidance document and the Application Instructions for instructions on completing this application.*

1. Project Title: Middle Fork Beargrass Creek Watershed-based Plan (Louisville, KY)

	2. Lead Agency & Primary Contact	3. Project Manager
Name	David Johnson	Erin Wagoner
Agency	Louisville Metropolitan Sewer District	Louisville Metropolitan Sewer District
Street Address	700 West Liberty Street	700 West Liberty Street
City	Louisville	Louisville
State	Kentucky	Kentucky
Zip	40203	40203
Telephone Number	502-540-6392	502-540-6307
Fax Number		
Email Address	David.Johnson@louisvillemisd.org	Erin.Wagoner@louisvillemisd.org

4. Project Start Date: September 1, 2019

5. Project End Date: September 1, 2021

6. Fiscal Summary

319 Funding	\$133,938.00	60%
Non-Federal Match	\$89,292.00	40%
Total Budget	\$223,230.00	100%

7. Type of Project

☒	Watershed Plan
☐	WSP Implementation
☐	BMP Technology Demonstration
☐	Education/Outreach Technology Transfer
☐	Other:

8. River Basin

☐ Statewide	☐ Tygarts	☒ Ohio Tributary	☐ Little Sandy
☐ Kentucky	☐ Green	☐ Lower Cumberland	☐ Mississippi
☒ Salt	☐ Tradewater	☐ Upper Cumberland	
☐ Licking	☐ Tennessee	☐ Big Sandy	

9. Geographic Coverage

☐	Statewide
☐	Regional
☒	Watershed

10. NPS Pollutant(s) to be addressed

☐	Low Dissolved Oxygen	☐	Pesticides
☒	Sedimentation/Siltation	☐	Oil and Grease
☐	Suspended Solids	☒	Nutrients
☒	Pathogens/Bacteria	☐	pH
☒	Organic Enrichment		
☐	Other:		

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11. Nonpoint Pollution Source(s) to be addressed. Select up to five sources and include the percentage to which the project addresses the source. Total must equal 100%.			
Percent		Percent	
	NPS All		Resource Extraction
	Agriculture	33.3	Habitat Modification
	Construction		Improper Waste Disposal (including onsite Waste Issues)
	Silviculture	33.3	Hydrologic Modification
33.3	Urban Runoff		Recreation
			Other:

12. Project Area		Yes	No
Project deals directly with groundwater, springs or karst?		☐	☒
Watershed Projects Only, Complete the following:			
Project Implements a TMDL		☒	☐
Project address a TMDL that is under development		☒	☐
Project is on the 2010 Integrated Report, Assessment Category 5A		☒	☐
Nonsupport Stream		☒	☐
Partial Support Stream		☐	☒
Project is on a Special Use Water with identified threat.		☐	☒
Project has other impairments or identified treats (describe in app.)		☐	☒

Map Attached: Yes ☒ N/A ☐

13. Location

Watershed Name	HUC#	County ₁	County ₂	Drainage Area
Middle Fork Beargrass Creek	HUC 14: 05140101250010	Jefferson	NA	25.2

The Middle Fork of Beargrass Creek is one of three streams (Muddy Fork, Middle Fork, and South Fork) that join to form the larger Beargrass Creek watershed. The 25 square mile watershed is located in the north central portion of Jefferson County. Headwaters originate in Middletown and flow in a westerly direction through St. Matthews. The stream continues into the Highlands via Seneca and Cherokee Parks, to finally outlet into the South Fork Beargrass Creek just south of Main Street. The major streams in the Middle Fork Beargrass Creek Watershed are Middle Fork and Weicher Creek.

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14. Project Summary (Two-page limit):

Problem:

The Middle Fork of Beargrass Creek is a nonpoint source priority watershed in need of restoration. A Fecal Coliform Total Maximum Daily Load (TMDL) was approved in 2011 (KDOW, 2011a), a proposed draft Organic Enrichment TMDL was published in 2011 (KDOW, 2011b) and one segment extending from River Mile 0.0 to 2.0 was listed as Assessment Category 5A (Nonsupport) in 2014. Despite these water quality impairments, the Middle Fork of Beargrass Creek is home to many parks, trails and a local favorite swimming hole at Big Rock. Many project partners and stakeholders are actively engaged in improving this watershed and enthusiastically support development of the watershed plan.

Middle Fork of Beargrass Creek is a historic landmark in the development of Louisville Metro since its establishment in 1778. Middle Fork of Beargrass Creek has a history of water quality impairments dating back to early settlement days. Historians have noted that slaughter houses drained waste directly into Beargrass Creek in the early 1800's and by the 1820's the first sewer was built along Second Street that drained into Beargrass Creek; downstream of the Middle Fork confluence. Since that time, the Middle Fork Beargrass Creek watershed has undergone urban, suburban and commercial development and impervious surfaces now cover about 23 percent of this watershed (MSD, 2016).

The Kentucky Division of Water (KDOW) identified impairments in the Middle Fork of Beargrass Creek (KDOW, 2010). As of the 2010 Integrated Report to Congress on the Condition of Water Resources in Kentucky, three segments were identified as impaired (List 5A). The downstream segment (river mile 0.0 to 2.0) was listed as impaired because warm water aquatic habitat and primary contact recreation uses were not supported. The middle segment (river mile 2.0 to 2.9) and the upper segment (river mile 2.9 to 15.3) were listed as impaired because primary contact recreation (i.e., swimming) uses were not supported.

Causes for the impairments were identified as habitat assessment (streams), fecal coliform, nutrients/eutrophication biological indicators and organic enrichment (sewage) biological indicators. Suspected sources for these impairments were listed as channelization, sanitary sewer overflows (collection system failures) and urban runoff/storm sewers and illegal dumps (KDOW, 2015).

To address the recreational designated use impairments, KDOW developed a Fecal Coliform Total Maximum Daily Load (TMDL) (KDOW, 2011a). This TMDL included target reductions of fecal coliform bacteria needed to achieve the water quality standards. A proposed draft TMDL was developed for organic enrichment impairments (KDOW, 2011b). Both of the TMDLs included development of a Beargrass Creek Watershed Plan as an important strategy to enable more effective targeting of restoration funds and resources, thus improving environmental benefit, protection, and recovery.

In addition to these impairments, sedimentation and loss or lack of riparian habitat are also of concern. MSD's 2016 Synthesis Report documented fair and declining habitat at Lexington Road (0.0-2.0), good and stable habitat at Old Cannons Lane (2.9-15.3) and fair and improving habitat at Browns Lane (2.9-15.3). Field investigations have identified unstable banks near stream crossings and other locations which may lead to downstream sedimentation. While engineering approaches and technology have changed over the last two centuries, one thing is certain, Middle Fork continues to fight the battle against pollution.

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15. Introduction/Background (Two-page limit):

The KDOW NPS Grant Guidance includes a flow chart to identify nonpoint source priority watersheds (KDOW, 2018). The Middle Fork of Beargrass Creek is a priority watershed requiring restoration based upon the following characteristics:

- Approved TMDL, 2014 Integrated Report Category 4A: three segments were classified as 4A-NS in 2014 after completion of the Beargrass Creek Fecal coliform TMDL in 2011.
- TMDLs under Development: one segment (river mile 0.0 to 2.0) is classified as TMDL under development due to the proposed draft status of the Organic Enrichment TMDL
- 2014 Integrated Report Assessment Category 5A (Nonsupport): one segment (river mile 0.0 to 2.0) is classified as 5A-NS for Warm Water Aquatic Habitat impairment

As outlined in Section 14, the Middle Fork of Beargrass Creek has endured a long history of pollution since the time that Louisville was initially settled. Many programs and projects have been implemented to reduce pollution. The early installation of sewers dramatically reduced the direct discharge of human sewage. MSD is continuing to make progress toward this goal with numerous projects to reduce the frequency and volume of combined sewer overflows, eliminate sanitary sewer overflows and to minimize impacts of stormwater to the maximum extent practicable.

These programs and projects have resulted in several notable improvements in water quality. MSD summarized water quality data collected over the 20-year history of the Long-Term Monitoring Network and published the results in the 2016 Water Quality Synthesis Report (MSD, 2016). The findings for Middle Fork Beargrass Creek include:

- A 34% reduction in fecal coliform bacteria at Lexington Road between 2004 and 2015
- A 24% and 12% improvement in fish community scores at Browns Lane and Lexington Road, respectively
- An 11% improvement in aquatic insect scores at Old Cannons Lane
- Aquatic habitat was rated as good and stable at Old Cannons Lane
- Nitrogen, phosphorus and total suspended solids were generally low at Browns Lane and Old Cannons Lane
- Dissolved oxygen met water quality criteria in 98% of the time between 2013 and 2015 and improved by 15% since 2005 at Old Cannons Lane and fair and improving at Browns Lane
- Although dissolved oxygen met water quality criteria only 76% of the time at Lexington Road, between 2013 and 2015, it had improved by 10% since 2005

These findings highlight the combined positive effects of ongoing programs and projects on water quality. However, much work remains to be done. The 2016 Synthesis Report included the following negative findings:

- Fish communities were rated as fair or poor at the three monitoring sites in 2015
- Aquatic insect communities were rated as fair at the three monitoring sites in 2015
- Aquatic habitat was rated as fair and declining at Lexington Road
- Fecal coliform levels were elevated above water quality standards at all three monitoring sites, were increasing at Browns Lane, and were unchanged at Old Cannons Lane
- Nitrate levels were elevated at Browns Lane and Old Cannons Lane

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- Total phosphorus and total suspended solids were elevated at Lexington Road

Extensive water quality modeling was performed to develop the Fecal Coliform TMDL for Beargrass Creek. The modeling was used to apportion existing loadings of bacteria to sanitary sewer overflows, combined sewer overflows, stormwater and nonpoint source / groundwater. The model was then used to simulate elimination of sanitary sewer overflows, reductions in combined sewer overflows as specified in the Long-Term Control Plan, and reductions in remaining stormwater and nonpoint source / groundwater. To achieve the TMDL goal of meeting water quality standards for fecal coliform bacteria, CSO sources must be reduced by 98%, stormwater MS4 sources by 95% and nonpoint source / groundwater by 88% to 91%.

The Organic Enrichment TMDL remains in proposed draft status and is therefore subject to change. However, extensive modeling was also performed to develop this TMDL and the results can be used as initial information for watershed planning purposes. The proposed draft TMDL recommended 40% reductions in oxygen demanding substances from nonpoint source / groundwater.

MSD has ongoing programs and projects that are designed to reduce or eliminate bacteria and oxygen demanding substances from combined and sanitary sewer overflows and MS4 stormwater. The focus of this watershed plan is to work with Project Partners and Watershed Stakeholders to identify and reduce the nonpoint sources of bacteria and oxygen demanding substances identified in the TMDLs focusing on the following nonpoint sources of pollution: urban runoff, habitat modification, and hydrologic modification.

A recent major planning effort was completed as a partnership between Louisville Metro Parks, USACE Louisville District, and TetraTech's consultant team in 2017 to evaluate the Beargrass Creek Trail Conceptual Shared Use Path and Ecological Restoration opportunities. This report outlines several restoration opportunities within the Beargrass Creek watershed, specifically along Middle Fork of Beargrass Creek and can be found on Louisville Metro Parks' website. Restoration opportunities include stream relocation and restoration, bank stabilization, and other storm water management through green practices.

One of the keys to successful development and implementation of watershed plans is the consistent involvement of project partners and stakeholders throughout the project. MSD formed the Steering Committee and Watershed Workgroup to assist with the initial grant application in 2017. Project partners such as Louisville Metro Parks, River City Paddle Sports, Kentucky Waterways Alliance, Louisville MSD, Salt River Watershed Watch, and others are committed to and enthusiastically support the development and implementation of this watershed plan.

In addition, this watershed has a local volunteer organization, Beargrass Creek Alliance, which actively works to engage the community to improve the watershed. Middle Fork Beargrass Creek is highly traveled by the community and individuals who love the outdoors. There are several paved trails along Middle Fork used for recreational activities and by commuters. Accessibility to the creek in some areas provides high visibility for potential outreach and education opportunities. With the support of project partners, work group, and consultants, we are proposing to develop a Watershed Plan to establish a framework for implementing projects that will improve water quality.

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16. NPS Pollution Control Project Goal, Objectives, and Activities:

Goal 1: Improve water quality in the Middle Fork of Beargrass Creek by developing a Kentucky Division of Water (DOW) and Environmental Protection Agency (EPA) approved watershed plan that meets EPA A-I criteria.

- Objective 1: Compile available background information about the Middle Fork of Beargrass Creek watershed.
 - Activity 1: Compile available GIS data including aerial imagery and land use data.
 - Activity 2: Gather existing water quality data from relevant sources. Analyze and interpret historical data for general trend analysis.
 - Activity 3: Assemble and evaluate information about natural features in the watershed, including geology, topography, soil types, rare and invasive species, important habitats, as well as social and demographic information.
 - Activity 4: Draft and final Watershed Plan Chapter 2. Exploring Middle Fork Beargrass Creek
- Objective 2: Determine current conditions of the Middle Fork of Beargrass Creek watershed through interpretation of collected water quality data and visual assessment.
 - Activity 1: Finalize QAPP and submit to DOW for review and approval.
 - Activity 2: Monitor water quality as described in Section 18 of this grant application.
 - Activity 3: Analyze and interpret monitoring data for as described in Section 17 of this grant application.
 - Activity 4: Using GIS data and visual assessment, evaluate the current conditions of the riparian habitat and buffer zones.
 - Activity 5: Calculate annual pollutant loads from each sampling location and determine the load reductions needed to meet water quality standards or benchmarks for parameters included in the Watershed Planning Guidebook.
 - Activity 6: Draft and final Watershed Plan Chapter 3. Monitoring.
 - Activity 7: Draft and final Watershed Plan Chapter 4. Analysis.
- Objective 3: Develop a Best Management Practices Implementation Plan for the Middle Fork of Beargrass Creek watershed.
 - Activity 1: Identify probable causes and sources of nonpoint source pollution based off analysis of the collected water quality data and visual assessment.
 - Activity 2: Select Best Management Practices (BMPs) that could be implemented to address the different sources of pollutants identified.
 - Activity 3: Estimate the load reductions that can be achieved for pollutants, and the number of BMPs needed to achieve desired load reductions.
 - Activity 4: Estimate the costs expected for implementation.
 - Activity 5: Estimate the timeline needed for implementing the plan.
 - Activity 6: Prioritize areas for implementation of BMPs while considering feasibility factors, including local concerns, landowner cooperation, load reductions needed to meet water quality goals, funding, etc.

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- Activity 7: Draft and final Watershed Plan Chapter 5. Finding Solutions
- Activity 8: Draft and final Watershed Plan Chapter 6. Strategy for Success
- Objective 4: Develop measurable milestones and evaluation criteria for determining the long-term success of the watershed planning and implementation efforts.
 - Activity 1: Develop plan for a long-term water-quality monitoring effort within the Middle Fork of Beargrass Creek watershed to assess whether progress towards meeting water quality standards is being made.
 - Activity 2: Develop a set of measurable milestones that can be used to gauge the overall progress of implementation over time.
 - Activity 3: Draft and final Watershed Plan Chapter 7. Implementation and Success Monitoring

Goal 2: Create greater opportunity for community members to become involved in watershed-improvement efforts and solutions.

- Objective 1: Continue to work with the Steering Committee and the Watershed Work Group.
 - Activity 1: Hold four Steering Committee meetings during the project timeframe.
 - Activity 2: Hold two Watershed Work Group meetings during the project timeframe.
- Objective 2: Support a watershed group for the Middle Fork of Beargrass Creek.
 - Activity 1: Form or update existing group about the watershed planning project
 - Activity 2: Hold monthly watershed group meetings
- Objective 3: Provide outreach to the local community on nonpoint source pollution and related environmental issues in their watershed.
 - Activity 1: Partner with other water quality education organizations
 - Activity 2: Perform education and outreach events such as but not limited to: stream clean ups, Every Drop events, storm drain marking projects, showings of “Beargrass: The Creek in Our Backyard,” celebration tours, social media campaigns, volunteer events, public interpretive programs, invasive species removal events, and canoe trips.
 - Activity 3: Develop (or edit existing) and distribute handouts, online information, public service announcements/commercials, etc., as needed.
 - Activity 4: Draft and Final Executive Summary and Watershed Plan Chapter 1. Getting Started

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17. Describe the NPS Pollution Control Plan of Work:

The Plan of Work describes the specific tasks that will be completed in order to develop KDOW and USEPA approved Watershed Plan that includes a BMP Implementation Plan. Roles and responsibilities are outlined below and further documented in the Budget.

Task 1 – Exploring Middle Fork Beargrass Creek: A consultant will compile existing GIS data from LOJIC, KY GeoNet, reports and other relevant resources to summarize background information about the watershed, including:

- Water Resources: hydrology, groundwater, flooding, regulatory status, geomorphic data, climate
- Natural Features: geology, topography, soils, ecoregions, riparian vegetation, flora, fauna
- Human Influences and Impacts: demographics, economy, water use, land use, watershed disturbances, hazardous materials, regulatory framework

A consultant will gather water quality data from relevant sources including MSD, KDOW, TMDL studies. Salt River Watershed Watch will summarize their data and provide to the consultant. The consultant will update water quality trends in Middle Fork Beargrass Creek previously reported in the 2016 Synthesis Report. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 2. Exploring Middle Fork Beargrass Creek for MSD and Project Partner review. MSD will then submit the Chapter to KDOW to review. MSD and a consultant will revise the draft per KDOW review.

Task 2 – Monitoring and Visual Assessment: Monitoring for this watershed plan will be performed by MSD and KDOW at three (3) LTMN sites and five additional (5) KDOW sites. MSD, KDOW and a consultant will finalize a QAPP describing the monitoring to be performed in support of this watershed plan as described in Section 18. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 3. Monitoring Middle Fork Beargrass Creek for MSD and Project Partner review. MSD will then submit the Chapter to KDOW to review. MSD and a consultant will revise the draft per KDOW review.

A consultant will analyze and interpret the monitoring data collected by MSD and KDOW using a tiered approach. The analysis will focus on bacteria, hydromodification and parameters included in the Watershed Planning Guidebook (i.e., Tier 1), supplemented by analysis of the additional parameters included in Section 18 (Supplemental).

MSD and the Project Partners will develop water quality benchmarks using applicable numeric water quality criteria, existing final and draft TMDLs and reasonable targets for Tier 1 parameters. A consultant will use stream monitoring results to estimate annual pollutant loads from each monitoring site and compare them to benchmarks. Benchmarks and pollutant loads will be analyzed for Supplemental parameters that exceed numeric water quality criteria.

A consultant will perform a desktop assessment of riparian habitat and adjacent stream buffers using GIS data and the most recent available aerial photography. MSD will perform stream walks to visually assess riparian and buffer zones. MSD will perform geomorphic assessments in selected locations that may be candidates for stream projects such as stabilization or restoration. A consultant will interpret the biological and habitat results in the context of historical data for the 3 LTMN sites and integrate the findings of the riparian and buffer

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assessments and stream walks. An initial list of priority areas will be identified by MSD, Project Partners and the consultant. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 4. Analysis for MSD and Project Partner review. MSD will then submit the Chapter to KDOW to review. MSD and a consultant will revise the draft per KDOW review.

Task 3 – Best Management Practices Implementation Plan: MSD, Project Partners and a consultant will use the data and information compiled in Chapters 2 through 4 of the Watershed Plan to identify probable causes and sources of nonpoint source pollution, focusing on the subwatersheds contributing to the priority areas identified in Chapter 4 of the Watershed Plan. A list of BMPs that minimize and reduce causes and sources will be identified by the consultant. The consultant will use the International BMP database and if available, local data, to estimate pollutant load reductions that can be achieved on a per BMP basis and the range of costs and timeline associated with implementation. MSD and Project Partners will host a BMP Workshop to gather input from a variety of local entities regarding the Initial BMP matrix. Materials used to advertise and host the BMP Workshop will be provided in advance to KDOW for review and approval. The BMP Workshop will provide a forum to gauge local support and identify local concerns regarding BMPs. The consultant will compile and synthesize the information gathered from the BMP Workshop. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 5. Finding Solutions for MSD and Project Partner review. MSD will then submit the Chapter to KDOW to review. MSD and a consultant will revise the draft per KDOW review.

The consultant will use the results of Chapter 5 to evaluate initial BMP feasibility, including opportunities for landowner cooperation, costs and benefits. The consultant will draft the initial BMP matrix to identify priority areas for BMP implementation, responsible entities and partnerships, potential funding sources and implementation approaches. MSD and Project Partners will review the BMP Matrix. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 6. Strategy for Success for MSD and Project Partner review. MSD will then submit the Chapter to KDOW to review. MSD and a consultant will revise the draft per KDOW review.

Task 4. Measurable Milestones: MSD and the consultant will develop a draft document describing roles and responsibilities for watershed plan implementation, communication and outreach strategy, a financial resources plan, monitoring, evaluating and updating the watershed plan. The monitoring plan will describe tracking BMP implementation and monitoring water quality. Periodic trends assessments will be conducted to evaluate the effectiveness of BMP implementation in the context of on-going changes in the watershed. A consultant will use the results of this task to develop the draft Watershed Plan Chapter 7. Implementation and Success Monitoring for MSD and Project Partner review. MSD will then submit Chapter 7 for KDOW review. MSD and a consultant will revise per KDOW review. The Executive Summary and Draft Final Watershed Plan will be submitted to KDOW for review, MSD will revise per comments to finalize the plan.

Task 5. Project Management and Reporting: MSD will prepare quarterly project reports and corresponding 319H invoices every quarter the project is open. MSD will institute a mechanism to track budget and match. Other tasks will include internal coordination meetings, phone and email communications and contracting with the consultant, KWA and other entities as needed for this project.

Public Involvement: Public involvement for this project is described in Section 19.

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18. Environmental Data Collection:

Monitoring for this watershed plan will be performed by MSD at two (2) LTMN sites and six (6) 319H sites. MSD, KDOW and a consultant will finalize a QAPP describing the monitoring to be performed in support of this watershed plan. A consultant will modify the draft QAPP to describe monitoring and quality assurance for monitoring performed by MSD. The consultant will provide the draft QAPP to MSD and KDOW for review. Monitoring locations are summarized on Table 1.

Table 1. Monitoring Sites

Station ID (KDOW, MSD, USGS)	Waterbody	Location	River Mile	Drainage Area mi ²	Latitude	Longitude
DOW08047007 EMIMI010 03293500	Middle Fork Beargrass Creek	Lexington Rd.	0.9	24.8	38.250276	-85.716868
DOW08047008 EMIMI002 03293000	Middle Fork Beargrass Creek	Below Old Cannons Ln.	5.4	18.7	38.23729	-85.66468
EMIMI009	Middle Fork Beargrass Creek (1)	At Browns Lane		15.2	38.2403	-85.6345
DOW08047009	Weicher Creek	Above Blossom- wood Dr.	0.55	1.3	38.23016	-85.63071
DOW08047010	Middle Fork Beargrass Creek UT 8.45 (Sinking Fork)	Below Bowling Blvd.	0.3	2.6	38.24683	-85.62881
DOW08047011	Middle Fork Beargrass Creek UT 9.1	Off Steeplecrest Circle	0.2	3.9	38.24093	-85.61867
DOW08047012	Middle Fork Beargrass Creek	Off Old Whipps Mill Rd.	11.7	5.0	38.25984	-85.58529
DOW08047013	Middle Fork Beargrass Creek UT 12.8	Above Foxboro Rd.	0.2	2.2	38.25867	-85.56680

Notes: 1. This site sampled only by MSD, KDOW does not sample this site

3 MSD Long Term Monitoring Network sites: EMIMI010, EMIMI002, EMIMI009.

2 USGS Gages record stream discharge, pH, DO, temperature, conductivity on 15-minute intervals: 03293500, 03293000

KDOW - Sampling will be performed monthly by KDOW at 7 of the 8 sites for the parameters listed below. KDOW will analyze samples at the State laboratory in Frankfort, KY. Parameters identified in bold below are included in the Watershed Planning Guidebook. Additional parameters were included by KDOW due to the urban environment in this watershed.

- **Bacteria: E. coli bacteria**
- **Bulk: biological oxygen demand**, bromide, chloride, fluoride, nitrate, nitrite, sulfate, turbidity, total dissolved solids, total suspended solids

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- **Nutrients:** ammonia (as N), **nitrate-nitrite**, **total Kjeldahl nitrogen**, total organic carbon, **total phosphorus**
- **Orthophosphorus:** **ortho-phosphorus** (field filtered)
- **Sediment (in Bulk): Total Suspended Solids**
- **Alkalinity:** acidity, alkalinity, alkalinity-carbonate, alkalinity-bicarbonate
- **Metals:** aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, total hardness, vanadium, zinc
- **Field Parameters: Turbidity, pH, Dissolved Oxygen, Dissolved Oxygen % Saturation (calculated) Conductivity, Temperature**, collected at each sample event.
- **Stream Flow: Stream flow** (measured by USGS flow gages at 2 sites with gages noted on Table 1. Measured manually using KDOW protocols at 7 sites, collected at each sample event).
- **Biology & Habitat: Benthic Macroinvertebrates, Habitat Assessment**

MSD - MSD has developed a draft QAPP. After KDOW approves the QAPP, MSD will sample the 8 sites listed on Table 1 for the parameters listed below. MSD will analyze bacteria samples at the MSD Laboratory located at the Morris Forman Water Quality Treatment Center. Parameters identified in bold below are included in the Watershed Planning Guidebook.

- **Bacteria: E. coli bacteria** (monthly for up to 11 months), and 5 times per month for 1 month during the recreation season of May 1 to October 31
- **Field Parameters: Turbidity, pH, Dissolved Oxygen, Dissolved Oxygen % Saturation (calculated) Conductivity, Temperature**, collected at each sample event.
- **Stream Flow: Stream Flow** (measured by USGS flow gages at 2 sites with gages noted on Table 1. Measured manually using KDOW protocols at 7 sites, collected at each sample event).

Quality Control: Quality control sampling includes field duplicates and field blanks, lab duplicates and lab blanks. In general, 10 % of samples will be quality control samples. The details of the quality control sampling will be established in the QAPP.

Data Management: MSD data will be stored in the MSD Laboratory Information Management System (LIMS). KDOW and MSD will share the data collected in this project for use in watershed plan development.

The analysis and interpretation of this data is described in Section 17. Task 2.

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19. Public Involvement:

This section describes efforts to support Goal 2: Create greater opportunity for community members to become involved in watershed improvement efforts and solutions.

As a continuation of planning efforts that lead to the development of this grant application, four (4) Steering Committee meetings and two Watershed Workgroup meetings will be planned and held during the 2-year project time frame. Monthly updates regarding watershed planning efforts will be provided to the existing watershed group – Beargrass Creek Alliance, which has working to improve Beargrass Creek for many years.

Partnerships with numerous agencies and organizations were formed or strengthened during the development of this grant application. These groups will assist with providing outreach and education to the Beargrass Creek Watershed community through the following opportunities:

- Develop Public Outreach & Involvement Plan – A consultant will develop a public outreach plan outlining the activities and schedule for outreach and education events during the project period
- Kentucky Waterways Alliance will host 2 creek cleanups (3 hours each), 2 Every Drop events, 2 Storm drain marking events (2 hours each), 2 bicycle or walking tours for watershed residents (2 hours each) and host 4 showings of the film, “Beargrass: The Creek in Our Backyard.” KWA will also provide monthly social media updates.
- River City Paddle Sports will host 3 canoe trips (3 hours each)
- Louisville Metro Parks will host 2 invasive species removal events, 4 annual volunteer events, 2 public interpretive programs and perform 15 8-hour cycles of Greenway maintenance

All meeting materials and handouts used for committee meetings and education and outreach events will be provided to KDOW for review and approval prior to distribution.

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20. Project Partners: *Letters of participation are required from all partners (see 2016 Grant Guidance Document). Attach letters of participation as an appendix to this application.*

Include the following information for each project partner:

Agency Name: AECOM

Agency Address: 500 West Jefferson Street, Suite 1600, Louisville, KY 40202

Role/Contribution to Project: Technical assistance, monitoring, public outreach, volunteering, plan development, and program assistance.

Contact Person: Meghan Dunn Brown

Phone No: (502) 569-2301

E-mail address: Meghan.Brown@aecom.com

Agency Name: Jacobs

Agency Address: One Riverfront Plaza, 401 West Main Street, Suite 800, Louisville, KY 40202

Role/Contribution to Project: Technical knowledge and results from sampling efforts, volunteering, public outreach and education, creek cleanups, and other activities that help meet the goals and vision of the watershed plan.

Contact Person: Nicholas Winnike

Phone No: (513) 595-7922

E-mail address: Nicholas.Winnike@Jacobs.com

Agency Name: Kentucky Waterways Alliance

Agency Address: 120 Webster Street, Suite 217, Louisville, KY 40206

Role/Contribution to Project: Lead public outreach and engagement, publicity, participation in watershed planning review, and in-kind contributions such as creek cleanups, Every Drop events, storm drain marking, and celebration bicycle tours.

Contact Person: Ward Wilson

Phone No: (502) 589-8008

E-mail address: ward@kwalliance.org

Agency Name: Louisville Department of Metro Parks and Recreation

Agency Address: PO Box 37280

Role/Contribution to Project: Public education, volunteer events, maintenance activities associated with the Louisville Loop from Beargrass Creek Greenway to River Road, and the recently completed Beargrass Creek Trail Conceptual Shared Use Path and Ecological Restoration report which evaluated potential trail paths and ecosystem restoration opportunities.

Contact Person: Bennett Knox

Phone No: (502) 366-2913

E-mail address: bennett.knox@louisvilleky.gov

Agency Name: Office of Sustainability Develop Louisville

Agency Address: 527 West Jefferson Street, Suite 606, Louisville, KY 40202

Role/Contribution to Project: Project endorsement of support.

Contact Person: Maria Koetter

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Phone No: (502) 574-4148

E-mail address: maria.koetter@louisvilleky.org

Agency Name: River City Paddle Sports

Agency Address: 6215 Deep Creek Court, Prospect, KY 40059

Role/Contribution to Project: Environmental field trips through the watershed and promotion of the documentary: The Creek in Our Backyard.

Contact Person: David Wicks

Phone No: (502) 671-3595

E-mail address: dwicks1@gmail.com

Agency Name: Salt River Watershed Watch

Agency Address: KDOW Watershed Watch Program 300 Sower Blvd, 3rd Floor, Frankfort, KY 40601

Role/Contribution to Project: Provide Salt River Watershed Watch (SRWW) sampling data for screening purposes, screening level water quality sampling, interpretation of screening level data and environmental education.

Contact Person: Karen Schaffer

Phone No: (502) 298-1932

E-mail address: kschaf4321@gmail.com

Agency Name: Stantec

Agency Address: 10509 Timberwood Circle, Suite 100, Louisville, KY 40223

Role/Contribution to Project: Technical assistance with developing watershed plan including knowledge from previous sampling efforts, coordination to identify mitigation opportunities, and historic knowledge of projects within the Middle Fork of Beargrass Creek watershed.

Contact Person: Melissa Tucker

Phone No: (502) 212-5048

E-mail address: melissa.tucker@stantec.com

Agency Name: Third Rock

Agency Address: 2526 Regency Rd # 180, Lexington, KY 40503

Role / Contribution to Project: Technical assistance with assessment and integration of biological and habitat assessments, technical assistance with visual surveys and geomorphic assessments, and identification of priority areas and BMPs to address hydromodification BMPs

Contact Person: Bert Remley

Phone No.: (859) 977-2000

E-mail address: bremley@thirdrockconsultants.com

Letters of Participation for each agency are provided in Appendix A.

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21. Project Measures of Success:

Goal 1: Improve water quality by developing a KDOW and EPA approved watershed plan.

- Objective 1: Compile available background information about the Middle Fork of Beargrass Creek watershed.
 - Deliverable 1: Background information compiled (Chapters 1 and 2 developed and approved).
- Objective 2: Determine current conditions of the Middle Fork of Beargrass Creek watershed through interpretation of collected water -quality data and visual assessment.
 - Deliverable 1: finalization of an approved QAPP.
 - Deliverable 2: monitoring per Section 18 complete.
 - Deliverable 3: riparian buffer assessment complete.
 - Deliverable 4: historic and current monitoring data compiled, analyzed, and load reductions calculated (Chapters 3 and 4 developed and approved).
- Objective 3: Develop a Best Management Practices Implementation Plan and Strategy for the Middle Fork of Beargrass Creek watershed.
 - Deliverable 1: BMP implementation plan developed (Chapters 5 and 6 developed and approved).
- Objective 4: Develop measurable milestones and evaluation criteria for determining the long-term success of the watershed planning and implementation efforts.
 - Deliverable 1: Set of milestones and long-term water quality monitoring plan developed (Chapter 7 developed and approved).

Goal 2: Create greater opportunity for community members to become involved in watershed improvement efforts and solutions.

- Objective 1: Continue to work with the Steering Committee and the Watershed Work Group.
 - Deliverable 1: Number of Steering Committee Meetings held.
 - Deliverable 2: Number of Watershed Work Group meetings held.
- Objective 2: Support a watershed group for the Middle Fork of Beargrass Creek.
 - Deliverable 1: Number of watershed group meetings held.
- Objective 3: Provide outreach to the local community on nonpoint source pollution and related environmental issues in their watershed.
 - Deliverable 1: Number of education and outreach events held.
 - Deliverable 2: Number of education and outreach materials developed or distributed.
 - Deliverable 3: Watershed Plan Chapter 1 developed and approved

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22. Milestone Schedule		
Milestone	Date	
	Expected Begin	Expected Completion
1. Receipt of Grant Funding	9/1/2019	10/1/2019
2. Facilitate internal and cross-departmental planning meetings and workshops as needed.	Duration	Duration
3. Select and secure contractors to perform necessary technical services for the project.	9/1/2019	1/31/2020
4. Select and secure contractors or organizations to perform necessary education and outreach services for the project.	9/1/2019	1/31/2020
5. Hold four Steering Committee meetings.	Duration	Duration
6. Hold two Watershed Work Group meetings.	Duration	Duration
7. Hold monthly watershed group meetings	Duration	Duration
8. Hold and/or facilitate education and outreach events. Submit advanced written notice to NPS Program staff for all educational public meetings, field days, workshops, etc.	Duration	Duration
9. Develop and/or distribute education materials. Submit to NPS Program staff for review and approval before distribution.	Duration	Duration
10. Finalize QAPP and submit to DOW for review and approval.	9/1/2019	12/31/2019
11. Conduct monitoring as described in Section 18	1/1/2020	12/31/2020
12. DOW Water Quality Branch and Nonpoint Source Program staff to conduct monitoring as described in Section 18	2/1/2019	1/31/2020
13. Gather background information and compose Chapters 1-2	2/1/2020	8/30/2020
14. Use GIS data and visual assessment, evaluate the current conditions of the riparian habitat and buffer zones.	2/1/2020	8/30/2020
15. Analyze and interpret historical data from previous water quality monitoring and compose Chapter 3	2/1/2020	8/30/2020
16. Analyze and interpret new data from water quality monitoring and compose Chapter 4	2/1/2020	3/31/2021
17. Calculate pollutant loads from each sampling location, determine load reductions to meet water quality standards or benchmarks, include in Chapter 4.	2/1/2020	3/31/2021
18. Develop BMP Implementation Plan (Chapters 5 and 6)	6/30/2020	3/30/2021
19. Develop measurable milestones and evaluation criteria for determining the long-term success of watershed planning and implementation (Chapter 7)	6/30/2020	3/30/2021
20. Finalize WSP and submit to DOW for review (Executive Summary & Final Plan)	4/1/2021	6/30/2021
21. Once DOW approves of the WSP, DOW will submit the WSP to EPA for review. MSD will address EPA's comments as necessary.	7/1/2021	9/1/2021
22. Develop and submit Final Report upon completion of the project	7/1/2021	9/1/2021

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23. Reference/Literature Cited:

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<http://eppcapp.ky.gov/spwaters/ReportViewer.aspx?Report=BasinDetails>. September 29, 2016.
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<http://watermaps.ky.gov/WaterHealthPortal/>. September 29, 2016.
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<http://water.ky.gov/waterquality/Pages/IntegratedReport.aspx>
- KDOW. 2015. Consolidated Assessment and Listing Methodology: Surface Water Quality Assessment in Kentucky, The Integrated Report (DOWSOP03036). <http://water.ky.gov/Pages/SurfaceWaterSOP.aspx>
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- Louisville MSD. 2016. State of the Streams 2016 Water Quality Synthesis Report.
www.louisvillemsd.org/WaterQuality
- Metro Parks. 2017. Beargrass Creek Trail Conceptual Shared Use Path and Ecological Restoration Plan.
<https://louisvilleky.gov/government/parks/beargrass-creek-trail-conceptual-shared-use-path-ecological-restoration-plan>

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24. Budget Summary							
Category	BMP Implement ation	Project Manage- ment	Education, Training, or Outreach	Monitor- ing	Technical Assistance	Other	Total Amount
Personnel		\$2,848	\$43,486	\$24,775	\$13,870		\$84,979
Supplies							
Equipment							
Travel							
Contractual (1)		\$9,360	\$27,453	\$14,100	\$82,320	\$705	\$133,938
Operating Costs (2)			\$1,600				\$1,600
Other (3)				\$2,713			\$2,713
TOTAL		\$12,208	\$72,539	\$41,588	\$96,190	\$705	\$223,230

Notes

1. Contractual Other category includes \$705 for Supplies, shown here to document that Section 319H funds are proposed to cover these expenses.
2. City of St. Matthews donated meeting space valued at \$1,600 as Non-Federal Match
3. Louisville MSD donated E. coli bacteria sample analysis valued at \$2,713 as Non-Federal Match. MS4 Permit samples are not included in this match.

25. Detailed Budget			
Budget Categories (Itemize all Categories)	§319(h) (60% of funds)	Non-Federal Match (40% of funds)	TOTAL
Personnel		\$77,179	\$77,179
Supplies	\$705		\$705
Equipment			
Travel			
Contractual	\$133,233	\$7,800	\$141,033
Operating Cost		\$1,600	\$1,600
Other		\$2,713	\$2,713
TOTAL	\$133,938	\$89,292	\$223,230

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26. Budget Narrative: Describe in detail the Federal and Non-Federal match for each of the following Budget Categories.

The following assumptions were used for this budget narrative:

- A 2,000-hour work year was used to calculate person years (PY); 4,000 hours over the 2-year project period.
- Monitoring includes visual and geomorphic assessments as well as water quality sampling, as described in Section 17, Task 2 and Section 18, and will be summarized in Watershed Plan Chapter 3
- Education, Outreach and Training is described in Section 19 and will be summarized in Watershed Plan Executive Summary and Chapter 1
- Budget for work associated with development of Watershed Plan Chapters 2, 4, 5, 6 and 7 was grouped under Technical Assistance

Personnel:

Federal

- ***Project Management*** – Not Applicable
- ***Education, Training or Outreach*** – See Federal Contractual
- ***Monitoring***– See Federal Contractual
- ***Technical Assistance*** – See Federal Contractual
- ***Other*** – Not Applicable

Non-Federal Match

- ***Project Management (\$2,848)***
 - MSD Project Manager – 32 hours at \$89 per hour (0.008 PY) (\$2,848)
- ***Education, Training or Outreach (\$43,686)***
 - Louisville MSD Project Manager – 46 hours at \$89 per hour (0.0115 PY) (\$4,094)
 - Metro Parks – 440 hours at \$25 per hour (0.11 PY) (\$11,000)
 - Metro Office of Sustainability – 16 hours at \$25 per hour (0.004 PY) (\$400)
 - Louisville Metro Health Department – 16 hours at \$25 per hour (0.004 PY) (\$400)
 - City of St. Matthews – 16 hours at \$25 per hour (0.004 PY) (\$400)
 - KWA Executive Director 40 hours at \$48 per hour (0.01 PY) (\$1,920)
 - Salt River Watershed Watch – 64 hours at \$21 per hour (\$1,344)
 - River City Paddle Sports – 16 hours at \$21 per hour (\$336)
 - Volunteer participation in education and outreach events - 752 hours at \$21 per hour (0.188 PY) (\$15,792)
 - Senior Consultant support for Project Partner meetings 60 hours at \$130 per hour (0.015 PY) (\$7,800)
- ***Monitoring (\$24,777)***
 - Louisville MSD
 - Project Manager – 12 hours at \$89 per hour (0.003 PY) (\$1,068)
 - Field Supervisor – 12 hours at \$96 per hour (0.003 PY) (\$1,152)
 - Field Technicians – 292 hours at \$65 per hour (0.073 PY) (\$18,980)
 - Lab Supervisor – 20 hours at \$96 per hour (0.005 PY) (\$1,920)
 - Assistant Director – 8 hours at \$131 per hour (0.002 PY) (\$1,048)
 - Salt River Watershed Watch – 28.9 hours at \$21 per hour (0.007 PY) (\$607)

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- **Technical Assistance (\$13,870)**
 - Louisville MSD
 - Project Manager – 118 hours at \$89 per hour (0.0295 PY) (\$10,502)
 - Field Supervisor – 8 hours at \$96 per hour (0.002 PY) (\$768)
 - Field Technicians – 40 hours at \$65 per hour (0.01 PY) (\$2,600)
- **Operating – (\$1,600)**
 - City of St. Matthews will provide the meeting space for four (4) 2-hour project partner meetings (8 hours total), valued at \$200 per hour
- **Other – (\$2,713)**
 - Louisville MSD will conduct analysis of 119 E. coli samples (108 project samples + 11 QC samples (10 %) valued at \$2713 as Non-Federal Match. Analysis of 36 MS4 samples collected at 3 sites was excluded from the Match.

Travel: – Not Applicable

Contractual:
Federal

- **Project Management – (\$9,630)**
 - Consultant Project Manager – 24 hours at \$150 per hour (0.006 PY)
 - Senior Consultant – 48 hours at \$120 per hour (0.012 PY)
- **Education, Training or Outreach – (\$27,453)**
 - Consultant Project Manager – 6 hours at \$150 per hour (0.0015 PY) (\$900)
 - Senior Consultant – 150 hours at \$120 per hour (0.0375 PY) (\$18,000)
 - GIS Consultant – 14 hours at \$90 per hour (0.0035 PY) (\$1,260)
 - Kentucky Waterways Alliance – 136 hours at \$48 per hour (0.034 PY) (\$6,528)
 - River City Paddle Sports – 18 hours at \$42.50 per hour (0.0045 PY) (\$765)
- **Monitoring – (\$14,100)**
 - Consultant Project Manager – 2 hours at \$150 per hour (0.0005 PY) (\$300)
 - Senior Consultant – 106 hours at \$120 per hour (0.0265 PY) (\$12,720)
 - GIS Consultant – 12 hours at \$90 per hour (0.003 PY) (\$1,080)
- **Technical Assistance – (\$82,320)**
 - Consultant Project Manager – 40 hours at \$150 per hour (0.01 PY) (\$6,000)
 - Senior Consultant – 588 hours at \$120 per hour (0.147 PY) (\$70,560)
 - Consultant – 18 hours at \$90 per hour (0.0045 PY) (\$1,620)
 - GIS Consultant – 46 hours at \$90 per hour (0.0115 PY) (\$4,140)
- **Other (Contractual Equipment and Supplies purchased with Section 319H funds) (\$705)**
 - **Supplies:**
 - **Education, Training or Outreach (\$575)**
 - Kentucky Waterways Alliance
 - Every Drop Event - \$300 for plantings
 - Creek Cleanups - \$150 for shovels, wheelbarrow, supplies
 - Storm Drain Marking - \$125 for approx. 36 marking kits @ \$3.50 each
 - Truck Rental and Sod Cutter - \$130 for three (3) Every Drop events

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Operating Costs: – Not Applicable

Other: – Not Applicable

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27. Grant Application Conditions

Completion of this section is required in order to receive funding consideration.

- Applicant agrees that the proposed project will comply with all applicable state laws and rules ☒ Yes ☐ N/A
- Applicant agrees to obtain all applicable permits. ☒ Yes ☐ N/A
- Reporting will be conducted in accordance with the legal contract. ☒ Yes ☐ N/A
- All Project Partners have agreed to participate. ☒ Yes ☐ N/A

I have read and agree to comply with all applicable conditions as specified in the Application Instructions

- Watershed Plan Condition (See Section 27, Page 15) ☒ Yes ☐ N/A
- Required Training Condition (See Section 27, Page 15) ☒ Yes ☐ N/A
- Education Materials Condition (See Section 27, Page 15) ☒ Yes ☐ N/A
- Material Review Condition (See Section 27, Page 15) ☒ Yes ☐ N/A
- Quality Assurance Condition (See Section 27, Page 15) ☒ Yes ☐ N/A
- BMP Implementation Plan Condition (See Section 27, Page 16) ☒ Yes ☐ N/A
- Onsite Wastewater Condition (See Section 27, Page 16) ☒ Yes ☐ N/A
- AFO Condition (See Section 27, Page 16) ☒ Yes ☐ N/A
- Stream Restoration Condition (See Section 27, Page 17) ☒ Yes ☐ N/A
- GIS Condition (See Section 27, Page 17) ☒ Yes ☐ N/A
- Annual Report Condition (See Section 27, Page 18) ☒ Yes ☐ N/A
- Project Partners Condition (See Section 27, Page 18) ☒ Yes ☐ N/A

WARNING: Any application which is determined to be deficient, not eligible or missing KEY components will not be considered for funding.

28. Application Signature:

I certify that the information contained in this document is complete and accurate to the best of my knowledge and agree to comply with all conditions of funding.

	
Signature of Lead Agency's Authorized Representative	Date
David Johnson, Development & Stormwater Services Director	502.540.6392
Typed Name and Title	Telephone Number

APPENDIX 1.2 REVISED OUTREACH AND COMMUNICATION PLAN

Middle Fork Beargrass Creek Communication Plan

To communicate the purpose and progress of the 319 grant for Middle Fork Beargrass Creek to the watershed working group, stakeholders, and community. Ensure watershed stakeholder involvement in the project by creating opportunities for participation in education and outreach, as well as opportunities to provide input for solutions to address non-point source pollution and its sources within the watershed.

Target Audiences (Partners)

- Kentucky Division of Water
- Kentucky Waterways Alliance
- Beargrass Creek Alliance
- Louisville Department of Metro Parks and Recreation
- Olmsted Parks Conservancy
- Salt River Watershed Watch
- River City Paddle Sports
- United States Army Corps of Engineers
- United States Geological Survey (USGS)
- University of Louisville
- Engineering and Environmental Science Firms and Professionals
- Professional Organizations
- Environmental Activist Groups

Target Audiences (Stakeholders)

- Metro Council District Representatives and Staff
 - o District 8
 - o District 9
 - o District 11
 - o District 17
 - o District 18
 - o District 19
 - o District 26
- MS4 Co-permittees
 - o Anchorage
 - o Jeffersontown
 - o Middletown
 - o St Matthews
 - o Louisville MSD
- Schools

- o Jefferson County Public Schools (JCPS)
 - o Private
- Country Clubs and Golf Courses
 - o Hurstbourne Country Club
 - o Big Spring Country Club
 - o Oxmoor Country Club
 - o Cherokee Golf Course
 - o Seneca Golf Course
- Malls
 - o Oxmoor Mall
 - o Mall St Matthews

Events

Watershed community engagement and participation is recognized as a vital part of addressing non-point source pollution within urban watersheds. In the original schedule for the Middle Fork Beargrass Creek 319 grant, partners committed to hosting outreach opportunities in support of the watershed planning efforts through engagement and outreach activities.

A year into the project in March 2020, the governor of the Commonwealth of Kentucky issued a stay-at-home order for all non-essential employees due to the health risks associated with the spread of COVID-19. The stay-at-home order affected MSD's internal operations and put a hindrance on MSD's ability to reach out to other organizations and consultants to continue to facilitate the community education and outreach activities. Project partners also had to adjust their mission and day-to-day activities in order to protect the health and safety of staff and the public. They adapted to virtual platforms when possible and encouraged participation through digital and virtual means. As a result, the original outreach schedule was modified to adjust to the new precautions in place while maintaining the original intent to create educational opportunities for the community.

Original Outreach Schedule

- Creek Cleanups (KWA, 2 events)
- Every Drop Events (KWA, 2 events)
- Storm Drain Marking Events (KWA, 2 events)
- Bicycle or Walking Tours for Watershed Residents (KWA, 2 events)
- Film Showings for "Beargrass: The Creek in Our Backyard" (KWA, 4 events)
- Monthly Updates to Beargrass Creek Alliance (KWA, 24 updates)
- Monthly Social Media Updates (KWA, 24 during project)
- Canoe Trips (River City Paddle Sports, 3 events)
- Invasive Species Removal Events (Metro Parks, 2 events)
- Annual Volunteer Events (Metro Parks, 2 events)

- Public Interpretive Programs (Metro Parks, 2 events)
- Beargrass Creek Greenway Maintenance (Metro Parks, 15 events)

Kentucky Waterways Alliance

In 2019, Kentucky Waterways Alliance (KWA) proposed to perform community outreach, engagement, and planning services for the Middle Fork Beargrass Creek 319 project. However, the original proposed outreach schedule was modified in the presence of the COVID-19 pandemic. While the planned events were modified, KWA and the Beargrass Creek Alliance (BCA) were able to contribute over 1,100 volunteer hours through creek cleanups and education/outreach events. The following activities were completed in support of the watershed plan by KWA and BCA.

- Beargrass Creek Alliance Monthly Watershed Meetings (virtual and in person when allowed)
- Cleanups
 - o Beargrass Creek Cleanup with Butchertown Neighborhood Association at Butchertown Greenway
 - o Beargrass Creek Cleanup Friends of Forecastle Foundation at Big Rock
 - o Beargrass Creek Cleanup with Lackadazee at Butchertown Greenway
 - o Beargrass Creek Cleanup with BCA and Olmsted Parks
 - o Beargrass Creek Cleanup with MSD, Metro Parks, City of St. Matthews
 - o Middle Fork of Beargrass Creek Cleanup with MSD
 - o Beargrass Creek Cleanup with BCA in Cherokee Park
 - o Beargrass Creek Cleanup with West Sixth, Hilltop Tavern, and Against the Grain in Cherokee Park
- Outreach/Environmental Education
 - o Pollinator Garden Planting with BCA
 - o Ramsey Middle School Field Day in Brown Park
 - o BCA Table at Louisville Sustainability Council
 - o Earth Day at Home
- Social Media Campaigns and Updates

Louisville Metro Parks and Recreation

In the original proposal, Louisville Metro Parks and Recreation committed to invasive species removal events, volunteer events, public programs, and Greenway maintenance. Due to COVID-19, the volunteer events and public programs were hard to put on and many of their contributed hours were for invasive species removal and maintenance. Hours spent at

Butchertown Greenway were for path clearing of overgrowth and litter cleanup, hours spent at Beargrass Greenway were for cleanups of litter, and hours spent at Forest Green Greenway were for litter cleanup, fixing eroded sections of path, invasive species control, and preparation for planting a pollinator meadow. The hours for the three Greenways are included below.

- Butchertown Greenway (8 dates)
- Beargrass Creek Greenway (15 dates)

- Forest Green Greenway (31 dates)

River City Paddle Sports

River City Paddle Sports committed to hosting three canoe trips on Beargrass Creek in the original proposal. Unfortunately, due to COVID-19, none of these trips were able to occur and no other events took their place.

Revised Outreach Schedule

- Creek Cleanups
 - o KWA, 6 events
 - o Metro Parks, 3 events
 - o MSD, KWA, and Metro Parks, 2 events
 - o Stantec, 1 event
- Monthly Updates to Beargrass Creek Alliance (KWA, 12 events)
- Monthly Social Media Updates (KWA, 11 events)
- Beargrass Creek Greenway Maintenance (Metro Parks, 12 events)
- Butchertown Greenway Maintenance (Metro Parks, 8 events)
- Forest Green Greenway Maintenance (Metro Parks, 31 events)
- Community Survey (MSD, 1 event)
- Pollinator Garden Planting (KWA and BCA, 1 event)
- Public Outreach (KWA, 3 events)
- Stakeholder Meetings (MSD, 3 events)
- Partners Meetings (MSD, 11 events)
- Salt River Watershed Watch Annual Meeting (SRWW, 1 event)

Community Survey

With the challenges COVID created for hosting outreach activities, the ability to obtain community input and engagement was limited. In the fall of 2020, an online community survey was distributed to the stakeholder group via email and social media to gather information specific to the Middle Fork Beargrass Creek Watershed community. The survey included questions that asked if the community knows where the streams are in their neighborhood, what parks they visit in the watershed, what activities they like to do in the watershed, and what kind of education and outreach opportunities they would be interested in. Responses were downloaded in February 2021.

Trash Cleanups

MSD partnered with Louisville Metro Parks and Recreation, Kentucky Waterways Alliance, and Olmsted Parks to put on two trash collection events. The first event took place on November 7, 2020 at five locations in the watershed: Cherokee Park at Lexington Road, Cherokee Park near Big Rock, Arthur K. Draut Park, A.B. Sawyer Park, and Forest Green Trail. There were a total of 58 volunteers who collected 62 bags of trash along with a shopping cart and plastic playhouse. There was a media presence at this event and the MSD project manager communicated the importance of picking up trash to prevent harm to the creek ecosystem.

The second trash cleanup event took place on May 8, 2021 at two locations: Cherokee Park near Big Rock and Arthur K. Draut Park. There were 23 volunteers at this event who collected a total of 10 bags of trash. These cleanup events served as a good reminder that a major contributor to water quality throughout the Middle Fork Beargrass Creek watershed is linked right back to litter and trash. These trash pickup days are a way to involve the community in protecting the health of the watershed and connect them to the streams. Each of these events followed COVID safety guidelines provided by Louisville Metro Parks to ensure the safety of volunteers.

Kentucky Waterways Alliance and Beargrass Creek Alliance also hosted and participated in trash cleanup events, contributing 700 volunteer hours for eight creek cleanups in Beargrass Creek.

Best Management Practices (BMP) Web Application

The BMP Web Application was created as an innovative way to allow stakeholders to review and provide input on the BMP plan for MFBGC Watershed Plan. At a stakeholder meeting held on June 3, 2021, the application was introduced to the group. In this app, stakeholders were asked to vote on potential BMP sites and partnerships as well as potential watershed-wide BMPs. They also were asked to submit their own suggested BMPs for specific locations. This application was available to the partners and stakeholders for a week and a half. The results of this application were downloaded in June 2021 and will be considered when prioritizing BMPs for the next phase of the watershed plan.

Communications Strategy

Communications Goals

1. **Educate the community** on how a 319(h) grant functions and where funding for projects comes from.
2. **Ensure that project partners** have planned activities to contribute their resources and expertise.
3. **Engage new partners** in the watershed planning effort who can contribute unique expertise and potentially increase the ability to implement projects.
4. **Create greater opportunity** for community members to become involved in watershed improvement efforts and solutions specifically through education and outreach activities.
5. **Educate the community** on non-point source pollution in the watershed so that they are aware of the challenges present in the watershed and how they could be contributing to them.
6. **Continue to engage the watershed community** in the watershed planning effort so that after the grant project is finished, they will want to continue bettering the watershed. While there may not be any more funding from the grant, a plan for best management practices to target problems in the watershed will exist if and when funding becomes available. Community support for these projects is critical for their success.

Key Messages

Key Message and Purpose	Delivery Method	Desired Result
In partnership with watershed groups, MSD hosts creek cleanups at parks throughout the watershed.	Website; Flyer	Community learns the importance of picking up trash and keeping it out of the creek.
To learn about the watershed community's prior knowledge when it comes to water quality and watershed health.	Email; Survey	Determine what educational opportunities to provide to the community.
To learn what locations in the watershed and activities are most important to the community and where they want to see improvements.	Email; Survey	Plan where projects will be most successful and accepted.
To learn what education and outreach opportunities the community is interested in participating in.	Email; Survey	Determine what education and outreach opportunities to plan and put on for the community.
To include stakeholder group in the BMP planning process and learn what options are favored by the community.	Email; Web Application	Prioritize potential BMP projects in the watershed.
Update stakeholders on the progress of the Middle Fork Beargrass Creek grant at events/meetings hosted by MSD, Salt River Watershed Watch, Beargrass Creek Alliance, and MS4 Co-permittees.	Presentation	Keep the watershed community and stakeholders up to date with the progress of the grant.

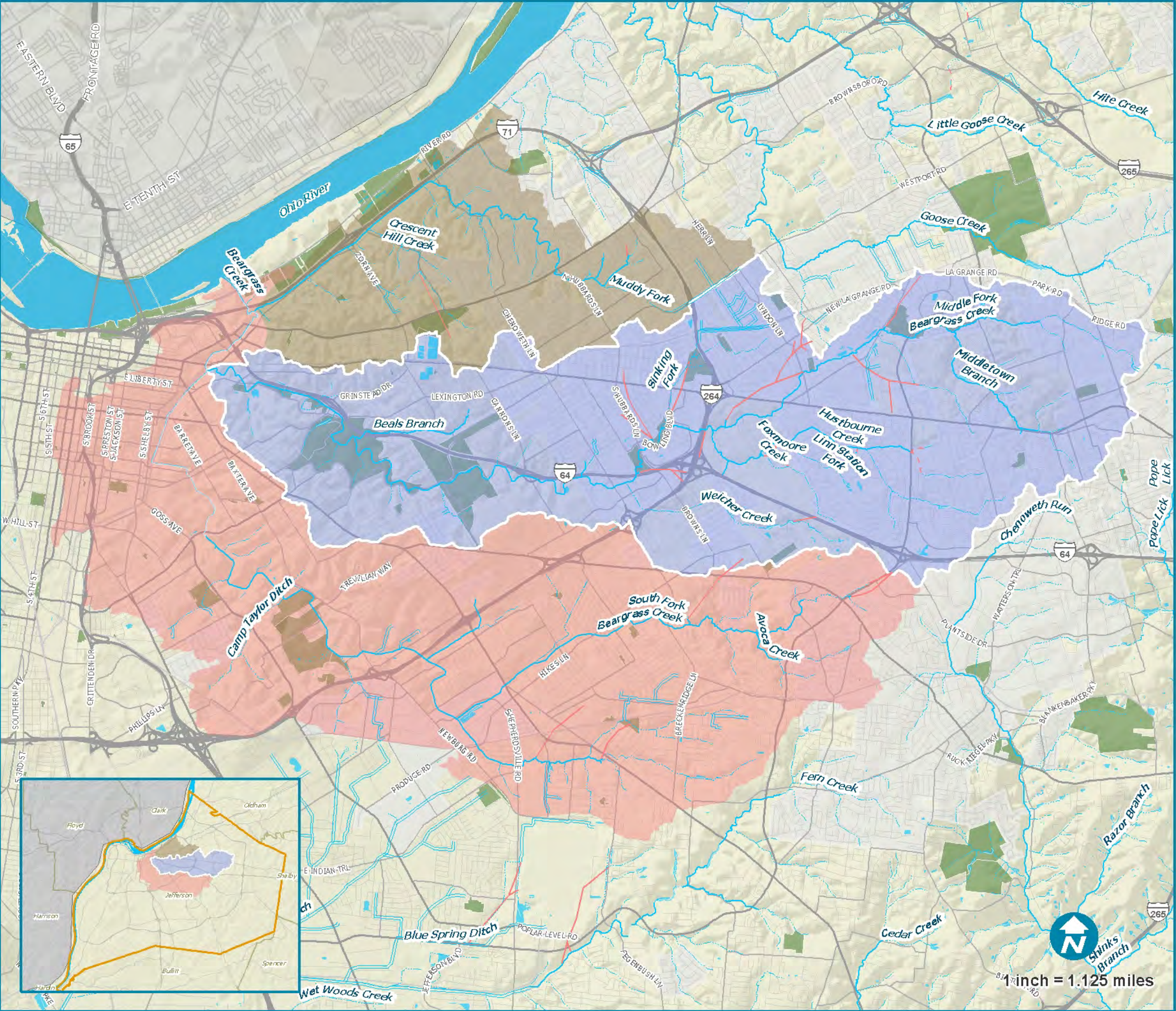
APPENDIX 1.3 CHAPTER 1 MAPS

The Three Forks of Beargrass Creek & Corresponding Watersheds

Middle Fork Beargrass Creek
319(h) Grant

Map Key

- Middle Fork BGC
- Muddy Fork BGC
- South Fork BGC
- State & Local Parks
- Bodies of Water
- Wet Areas
- Stream/River, Perennial
- Stream/River, Intermittent
- Canal/Ditch
- Canal/Ditch
- Underground Conduit
- Underground Conduit
- Pipeline
- Artificial Path
- Connector



Salt River Watershed

Middle Fork Beargrass Creek
319(h) Grant

Map Key

-  Middle Fork Beargrass Creek
-  Muddy Fork Beargrass Creek
-  South Fork Beargrass Creek
-  Salt River Watershed
-  Jefferson County Boundary

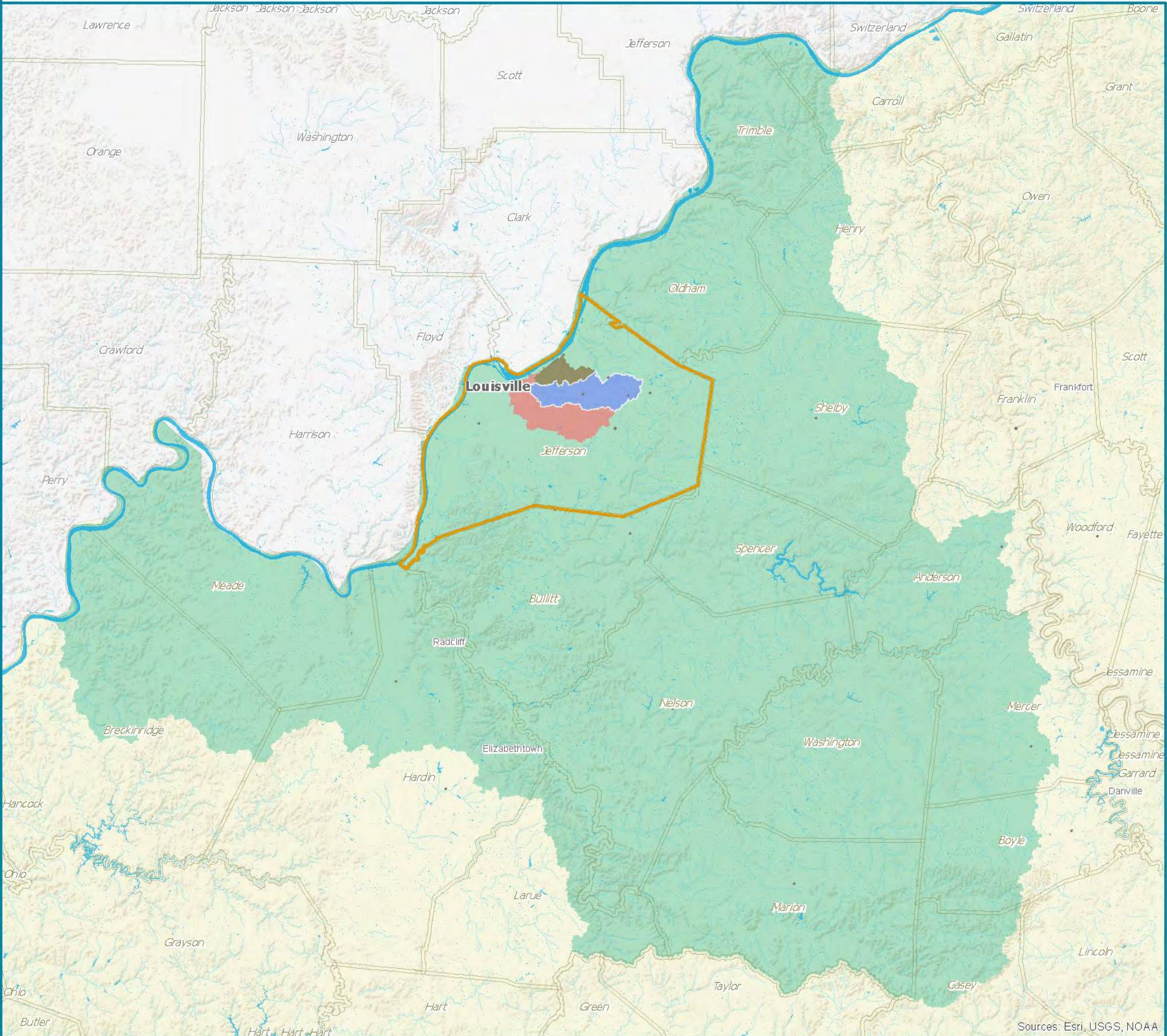


1 inch = 15 Miles



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Sources: Esri, USGS, NOAA

APPENDIX 2.1 SALT RIVER WATERSHED WATCH MIDDLE FORK BEARGRASS CREEK DATA

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Latitude NAD83	Longitude NAD83	COC ID	Sample Date	Sample Time	Flow Rate (0-5 Scale)	Rainfall (inches)
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	5/11/2019	38.26297	-85.56329	13940	5/11/2019	7:20:00	3	0
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	7/13/2019	38.26297	-85.56329	14752	7/13/2019	9:30:00	3	0
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	9/26/2020	38.26297	-85.56329	16596	9/26/2020	9:05:00	3	0
3386	Middle Fork Beargr	Arthur Draut Park	5/16/2015	38.24378	-85.63026	4607	5/16/2015	6:40:00	2	0
3386	Middle Fork Beargr	Arthur Draut Park	7/11/2015	38.24378	-85.63026	4976	7/11/2015	7:00:00	3	0.5
3386	Middle Fork Beargr	Arthur Draut Park	5/14/2016	38.24378	-85.63026	6415	5/14/2016	6:45:00	3	0.1
3386	Middle Fork Beargr	Arthur Draut Park	7/9/2016	38.24378	-85.63026	6986	7/9/2016	6:30:00	3	0.1
3386	Middle Fork Beargr	Arthur Draut Park	6/29/2017	38.24378	-85.63026	8440	6/29/2017	8:00:00	2	0.1
3386	Middle Fork Beargr	Arthur Draut Park	9/9/2017	38.24378	-85.63026	9998	9/9/2017	7:00:00	2	0.1
3386	Middle Fork Beargr	Arthur Draut Park	5/12/2018	38.24378	-85.63026	11307	5/12/2018	6:30:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/12/2014	38.238	-85.634	3944	7/12/2014	8:15:00	3	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	38.238	-85.634	3474	9/13/2014	9:55:00		0.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/11/2015	38.238	-85.634	4963	7/11/2015	10:45:00	4	1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	38.238	-85.634	5433	9/12/2015		3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/9/2016	38.238	-85.634	6993	7/9/2016	10:00:00	3	0.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	38.238	-85.634	7367	9/10/2016	8:30:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	38.238	-85.634	7367	9/10/2016	8:30:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	38.238	-85.634	7367	9/10/2016	8:30:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	38.238	-85.634	7367	9/10/2016	8:30:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/8/2017	38.238	-85.634	9540	7/8/2017	9:00:00	4	1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/8/2017	38.238	-85.634	9569	9/8/2017	13:05:00	3	0

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Latitude NAD83	Longitude NAD83	COC ID	Sample Date	Sample Time	Flow Rate (0-5 Scale)	Rainfall (inches)
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/12/2018	38.238	-85.634	11087	5/12/2018	12:00:00	3	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	6/18/2018	38.238	-85.634	8677	6/18/2018	10:50:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2018	38.238	-85.634	11043	7/13/2018	12:00:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/14/2018	38.238	-85.634	11060	9/14/2018	9:55:00	3	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/9/2019	38.238	-85.634	13852	5/9/2019	10:00:00	3	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2019	38.238	-85.634	14770	7/13/2019	8:40:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2019	38.238	-85.634	15168	9/13/2019	10:09:00	2	0
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/25/2020	38.238	-85.634	16606	9/25/2020	10:45:00	2	0
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	38.2383	-85.6638	3259	6/7/2014	8:30:00	2	
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	38.2383	-85.6638	2603	6/7/2014		3	
1784	Middle Fork Beargr	Old Cannons Lane.	5/16/2015	38.2383	-85.6638	4628	5/16/2015	8:28:00	3	0.1
1784	Middle Fork Beargr	Old Cannons Lane.	9/15/2018	38.2383	-85.6638	12875	9/15/2018	8:15:00	3	0
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/16/2015	38.228	-85.674	4611	5/16/2015	6:56:00	2	0.1
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	38.228	-85.674	5654	9/12/2015	8:30:00	3	0.5
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/14/2016	38.228	-85.674	6762	5/14/2016	8:00:00	4	0.5
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	6/20/2017	38.23427	-85.67595	9093	6/20/2017	12:00:00	3	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/8/2017	38.23427	-85.67595	9281	7/8/2017	9:45:00	3	1.99
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/9/2017	38.23427	-85.67595	9941	9/9/2017	11:05:00	3	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2018	38.23427	-85.67595	11082	5/11/2018	11:00:00	3	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2018	38.23427	-85.67595	11038	7/13/2018	10:00:00	3	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/15/2018	38.23427	-85.67595	11055	9/15/2018	9:30:00	4	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2019	38.23427	-85.67595	13676	5/11/2019	10:10:00	4	0.1
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2019	38.23427	-85.67595	14387	7/13/2019	9:40:00	3	0
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/14/2019	38.23427	-85.67595	15103	9/14/2019	8:30:00	2	0
2030	Beargrass Creek	Big Rock	5/19/2012	38.21694	-85.68333	4019	5/19/2012	8:14:00	3	0.1
2030	Beargrass Creek	Big Rock	7/14/2012	38.21694	-85.68333	4062	7/14/2012	7:45:00	2	0
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Latitude NAD83	Longitude NAD83	COC ID	Sample Date	Sample Time	Flow Rate (0-5 Scale)	Rainfall (inches)
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	9/8/2012	38.21694	-85.68333	3974	9/8/2012	8:38:00	4	1.99
2030	Beargrass Creek	Big Rock	5/18/2013	38.21694	-85.68333	1811	5/18/2013	8:05:00	3	0.5
2030	Beargrass Creek	Big Rock	7/13/2013	38.21694	-85.68333	1848	7/13/2013	9:02:00	3	0
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	9/14/2013	38.21694	-85.68333	966	9/14/2013		2	0.1
2030	Beargrass Creek	Big Rock	6/7/2014	38.21694	-85.68333	2677	6/7/2014	8:00:00	3	0
2030	Beargrass Creek	Big Rock	7/15/2014	38.21694	-85.68333	3277	7/15/2014	9:00:00	4	0.1
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	9/13/2014	38.21694	-85.68333	3660	9/13/2014	9:00:00	4	0
2030	Beargrass Creek	Big Rock	5/16/2015	38.21694	-85.68333	4584	5/16/2015	8:30:00	2	0
2030	Beargrass Creek	Big Rock	7/11/2015	38.21694	-85.68333	5064	7/11/2015	9:30:00	4	1
2030	Beargrass Creek	Big Rock	9/12/2015	38.21694	-85.68333	5645	9/12/2015	9:15:00	2	0.1
2030	Beargrass Creek	Big Rock	9/12/2015	38.21694	-85.68333	5645	9/12/2015	9:15:00	2	0.1
2030	Beargrass Creek	Big Rock	9/12/2015	38.21694	-85.68333	5645	9/12/2015	9:15:00	2	0.1
2030	Beargrass Creek	Big Rock	9/12/2015	38.21694	-85.68333	5645	9/12/2015	9:15:00	2	0.1
2030	Beargrass Creek	Big Rock	9/12/2015	38.21694	-85.68333	5645	9/12/2015	9:15:00	2	0.1
2030	Beargrass Creek	Big Rock	5/14/2016	38.21694	-85.68333	5976	5/14/2016	8:30:00	3	0.5
2030	Beargrass Creek	Big Rock	7/9/2016	38.21694	-85.68333	7156	7/9/2016	9:30:00	3	0.5

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Latitude NAD83	Longitude NAD83	COC ID	Sample Date	Sample Time	Flow Rate (0-5 Scale)	Rainfall (inches)
2030	Beargrass Creek	Big Rock	9/10/2016	38.21694	-85.68333	7630	9/10/2016	9:20:00	2	0
2030	Beargrass Creek	Big Rock	9/10/2016	38.21694	-85.68333	7630	9/10/2016	9:20:00	2	0
2030	Beargrass Creek	Big Rock	9/10/2016	38.21694	-85.68333	7630	9/10/2016	9:20:00	2	0
2030	Beargrass Creek	Big Rock	9/10/2016	38.21694	-85.68333	7630	9/10/2016	9:20:00	2	0
2030	Beargrass Creek	Big Rock	7/8/2017	38.21694	-85.68333	9372	7/8/2017	10:15:00	3	1.5
2030	Beargrass Creek	Big Rock	5/12/2018	38.21694	-85.68333	11310	5/12/2018	9:44:00	2	0
2030	Beargrass Creek	Big Rock	7/13/2018	38.21694	-85.68333	11393	7/13/2018	9:33:00	2	0
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	6/7/2014	38.23375	-85.6846	2659	6/7/2014		3	0
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	5/11/2019	38.23375	-85.6846	13842	5/11/2019	8:29:00	3	0
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2013	38.24395	-85.69812	1824	7/13/2013	10:00:00	3	0.5
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/12/2018	38.24395	-85.69812	11510	5/12/2018	9:49:00	3	0
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2018	38.24395	-85.69812	12381	7/13/2018	7:00:00	2	0
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/11/2019	38.24395	-85.69812	13846	5/11/2019	10:49:00	2	0
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2019	38.24395	-85.69812	14406	7/13/2019	11:47:00	2	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/16/2015	38.24669	-85.70149	4635	5/16/2015	9:39:00	3	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/11/2015	38.24669	-85.70149	4947	7/11/2015	10:45:00	4	1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	38.24669	-85.70149	5646	9/12/2015		2	0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	38.24669	-85.70149	5646	9/12/2015		2	0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	38.24669	-85.70149	5646	9/12/2015		2	0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	38.24669	-85.70149	5646	9/12/2015		2	0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	38.24669	-85.70149	5646	9/12/2015		2	0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/14/2016	38.24669	-85.70149	5977	5/14/2016	9:00:00	3	0.5
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/9/2016	38.24669	-85.70149	6023	7/9/2016	9:10:00	3	0.5
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	38.24669	-85.70149	6024	9/10/2016	10:15:00	2	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	38.24669	-85.70149	6024	9/10/2016	10:15:00	2	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	38.24669	-85.70149	6024	9/10/2016	10:15:00	2	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	38.24669	-85.70149	6024	9/10/2016	10:15:00	2	0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/8/2017	38.24669	-85.70149	9373	7/8/2017	11:14:00	3	1.5
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	38.25126	-85.71973	3881	9/13/2014	10:55:00	3	0.1

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Latitude NAD83	Longitude NAD83	COC ID	Sample Date	Sample Time	Flow Rate (0-5 Scale)	Rainfall (inches)
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	38.25126	-85.71973	5434	9/12/2015	9:30:00	3	0.1
2068	Middle Fork Beargr	Bridge at Payne Street	5/13/2017	38.25126	-85.71973	8676	5/13/2017	12:00:00	3	1

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Turbidity (0-3 Scale)	Dissolved Oxygen (mg/L)	pH (Std. Units)	Water Temp (Deg. C)	Conductivity (uS/cm)	Conductivity Meter Calibration Date
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	5/11/2019	0	7.6	8	12	630	5/10/2019
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	7/13/2019	0	6.2	8	18	660	7/13/2019
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	9/26/2020	0	5.2	7.5	16	590	9/25/2020
3386	Middle Fork Beargr	Arthur Draut Park	5/16/2015	1	4	7.5	13	630	5/16/2015
3386	Middle Fork Beargr	Arthur Draut Park	7/11/2015	1	7.3	7	13	620	7/11/2015
3386	Middle Fork Beargr	Arthur Draut Park	5/14/2016	1	7.5	7	10	740	
3386	Middle Fork Beargr	Arthur Draut Park	7/9/2016	1	7.5	7.5	12	740	7/9/2016
3386	Middle Fork Beargr	Arthur Draut Park	6/29/2017	1	7.5	7.5	14	520	
3386	Middle Fork Beargr	Arthur Draut Park	9/9/2017	1	4.4	7.5	14	620	9/9/2017
3386	Middle Fork Beargr	Arthur Draut Park	5/12/2018	1	7	7	10	670	5/12/2018
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/12/2014	0	5.7	8.6	20	750	7/12/2014
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	1	7	7.6	16	730	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/11/2015	2	6.3	8.7	21	560	7/10/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	1	6.4	8.2	19	690	9/12/2015
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/9/2016	1	6	7.35	20	470	7/9/2016
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	0	6	5.25	22.5	470	9/9/2016
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	0	6	5.25	22.5	470	9/9/2016
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	0	6	5.25	22.5	470	9/9/2016
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	0	6	5.25	22.5	470	9/9/2016
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/8/2017	2	8.2	7.2	21	270	7/7/2017
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/8/2017	1	10	7.8	20	440	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Turbidity (0-3 Scale)	Dissolved Oxygen (mg/L)	pH (Std. Units)	Water Temp (Deg. C)	Conductivity (uS/cm)	Conductivity Meter Calibration Date
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/12/2018	3	2	6.5	20	560	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	6/18/2018	1	6	8	22.5	590	0618/2018
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2018	1	2.6	8.5	23	440	7/12/2018
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/14/2018	1	4	7.8	20	630	9/14/2018
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/9/2019	1	5		17.9	53	5/9/2019
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2019	0	10	8.2	22		
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2019	0	6	7.6	23	630	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/25/2020	1		7	19	570	
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	1	5.5	7.6	23	780	7/12/2014
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	1	7	7.75	20	640	6/6/2014
1784	Middle Fork Beargr	Old Cannons Lane.	5/16/2015	0	4		20		
1784	Middle Fork Beargr	Old Cannons Lane.	9/15/2018	1	8	8	21	74	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/16/2015	1	3	7.5	21	720	5/15/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	0	5.5	7.5	21	580	9/11/2015
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/14/2016	1	9	7.5	7	690	5/14/2016
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	6/20/2017	1	8	8	26	550	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/8/2017	2			24	480	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/9/2017	0	6	8.3	22	660	9/8/2017
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2018	0	10	7.5	24	480	5/10/2018
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2018	0	6	7.5	25	580	7/12/2018
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/15/2018	0	9	8	23	740	9/14/2018
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2019	0	9	8	15	640	5/10/2019
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2019	0	8	7.5	25	590	7/12/2019
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/14/2019	0	7.1	7.5	24	580	9/14/2019
2030	Beargrass Creek	Big Rock	5/19/2012	0	7.6	7.5	16	710	
2030	Beargrass Creek	Big Rock	7/14/2012	0	3.8	7.5	22	690	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Turbidity (0-3 Scale)	Dissolved Oxygen (mg/L)	pH (Std. Units)	Water Temp (Deg. C)	Conductivity (uS/cm)	Conductivity Meter Calibration Date
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	9/8/2012	3	6.6	7	19	230	
2030	Beargrass Creek	Big Rock	5/18/2013	0	7	7.5	14	610	
2030	Beargrass Creek	Big Rock	7/13/2013	1	8.2	7.5	15	520	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	9/14/2013	0	6.4	7	12	630	
2030	Beargrass Creek	Big Rock	6/7/2014	1	6.9	7	20	770	6/7/2014
2030	Beargrass Creek	Big Rock	7/15/2014	2	6.2	8	22	480	
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	9/13/2014	2	8.2	8	18	700	9/12/2014
2030	Beargrass Creek	Big Rock	5/16/2015	1	3.7	8	22	670	
2030	Beargrass Creek	Big Rock	7/11/2015	1	7.6	8	22	480	7/11/2015
2030	Beargrass Creek	Big Rock	9/12/2015	0	8.2	7.5	19	680	9/12/2015
2030	Beargrass Creek	Big Rock	9/12/2015	0	8.2	7.5	19	680	9/12/2015
2030	Beargrass Creek	Big Rock	9/12/2015	0	8.2	7.5	19	680	9/12/2015
2030	Beargrass Creek	Big Rock	9/12/2015	0	8.2	7.5	19	680	9/12/2015
2030	Beargrass Creek	Big Rock	9/12/2015	0	8.2	7.5	19	680	9/12/2015
2030	Beargrass Creek	Big Rock	5/14/2016	0	8	7.5	16	650	5/14/2016
2030	Beargrass Creek	Big Rock	7/9/2016	0	8.5	8.5	24	660	7/8/2016

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Turbidity (0-3 Scale)	Dissolved Oxygen (mg/L)	pH (Std. Units)	Water Temp (Deg. C)	Conductivity (uS/cm)	Conductivity Meter Calibration Date
2030	Beargrass Creek	Big Rock	9/10/2016	0	6.1	8	25	780	9/10/2016
2030	Beargrass Creek	Big Rock	9/10/2016	0	6.1	8	25	780	9/10/2016
2030	Beargrass Creek	Big Rock	9/10/2016	0	6.1	8	25	780	9/10/2016
2030	Beargrass Creek	Big Rock	9/10/2016	0	6.1	8	25	780	9/10/2016
2030	Beargrass Creek	Big Rock	7/8/2017	0	6.9	8	22	430	7/8/2017
2030	Beargrass Creek	Big Rock	5/12/2018	0	6.2	8		700	5/12/2018
2030	Beargrass Creek	Big Rock	7/13/2018	0	7.2	7.5		580	7/13/2018
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	6/7/2014	0	4	8	19	730	
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	5/11/2019	0	7.6	8	14		
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2013	1	6	8	20	720	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/12/2018	1	4	7.7	21.5	560	5/12/2018
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2018	0	4.65	8	23.5	620	7/12/2018
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/11/2019	1	8.6	6.5	15	610	5/11/2019
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2019	1	6.2	8		590	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/16/2015	1		7.5	20	660	5/16/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/11/2015	3	7.6	7.5	20	470	7/11/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	0	3	7.25	20	570	9/12/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	0	3	7.25	20	570	9/12/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	0	3	7.25	20	570	9/12/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	0	3	7.25	20	570	9/12/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	0	3	7.25	20	570	9/12/2015
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/14/2016	1	7.8	7.5	16	630	5/14/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/9/2016	2	6.2	7.8	22	680	7/9/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	0	3.8	7.6	24.5	670	9/10/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	0	3.8	7.6	24.5	670	9/10/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	0	3.8	7.6	24.5	670	9/10/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	0	3.8	7.6	24.5	670	9/10/2016
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/8/2017	2	5.4	8	22	390	7/8/2017
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	2	6.4	8.4	17.9	690	9/12/2014

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Turbidity (0-3 Scale)	Dissolved Oxygen (mg/L)	pH (Std. Units)	Water Temp (Deg. C)	Conductivity (uS/cm)	Conductivity Meter Calibration Date
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	1	4.2	7.7	20	520	9/12/2015
2068	Middle Fork Beargr	Bridge at Payne Street	5/13/2017	1	8.2	7.8	17		

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Analyte Name	Analysis Date	Analysis Time	Result Modifier	Result Value
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	5/11/2019	E. coli	5/11/2019	14:20:00		398.6
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	7/13/2019	E. coli	7/13/2019	13:09:00		457
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	9/26/2020	E. coli	9/26/2020	13:45:00		340
3386	Middle Fork Beargr	Arthur Draut Park	5/16/2015	E. coli	5/16/2015	9:00:00		426
3386	Middle Fork Beargr	Arthur Draut Park	7/11/2015	E. coli	7/11/2015	9:15:00		880
3386	Middle Fork Beargr	Arthur Draut Park	5/14/2016	E. coli	5/14/2016	12:00:00		426
3386	Middle Fork Beargr	Arthur Draut Park	7/9/2016	E. coli	7/9/2016	9:30:00		486
3386	Middle Fork Beargr	Arthur Draut Park	6/29/2017					
3386	Middle Fork Beargr	Arthur Draut Park	9/9/2017	E. coli	9/9/2017	14:27:00		275
3386	Middle Fork Beargr	Arthur Draut Park	5/12/2018	E. coli	5/12/2018	14:26:00		307.6
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/12/2014	E. coli	7/12/2014	10:00:00		1024
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Ammonia (as N)	9/13/2014	12:00:00		0.022
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Chloride	9/13/2014	12:00:00		80.14
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Conductivity	9/13/2014	12:00:00		727
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Nitrate & Nitrite (as N)	9/13/2014	12:00:00		1.521
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Nitrogen, Total	9/13/2014	12:00:00		2.566
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Phosphorus, Total	9/13/2014	12:00:00		0.144
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Solids, Total Suspended	9/13/2014	12:00:00		6.1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Sulfate	9/13/2014	12:00:00		40.09
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	Total Hardness	9/13/2014	12:00:00		278
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/11/2015	E. coli	7/11/2015	11:20:00		1000
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Ammonia (as N)	9/12/2015	16:00:00	<	0.05
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Chloride	9/12/2015	16:00:00		69
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Nitrate & Nitrite	9/12/2015	16:00:00		1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Phosphorus, Total	9/12/2015	16:00:00	<	0.125
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Solids, Total Suspended	9/12/2015	16:00:00		15
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Sulfate	9/12/2015	16:00:00		45
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Total Hardness	9/12/2015	16:00:00		250
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Total Kjeldhal Nitrogen	9/12/2015	16:00:00	<	1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	Turbidity	9/12/2015	16:00:00		1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/9/2016	E. coli	7/9/2016	10:45:00		398
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	Ammonia (as N)	9/10/2016	13:00:00	<	0.05
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	Nitrate & Nitrite	9/10/2016	13:00:00	<	1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	Phosphorus, Total	9/10/2016	13:00:00	<	0.125
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	Total Kjeldhal Nitrogen	9/10/2016	13:00:00	<	1
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/8/2017	E. coli	7/8/2017	14:00:00		1291
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/8/2017	E. coli	9/8/2017	16:20:00		209.8

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Analyte Name	Analysis Date	Analysis Time	Result Modifier	Result Value
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/12/2018	E. coli	5/12/2018	15:06:00		249.5
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	6/18/2018					
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2018	E. coli	7/13/2018	17:17:00		1395.8
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/14/2018	E. coli	9/14/2018	15:53:00		495.9
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/9/2019	E. coli	5/9/2019	16:47:00		738
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2019	E. coli	7/13/2019	12:41:00		683
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2019	E. coli	9/13/2019	15:30:00		663
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/25/2020					
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	E. coli	7/12/2014	10:00:00		194
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	E. coli	6/7/2014	9:35:00		370
1784	Middle Fork Beargr	Old Cannons Lane.	5/16/2015	E. coli	5/16/2015	9:20:00		194
1784	Middle Fork Beargr	Old Cannons Lane.	9/15/2018	E. coli	9/15/2018	14:36:00		1049.7
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/16/2015	E. coli	5/16/2015	9:00:00		216
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Ammonia (as N)	9/12/2015	16:00:00	<	0.05
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Chloride	9/12/2015	16:00:00		68
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Nitrate & Nitrite	9/12/2015	16:00:00	<	1
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Phosphorus, Total	9/12/2015	16:00:00	<	0.125
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Solids, Total Suspended	9/12/2015	16:00:00	<	2
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Sulfate	9/12/2015	16:00:00		42
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Total Hardness	9/12/2015	16:00:00		215
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Total Kjeldhal Nitrogen	9/12/2015	16:00:00	<	1
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	Turbidity	9/12/2015	16:00:00		0
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/14/2016	E. coli	5/14/2016	12:00:00		196
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	6/20/2017					
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/8/2017	E. coli	7/8/2017	17:15:00		1529
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/9/2017	E. coli	9/9/2017	14:27:00		109
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2018	E. coli	5/11/2018	16:13:00		74.9
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2018	E. coli	7/13/2018	17:17:00		295.4
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/15/2018	E. coli	9/15/2018	15:40:00		882.3
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2019	E. coli	5/11/2019	14:20:00		201.1
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2019	E. coli	7/13/2019	13:09:00		161
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/14/2019	E. coli	9/14/2019	16:05:00		426
2030	Beargrass Creek	Big Rock	5/19/2012					
2030	Beargrass Creek	Big Rock	7/14/2012	E. coli	7/14/2012	11:30:00		280
2030	Beargrass Creek	Big Rock	9/8/2012	Ammonia (as N)	9/8/2012	13:00:00		0.269
2030	Beargrass Creek	Big Rock	9/8/2012	Chloride	9/8/2012	13:00:00		13.58
2030	Beargrass Creek	Big Rock	9/8/2012	Conductivity	9/8/2012	13:00:00		184

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Analyte Name	Analysis Date	Analysis Time	Result Modifier	Result Value
2030	Beargrass Creek	Big Rock	9/8/2012	Nitrate & Nitrite (as N)	9/8/2012	13:00:00		0.993
2030	Beargrass Creek	Big Rock	9/8/2012	Nitrogen, Total	9/8/2012	13:00:00		1.646
2030	Beargrass Creek	Big Rock	9/8/2012	Phosphorus, Total	9/8/2012	13:00:00		0.111
2030	Beargrass Creek	Big Rock	9/8/2012	Solids, Total Suspended	9/8/2012	13:00:00		41.8
2030	Beargrass Creek	Big Rock	9/8/2012	Sulfate	9/8/2012	13:00:00		5.3
2030	Beargrass Creek	Big Rock	9/8/2012	Total Hardness	9/8/2012	13:00:00		138
2030	Beargrass Creek	Big Rock	5/18/2013	E. coli	5/18/2013	10:00:00		342
2030	Beargrass Creek	Big Rock	7/13/2013	E. coli	7/13/2013	12:00:00		466
2030	Beargrass Creek	Big Rock	9/14/2013	Ammonia (as N)	9/14/2013	13:00:00		0.155
2030	Beargrass Creek	Big Rock	9/14/2013	Chloride	9/14/2013	13:00:00		71.3
2030	Beargrass Creek	Big Rock	9/14/2013	Conductivity	9/14/2013	13:00:00		621
2030	Beargrass Creek	Big Rock	9/14/2013	Nitrate & Nitrite (as N)	9/14/2013	13:00:00		0.344
2030	Beargrass Creek	Big Rock	9/14/2013	Nitrogen, Total	9/14/2013	13:00:00		0.874
2030	Beargrass Creek	Big Rock	9/14/2013	Phosphorus, Total	9/14/2013	13:00:00		0.089
2030	Beargrass Creek	Big Rock	9/14/2013	Solids, Total Suspended	9/14/2013	13:00:00		3.2
2030	Beargrass Creek	Big Rock	9/14/2013	Sulfate	9/14/2013	13:00:00		55.9
2030	Beargrass Creek	Big Rock	9/14/2013	Total Hardness	9/14/2013	13:00:00		228
2030	Beargrass Creek	Big Rock	6/7/2014	E. coli	6/7/2014	9:35:00		808
2030	Beargrass Creek	Big Rock	7/15/2014	E. coli	7/15/2014	10:50:00		824
2030	Beargrass Creek	Big Rock	9/13/2014	Ammonia (as N)	9/13/2014	12:00:00		0.114
2030	Beargrass Creek	Big Rock	9/13/2014	Chloride	9/13/2014	12:00:00		105.78
2030	Beargrass Creek	Big Rock	9/13/2014	Conductivity	9/13/2014	12:00:00		686
2030	Beargrass Creek	Big Rock	9/13/2014	Nitrate & Nitrite (as N)	9/13/2014	12:00:00		1.727
2030	Beargrass Creek	Big Rock	9/13/2014	Nitrogen, Total	9/13/2014	12:00:00		2.382
2030	Beargrass Creek	Big Rock	9/13/2014	Phosphorus, Total	9/13/2014	12:00:00		0.102
2030	Beargrass Creek	Big Rock	9/13/2014	Solids, Total Suspended	9/13/2014	12:00:00		2.4
2030	Beargrass Creek	Big Rock	9/13/2014	Sulfate	9/13/2014	12:00:00		36.91
2030	Beargrass Creek	Big Rock	9/13/2014	Total Hardness	9/13/2014	12:00:00		274
2030	Beargrass Creek	Big Rock	5/16/2015	E. coli	5/16/2015	11:10:00		564
2030	Beargrass Creek	Big Rock	7/11/2015	E. coli	7/11/2015	12:00:00		2020
2030	Beargrass Creek	Big Rock	9/12/2015	Ammonia (as N)	9/12/2015	16:00:00	<	0.05
2030	Beargrass Creek	Big Rock	9/12/2015	Nitrate & Nitrite	9/12/2015	16:00:00	<	1
2030	Beargrass Creek	Big Rock	9/12/2015	Phosphorus, Total	9/12/2015	16:00:00	<	0.125
2030	Beargrass Creek	Big Rock	9/12/2015	Total Kjeldhal Nitrogen	9/12/2015	16:00:00	<	1
2030	Beargrass Creek	Big Rock	9/12/2015	Turbidity	9/12/2015	16:00:00		0
2030	Beargrass Creek	Big Rock	5/14/2016	E. coli	5/14/2016	12:00:00		728
2030	Beargrass Creek	Big Rock	7/9/2016	E. coli	7/9/2016	10:40:00		320

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Analyte Name	Analysis Date	Analysis Time	Result Modifier	Result Value
2030	Beargrass Creek	Big Rock	9/10/2016	Ammonia (as N)	9/10/2016	13:00:00		0.06
2030	Beargrass Creek	Big Rock	9/10/2016	Nitrate & Nitrite	9/10/2016	13:00:00	<	1
2030	Beargrass Creek	Big Rock	9/10/2016	Phosphorus, Total	9/10/2016	13:00:00	<	0.125
2030	Beargrass Creek	Big Rock	9/10/2016	Total Kjeldhal Nitrogen	9/10/2016	13:00:00		2
2030	Beargrass Creek	Big Rock	7/8/2017	E. coli	7/8/2017	17:15:00		1081
2030	Beargrass Creek	Big Rock	5/12/2018	E. coli	5/12/2018	15:06:00		185
2030	Beargrass Creek	Big Rock	7/13/2018	E. coli	7/13/2018	17:17:00		1968.3
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	6/7/2014	E. coli	6/7/2014	9:35:00		320
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	5/11/2019	E. coli	5/11/2019	14:20:00		259
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2013	E. coli	7/13/2013	12:00:00		538
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/12/2018	E. coli	5/12/2018	15:06:00		191.8
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2018	E. coli	7/13/2018	14:40:00		7701
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/11/2019	E. coli	5/11/2019	14:20:00		253
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2019	E. coli	7/13/2019	13:09:00		495
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/16/2015	E. coli	5/16/2015	11:10:00		124
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/11/2015	E. coli	7/11/2015	12:00:00		2380
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	Ammonia (as N)	9/12/2015	16:00:00	<	0.05
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	Nitrate & Nitrite	9/12/2015	16:00:00	<	1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	Phosphorus, Total	9/12/2015	16:00:00	<	0.15
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	Total Kjeldhal Nitrogen	9/12/2015	16:00:00	<	1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	Turbidity	9/12/2015	16:00:00		0
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/14/2016	E. coli	5/14/2016	12:00:00		422
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/9/2016	E. coli	7/9/2016	10:40:00		1578
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	Ammonia (as N)	9/10/2016	13:00:00		0.1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	Nitrate & Nitrite	9/10/2016	13:00:00		1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	Phosphorus, Total	9/10/2016	13:00:00	<	0.125
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	Total Kjeldhal Nitrogen	9/10/2016	13:00:00	<	1
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/8/2017	E. coli	7/8/2017	17:15:00		1119
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Ammonia (as N)	9/13/2014	13:00:00		0.124
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Chloride	9/13/2014	13:00:00		106.57
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Conductivity	9/13/2014	13:00:00		662
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Nitrate & Nitrite (as N)	9/13/2014	13:00:00		1.664
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Nitrogen, Total	9/13/2014	13:00:00		2.597
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Phosphorus, Total	9/13/2014	13:00:00		0.121
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Solids, Total Suspended	9/13/2014	13:00:00		3.3
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Sulfate	9/13/2014	13:00:00		37.62
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	Total Hardness	9/13/2014	13:00:00		274

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Analyte Name	Analysis Date	Analysis Time	ResultModifier	Result Value
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Ammonia (as N)	9/12/2015	16:00:00		0.07
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Chloride	9/12/2015	16:00:00		50
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Nitrate & Nitrite	9/12/2015	16:00:00	<	1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Phosphorus, Total	9/12/2015	16:00:00		0.21
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Solids, Total Suspended	9/12/2015	16:00:00	<	2
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Sulfate	9/12/2015	16:00:00		31
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Total Hardness	9/12/2015	16:00:00		171
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Total Kjeldhal Nitrogen	9/12/2015	16:00:00	<	1
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	Turbidity	9/12/2015	16:00:00		1
2068	Middle Fork Beargr	Bridge at Payne Street	5/13/2017					

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Result Units	MDL	RL	Method	QAFlag
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	5/11/2019	MPN/100mL	10	10	SM9223B	
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	7/13/2019	MPN/100mL	0	10	SM9223B	
3841	Middle Fork Beargr	Middle Fork Beargrass Creek along Forest Green Trail, Louisville, .	9/26/2020	MPN/100ml	0	10	SM9223B	
3386	Middle Fork Beargr	Arthur Draut Park	5/16/2015	MPN/100mL	1	1	SM9223B	
3386	Middle Fork Beargr	Arthur Draut Park	7/11/2015	MPN/100mL	1	1	SM9223B	
3386	Middle Fork Beargr	Arthur Draut Park	5/14/2016	MPN/100mL	1	1	SM9223B	
3386	Middle Fork Beargr	Arthur Draut Park	7/9/2016	MPN/100mL	1	1	SM9223B	
3386	Middle Fork Beargr	Arthur Draut Park	6/29/2017					
3386	Middle Fork Beargr	Arthur Draut Park	9/9/2017	MPN/100mL	1		Colilert	
3386	Middle Fork Beargr	Arthur Draut Park	5/12/2018	MPN/100mL	1	1	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/12/2014	MPN/100mL	1	1	SM9223B (ColilertMPN)	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	0.02		SM4500NH3-G	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	1		SM4500CL-G	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	uS/cm	5		SM2510B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	0.01		SM4500NO3-F	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	0.1		SM4500N-C	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	0.01		SM4500P-F	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	1		SM2540D	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	1.5		SM4500SO4-F	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2014	mg/L	10		SM2340C	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/11/2015	MPN/100mL	1	1	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.00703	0.05	Hach 10205	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.05		SM4110B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.05		Hach 10206	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.00829	0.033	SM4500P-E	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	3		EPA 160.2	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.05		SM4110B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	10			
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	mg/L	0.288	1	Hach 10242	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/12/2015	NTU	0.08		SM2130B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/9/2016	MPN/100mL	1	1	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	mg/L	0.00703	0.05	Hach 10205	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	mg/L	0.2	1	Hach 10206	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	mg/L	0.02487	0.125	SM4500P-E	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/10/2016	mg/L	0.288	1	Hach 10242	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/8/2017	MPN/100mL	1		Colilert	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/8/2017	MPN/100mL	1		Colilert	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Result Units	MDL	RL	Method	QAFlag
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/12/2018	MPN/100mL	1	1	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	6/18/2018					
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2018	MPN/100mL	1	10	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/14/2018	MPN/100mL	1	10	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	5/9/2019	MPN/100mL	10	10	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	7/13/2019	MPN/100mL	0	10	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/13/2019	MPN/100ml	0	10	SM9223B	
1841	Middle Fork Beargr	J. Graham Brown Park, downstream from Browns Ln bridge.	9/25/2020					
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	MPN/100mL	1	1	SM9223B (ColilertMPN)	S
1784	Middle Fork Beargr	Old Cannons Lane.	6/7/2014	MPN/100mL	1	1	SM9223B	
1784	Middle Fork Beargr	Old Cannons Lane.	5/16/2015	MPN/100mL	1	1	SM9223B	
1784	Middle Fork Beargr	Old Cannons Lane.	9/15/2018	MPN/100mL	1	10	SM9223B	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/16/2015	MPN/100mL	1	1	SM9223B	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.00703	0.05	Hach 10205	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.05		SM4110B	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.05		Hach 10206	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.00829	0.033	SM4500P-E	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	3		EPA 160.2	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.05		SM4110B	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	10			
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	mg/L	0.288	1	Hach 10242	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	9/12/2015	NTU	0.08		SM2130B	
1899	Bowman Field Sprir	Intersection of Seneca Valley Rd and PeeWee Reese Ln	5/14/2016	MPN/100mL	1	1	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	6/20/2017					
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/8/2017	MPN/100mL	1		Colilert	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/9/2017	MPN/100mL	1		Colilert	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2018	MPN/100mL	1	1	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2018	MPN/100mL	1	10	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/15/2018	MPN/100mL	1	10	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	5/11/2019	MPN/100mL	10	10	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	7/13/2019	MPN/100mL	0	10	SM9223B	
3656	Middle Fork Beargr	Seneca Park, about two tenths of a mile from Pee Wee Reese Wa	9/14/2019	MPN/100ml	0	10	SM9223B	
2030	Beargrass Creek	Big Rock	5/19/2012					
2030	Beargrass Creek	Big Rock	7/14/2012	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	0.02		SM4500NH3-G	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	1		SM4500CL-G	
2030	Beargrass Creek	Big Rock	9/8/2012	uS/cm	5		SM2510B	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Result Units	MDL	RL	Method	QAFlag
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	0.01		SM4500NO3-F	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	0.1		SM4500N-C	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	0.01		SM4500P-F	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	1		SM2540D	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	1.5		SM4500SO4-F	
2030	Beargrass Creek	Big Rock	9/8/2012	mg/L	10		SM2340C	
2030	Beargrass Creek	Big Rock	5/18/2013	MPN/100mL	1	1	Colilert	
2030	Beargrass Creek	Big Rock	7/13/2013	MPN/100mL	1	1	Colilert	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	0.02		SM4500NH3-G	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	1		SM4500CL-G	
2030	Beargrass Creek	Big Rock	9/14/2013	uS/cm	5		SM2510B	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	0.01		SM4500NO3-F	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	0.1		SM4500N-C	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	0.01		SM4500P-F	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	1		SM2540D	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	1.5		SM4500SO4-F	
2030	Beargrass Creek	Big Rock	9/14/2013	mg/L	10		SM2340C	
2030	Beargrass Creek	Big Rock	6/7/2014	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	7/15/2014	MPN/100mL	1	1	SM9223B (ColilertMPN)	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	0.02		SM4500NH3-G	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	1		SM4500CL-G	
2030	Beargrass Creek	Big Rock	9/13/2014	uS/cm	5		SM2510B	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	0.01		SM4500NO3-F	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	0.1		SM4500N-C	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	0.01		SM4500P-F	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	1		SM2540D	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	1.5		SM4500SO4-F	
2030	Beargrass Creek	Big Rock	9/13/2014	mg/L	10		SM2340C	
2030	Beargrass Creek	Big Rock	5/16/2015	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	7/11/2015	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	9/12/2015	mg/L	0.00703	0.05	Hach 10205	
2030	Beargrass Creek	Big Rock	9/12/2015	mg/L	0.05		Hach 10206	
2030	Beargrass Creek	Big Rock	9/12/2015	mg/L	0.00829	0.033	SM4500P-E	
2030	Beargrass Creek	Big Rock	9/12/2015	mg/L	0.288	1	Hach 10242	
2030	Beargrass Creek	Big Rock	9/12/2015	NTU	0.08		SM2130B	
2030	Beargrass Creek	Big Rock	5/14/2016	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	7/9/2016	MPN/100mL	1	1	SM9223B	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Result Units	MDL	RL	Method	QAFlag
2030	Beargrass Creek	Big Rock	9/10/2016	mg/L	0.00703	0.05	Hach 10205	
2030	Beargrass Creek	Big Rock	9/10/2016	mg/L	0.2	1	Hach 10206	
2030	Beargrass Creek	Big Rock	9/10/2016	mg/L	0.02487	0.125	SM4500P-E	
2030	Beargrass Creek	Big Rock	9/10/2016	mg/L	0.288	1	Hach 10242	
2030	Beargrass Creek	Big Rock	7/8/2017	MPN/100mL	1		Colilert	
2030	Beargrass Creek	Big Rock	5/12/2018	MPN/100mL	1	1	SM9223B	
2030	Beargrass Creek	Big Rock	7/13/2018	MPN/100mL	1	10	SM9223B	
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	6/7/2014	MPN/100mL	1	1	SM9223B	
1886	Middle Fork Beargr	Big Rock pavilion in Cherokee Park.	5/11/2019	MPN/100mL	10	10	SM9223B	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2013	MPN/100mL	1	1	Colilert	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/12/2018	MPN/100mL	1	1	SM9223B	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2018	MPN/100mL	1	10	SM9223B	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	5/11/2019	MPN/100mL	10	10	SM9223B	
1785	Middle Fork Beargr	Cherokee Park Road and Lexington Road.	7/13/2019	MPN/100mL	0	10	SM9223B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/16/2015	MPN/100mL	1	1	SM9223B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/11/2015	MPN/100mL	1	1	SM9223B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	mg/L	0.00703	0.05	Hach 10205	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	mg/L	0.05		Hach 10206	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	mg/L	0.00829	0.033	SM4500P-E	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	mg/L	0.288	1	Hach 10242	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/12/2015	NTU	0.08		SM2130B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	5/14/2016	MPN/100mL	1	1	SM9223B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/9/2016	MPN/100mL	1	1	SM9223B	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	mg/L	0.00703	0.05	Hach 10205	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	mg/L	0.2	1	Hach 10206	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	mg/L	0.02487	0.125	SM4500P-E	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	9/10/2016	mg/L	0.288	1	Hach 10242	
3361	Middle Fork Beargr	On Beargrass Creek Road about a half mile before it meets with L	7/8/2017	MPN/100mL	1		Colilert	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	0.02		SM4500NH3-G	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	1		SM4500CL-G	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	uS/cm	5		SM2510B	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	0.01		SM4500NO3-F	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	0.1		SM4500N-C	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	0.01		SM4500P-F	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	1		SM2540D	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	1.5		SM4500SO4-F	
2068	Middle Fork Beargr	Bridge at Payne Street	9/13/2014	mg/L	10		SM2340C	

Salt River Watershed Watch Middle Fork Beargrass Creek Data

Site ID	Stream Name	Site Location	Sample Date	Result Units	MDL	RL	Method	QAFlag
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.00703	0.05	Hach 10205	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.05		SM4110B	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.05		Hach 10206	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.00829	0.033	SM4500P-E	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	3		EPA 160.2	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.05		SM4110B	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	10			
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	mg/L	0.288	1	Hach 10242	
2068	Middle Fork Beargr	Bridge at Payne Street	9/12/2015	NTU	0.08		SM2130B	
2068	Middle Fork Beargr	Bridge at Payne Street	5/13/2017					

APPENDIX 2.2 SALT RIVER WATERSHED WATCH BIG ROCK FINAL REPORT

Big Rock Bacteria Monitoring Project 1999-2008

Final Report



Salt River Watershed Watch
Louisville, Kentucky
December 2008

Acknowledgments

Salt River Watershed Watch recognizes these citizen volunteers who participated as water quality monitors in the project:

- Jean Fenn
- Stephanie Glasford
- Dorothy Gray
- Ken Machtolff
- Trina Palma
- Conrad Selle
- Lynn Schmidt
- Sandy Shroerlucke
- Dan and Anne Siebert
- Jack Still

Bruce Scott coordinated the volunteers, kept records, and prepared this report in addition to monitoring.

In turn, the citizen monitors thank the following people and their organizations for supporting the project:

- Sarah Wolfe and Katie Green, Olmsted Parks Conservancy
- Bud Shardein, Executive Director of the Louisville and Jefferson County Metropolitan Sewer Department
- Beckmar Environmental Laboratory, Louisville, Kentucky
- Judy Petersen, Kentucky Waterways Alliance
- Russ Barnett, Chair of the Steering Committee of Salt River Watershed Watch
- Ken Cooke and Kathy Ward, Water Watch, Kentucky Division of Water

We are grateful to Karen Schaffer, the current Science Coordinator for the SRWW Steering Committee, for her review of this report prior to publication.

We would like to dedicate our report to the late Dr. Jeff Jack who, as a member of the Biology Department of the University of Louisville, advised Salt River Watershed Watch and the Big Rock volunteers on the design of their studies.

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To request an electronic copy of the report and/or data:

bwscott@fewpb.net

Big Rock Bacteria Monitoring Project 1999-2008 Final Report

For nine years (June 1999– May 2008), citizen volunteers associated with Salt River Watershed Watch monitored bacteria that pollutes “Big Rock,” an area in Louisville’s Cherokee Park that is used for wading and swimming. This is a final report on the project.

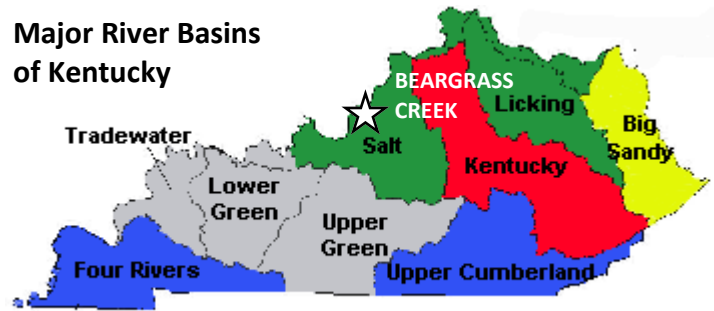
Salt River Watershed Watch

Salt River Watershed Watch (SRWW) is one of eight regional citizen monitoring programs that together span Kentucky’s watersheds. SRWW concentrates on the Salt River basin and watersheds of the minor Ohio River tributaries that neighbor it.

SRWW and its sister programs are based on the concept of watershed health. In addition to natural conditions such as soils, precipitation, and geology, a stream is affected by human activities on its watershed. A stream is also affected by groundwater flows, especially in areas of karst where underlying bedrock has been dissolved and permits the rapid transport of water (and pollutants) underground.

For the most part, SRWW monitors streams at locations chosen by volunteers. In addition to gathering information about dissolved oxygen, pH, temperature, and flow, volunteers sample for herbicides and pesticides in the spring, bacteria in the summer, and “low-flow” parameters in the fall. SRWW also may authorize volunteer teams to undertake “focus studies,” such as the Big Rock study.

Major River Basins of Kentucky



Source: Kentucky Division of Water



Children swimming at Big Rock, 1998. Photo credit: Karen Cairns

Big Rock

Big Rock is a streamside recreational area in Cherokee Park in Louisville, Kentucky. Opened in 1892, the park was laid out along the Middle Fork of Beargrass Creek by its designer, noted American landscape architect Frederick Law Olmsted. The “big rock” itself fell from a cliff above; scouring from floods has created a pool enjoyed by summertime swimmers.

Upstream from the big rock, the level limestone shelves of the stream bottom attract waders of all ages who visit a picnic and play area overlooking the stream. A nearby trailhead demonstrates Best

Management Practices for stormwater. The area is posted with signs warning against contact with the water after storms.

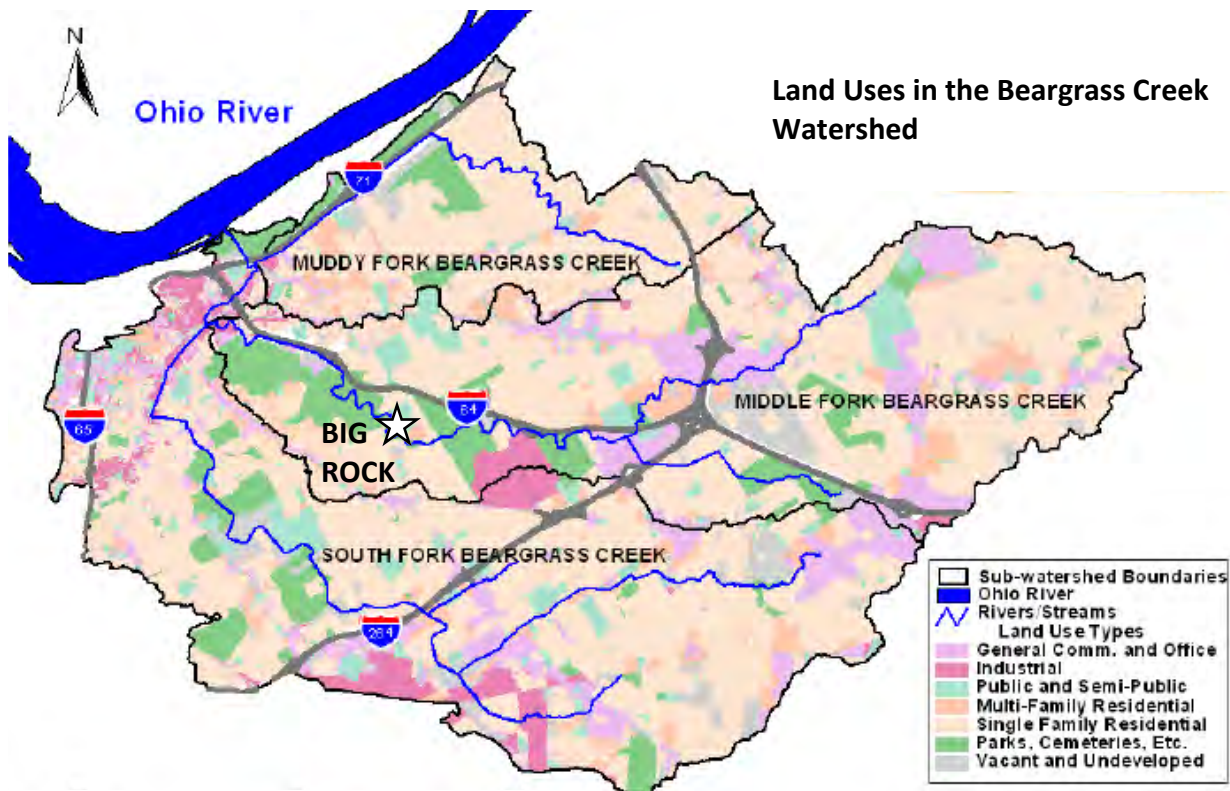
Beargrass Creek

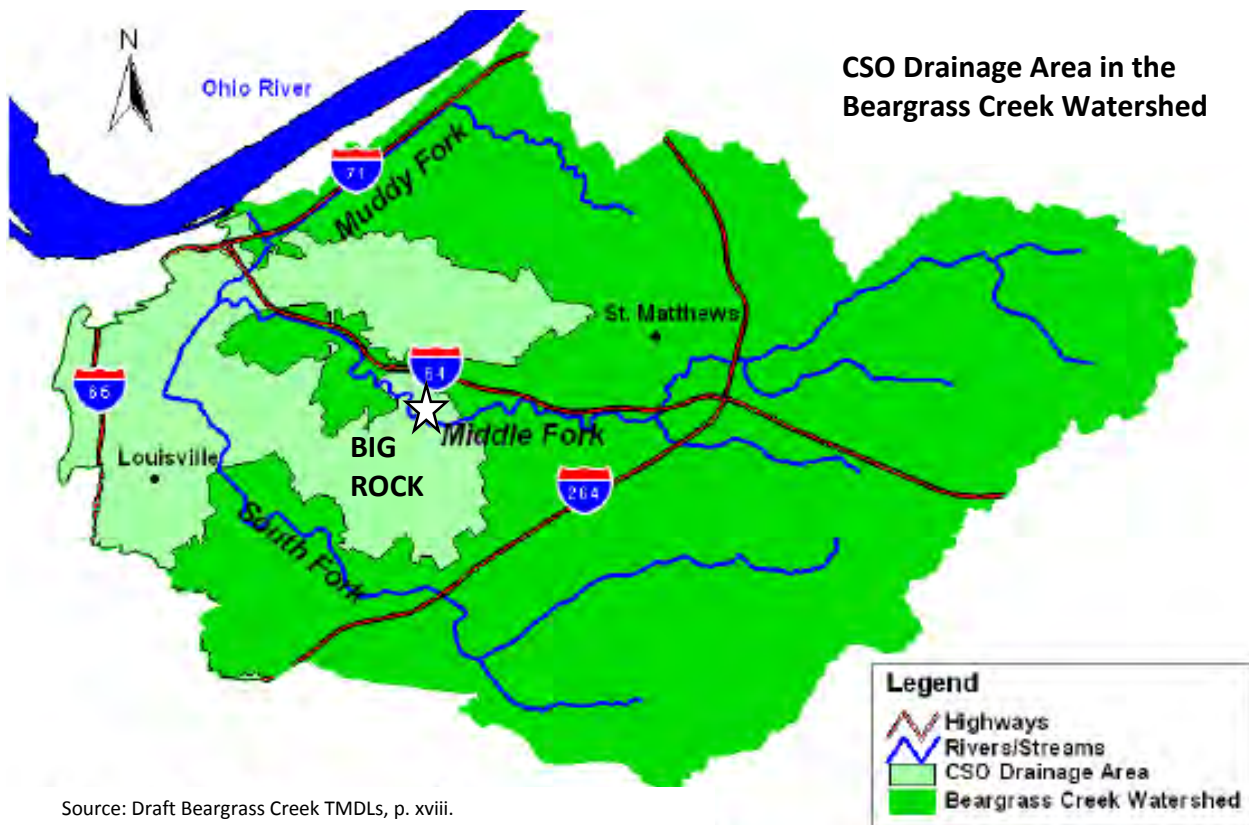
Beargrass Creek lies entirely within Jefferson County, Kentucky. Its political jurisdiction is primarily Metro Louisville, the combined city-county government, but several smaller cities including St. Matthews and Lyndon are other jurisdictions that its streams traverse.

The stream system consists of three major forks: the Muddy Fork (6.9 miles), the Middle Fork (15.8 miles), and the South Fork (13.6 miles). The three forks converge on a channel that formerly flowed across downtown Louisville; the original channel was closed in the 1850s and flow was diverted north through a new channel, called the Main Stem, to the point where it now joins the Ohio River near Eva Bandman Park. The entire watershed of Beargrass Creek covers 60 square miles, and is home to about 200,000 people. (1)

Big Rock is located in the Middle Fork watershed, which drains a surface area of 25 square miles. Land uses are primarily residential (see map, below). Extensive stretches of the stream are bordered by parklands including two of Louisville's historically significant "Olmsted Parks," Seneca and Cherokee, as well as newer parks and greenways developed by the cities of St. Matthews and Lyndon. About ten percent of the watershed is categorized as industrial. (2)

The watershed at and upstream of Big Rock is characterized by karst. Therefore, groundwater is an important consideration in the stream's hydrology.





Source: Draft Beargrass Creek TMDLs, p. xviii.

One of the biggest challenges facing an urbanizing watershed like Beargrass is the extent of impervious surfaces such as roads, parking lots, and building roofs. Impervious surfaces prevent stormwater from recharging aquifers; furthermore, rainfall is more likely to sweep pollutants, including significant amounts of pathogens, from impervious surfaces to streams without benefit of treatment from a vegetative buffer. The overall imperviousness of the Middle Fork was estimated in 1998 by MSD as 39 percent (3). A more recent study identified several subwatersheds with imperviousness in the range of 10-25 percent, although large areas including the headwaters in the City of Hurstbourne exceeded 25 percent, a threshold value in the literature that indicates that water quality becomes poor if Best Management Practices aren't installed to mitigate the effects of impervious surfaces. (4)

Another major influence on water quality in the Middle Fork of Beargrass Creek is the city's sewer system. Developed areas around Big Rock are within the combined sewer system built previous to World War II that carries both stormwater and sanitary waste (see map, above). During storms, stormwater overwhelms the system and strategically located overflows discharge the excess to the creek so that sewage doesn't back up into homes.

Combined sewer overflow (CSO) volumes in the Middle Fork are dwarfed by the volume of stormwater carrying pathogens that flows off the watershed during storms. A 2008 draft document estimating the Total Maximum Daily Load (TMDL) permissible for pathogens in Beargrass Creek estimated that CSO discharges, themselves consisting of wastewater and stormwater, account for only seventeen percent of the flow of the Middle Fork of Beargrass Creek. (5). The report also identifies aging sewer pipes as sources of pathogens during wet and dry weather. (6) It is important to note that no CSOs are located upstream of Big Rock; in addition, MSD has surveyed stormwater facilities to eliminate sanitary-storm system cross-connections.

Table 1.7 Aggregate Summary of Wastewater and Stormwater Statistics by Sub-basin

SUB-WATERSHED	Area (sqmi)	% Impervious	# Documented SSO Locations	# Documented CSO Locations	# Detention Basins
BEARGRASS					
	1.9	10.3	0	10	0
MIDDLE FORK BEARGRASS CREEK					
	25.0	22.2	132	12	17
MUDDY FORK BEARGRASS CREEK					
	7.5	11.4	15	0	3
SOUTH FORK BEARGRASS CREEK					
	26.4	29.1	110	38	23

Ruling out CSO and SSO contributions, potential sources of elevated pathogens at Big Rock would include:

- Stormwater from impervious surfaces;
- Animal feces from pets and wildlife;
- Failing or poorly sited septic tanks;
- Sanitary sewer overflows; and
- Aging, cracked sanitary sewers.

Water Quality Studies

When the project began, not much data was available about the water quality of the Middle Fork of Beargrass Creek. MSD had intermittently monitored pathogen and other parameters, mostly to assess the functioning of its combined sewer system. Still, the efforts established baseline conditions for further study of the stream's overall health.

In 2003, four years after SRWW's Big Rock project began, MSD established a comprehensive monitoring program in their service area's watersheds. In the Beargrass Creek watershed, five monitoring stations were established to gather data on flow, dissolved oxygen, temperature, and other basic parameters every fifteen minutes. Pathogens are sampled at the sites five times monthly to develop information for regulatory compliance. The diversity of aquatic life-forms, including fish, macro-invertebrates, and algae, are sampled every two years.

MSD's monitoring sites on the Middle Fork are at the intersection of Park and Beals Branch roads in Cherokee Park, downstream from Big Rock, and at Old Cannons Lane and Seneca Park Road, which is upstream. An additional site was established more recently in the lower reach of the Middle Fork where it joins the main stem to assist in the development of the TMDL for pathogens.

A report issued by MSD in 2005 summarized data collected from Beargrass stations in MSD's new monitoring network. The findings for pathogens were not quantified, but displayed in pie charts that show that the percent of samples that did not meet state single-sample standard for primary contact range from approximately 20 percent in the headwaters to about 45 percent in the lowlands. Dissolved oxygen problems were rare in the headwaters but increased to approximately 25 percent of samples in

the lowlands. Aquatic life had been measured in two locations: at Old Cannons Lane, where biodiversity was rated “poor,” and at Browns Lane, somewhat upstream, where it was rated “fair.” (7)

Based primarily on data provided by MSD, the Kentucky Division of Water considers the stretch of the Middle Fork of Beargrass Creek where Big Rock is located “impaired” for primary recreation contact due to elevated pathogens. (8)

History of the Project

In its planning meetings in the winter of 1999, the Steering Committee of SRWW identified a monitoring program at Big Rock as a desirable focus study. The committee suggested at least the minimum number of samples required by regulation (9) to characterize the stream’s condition in respect to pathogens.

The regulation governing recreational contact establishes a two-fold standard:

1. A single sample cannot exceed 400 colonies/ 100 ml; *and*
2. A geometric mean of at least five samples in a month cannot exceed 200 colonies/ 100 ml. A geometric mean is the square root of the sum of the squares of the items; it serves to “calm” a wide range of values and usually results in a lower number than an average.

Because of the second standard, five samples per month were ideal. Five volunteers were trained to sample the stream once a month according to a schedule established by the coordinator for the project.

The regulation identifies May through October as the “recreational season” when the standards apply, so monitoring was planned to begin in May, 1999; it actually began in June. That summer was unusual, marked by drought when the standards do not apply, creating a desire for more information; furthermore, volunteer samplers in the project were highly motivated and wanted the sampling to continue. Therefore, the Steering Committee authorized the indefinite continuation of the project.



MSD Biologist Jerry Terhune trains project samplers at the Big Rock picnic pavilion. From left, Conrad Selle, Dorothy Gray, and Trina Palmer.

Turnover among volunteer samplers at the end of the first and second summers required special recruitment and training for citizens from the adjoining neighborhoods who observed sampling activities and volunteered. Two special trainings were provided, in October 1999 and September 2000.

Monitoring results were shared with the community in a variety of ways. Reports on the project were made to SRWW’s annual conferences in 2000, 2003, and 2006. The Friends of Beargrass Creek, now defunct, published results in its quarterly newsletters for the first several years of the project.

At the invitation of the Jefferson County Health Department, a presentation on the results was made in 2002 to the Health Board. A poster developed with support from MSD was displayed at the “Big Rock Jazz Festival” in 2003. The project also received coverage in Louisville’s daily newspaper, the *Courier Journal*.

The project provided a platform for participation by volunteers in planning for the Beargrass Creek watershed. Two volunteers, Kenny Machtolff and Bruce Scott, were members of the Beargrass Creek Watershed Council that met under MSD auspices from 2002 to 2004. One tangible result of the Council's work was the installation in 2005 of a kiosk at Big Rock where the project's results could be posted. The kiosk was a cooperative project among the Council, MSD, Metro Parks, Kentucky Waterways Alliance, and the EPA, which provided matching funds.



The kiosk at Big Rock, where project data and water quality information were posted in cooperation with Metro Parks.

Design of the Study

The hypothesis of the study was that pathogen concentrations in the stream increase during storms. We believed this would occur because of two factors:

- Urban runoff of rainfall during storms is known to have high concentrations of pathogens and
- While there are no combined sewer overflows upstream of the study area, the aging sewers in the area as well as overflows from infiltration into upstream sanitary sewers will also contribute pathogens, again during storms.

In keeping with SRWW's sampling protocols, the study included the collection of these streamside parameters:

- Water temperature in degrees Centigrade;
- Characterization of flow (ponded, low, normal, bank full, flood);
- Characterization of recent rainfall in half-inch ranges;
- Dissolved oxygen in milligrams per liter; and
- pH.



The monitoring site, downstream of the Belknap Bridge and below Big Rock picnic pavilion. This shot is looking east and upstream.

Data for dissolved oxygen and pH were obtained using LaMotte kits. During the visit, streamside data were recorded on a standard SRWW chain of custody form (see Appendix). Samples were collected in accordance with Watershed Watch procedures. (10) Samples with chain of custody forms were transported to Beckmar Environmental Laboratory immediately after sample collection. Beckmar, which is certified by the Kentucky Division of Water to perform bacteria

analysis, sent its analysis report with the chain of custody document to the coordinator of the project, who entered the data on a spreadsheet.

Original documents were sent by the coordinator to the Water Watch program of the Kentucky Division of Water in Frankfort, Kentucky, where they are archived.

Results

The tables below show whether monitoring results each month during the recreation season met the two-fold regulatory standard established by the Kentucky Division of Water (summarized in this report on page seven). “OK” means that the two-fold standard was met; “Fail” means that one or both of the standards were not met. (Results for 1999 are not included because the year was marked by drought, when the standards don’t apply.)

At Big Rock, Beargrass Creek almost never meets water quality standards for primary contact recreation (swimming); of the 49 months included in the study, the standard was met only during one month, or two percent of the time. However, the stream often met standards for secondary contact (canoeing, wading, fishing but not for consumption); in 21 of the 49 months, or forty percent of the time, secondary contact standards were met.

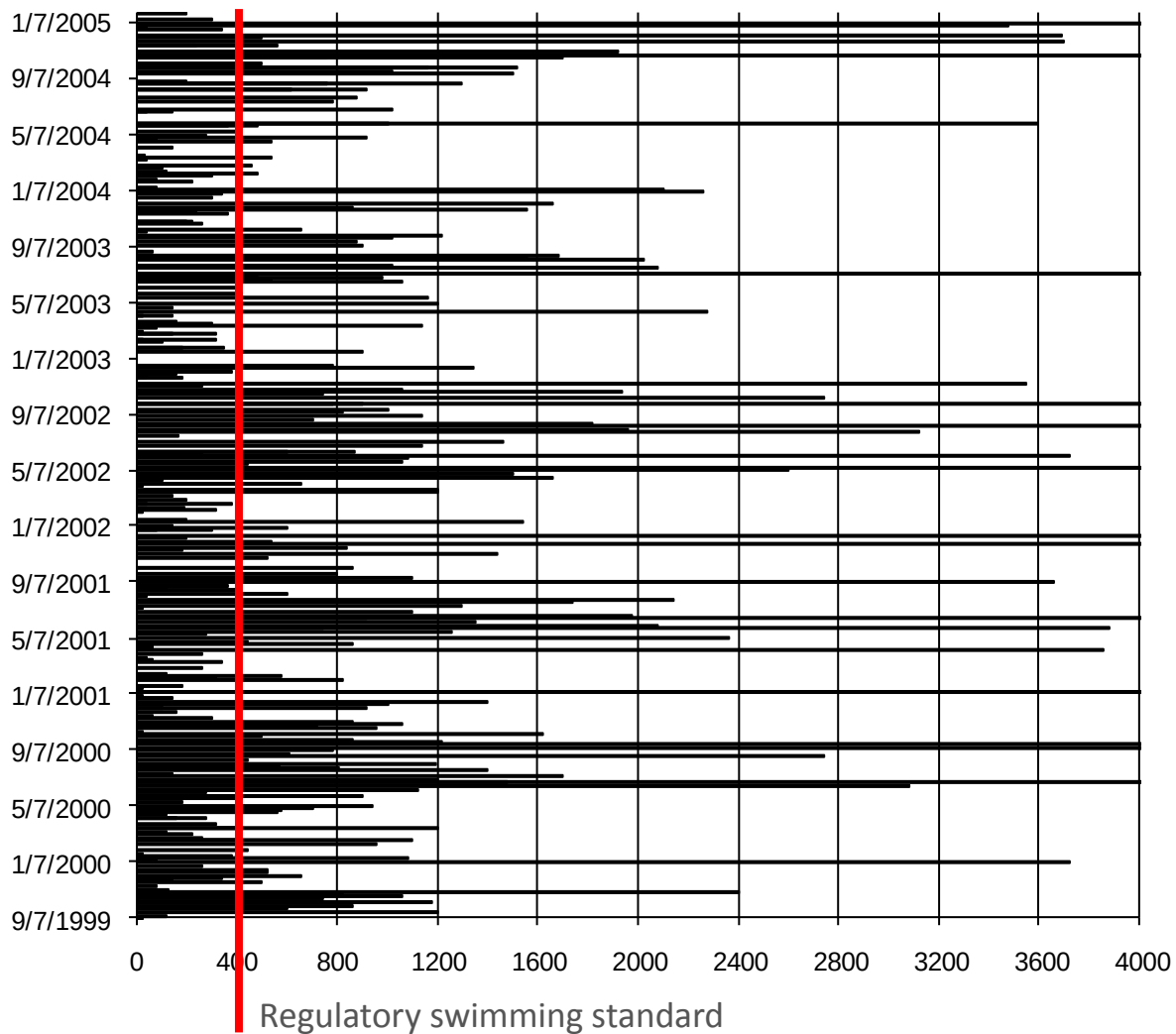
Primary Contact Recreation (Swimming)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
May	Fail	Fail	Fail	Fail	Fail	OK	Fail	Fail	Fail
June	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	
July	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	
August	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	
September	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	
October	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	

Secondary Contact Recreation (Canoeing, Fishing, etc.)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
May	OK	Fail	Fail	OK	Fail	OK	OK	OK	OK
June	Fail	Fail	Fail	OK	OK	Fail	Fail	Fail	
July	OK	Fail	Fail	Fail	OK	OK	Fail	Fail	
August	Fail	OK	Fail	Fail	OK	Fail	OK	Fail	
September	Fail	Fail	Fail	OK	OK	Fail	Fail	Fail	
October	OK	OK	Fail	OK	Fail	OK	OK	Fail	

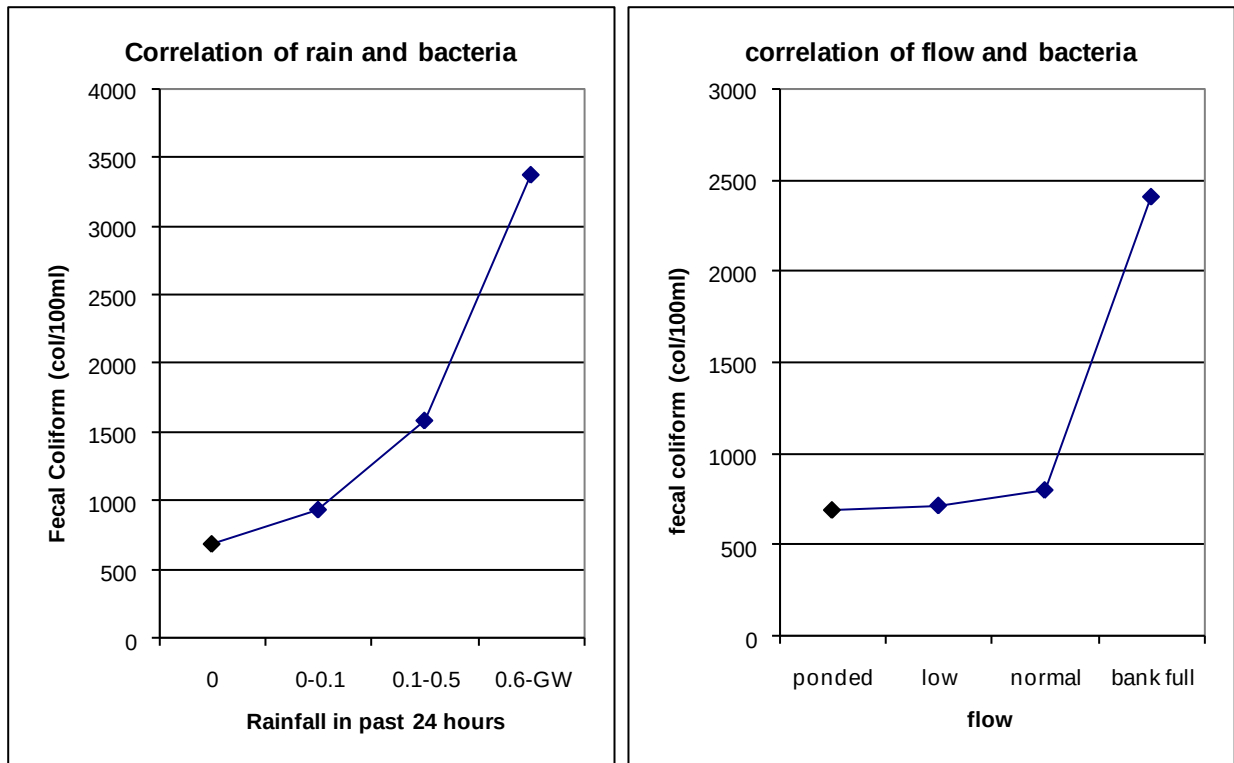
Fecal coliform colonies/ 100 ml, 1999-2004



A closer look at the data (chart, above) reveals the nature of the measure we used to measure pathogen pollution in the stream. The chart includes all data from the first six years of the project, and is not limited to the recreation months. To preserve the scale, values exceeding 4000 are cut off.

As can be observed in the chart, pathogen counts vary widely. While variation is certainly due to differences in flow and recent rainfall, limitations on the accuracy of the measure were observed. On eight occasions duplicate samples were taken because of the random nature of the schedules of some volunteers, and the table to the right reveals the range in their values.

date	first value	second value
12/28/01	300	80
6/19/02	600	870
2/27/03	140	320
10/20/04	760	1700
5/31/05	180	40
12/15/06	180	580
2/28/07	100	90
12/19/07	800	440



Analysis of correspondences between average fecal coliform colonies and flow and recent rainfall (N=274). In the chart on the left, rainfall is in inches; “GW” indicates “gullywasher,” a major downpour.

Although values ranged widely, trends emerged that validated our hypothesis when results were aggregated by “recent rainfall” or “flow” (charts, above).

Consistent with our findings about primary contact recreation, the average number of fecal coliform colonies at times of no **recent rainfall** exceeded the single sample standard of 400, but was less than the secondary contact standard of 2000. The secondary contact standard was only exceeded when recent rainfall exceeded 0.5 inches.

A similar finding occurred when the number of fecal coliform colonies was compared to the characterization of **flow**. The secondary contact standard was met, on average, until flow exceeded normal conditions and the banks of the stream were full. (Flood conditions were rarely sampled for safety reasons.)

With nine years of weekly data points, it was inevitable to ask the data whether pathogen concentrations were increasing or decreasing over time. MSD had made efforts during the project period to reduce flows from sewer overflows and septic tanks, Metro Parks was reducing mowing along stream banks to help filter stormwater runoff, and various public education campaigns on nonpoint sources like dog droppings had occurred.

By arraying data from 174 data points for low and normal flows over the nine years of the project, a definite trend of improvement appeared in water quality as plotted by the MS Excel program we used (see charts on next page). The trend was apparent when the data was arrayed by percent exceeding the single-sample standard and by geometric means of the data. The year 2002 was an

outlier in the data, but did not effect the trend lines when eliminated from the analysis.

Several caveats are necessary when discussing these results.

First, no Quality Assurance Project Plan was developed for the study. Neither duplicate nor blank samples were obtained for quality assurance purposes, although some duplicates were unintentionally generated as noted above and may be useful for quality analysis.

Second, when an average of our data is said to attain a standard, it must be understood that many of the values included in that average grossly exceed it. In a study prepared for the SRWW Annual Conference in January, 2007, a subset of 63 samples were selected where recent rainfall was zero and flow was characterized as normal. The samples had a geometric mean of 349, but ranged between 0 and 6240. Seventy percent (44 of the 63 samples) were below the primary contact single sample standard of 400; however, 21 percent (n = 14) were in the 400-2000 range, and nine percent (n = 6) exceeded the secondary contact single sample standard of 2000.

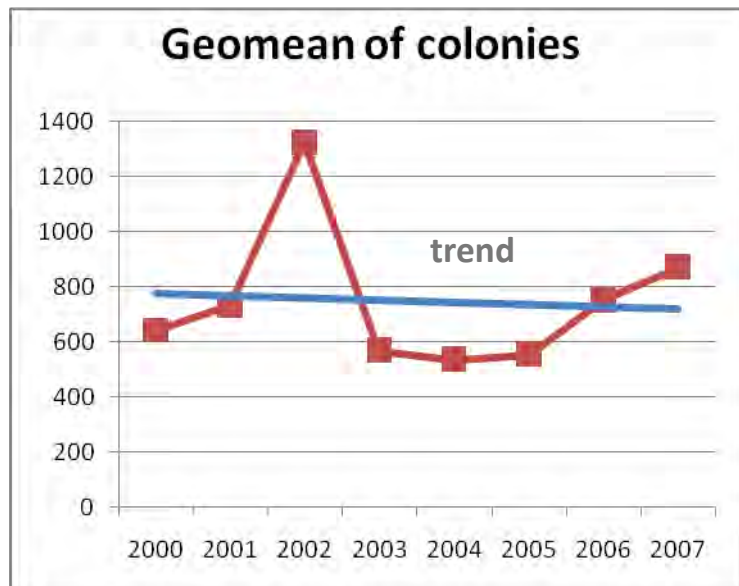
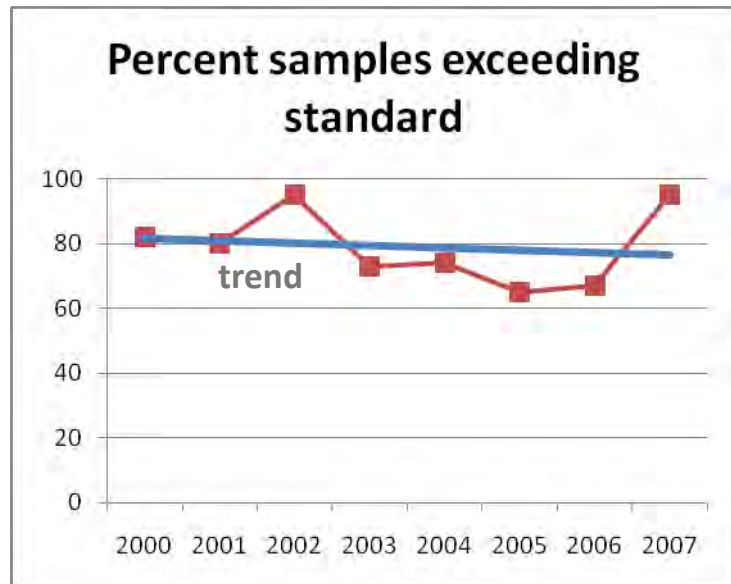
A final caution is the relationship of fecal coliform colonies to health risk. EPA studies estimate a risk of six additional illnesses per thousand people who have full body contact with water exceeding the state regulatory criteria used by the study. There is no certainty that someone who contacts the water under any circumstances will get sick; at the same time, a person with open wounds or a compromised immune system will be at greater risk than healthy individuals.

Conclusions

Our study's hypothesis was that pathogen concentrations increase during storms. We found that pathogen concentrations increase during wet weather and the higher flows that result.

We also made these findings:

- Standards for primary recreational contact (swimming, full immersion baptism, etc.) are rarely met during normal flow conditions;



- Standards for secondary recreational contact (wading, canoeing, recreational fishing, etc.) are often met during normal flow conditions; and
- The stream always exceeds primary and secondary recreational contact standards for 48 hours following one half inch of rainfall.

In addition, the large amount of data from a single site permitted us to make several preliminary observations about laboratory analysis results:

- Concentrations of fecal coliform in samples taken under similar flow conditions, and even among samples taken within hours of one another, vary widely. To obtain a consistent analytical result, approximately 20 samples taken under similar flow or recent rainfall conditions may be necessary to characterize concentrations of pathogens using fecal coliform analysis; and
- Because concentrations increase rapidly with recent rainfall and the resulting higher flows, flow and recent rainfall are crucial factors in designing studies of pathogen concentrations. A single month of the five-sample regimen, or five samples taken across an entire recreational season, may not adequately characterize pathogen loads.

Recommendations and Next Steps

People's continuing use of Big Rock for primary and secondary recreation indicates the following next steps:

- Results from MSD's pathogen monitoring station upstream of the site at the Old Cannons Lane crossing should be posted at the streamside kiosk used by the project, now that new project data is no longer becoming available.
- MSD should partner with Metro Parks to use the kiosk to educate the public about nonpoint sources of pollution to Beargrass Creek, consistent with its public education requirements under MSD's municipal stormwater (MS4) permit.
- The plans of MSD to reduce CSOs and SSOs through its Consent Decree should be implemented. Because private citizens can reduce the burden on overloaded sewer systems during storms by installing rain gardens, rain barrels, etc., the kiosk may provide an educational resource also for MSD's Consent Decree programming.
- MSD's next municipal stormwater permit should include pathogen reduction strategies with the long-term goal of meeting targets for pathogens in stormwater in the draft TMDL.
- Metro Louisville should educate citizens and implement ordinances that control pet waste.
- Metro Parks and other streamside landowners and land managers should continue to reduce mowing along streams and install native streamside vegetation to intercept runoff and increase infiltration into groundwater, improving dry-weather flows.

References

- (1) Kentucky Department for Environmental Protection, "Fecal Coliform TMDLs for Middle Fork, Muddy Fork, and South Fork of Beargrass Creek in Jefferson County, Kentucky," proposed draft, September 2008, p. 1. Online at: www.water.ky.gov/sw/tmdl/TMDLs+Under+Development.htm
- (2) *Ibid.*, p. 10
- (3) Louisville and Jefferson County Metropolitan Sewer District (MSD), "Beargrass Creek Watershed." Online at: www.msdlouky.org/insidemsd/wwwq/watershed/beargrass.htm
- (4) MSD, "Beargrass Creek Watershed, A community lifeline in critical condition," pamphlet, 2003.
- (5) "Fecal Coliform TMDLs," *op. cit.*, p. 45.
- (6) *Ibid.*, p. 42.
- (7) MSD, "Beargrass Creek Watershed, State of the Streams," pamphlet, 2005. Online at: www.beargrasswatershed.org/pdfs/BCW_State_of_the_Streams2005.pdf
- (8) Kentucky Division of Water, "Final 2008 Integrated Report on the Conditions of Water Resources in Kentucky," p. 139. Online at: www.water.ky.gov/sw/tmdl/303d.htm
- (9) Kentucky Administrative Regulations, 401 KAR 10:031, Surface water standards:
 - Section 7. Recreational Waters. (1) Primary contact recreation water. The following criteria shall apply to waters designated as primary contact recreation use:
 - (a) Fecal coliform content or *Escherichia coli* content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for *Escherichia coli*. These limits shall be applicable during the recreation season of May 1 through October 31. Fecal coliform criteria listed in subsection (2)(a) of this section shall apply during the remainder of the year.
 - (b) pH shall be between six and zero-tenths (6.0) to nine and zero-tenths (9.0) and shall not change more than one and zero-tenths (1.0) pH unit within this range over a period of twenty-four (24) hours.
 - (2) Secondary contact recreation water. The following criteria shall apply to waters designated for secondary contact recreation use during the entire year:
 - (a) Fecal coliform content shall not exceed 1,000 colonies per 100 ml as a thirty (30) day geometric mean based on not less than five (5) samples; nor exceed 2,000 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period.
 - (b) pH shall be between six and zero-tenths (6.0) to nine and zero-tenths (9.0) and shall not change more than one and zero-tenths (1.0) pH unit within this range over a period of twenty-four (24) hours.
- (10) Watershed Watch in Kentucky, "Standard Operating Procedures for Grab Sample Collection." Online at http://kywater.net/01-Watershed%20Watch/06_Sampling/2005-QAPP/01-WSW-Sampling-SOP-4.doc

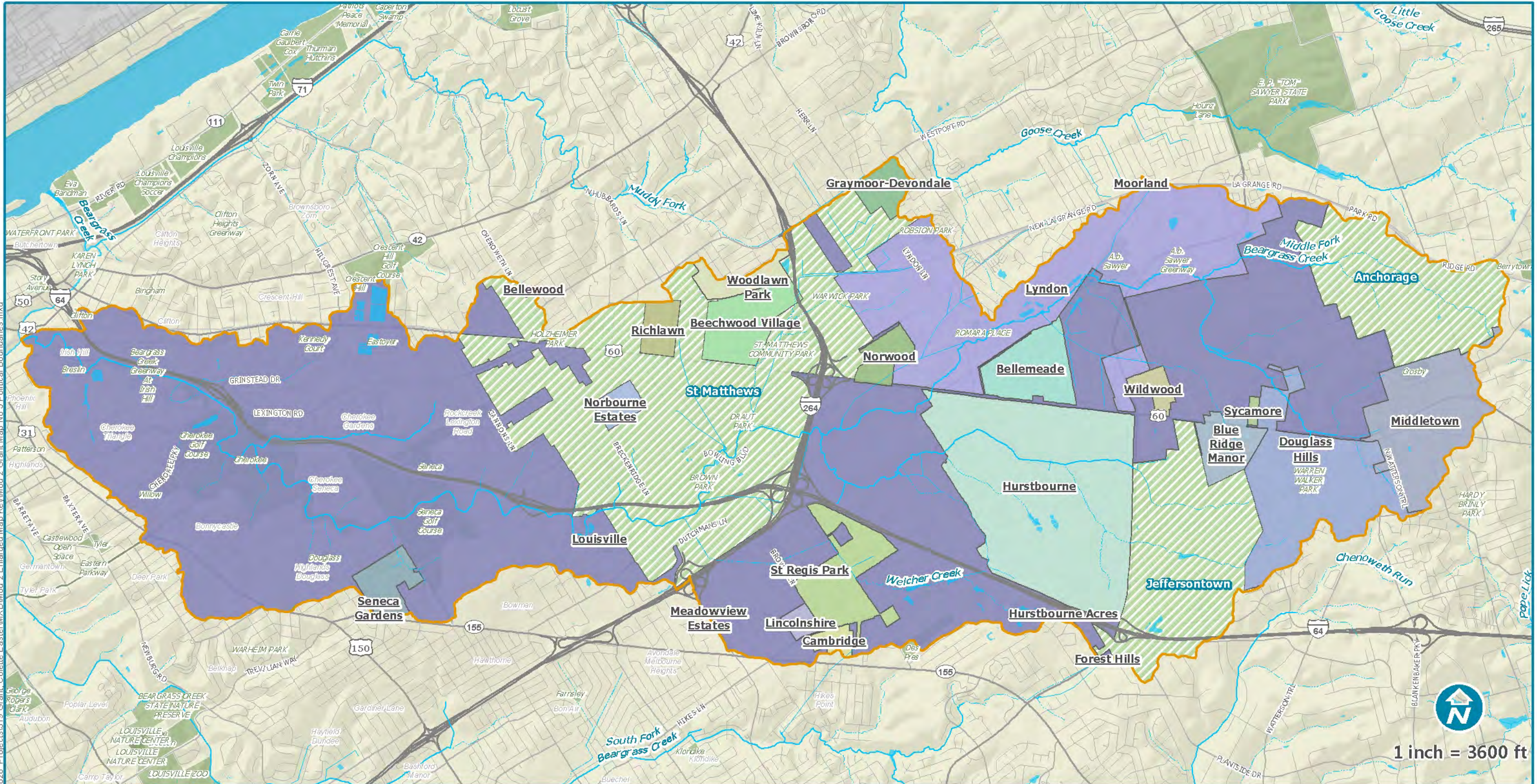
Appendix

Salt River Watershed Watch Chain of Custody Record *Big Rock Monitoring Program*

Sample #	Stream Name	Date	Time			
S77	Middle Fork Beargrass Creek					
Watershed	Sampling Location	Sampler Name	Telephone			
S39	Big Rock pavilion in Cherokee Park					
County	Description of general water conditions	Supervsng Sampler				
Jefferson		Bruce W. Scott				
Flow (m/sec)						
Flow Rate	Rain in last 48 hrs?	Water Chemistry				
◇ 0-Dry	◇ Zero	O2	pH	Temp	Cndvty	
◇ 1-Ponded	◇ Less than 0.1 inch					
◇ 2-Low	◇ 0.1-0.5 inch					
◇ 3-Normal	◇ 0.6-1.0 inch					
◇ 4-Bank full	◇ 1.1-1.5 inches					
◇ 5-Flood!	◇ Gullywasher!					
General comments, questions, concerns, or suggestions:				Sample for analysis:		
				Fecal Coliform		
When a sample's custody changes, the person relinquishing the sample and the person receiving it must sign below and provide the date and time:						
Relinquished by (signature)		Date/Time	Received by (signature)		Date/Time	
SAMPLER: Do your best to complete the unshaded parts of the form. This form must accompany your sample to the lab. When delivered, ask the lab to make a copy for you. LABORATORY: Please mail the original of this form with the fecal coliform result to: Bruce Scott Frankfort, KY 40601 Questions or concerns? Call Bruce at the number up above or Ken Cooke at Water Watch						

APPENDIX 2.3 CHAPTER 2 MAPS

Document Path: J:\gis\records\project_mxd\2020_P\projects\319_Grant_Colette_EasternMX\DMOD 2_Enlarged Map Key\Mod 2_Grant Map No.5 Political Boundaries.mxd



Map Key

	Watershed Boundary		Rivers & Streams
	Bodies of Water		Cities Outside of MSD's Drainage Service Area **
	Wet Areas		** Labels shown in alternate text.

Political Boundaries

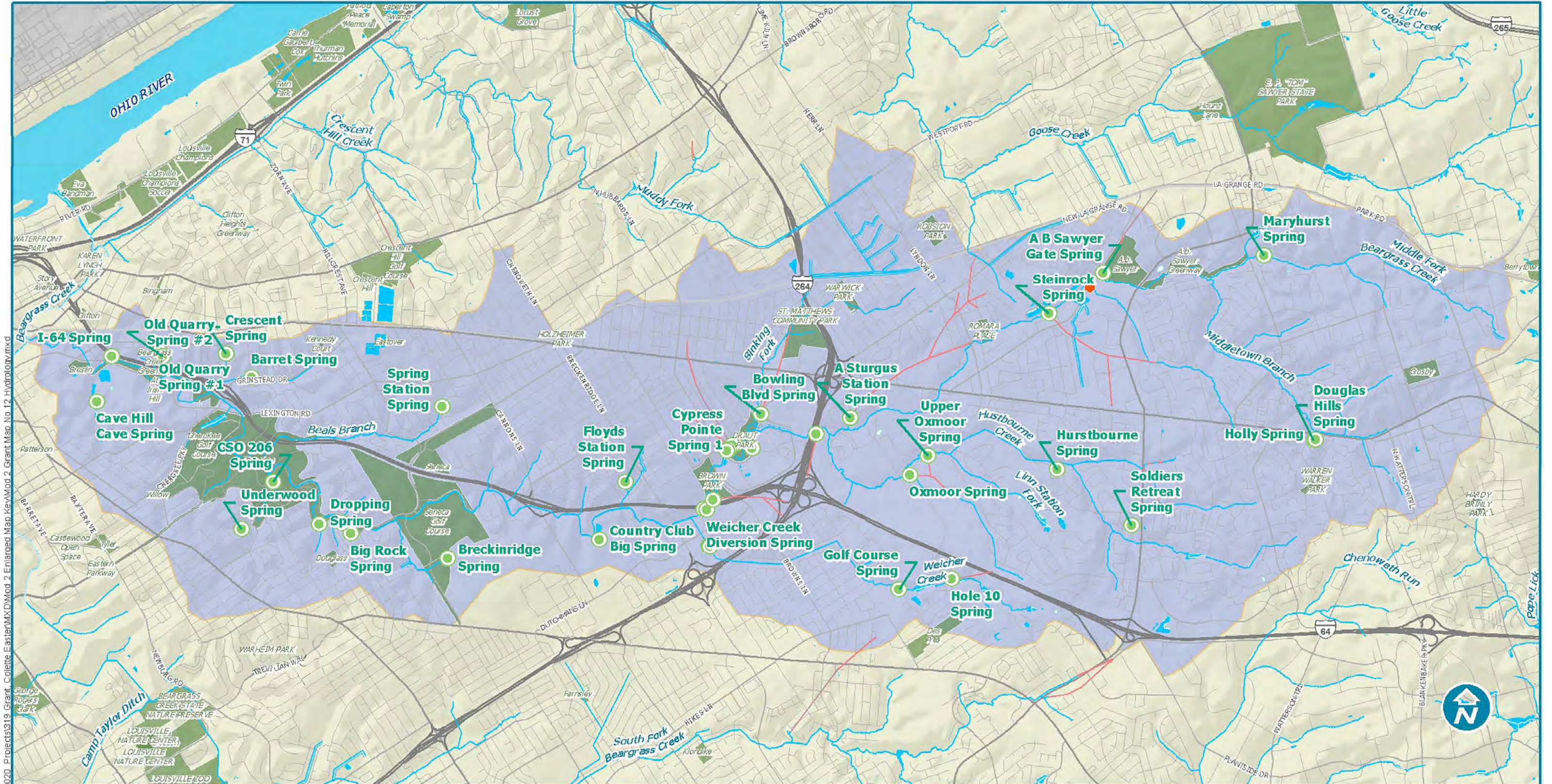
Middle Fork Beargrass Creek
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Map Key

- | | | | |
|--------------------|---------------------|----------------------------|------------------|
| Watershed Boundary | Parks | Stream/River, Perennial | Pipeline |
| Bodies of Water | Dams | Stream/River, Intermittent | Artificial Path |
| Wetlands | Groundwater Springs | Canal/Ditch | Connector |
| | | Underground Conduit | 1 inch = 3600 ft |

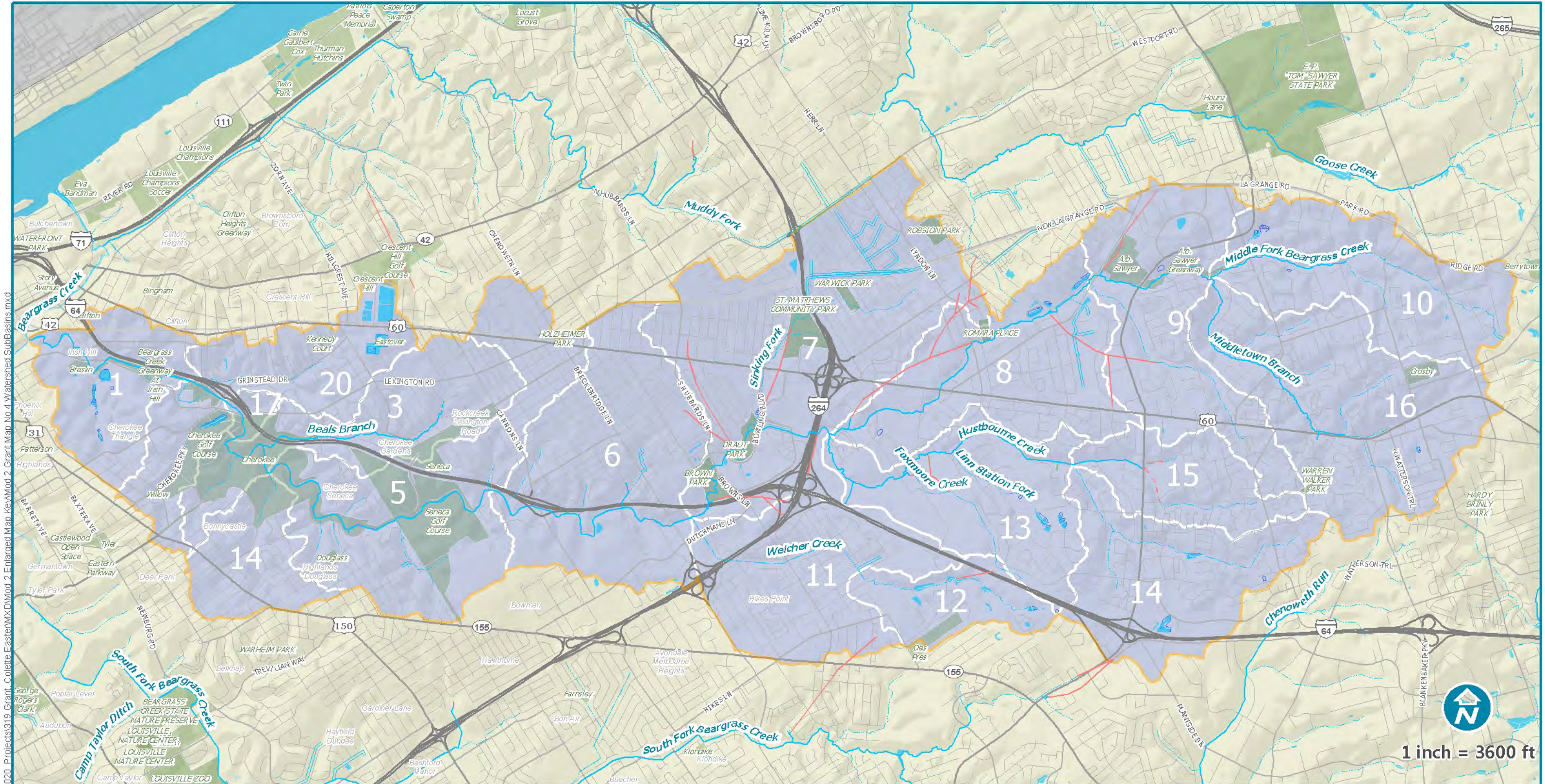
Hydrology

Middle Fork Beargrass Creek
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JANUARY 2020

Document Path: J:\GIS\records\project mxd\2020 Projects\319 Grant Colette EasternMX\DMOD 2 Enlarged Map Key\Mod 2 Grant Map No 4 Watershed SubBasins.mxd



1 inch = 3600 ft



Map Key

- | | | |
|-------------------------|----------------------------|---------------------|
| Watershed Boundary | Wetlands | Underground Conduit |
| Mid Fork BGC Sub Basins | Stream/River, Perennial | Pipeline |
| Parks | Stream/River, Intermittent | Artificial Path |
| Bodies of Water | Canal/Ditch | Connector |

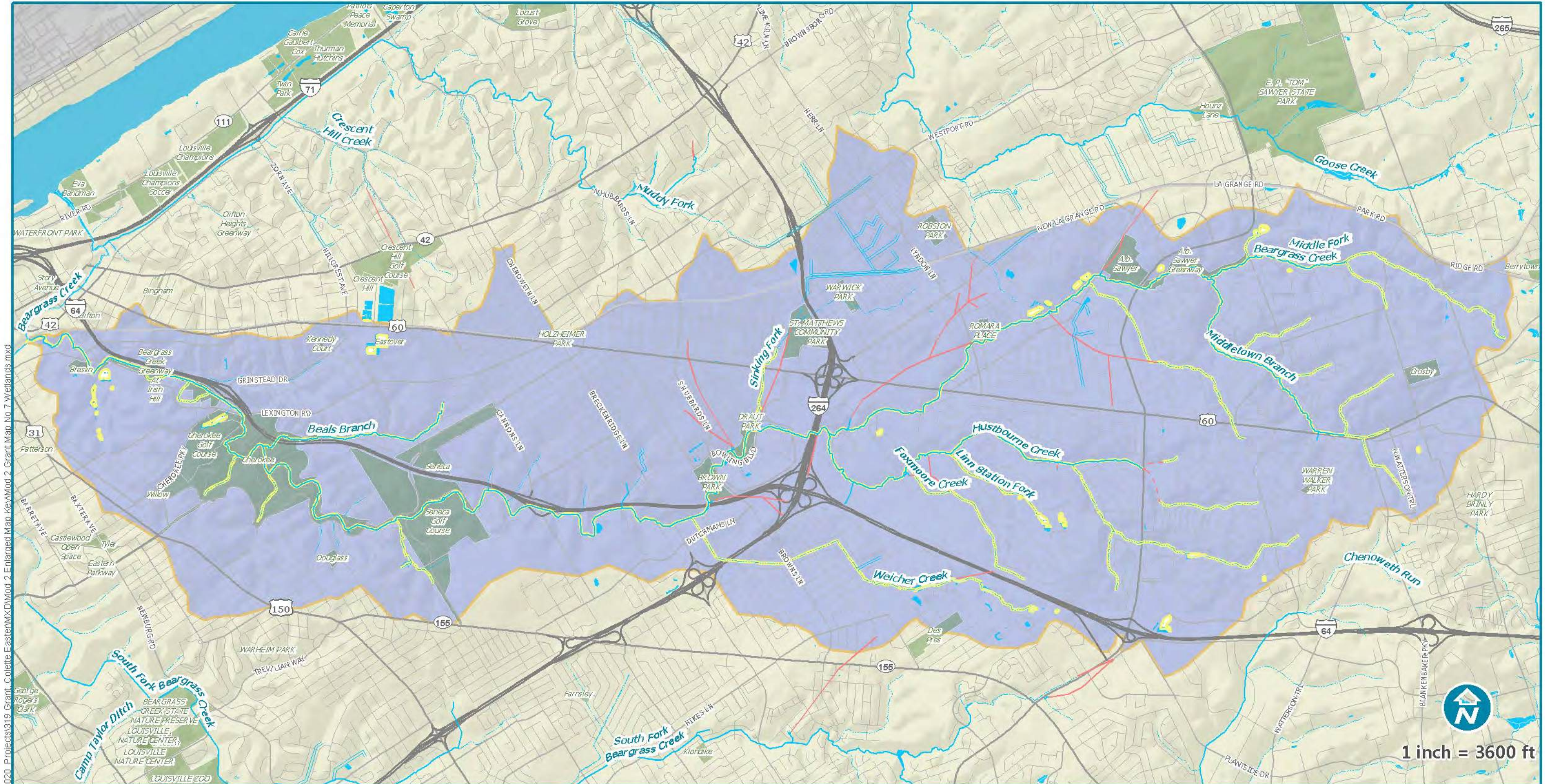
Watershed Boundary & Sub-Basins

Middle Fork Beargrass Creek
319(h) Grant



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Map Key

 Watershed Boundary	 Parks	 Canal/Ditch	 Artificial Path
 Bodies of Water	 Stream/River, Perennial	 Underground Conduit	 Connector
 Wetlands	 Stream/River, Intermittent	 Pipeline	

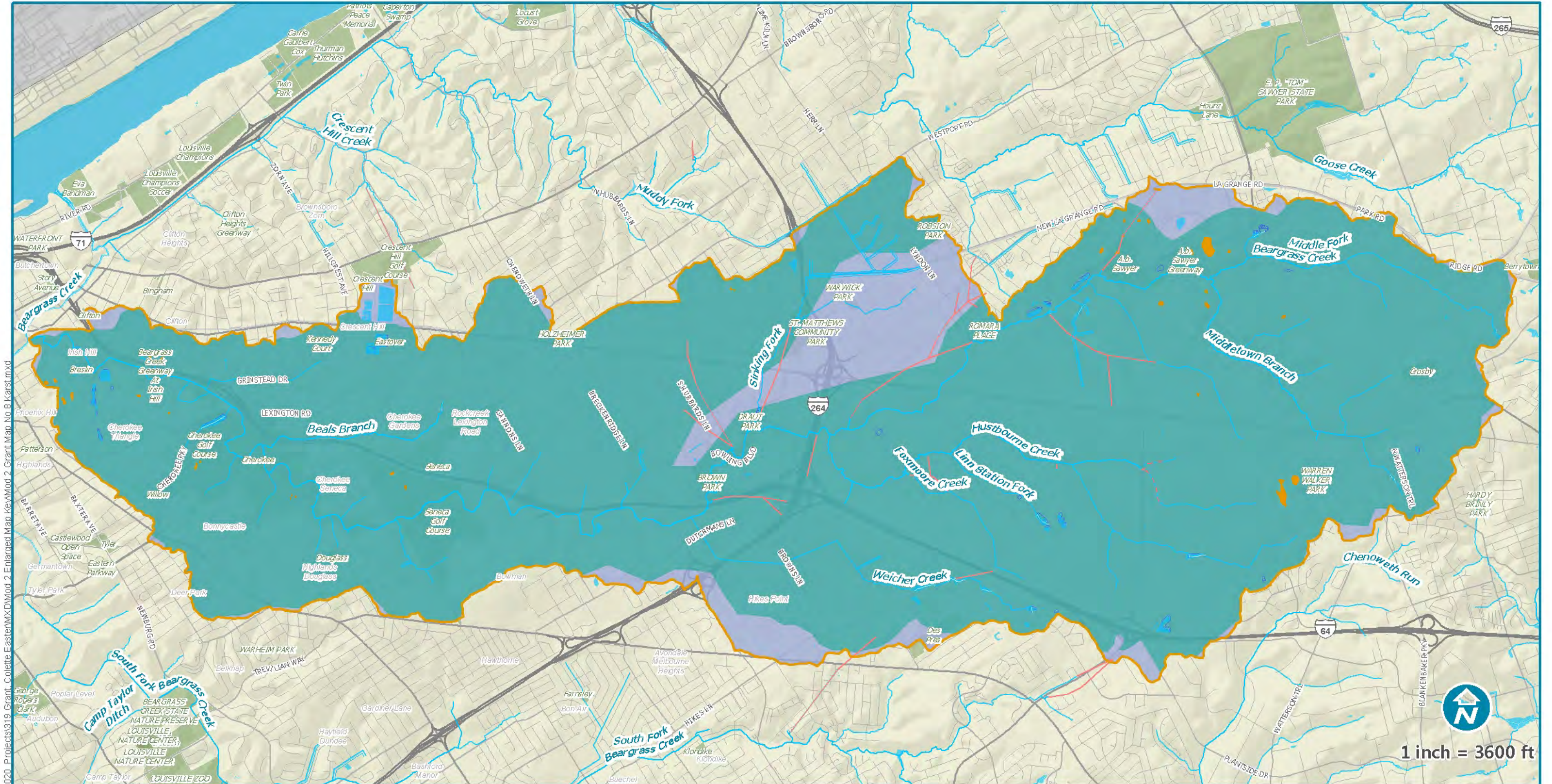
Wetlands

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Map Key

Watershed Boundary	Sinkholes	Stream/River, Perennial	Pipeline
Bodies of Water	Karst	Stream/River, Intermittent	Artificial Path
Wetlands	Connector	Underground Conduit	Canal/Ditch

Karst Features

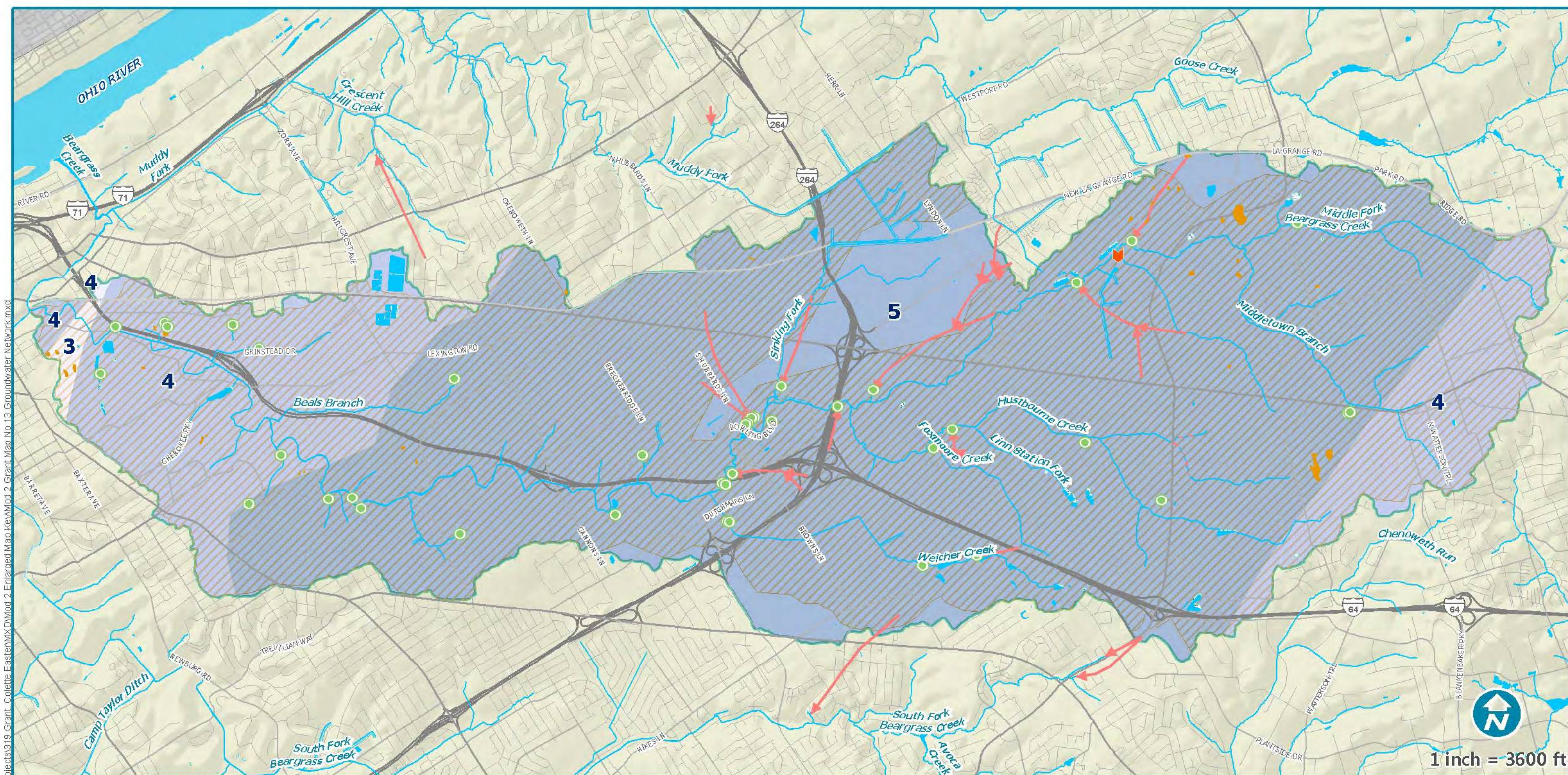
Middle Fork Beargrass Creek
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Map Key

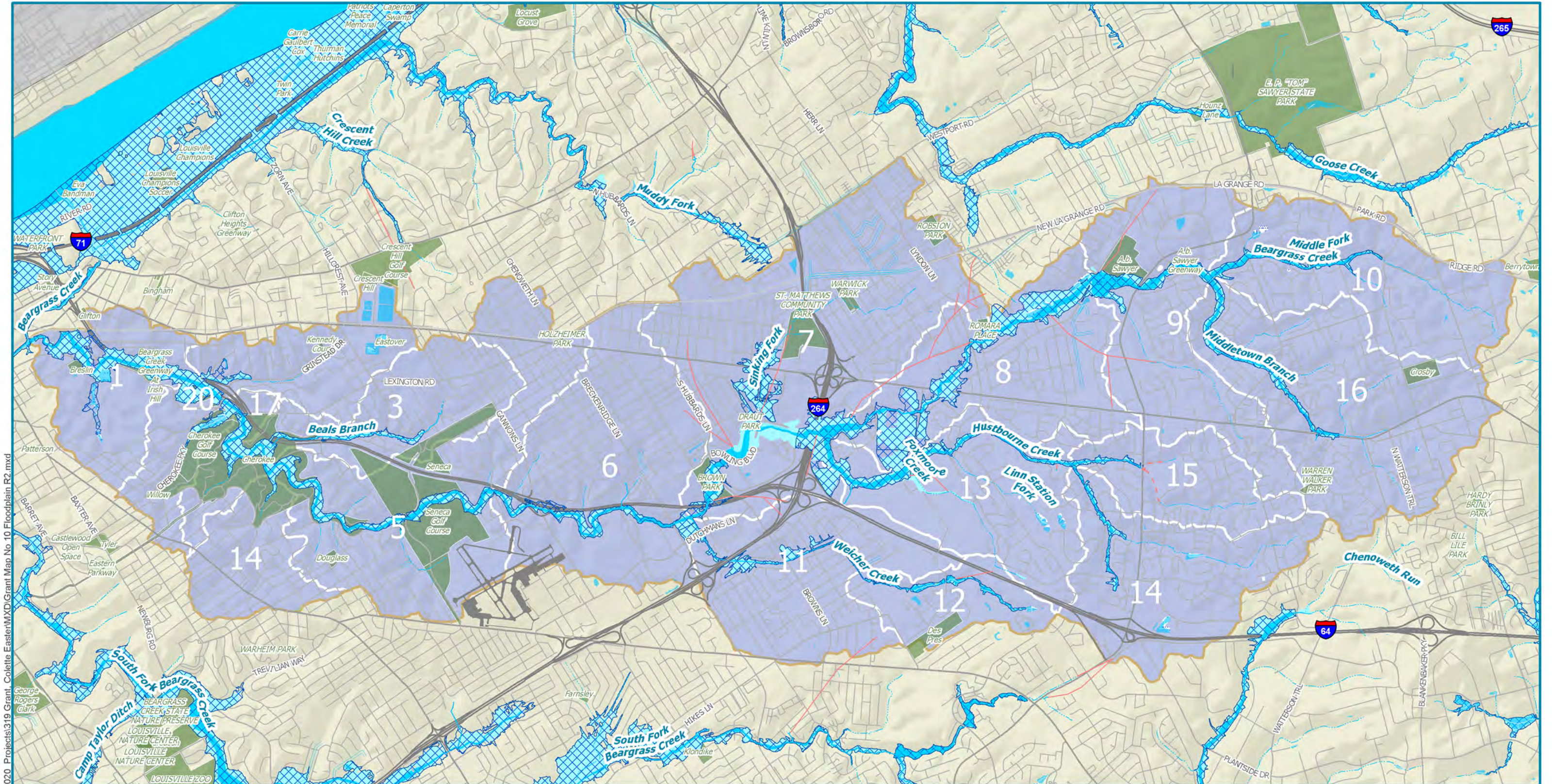
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	Bodies of Water		Sensitivity Level 4		Stream/River, Intermittent		Artificial Path
	Wetlands		Sensitivity Level 5		Canal/Ditch		Connector
	Karst		Groundwater Springs		Underground Conduit		
	Sinkholes		Dams				

Groundwater Network

Middle Fork Beargrass Creek
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Map Key

- | | |
|--------------------|-----------------|
| Watershed Boundary | Bodies of Water |
| Sub Basins | Wet Areas |
| Parks | Floodplain |
| LRFP | Floodway |

Major Streams

- | |
|----------------------------|
| Stream/River, Perennial |
| Stream/River, Intermittent |
| Canal/Ditch |

- | |
|---------------------|
| Underground Conduit |
| Pipeline |
| Artificial Path |
| Connector |

Floodplain Map

Middle Fork Beargrass Creek
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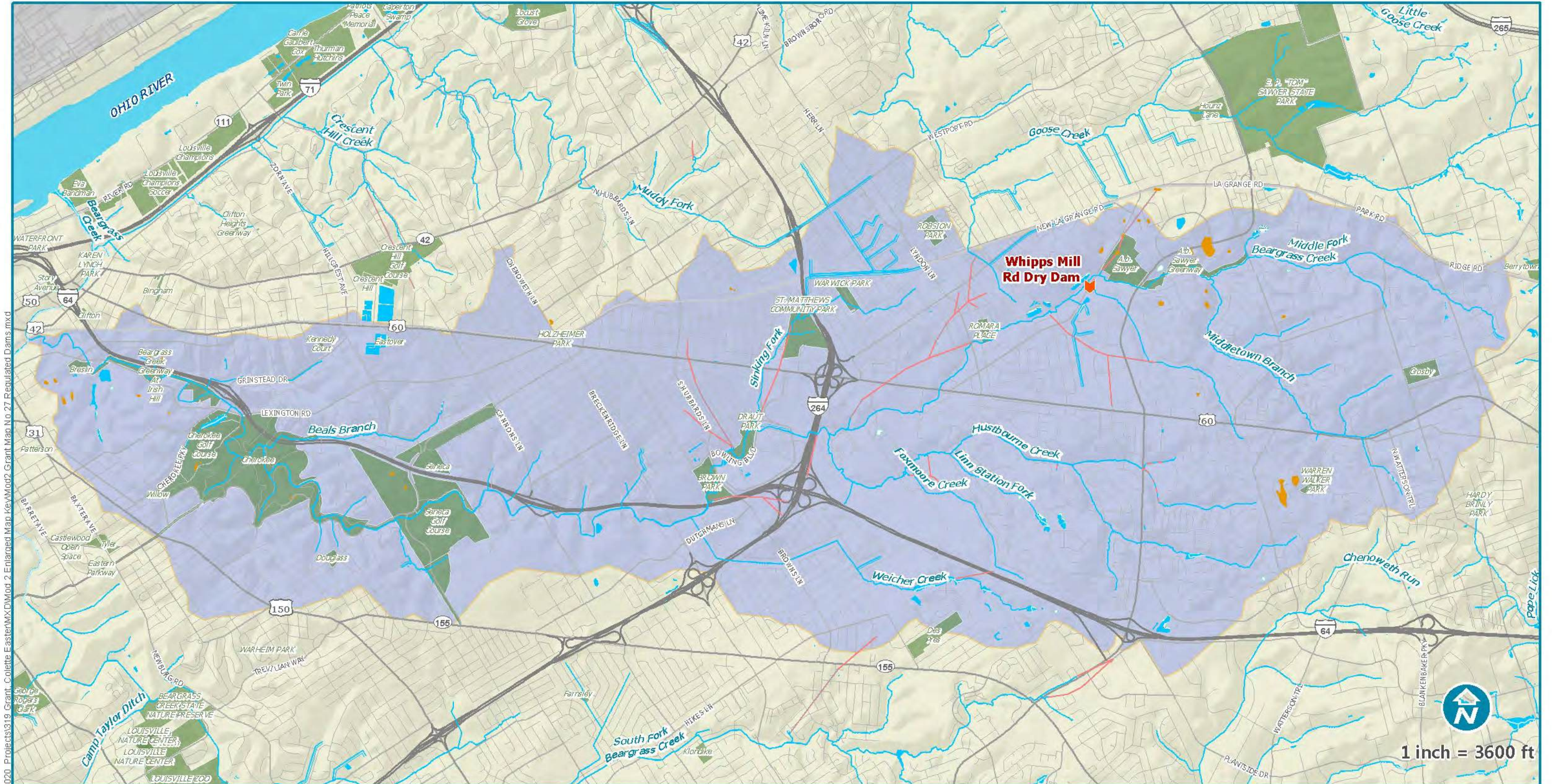


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1 inch = 3600 ft

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Map Key

Watershed Boundary	Bodies of Water	Stream/River, Perennial	Pipeline
Sinkholes	Wetlands	Stream/River, Intermittent	Artificial Path
Parks	Dams	Canal/Ditch	Connector
		Underground Conduit	

Regulated Dams

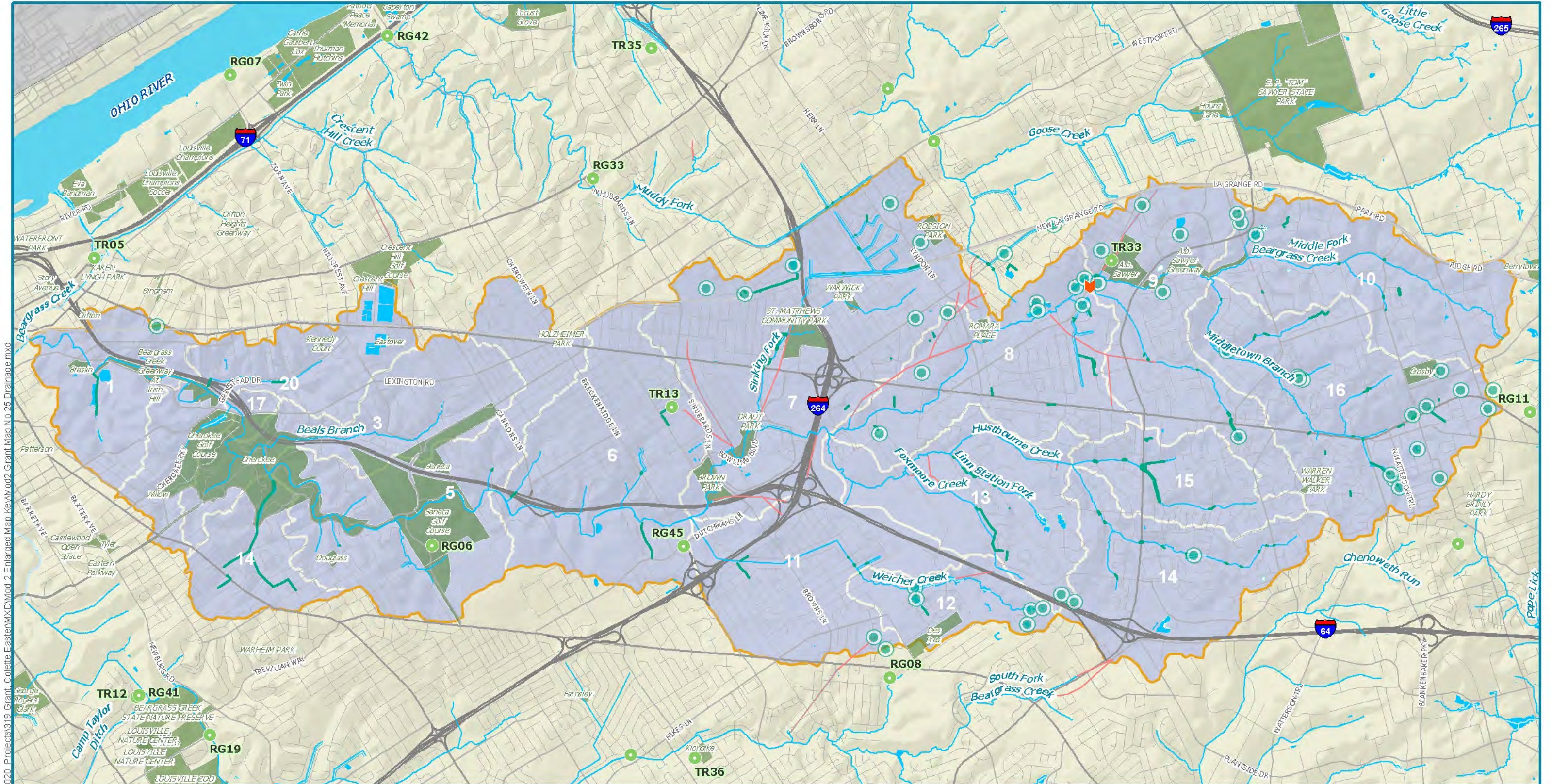
Middle Fork Beargrass Creek
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Map Key

Watershed Boundary	Wetlands	Stream/River, Perennial	Pipeline
MF BGC Sub-Basins	Detention Basin	Stream/River, Intermittent	Artificial Path
Parks	Rain Gauges	Canal/Ditch	Connector
Bodies of Water	Dams	Underground Conduit	Drainage Mains, by Dia
			48 - 96"
			96 - 240"

Drainage & Detention

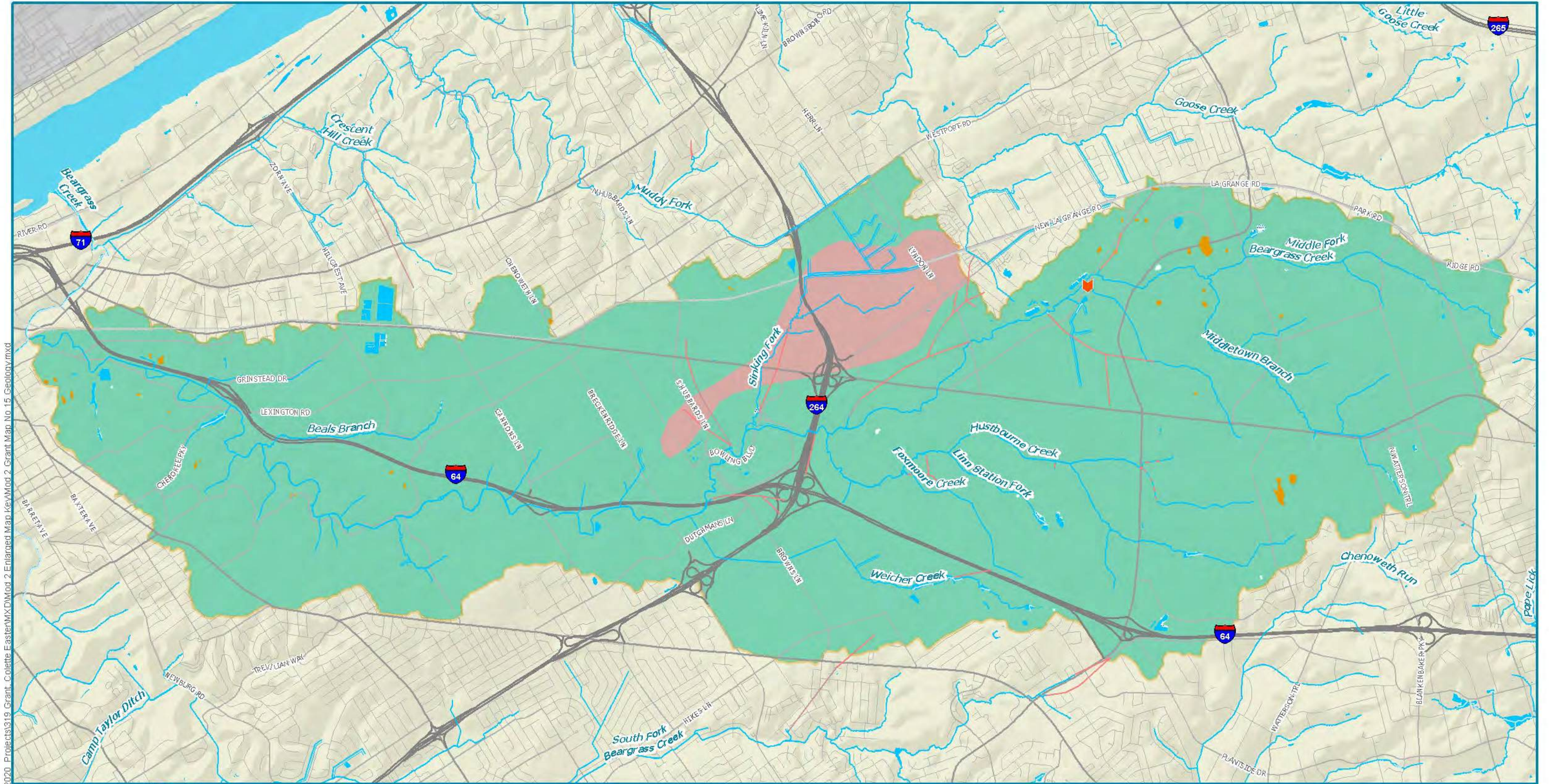
Middle Fork Beargrass Creek 319(h) Grant

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Document Path: I:\gis\records\project_mxd\2020_P\Projects\319 Grant_Colette_EasterMX\DMMod 2_Enlarged Map Key\Mod 2_Grant Map No 15_Geology.mxd



Map Key

- Watershed Boundary
- Bodies of Water
- Wetlands
- Dams

Geology

- Black Shale
- Limestone
- Sinkholes

- Stream/River, Perennial
- Stream/River, Intermittent
- Canal/Ditch
- Underground Conduit

- Pipeline
- Artificial Path
- Connector

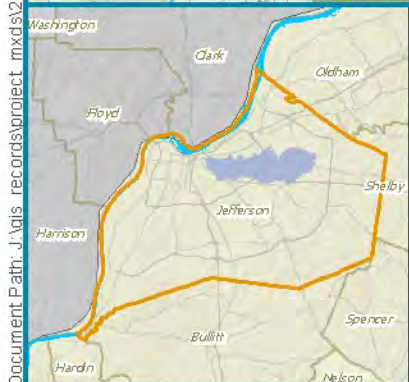
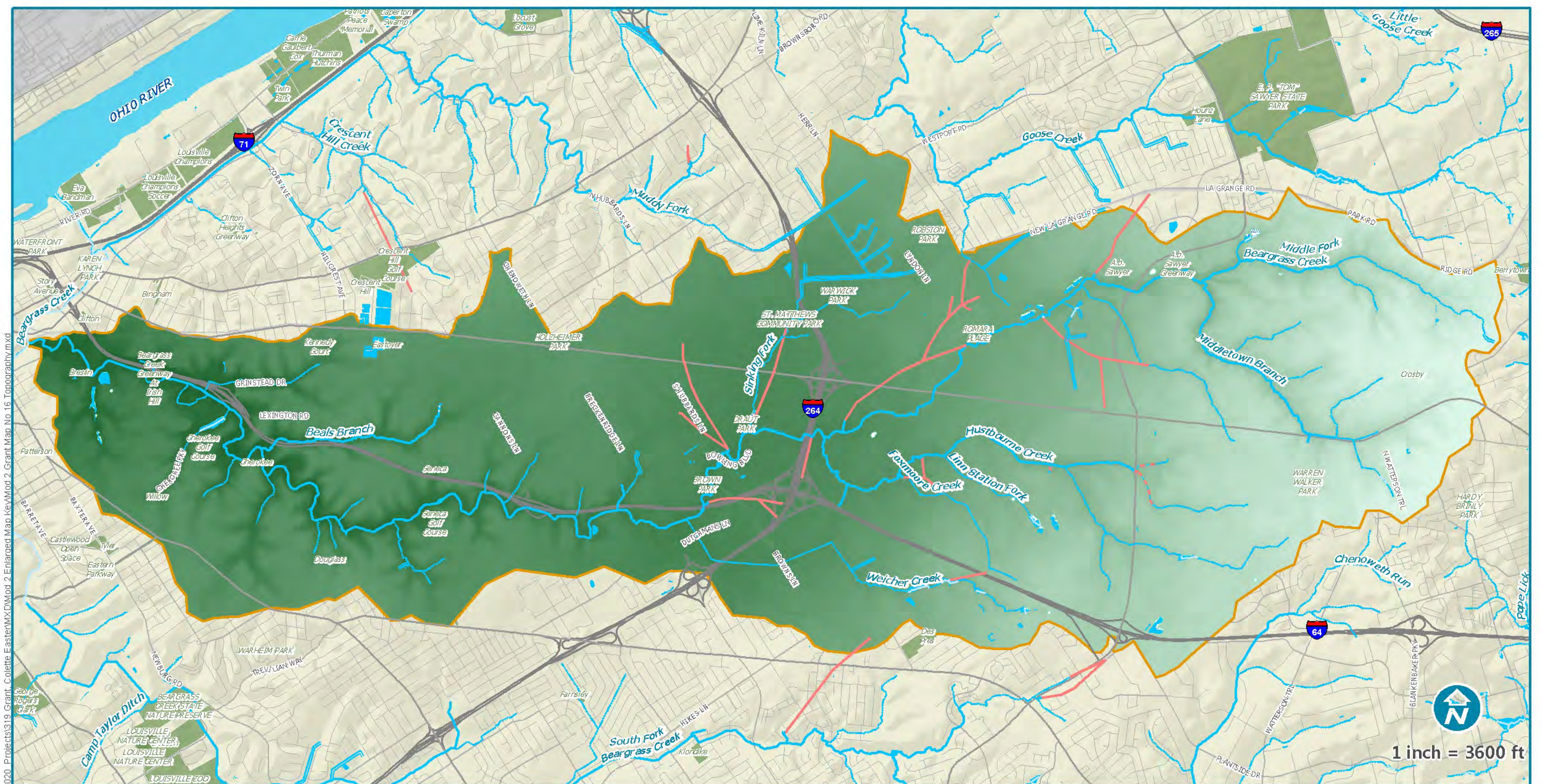
Geology

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Map Key

	Watershed Boundary		Stream/River, Perennial		Pipeline
	Bodies of Water		Stream/River, Intermittent		Artificial Path
	Wetlands		Canal/Ditch		Connector
			Underground Conduit		

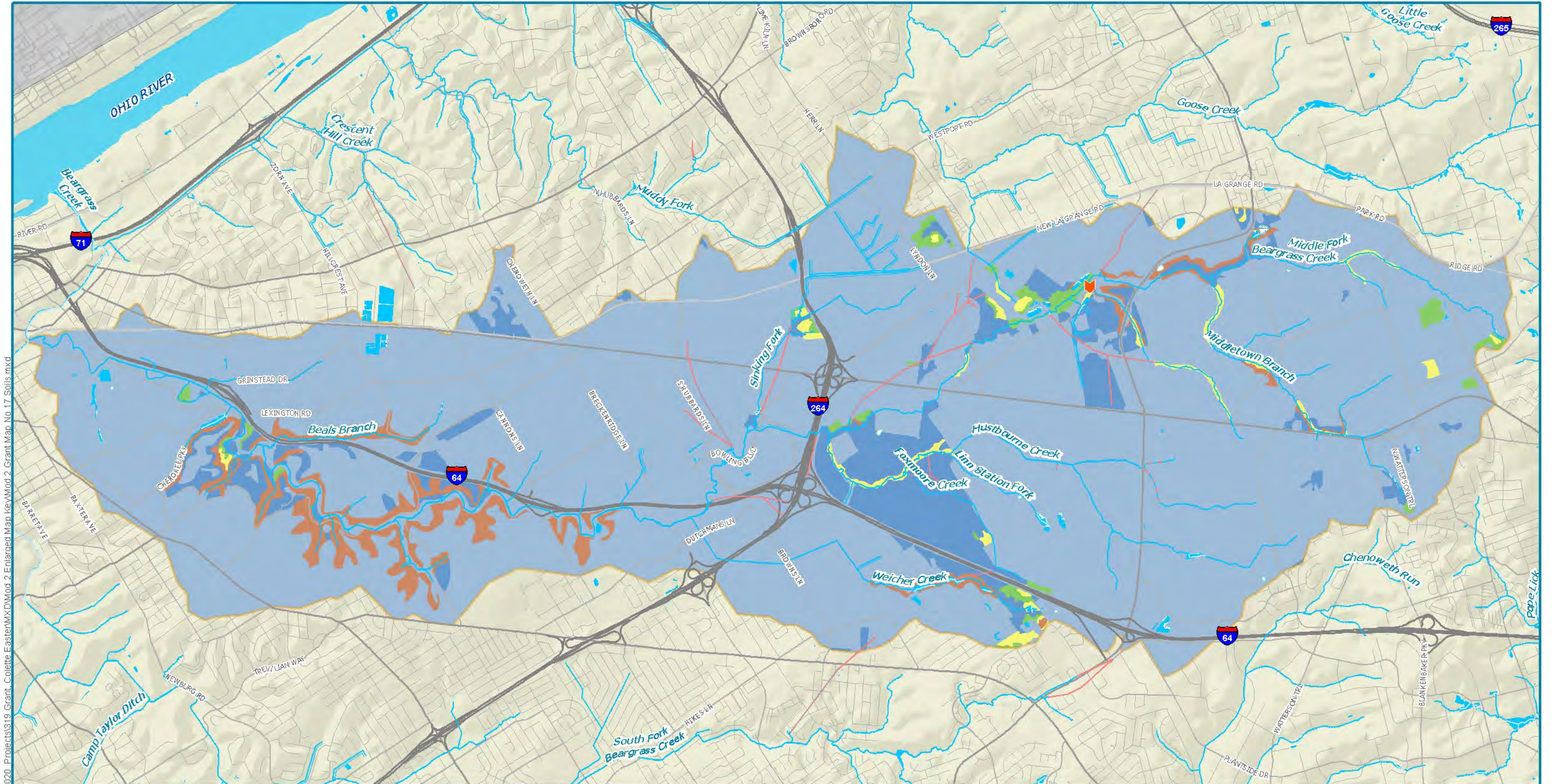
Topography

Middle Fork Beargrass Creek
319(h) Grant

749.2 Ft
405.0 Ft

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Map Key

- Watershed Boundary
- Bodies of Water
- Wetlands
- Dams

- Stream/River, Perennial
- Stream/River, Intermittent
- Canal/Ditch
- Underground Conduit

- Pipeline
- Artificial Path
- Connector

Hydraulic Group, Soils

- | | |
|-----|-----|
| B | C/D |
| B/D | D |
| C | NA |

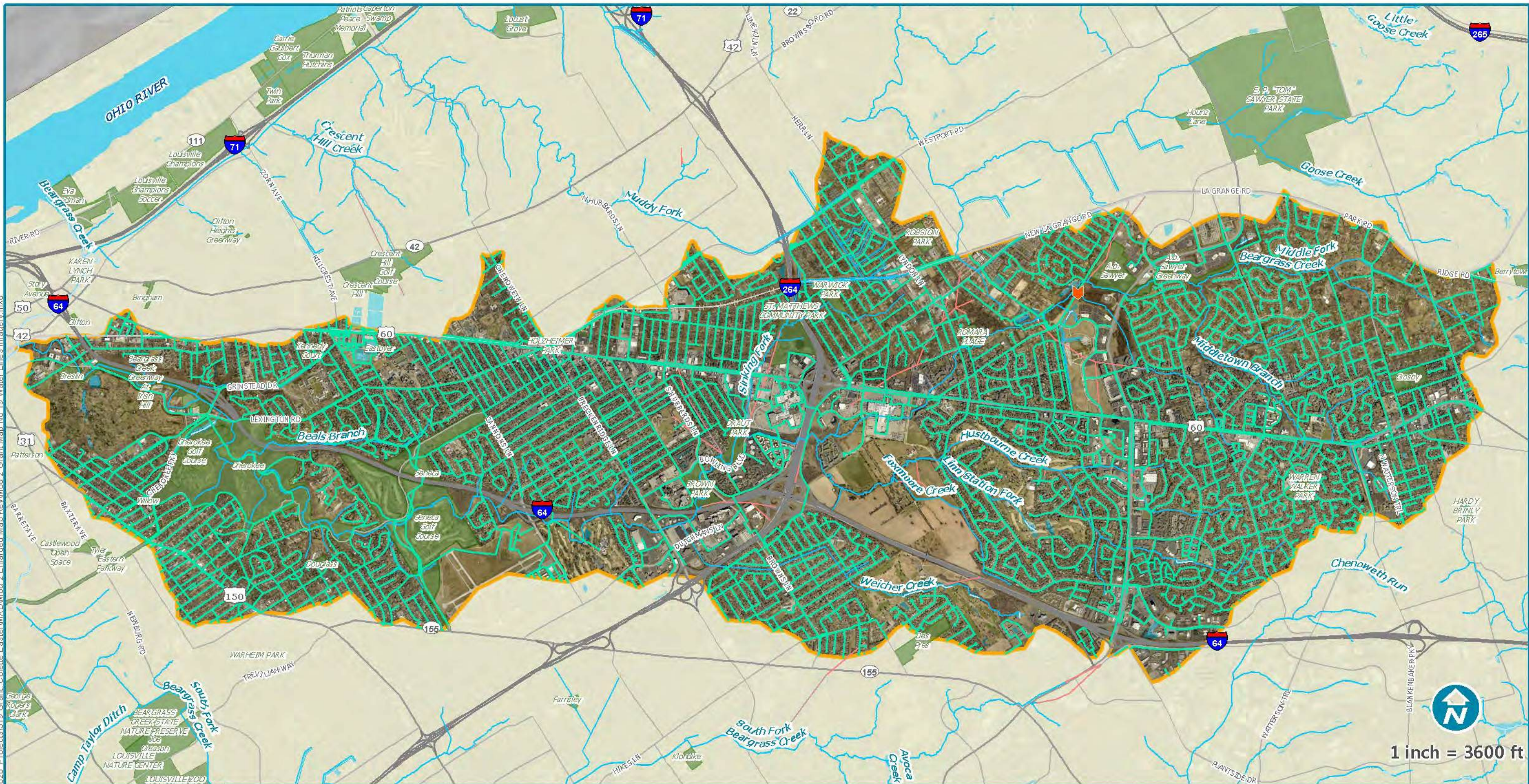
Soils

Middle Fork Beargrass Creek
319(h) Grant



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Map Key

	Watershed Boundary		Wetlands		Stream/River, Perennial		Pipeline
	Parks		Dams		Stream/River, Intermittent		Artificial Path
	Bodies of Water		LWC Water Mains		Canal/Ditch		Connector
			Underground Conduit				

Water Lines

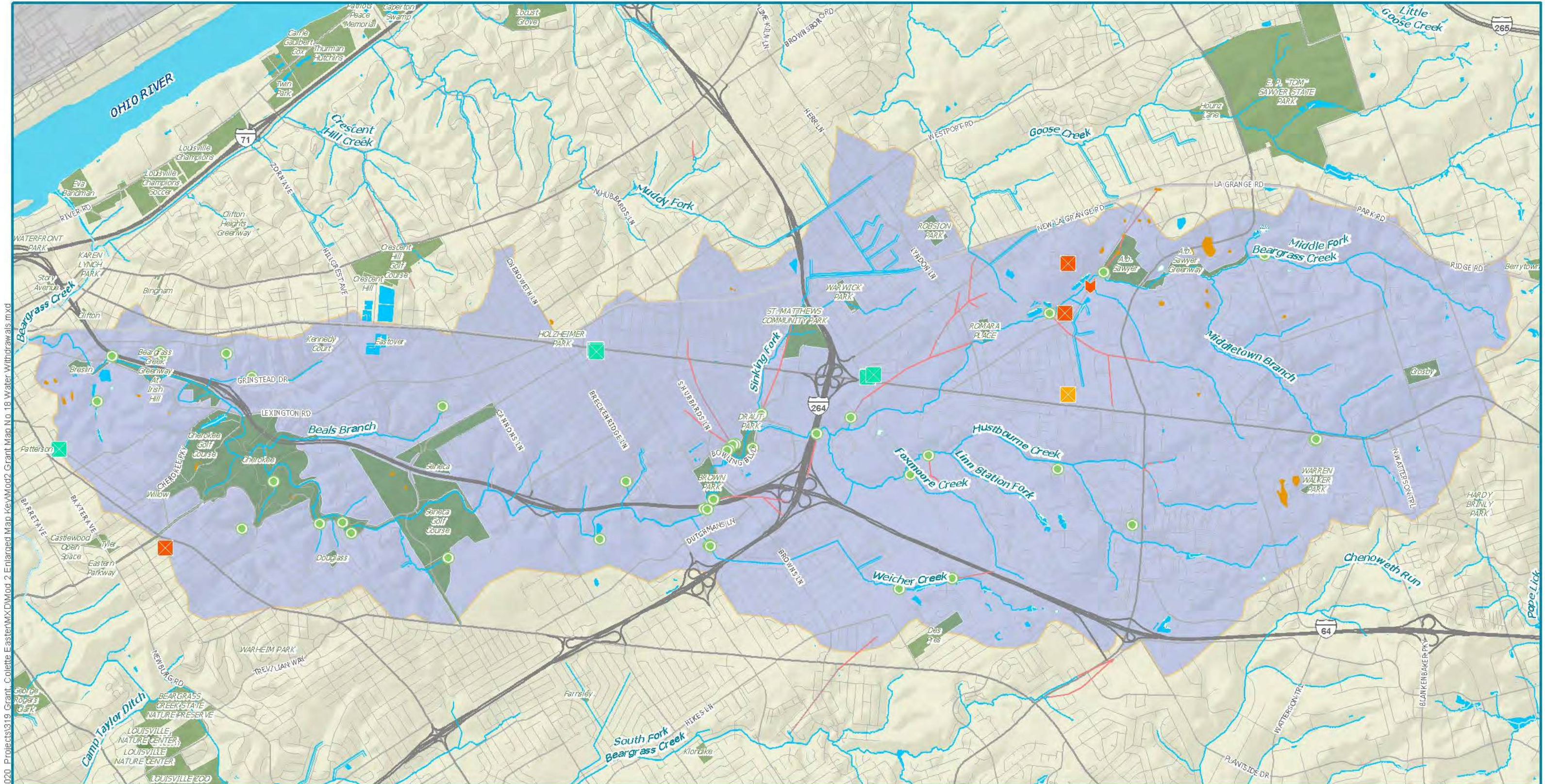
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Map Key

- | | | | |
|--------------------|----------------------------|-----------------|---------------------|
| Watershed Boundary | Stream/River, Perennial | Pipeline | Agriculture Wells |
| Sinkholes | Stream/River, Intermittent | Artificial Path | Domestic Wells |
| Bodies of Water | Canal/Ditch | Connector | Remediation Wells |
| Wetlands | Underground Conduit | Dams | Groundwater Springs |

Water Withdrawal

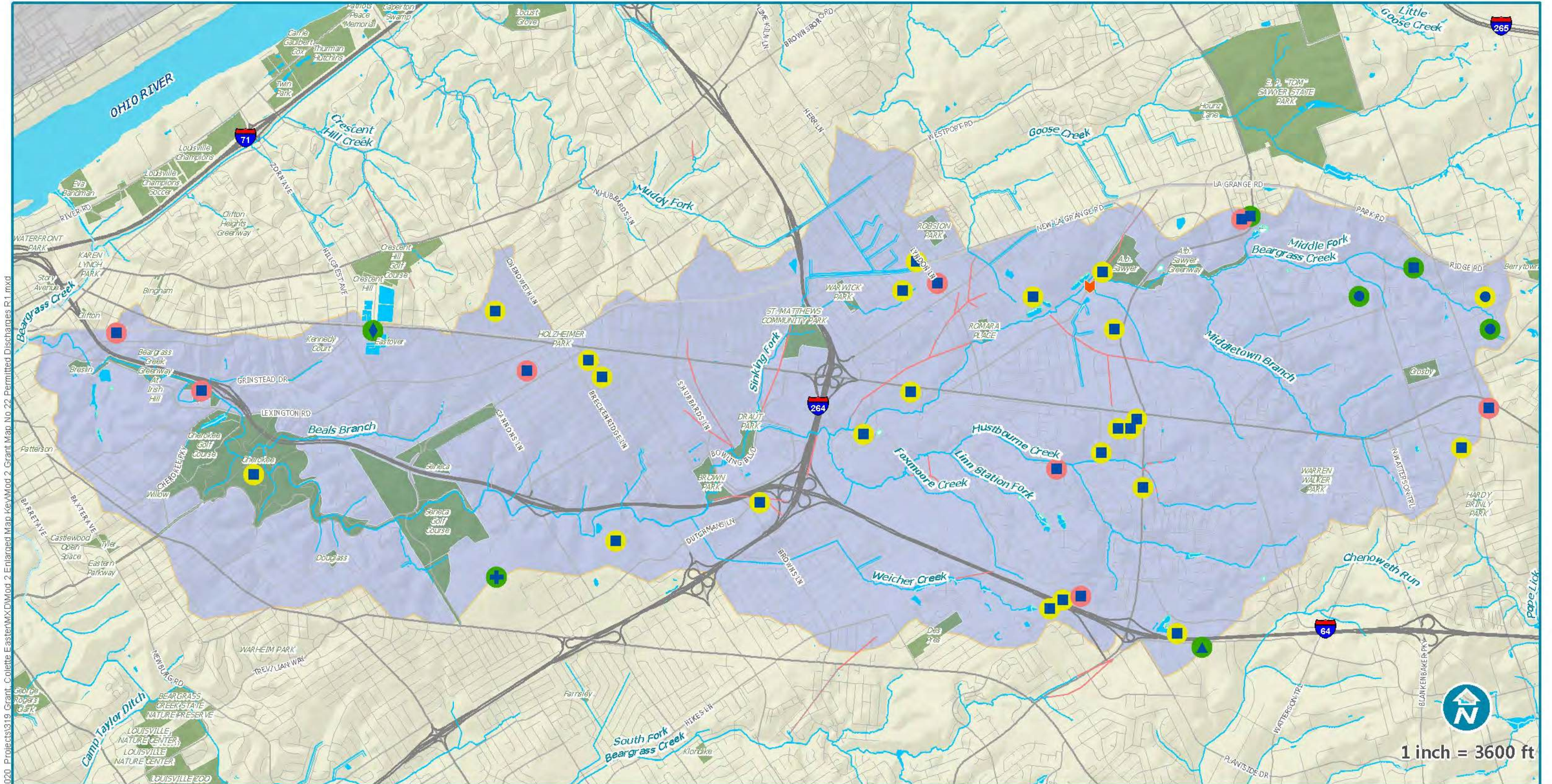
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Map Key

KDPES Permitted Discharge, Type

▲	KYR00s SW Industrial GP
■	KYR10s SW Const GP

◆	Minor DW Backwash
●	Minor Home Unit
+	SW Industrial-IP
🚧	Dams

KPDES Permitted Discharge, Status

●	Admin Continued
●	Effective
●	Expired

Permitted Discharges

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Map Key

Combined Mains	Overflows	Stream/River, Perennial	Pipeline
Combined Interceptor	Air Release Lines	Stream/River, Intermittent	Artificial Path
Force Mains	Sanitary Mains	Canal/Ditch	Connector
Siphons	Trunk/Interceptors	Underground Conduit	Pump Station, MSD
			Pump Station, Priv.

Sewer Lines

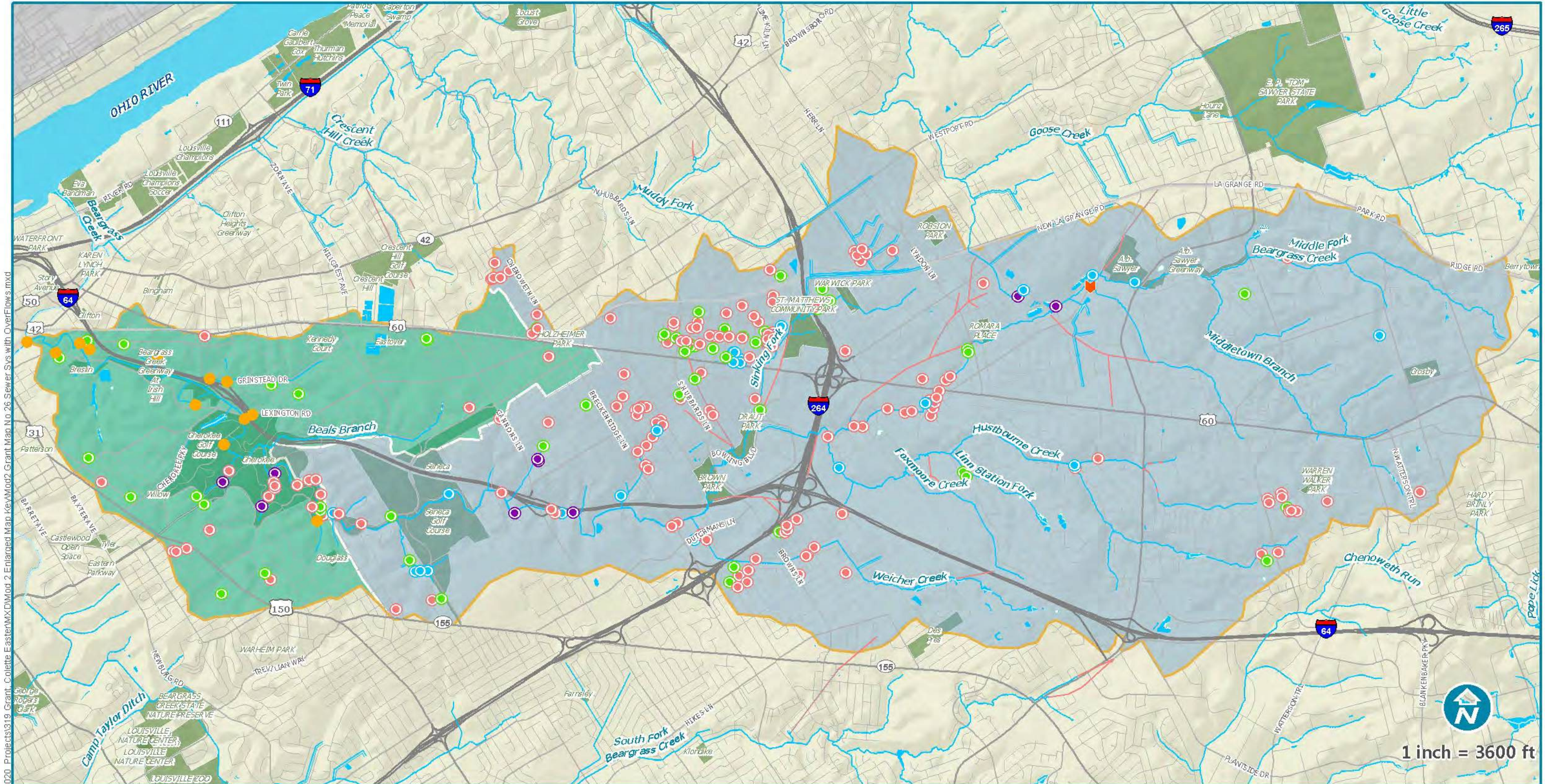
Middle Fork Beargrass Creek
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1 inch = 3600 ft



Map Key

- | | | |
|--------------------|-----------------------------|-----------------------------------|
| Watershed Boundary | Sanitary Sewer Service Area | Beyond Approved Design SSO, Storm |
| Parks | Combined Sewer Service Area | Documented SSO |
| Bodies of Water | Dams | Force Majeure SSO |
| Wetlands | CSO's | Suspected SSO |

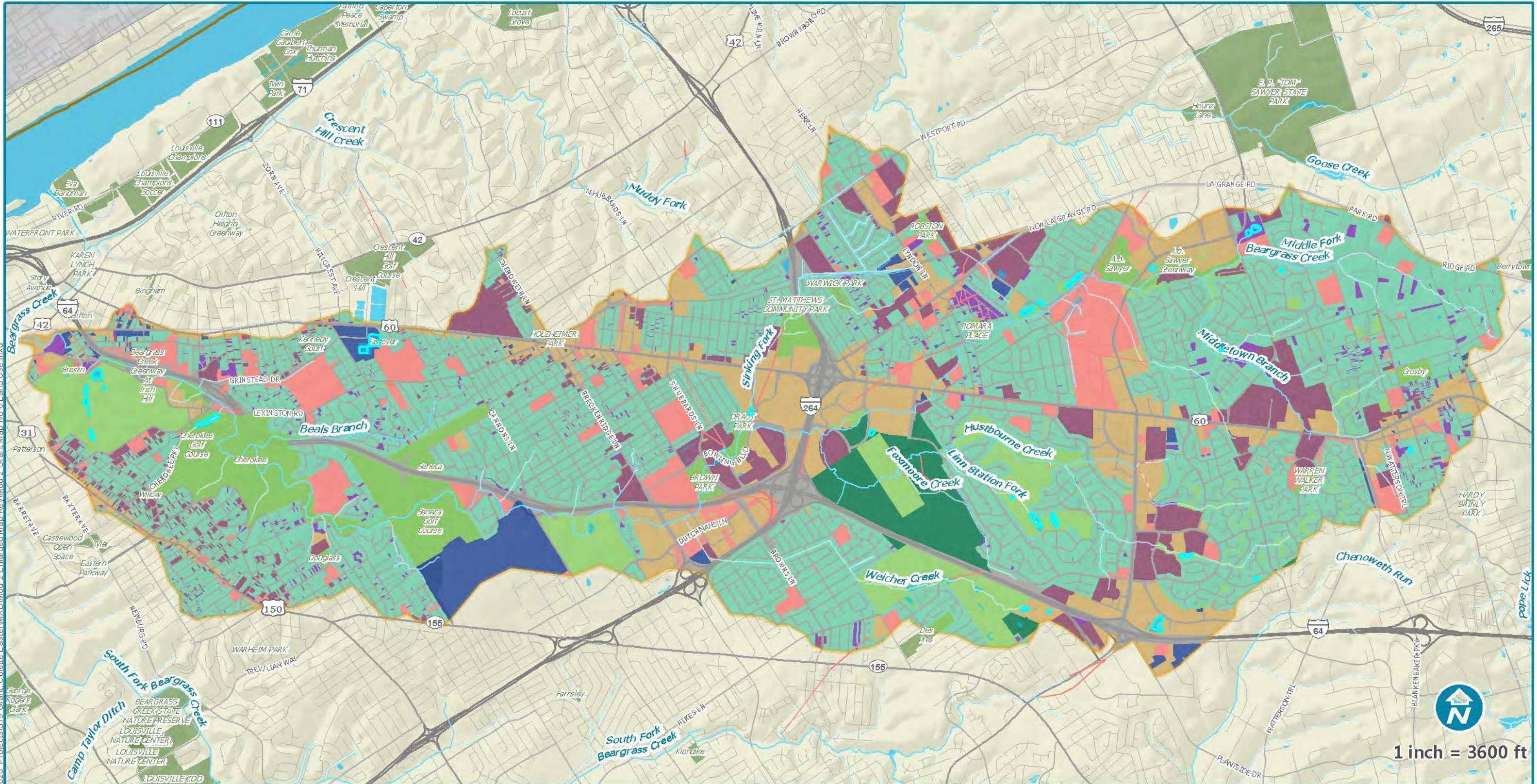
Sewer Systems & Overflows

Middle Fork Beargrass Creek
319(h) Grant



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Map Key

	Watershed Boundary		Commercial		Multi-Family		Right of Way
	Bodies of Water		Farmland		Parks & Open Space		Single Family
	Wetlands		Industry		Public & Semi-Public		Vacant

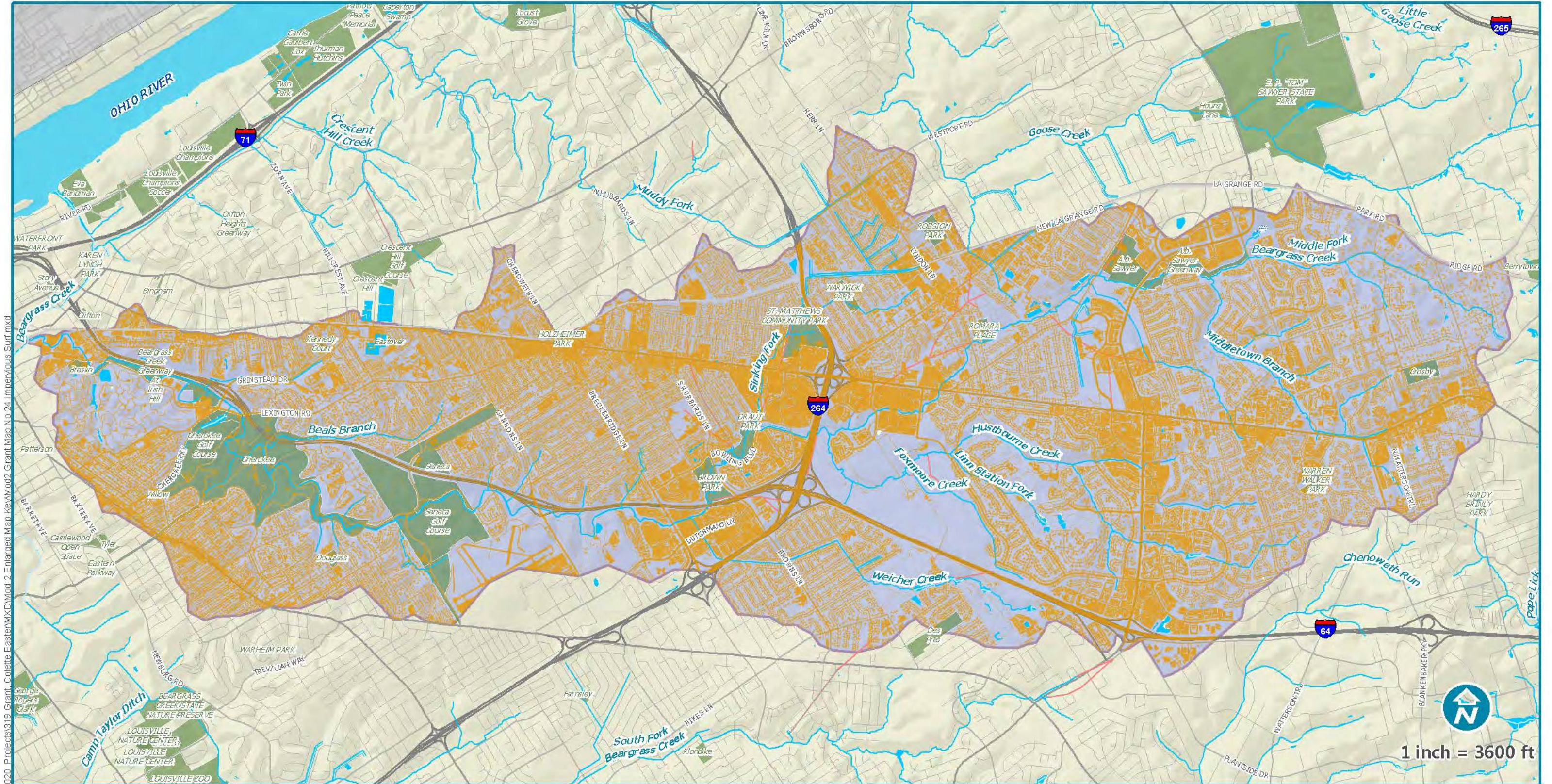
Land Use

Middle Fork Beargrass Creek
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Map Key

- | | | |
|--------------------|----------------------------|--------------------|
| Watershed Boundary | Stream/River, Perennial | Pipeline |
| Parks | Stream/River, Intermittent | Artificial Path |
| Bodies of Water | Canal/Ditch | Connector |
| Wetlands | Underground Conduit | Impervious Surface |

Total Impervious Area:
37%

Impervious Surface

Middle Fork Beargrass Creek
319(h) Grant



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APPENDIX 3.1 QAPP AND SOP



**Quality Assurance Project Plan (QAPP)
MSD 319(h) Monitoring for the Middle Fork of Beargrass
Creek Watershed Plan**

Prepared By:

Stantec Consulting Services, Inc.
10509 Timberwood Circle, Suite 100
Louisville, KY 40223-5301
502-212-5000

and

Louisville and Jefferson County Metropolitan Sewer District
700 West Liberty Street
Louisville, KY 40201
502-540-6000

Prepared For: Kentucky Division of Water
Watershed Management Branch
Nonpoint Source Section
300 Sower Boulevard
Frankfort, KY 40601

Effective Date: 5/8/2020
Revision No.: 0.0
Revision Date: _____

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1.0 PROJECT MANAGEMENT

1.1 Title and Approval Sheet

Action By	Signature	Date
Sarah Goodin , Project Quality Assurance Manager Louisville MSD		05/14/2020
Colette Easter , Reviewed Project Manager Louisville MSD		05/14/2020
Lori Rafferty , Approved MS4 Program Manager Louisville MSD		05/19/2020
Daymond Talley , Reviewed Laboratory Manager Louisville MSD		05/28/2020
Perry Thomas , Reviewed Nonpoint Source Technical Advisor Watershed Management Branch, DOW		
Dale Booth , Approved NPS and Basin Team Supervisor Watershed Management Branch, DOW		
John Webb , Approved Manager Watershed Management Branch, DOW		
Caroline Chan , Approved Quality Assurance Coordinator Watershed Management Branch, DOW		
Mary Rockey , Approved Quality Assurance Officer Division of Water		
Paul Miller , Approved Director Division of Water		

Larry Taylor , Approved Quality Assurance Manager Department for Environmental Protection		
---	--	--

1.2 **Revision History**

Initial revision date is the first preparation of the document. Consecutive revisions should be listed first, with the older revisions listed last.

Date of Revision	Page(s)/Section(s) Revised	Revision Explanation	Person Responsible

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- A. Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan
- B. MSD 319(h) Planned Schedule for Quality Control Sample Collection

Note: This Quality Assurance Project Plan (QAPP) was developed using the Quality Assurance Project Plan Template: Environmental Monitoring for a Watershed Plan provided by DOW personnel to MSD in March 2019.

1.4 Acronyms and Abbreviations

319(h) – Section 319(h) of the Clean Water Act (33 USC §1329)

BMP – Best Management Practice

COC – Chain of Custody (forms)

CSO- Combined Sewer Overflow

DOW- (Kentucky) Division of Water

DQI – Data Quality Indicators

DQO – Data Quality Objectives

E. coli – *Escherichia coli*

EPA – Environmental Protection Agency

FDCS – Field Data Capture Sheets

GA – Grant Advisor

GIS – Geographic Information System

DOW – Kentucky Division of Water

LIMS – Laboratory Information Management System

LOD – Limit of Detection

LOJIC – Louisville / Jefferson County Information Consortium

LOQ – Limit of Quantitation

LTMN – Long Term Monitoring Network

MDL – Method Detection Limit

MS4 – Municipal Separate Storm Sewer System

MSD – (Louisville and Jefferson County) Metropolitan Sewer District

NPS – Non-point source

NWIS – National Water Information System

QAPP – Quality Assurance Project Plan

QA – Quality Assurance

QC – Quality Control

RPD – Relative Percent Difference

RPPS – Resource Planning and Program Support

SOP – Standard Operating Procedure

SRWW – Salt River Watershed Watch

TA – Technical Advisor

TMDL – Total Maximum Daily Load

USGS – United States Geological Survey

WMB – Watershed Management Branch

WQTC – Water Quality Treatment Center

1.5 Distribution List

319(h) Grant Recipient Personnel		
Name	Role	Organization *
Lori Rafferty	Municipal Separate Storm Sewer System (MS4) Program Manager	MSD
Colette Easter	Project Manager	MSD
Dwight Mitchell	Field Team Manager	MSD
David Radke	Research Chemist	MSD
Daymond Talley	Laboratory Manager	MSD
Sarah Goodin	Project Quality Assurance Manager	MSD

These grant recipient members can be contacted at:

* Louisville and Jefferson County Metropolitan Sewer District (MSD)
700 W Liberty St
Louisville, KY 40203
502-540-6000

Kentucky Division of Water Personnel		
Name	Role	Division/Branch/Section (1)
Perry Thomas	Technical Advisor	DOW/WMB/NPS and Basin Team Section
Mike Reed	Grant Manager	DOW/Resource Planning and Program Support
Mary Rockey	Division Quality Assurance Officer	DOW
Dale Booth	NPS and Basin Team Supervisor	DOW/WMB/NPS and Basin Team Section
John Webb	WMB Manager	DOW/Watershed Management Branch
1. DOW: Division of Water WMB: Watershed Management Branch NPS: Non-point Source		

These DOW organization members can be contacted at:

Kentucky Division of Water (DOW)
300 Sower Blvd
Frankfort, KY 40601
502-564-3410

1.6 Project / Task Organization

DOW Project Technical Advisor (TA) – Perry Thomas: will oversee overall project operations. She communicates with MSD and is the liaison between the MSD and DOW personnel on project requirements and deliverables.

DOW NPS and Basin Team Supervisor – Dale Booth: may review the QAPP and will ensure the project Technical Advisor is assigned. She is ultimately responsible for overall project completion and preparing reports to DOW management and EPA.

DOW RPPS Grant Advisor (GA) – Mike Reed: will manage all grant operations. He will distribute required grant-related documents to the MSD and DOW.

DOW WMB Quality Assurance Coordinator – Caroline Chan: reviews and approves the QAPP and may make recommendations on project operations related to QA activities. She will be involved in reviewing data reports throughout the project.

DOW WMB Manager – John Webb: reviews and approves the QAPP.

DOW Quality Assurance Officer – Mary Rockey: reviews and approves the QAPP. She will provide technical input for QAPP development and will review data reports throughout the project.

MSD Grant Recipient Project Manager – Colette Easter: may write the QAPP or designate this role. She will be responsible for all communications between DOW and MSD. She will be responsible for project operations on the ground and reporting to DOW whenever this QAPP or the grant requires. She will be responsible for submitting progress and final reports and data to DOW.

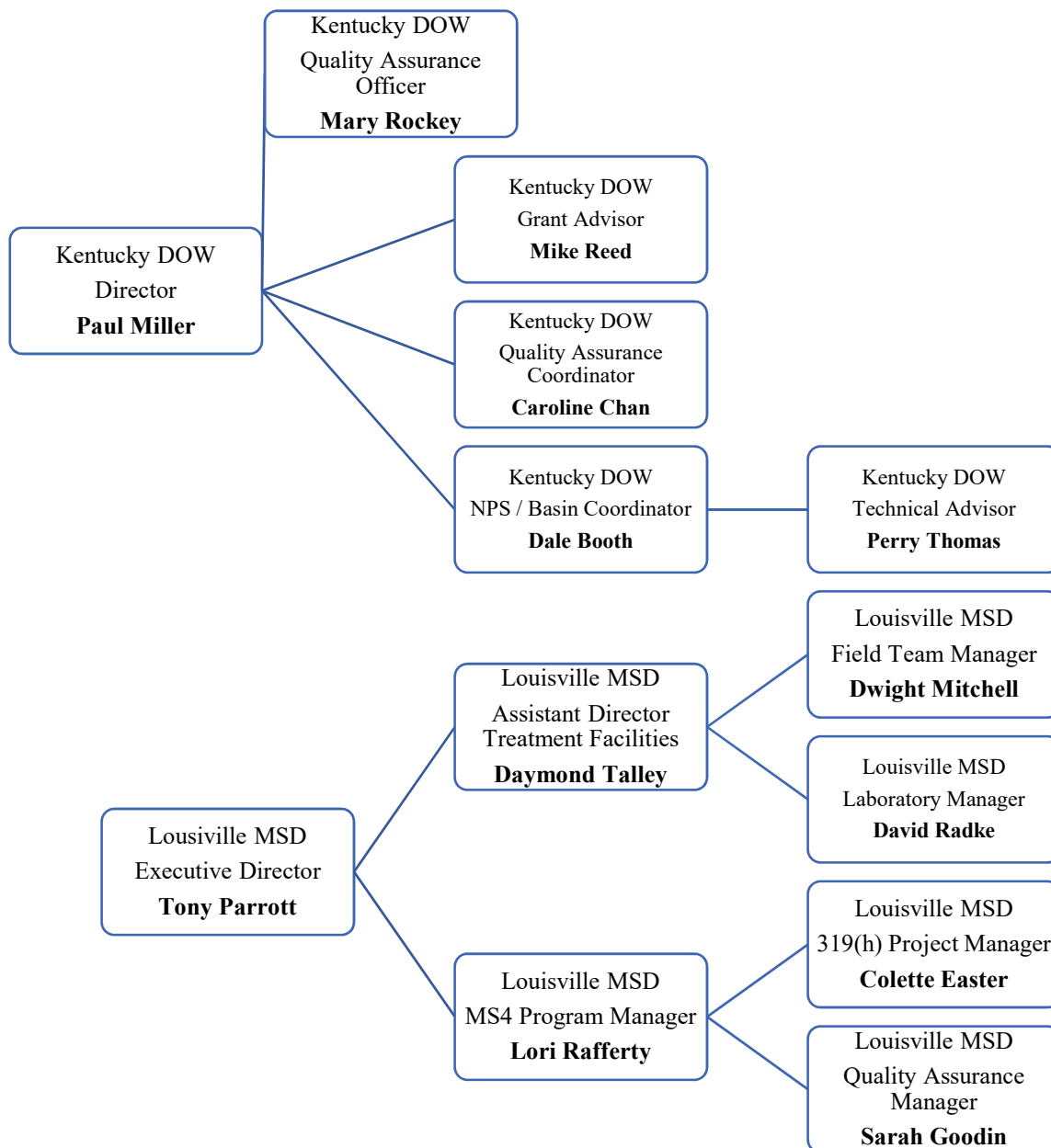
MSD Grant Recipient Project QA Manager – Sarah Goodin: will be separate from data collection for the project (if possible). She may be responsible for reviewing and implementing the QAPP and ensuring that all QA activities are followed throughout the project. She may conduct data analysis.

MSD Field Team Manager – Dwight Mitchell: is responsible for sample collection and ensuring that the field sample collection adheres to this QAPP.

MSD Morris Forman WQTC Laboratory Manager – Daymond Talley: oversees all aspects of laboratory operations including quality assurance, quality control, maintaining certifications, staffing, supplies and equipment, maintenance and operations, data management. This laboratory is certified by Kentucky Division of Water (DOW). The laboratory certification number is KY#08034.

MSD Morris Forman WQTC Laboratory Research Chemist – David Radke: is responsible for overseeing the water quality sample analysis performed at the MSD lab, data entry and QA/QC review and reporting for laboratory analysis.

Figure 1. Project Organizational Chart



1.7 Project Background and Overview

The Middle Fork of Beargrass Creek drains a 25.2 square mile watershed in Jefferson County, Kentucky (Figure 2). It includes approximately 61 linear miles of stream within the 14-digit Hydrologic Unit Code (HUC) 05140101250010. The Kentucky Division of Water (DOW) has identified water quality impairments in segments of Middle Fork Beargrass Creek (DOW, 2010a). The downstream segment (river mile 0.0 to 2.0) was listed as impaired because warm water aquatic habitat (fishable) and primary contact recreation (i.e., swimming) uses were not supported. The middle segment (river mile 2.0 to 2.9) and the upper segment (river mile 2.9 to 15.3) were listed as impaired because primary contact recreation uses (swimming) were not supported. Other designated uses were not assessed. In addition to these impairments, sedimentation and loss or lack of riparian habitat are also of concern.¹

To address the recreational designated use impairments, DOW developed a Fecal Coliform Total Maximum Daily Load (TMDL) (DOW, 2011a). This TMDL included target reductions of fecal coliform bacteria needed to achieve the water quality standards. In addition, a proposed draft TMDL was developed for organic enrichment impairments (DOW, 2011b). Both of these TMDLs recommended development of a Watershed Based Plan as a non-regulatory strategy to support attaining the goals of the TMDL.

Per the most recent Integrated Report published in 2018, the downstream end of Middle Fork Beargrass Creek (River Mile 0.0 to 2.0) is listed as being impaired for Warm Water Aquatic Health. Warm Water Aquatic Health uses were listed as fully supported in the two (2) segments extending from River Mile 2.0 to 2.9 and 2.9 and 15.3. All three (3) of these segments were listed as having an approved or established TMDL with Primary Contact Recreation (swimming) uses not met due to elevated bacteria concentrations (KDOW, 2018).

The focus of this watershed plan is to work with project partners and watershed stakeholders to identify and reduce the sources of bacteria, focusing on urban runoff as a non-point source of bacteria. This watershed planning project does not directly address sources of oxygen-demanding substances. However, the Best Management Practices identified through this project as well as extensive efforts being implemented by the Louisville and Jefferson County Metropolitan Sewer District (MSD) to reduce the frequency and volume of combined sewer overflows and to eliminate sanitary sewer overflows are anticipated to result in reductions in oxygen-demanding substances. Other aspects of the watershed planning project not addressed through water quality monitoring will focus on habitat modification, and hydrologic modification. MSD will assess progress toward

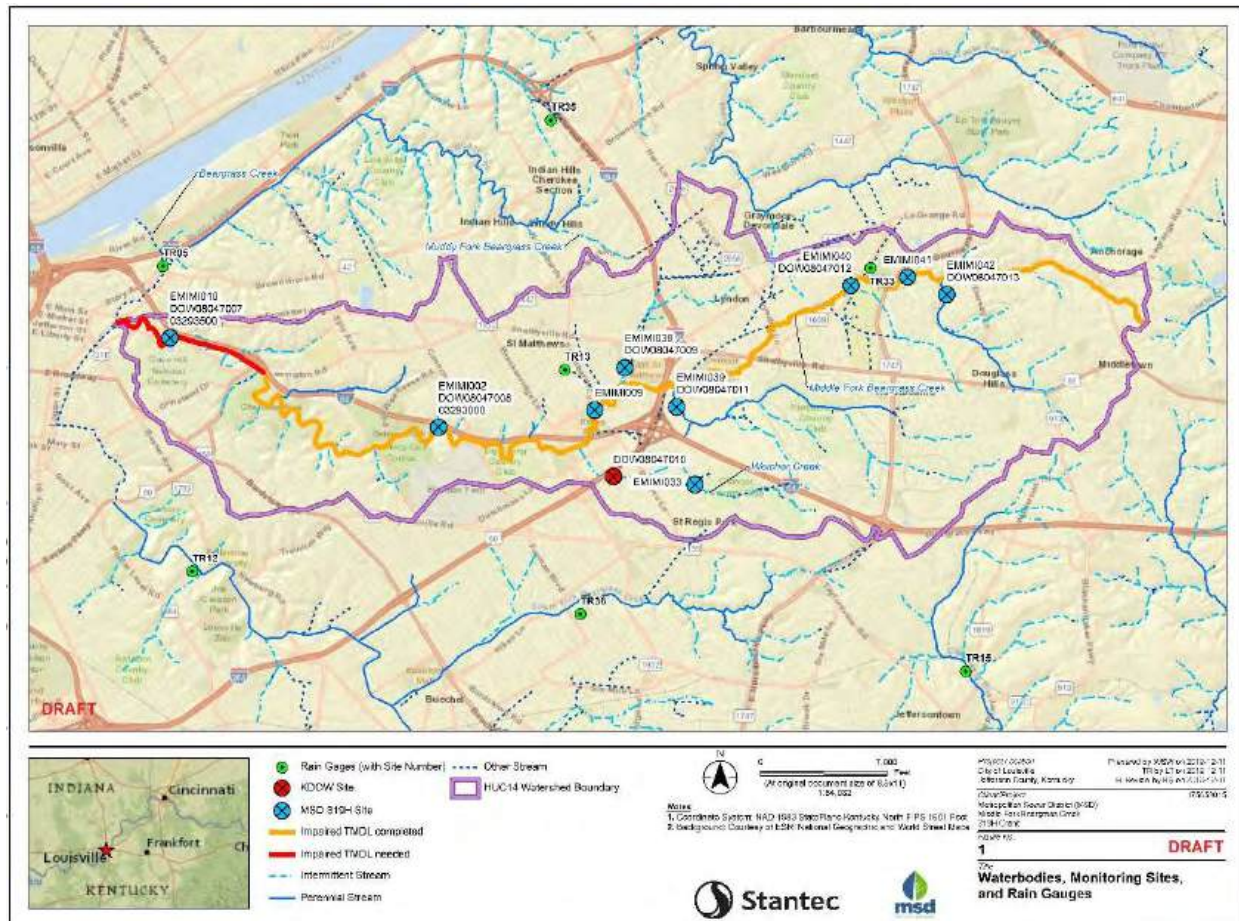
¹ Please see the Watershed Planning Guidebook, Watershed Basics, Part III: The Regulatory World for a more detailed description of designated uses and impairments (KDOW 2010b).

achieving the goals of watershed planning through the collection of water quality data at nine (9) locations within the watershed.

This Quality Assurance Project Plan (QAPP) was developed based on review of several guides and resources (EPA, 2002; DOW, 2011c; USGS, 2006), and outlines the measures taken to ensure the collection of quality surface water monitoring data throughout the conductance of this project.

The watershed boundary, mapped and assessed waterbodies, Long Term Monitoring Network sites (3 sites), DOW 319(h) monitoring sites (7 sites), MSD 319(h) monitoring sites (9 sites), some of which are co-located and MSD rain gauges are shown on Figure 2. This figure also depicts the impairment status per the *2016 Integrated Report 303(d) List* (DOW, 2018).

Figure 2. Waterbodies, Monitoring Sites, and Rain Gauges (1)



1. Map depicts watershed boundary, mapped and assessed waterbodies, Long Term Monitoring Network sites (3 sites), DOW 319(h) monitoring sites (7 sites), MSD 319(h) monitoring sites (9 sites), impairment status per the 2016 Integrated Report 303(d) List (DOW, 2018).

Monitoring performed by MSD under the Municipal Separate Storm Sewer System (MS4) Permit (KPDES Permit # KYS000001) and this 319(h) project and DOW in the Middle Fork Beargrass Creek Watershed is described below.

MSD MS4 Program Monitoring: MSD's Long Term Monitoring Network (LTMN) activities in the Middle Fork Beargrass Creek include continuous monitoring for stream discharge, gage height at three (3) sites, continuous monitoring for temperature, dissolved oxygen, pH, and specific conductance at two (2) sites. Monitoring activities at three (3) sites include: quarterly water quality, recreation season bacteria monitoring, and biological monitoring (every two years). Rain gauges continuously monitor precipitation at two (2) sites and NEXRAD radar data is also collected.

DOW 319(h) Monitoring: DOW completed monitoring at seven (7) locations in support of the Middle Fork Beargrass Creek Watershed-Based Plan between March 2019 and February 2020. Monitoring included *E. coli* bacteria, water chemistry, field observations, stream discharge, benthic macroinvertebrates, and habitat assessment. This monitoring will be reported in Chapter 3 of the Watershed-Based Plan.

MSD 319(h) Monitoring: The specific purpose of this monitoring is to collect additional *E. coli*, field parameters and flow data that more fully characterize bacteria concentrations and loadings as well as sources of bacteria pollution and watershed response to changes in season and flow. *Therefore, the E. coli and stream discharge data are considered to be the most critical parameters for this monitoring component of watershed-based plan development.*

Taken together, MS4 data, DOW 319(h) data and MSD 319(h) data will provide a stronger basis for identifying sources and tracking progress toward the ultimate goal of clean, safe waterways. This monitoring will be reported in Chapter 3 of the Watershed-Based Plan.

The MSD 319(h) Monitoring is the subject of this QAPP for nine (9) MSD locations (Figure 2). The types of samples, field activities, measurements/analyses collected, frequency and number of sites are summarized as in Table 1.

Table 1 – MSD 319(h) Monitoring Activities Overview

Monitoring Activity	Field Activities	Measurements/ Analyses Required	Frequency	# of Sites
<i>E. coli</i> bacteria	Grab sample	Standard Methods for the Examination of Water and Wastewater (SM9223B) 1997 MSD <i>E. Coli</i> Rev 6 090118 (or most recent update)	Monthly sampling event, plus 5 samples within 30 days for May or June	9

Monitoring Activity	Field Activities	Measurements/ Analyses Required	Frequency	# of Sites
Field Parameters	HydroTech Compact DS (1)	Dissolved oxygen, pH, specific conductance, water temperature, turbidity	Every sampling event	9
Stream discharge	Hach FH950 handheld flow meter & wading rod (1,2)	Stream discharge	Every sampling event	9

Notes:

1. At Middle Fork Beargrass Creek at Old Cannons Lane (03293000, EMIMI002) and Middle Fork Beargrass Creek at Lexington Road (03293500, EMIMI010), field parameters (i.e., dissolved oxygen, pH, specific conductance, water temperature) and stream discharge measurements will be supplemented with data from MSD/USGS sonde readings and USGS stream flow gages.
2. Hach FH950 is equipped with automatic depth sensor

The project schedule for the QAPP development, monitoring activities, data submittal, and report development are outlined in Table 2. The planned schedule for field quality control samples is provided in Appendix B.

Table 2 – MSD 319(h) Planned Project Schedule

<u>Year</u>	2019			2020 (1)												2021		
<u>Month</u>	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
QAPP/ Planning	X	X	X	X														
Monitoring					X	X	X	X	X	X	X	X	X	X	X	X		
Data Analysis					X	X	X	X	X	X	X	X	X	X	X	X	X	
Final Report																		X
1. Monitoring includes field parameters, stream discharge and E. coli measurements once per month. In May or June, samples will be collected five (5) times in 30 days.																		

1.8 Data Quality Objectives (DQOs)

Data Quality Objectives are qualitative and quantitative statements that clarify the intended use of the data, define the type of data needed to support the watershed plan, and identify the conditions under which the data should be collected. Note that these data quality objectives are focused on MSD 319(h) monitoring.

State the Problem: According to 2016 DOW Integrated Report, segments of the Middle Fork Beargrass Creek did not meet the primary contact recreation (swimming) designated use and therefore were designated as impaired. The purpose of this monitoring is to collect additional data to better characterize bacteria concentrations and loadings throughout the watershed, including mainstem and tributaries and to characterize source areas (subwatersheds) that may be contributing to elevated bacteria on the mainstem of Middle Fork Beargrass Creek. In addition, accurate baseline conditions will be necessary in order to show improvements in water quality after the implementation of any prescribed Best Management Practices (BMPs). MSD's MS4 monitoring will supplement the 319(h) monitoring performed by DOW.

Identify the Goal of the Study: Existing monitoring data collected by MSD occurs on the mainstem of Middle Fork Beargrass Creek at three (3) downstream locations: Lexington Road, Cannons Lane and Browns Park. The goal of this study is to further characterize the sources of *E. coli* bacteria and impacts on basic water chemistry parameters of nonpoint sources of urban runoff throughout the Middle Fork Beargrass Creek watershed and to establish baseline conditions for showing measurable improvements. The monitoring will be performed in support development of a watershed plan for the Middle Fork of Beargrass Creek that focuses on measurable improvements in the watershed, including recreational designated use attainment.

Identify Information Inputs: Information inputs include 319(h) monitoring, GIS mapping and existing data from other projects that have an equivalent QA system in place as described below.

- **MSD 319(h) Monitoring:** bacteria monitoring data, field parameters (pH, temperature, dissolved oxygen, conductivity, turbidity, stream discharge). Quality assurance requirements for these measurements are included in this QAPP.
- **DOW 319(h) Monitoring:** *E. coli* bacteria, water chemistry, field parameters, stream discharge, benthic macroinvertebrates and aquatic habitat. This monitoring will be reported in Chapter 3 of the Watershed-Based Plan.
- **GIS Mapping:** data sources include data that has been reviewed and published by the Louisville and Jefferson County Information Consortium (LOJIC) (<https://www.lojic.org/>), KY GeoNet (<http://kygeonet.ky.gov/>) and monitoring site locations provided by DOW. These data sources are responsible for quality assurance and metadata associated with their GIS data.
- **Existing Data with QA System in Place:** Monitoring is conducted at three (3) LTMN sites in the Middle Fork Beargrass Creek as described below and a more detailed description of the LTMN program is provided in the *2017 Municipal Separate Storm Sewer System (MS4) Annual Report* (Louisville / Jefferson County Metropolitan Sewer District, 2017).

- **USGS Stream Flow:** USGS collects stream flow measurements every 5 to 15 minutes from two (2) gauges in the Middle Fork Beargrass Creek, station numbers 03293500 and 03293000. USGS performs a quality assurance review and publishes final flow data and stream statistics. Provisional and final data are available for download on the USGS National Water Information System (NWIS) website: <http://waterdata.usgs.gov/ky/nwis>.
- **MSD / USGS Continuous Monitoring:** Temperature, dissolved oxygen, pH, and specific conductance data are collected by MSD and USGS at two (2) cooperatively operated monitoring locations using probes called sondes in the Middle Fork Beargrass Creek. Provisional water quality data is sent via telemetry to USGS every 15 minutes. Up to 35,136 records per year were collected for each parameter at each station during the year. Using USGS procedures, sondes are cleaned, calibrated, and maintained on a regular basis by MSD staff, which is trained annually by USGS (USGS, 2006). USGS performs a quality assurance review, adjusts or deletes some records, and publishes final data to the NWIS website.
- **MSD Quarterly Monitoring:** Trained MSD staff collect quarterly water quality samples at three LTMN sites in the Middle Fork Beargrass Creek for parameters required in the MS4 Permit. Samples are analyzed at MSD's Laboratory and MSD reports results in MS4 Annual Reports.
- **MSD Bacteria Monitoring:** As required by the MS4 Permit, trained MSD staff collect five *E. coli* bacteria samples at three LTMN sites in the Middle Fork Beargrass Creek. Samples are analyzed at MSD's Laboratory and MSD reports results in MS4 Annual Reports.
- **MSD Biological Monitoring:** As required by the MS4 Permit, trained biologists collect biological community data at three LTMN sites in the Middle Fork Beargrass Creek. Biological monitoring includes fish communities, benthic macroinvertebrate communities, algal communities and aquatic habitat. MSD reports results in MS4 Annual Reports.
- **MSD Precipitation Monitoring:** As required by the MS4 Permit, MSD collects rainfall data at 46 sites in Jefferson County and surrounding counties, including at two (2) rain gauges in the Middle Fork Beargrass Creek. MSD also collects NEXRAD data.

Define the Boundaries of the Study: Monitoring sites located within the Middle Fork Beargrass Creek watershed were selected by MSD with consideration for DOW 319(h) monitoring sites (Figure 2). All are publicly accessible; landowner permission is not required. Samples will be collected from representative areas of the stream (thalweg) by MSD field staff during work hours.

Per the *Watershed Planning Guidebook for Kentucky Communities* (DOW, 2010b), two wet weather samples will be collected during the 12-month monitoring period. All other samples will be collected under ambient conditions occurring at the time of sampling.

Develop the Analytical Approach: Data analysis will be performed on final data (i.e., data quality reviews completed, results approved for use) per this QAPP. Results will be compared to the applicable water quality criteria (401 KAR 10:031). Criteria comparisons will be performed for *E. coli* criteria for May or June, when five (5) bacteria samples in 30 days have been collected, pH, dissolved oxygen, and water temperature. For months with fewer than five (5) *E. coli* samples, and for remaining parameters (i.e., specific conductance and stream discharge), medians or percentiles of data will be used to compare sites to each other and assess patterns at individual sites over time and to compare water quality under dry and wet conditions. Loads of *E. coli* bacteria, reported as colonies per day, will be calculated using final available concentration and flow data.

Specify Acceptance Criteria: Data will be reviewed per the Data Quality Indicators (DQIs) in Table 3 to ensure that sample data are within the expected range. and included in the results database as reported (qualified using data quality codes that indicate a data quality issue) or excluded from the analysis if sample contamination is reasonably suspected. Field parameter accuracy and resolution values are as reported by HydroTech Compact DS User Manual (HydroTech, undated). Acceptance criteria are provided in Tables 7 and 8, and data qualifier codes are provided in Table 11.

Table 3 – MSD 319(h) Data Quality Indicators and QC Requirements

Parameter (Units)	Method	Expected Range	Accuracy	Sensitivity (Resolution)	QC
Temperature (°C)	HydroTech Compact DS	0-35	0.01° C	0.10 ° C	As-needed maintenance per SOP
Specific Conductance (uS/cm)	HydroTech Compact DS	100-2,000	1% of reading	0.1 uS/cm	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
pH (Std. units)	HydroTech Compact DS	4-10	0.2	0.01	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP

Parameter (Units)	Method	Expected Range	Accuracy	Sensitivity (Resolution)	QC
Dissolved Oxygen (mg/l)	HydroTech Compact DS	0-20	± 0.01 mg/L for 0–8 mg/L; ± 0.02 mg/L for greater than 8 mg/L	0.01 or 0.1 mg/L	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
Turbidity (NTU)	HydroTech Compact DS	0-1,000	± 1% up to 100 NTU, ± 3% up to 100–400 NTU, ± 5% from 400–3000 NTU	0.1 NTU: 0–400 NTU, 1 NTU: >400 NTU	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
Velocity (used to calculate discharge) (f/s)	Hach FH950 handheld flow meter & wading rod	0-5,000	0 to 10 ft/s: ±2% of reading 10 to 16 ft/s: ± 4% of reading	0.05 cfs	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
<i>E. coli</i> (MPN/100 mL)	Grab sample	4 -240,000		4 MPN/100 mL	Field blanks and splits, laboratory blanks (1)
1. These project specific quality control measures are in addition to the extensive quality control measures and sterility checks employed by MSD's laboratory as required by DOW certification (MSD, 2019)					

The following DQIs apply to this MSD 319(h) sampling project. The purpose of the DQIs defined below is to ensure that the quality of the data collected is appropriate for its intended use in this watershed planning project. The planned schedule for field quality control sample collection is provided in Appendix B.

Table 4 – MSD 319(h) Data Quality Indicators

DQI	Definition	Project QC Samples
Precision (1)	Measure of agreement among repeated measurements of the same property under similar conditions. Usually expressed as a range, standard deviation, variance, percent difference in either absolute or relative terms.	<i>E. coli</i> - one split sample on each sample day (11%).

DQI	Definition	Project QC Samples
Accuracy	Measure of closeness of an individual measurement to a known or reference value. Expressed as percent recovery or percent bias.	All <i>E. coli</i> samples will be collected directly into sample bottles. All SOPs and QA/QC procedures will be followed throughout the sampling period.
Bias	Systematic or persistent distortion of a measurement process that results in errors in one direction.	Bias will be assessed one <i>E. coli</i> field blank, one method blank per sample event.
Representativeness	A qualitative measure of the degree to which data accurately and precisely represent a characteristic of a population parameter.	Bacteria samples and field parameter measurements will be collected using procedures described in the SOP, from representative thalweg areas with flowing water just above a riffle at the selected monitoring sites as described in the SOP. Stream discharge measurements will be collected from a representative location as described in Section 8.3.1.1 of the SOP.
Comparability	A qualitative term describing the degree to which different processes, methods or data agree or can be represented as similar. Expresses the measure of confidence that two data sets can contribute to a common analysis.	Comparability will be maintained by following the quality assurance procedures outlined in this QAPP and all relevant SOPs.
Completeness	An evaluation of the amount of data needed to be obtained from a measurement system. Expressed as a percentage of the number of measurements that should have been collected or were planned to be collected.	The target is to collect at least 90% of the monitoring data described in this plan (i.e., at least 130 out of 144 samples or measurements per parameter). Five (5) samples per 30 days will be collected in May or June 2020 to support comparison of <i>E. coli</i> data to primary contact recreation criteria (401 KAR 10:031)
Sensitivity	Capability of a method to discriminate between measurement responses representing different levels of the variable of interest. Terms used to describe sensitivity include MDL, LOD and LOQ.	Achieve MDL, LOD, LOQ targets for <i>E. coli</i> data per MSD's Laboratory SOP and QAPP. Sensitivity of <i>E. coli</i> (i.e., MDL, LOD and LOQ) are proportional to dilution needed to increase method

DQI	Definition	Project QC Samples
		sensitivity and minimize the number of “greater than” results.
1. Per In situ Water Quality Measurements and Meter Calibration for Lotic Waters DOWSOP03014 duplicate analysis is not appropriate for in situ measurements for lotic waters (KDOW, 2018a),		

1.9 Special Training Requirements

See Section 3 of *Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan* (Louisville / Jefferson County Metropolitan Sewer District, 2019).

1.10 Documentation and Records

Records management and progress data reports are described below.

1.10.1 Records Management

Critical records for this project include:

- Hach FH950 handheld flow meter and HydroTech Compact DS meter maintenance records are stored in bound notebooks at MSD’s Central Maintenance Facility
- Hach FH950 handheld flow meter and HydroTech Compact DS meter calibration logs – originals are stored by MSD Field Staff Manager and scanned to MSD’s network project folder
- Field Data Collection Sheets – originals stored by MSD Project Manager in paper files and scanned to the project file on MSD’s network project folder
- Stream Discharge Excel Sheets – files downloaded from the Hach FH950 are transferred to Excel and used to calculate stream discharge per the SOP
- Chain of Custody Sheets – one copy delivered to MSD’s laboratory and stored in laboratory paper files, one copy stored by MSD Project Manager in paper files and scanned to the project file on MSD’s network project folder
- Site Photographs – digital files stored in the project file on MSD’s network
- Laboratory Bench Sheets – used in the lab to record *E. coli* results
- Field parameters and stream discharge data are entered into MSD’s Laboratory Information Management System (LIMS) by MSD Field Staff

- Laboratory data are entered into MSD's Laboratory Information Management System (LIMS) by Laboratory Technicians
- Monthly Monitoring Reports – digital files stored in the project file on MSD's network and submitted to DOW (See Section 4.5)

All project records will be maintained for three (3) years from the grant end date per DOW grant requirements (September 30, 2022 – September 29, 2025). File locations are described in Section 2.8 Data Management.

1.10.2 Monthly Monitoring Reports

As required by DOW, a progress data report and field and laboratory documentation will be submitted to DOW prior to the next sample event, generally within 30 days. The Monthly Monitoring Report will include all data collected during the event. The following sections describe specific elements of a progress data report that will be required after each sampling event.

Field Documentation

Field documentation will include copies or scans of calibration records, Field Data Collection Sheets, Chain of Custody sheets and site photographs. Photos will be retained and submitted so that the original date and location is recorded.

Laboratory Documentation

Sample results from the MSD Morris Forman WQTC Lab will be included in both report format (copies of lab reports) and electronic data (in Excel or another electronic spreadsheet) format. Lab reports will include data qualifiers and a narrative explanation of qualifiers (lab flags). If data problems are reported that may affect the usability of the data, quality control sample results may be requested. The MSD Morris Forman WQTC Laboratory is certified for wastewater analysis under the Kentucky Laboratory Wastewater Certification Program (KY#08034); these documents can be provided upon request.

2.0 DATA ACQUISITION

2.1 Sampling Design

Sampling will occur monthly, as described in Table 1. Sampling will be conducted during the third week of each month, between Monday and Thursday, and samples will be delivered to the laboratory before 1:00 pm on the day of sampling to allow time for laboratory analysis of samples. Monitoring sites are described in Table 5 and shown on Figure 2. The rationale for monitoring sites is provided in Table 6.

Table 5 - MSD and DOW 319(h) Monitoring Site Locations

Station ID (DOW, MSD, USGS)	Waterbody	Location	River Mile	Drainage Area (mi²)	Latitude	Longitude
DOW08047007 EMIMI010 03293500	Middle Fork Beargrass Creek (1,2)	Lexington Road	0.9	24.8	38.250276	-85.716868
DOW08047008 EMIMI002 03293000	Middle Fork Beargrass Creek (1,2)	Old Cannons Lane	5.4	18.7	38.23729	-85.66468
EMIMI009	Middle Fork Beargrass Creek (2,3)	Browns Lane	7.97	15.2	38.2403	-85.6345
DOW08047010	Weicher Creek (4,5)	Above Blossom- wood Drive	0.55	1.3	38.23016	-85.63071
EMIMI033	Weicher Creek	Lincoln Road	1.56	0.57	38.22902	-85.61491
DOW08047009 EMIMI038	Middle Fork Beargrass Creek UT 8.45 (Sinking Fork) (4)	Below Bowling Boulevard	0.3	2.6	38.24683	-85.62881
DOW08047011 EMIMI039	Middle Fork Beargrass Creek UT 9.1	Off Steeplecrest Circle	0.2	3.9	38.24093	-85.61867
DOW08047012 EMIMI040	Middle Fork Beargrass Creek	Off Old Whipps Mill Road	11.7	5.0	38.25984	-85.58529
EMIMI041	Middle Fork Beargrass Creek (3)	Forest Bridge Road	12.38	4.07	38.26126	-85.57434
DOW08047013 EMIMI042	Middle Fork Beargrass Creek UT 12.8	Above Foxboro Road	0.2	2.2	38.25867	-85.56680
Notes: 1. USGS Gages record stream discharge; MSD/USGS sondes record pH, DO, temperature, conductivity on 15-minute intervals: 03293500, 03293000 2. MSD Long Term Monitoring Network sites: EMIMI010, EMIMI002, EMIMI009 3. This site sampled only by MSD, DOW did not sample this site 4. These sites were reversed in the grant application and are updated in this QAPP 5. MSD not monitoring this site for 319(h) monitoring; DOW monitored this site but it's an intermittent tributary, so MSD discontinued this site						

Table 6 - MSD 319(h) Monitoring Site Rationale

Station ID (DOW, MSD, USGS)	Waterbody	Location	Monitoring Rationale
DOW08047007 EMIMI010 03293500	Middle Fork Beargrass Creek	Lexington Road	Downstream end of watershed, add to LTMN and DOW 319(h) monitoring database
DOW08047008 EMIMI002 03293000	Middle Fork Beargrass Creek	Below Old Cannons Lane	Within Combined Sewer Overflow (CSO) area, add to LTMN and DOW 319(h) monitoring database
EMIMI009	Middle Fork Beargrass Creek	At Browns Lane	Upstream of CSO area, add to LTMN and DOW 319(h) monitoring database
DOW08047009 EMIMI038	Middle Fork Beargrass Creek UT 8.45 (Sinking Fork)	Below Bowling Boulevard	Commercial area
EMIMI033	Weicher Creek	Lincoln Road	Downstream of golf course
DOW08047011 EMIMI039	Middle Fork Beargrass Creek UT 9.1	Off Steeplecrest Circle	Suburban area
DOW08047012 EMIMI040	Middle Fork Beargrass Creek	Off Old Whipps Mill Road	Downstream of flood control dam and large wetland upstream of dam
EMIMI041	Middle Fork Beargrass Creek	Forest Bridge Road	Upstream of Old Whipps Mill Road dam
DOW08047013 EMIMI042	Middle Fork Beargrass Creek UT 12.8	Above Foxboro Road	Upstream end of watershed, characterize suburban area

Equipment and supplies, step-by-step procedures, and instrument or method calibration and standardization are documented Sections 6, 7, and 8 of the *Technical Standard Operating Procedure MSD 319(h) Monitoring for Middle Fork Beargrass Creek Watershed-Based Plan*, which is included as Appendix A.

Monitoring activities are described in Table 1 and field QC samples are described in Table 4.

2.2 Sampling Procedures and Requirements

Sampling procedures are described in the *Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan*, which is included as Appendix A.

2.3 Sample Handling and Custody Requirements

Sampling procedures are described in the *Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan*, which is included as Appendix A.

2.4 Analytical Methods Requirements

The *E. coli* analysis will be performed by MSD's laboratory using IDEXX Colilert based on *Standard Methods for the Examination of Water and Wastewater, 23rd. Edition*, 9223B Enzyme Substrate Coliform Test (Water Environment Federation, 2017b). This method is included in *U.S. Code of Federal Regulations: 40 CFR Part 136.4* (US CFR, 2012). The laboratory method is described in MSD's *Laboratory Standard Operating Procedure: E. coli, Rev 6 090118* (Louisville / Jefferson County Metropolitan Sewer District, 2018), or the most recent update. The laboratory is certified by the Kentucky Division of Water (KY#08034).

2.5 Quality Control Requirements

Quality control requirements for field sampling and field measurement instrumentation are shown on Tables 7 and 8. All documentation of calibration checks and calibrations will be retained in the project file and submitted to DOW with the event report after each sampling event. If measurement performance criteria are not met per these tables, corrective action will be taken promptly to address the problem. Every effort will be made to address QA/QC issues prior to the next sample event.

Table 7 – MSD 319(h) Field Sampling Quality Control Requirements

Requirement	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
<i>E. coli</i> Field Splits (1)	1 field split each sample day (11%)	▪ Censor or qualify data as necessary ▪ Review sample collection procedures	Project Manager and QA Manager	Precision	The acceptable range of deviation between sample results will be determined by the precision criteria set using the procedures in SM 9020B, Section 8b (See SOP Appendices)

Requirement	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
<i>E. coli</i> Field Blanks (2)	1 field blank each sample day (11%)	▪ Censor or qualify data as necessary ▪ Review sample collection and storage procedures	Project Manager and QA Manager	Accuracy or Bias, Contamination	Result is < 1 MPN/100ml
1. Field Split – single sample collected by field team. The lab will split into two samples and analyze separately in the lab. Used to estimate subsampling and laboratory analysis precision. 2. Field Blank – de-ionized water from the carboy or other container which is treated as a sample. Used to identify errors or contamination in sample collection and analysis.					

Table 8 – MSD 319(h) Field Measurement/Analysis Quality Control Requirements

Requirement	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Calibration of HydroTech Compact DS Field Meter	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP	Re-calibrate to within allowable specifications	Field Manager, Project QA Manager, Project Manager	Accuracy	Must meet or exceed instrument accuracy specifications
Calibration of Hach FH950 Flow Meter	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP	Send to manufacturer for factory calibration	Field Manager, Project QA Manager, Project Manager	Accuracy	Must meet or exceed instrument accuracy specifications

Because *E. coli* varies widely within streams, field duplicates are representative of variability of bacteria in the stream as well as variability in the sample procedure. Therefore, field splits will be used to assess the variability of the sample procedure, using methods applied by DOW for their monitoring in Middle Fork Beargrass Creek. Field splits will be collected into one sterile bottle in the field and split into two samples in the laboratory. Each sample will be analyzed separately by the laboratory. The precision criterion will be calculated using methods described in *Standard*

Methods for the Examination of Water and Wastewater, 23rd. Edition: 9020 Quality Assurance/Quality Control (Water Environment Federation, 2017a).

2.6 Testing, Calibration and Maintenance Requirements for Equipment and Supplies

2.6.1 Instrument Testing and Calibration

Instrument testing and calibration procedures are described in the *Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan*, which is included as Appendix A.

Table 9 – MSD 319(h) Instrumentation and Required Checks

Instrument	Calibration	Maintenance
Hach FH950 Flow Meter	Velocity calibration check, calibrate as needed prior to each trip	As needed and per manufacturer's instructions
HydroTech Compact DS Field Meter	Calibration check, calibrate as needed prior to each trip	As needed and per manufacturer's instructions

2.6.2 Supplies and Consumables

The MSD Field Supervisor is responsible for ordering supplies and consumables including calibration solutions, pH buffers and sterile sample bottles. A sterility certificate accompanies the bottles and the field blank collected during each sample serves as an additional check of bottle sterility. The Field Supervisor oversees inspection of supplies and consumables to ensure that reagents are appropriate for the meters, not expired, containers are intact, and batteries are in working order. To ensure that adequate supplies and consumables are available to meet project needs, the MSD Field Supervisor will order supplies and consumables prior to expiration dates and / or when supplies are depleted.

The MSD Laboratory's Research Chemist is responsible for ordering all supplies and consumables related to *E. coli* analysis, inspection of these supplies and consumables, performing required sterility checks and ensuring an adequate supply of de-ionized water is available for field blanks and laboratory use.

Equipment and supplies are described in the *Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan*, which is included as Appendix A. Table 10 defines the acceptance criteria for supplies and consumables.

Table 10 – MSD 319(h) Supplies and Consumables

Supply Item	Acquired By	Acceptance Criteria
Sample Bottles	MSD Morris Forman WQTC Lab	Free from defects, residues, and flaws. Laboratory blanks (1 per 10 samples, 10%) serve as the check to ensure sample bottles are sterile. Bottle sterility certificates are on file at MSD and available upon request
Calibration Solutions	MSD Field Supervisor	Solution documented when received, when opened, and used prior to expiration. The expiration of calibration solutions may be different from the date printed on the label. It is the date printed on the label OR 1-6 months (depending on the type of solution) after the container was opened, whichever comes first.

2.7 Data Acquisition Requirements for Non-direct Measurements

Non-direct measurements include monitoring data that is relevant to the development of the Middle Fork Beargrass Creek Watershed-Based Plan, but the collection of this data is not included in this QAPP. The following monitoring efforts are considered non-direct measurements.

- **MSD LTMN Monitoring:** Water quality monitoring data are collected at three sites that are also being monitored for this 319(h) monitoring project. MSD has prepared a QAPP for MSD 319(h) Monitoring Programs that describes quality assurance.
- **MSD Rain Gauge Network:** Rain gauge data are collected at two (2) gauges in the Middle Fork Beargrass Creek watershed.
- **USGS Stream Gaging:** USGS has developed extensive quality assurance documentation for the national stream gaging program and for the Ohio-Kentucky-Indiana Water Science Center (Griffin, M., 2006). Stream gaging data will be used to evaluate stream flow patterns at the two gaged sites in this watershed.
- **DOW 319(h) Monitoring:** DOW collected monitoring data at 7 sites in the Middle Fork Beargrass Creek Watershed. DOW has stated that they will use this data to assess designated use attainment to support development of the Middle Fork Beargrass Creek Watershed-Based Plan
- **Salt River Watershed Watch Monitoring:** The Salt River Watershed Watch (SRWW) uses statewide protocols to train and equip volunteer monitors to test waterbodies of

interest to them, including sites in the Middle Fork Beargrass Creek. SRWW have collected bacteria data using a certified laboratory and field parameters using Hach and LaMotte test kits three (3) times per year. Some SRWW data extends back to 1999. This volunteer monitoring group does not have an approved QAPP, therefore, SRWW's data will be summarized in the Chapter 2 of the Watershed-Based Plan and used to evaluate reaches that may not be sampled by agency monitoring. If issues are identified, additional sites may be considered for future agency sampling efforts. SRWW data is not of sufficient quality to inform Best Management Practice (BMP) selection decisions.

2.8 Data Management

All project records will be maintained for three (3) years per KDOW grant requirements. All raw data and laboratory reports will be electronically stored and submitted to DOW. The MSD Project Manager is responsible for maintaining project documentation and records for a minimum of three years from the grant end date (September 30, 2022 – September 29, 2025).

Monitoring records will be in paper and digital format or digital format only (i.e., site photographs) and include, but are not limited to:

- QAPP, SOP and appendices
- Meter maintenance and calibration records
- Field data sheets
- Stream discharge Excel files
- Chain of custody sheets
- Site photographs (digital only)
- Monitoring data housed in MSD's Laboratory Information Management System
- Monthly Monitoring event reports

Paper records will be maintained by the MSD Project Manager. Digital files will be stored in the project directory on MSD's network.

Specific digital file locations are listed below:

- W:\DATA\MS4\Grants\319 Watershed\Middle Fork Beargrass
- Laboratory data will be stored in MSD's Laboratory Information Management System (LIMS).
- Laboratory SOPs: L:\sfile201\vol1\mfwtp\data\lab

3.0 ASSESSMENTS

Project assessments are designed to determine whether the QAPP is being implemented as approved, and ultimately to ensure that the information will be usable for the intended purpose.

3.1 Technical Assessments

Monthly monitoring reports submitted after each sampling event will also serve as technical assessments, and DOW follow-up may occur if issues are found.

3.2 Audits of Data Quality

E. coli and field data will be reviewed when collected in field and when received in office for completeness and accuracy according to SOPs and laboratory standards.

Data quality will be assessed after each sampling event for completeness and range of acceptability of QC samples.

4.0 REVIEW, EVALUATION AND REPORTING REQUIREMENTS

This section describes initial data review, validation and verification methods, evaluation of data usability, and reconciliation with project requirements in Sections 4.1 to 4.4. Products from this section are reports to management which are described in Section 4.5.

4.1 Initial Data Review

MSD field staff will check Field Collection Data Sheets for completeness and accuracy prior to leaving the site. The MSD Quality Assurance Manager will review each Field Collection Data Sheets after each sample event.

MSD field staff will check COCs for completion and accuracy prior to leaving the site, including site ID, date, time, sampler initials, sample location number, parameters to be analyzed, and preservative. MSD's Research Chemist and Quality Assurance Manager will review the COCs after each sample event.

The MSD Research Chemist will oversee QA/QC reviews of raw laboratory data, including assigning data flags as needed. Flagged data (Table 11) will be assessed for usability according to project objectives. If flagged data are not within the expected ranges shown on Table 3, it could be rejected and not be used in water quality assessments.

The MSD Quality Assurance Manager will review stream flow spreadsheets and calculations of stream discharge.

The MSD Quality Assurance Manager will compare all (100%) records (i.e., Field Data Collection Sheets, COCs, stream flow spreadsheets) to records entered into the Laboratory Information Management System. Any discrepancies will be rectified with assistance from the MSD Field

Supervisor and MSD Research Chemist. Final values reflecting the culmination of quality assurance checks will be reported in the Monthly Monitoring Reports.

Deviation from the QAPP and or SOP will be described in the Monthly Monitoring Report and reviewed for applicability to each step in the project. The entire project team may be involved in this review and will therefore be informed of each step. If issues arise that need additional review, laboratory staff may be asked for clarification, before informing management of critical elements that may need to be addressed at a higher level.

The MSD Project Manager and/or QA Manager will be responsible for reviewing all (i.e., 100%) of project data initially, with a secondary review conducted by DOW staff. The reviews will determine if the data results provide enough information for making project decisions. The Monthly Monitoring Report will discuss all corrective actions taken with regard to oversight functions.

4.2 Validation and Verification Methods

The following data reviews for *E. coli* sampling and field data collection as well as laboratory analysis will be performed to ensure that the data collected throughout the project meet or surpass the data quality objectives defined in Section 1.8. Methods for validation will be according to the following items:

Field

QAPP Objectives

- Samples collected from correct site
- Timing of sample collection appropriate (stream was flowing, SOP conditions met, etc.)
- QC samples completed for each parameter and appropriate statistics calculated
- Deviations from sampling plan explained

Documentation

- Calibration sheets and maintenance logbooks complete and accurate
- Field data sheets complete and accurate
- Site photograph files labeled and filed correctly
- COCs complete and accurate
- Collection, preparation, and analysis techniques consistent with QAPP and SOPs
- Any missing data fields on field data sheets explained and qualified
- Secondary data referenced and qualified

Equipment

- Calibration standards traceable and not expired
- Calibration records traceable to instrument
- Maintenance and calibration records complete and acceptable in bound logbooks

Laboratory

QAPP Objectives

- Appropriate number of samples completed for each site
- Samples collected from correct site
- QC samples completed and appropriate statistics calculated

Sample Handling – Bacteriological

- Samples labeled with correct, unique identifier
- Samples labeled with date and time
- Samples preserved correctly
- Correct bottle and sample volume utilized
- Delivery hold time not exceeded – if so, explanation of why and final outcome
- Incubation times and temperatures were met

Documentation

- COCs complete and acceptable
- Sample login documentation complete and accurate
- Missing data fields explained and qualified
- Identification bench sheets completed and accurate

Sample Analysis

- Correct method and analysis performed by the MSD Morris Forman WQTC Lab
- Detection Limits identified and recorded as a value; ensured acceptable for all parameters
- All flagged data explained; description provided for acceptance/rejection criteria
- Data outliers confirmed and documented
- QC samples met performance and project specifications

Data Entry

- 100% of all field and laboratory data entered
- Data entry QA performed on 100% of all data entered
- Data entry QA documentation complete

Table 11 lists the data flags used by MSD's Laboratory for *E. coli* data.

Table 11 – MSD 319(h) Data Flags for *E. coli* Analyses

MSD Qualifier	Description
C	Analyte detected in associated method blank
H	Duplicate/Replicate precision outside control limits
Q	Samples held at incorrect temperature
R	Sample analyzed out of the established method hold time
W	Samples reported outside of quantifiable range
7	Samples not analyzed correctly as required by the method
8	Instrument Performance Check Sample did not meet the required range
9	Microbiological incubation period outside of required method limits
<	Less Than
>	Greater Than

4.3 Evaluation of Data Usability

The MSD Project Manager will oversee the review, verification and validation of monitoring data collected in this project. The review will be accomplished by comparing the data collection process to the requirements established in this Quality Assurance Project Plan and Standard Operating Procedures. Errors will be resolved as soon as possible to ensure that they do not become propagated in databases or other permanent records.

Any data collection that deviates from the procedures or does not meet the data quality indicators will be evaluated by the MSD Project Manager and QA Manager. If the deviations are considered to be minor, the data may be included with appropriate data flags (Table 11); otherwise the data will be excluded from the dataset that is used to develop the Watershed-Based Plan. If *E. coli* contamination is found in field or laboratory blanks, the data associated with the compromised samples will be excluded from further analysis.

The MSD Project Manager and QA Manager will evaluate data anomalies by comparing data from each event among all of the sites. For example, if stream flow decreases downstream, the intervening reach will be evaluated for the presence of karst and potential issues with the flow meter or data collection. Data anomalies in field meter readings and flow measurements may be identified by comparing the field data to provisional data available from sondes and flow gages. If *E. coli* is locally elevated, the upstream reach will be evaluated for potential bacteria sources and field QC efforts will be targeted at that site for the next sample event.

When data anomalies are identified, they will be discussed with the MSD Field Supervisor and field crew members that sampled the site(s) in question. The MSD Project Manager and QA Manager will work with the MSD Field Supervisor and field crews and MSD Laboratory personnel

to address deviations from the QAPP and SOP prior to the next sample event and may shadow the field crew to observe the sample event.

4.4 Reconciliation with Project Requirements

The data will meet project objectives through collecting samples according to all SOPs, by analysis results meeting all reporting limits, and data meeting all QC requirements. Assessments for water quality reporting will be met by obtaining all raw data and lab reports, and correctly completing the field forms.

Any limitations in the data sets will be documented in the field notes, project files, and the final report. Data may be rejected by not meeting QC guidelines or by anomalies in the analysis process communicated through flags. The DOW Project Manager and DOW QA personnel will be responsible for reviewing data and will assist in making determinations about the usability of the data.

4.5 Reports to Management

Sampling Event Reports will be produced prior to the next monthly sample event under the direction of the MSD Project Manager. One monthly report will be produced for the month May or June 2020 during which five (5) E. coli samples will be collected within 30 days.

Monthly Monitoring Reports will be reviewed by the Field Manager and Lab Manager and made available to the MSD project team via MSD's network. Reports will include a narrative description of the sample event with attachments for COC, FDSCS, Laboratory Bench Sheets, Water Quality Data Table and Flow Data. The reports will identify any significant quality assurance problems and recommended solutions.

Any aspects of the QAPP and SOP encompassing field and lab work that were not followed will be noted the Monthly Monitoring Report and reviewed for potential impacts on the project. This includes deviations from meter maintenance (documented in bound log books), calibration checks with calibration as needed within 24-hours of the sample event, field data, site photographs and laboratory sample collection in the field, laboratory analysis, accompanying documentation (i.e., calibration sheets, field data collection sheets, chain of custody forms) and data management. The entire project team may be involved in this review and will therefore be informed of each step. If issues arise that need additional review, laboratory staff may be asked for clarification, before informing management of critical elements that may need to be addressed at a higher level.

The final report will document all findings and conclusions of the project. The report will be available for management review. The MSD Project Manager will prepare the final report, with assistance from the QA staff or field staff as needed.

The MSD Project Manager and/or QA Manager will be responsible for reviewing project data initially, with a secondary review conducted by DOW staff. The reviews will determine if the data results provide enough information for making project decisions. The final report will discuss all corrective actions taken with regard to oversight functions.

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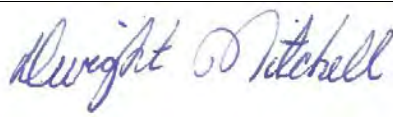
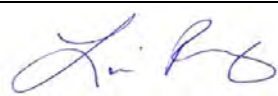
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Appendix A.

Technical Standard Operating Procedure MSD 319(h) Monitoring for Middle Fork Beargrass Creek Watershed-Based Plan

Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan

Prepared by: Stantec Consulting Services and Louisville and Jefferson County Metropolitan Sewer
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Document ID
Effective Date May 8, 2020
Revision Date
Revision #: 0

Document Revision History

The most recent revision should be listed first, with consecutive revisions listed afterwards. The original document date should be last on the list.

Date of Revision	Page(s) Revised	Revision Explanation

Document Citation: Louisville and Jefferson County Metropolitan Sewer District. 2019, Technical Standard Operating Procedure for MSD 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed-Based Plan, Louisville, KY.

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5. Hach FH950 Manual

Note: This Standard Operating Procedure (SOP) was developed using the Technical SOP Template Final 2018, downloaded from the Kentucky Division of Water's Quality Assurance Website (<https://eec.ky.gov/Environmental-Protection/Water/QA/Pages/default.aspx>)

1 Purpose/Scope

The purpose of this document is to describe the data collection procedures for monitoring that the Louisville and Jefferson County Metropolitan Sewer District (MSD) will perform in support of the 319(h) funded watershed planning project for Middle Fork Beargrass Creek.

This document and the procedures and standards included herein were developed after an extensive review of relevant material and resources relevant to surface water quality monitoring and quality assurance for sampling and data collection (DOW, 2009; DOW, 2011; DOW, 2018; DOW, 2019; Louisville / Jefferson County Metropolitan Sewer District, 2018) as well as manuals supplied with the HydroTech Compact DS5 field parameter meter and Hach HF950 hand held flow meter.

2 Definitions & Acronyms

Acronyms

BP	Barometric Pressure
COC	Chain of Custody
DO	Dissolved Oxygen
DOW	(Kentucky) Division of Water
<i>E. coli</i>	<i>Escherichia coli</i>
EDCA	Environmental Data Collection and Assessment
FDCS	Field Data Capture Sheet
LDO	Luminescent Dissolved Oxygen (probe)
LEW	Left Edge of Water (looking downstream)
LIMS	Laboratory Information Management System
MSD	(Louisville and Jefferson County) Metropolitan Sewer District
NTU	Nephelometric Turbidity Unit
PPE	Personal Protective Equipment
REW	Right Edge of Water (looking downstream)
QA / QC	Quality Assurance / Quality Control

Document ID
Effective Date May 8, 2020
Revision Date
Revision #: 0

QAPP	Quality Assurance Project Plan
SC	Specific Conductance
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
<	Less than
>	Greater than

Definitions

Absolute barometric pressure - the actual atmospheric air pressure at a specific location that depends significantly upon the location altitude.

Conductivity – a measure of the ability of water to conduct electricity. The presence of dissolved salts and other chemicals increases conductivity of streams.

Dissolved Oxygen - a measure of how much oxygen is dissolved in the water

In-situ – in the original place.

Field Blank – de-ionized water from the carboy which is treated as a sample. Used to identify errors or contamination in sample collection and analysis.

Field Split – single sample collected by field team. The lab will split into two samples and analyze separately in the lab. Used to estimate subsampling and laboratory analysis precision.

pH - a scale used to specify how acidic or basic a water-based solution is. Acidic solutions such as vinegar have a lower pH, while basic solutions such as bleach have a higher pH. At room temperature, pure water is neither acidic nor basic and has a pH of 7.

Relative barometric pressure - the corrected barometric pressure calculated for the sea or zero feet of elevation, and usually used to refer atmospheric conditions.

Riffle – a rocky, shallow area in a stream, generally with faster flowing, more turbulent water.

Sonde - a devices that automatically transmits testing data for physical conditions, in this case, used for measuring several water quality parameters (i.e., pH, temperature, dissolved oxygen, specific conductance and turbidity)

Specific Conductance – a conductivity measurement made at or corrected to 25° C. Since water temperature affects the readings, reporting conductivity at 25° C allows data to be easily compared.

Stream discharge – the amount (volume) of water carried by a stream past a point per second, measured for this SOP in cubic feet per second. As a reference, one (1) cubic foot is about 7.5 gallons.

Tagline – a tape measure, usually with 1/10-foot increments, stretched across the stream used to locate the verticals during a discharge measurement.

Temperature - a physical property of water that quantitatively expresses hot and cold.

Thalweg – the deepest part of the stream channel, generally forming a deeper channel within the stream channel.

Vertical – a point along the cross- section of a stream where stream velocity is measured at a defined depth or depths.

3 Health & Safety Statement

3.1 Job Specific Training

Louisville MSD provides annual health and safety training to field technicians regarding safe work practices.

Supervisors, or designee, will observe employees performing the work previously demonstrated. If necessary, remedial instruction will be provided to correct training deficiencies prior to final release to perform unsupervised work.

Employees will be trained to use safe operating instructions prior to the use and operation of new equipment or processes.

Supervisors shall be responsible for reviewing safe work practices with employees before permitting new, non-routine, or specialized procedures to be performed.

The Kentucky Division of Water (DOW) will provide sample collection training to Louisville MSD field staff prior to initiating field work for this project. This training will include demonstration of job tasks using known safe work practices.

In case of emergency, MSD staff call 502-540-6182 and then their supervisor.

3.2 Human Health

Human health procedures are available in MSD Health and Safety Rule Book

3.3 Safety Equipment

The Personal Protective Equipment (PPE) to be used during this project are listed below. All personnel involved in field sampling for this project are required to adhere to Louisville MSD field safety standards.

- Reflective safety vest
- Personal floatation device (life jacket)
- Hard hat with chin strap
- Waders with non-slip boots
- Safety Cones
- Roof mounted flashers
- Hand sanitizer
- Safety harness
- First aid kit
- Bug spray

3.4 Safety Precautions

The buddy system should be implemented when conducting field work.

Monitoring may include field activities during all stages of the hydrologic cycle, including high discharge/flood stage conditions. Additional precautions should be taken during high flow events.

Work in streams can be dangerous due to a variety of factors including fast flow, water depth, temperature, and visibility. Prior to sampling, weather will be monitored to avoid potentially dangerous conditions. At no time will MSD employees enter streams with swift, high water or when the stream is at flood stage.

- **Water Temperature** - Hypothermia can quickly set in and overwhelm even the strongest of swimmers. Ensure that equipment appropriate for encountered stream temperatures is used during survey activities.
- **Current** - Even a slow current can have enough force to knock you off your feet. Do not attempt to cross streams that are swift and above the knee in depth.

- **Water Hazards** - Be very careful when walking in any stream. Rocky-bottom streams can be very slippery and may contain deep pools. If needed, use a walking stick or rod to help with stability and determine depths.

The best advice is to use common sense judgment when entering a waterway and avoid working in streams when flows are elevated. If depth is undetectable from the bank, use a pole or rod to feel for bottom depth before entering.

If high stream flow conditions make it unsafe to enter the stream, collect the water quality sample from the bank using the pole sampler or from a nearby bridge using the two-cup sampler. When working around fast flowing water, use of a personal floatation device (life jacket) is recommended. If samples are collected from the top of a culvert, use of a harness is required.

If it is not possible to sample safely, do not enter the stream. The team should try to sample from a nearby bridge, and if this is not safe, do not sample. Any team member can make this decision.

4 Interferences and Troubleshooting

Latex-free gloves should always be worn when collecting a sample. Immediately close all bottles after filling with the sample water and double check that the caps are completely secured on the sample bottles, and each bottle is placed in a clean Ziploc bag prior to storing in a cooler.

Samples should be collected from flowing water. If water is pooled, move upstream or downstream until an area with flowing water is found. If no nearby flowing water is found, do not sample and note the pooled or dry on the Chain of Custody (COC) form.

Store samples in a cooler on wet ice in a locked vehicle to ensure that they cannot be tampered with.

Completely fill out the COC form and keep it with the samples until they are delivered to the lab. The lab should only accept samples that are accompanied by a completed COC form.

5 Personnel Qualifications

All personnel involved in surface water quality sampling will meet at least the minimum qualifications for their job classification. In addition, all field staff will be trained in the proper collection and preservation techniques for water quality samples as well as meter maintenance, calibration and operation. Training will continue on-the-job through interaction with experienced field personnel and continued outside training when educational opportunities become available. In addition, training videos are available from the HydroTech website: <http://www.hydrotechzs.com/videos/compact-training-videos.html>

6 Equipment and Supplies

6.1 *E. coli* Bacteria Sampling Equipment and Supplies

- Labeled sterile *E. coli* sample bottles with sodium thiosulfate tablet. Sterile *E. coli* bottles are screw cap and tab seal with identification label (Appendix 1)
- COC Forms (one per site) See Appendix 2 Project Forms.
- Plastic carboy filled with de-ionized water for Field Blanks
- Cooler
- Wet ice
- Ziploc bags to store each sample in a separate bag
- Ziploc bag with wet ice (temporary cooler)
- Waterproof pen
- Double-cup sampler (modified for direct fill of *E. coli* bacteria bottles)
- Trash bags
- Latex-free gloves, extra large
- Elbow length gloves for cold water sampling
- Hand sanitizer
- Hatchet (to break ice)
- Camera
- Laminated sheets with site number (for site ID in photographs)

6.2 Compact DS Field Meter Readings Equipment and Supplies

- Field Data Capture Sheets (one per site) See Appendix 2. Project Forms
- HydroTech Compact DS Field Meter with probes for pH, temperature, dissolved oxygen ¹, specific conductance ², turbidity

¹ MSD's dissolved oxygen probe has a Luminescent Dissolved Oxygen (LDO) sensor without a stirrer.

² MSD's specific conductance probe has a temperature compensation feature.

- pH buffers
- Conductivity calibration solutions
- Turbidity calibration solutions
- NX-10 tablet with stylus, zipper pouch and arm strap
- Detachable cable
- Protective plugs
- Backpack
- Paper towels
- Bucket sampler with rope, large enough to submerge the probes
- (8) AA batteries (optional backup power)
- Clean tap water for pre- and post-tap water check and storage
- Bucket for pre- and post-tap water check
- Probe storage cup and sensor guard
- HydroTech Meter Manual, LDO™ Dissolved Oxygen Calibration Transcript, Self-Cleaning Turbidity Two Point Calibration Video Transcript (Appendix 3)

6.3 Stream Flow Equipment and Supplies

- Hach FH950 handheld flow meter
 - Portable meter
 - Sensor height lock/release device
 - Top setting wading rod
 - Sensor cable
 - Adjustable mount for portable meter
 - Sensor assembly
 - Lanyard
 - Velcro strap

- Non-metallic bucket for meter calibration
- Potable tap water
- Flow meter user manual (Appendix 4)
- Tape measure with 1/10-foot increments (i.e., tagline)
- Stakes to secure the tape measure

7 Instrument Setup, Calibration and Standardization

7.1 HydroTech Compact DS Field Meter Setup

The following steps describe setting up the Compact DS field meter.

1. Remove all protective plugs and keep them in a safe place, they will be used again for moving and storage.
2. Connect the detachable cable to the Compact DS. The connectors are keyed for proper assembly. Align the bigger pin on the Compact DS male connector to the indicator dots on the female cable connector. Do not rotate the cable or force or twist the pins into the connectors to prevent damage to the connector pins. (Note, there will be resistance so firm pressure may be required to get the cord plugged into the Compact DS). See HydroTech Manual, Section 3.2 in Appendix 3.1.
3. Connect the other end of the detachable cable to the NX10. The NX10 is also the battery power for the Compact DS.
4. Start the communications program (Hydras 3 LT).
5. The software will automatically scan for Sondes (i.e., probes). All detected Sondes are displayed in the 'Connected Sondes' list in the Main window displayed below. If a Sonde is not found, reattach the data cable and press RE-SCAN FOR SONDES. Retry until the Sonde(s) are found.

7.2 Compact DS Calibration

The Compact DS will be maintained and calibrated in accordance with the manufacturer's recommendations in the Appendix 3. MSD will perform a calibration check on each of the probes within 24-hours of the sample event. If any of the calibration checks falls outside the acceptable range found on the calibration sheet, that probe will be calibrated.

Field technicians will record calibrations on calibration sheets (Appendix 2.1). Meter maintenance and the checks performed before and after the sampling event will be recorded in the bound meter maintenance logbooks. The logbooks are maintained by the MSD Field Supervisor and are available upon request.

On the morning of the sample event and after sampling is completed, pre- and post- tap water checks will be done in a bucket of clean tap water to check for meter drift. If the tap water check does not show anticipated readings, which could be an indication of an overnight calibration drift, the water in the bucket will be replaced and the meter will be checked again. If the readings still do not show expected results, both meters will be placed in the same bucket of water at the same time to compare readings. If the readings do not match, the meter with the erroneous readings will be re-calibrated prior to use in the field. Pre-and post- tap water checks will be recorded in the bound meter maintenance logbooks. **Note:** Save the check water for the End of Day check.

The U.S. Environmental Protection Agency (U.S. EPA, 2007) recommends the following order for calibration of a field meters:

- 1) Specific Conductance
- 2) pH
- 3) Dissolved Oxygen
- 4) Turbidity

The temperature sensor is factory-set and does not require calibration.

7.3 Calibration Supplies

Per the project QAPP (Louisville / Jefferson County Metropolitan Sewer District, 2019), ensure that calibration standards are not expired, and sufficient volume is available to complete the calibration. The Field Staff will notify the MSD Field Manager who will order additional supplies as expiration date approaches or when standards run low.

- De-ionized water (for conductivity, pH and turbidity calibrations)
- Tap water (for dissolved oxygen calibration)
- Conductivity Standards Low, Medium and High Range concentrations
- pH standards

- Turbidity standards:. MSD may purchase premade standards or prepare standards for each field event by diluting a 4,000 NTU primary standard.
- Calibration Sheet (Appendix 2)

7.4 Specific Conductance Calibration Check and Calibration

7.4.1 Specific Conductance Calibration Check

1. Run a minimum of 3 calibration standards that bracket the desired analytical range. An example would be 250, 500 and 1000 $\mu\text{S}/\text{cm}$. Check the lot # and expiration date of each standard on the Calibration Sheet. These are pre-printed and will be updated by the MSD Project QA Manager when new calibration solutions are used.
2. If any are due to expire or are running low, notify the MSD Field Manager, who will place an order for new calibration solutions.
3. Record the temperature of each calibration standard on the Calibration Sheet.
4. Wipe SC chamber ***completely dry!*** Record what the sensor reads in air (this is the zero check).
5. Rinse sensor three(3) times with the lowest concentration standard (usually the **250 $\mu\text{S}/\text{cm}$** standard). Fill calibration cup with standard so that the SC chamber is submerged. Make sure there are no bubbles in the chamber. Record the sensor reading and time. Discard standard and rinse with de-ionized water three (3) times.
6. Rinse sensor three (3) times with the middle range concentration standard (usually the **500 $\mu\text{S}/\text{cm}$** standard). Fill calibration cup with standard so that the SC chamber is submerged. Make sure there are no bubbles in the chamber. Record the sensor reading and time. Discard standard and rinse with de-ionized water three (3) times.
7. Rinse sensor three (3) times with the highest concentration standard (usually the **1,000 $\mu\text{S}/\text{cm}$** standard). Fill calibration cup with standard so that the SC chamber is submerged. Make sure there are no bubbles in the chamber. Record the sensor reading and time.

Note: If any of the readings from steps 1-4 differs by more than +/- 5 $\mu\text{S}/\text{cm}$ or 3% (See Table 1), then move onto step 7. If it reads within the guidelines you are finished and can move on to the next parameter.

Table 1. Common Calibration Standards with 3% Differences

Standard	Minus 3%	Plus 3%
250 uS/cm	242.5	257.5
500 uS/cm	485	515
1,000 uS/cm	970	1,030

7.4.2 Specific Conductance One Point Calibration

1. You should still have high concentration standard (usually 1000 $\mu\text{S}/\text{cm}$) in your calibration cup from Step 6. Enter this value into HYDRAS and hit calibrate. You have now completed a one-point calibration.
2. Discard standard and rinse with de-ionized water three (3) times.

To ensure that the calibration was successful, complete the following steps:

3. Rinse with de-ionized and fill with the mid-range concentration (usually 500 $\mu\text{S}/\text{cm}$) standard, record this reading.
4. Rinse with de-ionized and fill with lowest concentration (usually 250 $\mu\text{S}/\text{cm}$) standard, record this reading.

TIP: If readings are still off or you see an asterisk next to the sensor reading, it may be necessary to perform a 2-point calibration.

7.4.3 Specific Conductance Two Point Calibration

1. Completely dry sensor of all water and enter 0 into the HYDRAS software and hit calibrate.
2. Next, rinse the sensor with the highest concentration (usually 1000 $\mu\text{S}/\text{cm}$) standard three (3) times. Fill calibration cup with the same standard and make sure there are not any bubbles in the SC chamber. Enter the highest concentration value into the HYDRAS software and hit calibrate. You have now completed a 2-point calibration.
3. If you are still having trouble call HydroTech Technical and Customer Service 512-846-2893 or through their website (<http://www.hydrotechzs.com/>) for Technical Assistance.

7.5 pH Calibration Check and Calibration

Calibration of pH focuses on pH 7 and pH 10 because this is the typical range for Jefferson County streams. Always use fresh standard and do not alter the standards in any way.

The calibration standards for pH are affected by temperature. To reduce the time for stabilization, keep all calibration standards and equipment stored at the same temperature before parameter calibration. Always allow sufficient time for thermal stabilization of standards. Refer to the table in Appendix 4-RICCA Temperature Dependence of pH for Reference Buffers to check pH calibration readings based on the temperature of the solution.

7.5.1 pH Calibration Check

1. Ensure the lot # and expiration date of each standard is reported correctly on the Calibration Sheet.
2. If any are due to expire or are running low, notify the MSD Field Manager, who will place an order for new calibration solutions.
3. Record the temperature of each pH buffer on the Calibration Sheet.
4. Rinse sensors with de-ionized water and pH 10 standard three (3) times each. Fill calibration cup with fresh standard within one (1) centimeter of the top of the cup. Place the probes into the sample cup and allow readings to stabilize. Record the sensor reading. Note that the pH of this buffer depends on its temperature. Refer to the Temperature Dependence table in Appendix 4 for the actual pH of the buffer at the current temperature.³ Discard standard and rinse with de-ionized water three (3) times.
5. Rinse sensor three (3) times with pH 7 standard. Fill calibration cup with standard within one (1) centimeter of the top of the cup. Place the probes into the sample cup and allow readings to stabilize. Record the sensor reading. Note that the pH of this buffer depends on its temperature. Refer to the Temperature Dependence table in Appendix 4 for the actual pH of the buffer at the current temperature.
6. If the pH 10 OR pH 7 reading differs by more than +/- 0.2 units from the pH of the buffer at the current temperature, then move onto pH Calibration. If the sensor reads within the guidelines you are finished.

7.5.2 pH Calibration

1. The pH sensor should still be submerged in the pH 7 standard from step 6 above. In HYDRAS enter the temperature adjusted pH value and hit calibrate.

³ Note that if a different vendor is used for pH buffers, the temperature dependence table in SOP Appendix 4 will be updated.

2. Rinse the sensor with de-ionized water and pH 10 standard three (3) times each. Fill the calibration cup with pH 10 standard. Enter the temperature adjusted pH value into HYDRAS and hit calibrate. You have now completed the 2-point calibration. Rinse sensors.

7.6 Dissolved Oxygen Calibration

This method uses air-saturated water to calibrate the sensor. The manufacturer does not recommend using water-saturated air to perform calibration.

The LDO sensor compensates for the temperature of the water. To perform an accurate calibration, it is important that the temperature of the water remain constant during the procedure. The easiest way to do this is to allow the water used for calibration to sit overnight in an open container until it equilibrates to room temperature. **Important:** If the temperature changes by more than 0.5 °C during calibration, dissolved oxygen measurements may be inaccurate, and the sensor will need to be recalibrated when the temperature of the water stabilizes. For this reason, the calibration should also not be done in direct sunlight.

The steps outlined below are based on a transcript of the DO sensor calibration video (Ott HydroMet, undated). The LDO sensor manual includes more information regarding maintenance and operation of this sensor and is included in Appendix 3.2. Note that the LDO manual includes a calibration in air, but the air-saturation water will be used for this project.

1. Stand the Compact DS so the sensors are pointed upwards with the storage cup attached.
2. Add about one (1) liter of room temperature de-ionized water (or clean tap water with a conductivity of less than 500 micro-Siemens per centimeter) to a clean one-gallon jug. Shake the jug very vigorously for 40 seconds. Alternatively, running an air bubbler through the water for ten (10) minutes can be used to saturate the water with air.
3. Establish a connection to the sonde using Hydras3 LT and click the button labeled 'Operate Sonde'. Wait for Hydras to initialize the sensors. Progress can be monitored on the bar at the bottom of the screen.
4. Fill the storage cup with the air-saturated water over the sensors to the bottom of the threads and place the storage cap on upside-down. Do not screw on the cap!
5. When the sonde is ready to operate click the 'Calibration' tab.
6. Select the 'LDO (%Sat)' tab. A picture of the LDO sensor should appear on the screen.

7. Wait for the current value and temperature readings to stabilize. If the cap was stored wet this should happen very quickly. A dry cap may take several minutes to stabilize.
8. Enter the current absolute barometric pressure (BP)⁴ in mm/Hg in the box. BP readings may be obtained from MSD's HL4 Surveyor sonde with internal barometer which measures absolute BP, local weather reports or other sources. It is important to ensure that the readings are absolute BP which has been corrected for elevation. Relative BP (at sea level) is typically used in weather reports. As needed use the Actual BP tool on HydroTech's website to convert relative (sea level) BP readings to absolute BP readings:
<http://www.hydrotechzs.com/references/calculators.htm>.
9. Click 'Calibrate'.
10. A "Calibration Successful" message will be displayed.

Verification

1. Click the red 'X' in the upper right corner and close the Calibration window. In the Connection window click the button labeled 'Terminal mode'
2. Using the Arrow keys, highlight 'Login' and press <Enter>.
3. Highlight 'Level 3' and press <Enter>.
4. Type the password and press <Enter>. The default is 'Hydrolab' and it is case sensitive.
5. Use the Arrow keys to highlight 'Setup' and press <Enter>.
6. Highlight 'Sensors' and press <Enter>.
7. Highlight 'LDO' and press <Enter>.
8. Highlight 'LDO % SAT' and press <Enter>.
9. Read the Scale Factor. A valid calibration will produce a Scale Factor between 0.5 and 1.5. Values outside of these parameters may indicate a problem with the sensor or electronics.
10. DO NOT type a new value for the Scale Factor. This will invalidate the calibration and

⁴ Absolute barometric pressure is the actual atmospheric air pressure at a specific location that depends significantly upon the location altitude. Relative barometric pressure is the corrected barometric pressure calculated for at sea level or zero elevation, and usually used to refer atmospheric conditions.

cause the sensor to take incorrect readings!

11. Press <Esc> after you have verified the Scale Factor is acceptable.

12. Your LDO is now calibrated and ready to deploy.

Table 2. DO Calibration Responses

Response	Explanation
Cal Complete	Calibration is complete
Cal Fail, Offset High	Indicates the air calibration has failed due to an excessively high calculated gain value. Repeat the calibration
Cal Fail, Offset Low	Indicates the air calibration has failed due to too low of a calculated gain value. Repeat the calibration
Cal Fail, Unstable	Indicates the air calibration has failed because the readings did not stabilize during the maximum allowed calibration time interval. Repeat the calibration.

Record calibration status on Calibration Sheet.

For continued accuracy and repeatability, the manufacturer recommends replacing the sensor cap after one year of operation.

7.7 Turbidity Calibration Check and Calibration

The Self Clean Turbidity sensor uses scattered light to report the concentration of suspended particles in water, so it is important to clean the instrument as thoroughly as possible prior to calibration. Use a soft brush and mild soap to remove dirt and debris from all of the sensors and the inside of the storage cup. Rinse the storage cup and sensors until they are free of soap and dirt, then dry with lint free towels.

Calibration checks and calibrations can be performed in the calibration cup or in a stirred vessel. The stirred vessel is preferred for high turbidity standards because the standard can settle and cause low readings for the standards. Shaking the standards will produce bubbles which cause high readings for the standards.

Some helpful techniques for calibrating turbidity include gently rocking the bottle of standard back and forth about 30 times, then rinse the calibration cup with the standard. Pouring the standard slowly and gently into the calibration cup will help to avoid bubbles.

Run a minimum of 3 calibration standards that bracket the desired analytical range. The following can be used as a guide for determining calibration ranges based on expected stream flows:

- Low or Normal Flows: 0 NTU; ≤ 100 NTU
- High Flows: < 100 NTU

7.7.1 Turbidity Calibration Check

1. In the Hydras 3LT software on the NX10, click on the Calibration Tab and select Turbidity NTU.
2. Rinse the sensor and the calibration cup with turbidity-free water⁵ several times and dry with a lint-free cloth or compressed air. Any residue or fluids left behind will affect the calibration accuracy.
3. Rinse and thoroughly dry the sensor end of the turbidity probe.
4. Read the turbidity of the 0 NTU standard (i.e., deionized water) and record on the Calibration Sheet (Appendix 2)
5. Fill the cup with predetermined turbidity standard to check for the 0 NTU, low, normal and high flow concentrations. To prevent excess air bubbles, slowly pour the standard down the interior side of the cup.
6. Wait at least 30 seconds for the turbidity values to stabilize.
7. Read the turbidity of the standard and record on the Calibration Sheet (Appendix 2). Repeat Steps 5 and 6 with the middle and high range calibration standards.
8. If the values are not within the accepted ranges shown on the Calibration Sheet, rinse the sensor and repeat the measurements.
9. Turbidity sensor maintenance is required when any of the optical surfaces have a visible coating, or when the zero check reads > 0.9 NTU.

⁵ Turbidity-free water can be prepared by running distilled water through a 0.2-micron filter.

7.7.2 Turbidity Calibration

Follow the steps below if calibration is required because the values are not within accepted ranges shown on the Calibration sheet. The steps outlined below are based on a transcript of the turbidity sensor calibration video (Ott HydroMet, undated). The turbidity sensor instruction sheet includes more information regarding maintenance and operation of this sensor and is included in Appendix 3.3.

1. In the Hydras 3 LT program, click the 'Operate Sonde' button. Wait for the sensors to initialize (less than one minute).
2. Zero Point Calibration – With the sensors pointed upwards, fill the storage cup approximately 75% with De-ionized Water or <0.1 NTU standard and screw the storage cap on tightly. Slowly turn the sonde over so the sensors point downwards.
3. In Hydras 3 LT, click on the 'Calibration' tab, then click on the 'Turbidity [rev]' tab. You should see a picture of the Self-Cleaning Turbidity sensor. Verify that the value in the box is '1' and click the 'Calibrate' button. The wiper should make one complete revolution, removing any air bubbles from the optics.
4. Click the 'OK' button in the "Calibration Successful" window.
5. Now click on the 'Turbidity [NTU]' tab. There are two boxes on this page.
6. In the box labeled 'Turbidity [Point]' enter a '1'.
7. In the box labeled 'Turbidity [NTU]' enter a value of 0.3 to 0.6 depending on the cleanliness of the sensors.
8. When the readings at the top of the page are stable, click 'Calibrate'.
9. Click the 'OK' button in the "Calibration Successful" window.
10. The highest calibration point should be a value higher than the highest value anticipated at the deployment site. The standard factory high point is 100 NTU. Note that different standards may be used for elevated flow samples.
11. Pour the de-ionized water out of the storage cup and dry the sensors again.
12. Gently swirl or invert the bottle of the high range calibration standard for two to three minutes to mix the suspension.
13. DO NOT shake the bottle of calibration standard! This will suspend air bubbles in the solution and change the turbidity of the standard.

14. Pour the calibration standard into the storage cup until it is about 25% filled. Screw the cap on tightly and shake the sonde. Remove the cap and pour the solution out.
15. Gently pour calibration standard into the storage cup again, this time filling the cup to 75%. Screw the cap on and gently turn the sonde over so the sensors are pointing downward. The end of the Self-Cleaning Turbidity sensor should be fully submerged.
16. Again, in Hydras 3 LT, click on the 'Calibration' tab, then click on the 'Turbidity [rev]' tab. Verify that the value in the box is '1' and click the 'Calibrate' button. The wiper should make one complete revolution, removing any air bubbles from the optics.
17. Click the 'OK' button in the "Calibration Successful" window.
18. Now click on the 'Turbidity [NTU]' tab.
19. In the box labeled 'Turbidity [Point]' enter a '2'.
20. In the box labeled 'Turbidity [NTU]' enter the high range value (Ex '100').
21. When the readings at the top of the page are stable, click 'Calibrate'.
22. Click the 'OK' button in the "Calibration Successful" window.
23. The Self-Cleaning Turbidity sensor is now calibrated. Perform a check with the low and mid-range turbidity standards as in section 7.7.1.
24. After all the calibrations are complete, fill the storage cup with one inch of clean tap water. This will prevent the sensors from dehydrating.
25. If the meter is going to be used for sampling on the same day as calibration, leave the equipment as is. If not, turn off the NX10 and detach the cable from both the NX10 and the sonde. The NX10 goes on the charger and the probe is to be placed in a temperature regulated room for overnight storage.

7.8 Flow Meter Calibration and Standardization

The flow meter will be maintained and calibrated in accordance with the manufacturer's recommendations contained in the manual (Appendix 5). Maintenance will be documented in bound logbooks, maintained by the MSD Field Manager. Logbooks are available upon request. Calibration will be recorded on the Calibration Sheet.

Flow meter calibration will take place on the morning of sampling, before its use at the first monitoring location. Each flow meter to be used for sampling must be calibrated. The calibration will take place according to the following steps:

1. Fill a bucket with tap water. The bucket must be non-metallic and at least eight (8) inches (20.32 cm). The water depth must be at least six (6) inches (15.24 cm).
2. Got to *Main Menu* on the Hach handheld device, select *Setup*, and then *Velocity Calibration*.
3. Put the sensor in the center of the bucket so that it does not touch the sidewall or the bottom of the bucket.
4. Let the water become still.
5. Let the velocity reading stabilize.
6. Select Zero Velocity.

If there is moving water and the meter shows zero (0) velocity or if the water is moving in a positive direction and the flow meter shows negative flow; both circumstances are indicators that the meter has lost its calibration. The user will follow the above steps using water from the stream to recalibrate the meter. Record the calibration and recalibrations (if any) on the Calibration Sheet.

If the meter fails to achieve zero velocity in still water, contact the manufacturer. The meter may need repair.

8 Step-by-Step Field Sampling Procedure

Sampling will occur monthly, as described in Table 2 of the project QAPP. Sampling will be conducted during the third week of each month, between Monday and Thursday, and samples will be delivered to the laboratory **before 1:00 PM** (13:00) on the day of sampling to allow time for laboratory analysis of samples. If needed, samples can be delivered by 10 AM on Friday.

8.1 Sample Preparation

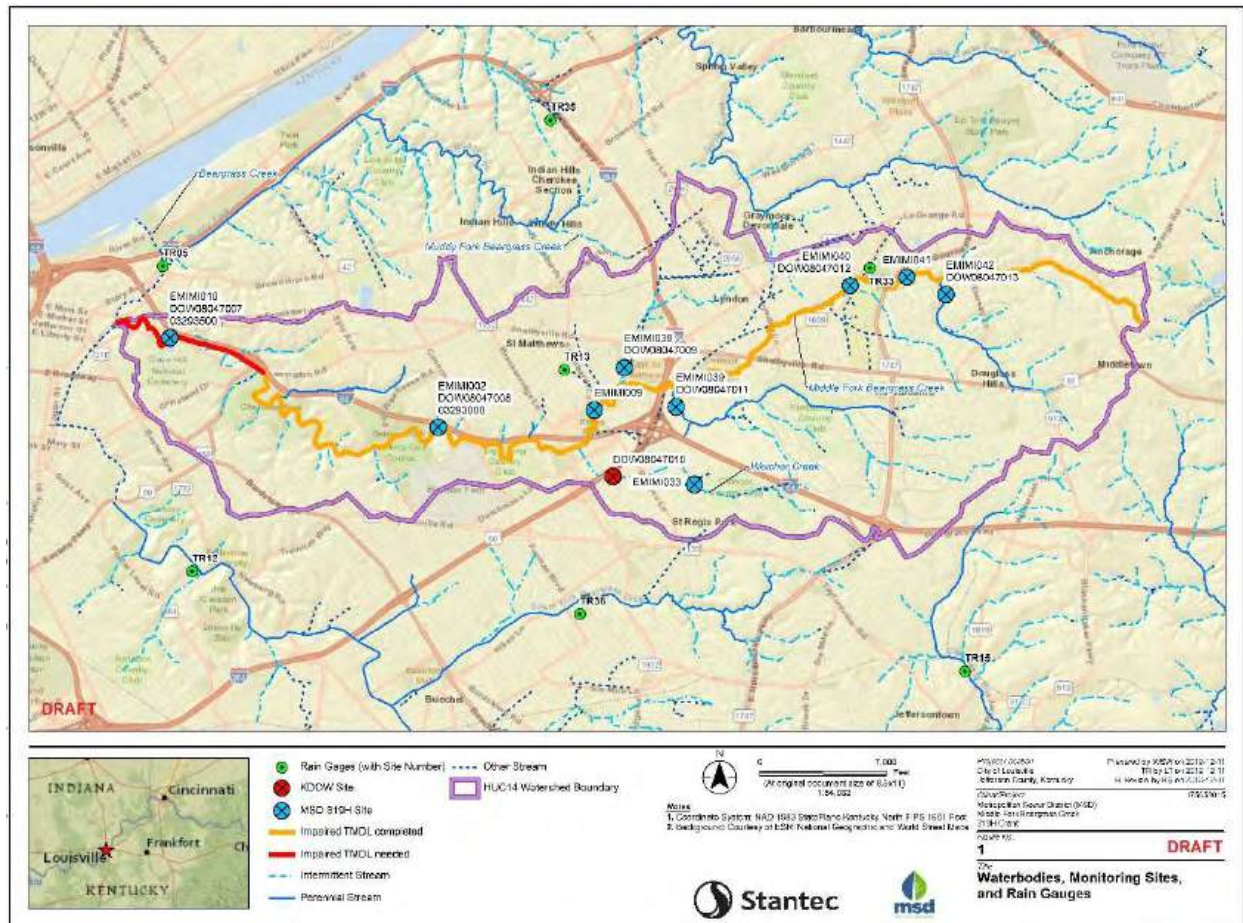
- Assemble Equipment and Supplies identified in **Section 6**.
- Ensure all bottles are labeled with Location Code and Site Name.
- Field Blank and Field Splits will be collected on a rotating schedule shown on **Table 3. Field Quality Control Sample Schedule**

Table 3. Field Quality Control Sample Schedule

Event	Site	Event	Site
1 – 2/2020	EMIMI010 – MFBGC @ Lexington Road	7 – 8/2020	EMIMI040 – MFBGC off Old Whipps Mill Road
2 – 3/2020	EMIMI002 – MFBGC Below Old Cannons Lane	8 – 9/2020	EMIMI041 – MFBGC at Forest Bridge Road
3 – 4/2020	EMIMI009 – MFBGC at Browns Lane	9 – 10/2020	EMIMI042 MFBGC UT above Foxboro Road
4 – 5/2020	EMIMI038 – Sinking Fork below Bowling Boulevard	10 – 11/2020	EMIMI010 – MFBGC @ Lexington Road
5 – 6/2020	EMIMI033 – Weicher Creek at Lincoln Road	11 – 12/2020	EMIMI002 – MFBGC Below Old Cannons Lane
6 – 7/2020	EMIMI039 – MFBGC UT off Steeplecrest Circle	12 – 1/2021	EMIMI009 – MFBGC at Browns Lane

Sampling locations are shown on Figure 1.

Figure 1. Monitoring Sites, and Rain Gauges



8.2 Arriving at the Site

- Team members will put on safety vests prior to arriving at the sampling site.
- Utilize other appropriate Personal Protective Equipment (PPE) including hard hat with chin strap, waders, life jackets, eye protection, disposable gloves and harnesses if the site hazards call for them.
- Park carefully and use the hazard flashers on the car as well as the roof mounted strobe flasher in your sampling kit and place safety cones as appropriate to the site. Follow all other safety requirements from MSD and / or outlined in this SOP.
- Prior to sample collection, establish an appropriate safety zone around the work area, especially related to traffic and walking hazards.

- Record the time of arrival and time of departure from the site, on the Field Data Capture Sheet(FDCS). The arrival time is the time that the team arrives at the site and the departure time is the time that the team leaves the site.
- Record the 24-hour and 48-hour rainfall from rain gauge TR-13: St. Matthews Elementary School using the MSD website: <http://raingauge.louisvillemsd.org/> Use the arrival time recorded on the FDCS as the start time to review 24 & 48-hour rainfall.
- Assess the stream and decide if it is safe to sample. ***Follow the safety precautions in Section 3.4.***
- If it is possible to safely wade in the stream, follow the steps in ***Section 8.3, Sampling When Stream Flow is Normal.***
- If it is not possible to safely wade into the stream, do not collect stream flow measurements. Follow steps in ***Section 8.4 Sampling When Stream Flow is High.***
 - If it is safe to sample from the stream bank, use the pole sampler to collect the *E. coli* sample and bucket sampler to collect field parameters.
 - If the stream bank is unsafe, try to sample from a nearby bridge using the double-cup sampler for *E. coli* and bucket sampler for field parameters.
- Samples should be taken from flowing water; samples should not be collected if the stream is pooled or not flowing. Move a short distance up or downstream to find flowing water. If flowing water is not found, do not sample. Write POOLED or DRY on the COC form and FDCS, take site photos and go on to the next site.

8.3 Sampling When Stream Flow is Normal

If the stream is safe to sample in the stream and is flowing, collect data in this order:

- **Team Member 1:**
 - Stream flow measurement
- **Team Member 2:**
 - Site Photos
 - Field Parameters
 - *E. coli* bacteria

- Chain of Custody Form (COC)
- Field Data Capture Sheet (FDCS)

To the extent possible, *E. coli* samples, field parameters and flow measurements should be collected from flowing water just above (upstream) of a riffle. Pools should be avoided if possible because water may be too deep to sample safely and the stagnant water may affect results.

Important: The flow measurement should be collected *downstream* of the field parameter readings and *E. coli* samples. This set up avoids contaminating the meter readings and bacteria samples if sediment is disturbed when flow measurements are made.

8.3.1 Stream Flow Measurements

An overview of the stream flow measurement collection is provided in Section 8.3.1.1, the specific instructions for setting up the Hach FH950 meter are provided in Section 8.3.1.2 and meter operations to collect stream flow measurements are provided in Section 8.3.1.3.

8.3.1.1 Overview of Stream Flow Measurements

Stream flow will be measured only when it is safe to wade in the stream. Measuring the flow is done in four (4) steps, as described below, based on DOW Stream Discharge SOP (Kentucky DOW, 2010). Operation of the Hach FH950 Meter used by MSD follows these general steps (Hach, 2018).

Step 1. Select a Cross-Section: The following are ideal conditions for selecting the cross-section.

- The site lies within a straight reach of stream and flowlines are parallel to each other. Avoid sites directly below sharp bends.
- Flow is relatively uniform and free from eddies, slack water, and excessive turbulence.
- The streambed is free from large obstructions, such as boulders and aquatic vegetation.
- Water velocity is >0.5 ft/s (may not be possible during low flow).
- Water depth >0.5 ft is preferred, but a minimum depth of >0.1 ft is required per DOW SOP (Kentucky DOW, 2010).
- The flow is perpendicular to the tagline at all points.

Prior to starting the flow measurements, it may be necessary to move rocks, logs, algae mats, rooted aquatic vegetation or other debris to meet as many of the cross-section conditions as possible.

Important: Do not move rocks, logs, or other obstructions **during the measurement process** as this may cause the stream flow to change in an area of the stream where velocity has already been measured. Once the process of measuring velocity has begun, the stream should not be altered further.

Step 2. Setting the Tagline and Vertical Spacing: Set up a tagline by stretching a tape measure across the stream so that it is tight and perpendicular to the stream flow. The tagline should be at the cross-section to be measured and must not touch the water surface.

Identify the starting edge as either left edge of water (LEW) or right edge of water (REW) when **facing downstream**. Determine the approximate width of the stream.

Discharge measurements are taken at several verticals, defined as a point along the cross-section where water velocity is measured at a defined depth (or depths). If the width of the stream flow is:

- <2.2 feet: collect velocity measurements at 1 to 12 verticals
- 2.2 to 20 feet: collect velocity measurements at 12 to 20 verticals
- >20 feet: collect velocity measurements at 20-30 verticals

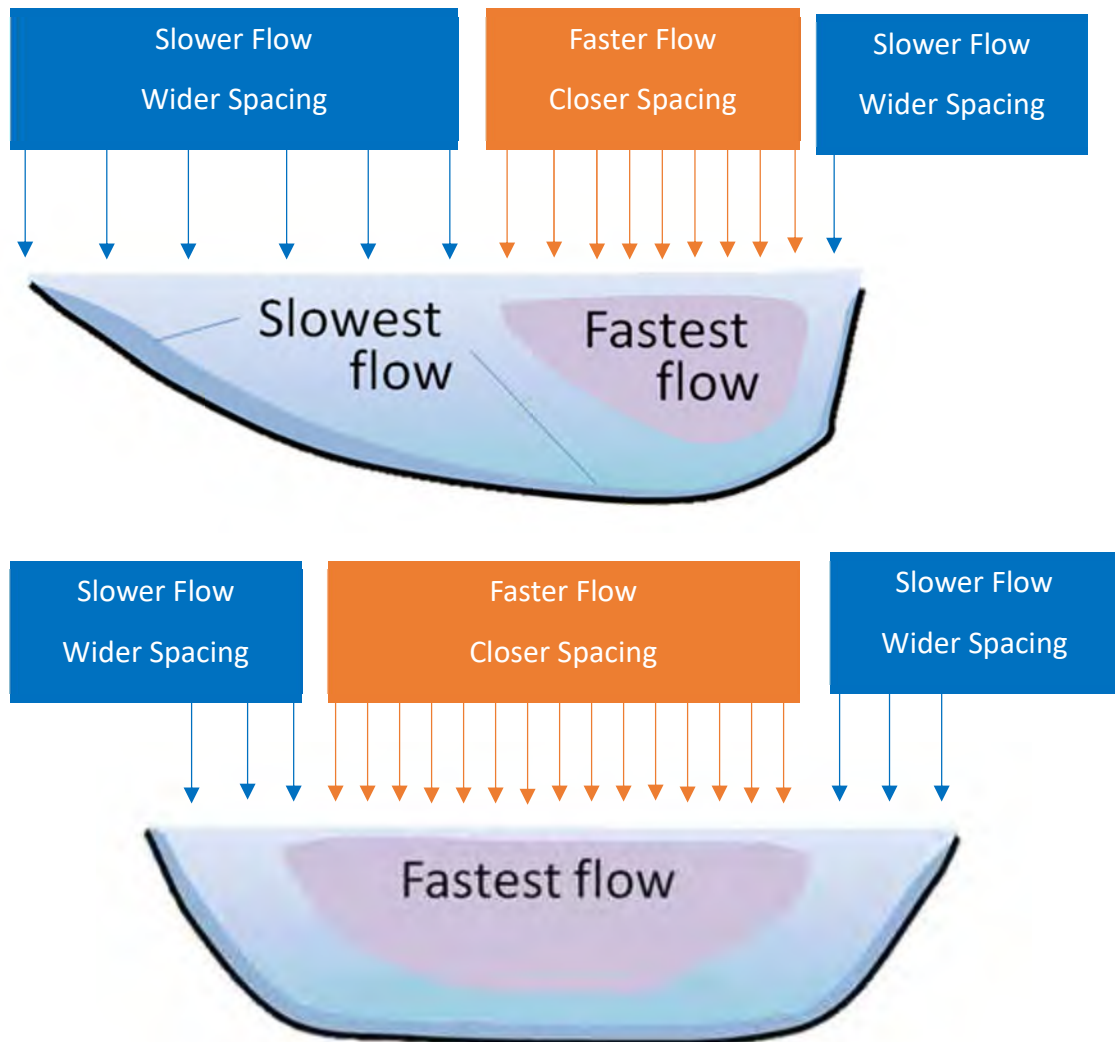
The stream flow measurements are NOT collected uniformly across the stream (e.g., every (2) feet). This is because the flow of the stream varies across the stream and the discharge of each vertical should not exceed 10% of the total stream discharge. For example, if the width of the stream is 18 feet wide the verticals may be placed accordingly:

- Farther apart (i.e. 1 foot to 2 feet) where the stream is shallow and / or flowing slower compared to other sections of the cross-section profile
- Closer together (i.e. 0.8 feet or 1 foot) where stream is slightly deeper and / or flowing faster
- Very close together (i.e. 0.2 to 0.4 feet) where stream depth is the deepest and / or flowing the highest, typically near the thalweg

The spacing mentioned in the example above relates to a stream with varying depth and flow. If depth and flow is uniform across the cross-section it is likely that less variation in

verticals is needed. The concept of using stream flow to adjust vertical spacing is shown in Figure 2.

Figure 2. Spacing Verticals based on Stream Flow



Note: Per the DOW SOP (DOW, 2010) verticals should not be less than 0.2 feet apart. Because of the minimum vertical spacing requirement, small streams with a flowing width of less than 2.2 feet will have less than 12 verticals and can have as few as one vertical during very low stream flow.

Initial readings should be at least 0.2 feet apart. Vertical spacing less than 0.2 feet is acceptable if needed to ensure that all sections account for less than 10% of the total flow.

Note: The vertical spacing in the Hach FH950 User's Manual are less stringent (i.e., fewer verticals per stream width) than DOW requirements. DOW requirements are used in this project (DOW, 2010).

Step 3. Measuring Depth: A standard top-setting wading rod should be used to correct for depth when using flow meters. The flow meter probe and depth sensor (pressure transducer) must be mounted according to the user manual to achieve accurate measurements. Ensure the probe is adjusted to bottom of the wading rod. The Hach FH950 will display the depth reading from the sensor. The user should perform a check on the depth displayed versus the marks on the wading rod. If the readings between the Hach device and wading rod are off by more than 0.05 feet, the user should ensure the sensor is set to the bottom of the rod or confirm the wading rod is in an upright/vertical position. If neither action closes the difference of the depth reading, the user should lift the sensor out of the water to auto zero depth. The instrument does an air calibration when the sensor is removed from the water and is in the air. As explained in Section 8.3.1.2, this function needs to be turned on in the setup window. The wading rod is marked in 0.10-foot increments. It is appropriate to further estimate depth to the 0.02-foot or 0.05-foot increment level, despite the wading rod not being marked to this level. It is advisable to permanently mark these increments on the wading rod to increase the accuracy of depth measurements.

Step 4. Measuring Velocity: The number of measurements taken at each vertical is dependent upon the depth of the stream. Follow these guidelines when determining the number of measurements to make:

Stream Depths $\leq$ 2.5 feet: When stream depth is $\leq$ 2.5 feet, velocity is measured at 0.6 times the total water depth, measured from the water surface. A standard top-setting wading rod will automatically adjust the probe to the 0.4 times the total water depth up from the streambed.

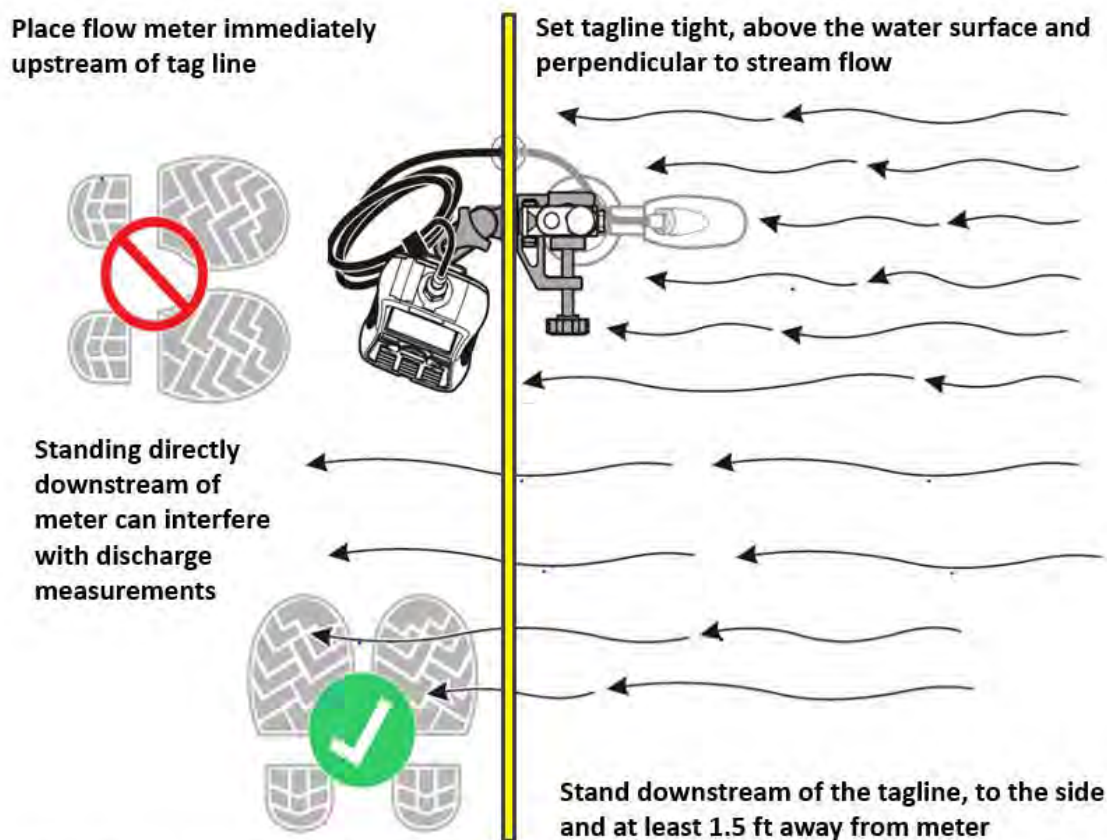
Stream Depths $\geq$ 2.5 feet: When stream depth is $\geq$ 2.5 feet, velocity is measured at 0.2 and 0.8 of the total depth below the water's surface at each vertical, referred to as the two-point method. For example, if the stream depth is three (3) feet, one should take a velocity measurement at 0.6 feet and another at 2.4 feet up from the streambed. An average of these two readings will be used as the average velocity for the vertical.

A standard top-setting wading rod can be adapted to this method by following these instructions:

- To set the rod at the 0.2-depth, position the setting rod at half the water depth.
- To set the rod at the 0.8-depth, position the setting rod at twice the water depth.

The wading rod should be placed just upstream of the tagline, held perpendicular to the water's surface and parallel to the stream flow. As shown on Figure 3, the individual making the measurements should stand at least 1.5 feet away and to the left or right of the wading rod. This positioning helps to keep the meter close to the tagline.

Figure 3. Correct Standing Position during Velocity Measurements



Note: Figure adapted from HACH FH950 Manual

Record the location of the starting edge in the meter as LEW or REW looking downstream. If the starting edge has a water depth, record this. No velocity measurements should be made at the starting or ending edges.

Facing upstream, place the wading rod behind the tape measure at the first vertical and record the location and stream depth. Velocity readings should be averaged over a time period of 25 to 45 seconds, depending on in-stream conditions. Typically, 25 seconds is sufficient, but 45 seconds should be used if the water is turbulent.

Once the stream velocity has been measured and recorded at the first vertical, continue measuring water velocity at each vertical, making sure that the appropriate number of measurements are being taken based on water depth (0.6-depth method vs. two-point method). Continue until you have reached the end of the cross-section. Record the location and depth of the ending edge.

The meter will calculate stream discharge once the ending edge has been reached. Flow calculation will be done using the **Mid-Section Method** to calculate stream discharge; this method has been shown to be more accurate than the Mean-Section Method. Record the final calculated discharge on the COC form.

8.3.1.2 Using the Hach FH950 - Main Menu and Initial Set Up

- On the Main Menu, select PROFILER
- Select STREAM (not conduit)
- In SET UP, the following options can be accessed
 - Velocity Calibration – use to calibrate the meter
 - Filter Parameters – set to Fixed Period Averaging, 25 seconds for stable flow, 45 seconds for turbulent flow
 - Wet Dry Threshold – use default of 5
 - Auto Zero Depth – set to ON – the instrument will do an automatic air calibration when the sensor is removed from the water
 - EMI – use default
 - Clock – set date and time in 24-hour format. Daylight savings time is not supported. Manually adjust the meter clock to the current time (i.e., standard time or Eastern Daylight Savings Time), as appropriate.
 - USB – use Mass Storage default
 - Language – English

- Units – use English (cubic feet per second, cfs)
- Beeper – use default ON, the meter makes an audible tone when the sensor is at the correct depth for applicable profile methods. The meter also makes an audible tone when an inactive button is pushed in any menu. This feature is available only with the optional depth sensor.
- Flow Calculation – set to Mid-Section method (not Mean-Section Method)
- Station Entry – use default NON-FIXED
- Restore defaults – resets the meter to factory defaults

8.3.1.3 Stream Flow Measurements

1. In the Main Menu, select PROFILER.
2. Enter the Operator Name.
3. Select Setup > Maximum Depth > Automatic. (MSD's meter is equipped with an automatic depth sensor)
 - Put the sensor at the lowest position on the wading rod.
 - Enter the measured distance from the ground to the bottom of the sensor. This is the minimum depth that the sensor can read.
4. Select **Top** for the measurement reference then push OK
5. In Setup>Filter Parameters>Main Filter, set the Fixed Period Averaging to 25 seconds. Adjust to 45 seconds if flow is turbulent
6. In the Profiler menu, select Stream
7. Enter a name for the stream (MFBGC LOCODE) (Max is 11 characters).
8. The menu may ask for a stage reference to be entered, if so, skip this step.⁶
9. In the Station Menu, select Edge/Obstruction and select one of the options:
 - LEFT – select if the station is at the LEW (facing downstream) or an obstruction.

⁶ The stage reference is a tape down from a bridge / culvert to the water surface. It is used to get a reference point to relate water surface to stream discharge for developing a rating curve. Most of the 319(h) sites do not have a bridge / culvert to get this measurement from and it's not required by DOW SOP.

- RIGHT - Use this option if the station is at the REW (facing downstream) or an obstruction.
- OPEN WATER - Use this option to configure the edge as an open water environment (default).

10. Select DISTANCE TO VERTICAL and enter the value from the tagline.

11. Select SET DEPTH. In Automatic mode, push OK to set the maximum flow depth at the value shown. Ensure that the sensor is at the bottom of the wading rod (as low as possible, until it touches the disk at the bottom of the rod), and that the sensor is out of the water if the depth at the edge is zero. If there is a depth at the edge, place the sensor in the water as close as possible to the edge and to the full depth of the water.

Note: If Left or Right Edge of Water was selected in Step 9 and a depth is assigned, enter an edge factor for the vertical. Select a factor from the list or User-defined. For User-defined values, enter a roughness factor between 0.50 (very rough) and 1.00 (smooth). The roughness factor is relevant only for right angled cross sections. It is used as a factor in the calculation of the discharge proportion of edge areas. For example:

- Smooth edge with no vegetation (e.g., concrete, steel, cement)— 0.8 to 0.9
- Brick sides with vegetation— 0.7
- Rough walls with heavy vegetation—0.6 to 0.5

12. Select MEASURE VELOCITY. Select the number of points on the vertical to collect. Per DOW Stream Discharge SOP, the following points on the vertical should be collected based on stream depth (DOW, 2010).

- If depth is < 2.5 feet, select 1
- If depth is $\geq$ 2.5 feet, select 2

Reminder: Stand at least 1.5 feet away from the meter to the left or right as shown in **Figure 3**.

13. Select a measurement point from the list. Obey the instrument prompts and adjust the sensor to the correct depth. If the sensor has a depth option, adjust the sensor depth until the depth box is green. This means the sensor is in at the correct position.

Note: Red indicates more adjustment is necessary. Yellow indicates the depth is close to the correct depth.

14. Select CAPTURE to start the measurement process. DOW Stream Discharge SOP requires collecting measurements for 25 seconds for most measurements and 45 seconds for turbulent flow (DOW, 2010).
15. If necessary, the setup can be changed, and the measurement can be repeated. When the measurement is complete, push OK to store the data.
16. If necessary, repeat steps 13–16 for the other measurement point on the vertical.
17. When all measurements for the station are complete, select Main or Verify. Push OK to return to the list of measurement points.
 - MAIN – Returns to the station menu
 - VERIFY - Shows the average velocity reading for the station based on the measurement method
18. Select NEXT to go to the next station.
19. Repeat steps 10–19 for the remaining stations.
20. When all measurements for all stations in the profile are complete, select Channel Summary to view the results.
 - **Note:** The Hach FH950 flow meter will show a visual bar chart of the stream profile measurements when the cross-section is completed. Sections that are calculated to be < 5% of total stream flow will appear as green bars, sections calculated to be between 5% and 10% of the total stream flow will appear as yellow/orange bars, sections calculated to be > 10% of total stream flow will appear as red bars. Sections with > 10% calculated flows will have to be subdivided with additional measurement points before saving the results or leaving the site.
21. If any sections are determined to be > 10% of total cross-sectional flow, insert additional flow measurements at the correct cross-section locations according to the following procedure:

Insert or delete a station

Prev, **Next**, **Ins** and **Del** options show at the bottom of the display in the Station screen. **Prev** and **Next** are used to navigate to a previous or subsequent station.

Ins and **Del** are used to insert or delete a station.

For example, after measurements have been done at 10 stations, a user may wish to insert a new station between stations 3 and 4. The steps below describe how to do this. These steps can be applied in similar situations.

- Select **Prev** and push **OK** until the display shows the information for Station 3.
- Select **Ins** and push **OK**.

The instrument adds a new station named Station 4. Subsequent stations are automatically given new sequential numbers.

- To delete the current station (when in non-fixed mode), select **Del** and push **OK**.

Troubleshooting the Hach FH950 Meter

The meter and sensor contain no user-serviceable parts. For the errors and messages listed, try the corrective action. If the problem does not go away or a problem occurs that is not in the list, contact the manufacturer.

Table 4. Hach FH950 Flow Meter Troubleshooting

Message or problem	Solution
Sensor is not connected	Connect a sensor and try the action again.
Value is out of range	Change the measurement parameters or put in a different value, then try the action again.
Sensor data is known to be not correct or not accurate	Clean the sensor and test.
Sensor is not recognized	Check the sensor connection. Make sure that the lock nut on the connection port is tight (finger-
Display is dim or is not visible	Push a key on the keypad.
Data is not available or access to the data is not	Make sure that the USB option (Main Menu) is set to Mass Storage.

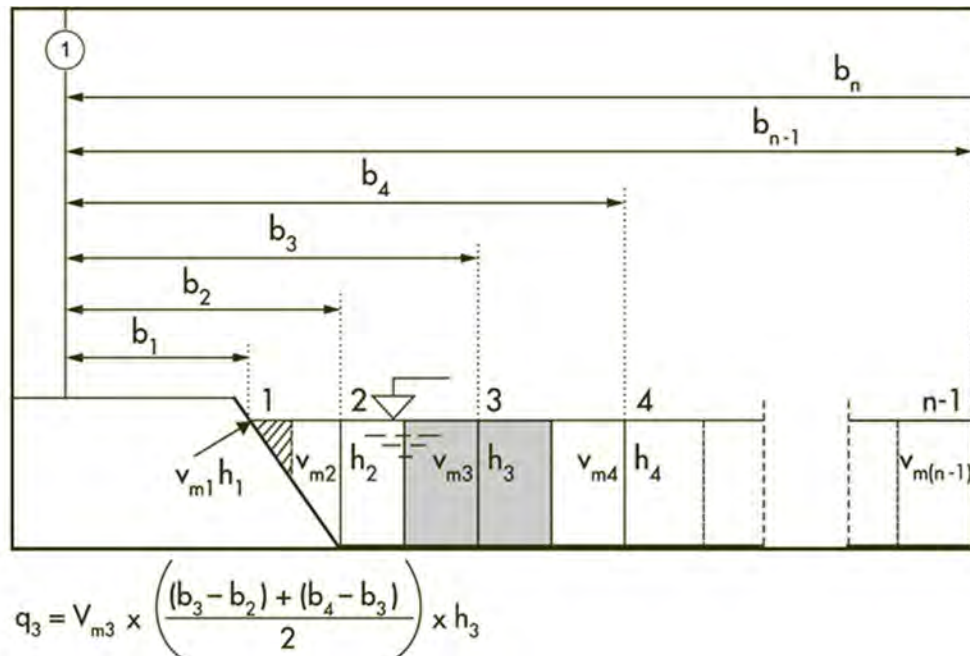
Message or problem	Solution
Meter is unresponsive	Push and hold the power button for at least three (3) seconds. This de-energizes the meter. Energize the meter again. Note: Do not use this method to power off while in normal operation or if the file access icon is visible in the display.

22. Calculate Discharge and Record on FDACS

The user can select the Mean-section or the Mid-Section Method for flow calculations. Per the Hach FH950 User Manual for the flow meter, the Mid-Section Method gives more exact results compared to the Mean-section method. The Mid-Section method will be used for this project.

The Mid-Section Method divides the cross-section into individual flow segments. With the Mid-Section Method, the segments are defined by half of the distance to neighbor verticals in each case. For this reason, the first and last verticals should be as near to the edges as possible (i.e., LEW, REW). Boundary conditions dictate the proximity of the first and last vertical to the edge of water. Figure 4 shows the definitions and equation for the Mid-Section Method.

Figure 4. Mid-Section Method for Discharge Calculation



Where:

m = station number

n = total number of stations V = velocity at vertical

b = distance to vertical from bank h = depth at vertical

q = flow at vertical

23. Download Data and Delete from Hach FH950 Meter

A good practice is to download after two (2) sites have been completed if time allows in the field. This will ensure that not all data is lost if the device was accidentally damaged and data cannot be recovered. The FH950 Manual can hold up to 10 profiles with 32 stations per profile.

The meter directory is Read Only. In Windows, the meter operates as a mass storage device or removable hard drive.

Download Data

- Set the meter to USB Mass Storage mode.

- To edit the data in a file, drag and drop the file to a laptop or PC. File names are limited to eight characters. Use the MSD LOCODE for the file name.
- Data files are kept in the tab separated variable (.TSV) format. To see files in Microsoft® Excel, double or right-click a file and open the file with Excel.
- Open the Excel file on the laptop to ensure that the data downloaded correctly.
- Resave the Excel file with the MSD LOCODE and date. (Example: EMIMI010_2020-03-18)

Delete data files

To delete Profiler files:

- Go to Main Menu > Profiler > Files.
- Select Delete All or use the UP or DOWN arrow to select a file in the list.
- Push OK once to delete the files, then one more time to return to the previous screen.

8.3.2 Site Photos

Take the first picture at each site of the laminated Site ID sheet, then take at least three site photos: looking upstream, looking downstream, and across the tagline location (take the tagline photo with both banks visible).

Take other site photos to document unusual conditions or changes since the previous sample event.

8.3.3 Field Parameters Water Quality Meter

- Unscrew the storage cup on the sonde and replace it with the sensor guard.
- Unwind the cable and place the Compact DS in the stream upstream of the tag line used for stream discharge measurements.
- Try to place the probes near the center of flow to avoid ponded or stagnant water. At least three (3) inches of flow depth is necessary for full immersion of the meter.
- There is no specified orientation for the Compact DS meter (parallel or perpendicular to the stream flow), though the team member will ensure the probes are not obstructed by

debris or the streambed. The team member will also ensure that nothing is inside the sensor guard or that no algae/aquatic plants are touching any of the probes during stabilization prior to taking final reading as this will cause the meter to read incorrectly.

- Return to the stream bank and power up the NX10 from sleep mode. Use your finger or stylus to select and open the Hydrolink Terminal program. A dialog box will pop up. Hit ok. Readings should almost immediately start and update every second across the screen. Place the meter the plastic bag to keep the case clean and step away to allow the probes to stabilize. Do not enter the stream around or upstream of the sonde until the readings have been collected.
- Allow the meter to stabilize for three (3) to five (5) minutes and ensure that any sediment disturbed when placing meters in the stream has settled before taking readings. The team member will stand downstream of the field meter if it is necessary to enter the stream to collect the reading.
- If parameter readings are still fluctuating after the meter has been in the stream for five (5) minutes or more try these steps:
 - Move probes to a different location in stream
 - Examine probes for acceptable operating condition
 - Gently swirl the probes in low flow conditions⁷
 - Suspend the probes vertically in water column
- Per [401 KAR 10:031 section 4\(e\)2](#) , measurements should be collected at mid-depth at sites < 10 feet deep and at representative depths at sites that are > 10 feet deep. Readings for this project will be collected at mid-depth.
- If the stream depth is too shallow, collect stream water into a bucket that has been rinsed three (3) times with stream water. Move the bucket to a location that is shaded from direct sunlight and strong breezes. Immediately, gently swirl the probes in the bucket until the reading stabilizes. ***Do not allow the probe guard to touch the bottom or sides of the bucket.*** Then record the reading on the FDCS as described below.
- After allowing the probe to stabilize and without removing the meter from the water,

⁷ MSD's field meter does not have a stirrer. Gentle swirling is used to collect measurements during low flow conditions, either in the stream or in a bucket.

note the times the measurements were captured from the Hydrolab program. Then record the time along with the following on the FDCS:

- **Temperature:** Record water temperature in °C on the FDCS.
 - **pH:** Record pH on the FDCS.
 - **Dissolved Oxygen (DO):** Record DO in mg/L on the FDCS.
 - **Specific Conductance:** Record specific conductance in µS/cm on the FDCS.
 - **Turbidity:** . Record turbidity in NTU on the FDCS.
- After measurements have been taken, exit out of the program and remove the sonde from the stream. Take a paper towel and wiped down the sonde and cord but not the probes.
 - Replace the sensor guard with the storage cup that should contain tap water, not DI water. Wind up the cord and place the NX10 and the sonde into the backpack provided.
 - Check the Field Parameters section on the FDCS to ensure all data has been collected and recorded.
 - If unable to collect data for one or more parameters, write Not Sampled on the FDCS and provide comments to explain why.

8.3.4 *E. coli* Bacteria

- Fill out the date, time, and initials of one or both of the sampling personnel on each bottle label using waterproof ink pen (i.e., Sharpie). Military format should be used for the time (for example, if a sample is collected at 5:15 PM, the time should be shown as 17:15).
- The team member collecting the sample puts on latex-free gloves.
- The sampler should enter the **upstream** of the work areas for field parameters and stream discharge measurements.
- Face upstream and approach the site from downstream ensuring no disturbed streambed sediments contaminate the sample.
- Do not pre-rinse sample bottle prior to use.
- The sample should be collected from the center of flow (this may or may not be the center of the stream).

- Open the sample bottle and pour the sodium thiosulfate tablet on the lid of the bottle; without touching the tablet.
- To collect a subsurface sample, scoop water from beneath the surface of the stream in one (1) swift motion to fill the bottle at least to 100 mL line; do not pour off excess water
- If adequate volume is not obtained on first effort, do not re-dip the bottle in the water to get the volume over the 100ml mark or reuse the bottle. Use a new, uncontaminated bottle and repeat the procedure.
- Close and secure the sample bottle lid immediately, ensuring that the non-contaminated sodium thiosulfate tablet is returned to the bottle.

Note: The sodium thiosulfate tablet is not absolutely necessary for stream samples. However, in order to maintain consistency, the tablet should be included if possible, using the above method. If for some reason the tablet is dropped or otherwise not included, note this in the Field Data Capture Sheet and the Chain of Custody form.

- On the COC form, record the date/ time in the Grab Sample columns, Sample Volume (100 ml), Sample Matrix and check the box for *E. coli* analysis.
- Add Samplers name in the bottom right corner of the COC
- Within 15-minutes, place the sample in a clean Ziploc bag and place the sealed bag in the cooler containing wet ice. If it is not possible to place the sample in the cooler within this timeframe, use a gallon Ziploc bag containing wet ice as a temporary cooler until you return to the vehicle.
- Dispose of the gloves and sanitize your hands.
- Lock the cooler in the vehicle and prepare to go to the next site.

8.3.5 Field Data Capture Sheet

Complete the field observations section of the Field Data Capture Sheet(FDCS) and check the form to ensure all fields are completed. As needed, write Not Sampled for any field parameters, *E. coli* or stream flow samples/measurements that were not collected and add the reasons in the comment section.

8.4 Step-by-Step Procedures for Sampling Under Difficult Conditions

- ***During high flow events, do not wade into the stream to collect stream discharge measurements!***
- ***If the stream is icy, you may use the hatchet to break a hole in the ice near the stream bank to collect field parameter readings and E. coli samples. Do not attempt to collect stream discharge measurements from an icy stream.***
- Decide if it is safe to sample from the stream bank or nearby bridge.

8.4.1 High Flow Field Parameter Readings

- Rinse the bucket sampler three (3) times with water from the stream, ensuring that the entire inside of the bucket has been in contact with water from this site
- Collect a bucket of water and place it out of direct sunlight and strong breezes before and during temperature measurement
- Hold the meter housing to immediately suspend the field meter probes in the water; avoid touching the bottom of the bucket with the meter probes
- Allow the meter to stabilize
- Fill in the Field Parameters section on the FDCS
- Empty the bucket and rinse out any sediment before leaving the site

8.4.2 High Flow Sample Collection for *E. coli*

- Fill out the date, time, and initials of one or both of the sampling personnel on each bottle label using waterproof ink pen (i.e., Sharpie). Military format should be used for the time (for example, if a sample is collected at 5:15 PM, the time should be shown as 17:15).
- Put on latex-free gloves.
- Lower the sampling device into the stream flow to rinse the sampler.
- Insert a clean bottle into *the E. coli* bottle holder on the double-cup sampler and make sure the top of the bottle extends above the top of the double-cup sampler.
- Remove the sample bottle cap.
- Then, lower the sampling device into the flow and collect the sample from below the surface (i.e., subsurface) of the stream.

- Raise the sampler from the stream, cap the sample bottle and remove it from the double-cup sampler.
- Within 15-minutes, place the sample in a clean Ziploc bag and place the sealed bag in the cooler containing wet ice. If it is not possible to place the sample in the cooler within this timeframe, use a gallon Ziploc bag containing wet ice as a temporary cooler until you return to the vehicle.
- On the COC form, record the date/ time in the Grab Sample columns, Sample Volume (100 ml), Sample Matrix and check the box for *E. coli* analysis. On the FDCS, circle the correct method used to collect the sample.
- Dispose of the gloves and sanitize your hands.
- Lock the cooler in the vehicle and prepare to go to the next site.

8.5 Field Quality Control Samples

Field quality control (QC) samples for this project include Field Splits and Field Blanks. One Field Split and one Field Blank will be collected on each sample day. The sites where field QC samples are collected are based on a rotating schedule shown in Table 3. Field Quality Control Sample Schedule.

8.5.1 Field Split Sample

- Label the sample bottle as Field Split sample, add field team initials, date and time of sample collection.⁸
- Collect the *E. coli* sample as described in Section 8.3.4 for normal flow conditions or Section 8.4.2 for high flow conditions.
- Within 15-minutes, place the sample in a clean Ziploc bag and place the sealed bag in the cooler containing wet ice. If it is not possible to place the sample in the cooler within this timeframe, use a gallon Ziploc bag containing wet ice as a temporary cooler until you return to the vehicle.

⁸ The Field Split sample is different from a field duplicate. Field duplicates are collected into two (2) bottles and analyzed separately in the lab. The Field Split sample is collected into one (1) bottle and the lab will extract two (2) 1 mL subsamples and two (2) 25-ml subsamples to analyze separately. Since subsamples total 52 ml, the standard 120 ml bacteria bottle is used for sample collection. DOW used the Field Split sample for bacteria in their 319(h) sampling of Middle Fork Beargrass Creek (DOW, 2019).

- Record the sample on a Chain of Custody Form.
- The lab will split this sample into two samples analyzed separately. Results will be used to check accuracy of subsampling and analysis in the lab.

8.5.2 Field Blank Sample

- Label the sample bottle as Field Blank sample, add field team initials, date and time of sample collection.
- At the MSD vehicle, collect the field blank by pouring the de-ionized water from the carboy (located inside MSD vehicle) into the labeled sample bottle.
- Within 15-minutes, place the sample in a clean Ziploc bag and place the sealed bag in the cooler containing wet ice. If it is not possible to place the sample in the cooler within this timeframe, use a gallon Ziploc bag containing wet ice as a temporary cooler until you return to the vehicle.
- Record the sample on a Chain of Custody Form.
- The lab will analyze this sample to check that samples are not contaminated with *E. coli* during handling in the field.

8.6 Wrapping Up at a Site

- Return to the vehicle and place the sample and blank (if any) in the cooler with wet ice for storage, adding fresh ice as needed to ensure samples are kept cold (above freezing and less than 4 °C).
- The sample bottles should be kept upright in the cooler and the vehicle should be kept locked.
- If sampling device was used, place the sampling device in a clean plastic bag.
- Place all equipment and trash back in the vehicle.
- Remove/dispose of gloves and sanitize your hands.
- Check COC forms to ensure they are completed correctly. The date/times/initials on the COC form and sample bottles must match!
- Check the FDCS for any blank fields and/or add comments to ensure they are completely filled out and that site photos were taken.

- As needed, write Not Sampled for any field parameters or flow measurements that were not collected and provide a brief explanation in the comments section provided on the FDCS.

8.7 Wrapping Up for the Day

- The lab must analyze the samples within eight (8) hours to meet the maximum holding time.
- Samples will be delivered to the MSD lab **no later than 1:00 PM** (13:00) on the day of sampling.
- Samples will be analyzed using MSD SOP (*E. coli* Rev 6 090118) or most recent update. MSD's lab is certified by DOW as KY#08034.
- At the end of the sampling day, take a second reading of the check water to check for drift. (Note that temperature may be subject to change).
- Download stream flow measurements from the flow meter, see Section 8.7.1.
- Download site photos to the project directory, labeled by site and date.
- The lab will make a copy of the COC form to retain with the sample. Laboratory copies of the COC forms are stored at the Laboratory
- The Field Team will scan the copies of COC Forms and original FDCS to the project directory. The Field Supervisor will then notify the QA Officer once these forms are available for review.
- The Field Team will enter field parameters from the FDCS into Laboratory Information Management System (LIMS) by the end of the week. If no data was collected for a parameter, enter "Not Sampled".
- The Laboratory Technicians will enter *E. coli* results into LIMS
- Upon returning to the office, a final meter check will be performed in the same bucket of water used in the morning check. This will be recorded in the maintenance log.
- Clean, organize and restock field equipment.
 - a. Disconnect the detachable cable from the Compact DS and IMMEDIATELY place the protective plug cover over the now exposed pins.
 - b. Discard the tap water in the sampling cap that was used in the field and replace it

with fresh tap water for long term storage.

- c. Turn off the NX10 completely and detach the cable. Wrap the cable and place it with the probe. Place the NX10 on the charging cable.
- Clean and store meters according to manufacturer's instructions.
 - Recharge meters according to manufacturer's instructions.
 - As needed, update meter software according to manufacturer's instructions.

8.7.1 Downloading Stream Flow Measurements

The meter directory is Read Only. In Windows, the meter operates as a mass storage device or removable hard drive.

1. Set the meter to USB Mass Storage mode.
2. To edit the data in a file, drag and drop the file to a laptop or PC. File names are limited to eight characters.
3. Data files are kept in the tab separated variable (.TSV) format. To see files in Microsoft® Excel, double or right-click a file and open the file with Excel. Real time files are stored in a directory called RT. Stream and conduit profile files are stored in a directory called P.
4. Save files to MSD Directory labeled by sample date.
5. The Field Team will convert flow data from cubic feet per second (CFS) to cubic feet per minute (CFM) as follows: $CFS * 60 = CFM$ then enter data into LIMS.

Delete data files

- Go to Main Menu > Profiler > Files.
- Select Delete All or use the UP or DOWN arrow to select a file in the list.
- Push OK once to delete the files, then one more time to return to the previous screen.

9 Data and Records Management

MSD's Field Technicians, overseen by the Field Team Manager, will enter field parameters and stream discharge data from the FDCS into MSD's Laboratory Information Management System (LIMS). Missing data due to no data collected for field parameters or flow will be documented in LIMS as Not Sampled.

MSD's Laboratory Technicians, overseen by the Laboratory Manager will enter data from the COC and laboratory results into MSD's Laboratory Information Management System (LIMS). Missing data due to no *E. coli* sample collected will be documented in LIMS as "Not Sampled". MSD's Research Chemist will review COC forms, bench sheets and check data entry into LIMS.

The Project Quality Assurance Manager will conduct quality assurance review to document accurate data entry from the FDCS forms. The Project Quality Assurance Manager will work with MSD's Field Team Manager and Laboratory Manager to address quality assurance and / or quality control issues associated with the sampling event.

A Monthly Sampling Event Report will be completed after each sampling run and distributed to the MSD project team and DOW project staff prior to the next sample event, generally within 30 days. MSD's Project Quality Assurance Manager will review 100% of field data, including field parameters, flow data, and laboratory data will be reviewed for quality after each sampling event and included in this report. The Monthly Sampling Report will include:

- Narrative description of event, including any deviations from the QAPP and SOP and corrective actions to be taken before the next sample event
- Chain of Custody Sheets
- Field Data Capture Sheet
- Flow spreadsheets
- Laboratory Bench Sheets
- LIMS Data in Excel Format

See the project QAPP for further information on project Data and Records Management.

10 Quality Control

See QAPP Section 2.5.

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Appendices

1. Sample Bottle Label
2. Project Forms
 - 2.1. Calibration Sheet
 - 2.2. Field Data Collection Sheet
 - 2.3. Chain of Custody Form
 - 2.4. Photo Log Template
3. HydroTech Compact DS
 - 3.1. HydroTech Compact DS5 Manual
 - 3.2. LDO™ Dissolved Oxygen Sensor User Manual
 - 3.3. Self-cleaning Turbidity Sensor Instruction Sheet
4. Temperature Dependence of pH for RICCA Reference Buffers
5. Hach FH950 Manual

Appendix B: MSD 319(h) Field Quality Control Sample Schedule

Event	Site	Event	Site
1 – 2/2020	EMIMI010 – MFBGC @ Lexington Road	7 – 8/2020	EMIMI040 – MFBGC off Old Whipps Mill Road
2 – 3/2020	EMIMI002 – MFBGC Below Old Cannons Lane	8 – 9/2020	EMIMI041 – MFBGC at Forest Bridge Road
3 – 4/2020	EMIMI009 – MFBGC at Browns Lane	9 – 10/2020	EMIMI042 MFBGC UT above Foxboro Road
4 – 5/2020	EMIMI038 – Sinking Fork below Bowling Boulevard	10 – 11/2020	EMIMI010 – MFBGC @ Lexington Road
5 – 6/2020	EMIMI033 – Weicher Creek at Lincoln Road	11 – 12/2020	EMIMI002 – MFBGC Below Old Cannons Lane
6 – 7/2020	EMIMI039 – MFBGC UT off Steeplecrest Circle	12 – 1/2021	EMIMI009 – MFBGC at Browns Lane

APPENDIX 3.2 DOW WATER QUALITY MONITORING RESULTS

1 INTRODUCTION

The objective of the water quality monitoring was to provide sufficient temporal and geographic data to evaluate the sources and loadings of water quality parameters.

This appendix focuses on the data collection and quality assurance review of data collected by DOW in support of watershed plan development. The Data analysis is presented in Chapter 4. Analyzing Results.

2 MONITORING METHODS

2.1 Monitoring Locations

DOW selected seven monitoring locations that included two of MSD's LTMN locations and five locations in the upper part of the watershed and on tributaries. DOW monitoring locations are shown on Table 1 and in Appendix 2.1.

Table 1 DOW Monitoring Locations

Site ID	Station ID	Waterbody	Location	River Mile	Drainage Area (mi ²)	Latitude	Longitude
1	DOW08047007	Middle Fork Beargrass Creek	Lexington Road (1)	0.9	24.8	38.250276	-85.716868
2	DOW08047008	Middle Fork Beargrass Creek	Old Cannons Lane (1)	5.4	18.7	38.23729	-85.66468
4	DOW08047010	Weicher Creek	Above Blossomwood Drive	0.55	1.3	38.23016	-85.63071
6	DOW08047009	Middle Fork Beargrass Creek Tributary 8.45 (Sinking Fork)	Below Bowling Boulevard	0.3	2.6	38.24683	-85.62881
7	DOW08047011	Middle Fork Beargrass Creek Tributary 9.1	Off Steeplecrest Circle	0.2	3.9	38.24093	-85.61867
8	DOW08047012	Middle Fork Beargrass Creek	Off Old Whipps Mill Road	11.7	5	38.25984	-85.58529
10	DOW08047013	Middle Fork Beargrass Creek Tributary 12.8	Above Foxboro Road	0.2	2.2	38.25867	-85.5668

Notes:

1. MSD monitors this location as part of the LTMN

2.2 Sampling Schedule

DOW collected monitoring data between March 21, 2019 and February 18, 2020. In general, seven site visits occurred monthly for collection of field measurements and observations and water chemistry samples. *E. coli* bacteria and field measurements and observations were collected during the May 1 to October 31 recreation season, including five times per month between May 9 and June 6, 2019, then monthly during July to October. Benthic macroinvertebrate communities, habitat, and water chemistry were collected concurrently once at each site between March and July 2019. In general, sampling was conducted as planned. However, dry or pooled stream conditions precluded sampling at three monitoring sites between May and October, affecting water chemistry, *E. coli* bacteria and field measurements and observations: DOW08047009 - Middle Fork Beargrass Creek Tributary 8.45 (Sinking Fork) Below Bowling Boulevard and DOW08047011 - Middle Fork Beargrass Creek Tributary 9.1 Off Steeplecrest Circle. The number of site visits per month is shown on Table 2. Note that it was not possible to collect all of the planned samples and field measurements due to dry or pooled stream conditions. Specific information regarding the effects of dry and pooled stream conditions on sampling schedule is presented in Sections 4 through 7.

Table 2 Number of Sample Events per Month at Seven DOW Sites

Monitoring Type	2019										2020	
	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Water Chemistry (1)	8	7	9	8	6	6	4	5	6	7	7	7
<i>E. coli</i> Bacteria (2)			28	7	7	7	7	7				
Field Measurements & Observations (3)	7	7	28	7	7	7	7	6	6	7	7	7
Macroinvertebrates Habitat Assessment (4)	2		2	1	2							
Notes: 1. Water chemistry collected approximately monthly and also concurrently with macroinvertebrate & habitat assessments 2. <i>E. coli</i> bacteria collected five (5) times in 30 days between May 9, 2019 and June 6, 2019 3. Field measurements and observations collected concurrently with most water chemistry and <i>E. coli</i> sample events 4. Macroinvertebrates, habitat assessments performed once at each site, concurrent water chemistry data collected												

Wet and Dry Sample Conditions: The Watershed Planning Guidebook states that two wet and two dry samples must be collected, defined as follows: A wet weather event is defined as a seven-day antecedent dry period (in which no more than 0.1 inch of precipitation occurs) followed by visible run-off conditions, such as sheet flow on impervious surfaces and visible surface flow in ephemeral channels. A dry weather event is defined as following a seven-day dry period, in which no more than 0.1 inch of precipitation occurs.

The sampling data from DOW were classified as wet or dry sampling events based on the rainfall patterns prior to and during the sampling dates. Wet weather sampling demonstrates pollutants that have accumulated across the watershed and are being flushed into the waterways via stormwater runoff, while dry weather sampling events demonstrate the existing pollutants in the waterways and may indicate leaks or illicit discharges somewhere in the watershed.

For the purposes of this analysis, rain data for the prior seven days up to the day of sampling were pulled from two MSD Rain Gauges: TR13 St. Matthews Elementary School and TR33 AB Sawyer Park. Rainfall patterns

across Jefferson County vary in distribution and intensity. While these gages are geographically within and near the watershed, rainfall totals in the headwaters of the watershed may be different from the recorded totals at the gages located lower in the watershed. The total rain amounts were recorded on the sampling date, 0-24 hours prior to the sampling, 24-48 hours prior, and the total seven days prior to sampling.

Events with greater than 0.1 inches of rain recorded in the prior 24 hours were classified as wet events. **Error! Reference source not found.** Table 3 summarizes each sampling event's rain totals and classification, as well as notes regarding antecedent conditions and rainfall patterns.

Table 3 Rainfall Records on and Prior to Sampling Days

Sampling Date	Sampling Start Time	Wet vs Dry	TOTAL RAINFALL (in)				Notes
			On sample date	0-24 hours Prior to Sample Time	24-48 hours Prior to Sample Time	Total 7 days prior to sample date	
3/21/2019	9:45AM	Dry	0.06	0	0	1.05	.99" of rain on March 14
3/28/2019	9:40AM	Dry	0	0	0	0.46	
4/24/2019	10:15AM	Dry	0	0	0	2.555	Majority of rain occurred April 19-20, some sites had not returned to base flow before sampling
5/9/2019	9:45AM	Dry	0.02	0	0	1.735	1.4" of rain on May 2-3
5/16/2019	10:20AM	Dry	0	0	0	0.3	0.51" of rain on May 16 not included in total, occurred after sampling time
5/23/2019	10:15AM	Dry	0.035	0	0	0.95	0.1" of rain on May 23 not included in total, occurred after sampling time
5/30/2019	10:20AM	Wet	0.3	0.815	0.24	2.215	
6/4/2019	9:30AM	Dry	0	0	0	1.305	1.3" of rain on May 29-30
6/6/2019	9:50AM	Wet	0	0.65	0.04	0.925	Rain on June 6 not included in total, occurred after sampling time
7/10/2019	9:45AM	Dry	0.04	0	0	2.01	1.97" of rain on July 3-4
7/16/2019	9:35AM	Dry	0	0	0	0.1	Rain on July 16 not included in total, occurred after sampling time
8/22/2019	10:00AM	Wet	0.915	0	0.07	1.07	
9/17/2019	10:15AM	Dry	0	0.04	0	0.04	
10/23/2019	8:40AM	Dry	0	0	0.02	0.245	

Sampling Date	Sampling Start Time	Wet vs Dry	TOTAL RAINFALL (in)				Notes
			On sample date	0-24 hours Prior to Sample Time	24-48 hours Prior to Sample Time	Total 7 days prior to sample date	
11/12/2019	9:00AM	Dry	0	0.11	0	0.845	TR13 recorded 0.13" rain on November 11 and TR13 recorded 0.09", the average was rounded to 0.1" and event classified as dry
12/4/2019	10:10AM	Dry	0	0	0.03	2.34	1.885" of rain on November 30; 0.415" of rain on November 27
1/16/2020	10:00AM	Dry	0	0	0	1.685	1.075" of rain on January 11; 0.61" of rain on January 10
2/18/2020	10:00AM	Wet	0.295	0	0	1.585	

2.3 Sample Collection and Analysis

DOW field teams performed sample collection activities as described in Water Quality Monitoring Quality Assurance Project Plan, Revision 2.0 (DOW, 2019), 2019 Success Monitoring Program Study Phase 1 Watershed Plan Monitoring in Middle Fork Beargrass Creek (DOW, 2019a) and accompanying Standard Operating Procedures. DOW sample collection included *E. coli* bacteria and water chemistry samples, field measurements including pH, water temperature, dissolved oxygen, dissolved oxygen percent saturation, conductivity and stream discharge, and field observations.

Analysis for DOW water quality and *E. coli* samples was performed by Department for Environmental Protection Laboratory in Frankfort, Kentucky using analytical methods specified in the DOW QAPP (DOW, 2019). This laboratory was certified to perform the analysis included in this appendix. DOW provided laboratory analytical reports, scans of field data sheets and data in Excel format to MSD for incorporation into the Middle Fork Beargrass Creek Watershed Plan.

2.4 Benthic Macroinvertebrate Communities and Aquatic Habitat Assessments

Benthic macroinvertebrates and aquatic habitat assessments were completed in the spring and summer months of 2019. DOW biologists identified benthic macroinvertebrates to the species level and these data were used to calculate the Macroinvertebrate Index of Biological Integrity (MIBI). MIBI scores were used to assign the narrative rating of Good, Fair, or Poor for headwater and wadeable sites in the Bluegrass Physiographic Province based on DOW protocols.

USEPA's Rapid Bioassessment Protocol (RBP) was used to assess the quality of aquatic habitat using DOW protocols. RBP scores were used to assign a narrative rating of Good, Fair, Poor for headwater and wadeable sites in the Bluegrass Physiographic Province based on DOW protocols and SOP. Stream habitat was evaluated using the high gradient RBP assessment form. High gradient indicates streams have velocities greater than 0.5 ft/second and riffle habitat. Representative upstream and downstream photographs were collected at each site and are provided in Chapter 4. Headwater and wadeable streams are included in this study and were analyzed accordingly (Table 4).

Table 4 Wadeable and Headwater Sampling Stations

Station	Watershed Area (sq mi)	Scoring Type	Sample Period
DOW08047007	24.8	Wadeable	July 10, 2019
DOW08047008	18.7	Wadeable	July 16, 2019
DOW08047009	15.2	Wadeable	May 23, 2019
DOW08047010	1.3	Headwater	March 21, 2019
DOW08047011	3.9	Headwater	May 23, 2019
DOW08047012	5	Wadeable	June 4, 2019
DOW08047013	2.2	Headwater	March 21, 2019

Note that DOW collected and reviewed the data and then provided it to MSD in PDF and excel formats. MSD prepared the monitoring report to support development of this plan. Note that this report does not include data analysis such as comparison to water quality criteria, non-regulatory benchmarks, or estimates of pollutant loads. These analysis are provided in Chapter 4. Analyzing Results.

3 QUALITY ASSURANCE OVERVIEW

The quality assurance review focused on comparing quality assurance sample results to data quality objectives included in the DOW QAPP (DOW, 2019) as summarized on Table 5.

Table 5 DOW Data Quality Objectives

Data Quality Measure	Definition (1)	Measurement (2)
Completeness	The amount of valid data needed so that the data may be used for its intended purpose	(3)
Representativeness and Comparability	All project activities will follow DOW SOPs to ensure representativeness and comparability with past and future data.	Documentation of adherence to SOPs
Precision	The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions.	Field duplicates and for <i>E. coli</i> , field splits of at least 10% of sample distributed across the project
Accuracy	A measure of the overall agreement of a measurement to a known value. Measured by “spiking” a sample with a known concentration of specific analytes.	Percent recovery of laboratory spikes between 90 to 110%
Bias	The systematic or persistent distortion of a measurement process that causes error in one direction.	Field blanks (water quality – 10% of samples distributed across project), (<i>E. coli</i> – one per sample day) Equipment rinsate blanks (ortho-phosphorus – one per sample day), laboratory method blanks

Data Quality Measure	Definition (1)	Measurement (2)
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Comparison of published detection limits for the analysis to actual detection limits achieved in the laboratory
Notes: 1. Definitions from DOW QAPP, Section 1.3.2 Performance and Acceptance Criteria (DOW, 2019) 2. Measurements from DOW 2019 Success Monitoring Program Study Phase 1 Watershed Plan Monitoring in Middle Fork Beargrass Creek, Table 3 (DOW, 2019a) 3. For the purpose of watershed plan development, completeness will be assessed by comparing the collected data to the monitoring requirements of the Watershed Planning Guidebook for Kentucky Communities, 1st Edition (KWA and DOW, 2010)		

Field quality control samples included field duplicates, field splits, field blanks, and equipment rinsate blanks. In addition, a method blank is analyzed in the laboratory as one type of laboratory quality control sample. A description of these quality control samples is included on Table 6.

Table 6 Types of Quality Control Samples

Sample Type	Description (1)	Purpose
Field Duplicate	A sample taken from the same location as the 'regular grab' sample, at the same time. The sample is used to assess variability of environmental conditions at sampling sites.	Evaluate precision (i.e., reproducibility) of water quality samples and measurements
Field Split	A sample that is collected by initially collecting twice as much volume as is normally collected and then thoroughly mixed and split in the lab into two sets of containers. This type of sample is used to assess analysis variability.	Evaluate precision (i.e., reproducibility) of <i>E. coli</i> analysis
Field Blank	A sample that is prepared in the field using de-ionized or certified ultrapure water. The water is poured into appropriate sample containers at specific locations during a sampling event. The sample is used to assess potential contamination from the environment, not associated with the source being sampled.	Evaluate potential contamination (i.e., bias) of water quality and <i>E. coli</i> samples
Equipment Rinsate Blank	A sample used to assess the possible contamination level of equipment that is field cleaned and re-used on-site. The sample is taken by rinsing field cleaned equipment with de-ionized water and collecting the rinse water to be submitted for analyses of all constituents that are normally collected using that piece of equipment.	Evaluate potential sampling equipment contamination (i.e., bias) used for ortho-phosphorus filtration equipment
Method Blank (2)	Laboratory pure water that is treated exactly as a sample including exposure to glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples.	Evaluate potential contamination in the laboratory.
Note: 1. DOW (2011). Sampling Surface Water Quality in Lotic Systems, Revision 2. DOWSOP03015 2. MSD (2019). Quality Assurance Plan, Effective Date: 10/14/2019		

Data flags are assigned by the lab to provide additional information about field collection and sample analyses performed in the laboratory as part of routine laboratory data management. Data flags B. Analyte in Method Blank and K. Analyte in Trip or Field Blank are used to evaluate potential bias in the sample results caused by contamination in the field or laboratory. DOW recommended that data associated with flags H. Exceeded Prep Hold Time, P. Improper Preservative and T. Exceeded Holding Time be excluded from further analysis. One or more data qualifiers may be assigned when sample concentrations are near the lower limits of the analytical range (i.e., low concentrations). It is important to note that data flags provide additional information about analytical results and their presence does not indicate “bad” data. Data flags that were assigned to the DOW data and potential data implications are shown on

Table 7.

Table 7 Data Flags and Potential Data Implications

Flag	Flag Description	Potential Data Implications
B	Analyte in Method Blank	Blank sample may have been inadvertently contaminated in the lab and the source of the contamination may also have affected samples, increasing the resulting concentration (i.e., bias). Blank concentrations may be subtracted from detected sample concentrations analyzed in the same batch.
D	Analyzed at a Higher Dilution	DOW applied this flag to <i>E. coli</i> bacteria note samples analyzed at 1:10 dilution. No adjustment to sample results.
J	Estimated Value	This qualifier is typically assigned to values outside the upper or lower range of the analytical method. For results reported as greater than the maximum detectable value, the reported numeric result may be used in subsequent analysis. For results reported as less than the minimum reporting limit, the reported numeric result may be multiplied by 0.5, and that adjusted value is used for subsequent results
K	Analyte in Trip or Field Blank (1)	Blank concentrations may be subtracted from detected sample concentrations collected on that day.
M	Matrix Spike Limits Exceeded	No change to sample results
O	Lab Fortified Blank Limits Exceeded	No change to sample results
Q	QC Limits Exceeded	No change to sample results
T	Exceeded Holding Time	Some samples, notably <i>E. coli</i> bacteria, must be analyzed within a specified time between collection and analysis in order to ensure a valid sample. DOW recommended results with this data flag be excluded from further analysis.
U	Analyte Not Detected	For results reported as less than the minimum reporting limit, the reported numeric result may be multiplied by 0.5, and that adjusted value is used for subsequent results
V	Calibration Verification Limits Exceeded	No change to sample results

Flag	Flag Description	Potential Data Implications
X	See Case Narrative	May or may not affect sample results, depending upon the case narrative provided by the lab
Z	Sample Preserved by Freezing	No change to sample results, except if applied to bacteria sample (which did not occur in this dataset).
Notes: 1. Data flag K was not assigned by DOW; however, several field blanks had detected concentrations		

4 E. COLI MONITORING AND DATA QUALITY REVIEW

The Watershed Planning Guidebook specifies monthly *E. coli* sample collection at the selected watershed monitoring sites over one year and collection of five samples in 30 days during May or June. (KWA and DOW, 2010) The DOW sampling schedule focused on the May 1 to October 31 recreation season, with five samples in 30 days collected in May 2019. MSD's sampling extends from March 2020 to February 2021. Taken together, the DOW and MSD monitoring efforts exceed the Guidebook monitoring requirements for *E. coli* bacteria.

DOW collected *E. coli* bacteria samples using methods described in the Standard Operating Procedure (SOP) Sampling Surface Water Quality in Lotic Systems, Revision 2, DOWSOP03015 (DOW, 2011). Sample bottles were filled directly from the subsurface of the stream to minimize sample handling and stored on ice. Five samples in 30 days were collected between May 9 and June 6, 2019. The *E. coli* sample collection schedule is shown on

Table 8.

Table 8 DOW *E. coli* Sample Collection Schedule (2019)

DOW Monitoring Sites	May				Jun	Jul	Aug	Sept	Oct	# Samples
	9	16	23	30	6	16	22	17	23	
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	1	1	1	1	1	1	1	1	1	9
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	1	1	1	1	1	1	1	1	1	9
DOW08047009 Sinking Fork at Bowling Blvd	1	1	1	1	1	1	1	X	1	8
DOW08047010 Weicher Creek at Blossomwood Drive	1	X	X	1	1	X	X	X	X	3
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	1	1	1	1	1	X	1	X	X	6
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	1	1	1	1	1	1	1	1	1	9
DOW08047013 Middle Fork Beargrass Creek Tributary at Foxboro Road	1	1	1	1	1	1	1	1	1	9
Total										53

Samples were transported to the Department for Environmental Protection Laboratory for analysis using procedures described in SOP Enzyme Substrate Test for the Detection Total Coliforms and *Escherichia coli*,

Revision 2, DOWSOP03025 (DOW, 2018). Results were reported as Most Probable Number per 100 milliliters (MPN/100 mL). As a reference, 100 mL is approximately 3.2 ounces. The detection range for this method is <1 MPN/100 mL to 2,419 MPN/100 mL for undiluted samples. 20 samples were diluted 1:10 with sterile water in the laboratory and were assigned a data flag of D. Analyzed at a Higher Dilution. The detection range for samples at this dilution is <10 MPN/100 mL to 24,196 MPN/100 mL. A total of 63 samples were planned (i.e., nine samples at seven sites). Of these, 53 samples (84%) were collected. It was not possible to collect 10 of the samples due to dry or pooled stream conditions.

The data quality review included evaluation of results from analysis of quality control samples and data flags. Quality control samples collected for *E. coli* bacteria included field blanks and field splits. Per the 2019 Success Monitoring Program Study Phase 1 Watershed Plan Monitoring in Middle Fork Beargrass Creek one field blank was collected on each sample day. All nine samples were reported as less than the detection limit of 1 MPN/100 mL, indicating that the reported results were not biased by contamination during sample collection and analysis. Data flag D was assigned to the 20 samples analyzed at 1:10 dilution; no other data flags were assigned by the laboratory.

Nine *E. coli* field splits¹ were collected over the duration of the study and used to assess precision (i.e., reproducibility) of the analysis. Field split results were analyzed using a statistical method published by Standard Methods (Eaton, et. al., 1998) as recommended by DOW. Because the absolute difference was less than the calculated performance criteria, the field duplicates met the precision target. The precision analysis is shown on

Table 9.

Table 9 *E. coli* Field Split Precision Analysis

Monitoring Site	Sample Date	Field Split 1 (MPN/100 mL)	Field Split 2 (MPN/100 mL)	Log (Split 1)	Log (Split 2)	Absolute Difference
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	5/16/2019	81	108	1.91	2.03	0.12
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	5/30/2019	4,106	4,884	3.61	3.69	0.08
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	9/17/2019	122	102	2.09	2.01	0.08
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	5/9/2019	548	411	2.74	2.61	0.12
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	5/23/2019	>2,419	>2,419	3.38	3.38	0.00

¹ One *E. coli* sample was identified as a field duplicate collected from mid-depth, rather than subsurface (Lab sample ID FF19403). This sample was treated as a field split collected from subsurface.

Monitoring Site	Sample Date	Field Split 1 (MPN/100 mL)	Field Split 2 (MPN/100 mL)	Log (Split 1)	Log (Split 2)	Absolute Difference
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	6/6/2019	3873	5794	3.59	3.76	0.17
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	7/16/2019	158	158	2.20	2.20	0.00
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	10/23/2019	285	194	2.45	2.29	0.17
DOW08047013 Middle Fork Beargrass Creek Tributary at Foxboro Road	8/22/2019	>2,419	>2,419	3.38	3.38	0.00
Average						0.08
Performance Criteria: Less than (3.27 * Average)						0.27

Summary: DOW sample and collection analysis was consistent with the DOW QAPP (DOW, 2019). The Watershed Planning Guidebook bacteria monitoring requirements (KWA and DOW, 2010) specify monthly bacteria monitoring for one year, with five samples in 30 days collected in either May or June. The DOW *E. coli* data was collected during the recreation season of May 1 to October 31, with five samples collected in 30 days between May 9 and June 6, 2019, for a total of nine sample events. MSD *E. coli* data was collected monthly from February 2019 to January 2020, so the two sampling efforts exceed the bacteria monitoring requirements of the Guidebook. The *E. coli* data collected by DOW and MSD will be integrated for the data analysis performed in Chapter 4. Analyzing Results, providing approximately two years of *E. coli* record for this watershed.

DOW planned a total of 63 samples (i.e., nine samples at seven sites). Of these, 53 samples (84%) were collected. It was not possible to collect 10 of the samples due to dry or pooled stream conditions. One field blank was collected on each sample day. All nine samples were reported as less than the detection limit of 1 MPN/100 mL, indicating that the reported results were not biased by contamination during sample collection and analysis. Nine *E. coli* field splits² were collected over the duration of the study and used to assess precision (i.e., reproducibility) of the analysis. Because the absolute difference was less than the calculated performance criteria, the field duplicates met the precision target.

5 WATER CHEMISTRY MONITORING AND DATA QUALITY REVIEW

The Guidebook specifies monthly water chemistry sample collection at the selected watershed monitoring sites over one year (KWA and DOW, 2010). DOW collected water chemistry samples using methods described in the Standard Operating Procedure (SOP) Sampling Surface Water Quality in Lotic Systems, Revision 2, DOWSOP03015 (DOW, 2011). Sample bottles were filled directly from the mid-depth of the stream to minimize sample handling, preserved as necessary and stored on ice in

² DOW collected eight (8) field splits and one (1) field duplicate. These results were combined to evaluate precision of the analysis.

the field. The DOW water chemistry sampling occurred between March 28, 2019 to February 18, 2020 as shown on

Table 10.

Table 10 Monthly Water Chemistry Sampling Schedule

Monitoring Location	2019										2020		Total
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
	28	24	30	6	16	22	17	23	12	4	16	18	
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	1	1	1	1	1	1	1	1	1	1	1	1	12
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	1	1	1	1	1	1	1	1	1	1	1	1	12
DOW08047009 Sinking Fork at Bowling Blvd	1	1	1	1	1	1	X	1	1	1	1	1	11
DOW08047010 Weicher Creek at Blossomwood Drive	X	1	1	1	X	X	X	X	X	1	1	1	6
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	1	1	1	1	X	1	X	X	1	1	1	1	9
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	1	1	1	1	1	1	1	1	1	1	1	1	12
DOW08047013 Middle Fork Beargrass Creek Tributary at Foxboro Road	1	1	1	1	1	1	1	1	1	1	1	1	12
Total # of Monthly Water Chemistry Sampling Events													74

In addition, DOW collected water chemistry samples concurrently with benthic macroinvertebrate communities and habitat assessments on the dates shown on Table 11.

Table 11 Water Chemistry Samples Collected with Benthic Macroinvertebrate Communities

Monitoring Location	Date
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	July 10, 2019

Monitoring Location	Date
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	July 23, 2019
DOW08047009 Sinking Fork at Bowling Blvd	May 23, 2019
DOW08047010 Weicher Creek at Blossomwood Drive	March 21, 2019
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	May 23, 2019
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	June 4, 2019
DOW08047013 Middle Fork Beargrass Creek Tributary at Foxboro Road	March 21, 2019
Total # of Concurrent Water Chemistry and Macroinvertebrate Sampling Events	7

DOW planned 91 water chemistry sampling events, including 84 monthly events and one concurrent collection with benthic macroinvertebrate communities at seven sites. A total of 81 of 91 (89%) planned water chemistry sampling events were completed. It was not possible to collect samples for the remaining ten events due to pooled or dry stream conditions.

Water chemistry samples were transported to the Department for Environmental Protection Laboratory in Frankfort, Kentucky for analysis for the parameters shown on Table 11.

Table 12 Water Chemistry Parameters Analyzed by DOW

Parameter Type	Water Chemistry Parameters (1)
Bulk	biochemical oxygen demand , bromide, chloride, fluoride, nitrate, nitrite, sulfate, turbidity, total dissolved solids
Nutrients	ammonia (as N), nitrate+nitrite (as N), total Kjeldahl nitrogen, total organic carbon, total phosphorus, ortho-phosphorus (field filtered)
Sediment	total suspended solids
Alkalinity	acidity, alkalinity, alkalinity-carbonate, alkalinity-bicarbonate
Metals and Hardness	aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, total hardness
Notes: 1. Parameters required by the Watershed Planning Guidebook for Kentucky Communities, 1 st Edition (KWA and DOW, 2010) are shown in bold.	

The laboratory analyzed the samples using approved methods specified in the QAPP (DOW, 2019). Data provided to MSD for use in the watershed plan included scanned field sheets, site photographs, laboratory analysis reports in PDF format and water chemistry data in Excel format.

The water chemistry data quality review included evaluation of results from analysis of quality control samples and data flags. The DOW recommended excluding results with data flags H. Exceeded Prep Hold Time, P. Improper Preservative, and T. Exceeded Holding Time. 13 results with data flag T were excluded from all subsequent quality control reviews and analyses; data flags H and P did not occur in the dataset. Four acidity samples did not have reported values and were removed from the dataset. Orthophosphorus samples were

analyzed by two different methods: EPA 300.0 Inorganic Anions by Ion Chromatography (Detection Limit 0.03 mg/L) and EPA 365.1 Phosphorus (all forms) by Semi-Automated Colorimetry (Detection Limit 0.01 mg/L).

Quality control samples collected for water chemistry included field blanks, equipment rinsate blanks (Orthophosphorus only), field duplicates and method blanks. Per the 2019 Success Monitoring Program Study Phase 1 Watershed Plan Monitoring in Middle Fork Beargrass Creek one of each type of field quality control sample was collected on each sample day.

Nine of 493 field blank results (1.8%) were detected in concentrations greater than the minimum detection limit, indicating a potential positive bias in samples associated with these blanks. A total of 16 equipment rinsate blanks were collected to identify potential contamination in filtering equipment used in the field for ortho-phosphorus samples. Concentrations of ortho-phosphorus were reported as less than the reporting limit for all but one of the samples indicating a potential positive bias in samples associated with these blanks.

Table 13 Water Chemistry Field Blank Detected Concentrations

Monitoring Location	Characteristic	Date	Detection Limit	Result	Units
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	Phosphorus, Total (as P)	9/17/2019	0.01	0.04	mg/L
	Sulfate	9/17/2019	0.1	0.245	mg/L
	Sulfate	1/16/2020	0.1	0.244	mg/L
	Zinc	11/12/2019	2	10.5	µg/L
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	Sulfate	10/23/2019	0.1	0.235	mg/L
	Sulfate	12/4/2019	0.1	0.204	mg/L
	Zinc	10/23/2019	2	6.48	µg/L
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	Aluminum	3/28/2019	2	6.03	µg/L
	Turbidity	6/6/2019	0.05	0.118	mg/L

Four samples and two field blanks collected had detectable concentrations of phosphorus as indicated by data flag B. Analyte in Method Blank indicating a potential positive bias in samples associated with these blanks. The concentration detected in the method blank was not reported in the DOW data.

Field duplicates were collected during each of the 12 sample events and used to assess precision (i.e., reproducibility) of the analysis. The field duplicate collection schedule is shown on

Table 14. There were twelve sets of field duplicate results per parameter, except for Orthophosphorus, which had 24 pairs of results. Orthophosphorus samples were analyzed by two different methods: EPA 300.0 Inorganic Anions by Ion Chromatography (Detection Limit 0.03 mg/L) and EPA 365.1 Phosphorus (all forms) by Semi-Automated Colorimetry (Detection Limit 0.01 mg/L). Field duplicate results from each method were analyzed separately.

Table 14 Water Chemistry Field Duplicate Collection Schedule

Monitoring Site	Date	Date	Date
DOW08047007 Middle Fork Beargrass Creek at Lexington Road	9/17/2019	12/4/2019	

Monitoring Site	Date	Date	Date
DOW08047008 Middle Fork Beargrass Creek at Old Cannons Lane	3/28/2019	6/6/2019	11/12/2019
DOW08047009 Sinking Fork at Bowling Blvd	2/18/2020		
DOW08047010 Weicher Creek at Blossomwood Drive	NA		
DOW08047011 Middle Fork Beargrass Creek Tributary at Steeplecrest Circle	5/30/2019		
DOW08047012 Middle Fork Beargrass Creek at Old Whipps Mill Road	4/24/2019	7/16/2019	10/23/2019
DOW08047013 Middle Fork Beargrass Creek Tributary at Foxboro Road	8/22/2019	1/16/2020	

Per the DOW QAPP Table 1.5 (DOW, 2019), the acceptance criteria shown on Table 15 were applied to water quality samples collected by DOW. Field duplicates and the concurrent routine samples were paired, and results were compared to detection limits, as indicated by “<” values in the dataset, and Limits of Quantitation (LOQ) specified in Table 2.2 of the DOW QAPP (DOW, 2019).

Table 15 Water Chemistry Acceptance Criteria

Sample Spread (1)	Acceptance Criterion
Both samples are $\geq 5x$ the LOQ	A relative percent difference (RPD) of 20%
1 of 2 samples is $\geq 5x$ the LOQ	An absolute difference $\leq$ to the $2x$ LOQ ⁽¹⁾
Both samples are $< 5x$ the LOQ (2)	An absolute difference $\leq$ to the $2x$ LOQ ⁽¹⁾
Both samples are non-detect	Not Applicable – No Calculation Required
Notes - Excerpted from DOW QAPP Table 1.5 (DOW, 2019) - If both samples are less than $5x$ the LOQ and are also found to have an absolute difference of $>2x$ the Limit of Quantitation (LOQ), these data will be investigated further. If sufficient additional indicators of QA issues are found, the samples will be considered to have failed this QA check. Corrective action will be implemented as appropriate and outlined in this QAPP. All corrective actions must be reported in the final data report.	

The results of the precision review for parameters included in the Guidebook, 1st Edition (KWA and DOW, 2010) are presented on Table 16.

Table 16 Results of Precision Review for Guidebook Parameters

Characteristic	Analysis Method	LOQ (1)	Number of Paired Analyses	Number Meeting Acceptance Criteria
Ammonia (as N)	EPA 350.1 r2	0.05 mg/L	12	12
CBOD-5	SM20 5210 B	(2)	11	11

Characteristic	Analysis Method	LOQ (1)	Number of Paired Analyses	Number Meeting Acceptance Criteria
Nitrate & Nitrite (as N)	EPA 353.2 r2	0.02 mg/L	12	12
Nitrate (as N)	EPA 300.0 r2.1	0.02 mg/L	12	12
Nitrite (as N)	EPA 300.0 r2.1	0.02 mg/L	12	12
Nitrogen, Total Kjeldahl (as N)	EPA 351.2 r2	0.5 mg/L	12	12
Orthophosphate (as P)	EPA 300.0 r2.1	0.02 mg/L	12	12
Orthophosphate (as P)	EPA 365.1 r2	0.02 mg/L	11	11
Phosphorus, Total (as P)	EPA 365.4	0.02 mg/L	12	12
Solids, Total Suspended	SM20 2540 D	1.5 mg/L	12	10
Turbidity	EPA 180.1 r2	0.1 NTU	11	11
Total			129	127
Notes: 1. Limit of Quantification excerpted from DOW QAPP, Table 2.2 (DOW, 2019) 2. DOW QAPP, Table 2.2 did not include an LOQ CBOD-5. (DOW, 2019) However, CBOD-5 was detected in only one (1) of 12 paired duplicate samples.				

Eight of twelve pairs of aluminum samples met the acceptance criteria. Relative percent difference between duplicate samples with aluminum concentrations above the detection limit ranged from 1.7% to 126.5%. Four values did not meet the relative percent difference acceptance criteria of 20%. For the remaining additional parameters analyzed by DOW, at least ten of twelve pairs of samples met the acceptance criteria. One lead sample collected from DOW08047007 Middle Fork Beargrass Creek at Lexington Road in December 2019 was slightly above the criteria for additional investigation shown in Table 13, Note 2. The Field Duplicate lead concentration was 1.11 micrograms per liter (ug/L) and the concurrent field sample lead concentration was 0.1 ug/L. With these few exceptions, the precision review indicates good reproducibility in the dataset.

Stream discharge was not measured on May 9 at any of the sites due to an impending thunderstorm. Stream discharge was not measured on May 30 in Middle Fork Beargrass Creek at Lexington Road (DOW08047007) and Old Cannons Lane (DOW08047008) due to safety issues from high water. Discharge data from USGS gages will be used at these sites.

The DOW monitoring included parameters that are required by the current Guidebook (KWA and DOW, 2010), plus 34 additional parameters. The DOW monitoring parameters are shown on Table 17, with parameters required by the Guidebook are shown in bold.

Table 17 DOW Monitoring Parameters

Parameter Type	Parameter(s) (1)
Bacteria	<i>E. coli</i> bacteria
Bulk	biochemical oxygen demand , bromide, chloride, fluoride, nitrate, nitrite, sulfate, turbidity, total dissolved solids, total suspended solids

Parameter Type	Parameter(s) (1)
Nutrients	ammonia (as N), nitrate-nitrite, total Kjeldahl nitrogen, total organic carbon, total phosphorus, ortho-phosphorus (field filtered)
Sediment	total suspended solids
Alkalinity	acidity, alkalinity, alkalinity-carbonate, alkalinity-bicarbonate
Metals and Hardness	aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, total hardness
Field Parameters	turbidity, pH, dissolved oxygen, dissolved oxygen % saturation (calculated), conductivity, temperature
Stream Flow	stream discharge
Biology & Habitat	benthic macroinvertebrates, habitat assessment
Notes: 1. Parameters required by the Guidebook are shown in bold.	

5.1 Riparian Assessment

The riparian assessment will be analyzed in Phase 2.

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APPENDIX 3.3 MSD WATER QUALITY MONITORING RESULTS

1 INTRODUCTION

The objective of the water quality monitoring was to provide sufficient temporal and geographic data to evaluate the sources and loadings of water quality parameters.

This appendix focuses on the data collection and quality assurance review of data collected by MSD in support of watershed plan development. Data analysis is presented in Chapter 4. Analyzing Results.

2 MONITORING METHODS

2.1 Monitoring Locations

MSD selected nine monitoring locations that included three of MSD's LTMN locations and seven locations selected to provide representative data in the upper part of the watershed and on tributaries. MSD monitoring locations are shown on Table 1 and Figure 1. Some of these sites were the same locations that DOW monitored for this plan.

Table 1 MSD Monitoring Locations

Site ID	Station ID	Waterbody	Location	River Mile	Drainage Area (mi ²)	Latitude	Longitude
1	EMIMI010	Middle Fork Beargrass Creek (1)	Lexington Road	0.9	24.8	38.250276	-85.716868
2	EMIMI002	Middle Fork Beargrass Creek (1)	Old Cannons Lane	5.4	18.7	38.23729	-85.66468
3	EMIMI009	Middle Fork Beargrass Creek (1)	Browns Lane	7.97	15.2	38.2403	-85.6345
5	EMIMI033	Weicher Creek	Lincoln Road	1.56	0.57	38.22902	-85.61491
6	EMIMI038	Middle Fork Beargrass Creek UT 8.45 (Sinking Fork)	Below Bowling Boulevard	0.3	2.6	38.24683	-85.62881
7	EMIMI039	Middle Fork Beargrass Creek UT 9.1	Off Steeplecrest Circle	0.2	3.9	38.24093	-85.61867
8	EMIMI040	Middle Fork Beargrass Creek	Off Old Whipps Mill Road	11.7	5.0	38.25984	-85.58529
9	EMIMI041	Middle Fork Beargrass Creek	Forest Bridge Road	12.38	4.07	38.26126	-85.57434

Site ID	Station ID	Waterbody	Location	River Mile	Drainage Area (mi ²)	Latitude	Longitude
10	EMIMI042	Middle Fork Beargrass Creek UT 12.8	Above Foxboro Road	0.2	2.2	38.25867	-85.56680
Notes: 1. MSD Long Term Monitoring Network sites: EMIMI010, EMIMI002, EMIMI009							

2.2 Sampling Schedule

MSD collected monitoring data between March 11, 2020 and February 24, 2021. In general, nine site visits occurred monthly for collection of field measurements and observations and water chemistry samples. *E. coli* bacteria was collected during the May 1 to October 31 recreation season, including five times per month between May 27 and June 24, 2020. Field parameters, stream flow, and *E. coli* bacteria were collected concurrently once at each site between March 2020 and February 2021. In general, sampling was conducted as planned. However, dry or pooled stream conditions precluded sampling at three monitoring sites between April and September, affecting *E. coli* bacteria and field measurements and observations: EMIMI033 – Weicher Creek, EMIMI038 Middle Fork Beargrass Creek UT 8.45 (Sinking Fork), and EMIMI039 Middle Fork Beargrass Creek UT 9.1. During the March 11, 2020 sampling event, flow was not collected at two sites due to high volumes of flow causing a safety hazard to wade into the stream, EMIMI002 – Middle Fork Beargrass Creek at Old Cannons Lane and EMIMI010 – Middle Fork Beargrass Creek at Lexington Road. There was an equipment malfunction on June 3, 2020 and some field measurements were not collected at EMIMI041 – Middle Fork Beargrass Creek at Forest Bridge Road and EMIMI042 – Middle Fork Beargrass Creek UT 12.8 Above Foxboro Road. The number of site visits per month is shown on Table 2. Number of Sample Events per Month at Nine MSD Sites

Table 2 Number of Sample Events per Month at Nine MSD Sites

Monitoring Type	2020										2021	
	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
<i>E. coli</i> Bacteria (1)	9	8	9	35	9	8	8	9	9	9	9	9
Field Measurements & Observations (2)	9	8	9	34	9	8	8	9	9	9	9	9
Notes: 1. <i>E. coli</i> bacteria collected five times in 30 days between May 27, 2020 and June 24, 2021 2. Field measurements and observations collected concurrently with most <i>E. coli</i> sample events												

Wet and Dry Sample Conditions: The Guidebook states that two wet and two dry samples must be collected, defined as follows: A wet weather event is defined as a seven-day antecedent dry period (in which no more than 0.1 inch of precipitation occurs) followed by visible run-off conditions, such as sheet flow on impervious surfaces and visible surface flow in ephemeral channels. A dry weather event is defined as following a seven-day dry period, in which no more than 0.1 inch of precipitation occurs.

The sampling data from MSD were classified as wet or dry sampling events based on the rainfall patterns prior to and during the sampling dates. Wet weather sampling demonstrates pollutants that have accumulated across

the watershed and are being flushed into the waterways via stormwater runoff, while dry weather sampling events demonstrate the existing pollutants in the waterways and may indicate leaks or illicit discharges somewhere in the watershed.

For the purposes of this analysis, rain data for the prior seven days up to the day of sampling were pulled from two MSD Rain Gauges: TR13 St. Matthews Elementary School and TR33 AB Sawyer Park. During June 2020, TR13 rain gauge was offline and two nearby gauges were used: TR05 Beargrass Creek and TR12 Nightingale PS. Rainfall patterns across Jefferson County vary in distribution and intensity. While these gages are geographically within and near the watershed, rainfall totals in the headwaters of the watershed may be different from the recorded totals at the gages located lower in the watershed. The total rain amounts were recorded on the sampling date, 0-24 hours prior to the sampling, 24-48 hours prior, and the total seven days prior to sampling.

Events with greater than 0.1 inches of rain recorded in the prior 24 hours were classified as wet events. Table 3 summarizes each sampling event's rain totals and classification, as well as notes regarding antecedent conditions and rainfall patterns.

Table 3 Rainfall Records On and Prior to Sampling Days

Sampling Date	Sampling Start Time	Wet vs Dry	TOTAL RAINFALL (in)				Notes
			On sample date	0-24 hours Prior to Sample Time	24-48 hours Prior to Sample Time	Total 7 days prior to sample date	
3/11/2020	9:22AM	Dry	0	0	0.45	0.45	Rain stopped by 9AM 3/10/2021
4/22/2020	8:41AM	Dry	0	0	0	0.595	Rain occurred evening of 4/17/2020
5/27/2020	7:28AM	Wet	0.215	0.135	0.015	1.125	Rain on sample day occurred at 4 AM
6/3/2020	10:42AM	Dry	0	0	0	0.257	Rain occurred 5/27-29/2020
6/10/2020	9:53AM	Dry	0	0.16	0	0.913	Rain during Day prior on gauge north of watershed, gauge inside watershed read zero and to the east read 0.05" Majority of rain occurred 6/4/2020
6/17/2020	9:46AM	Dry	0	0	0	0.077	Rain occurred 6/14/2020
6/24/2020	11:05AM	Wet	0	0.84	0.37	2.1	Rain ended at noon day prior to sampling
7/22/2020	8:42AM	Wet	0.645	0.12	0.09	0.875	Majority of rain on sample day after 5 PM, but 0.2 did occur early before 8 AM
8/19/2020	9:23AM	Dry	0.01	0.08	0	0.725	Majority of rain occurred 8/14/2020
9/16/2020	11:03AM	Dry	0	0	0	0.035	

Sampling Date	Sampling Start Time	Wet vs Dry	TOTAL RAINFALL (in)				Notes
			On sample date	0-24 hours Prior to Sample Time	24-48 hours Prior to Sample Time	Total 7 days prior to sample date	
10/21/2020	7:50AM	Wet	0.06	1.175	0.75	2.075	Majority of rain day prior occurred before 4 AM
11/18/2020	8:00AM	Dry	0	0	0	0.725	Rain occurred on 11/11/2020 and 11/15/2020
12/16/2020	8:19AM	Wet	0.305	0.01	0.025	0.505	Majority of rain on sample day occurred in the morning from 5-11 AM
1/20/2021	9:50AM	Dry	0	0	0.03	0.255	
2/24/2021	8:40AM	Dry	0	0	0.14	1.045	4-6 inches snow/ice melt caused elevated flow. Pollutant concentrations and loads not elevated.

2.3 Sample Collection and Analysis

MSD field teams performed MSD sample collection activities as described in Quality Assurance Project Plan MSD 319(h) Monitoring for the Middle Fork of Beargrass Creek Watershed Plan Version 1.0 and accompanying Standard Operating Procedures included in the References section of this document. MSD sample collection included *E. coli* bacteria and field measurements including pH, water temperature, dissolved oxygen, dissolved oxygen percent saturation, turbidity, conductivity and stream discharge, and field observations.

Field Quality Control Samples: Field quality control samples included field duplicates, field splits, field blanks, and equipment rinsate blanks. A description of the MSD field sampling quality control requirements is included on Table 4.

Table 4 MSD Field Sampling Quality Control Requirements

Requirement	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
<i>E. coli</i> Field Splits (1)	1 field split each sample day (11%)	▪ Censor or qualify data as necessary ▪ Review sample collection procedures	Project Manager and QA Manager	Precision	The acceptable range of deviation between sample results will be determined by the precision criteria set using the procedures in SM 9020B, Section 8b (See SOP Appendices)

Requirement	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
<i>E. coli</i> Field Blanks (2)	1 field blank each sample day (11%)	▪ Censor or qualify data as necessary ▪ Review sample collection and storage procedures	Project Manager and QA Manager	Accuracy or Bias, Contamination	Result is < 1 MPN/100ml

Notes:

1. Field Split – single sample collected by field team. The lab will split into two samples and analyze separately in the lab. Used to estimate subsampling and laboratory analysis precision.
2. Field Blank – de-ionized water from the carboy or other container which is treated as a sample. Used to identify errors or contamination in sample collection and analysis.

The types of samples, field activities, measurements/analyses collected, frequency and number of sites are summarized in Table 5.

Table 5 MSD 319(h) Monitoring Activities Overview

Monitoring Activity	Field Activities	Measurements/ Analyses Required	Frequency	# of Sites
<i>E. coli</i> bacteria	Grab sample	Standard Methods for the Examination of Water and Wastewater (SM9223B) 1997 MSD <i>E. Coli</i> Rev 6 090118 (or most recent update)	Monthly sampling event, plus 5 samples within 30 days for May or June	9
Field Parameters	HydroTech Compact DS (1)	Dissolved oxygen, pH, specific conductance, water temperature, turbidity	Every sampling event	9
Stream discharge	Hach FH950 handheld flow meter & wading rod (1,2)	Stream discharge	Every sampling event	9

Notes:

1. At Middle Fork Beargrass Creek at Old Cannons Lane (03293000, EMIMI002) and Middle Fork Beargrass Creek at Lexington Road (03293500, EMIMI010), field parameters (i.e., dissolved oxygen, pH, specific conductance, water temperature) and stream discharge measurements will be supplemented with data from MSD/USGS sonde readings and USGS stream flow gages.
2. Hach FH950 is equipped with automatic depth sensor

Data collection did not occur at the following sites due to pooled or no flow conditions. These conditions affected EMIMI033 – Weicher Creek, EMIMI038 Middle Fork Beargrass Creek UT 8.45 (Sinking Fork), and EMIMI039 Middle Fork Beargrass Creek UT 9.1. Due to the pooled or no flow conditions, one of five samples in 30 days were not collected at these sites. Monthly samples were unable to be collected as identified on the table.

Table 6 Samples Not Collected due to Dry or Pooled Stream Conditions

Station ID / Waterbody / Location	<i>E. coli</i> Bacteria	Field Measurements and Observations (1)
EMIMI033 Weicher Creek Lincoln Road	4/22/2020 6/17/2020 (2)	4/22/2020 6/17/2020
EMIMI038 Middle Fork Beargrass Creek UT 8.45 (Sinking Fork) Below Bowling Boulevard	6/17/2020 (2) 9/16/2020	6/17/2020 9/16/2020
EMIMI039 Middle Fork Beargrass Creek UT 9.1 Off Steeplecrest Circle	6/17/2020 (2) 8/19/2020	6/17/2020 8/19/2020
Notes: 1. Field Measurements and Observations were taken on dates listed. Data removed from analysis per QAPP. 2. These <i>E. coli</i> bacteria sampling dates were part of the five (5) samples in 30 days collected between May 27 and June 24, 2020.		

3 QUALITY ASSURANCE OVERVIEW

The quality assurance review focused on comparing quality assurance sample results to data quality objectives included in the MSD QAPP (MSD, 2020) as summarized on Table 7 and Table 8.

Table 7 MSD 319(h) Data Quality Indicators and QC Requirements

Parameter (Units)	Method	Expected Range	Accuracy	Sensitivity (Resolution)	QC
Temperature (°C)	HydroTech Compact DS	0-35	0.01° C	0.10 ° C	As-needed maintenance per SOP
Specific Conductance (uS/cm)	HydroTech Compact DS	100-2,000	1% of reading	0.1 uS/cm	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
pH (Std. units)	HydroTech Compact DS	4-10	0.2	0.01	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP

Parameter (Units)	Method	Expected Range	Accuracy	Sensitivity (Resolution)	QC
Dissolved Oxygen (mg/l)	HydroTech Compact DS	0-20	± 0.01 mg/L for 0–8 mg/L; ± 0.02 mg/L for greater than 8 mg/L	0.01 or 0.1 mg/L	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
Turbidity (NTU)	HydroTech Compact DS	0-1,000	$\pm 1\%$ up to 100 NTU, $\pm 3\%$ up to 100–400 NTU, $\pm 5\%$ from 400–3000 NTU	0.1 NTU: 0–400 NTU, 1 NTU: >400 NTU	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
Velocity (used to calculate discharge) (ft/s)	Hach FH950 handheld flow meter & wading rod	0-5,000	0 to 10 ft/s: $\pm 2\%$ of reading 10 to 16 ft/s: $\pm 4\%$ of reading	0.05 cfs	Calibration check within 24-hours of sampling, calibration and maintenance as-needed per SOP
<i>E. coli</i> (MPN/100 mL)	Grab sample	4 -240,000		4 MPN/100 mL	Field blanks and splits, laboratory blanks (1)
Notes: 1. These project specific quality control measures are in addition to the extensive quality control measures and sterility checks employed by MSD's laboratory as required by DOW certification (MSD, 2019)					

Table 8 MSD 319(h) Data Quality Indicators

DQI	Definition	Project QC Samples
Precision (1)	Measure of agreement among repeated measurements of the same property under similar conditions. Usually expressed as a range, standard deviation, variance, percent difference in either absolute or relative terms.	<i>E. coli</i> - one split sample on each sample day (11%).
Accuracy	Measure of closeness of an individual measurement to a known or reference value. Expressed as percent recovery or percent bias.	All <i>E. coli</i> samples will be collected directly into sample bottles. All SOPs and QA/QC procedures will be followed throughout the sampling period.

DQI	Definition	Project QC Samples
Bias	Systematic or persistent distortion of a measurement process that results in errors in one direction.	Bias will be assessed one <i>E. coli</i> field blank, one method blank per sample event.
Representativeness	A qualitative measure of the degree to which data accurately and precisely represent a characteristic of a population parameter.	Bacteria samples and field parameter measurements will be collected using procedures described in the SOP, from representative thalweg areas with flowing water just above a riffle at the selected monitoring sites as described in the SOP. Stream discharge measurements will be collected from a representative location as described in Section 8.3.1.1 of the SOP.
Comparability	A qualitative term describing the degree to which different processes, methods or data agree or can be represented as similar. Expresses the measure of confidence that two data sets can contribute to a common analysis.	Comparability will be maintained by following the quality assurance procedures outlined in this QAPP and all relevant SOPs.
Completeness	An evaluation of the amount of data needed to be obtained from a measurement system. Expressed as a percentage of the number of measurements that should have been collected or were planned to be collected.	The target is to collect at least 90% of the monitoring data described in this plan (i.e., at least 130 out of 144 samples or measurements per parameter). Five (5) samples per 30 days will be collected in May or June 2020 to support comparison of <i>E. coli</i> data to primary contact recreation criteria (401 KAR 10:031)
Sensitivity	Capability of a method to discriminate between measurement responses representing different levels of the variable of interest. Terms used to describe sensitivity include MDL, LOD and LOQ.	Achieve MDL, LOD, LOQ targets for <i>E. coli</i> data per MSD's Laboratory SOP and QAPP. Sensitivity of <i>E. coli</i> (i.e., MDL, LOD and LOQ) are proportional to dilution needed to increase method sensitivity and minimize the number of "greater than" results.
Notes: 1. Per In situ Water Quality Measurements and Meter Calibration for Lotic Waters DOWSOP03014 duplicate analysis is not appropriate for in situ measurements for lotic waters (KDOW, 2018a).		

Data flags are assigned by the lab to provide additional information about field collection and sample analyses performed in the laboratory as part of routine laboratory data management. Data flags C Analyte in Method Blank is used to evaluate potential bias in the sample results caused by contamination in the field or laboratory. A few of the qualifiers may be used to exclude data from further analysis. One or more data qualifiers may be assigned when sample concentrations are near the lower limits of the analytical range (i.e., low concentrations). It is important to note that data flags provide additional information about analytical results, their presence does not indicate "bad" data. Data flags for *E. coli* analysis are shown on Table 9.

The MSD QA Manager oversaw the review, verification and validation of monitoring data collected in this project. The review was accomplished by comparing the data collection process to the requirements established in this Quality Assurance Project Plan and Standard Operating Procedures. Errors were resolved as soon as possible to ensure that they did not become propagated in databases or other permanent records.

Any data collection that deviated from the procedures or did not meet the data quality indicators were evaluated by the MSD Project Manager and QA Manager. If the deviation was considered to be minor, the data was included with appropriate data flags (Table 9); otherwise the data was excluded from the dataset that was used to develop the Watershed-Based Plan. If *E. coli* contamination was found in field or laboratory blanks, the data associated with the compromised samples would be excluded from further analysis. No *E. coli* contaminations were found.

Table 9 MSD Data Flags for *E. coli* Analyses

MSD Qualifier	Description
C	Analyte detected in associated method blank
H	Duplicate/Replicate precision outside control limits
Q	Samples held at incorrect temperature
R	Sample analyzed out of the established method hold time
W	Samples reported outside of quantifiable range
7	Samples not analyzed correctly as required by the method
8	Instrument Performance Check Sample did not meet the required range
9	Microbiological incubation period outside of required method limits
<	Less Than
>	Greater Than

A summary of the data collection and quality assurance review for *E. coli* bacteria is provided in the Section 4.

4 *E. COLI* MONITORING AND DATA QUALITY REVIEW

The Guidebook specifies monthly *E. coli* sample collection at the selected watershed monitoring sites over one year and collection of five samples in 30 days during May or June (KWA and DOW, 2010). The MSD sampling schedule included monthly sampling for one year as well as five samples in 30 days collected in May and June 2020. DOW's sampling schedule focused on the May 1 to October 31 recreation season in 2019, with five samples in 30 days collected in May and June 2019. Taken together, the DOW and MSD monitoring efforts exceed the Guidebook monitoring requirements for *E. coli* bacteria.

MSD collected *E. coli* bacteria samples using methods described in the Technical Standard Operating Procedure for MSD 319(h) Monitoring for Middle Fork Beargrass Creek Watershed-Based Plan. (MSD 2020) Sample bottles were filled directly from the subsurface of the stream to minimize sample handling and stored on ice. Five samples in 30 days were collected between May 27 and June 24, 2020. The *E. coli* sample collection schedule is shown on Table 10.

Table 10 MSD *E. coli* Sample Collection Schedule (2020-2021)

MSD Monitoring Sites	Mar	Apr	May	June				Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	# Samples
	11	22	27	3	10	17	24	22	19	16	21	18	16	20	24	
EMIMI010 MFBGC at Lexington Rd	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
EMIMI002 MFBGC at Old Cannons Ln	1	1	1	1	1	1	1	1	1	1	1	1	X	1	1	14
EMIMI009 MFBGC at Browns Ln	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
EMIMI038 Sinking Fork at Bowling Blvd	1	1	1	1	1	X	1	1	1	1	1	1	1	1	1	14
EMIMI033 Weicher Cr. at Lincoln Rd	1	X	1	1	1	X	1	1	1	1	1	1	1	1	1	13
EMIMI039 MFBGC UT 9.1 at Steeplecre st Cir	1	1	1	1	1	X	1	1	X	X	1	1	1	1	1	12
EMIMI040 MFBGC Off Old Whipps Mill Rd	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
EMIMI041 MFBGC at Forest Bridge Rd	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
EMIMI042 MFBGC UT 12.8 at Foxboro Rd	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Total	9	8	9	9	9	6	9	9	8	8	9	9	9	9	9	129

Samples were transported to the MSD Laboratory for analysis using procedures described in MSD SOP Escherichia coli, Revision 6, 090118 (MSD, 2019). Results were reported as Most Probable Number per 100 milliliters (MPN/100 mL). As a reference, 100 mL is approximately 3.2 ounces. The detection range for this method is <1 MPN/100 mL to 2,419 MPN/100 mL for undiluted samples. A total of 135 samples were planned

(i.e., 15 samples at nine sites). Of these, 129 samples (96%) were collected. It was not possible to collect six of the samples due to dry or pooled stream conditions.

The data quality review included evaluation of results from analysis of quality control samples and data flags. Quality control samples collected for *E. coli* bacteria included field blanks and field splits. Per the 2020 Quality Assurance Project Plan MSD 319(h) Monitoring for the Middle Fork of Beargrass Creek Watershed Plan one field blank was collected on each sample day. All fifteen samples were reported as less than the detection limit of 1 MPN/100 mL, indicating that the reported results were not biased by contamination during sample collection and analysis.

Seventeen *E. coli* field splits were collected over the duration of the study and used to assess precision (i.e., reproducibility) of the analysis. Field split results were analyzed using a statistical method published by Standard Methods (Eaton, et. al., 1998) as recommended by DOW. Because the absolute difference was less than the calculated performance criteria, the field duplicates met the precision target. The precision analysis is shown on Table 11.

Table 11 E. coli Field Split Precision Analysis

Monitoring Site	Sample Date	Field Split 1 (MPN/100mL)	Field Split 2 (MPN/100mL)	Log (split1)	Log (split2)	Absolute Difference
EMIMI010 MFBGC at Lexington Rd	11/18/2020	1350	1120	3.13	3.05	0.08
EMIMI010 MFBGC at Lexington Rd	10/21/2020	2660	2370	3.42	3.37	0.05
EMIMI002 MFBGC at Old Cannons Ln	12/16/2020	226	156	2.35	2.19	0.16
EMIMI002 MFBGC at Old Cannons Ln	3/11/2020	364	557	2.56	2.75	0.18
EMIMI009 MFBGC at Browns Ln	4/22/2020	182	105	2.26	2.02	0.24
EMIMI009 MFBGC at Browns Ln	1/20/2021	329	331	2.52	2.52	0.00
EMIMI009 MFBGC at Browns Ln	5/27/2020	2690	2460	3.43	3.39	0.04

Monitoring Site	Sample Date	Field Split 1 (MPN/100mL)	Field Split 2 (MPN/100mL)	Log (split1)	Log (split2)	Absolute Difference
EMIMI033 Weicher Creek	6/10/2020	443	440	2.65	2.64	0.00
EMIMI033 Weicher Creek	6/24/2020	920	880	2.96	2.94	0.02
EMIMI033 Weicher Creek	6/3/2020	11000	7420	4.04	3.87	0.17
EMIMI038 Sinking Fork	2/24/2021	618	830	2.79	2.92	0.13
EMIMI038 Sinking Fork	4/22/2020	2347	2030	3.37	3.31	0.06
EMIMI038 Sinking Fork	5/27/2020	13500	13800	4.13	4.14	0.01
EMIMI039 MFBGC UT 9.1 Off Steeplecrest Cir	7/22/2020	1560	1640	3.19	3.21	0.02
EMIMI040 MFBGC Off Old Whipps Mill Road	8/19/2020	525	592	2.72	2.77	0.05
EMIMI041 MFBGC at Forest Bridge Road	9/16/2020	133	145	2.12	2.16	0.04
EMIMI042 MFBGC UT 12.8 Above Foxboro Road	10/21/2020	1180	2120	3.07	3.33	0.25
Average						0.10
Performance Criteria: Less than (3.27*Average)						0.32

Summary: The *E. coli* data collected by MSD were consistent with the data requirements included in the DOW QAPP (DOW, 2019) and Guidebook for developing a watershed plan. The gap in *E. coli* data that affected four sites was caused by dry and pooled conditions, beyond the control of MSD. The *E. coli* data collected by DOW and MSD will be integrated for the data analysis performed in Chapter 4. Analyzing Results, providing approximately two years of *E. coli* record for this watershed.

4.1 Louisville MSD Monitoring Locations

MSD invested significant effort to develop the QAPP (MSD, 2020) and SOP (MSD, 2020a) using templates provided by DOW. These documents were approved by DOW on May 11, 2020. Development of these documents included two field visits with DOW to observe their water quality sample collections, training for MSD field technicians and extensive review by DOW. The QAPP and SOP outline MSD's quality assurance and quality control procedures that addressed safety, staff training, instrument calibration, maintenance and operation, sample collection procedures and collection of quality control instrument measurements and quality control samples. These documents were used to review the quality of MSD's data. MSD's QAPP and SOP are included in Appendix 3.2.

The purpose of the MSD 319(h) monitoring was to support the development of the Middle Fork Beargrass Creek Watershed-Based Plan, characterize water quality and stream flow at the selected sites and to supplement the water quality monitoring performed by DOW.

Water quality monitoring sites were selected to address monitoring needs more broadly across the watershed described in Section 3.3 and to build upon the data collected by DOW. MSD accompanied DOW to their monitoring sites and performed several site reconnaissance efforts to identify the final sampling locations. The rationale for MSD's monitoring locations is presented on Table 3.7 and is also included as Table 6 in MSD's Approved QAPP for 319(h) Monitoring for the Middle Fork Beargrass Creek Watershed Plan (MSD, 2020).

Table 12. MSD 319(h) Monitoring Site Rationale

Station ID (DOW, MSD, USGS)	Waterbody	Location	Monitoring Rationale
DOW08047007 EMIMI010 03293500	Middle Fork Beargrass Creek	Lexington Road	Downstream end of watershed, add to LTMN and DOW 319(h) monitoring database
DOW08047008 EMIMI002 03293000	Middle Fork Beargrass Creek	Below Old Cannons Lane	Within CSO area, add to LTMN and DOW 319(h) monitoring database
EMIMI009	Middle Fork Beargrass Creek	At Browns Lane	Upstream of CSO area, add to LTMN and DOW 319(h) monitoring database
DOW08047009 EMIMI038	Middle Fork Beargrass Creek UT 8.45 (Sinking Fork)	Below Bowling Boulevard	Commercial area
EMIMI033	Weicher Creek	Lincoln Road	Downstream of golf course
DOW08047011 EMIMI039	Middle Fork Beargrass Creek UT 9.1	Off Steeplecrest Circle	Suburban area
DOW08047012 EMIMI040	Middle Fork Beargrass Creek	Off Old Whipps Mill Road	Downstream of flood control dam and large wetland upstream of dam
EMIMI041	Middle Fork Beargrass Creek	Forest Bridge Road	Upstream of Old Whipps Mill Road dam
DOW08047013 EMIMI042	Middle Fork Beargrass Creek UT 12.8	Above Foxboro Road	Upstream end of watershed, characterize suburban area

Six sampling locations were sampled by both DOW and MSD; however, samples were collected during different periods and frequencies. MSD added two new monitoring locations at Browns Lane and Forest Bridge Road. DOW sampled Weicher Creek at Blossomwood Drive, however MSD sampled upstream at Lincoln Road (EMIMI033) which is downstream of the golf course. The Browns Lane location (EMIMI009) is one of MSD's LTMN sites and by adding it to the 319(h) project, the MSD LTMN data from this site can be used to support development of this watershed plan. The Forest Bridge Road location (EMIMI041) is located on the mainstem above the Whipps Mill dam where there are two holding ponds that have potential to overflow into the creek. The proposed MSD monitoring sites were mapped and provided to DOW for review and approval prior to establishing the location as a monitoring site.

The MSD monitoring parameters are presented on Table 3.8. MSD monitoring was conducted between March 2020 and February 2021. Sampling events on May 27, June 24, July 22, October 21, and December 16 were considered to be wet weather events.

Table 13. MSD Monitoring Parameters

Parameter Type	Parameter(s) (1)
Bacteria	<i>E. coli</i> bacteria
Field Parameters	Turbidity, pH, Dissolved Oxygen, Dissolved Oxygen % Saturation (calculated) Conductivity, Temperature
Stream Flow	Stream discharge
Notes: 1. Parameters required by the Guidebook are shown in bold.	

DOW water quality monitoring is presented in Appendix 3.2 DOW Water Quality Monitoring Report. Note that this report does not include data analysis such as comparison to water quality criteria, non-regulatory benchmarks, or estimates of pollutant loads. This analysis is provided in Chapter 4. Analyzing Results.

5 REFERENCES

- Eaton, A.D., L.S. Clesceri, A.E. Greenberg, M.A.H Franson. 1998. Standard Methods for The Examination of Water and Wastewater (22nd ed. 1998). American Public Health Association, American Water Works Association, & Water Environment Federation, Washington, DC.
- Kentucky Waterways Alliance and Kentucky Division of Water. 2010. *Watershed Planning Guidebook for Kentucky Communities, 1st Edition* <https://eec.ky.gov/Environmental-Protection/Water/Protection/Pages/WatershedPlanningGuidebook.aspx>
- Kentucky Administrative Regulations. Surface Water Standards. (401 KAR 10:031) <https://apps.legislature.ky.gov/Law/KAR/401/010/031.pdf>
- Louisville / Jefferson County Metropolitan Sewer District. 2019. Laboratory Standard Operating Procedure: Micro QC Rev 6 012519.
- Louisville / Jefferson County Metropolitan Sewer District. 2020. Quality Assurance Project Plan MSD 319(h) Monitoring for the Middle Fork of Beargrass Creek Watershed Plan.
- Louisville / Jefferson County Metropolitan Sewer District, 2020. Technical Standard Operating Procedure for MSD 319(h) Monitoring for Middle Fork Beargrass Creek Watershed-Based Plan.

APPENDIX 4.1 TABLES AND FIGURES

Table 1 Percent of Benchmark Exceedances

Parameters			<i>E.coli</i>	TSS	Turbidity	TN	SpCond	TP	Ammonia (as N)	UIA
Sample Count			181	78	203	80	220	80	80	76
Dry Sample Count			116	52	135	53	148	53	53	49
Wet Sample Count			65	26	68	27	72	27	27	27
Benchmark			240 CFU/100mL	12.9 mg/L	11.6 NTU	1.2 mg/L	521.8 µS/cm	0.2 mg/L	0.1 mg/L	0.05 mg/L
Percent Exceeding Benchmark										
Sampling Sites and Event Classifications	1	All	71%	31%	26%	85%	72%	0%	54%	0%
		Dry	56%	11%	16%	78%	90%	0%	56%	0%
		Wet	100%	75%	50%	100 %	33%	0%	50%	0%
	2	All	71%	8%	4%	83%	67%	0%	0%	0%
		Dry	63%	0%	0%	75%	90%	0%	0%	0%
		Wet	88%	25%	13%	100 %	11%	0%	0%	0%
	3	All	80%		0%		67%			
		Dry	70%		0%		90%			
		Wet	100%		0%		20%			
	4	All	100%	0%	0%	71%	0%	0%	0%	0%
		Dry	100%	0%	0%	100 %	0%	0%	0%	0%
		Wet	100%	0%	0%	33%	0%	0%	0%	0%
	5	All	62%		0%		31%			
		Dry	38%		0%		25%			
		Wet	100%		0%		40%			
	6	All	81%	18%	8%	83%	78%	0%	0%	0%
		Dry	69%	0%	0%	88%	100%	0%	0%	0%
		Wet	100%	67%	25%	75%	33%	0%	0%	0%
	7	All	67%	10%	0%	100 %	71%	0%	0%	0%

Parameters			<i>E.coli</i>	TSS	Turbidity	TN	SpCond	TP	Ammonia (as N)	UIA
		Dry	50%	0%	0%	100%	93%	0%	0%	0%
		Wet	88%	25%	0%	100%	33%	0%	0%	0%
	8	All	63%	33%	7%	85%	83%	0%	31%	0%
		Dry	50%	25%	5%	78%	100%	0%	33%	0%
		Wet	88%	50%	11%	100%	44%	0%	25%	0%
	9	All	60%		7%		86%			
		Dry	40%		0%		100%			
		Wet	100%		20%		60%			
	10	All	79%	0%	0%	85%	65%	0%	0%	0%
		Dry	69%	0%	0%	78%	86%	0%	0%	0%
		Wet	100%	0%	0%	100%	11%	0%	0%	0%



USGS 03293500 M FK BEARGRASS CR AT LEXINGTON RD AT LOUISVILLE, KY

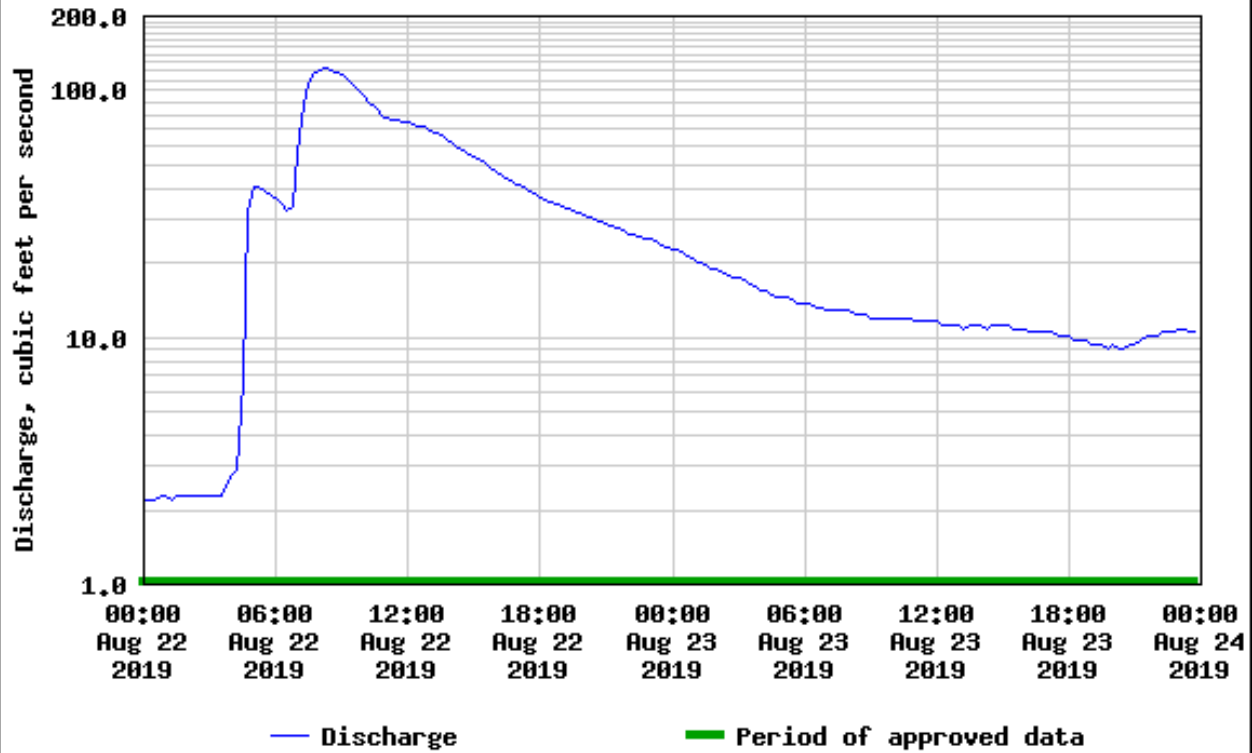


Figure 1 USGS Stream Gage at Lexington Road August 22, 2019 Wet Weather Event

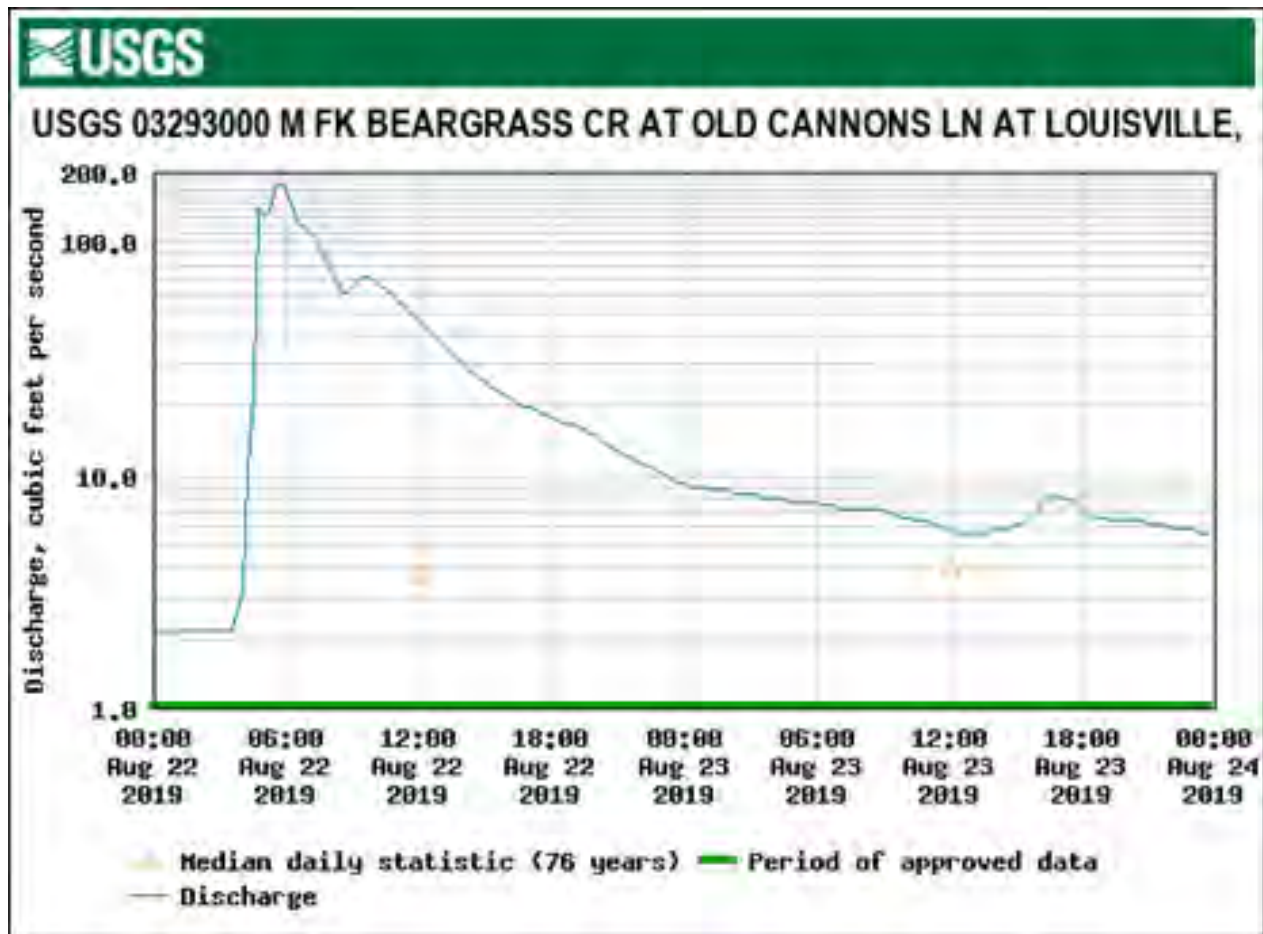


Figure 2 USGS Stream Gage at Old Cannons August 22, 2019 Wet Weather Event

Table 1 Station Visit Comments for Flow Not Measured

Site	Site Name	Station	Date	Station Visit Comments
1	Lexington Road	DOW08047007	5/9/2019	No flow measured because of impending thunderstorm.
2	Old Cannons Lane	DOW08047008	5/9/2019	No flow measured because of impending thunderstorm.
6	Sinking Fork	DOW08047009	5/9/2019	No flow measured because of impending thunderstorm.
4	Weicher Creek (DOW)	DOW08047010	5/9/2019	No flow measured because of impending thunderstorm.
7	Steeplecrest Circle	DOW08047011	5/9/2019	No flow measured because of impending thunderstorm.
8	Old Whipps Mill Road	DOW08047012	5/9/2019	No flow measured because of impending thunderstorm.
10	Foxboro Road	DOW08047013	5/9/2019	No flow measured because of impending thunderstorm.
4	Weicher Creek (DOW)	DOW08047010	5/16/2019	Dry conditions
4	Weicher Creek (DOW)	DOW08047010	5/23/2019	Stream dry. One small isolated pool at overpass.
1	Lexington Road	DOW08047007	5/30/2019	Flow not sampled, high water. USGS stream gauge 03293500 at this location.
2	Old Cannons Lane	DOW08047008	5/30/2019	Too deep, No flow sampled, see USGS gauge 03293000.
4	Weicher Creek (DOW)	DOW08047010	9/17/2019	No flow. Dry.
6	Sinking Fork	DOW08047009	9/17/2019	No flow. Pooled.
7	Steeplecrest Circle	DOW08047011	9/17/2019	Dry.
2	Old Cannons Lane	DOW08047008	2/18/2020	discharge not measured (Flowtracker malfunction)
4	Weicher Creek (DOW)	DOW08047010	2/18/2020	discharge not measured (Flowtracker malfunction)
6	Sinking Fork	DOW08047009	2/18/2020	discharge not measured (Flowtracker malfunction)
7	Steeplecrest Circle	DOW08047011	2/18/2020	discharge not measured (Flowtracker malfunction)
8	Old Whipps Mill Road	DOW08047012	2/18/2020	discharge not measured (Flowtracker malfunction)
10	Foxboro Road	DOW08047013	2/18/2020	discharge not measured (Flowtracker malfunction)
5	Weicher Creek (MSD)	EMIMI033	4/22/2020	No Flow Taken due to pooled conditions
9	Forest Bridge Road	EMIMI041	6/3/2020	flow not measured (Flowtracker malfunction)
5	Weicher Creek (MSD)	EMIMI033	6/17/2020	No Flow Taken due to dry or pooled conditions
6	Sinking Fork	EMIMI038	6/17/2020	No Flow Taken due to dry or pooled conditions
7	Steeplecrest Circle	EMIMI039	6/17/2020	No Flow Taken due to dry or pooled conditions

Site	Site Name	Station	Date	Station Visit Comments
7	Steeplecrest Circle	EMIMI039	8/19/2020	No Flow Taken due to dry or pooled conditions
6	Sinking Fork	EMIMI038	9/16/2020	No Flow Taken due to dry or pooled conditions

Table 3 Stream Flow Results

Recorded Flow (cfs)											
Date	Event	Site ID and Location									
		1	2	3	4	5	6	7	8	9	10
		Lexington Road	Old Cannons Lane	Browns Lane	Weicher Creek (DOW)	Weicher Creek (MSD)	Sinking Fork	Steeple-crest Circle	Old Whipps Mill Road	Forest Bridge Road	Foxboro Road
3/21/2019	Dry				1.2						2.0
3/28/2019	Dry	12.7	12.1				1.0	0.5	3.8		1.6
4/24/2019	Dry	55.1	33.4		2.8		3.8	5.7	12.7		5.8
5/9/2019	Dry	34.8	17.7		1.3		2.5	3.8	4.9		2.1
5/16/2019	Dry	9.5	10.1		0.0		0.7	0.2	4.0		1.4
5/23/2019	Dry	9.3	10.2		0.0		1.0	0.3	5.2		3.0
5/30/2019	Wet	71.4	41.4		1.2		27.0	32.9	27.0		8.5
6/6/2019	Wet	50.7	26.8		0.3		2.0	1.6	6.8		2.1
6/4/2019	Dry								2.2		
7/10/2019	Dry	11.9									
7/16/2019	Dry	4.7	5.1				0.0		0.5		0.6
8/22/2019	Wet	89.0	55.9				1.6	1.4	9.9		1.5
9/17/2019	Dry	1.3	1.1		0.0		0.0	0.0	0.5		0.3
10/23/2019	Dry	1.9	1.4				0.0		0.3		0.5
11/12/2019	Dry	11.6	8.6				0.6	0.8	2.9		1.6
12/4/2019	Dry	30.1	21.1		1.1		2.4	2.6	6.1		2.7
1/16/2020	Dry	29.7	25.3		0.3		2.4	2.3	7.0		2.9
2/18/2020	Wet	29.5	38.6		2.8		5.6	9.6	13.1		5.9
3/11/2020	Dry			15.7		0.7	1.4	2.6	6.3	7.3	3.2
4/22/2020	Dry	11.3	8.8	8.3			0.6	0.2	2.9	3.8	1.7
5/27/2020	Wet	24.2	31.5	14.7		0.6	1.2	2.0	5.8	5.6	3.1
6/3/2020	Dry	8.5	6.6	6.5		0.2	0.3	0.1	2.1	2.1	1.1
6/10/2020	Dry	7.8	5.3	5.6		0.0	0.2	0.1	1.6	2.0	1.0
6/17/2020	Dry	4.3	0.9	3.1					0.8	1.2	0.5

Recorded Flow (cfs)											
Date	Event	Site ID and Location									
		1	2	3	4	5	6	7	8	9	10
		Lexington Road	Old Cannons Lane	Browns Lane	Weicher Creek (DOW)	Weicher Creek (MSD)	Sinking Fork	Steeple-crest Circle	Old Whipps Mill Road	Forest Bridge Road	Foxboro Road
6/24/2020	Wet	20.4	14.6	13.7		0.3	2.1	1.2	3.6	2.7	1.5
7/22/2020	Wet	17.1	9.6	10.3		0.0	0.9	1.8	2.3	11.2	3.7
8/19/2020	Dry	5.7	3.6	4.5		0.0	0.1		1.0	1.5	0.5
9/16/2020	Dry	3.9	1.0	2.7		0.0			0.8	1.7	0.5
10/21/2020	Wet	38.5	19.1	19.2		0.5	1.8	1.8	4.3	3.6	1.7
11/18/2020	Dry	9.4	6.8	7.4		0.2	0.4	0.2	2.4	2.0	1.1
12/16/2020	Wet	7.2	7.0	9.1		0.5	0.2	0.1	3.2	5.0	6.1
1/20/2021	Dry	7.8	6.9	6.3		0.2	0.3	0.1	2.4	1.7	1.1
2/24/2021	Dry	44.7	28.1	27.1		1.4	2.6	4.4	9.4	8.9	3.7
Wet Events Average		38.7	27.2	13.4	1.4	0.4	4.7	5.8	8.4	5.6	3.8
Dry Events Average		15.0	10.7	8.7	0.8	0.4	1.1	1.5	3.6	3.2	1.8

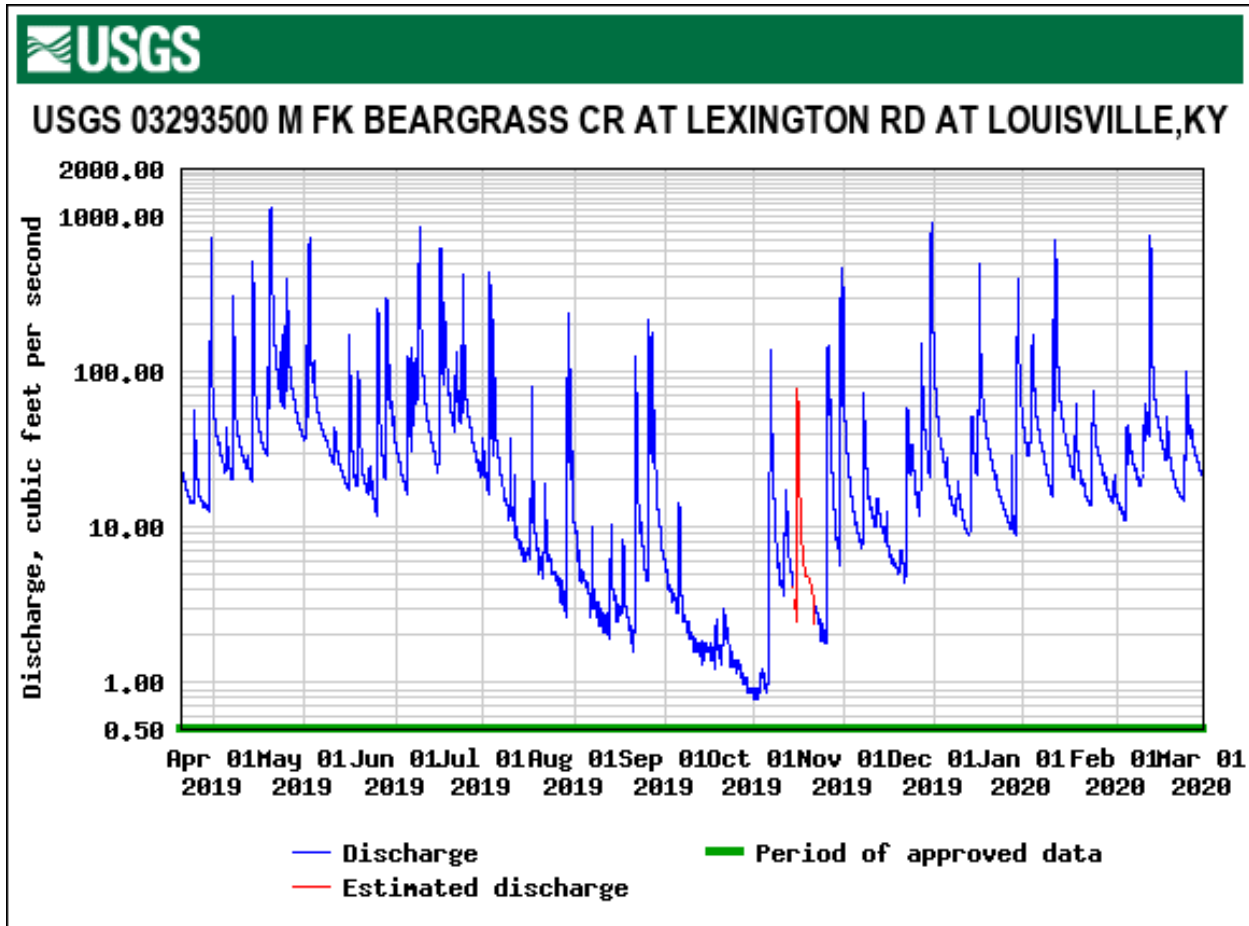


Figure 3 USGS Stream Gage Middle Fork Beargrass Creek at Lexington Road During Phase I Sampling

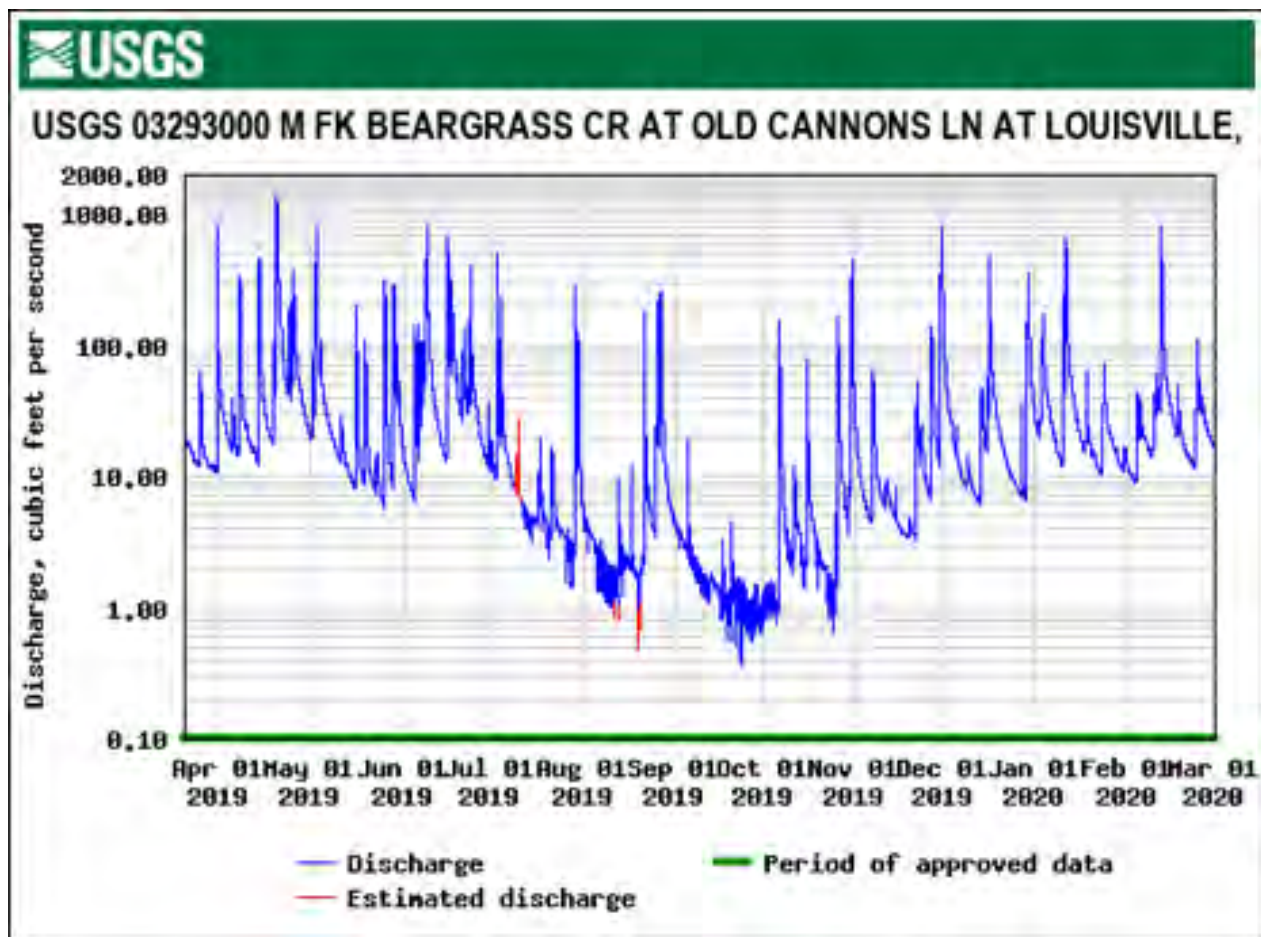


Figure 4 USGS Stream Gage at Middle Fork Beargrass Creek at Old Cannons Lane During Phase I Sampling

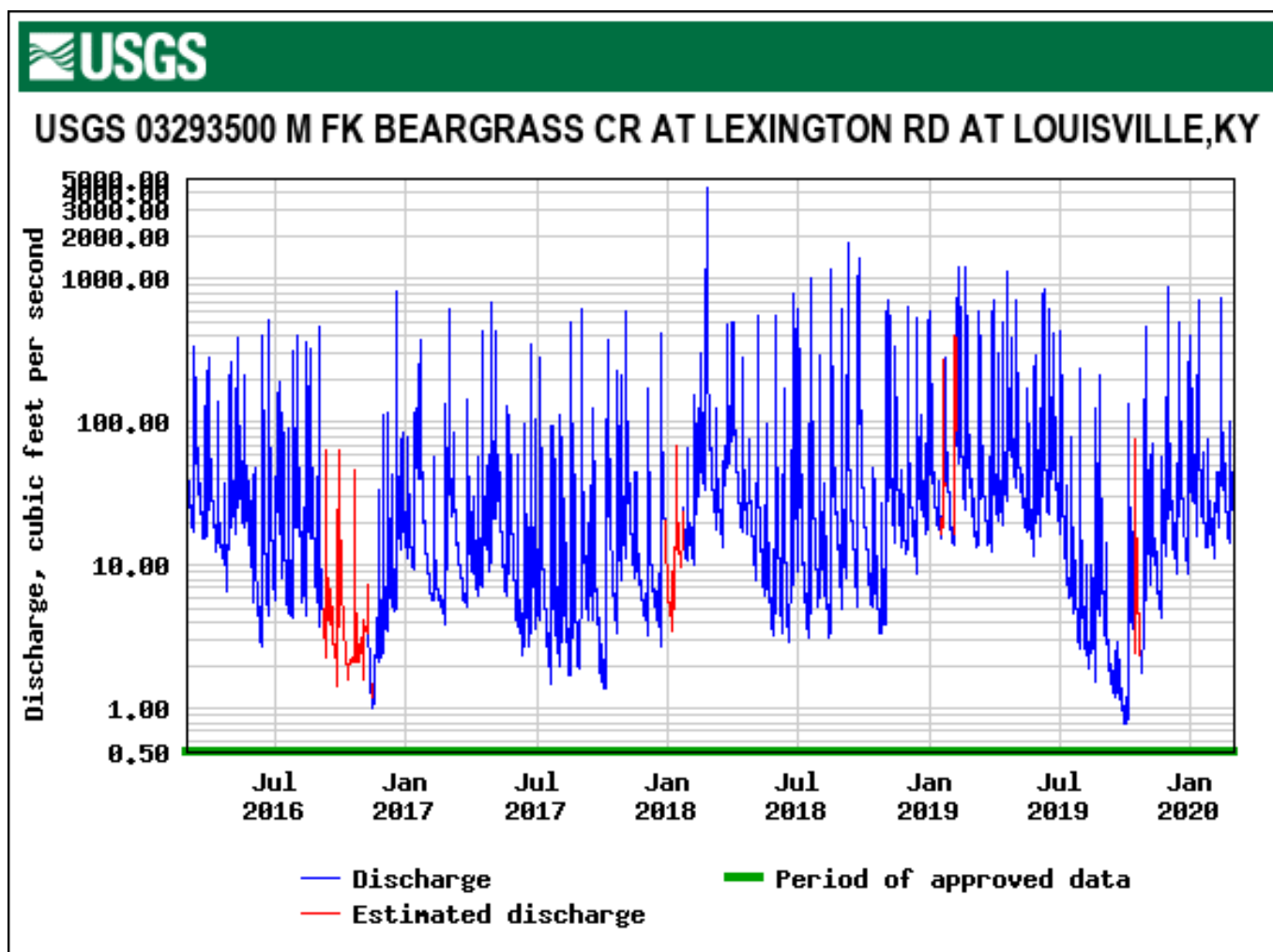


Figure 5 USGS Stream Gage Middle Fork Beargrass Creek at Lexington Road March 2016 to March 2020

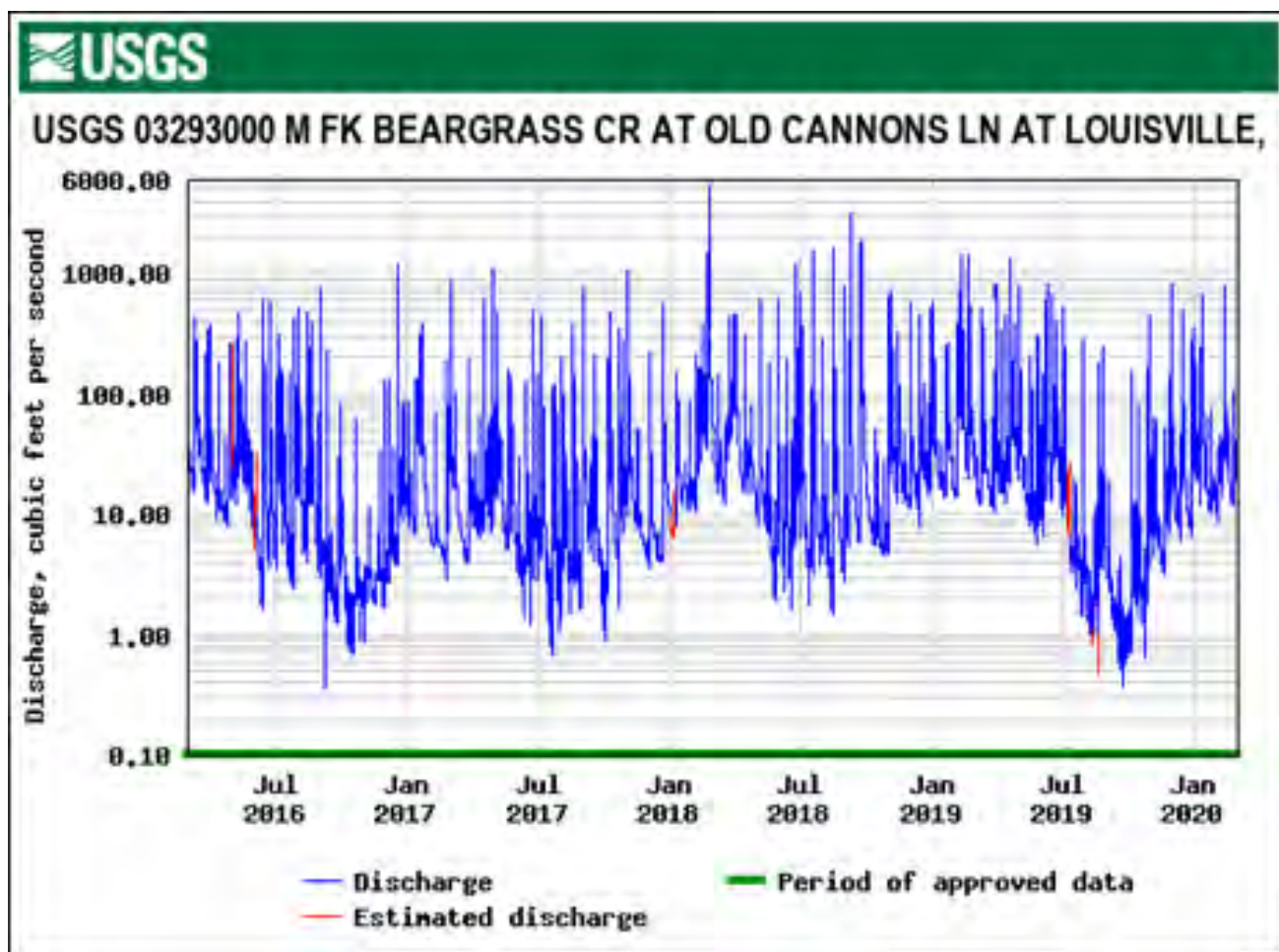


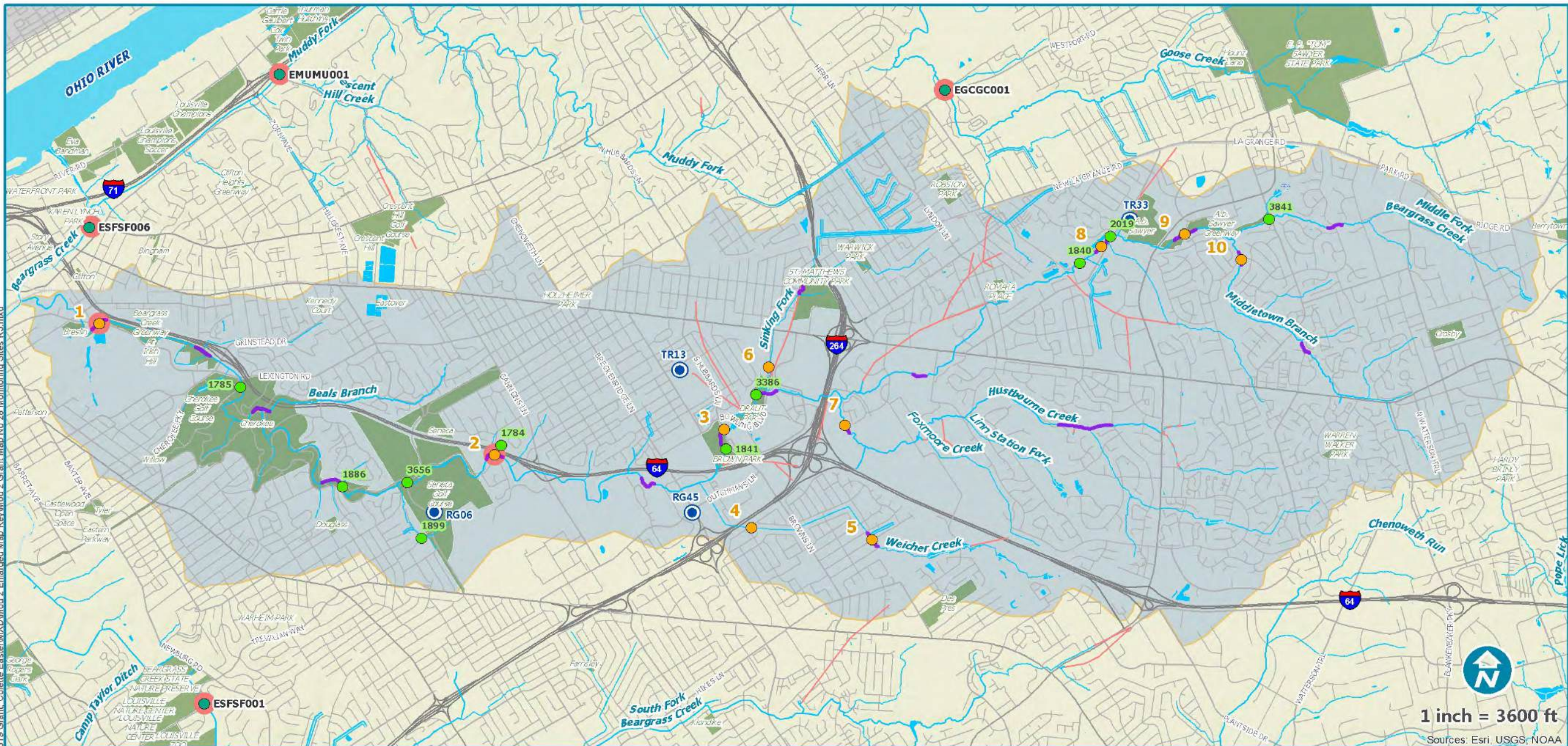
Figure 6 USGS Stream Gage at Middle Fork Beargrass Creek March 2016 to March 2020

USGS Flow Data

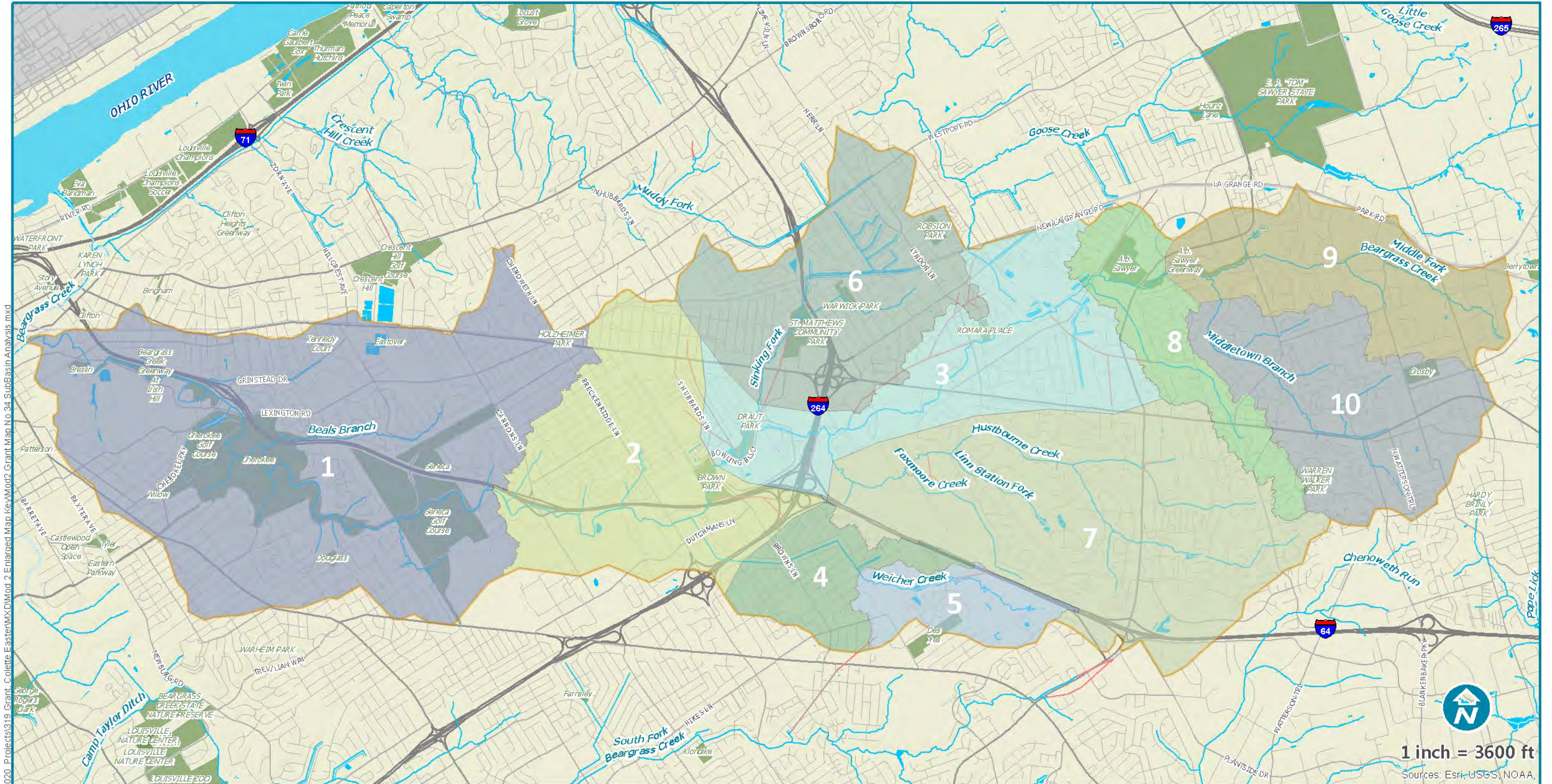
Discharge data and other parameters collected at USGS gages can be accessed and viewed using the following steps.

- From usgs.gov website scroll down to Real-time Data section and click on Water header or Explore box
- Hover over the image on the left displaying the United States and all the current USGS gaging stations and click on the state of Kentucky
- This will bring user to the following website that you can type in directly: waterdata.usgs.gov/ky/nwis/rt
- On the USGS Current Water Data for Kentucky page click on the text that says Statewide Streamflow Table on the right.
- The default of this page is to group the gages by Major River Basin. For USGS sites in Jefferson County scroll down to Salt River Basin section. User can also change the grouping by County, click go to the right and scroll down to Jefferson County
- At this point a gage number can be selected to which real-time data can be viewed.
- The default on the graphs shown are the past 7 days. User can identify the past number of days to display or set a range to be shown on the graphs.
- The default on graphs shown are discharge and gage height. User can also check parameters such as Temperature, Specific Conductivity, Dissolved Oxygen and pH (if parameters are available at the USGS gaging station)
- Once a desired parameter is selected and date range selected, user should hit the GO box to the right side of the webpage.
- User can scroll down to the parameter/graph created and create a presentation-quality or stand-alone graph.

APPENDIX 4.2 CHAPTER 4 MAPS



Document Path: J:\gis\records\project mxd\2020 Projects\319 Grant Colette EasternMXDMod 2 Enlarged Map KeyMod2 Grant Map No. 34 SubBasin Analysis.mxd



Map Key

- | | | |
|--------------------|----------------------------|-----------------|
| Watershed Boundary | Stream/River, Perennial | Pipeline |
| Bodies of Water | Stream/River, Intermittent | Artificial Path |
| Wetlands | Canal/Ditch | Connector |
| Parks | Underground Conduit | |

Sub-Basin Analysis

Middle Fork Beargrass Creek
319(h) Grant

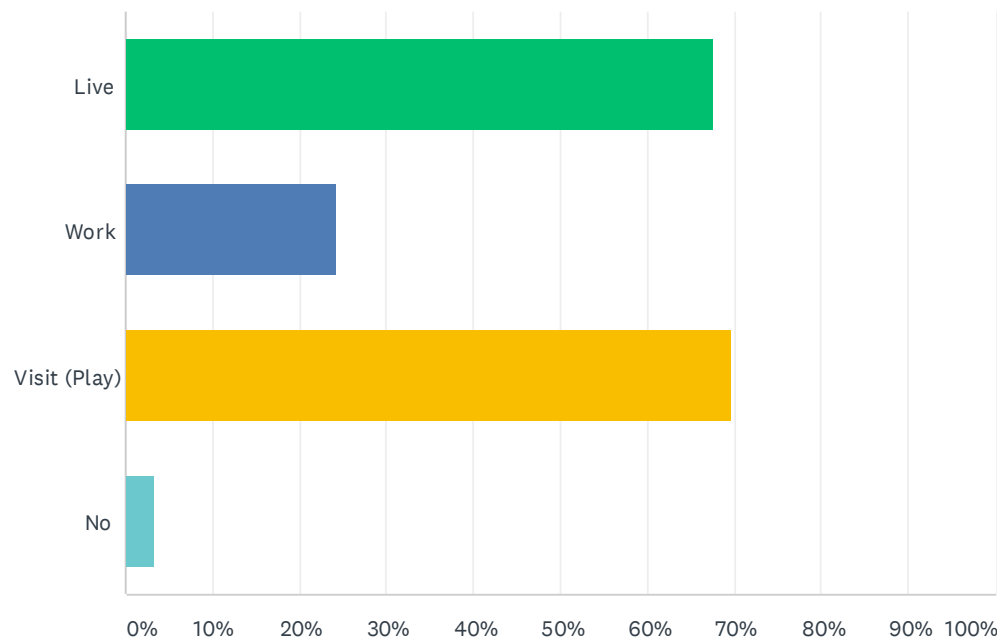


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APPENDIX 6.1 COMMUNITY SURVEY RESULTS

Q1 Do you live, work, or visit the Middle Fork Beargrass Creek watershed?

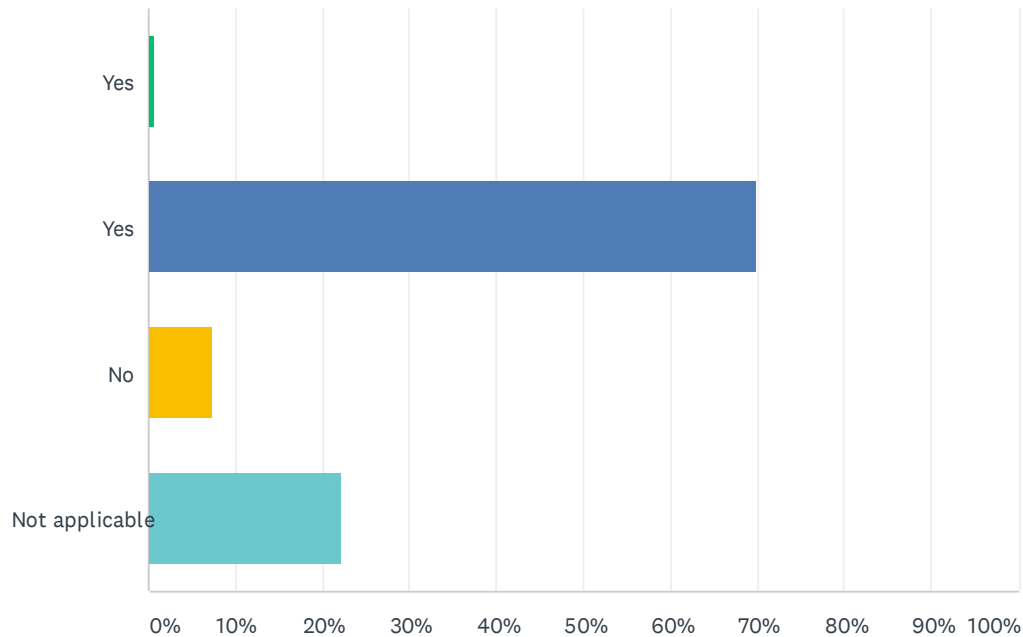
Answered: 148 Skipped: 2



ANSWER CHOICES	RESPONSES	
Live	67.57%	100
Work	24.32%	36
Visit (Play)	69.59%	103
No	3.38%	5
Total Respondents: 148		

Q2 If you live in the Middle Fork Beargrass Creek Watershed, do you know where the streams are in your neighborhood?

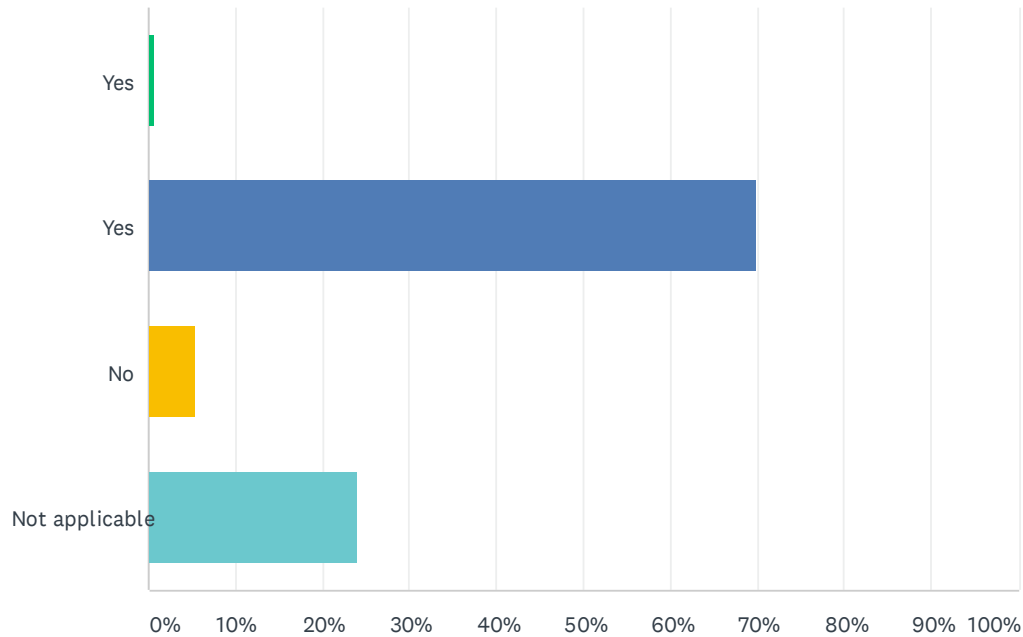
Answered: 149 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	0.67%	1
Yes	69.80%	104
No	7.38%	11
Not applicable	22.15%	33
TOTAL		149

Q3 If you answered "yes" to #2, do you enjoy visiting the streams?

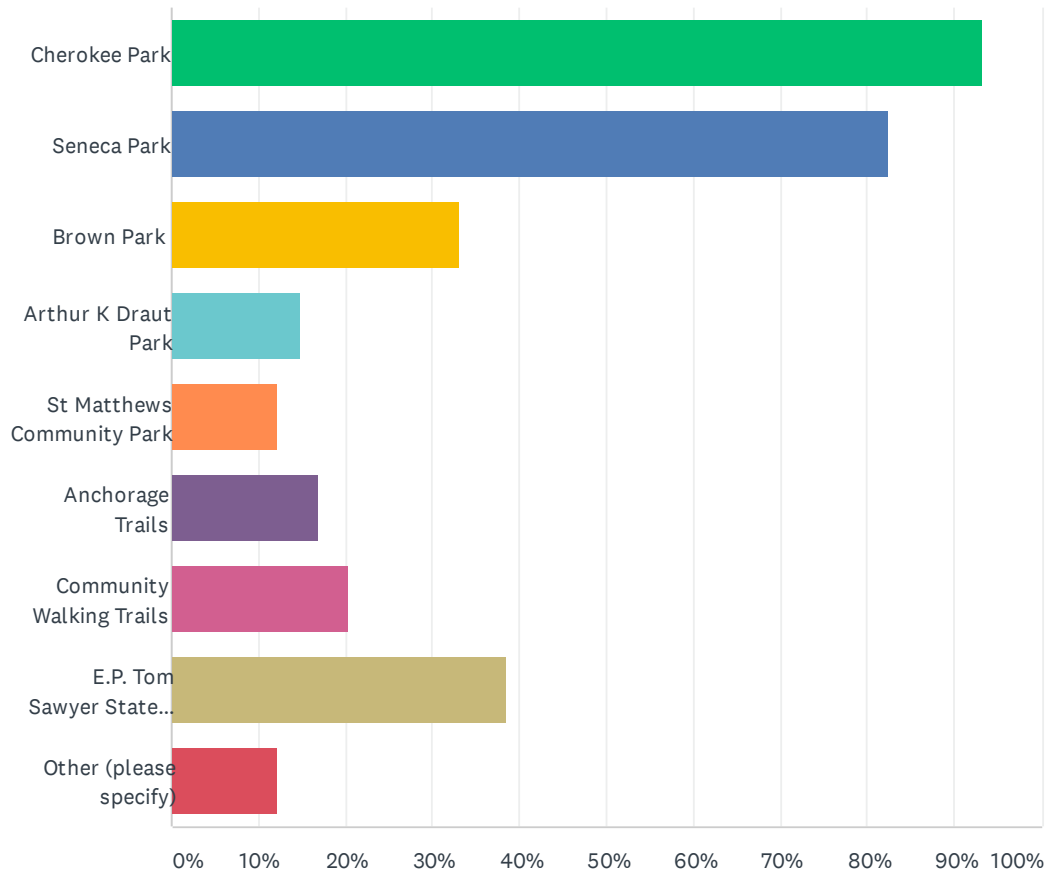
Answered: 149 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	0.67%	1
Yes	69.80%	104
No	5.37%	8
Not applicable	24.16%	36
TOTAL		149

Q4 What parks do you visit in the watershed? (Check all that apply)

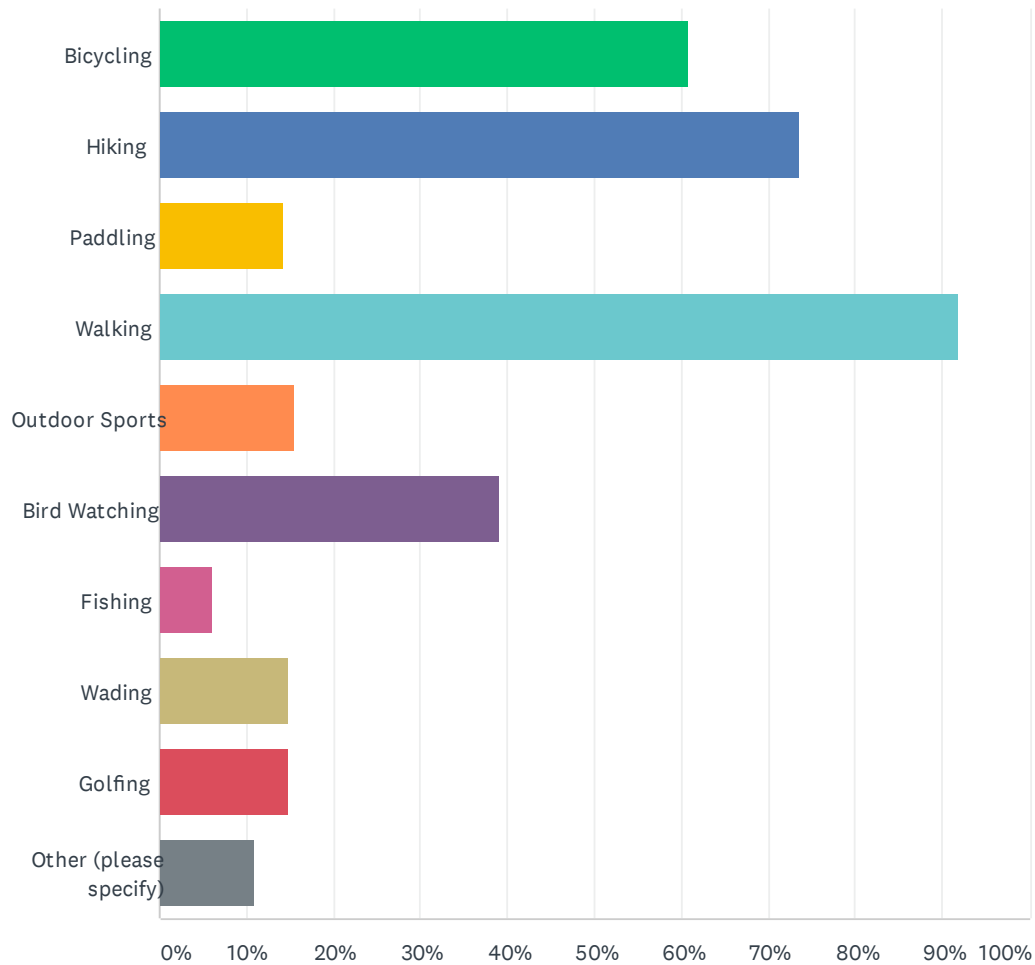
Answered: 148 Skipped: 2



ANSWER CHOICES	RESPONSES	
Cherokee Park	93.24%	138
Seneca Park	82.43%	122
Brown Park	33.11%	49
Arthur K Draut Park	14.86%	22
St Matthews Community Park	12.16%	18
Anchorage Trails	16.89%	25
Community Walking Trails	20.27%	30
E.P. Tom Sawyer State Park	38.51%	57
Other (please specify)	12.16%	18
Total Respondents: 148		

Q5 What activities do you like to do in the Middle Fork Beargrass Creek Watershed? (Check all that apply)

Answered: 148 Skipped: 2

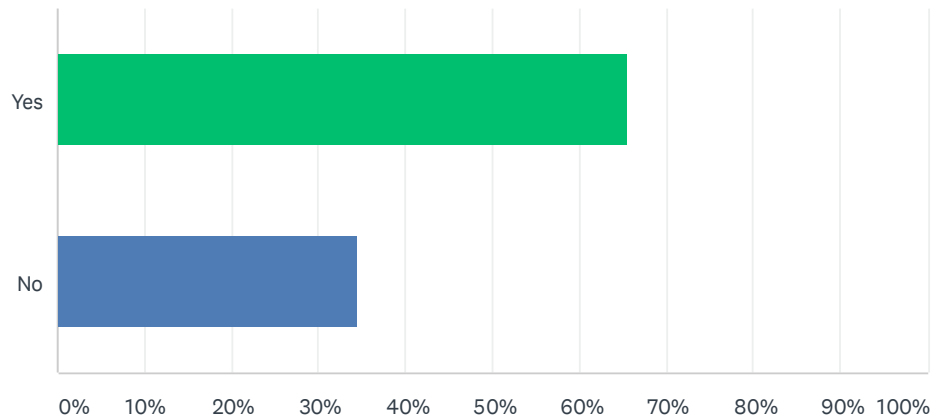


319(h) Middle Fork Beargrass Creek Watershed Community Survey

ANSWER CHOICES	RESPONSES	
Bicycling	60.81%	90
Hiking	73.65%	109
Paddling	14.19%	21
Walking	91.89%	136
Outdoor Sports	15.54%	23
Bird Watching	39.19%	58
Fishing	6.08%	9
Wading	14.86%	22
Golfing	14.86%	22
Other (please specify)	10.81%	16
Total Respondents: 148		

Q6 Are you interested in participating in education and outreach opportunities related to Middle Fork Beargrass Creek?

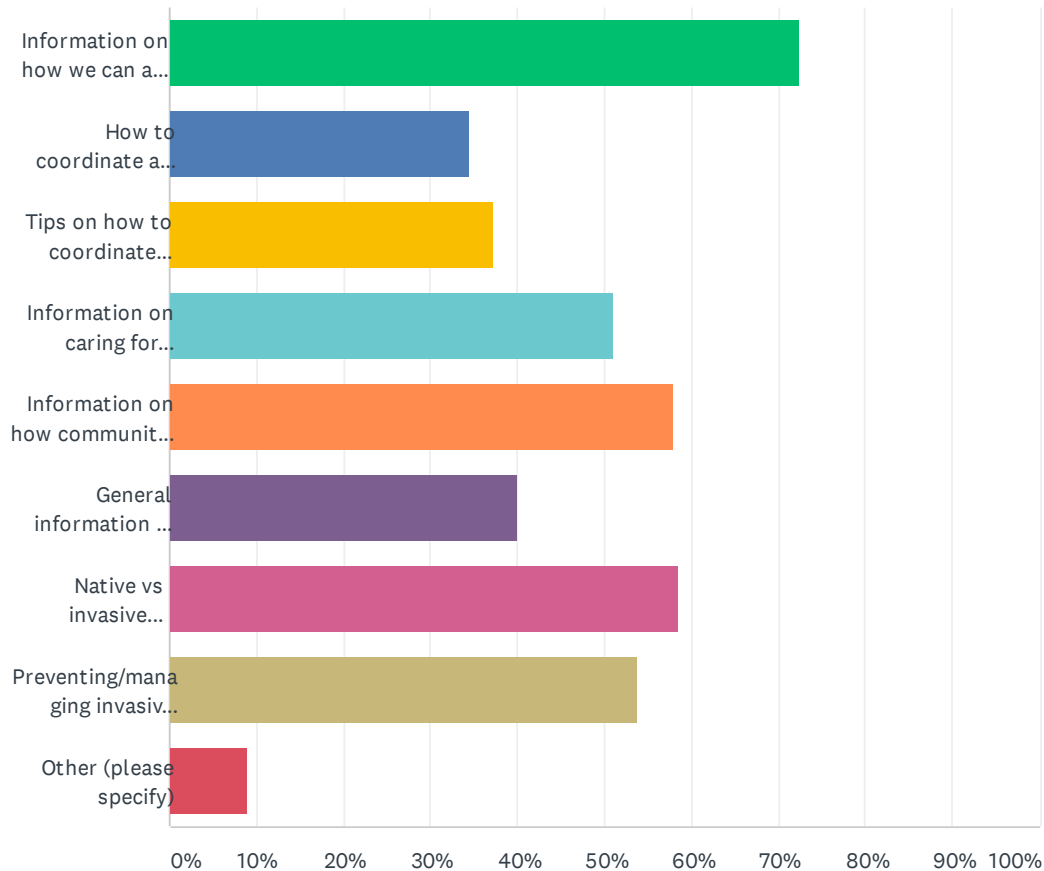
Answered: 148 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	65.54%	97
No	34.46%	51
TOTAL		148

**Q7 If there were information available to better care for streams in your backyard or neighborhood, what kind of information would you like to see?
(Check all that apply)**

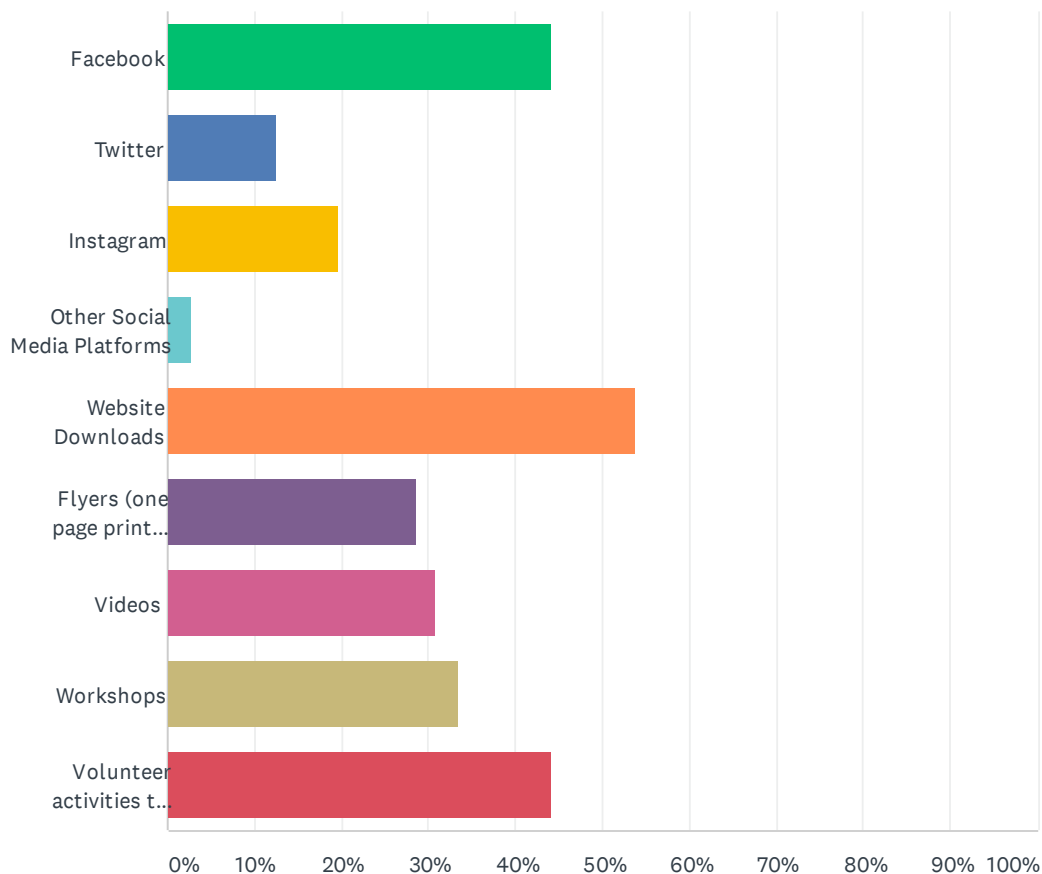
Answered: 145 Skipped: 5



ANSWER CHOICES	RESPONSES	
Information on how we can all improve water quality?	72.41%	105
How to coordinate a trash pick-up in your neighborhood?	34.48%	50
Tips on how to coordinate neighborhood water quality monitoring activities?	37.24%	54
Information on caring for riparian zones (vegetated areas along the stream)?	51.03%	74
Information on how communities can work together to increase habitat along waterway?	57.93%	84
General information on how to care for a stream in your backyard?	40.00%	58
Native vs invasive species identification?	58.62%	85
Preventing/managing invasive species?	53.79%	78
Other (please specify)	8.97%	13
Total Respondents: 145		

Q8 How would you like to receive education and outreach materials?
(Check all that apply) Note: This is the last question in the Middle Fork
Beargrass Creek Watershed survey. Thank you for your participation!
Survey Monkey may invite you to complete another survey after you click
“Done” below. You are under no obligation to do so.

Answered: 143 Skipped: 7



319(h) Middle Fork Beargrass Creek Watershed Community Survey

ANSWER CHOICES	RESPONSES	
Facebook	44.06%	63
Twitter	12.59%	18
Instagram	19.58%	28
Other Social Media Platforms	2.80%	4
Website Downloads	53.85%	77
Flyers (one page print outs)	28.67%	41
Videos	30.77%	44
Workshops	33.57%	48
Volunteer activities that include training	44.06%	63
Total Respondents: 143		

APPENDIX 6.2 BMP PLAN

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
1	Establish a Watershed Coordinator to implement watershed plan BMPs	General Watershed Health	Improve Water Quality	1. Apply for grant funding 2. Hire coordinator 3. Prioritize non-structural BMPs based on watershed needs and strengths	MSD	Not calculable	High	N/A	Estimated \$75,000/year	319(h)	X		
2	Add watershed plan documents to project partner's websites	General Watershed Health	Involve Community Members	1. Upload watershed plan, watershed maps, and BMP plan to partner's website	MSD, KWA, BCA	Not calculable	Medium	N/A	Staff time	N/A	X		
3	Regulation, ordinance, and benchmark review and assessment: Review and assess local regulations and policies, as well as local ordinances that have the potential to impact water quality	General Watershed Health	Improve Water Quality	1. Evaluate existing regulations, ordinances, and benchmarks to understand potential water quality impacts 2. Develop recommendations for improvements/changes to regulations, ordinances, and benchmarks	MSD	Dependent on ordinance revisions	High	MSD, Project Partners	Staff time	MSD	X		
4	Create additional outreach for existing stream buffer requirements in Floodplain Ordinance	General Watershed Health	Improve Water Quality	1. Establish an outreach program to educate homeowners about the benefits of stream buffers	MSD, Property owners	Not calculable	High	MSD	Staff time	MSD, 319(h)	X		
5	Adopt-a-storm drain program to promote nonpoint source awareness in the watershed	General Watershed Health	Involve Community Members	1. Utilize Watershed Coordinator to identify willing partners to develop and promote program 2. Leverage partnerships to develop an 3. Prioritize potential subwatersheds for program	MSD, Anchorage, St Matthews, Jefferstontown	Not calculable	Medium	MSD, Middle Fork Community Partners, Engineering Firms	Varies	MSD, Local, 319(h)	X		
6	Utilize public art and art education programs and activities to create energy around public awareness and activism to improve water quality	General Watershed Health	Involve Community Members	1. Leverage partnerships and relationship with Metro and other cities in the watershed 2. Citizen Lead Programs fostering arts and sciences with a water quality focus	MSD, Local environmental/ non-profit organizations, JCPS, Private Schools	Not calculable	Medium	MSD, Middle Fork Community Partners, Engineering Firms	Volunteer-donated costs	Art grants - External Agency Fund (Louisville Metro), MSD, 319(h), Environmental Education Grants	X		

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
7	Promote existing stormwater credit program	General Watershed Health	Involve Community Members	1. Distribute materials and promote existing stormwater credit program	MSD	Dependent on practice	High	MSD	\$5,000-\$25,000 per campaign	MSD	X		
8	Promote nonpoint source awareness in the watershed through education and outreach to schools	General Watershed Health	Involve Community Members	1. Partner with schools to develop curriculum for non-point source pollution and water quality 2. Present developed curriculum	KWA, JCSWCD, MSD, Parks, SRWW, Cities, JCPS, Private Schools, Home Schools	Not calculable	Medium	JCSWCD, JCPS, Curriculum Developers	\$500 - \$5,000 per curriculum	MSD, 319(h), Environmental Education Grants	X	X	
9	Outreach with Community Master Gardener and Community Gardener Groups to promote watershed health	General Watershed Health	Involve Community Members	1. Coordinate with Community Master Gardener and Community Gardener Groups to educate on watershed health and priorities.	JCSWCD, MSD	Not calculable	Medium	Master Gardeners	Volunteer and staff time	N/A	X	X	
10	Ongoing watershed planning and evaluation	General Watershed Health	Continuous Improvement	1. On a five year cycle the watershed plan will be reviewed and evaluated by steering committee 2. On a five year cycle action items specific to watershed needs and priorities will be developed 3. A complete update of the watershed plan will be completed when significant changes are identified	MSD, Watershed Coordinator, Steering Committee	Not calculable	High	KWA, BCA, Partners	\$10,000-\$50,000 per update	MSD, local	X	X	
11	Continue to implement the downspout disconnection program within the combined sewer system	General Watershed Health	Involve Community Members	1. Promote downspout disconnection program and explore ideas for similar programs	MSD, Property Owners	Dependent on project	High	MSD	\$100/down-spout plus staff time	MSD	X	X	
12	Protect streams with conservation easements	General Watershed Health	Improve Water Quality	1. Identify areas where conservation easements are feasible	MSD, Jefferson County Environmental Trust	Dependent on project	Medium	MSD , Jefferson County Environmental Trust	Varies	Jefferson County Environmental Trust		X	

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
13	Implement a trash removal program focused on determing sources of trash in watershed	General Watershed Health	Improve Water Quality	1. Identify appropriate partner to conduct study 2. Develop program to catch trash that would otherwise end up in the waterways 3. Implement study to analyze trash collected in this process--then target the source 4. Develop multimedia outreach to address the key trash items found	Kentucky Waterways Alliance, Beargrass Creek Alliance, MSD, Metro Parks Landowner	Unknown	Medium	MSD, Universities, EPA	Varies	USACE, MSD, 319(h), 2-year EPA Grant		X	
14	Implement a car wash campaign to reduce pollution in waterways	General Watershed Health	Improve Water Quality	1. Education and outreach to general public	MSD, Cities	Unknown	Low	MSD	\$5,000-\$25,000 per campaign	MSD, Cities, 319(h)		X	
15	Continue implementation of chlorinated pools outreach program	Specific Conductance	Improve Water Quality	1. Review existing materials and promote and distribute	MSD, Board of Health, Cities	Unknown	Medium	MSD	Staff time	MSD, Cities, 319(h)	X		
16	Implement a salt management strategy with education and outreach component	Specific Conductance	Determine Current Conditions	1. Study other salt management strategies 2. Study salt usage and users in watershed 3. Draft materials	MSD, Louisville Metro, KYTC, Cities	Unknown	Medium	MSD, KYTC, Local Engineering Firms	Varies	Louisville Metro Public Works, MSD, Cities, 319(h)		X	
17	Street sweeping and catch basin cleaning	Sediment and Specific Conductance	Improve Water Quality	1. Work with cities in the watershed with street sweeping practices to understand frequency and perform cost benefit analysis for more frequent sweeping	MSD, Cities	Unknown	Low	KYTC	Varies	Louisville Metro Public Works, Cities	X		
18	Install green infrastructure, such as tree boxes, rain gardens, infiltration trenches	Sediment and Specific Conductance	Improve Water Quality	1. Identify potential project locations 2. Evaluate and design BMPs 3. Install BMPs	MSD, Louisville Metro, KYTC, Cities	Dependent on project	Medium	MSD, KYTC, Local Engineering Firms	Varies	MSD, Cities, 319(h)		X	
19	Increase education for EPSC	Sediment	Improve Water Quality	1. Expand education programs for EPSC	MSD	Not calculable	High	MSD, Engineering Firms	Staff time	MSD	X		

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
20	Encourage private land owners to establish and widen riparian buffers to stabilize banks with native trees and bushes	Sediment and Nutrients	Improve Water Quality	1. Provide grants or incentives for waterway bank stabilization	KWA, BCA, MSD, Property owners	Not calculable	High	MSD, Tree Nurseries, NRCS, Extension Office	\$5,000 - \$1,000,000 per project	USACE, MSD, 319(h), NRCS	X		
21	Design and install structural BMPs along the north side of Linn Station Road in Jeffersontown	Sediment and Nutrients	Improve Water Quality, Roadway Safety, Linear Flooding Impacts	1. Evaluate and design strucutral BMPs that address the drainage upstream of the degraded area 2. Install structural BMPs to capture and treat stormwater to address water quality and flooding concerns	Jeffersontown	Dependent on project	Medium	Engineering firms, MSD	Dependent on project	319(h), Jeffersontown	X	X	
22	Design and install structural BMPs along Valley View Road within the City of Anchorage	Sediment and Nutrients	Improve Water Quality, Roadway Safety, and Reduce Flooding	1. Evaluate and design structural BMPs that address the drainage upstream of the degraded area 2. Install structural BMPs to capture and treat stormwater to address water quality and flooding concerns	Anchorage	Dependent on project	Medium	Engineering Firms, MSD	Dependent on project	319(h), Anchorage	X	X	
23	Design and install structural BMPs along Woodland Drive	Sediment and Nutrients	Improve Water Quality, Roadway Safety, Linear Flooding Impacts	1. Evaluate and design strucutral BMPs that address the drainage upstream of the degraded area 2. Install structural BMPs to capture and treat stormwater to address water quality and flooding concerns	Anchorage	Dependent on project	Medium	Engineering Firms, MSD	Dependent on project	319(h), Anchorage	X	X	
24	Retrofit of detention basin at Osage Road and Cold Springs Road	Sediment and Nutrients	Improve Water Quality and Reduce Flooding	1. Evaluate and design a retrofit of the existing basin to current design standards to address the drainage upstream of the basin 2. Retrofit detention basin to a green basin to address water quality and volume control	Anchorage	Dependent on project	Medium	Engineering Firms, MSD	Dependent on project	319(h), Anchorage	X	X	

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
25	Design and implement structural BMPs along Bluegrass Parkway in Jeffersontown	Sediment and Nutrients	Improve Water Quality and Reduce Flooding	1. Evaluate and design strutural BMP to address sediment and water quality impacts due to flooding along Bluegrass Parkway 2. Install strutural BMPs to address water quality and flooding concerns	Jeffersontown	Dependent on project evaluation	Medium	Engineering Firms, MSD	Dependent on project	319(h), Jeffersontown	X	X	
26	Design and install structural BMPs at Blairwood Apartments	Sediment and Nutrients	Improve Water Quality, Increase Volume Storage, and Reduce Flooding	1. Evaluate and design structural BMPs that address the drainage upstream of site. Low lying area could potentially be used to create storage on site. 2. Install structural BMPs to capture and treat stormwater to address water quality and flooding concerns.	Hurstbourne, Landowner	Dependent of project	Medium	MSD, Engineering Firms	Dependent on project	319(h), Hurstbourne, MSD	X	X	
27	Retrofit impervious surfaces where feasible to utilize pervious pavers to decrease peak flows and associated pollutants	Sediment	Improve Water Quality	1. Identify locations and/or for potential pervious pavement projects 2. Install pervious pavers with long term maintenace agreements identifying responsible parties with an MOA	MSD and Watershed Partners	Dependent on Project	Medium	MSD, Engineering Firms	\$10,000-\$500,000 +/- per project	USACE, MSD, 319(h), Research funds		X	
28	Characterize subwatershed's erosion potential instream	Sediment and Nutrients	Determine Current Conditions	1. Determine nonpoint source pollution load potential 2. Select subwatersheds for further characterization 3. Utilize current methods and strategies to calculate load reduction potential within the system 4. Evaluate background and conduct a benchmarking study to specifically address instream sediment loading concerns	MSD, Cities, Metro Parks	Dependent of Project	Medium	Parks, KWA, BCA, NRCS, USACE, Extension Office, JCSWCD	\$20,000 to \$250,000 +/- per subwatershed	USACE, MSD, 319(h), Research funds		X	

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
29	Install infiltrative overbank streamside features (diversion/detention/ponding)	Sediment and Nutrients	Improve Water Quality	1. Identify priority areas to apply practice 2. Install overbank streamside features	MSD	Dependent on project	High	MSD, Engineering Firms	Dependent on project	USACE, MSD, 319(h)		X	
30	Implement stream restoration projects to prevent soil erosion and restore natural channel function	Sediment and Nutrients	Improve Water Quality	1. Identify potential project locations 2. Evaluate and design a stream 3. Construct stream restoration project	Conservation Landowners, MSD and Cities	0.02 lb./ft/yr. TN, 2.55 lb./ft/yr. TSS	High	KWA, BCA, NRCS, Extension Office	\$25,000-\$1,000,000 +/- per project	USACE, MSD, 319(h) , NRCS		X	
31	Evaluate and improve channels within the Hurstbourne Country Club property	Sediment and Nutrients	Improve Water Quality and Reduce Flooding	1. Evaluate existing channels 2. Use natural channel design to reduce 3. Install strutural BMPs according to evaluation and design with natural channel approach	Hurstbourne, Hurstbourne Country Club, MSD	Dependent on project	Medium	MSD, Engineering Firms	Dependent on project	319(h), Hurstbourne, Hurstbourne Country, Club, MSD		X	X
32	Create Stormwater Detention Features (regional, subregional, &/or pockets) to reduce peak flows and filter nutrients	Sediment and Nutrients	Improve Water Quality	1. Identify locations and partners for detention features 2. Design detention features 3. Construct detention features	MSD, Cities, Property Owners	~20% TN, ~60% TSS	Medium	MSD, Engineering Firms	\$25,000 - \$1,000,000+/- per project	MSD, Cities, 319(h)		X	X
33	Evaluate subwatersheds for the existing and potential constructed wetlands and enhance/construct wetlands	Sediment and Nutrients	Improve Water Quality	1. Identify locations of existing and potential wetlands and partners 2. Design constructed wetlands 3. Construct new wetlands and/or improve existing wetlands	MSD, Cities, Property Owners	25-55% TN, ~60% TSS	Medium	MSD, Engineering Firms	Low cost for location identification	MSD, Cities, 319(h)		X	X
34	Conduct tree planting events	Nutrients	Involve Community Members, Improve Water Quality	1. Identify potential locations for tree planting 2. Coordinate with community members on the location and planting plan 3. Plant trees and assign maintenance responsibilities	MSD, Property owners, Schools, KYTC	Not calculable	Medium	MSD, Louisville Metro	\$5,000-\$25,000 per campaign	MSD, Cities, 319(h), Trees Louisville, Louisville Grows	X		

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term 0-5 Years	Medium Term 5-10 Years	Long Term 10 + Years
35	Implement nutrient management program	Nutrients	Improve Water Quality	1. Establish partners for program 2. Determine target audience for program (e.g. golf courses, home owners, HOAs, commercial properties, etc.) 3. Implement program	MSD, SWCD	Dependent on practices	Medium	MSD, SWCD, Engineering Firms	\$10,000-\$25,000 per campaign	MSD, 319(h)	X		
36	Characterize subwatershed's bacteria load potential	Bacteria	Determine Current Conditions	1. Prioritize subwatersheds with high bacteria data 2. Correlate E. coli and fecal coliform data specific to MFBGC watershed 3. Identify projects and partners that reduce bacteria within prioritized subwatersheds	MSD	Unknown	High	MSD, Health Department	\$50,000 to \$250,000	MSD, 319(h)	X		
37	Conduct a "Pick up after your dog" campaign	Bacteria	Improve Water Quality	1. Partner with dog parks, parks, and cities 2. Create outreach campaign	MSD, Cities, Dog Parks	Unknown	Medium	MSD	\$5,000-\$25,000 per project	MSD, Cities, 319(h)	X		
38	Implement geese-control program	Bacteria	Improve Water Quality	1. Review geese population in watershed to determine extent of problem and establish specific control practices, including do not feed campaigns, anti-roost controls, etc.	MSD, KWA, BCA, Local Communities	Unknown	Medium	MSD, Ky Department of Fish and Wildlife	\$10,000-\$25,000 per campaign	MSD, Cities, 319 (h)	X		
39	Implement septic system outreach program such as EPA Septic SMART targeting areas with septic systems	Bacteria	Improve Water Quality	1. Identify areas with septic systems in the watershed 2. Work with landowners regarding maintenance 3. Work with local communities regarding transition to sewers 4. Education and outreach regarding septic systems	MSD, Health Department, Cities	Unknown	High	MSD, Health Department	\$5,000-\$25,000 per campaign, Varies for sewer projects	MSD, Cities, 319(h)	X	X	

Middle Fork Beargrass Creek Watershed Plan BMP Plan

BMP No.	BMP Description/Action Item	BMP Type/Pollutant Addressed	Additional Priority Goals and Objectives	Priority Action Items	Potential Responsible Party	Load Reduction*	Priority	Technical Assistance	Costs	Funding Mechanisms	Short Term	Medium Term	Long Term
											0-5 Years	5-10 Years	10 + Years
40	Install pet waste stations, including bags and disposal	Bacteria	Improve Water Quality	1. Identify location for pet waste stations 2. Locate stations in parks and neighborhoods in watershed	Dog Parks, Metro Parks, City Parks	Unknown	Medium	MSD	\$3,000 to \$15,000 per station and annual maintenace costs	MSD, Cities, 319(h)		X	
41	Implement inflow and infiltration sanitary sewer projects and other IOAP Projects	Bacteria and Nutrients	Improve Water Quality	1. Construct projects in 2021 IOAP Modification including Middle Fork Relief Interceptor and Pump Station 2. Construct rehabilitation projects identified in 20-year Comprehensive Facility Plan 3. Identify other potential interceptor projects in the watershed	MSD	Unknown	Medium	MSD, Local Engineers	Based on project (See 2021 IOAP and 20-Year Comp. Fac. Plan)	MSD			X

APPENDIX 6.3 BMP WEB APPLICATION REPORT

Middle Fork Beargrass Creek BMP Web Application Report

In order to facilitate community engagement, MSD GIS created an ArcGIS Online web app that allowed users to see the physical boundaries of proposed projects, report problem areas, and express their support of specific projects. This web app was designed specifically for crowdsourcing projects and was accessible by web browser on both mobile devices and desktops. While community participation was modest, the concept was proven and some feedback was recorded. That feedback is outlined below.

Table 1 Proposed BMP Sites

Project Location	BMP	Vote Tally
Brown Park	Riparian Buffer	2
Arthur Draut Park	Stream Restoration	2
Cherokee Park	Pet Waste Management	4
I-64 & Grinstead Dr	Riparian Buffer	3
Middle Fork & South Fork Confluence	Brush Layering, Invasive Species Management	3
Home Depot Breckenridge Ln	Riparian Buffer, Fertilizer Management, Brush Layering, Mowing	2
Big Spring Country Club	Riparian Buffer, Fertilizer Management, Education, Brush Layering, Mowing	1
Oxmoor Country Club	Riparian Buffer, Fertilizer Management, Education, Brush Layering, Mowing	1
Hurstbourne Country Club	Riparian Buffer, Fertilizer Management, Education, Brush Layering, Mowing	3
TBD	Wetlands, bioswales, bioretention, rain gardens, engineered storage	0

Table 2 Proposed Watershed Wide BMPs

Priorities	BMP	Vote Tally
Outreach	Stream In My Backyard Program	0
Outreach	Public Announcements (multi-media messaging)	0
Outreach	Community Trash Cleanups	1
Outreach	Pet and Wildlife Do's and Don'ts	0
Outreach	Adopt a Storm Drain Program	0
Outreach	Inlet Painting	0
Outreach	Trash Trappers Collection Study	0
Outreach	Watershed Coordinator	1
Pollutants	Riparian Buffers	0
Pollutants	Stormwater Detention Features	1
Pollutants	Green Infrastructure	1
Flooding	Connect the Creek to Its Floodplains and Existing Wetlands	1
Flooding	Explore Flood Mitigation Funding Opportunities	0
Restoration	Stream Restoration	1
Restoration	Bank Stabilization	0
Restoration	Invasive Species Management	0
Roadways	Salt Management	0

Priorities	BMP	Vote Tally
Roadways	Roadside Infiltration Trenches	1
Roadways	Roadside Vegetative Buffers	1

Table 3 Proposed Stakeholder Projects (Crowdsourced Points)

All reported points located within Cherokee Park

Indicator Being Reported	BMP	Comments	ID #
Trash	Example	Example	1
Other	Bank Stabilization	Exposed high pressure gas line. Requires stream bank restoration.	2
Other	Bank Stabilization	Very steep stream bank, loss of riparian trees ongoing. Requires stream bank restoration and creation of secondary floodplain.	3
Other	Bank Stabilization	Stream bank restoration required. Loss of riparian trees.	4
Other	Bank Stabilization	Streambank restoration required.	5
Other	Bank Stabilization	Site of previous streambank restoration.	6

