Threemile Creek TMDL Alternative: Implementation Plan to Address Primary Contact Recreation (PCR) Impairments

October 2022

Contents

1.0 Summary

The Threemile Creek Watershed Total Maximum Daily Load (TMDL) Alternative Plan addresses one impaired waterbody on the 2018/2020 303(d) list. This waterbody, Threemile Creek 0.1 to 4.8, is impaired for pathogens for the Primary Contact Recreation (PCR) designated use (Table 2.1). This TMDL Alternative Plan includes an update on information reported in the Three Mile Creek Watershed Characterization report and an updated implementation schedule (Appendix A) for addressing the PCR impairment. The implementation schedule includes projects outlined in the amended Northern Kentucky Consent Decree and SD1's Updated Watershed Plan for Northern Kentucky (UWSP).

The Threemile Creek watershed is 5.9 square miles in size and is located entirely in Campbell County, KY. The mainstem of Threemile Creek originates west of Highland Heights and flows westward to the Licking River. This small watershed is residential in nature and crossed by two interstate highways that intersect near its center. Figure 1.1 shows the watershed and the subwatershed of the North Branch.

The Three Mile Creek Watershed Characterization Report was developed by SD1 in 2009 as part of a larger effort to produce reports for watersheds throughout SD1's service area. The purpose of these reports was to describe the physical and natural features, land cover, infrastructure, waterbody conditions, potential pollutant sources and other features within the watersheds. The Three Mile Creek Watershed Characterization Report provided an overview of local conditions and historical bacteria data from 1985-2005 and an analysis of bacteria data collected from 2006-2008. Overall, elevated densities of fecal coliform and *E. coli* were found at several locations. The pollutant sources of bacteria identified in the report were sanitary sewer overflows (SSOs), storm water runoff, and septic systems. These three sources of bacteria were also predicted by the Watershed Assessment Tool (WAT!) as the source of fecal coliform loads within the watershed.

A TMDL alternative plan outlines a set of actions and milestones that comprise a detailed roadmap to restore water quality in advance of efforts to develop a TMDL. The following chapters present a summary of the new bacteria data collected within the Threemile Creek watershed (Section 3.0), an updated analysis of sources (Section 4.0), and a refined plan for implementation and effectiveness monitoring focused on the PCR impairment (Section 6.0). SSOs are likely a major source contributing to the PCR impairment and are the focus of implementation projects outlined in this plan. Annually, SD1 will analyze and report the results of continued monitoring and implementation activities to KDOW to evaluate whether the plan is on track for achieving water quality standards.

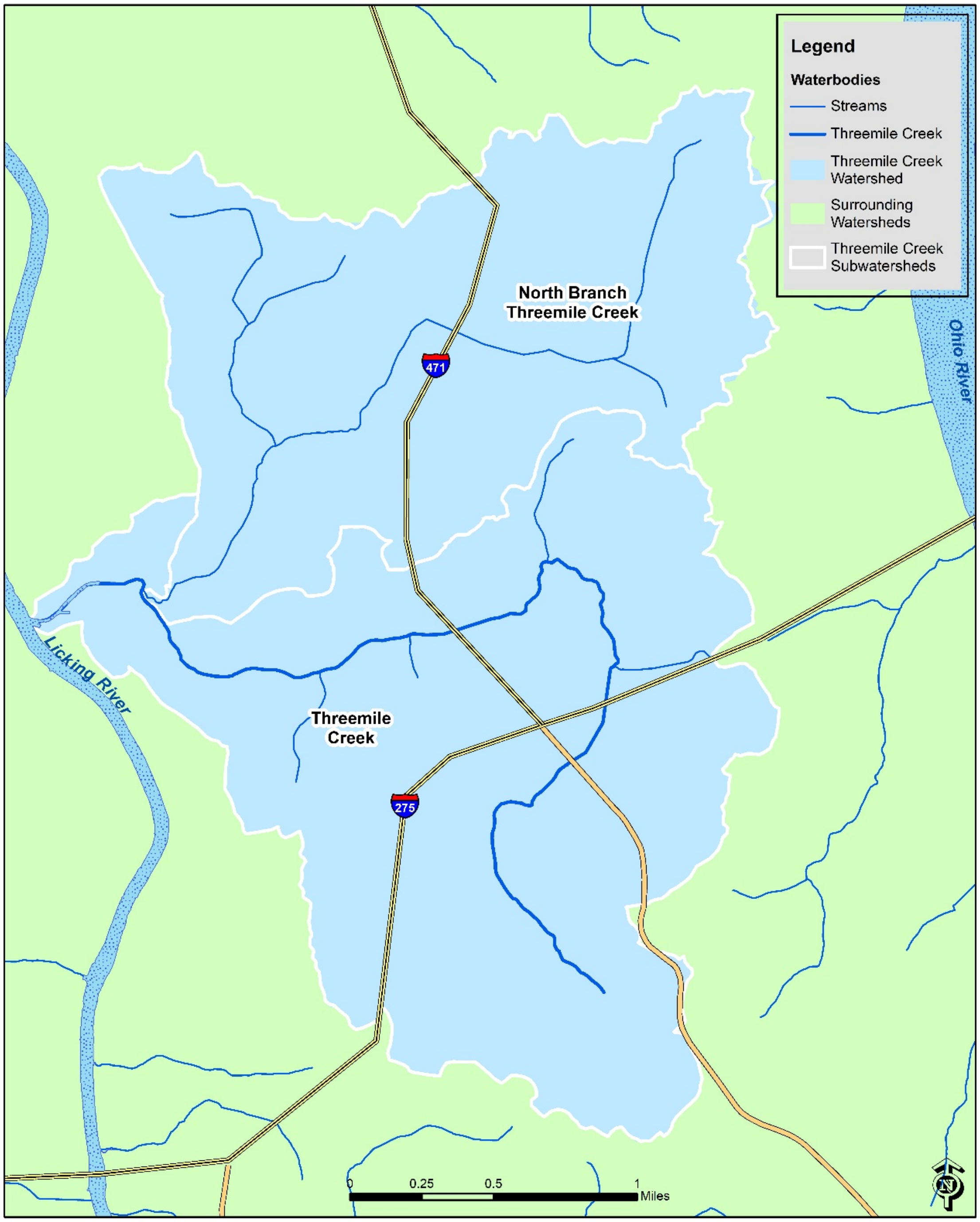

Figure 1.1 Threemile Creek Watershed and Subwatersheds

2.0 303(d) Listed Segment for Primary Contact Recreation (PCR)

The entire mainstem of Threemile Creek was first listed as impaired for PCR for Pathogens on the 1998 303(d) List of Impaired Waters. The listing was updated in the 2004 reporting cycle based on data from May – October 1999. The segment remains on the current 2020 303(d) list, The listing includes sanitary sewer overflows (SSOs) as a suspected source. Section 4 provides a more in-depth review of SSOs as well as other suspected sources. The segment is included in Table 2.1 and Figure 2.1.

Table 2.1 KDOW 2018/2020 303(d) Listed Segment for PCR

Waterbody & Segment	Total Size (miles)	AU ID	PCR Use Status*	Pollutant	Suspected Source(s)
Threemile Creek 0.1 to 4.8	4.7	KY-1889	Non Support	Pathogens	Sanitary Sewer Overflows (Collection System Failures), Source Unknown

*401 KAR 10:031 Section 7 includes the surface water standards for PCR. In summary, *E. coli* shall not exceed 130 colonies per 100 ml as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 240 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for *Escherichia coli*.

According to the Consolidated Assessment and Listing Methodology: Surface Water Quality Assessment in Kentucky, The Integrated Report (2015), KDOW assesses non-support and partial support based on the following:

A segment is listed as <u>non-support</u> if any of the following occur during the PCR season (May - Oct):
(1) Two or more sets of 5 samples in 30 days have a geomean that exceeds 130 colonies/mL
(2) 3 of 5 samples exceed 240 colonies/mL
(3) 34-100% of 6 or more samples exceed 240 colonies/mL

A segment is listed as <u>partial support</u> if any of the following occur during the PCR season (May - Oct):
(1) One set of 5 samples in 30 days have a geomean that exceeds 130 colonies/mL
(2) 20-33% of 6 or more samples exceed 240 colonies/mL

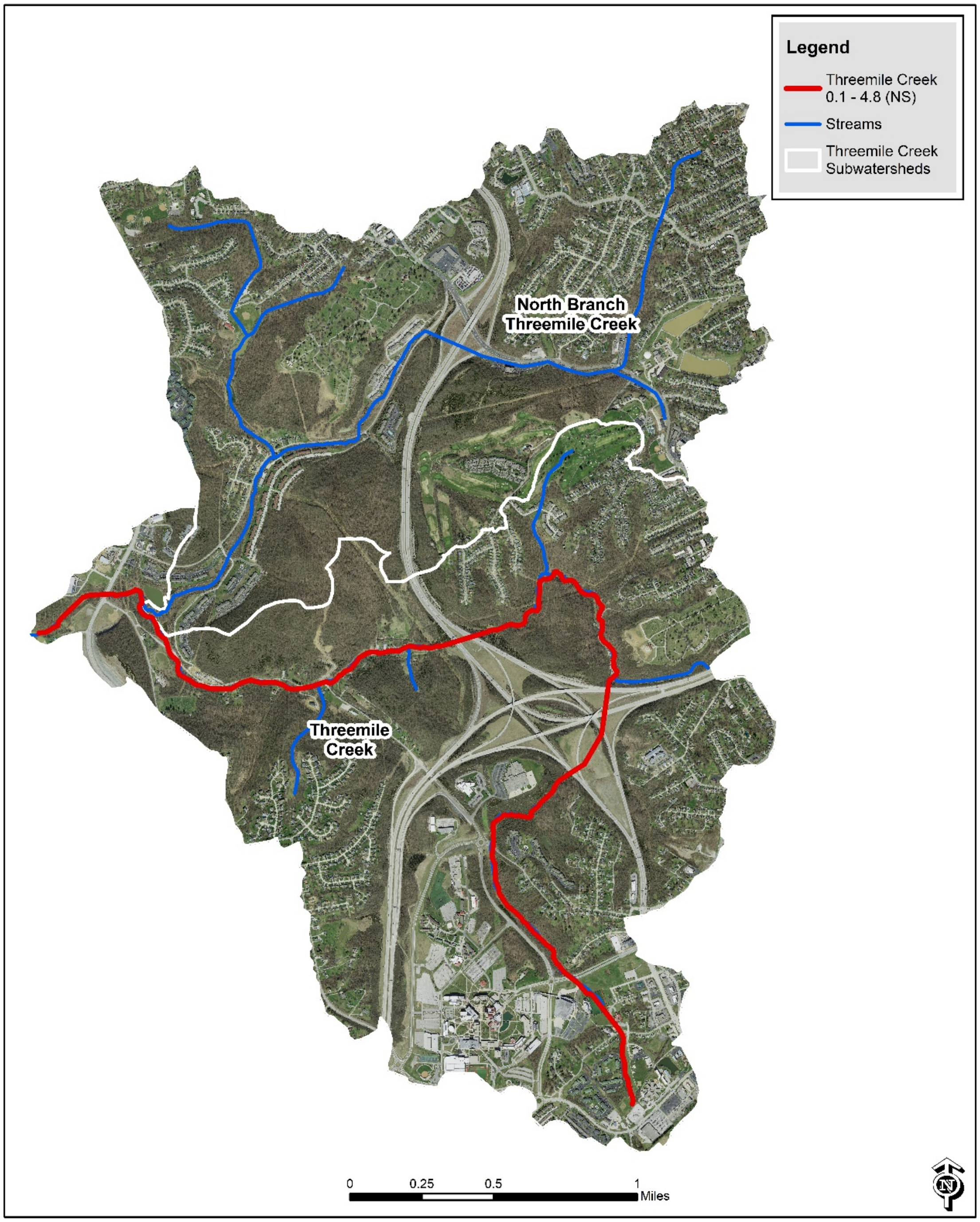

Figure 2.1 303(d) Listed Segment for PCR (Non-support (NS))

3.0 Data Collection and Updated Analysis

Since the 2004 assessment of the segment, Sanitation District No. 1 of Northern Kentucky (SD1) has conducted additional *E. coli* monitoring within the watershed. This monitoring has been conducted following the SD1 developed Field Monitoring and Sampling Plans (see Appendices B, C, and D), which aligns with quality and quantity requirements used by KDOW. This includes specific grab sampling procedures, proper temperature regulation and holding times, and the use of blanks and duplicates for quality control. Samples are processed at SD1's Dry Creek lab, which is certified under the Kentucky Laboratory Certification Program (KLCP).

3.1 Monitoring Sites and Events

SD1 has established three long-term monitoring sites within the Threemile Creek Watershed THC0.7, THC1.4 and NTB0.8 (Figure 3.1). All three sites are part of SD1's base flow characterization program and are located within the Central Basin (Appendix B). Sampling events for the base flow program were conducted once during dry weather conditions (i.e., no precipitation in watershed 72 hours prior to event and prevailing dry weather conditions throughout event) during the PCR monitoring periods of 2007 – 2010, 2013 and 2017. The use of the term "base flow" throughout this document refers to sampling events that are part of the base flow characterization program.

SD1 also sampled at THC 0.7 as part of the bi-weekly monitoring program (Appendix C) during July – November 2015, April – November 2016, and April – June 2017. Samples were collected every fourteen days over the course of these months. These samples were collected under various weather and flow conditions.

Site THC 0.7 is part of SD1's ambient monitoring network (Appendix D). This site has been sampled multiple times between March through November on an annual basis, starting in 2017. Sampling dates for this program are established at the beginning of the season and may include samples collected under various weather and flow conditions. A USGS stream gage is located at this site, which provides stream flow data (gage height and discharge) in 15 minutes intervals.

Although some samples were collected outside of the PCR season, only results of samples collected during the PCR season (May 1 – October 31) are summarized in this report. Table 3.1 includes the number of samples collected each year during the PCR season.

Table 3.1 Number of Samples Collected During the PCR Season by Year and Program/Event Type

	2007-10	2013	2015	2016	2017			2018	2019	2020	2021
	Base Flow	Base Flow	Bi-Weekly	Bi-Weekly	Base Flow	Bi-Weekly	Ambient	Ambient	Ambient	Ambient	Ambient
THC 0.7	1	1	9	13	1	4	6	9	9	9	9
THC 1.4	1	1	-	-	1	-	-	-	-	-	-
NBT 0.8	1	1	-	-	1	-	-	-	-	-	-

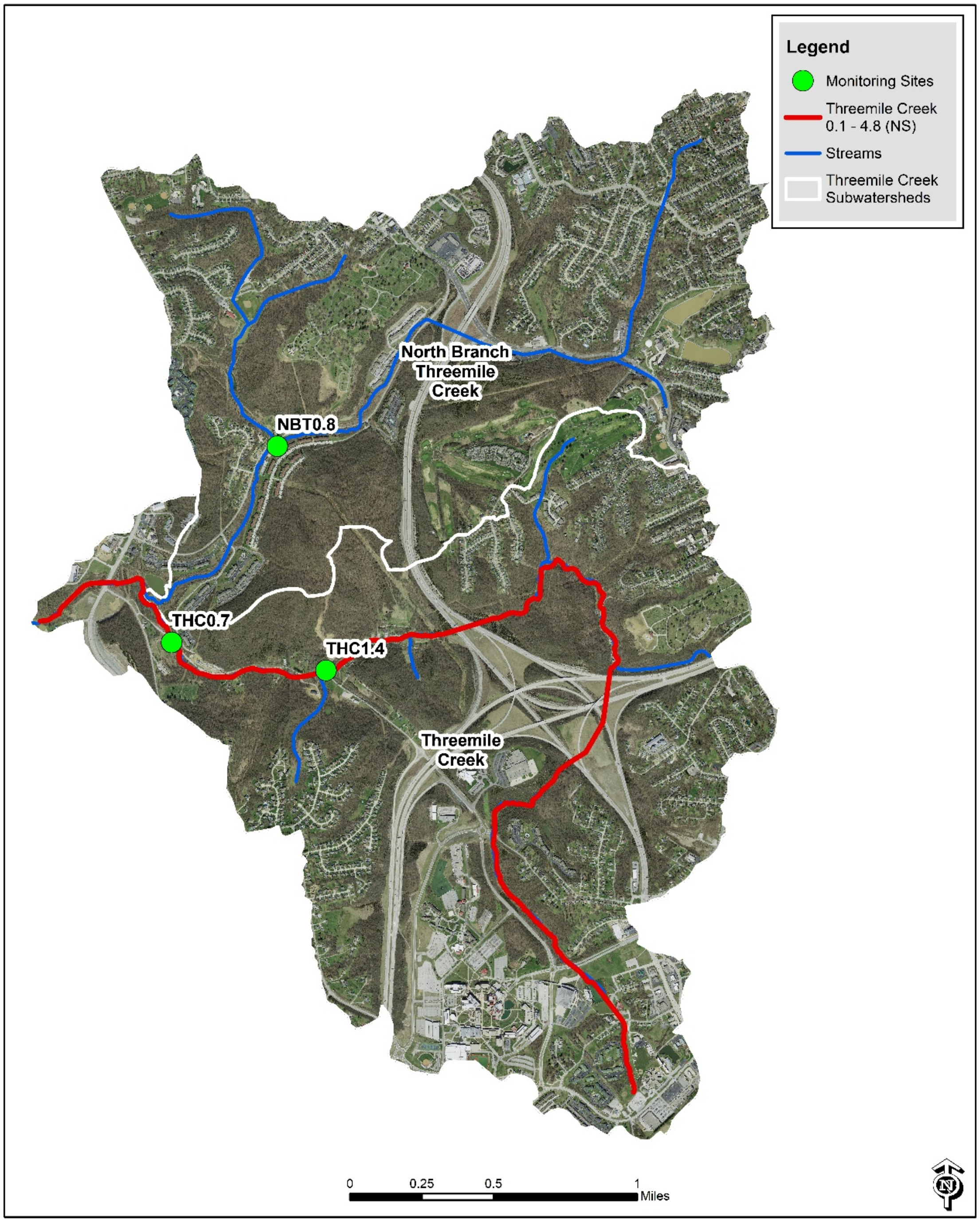

Figure 3.1 Monitoring Locations in the Threemile Creek Watershed

3.2 Monitoring Results and Analysis

Central Basin base flow characterization monitoring

E. coli results collected within the PCR season for the three Threemile Creek sites during the

2007-2010, 2013, and 2017 sample cycles are presented in Table 3.2. All results exceeding the 240 colonies/mL standard are displayed in red font.

Table 3.2 SD1 Base Flow Monitoring *E. coli* Results from 2007-2010, 2013 and 2017 (excludes samples collected outside of the PCR Season)

Site	Description	Results (cfu/100mL)					
		2007	2008	2009	2010	2013	2017
THC 0.7	Threemile Creek (Above Threemile Road Bridge)	445	393	373	92	136	208
THC 1.4	Threemile Creek (Gibson Lane)	343	146	258	58	92	220
NBT 0.8	North Branch Threemile Creek (Moock Rd)	108	880	1102	225	98	612

The base flow monitoring results show exceedances of the *E. coli* water quality standard. With only one sample for each site per year a determination of attainment cannot be made. However, the number of samples exceeding the criteria have decreased since 2010.

Bi-weekly and Ambient Monitoring Results

As noted in Section 3.1, site THC 0.7 was sampled at a greater frequency as part of the ambient and bi-weekly programs. The results of both the bi-weekly and ambient monitoring for site THC 0.7 are compiled in Table 3.3. The table includes the number of samples analyzed for each weather condition (#), the average of those sample results (AVG) and the percent of the samples that exceeded the water quality standard (%EX). The data are compiled according to weather conditions. Samples with no precipitation 72 hours prior to event and prevailing dry weather conditions throughout event are classified as dry and all others are classified as wet. Refer to Appendix E for the results of all events.

Table 3.3 Bi-weekly and Ambient *E. coli* Results for Site THC 0.7 - Number of Samples, Average and Percent of Samples Exceeding the Standard (excludes samples collected outside of the PCR Season)

SITE		2015			2016			2017			2018		
		#	AVG	%EX	#	AVG	%EX	#	AVG	%EX	#	AVG	%EX
THC 0.7	ALL	9	1750	78	13	1645	69	11	562	64	9	438	67
	WET	5	2930	100	5	3452	100	5	2982	60	5	562	80
	DRY	4	275	50	8	515	50	6	400	67	4	283	50
		2019			2020			2021					
		#	AVG	%EX	#	AVG	%EX	#	AVG	%EX			
	ALL	9	432	56	9	202	11	9	243	44			
	WET	2	1226	100	3	399	33	4	308	50			
	DRY	7	205	43	6	104	0	5	191	40			

The bi-weekly and ambient monitoring events include more than six samples collected within the PCR season for the year. Due to this, the percent of samples exceeding the PCR water quality standard can be used to evaluate possible impairments based on the factors for non-support (34-100% of 6 or more samples exceed 240 colonies/mL) and partial support (20-33% of 6 or more samples exceed 240 colonies/mL).

The results for site THC 0.7 in Table 3.3 include the bi-weekly as well as the ambient events, which provides a larger data set for this site. As displayed in Figure 3.3, the percent exceedances for all samples across the years has continued to decrease. The percent exceedances for the wet weather samples were consistently higher than the "all" and "dry" categories, however the 2020 and 2021 wet weather samples show lower percent exceedances compared to previous years.

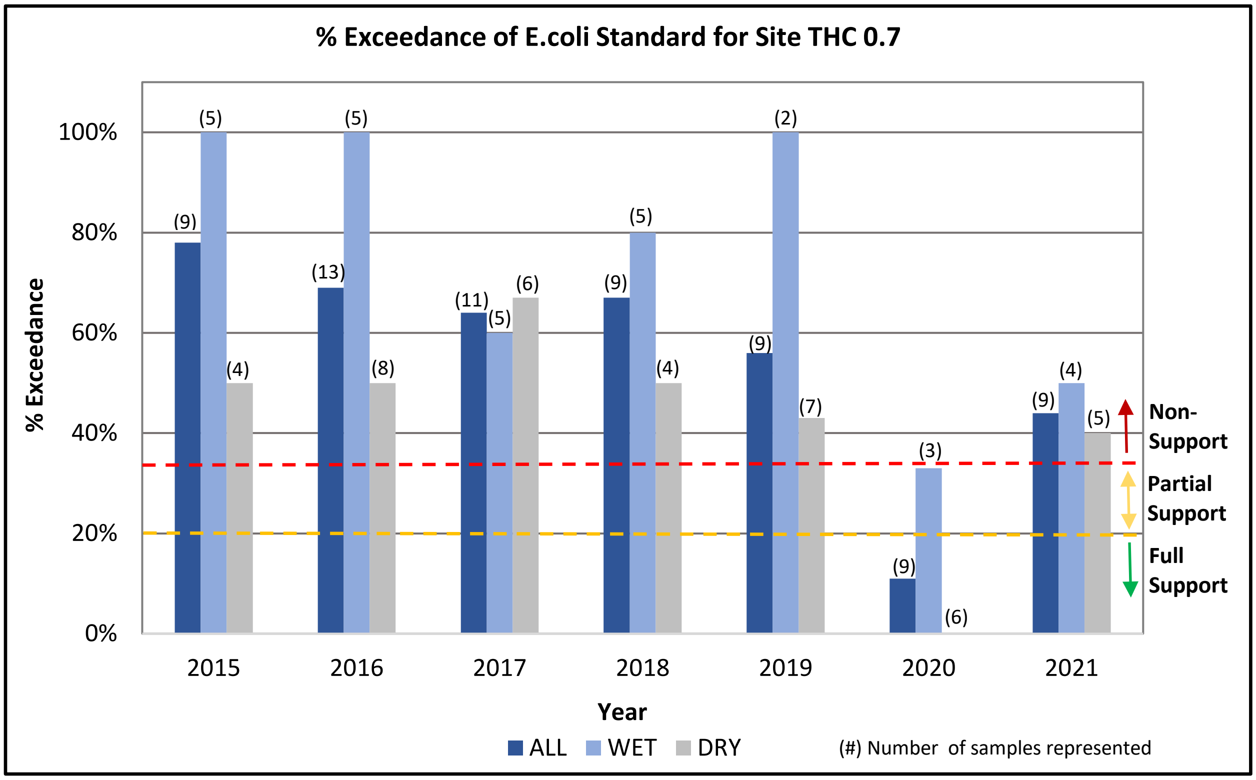

Figure 3.3 Percent Exceedance of the Standard for Site THC 0.7

An increase in the percent exceedances for all conditions was observed in 2021 compared to 2020 but the mean of the samples (243 cfu/100mL) was only slightly above the criteria (240 cfu/100mL). Figure 3.4, a box and whisker plot comparing the data across years, shows a decrease in the range of the values as well as the mean. These results indicate an improvement trend at the site and suggest that work to date combined with the activities outlined in this plan are likely to result in further reductions in concentrations. It is anticipated that these reductions will over the long-term help to return Threemile Creek to meeting standards. In the short term (over the next several years), it is anticipated that the concentrations may reflect an improvement from non support to partial support of the use.

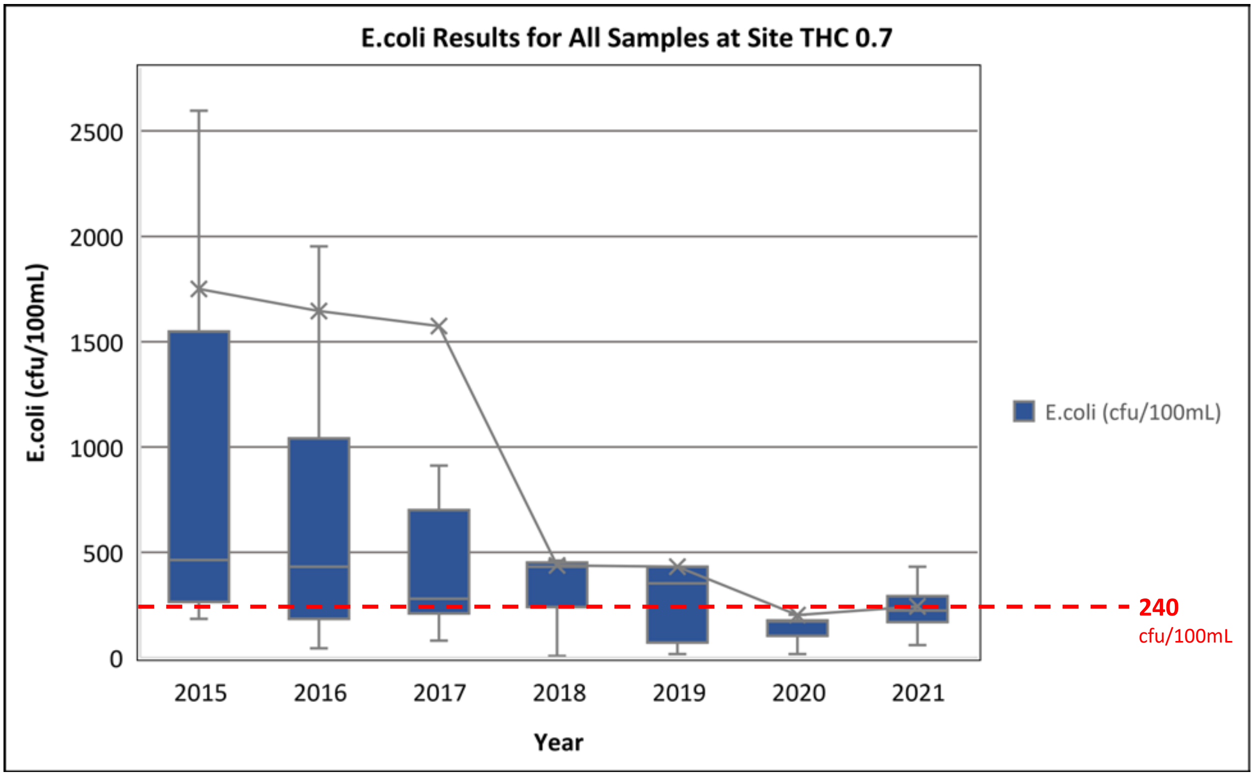

Figure 3.4 Box and Whisker Plot of All Samples at Site THC 0.7

Summary of Results

Overall, the data collected by SD1 suggest improvement at site THC 0.7 located within the 303(d) listed segment. Samples collected during wet weather events are consistently elevated (Figure 3.3) but the mean values and percent exceedances have decreased in recent years. Potential factors influencing these trends and existing sources contributing to impairments are evaluated in Section 4.0.

SD1 is in the process of updating the monitoring approach within the region, including the Threemile Creek Watershed. As part of this update SD1 will sample all three sites in Threemile Creek ten times in 2022. The purpose of this update is to provide a more complete data set, which will allow for better trend analysis across monitoring cycles.

4.0 Potential Sources of PCR Impairments and Current Efforts

The following sub-sections provide an overview of the potential sources of the PCR impairments and current efforts underway to address these sources. This information was used to develop the targeted implementation plan outlined in Section 5.

4.1 Centralized Wastewater

The vast majority of the watershed is served by public sanitary sewers, which are maintained by SD1. All of the centralized wastewater sewers within the watershed flow to the SD1-owned and operated Dry Creek Wastewater Treatment Plant where it is treated and discharged to the Ohio River.

The system is a separate sewer system with no combined system existing in the watershed. Based on the potential sources identified in this section, bacteria loads to the stream associated with the public sanitary system are likely due to sanitary sewer overflows (SSOs) identified in Figure 4.1.

By the year 2040, SD1 will eliminate typical-year SSOs to meet the requirements of Northern Kentucky's amended consent decree. This will be accomplished through a number of strategic projects specifically designed to address sewer overflows, which is further outlined in Section 5. Table 4.1 displays the overflow volume at locations in the subwatersheds of the main stem and the North Branch of Threemile Creek. These volumes are based on modeled data for events occurring in 2021, 2029 and 2040.

Table 4.1 Modeled Overflow Volumes for SSOs in Threemile Creek

Sub-watershed	**2021**	**2029**	**2040**
	SSO (MG)	**SSO (MG)**	**SSO (MG)**
North Branch	1.75	0.60	0.00
Main Stem	2.43	1.74	0.00

SSO represents the 2-year 6-hour overflow volume based on modeled data

Projects outlined at this time are conceptualized at a very broad planning level. Actual projects will likely present different results based upon optimizing the infrastructure that is constructed. Also of note is that flow predictions in the model are very high level and actual flows will vary depending on the development that does occur. Due to these factors, the predicted overflow volumes prior to 2040 in Table 4.1 may change based on the projects implemented, however all typical year overflow volumes from SSOs will be eliminated by 2040. SD1's ongoing system calibration will likely alter the overflow volumes presented and this updated information will be submitted to KDOW on an annual basis. Additional information about the implementation projects identified in the consent decree is presented in Section 5.0.

Additionally, as part of ongoing Capacity, Management, Operations and Maintenance (CMOM) efforts, SD1 continues to address sanitary issues on a prioritized basis throughout the Northern Kentucky region. Annually, SD1 addresses these issues by implementing a program to systematically repair and replace aging and damaged sanitary sewer infrastructure, perform capacity upgrades to the existing systems and develop plans for new systems. This information will be reviewed, reported to KDOW, and used to continue to target future water quality improvement activities within the watershed.

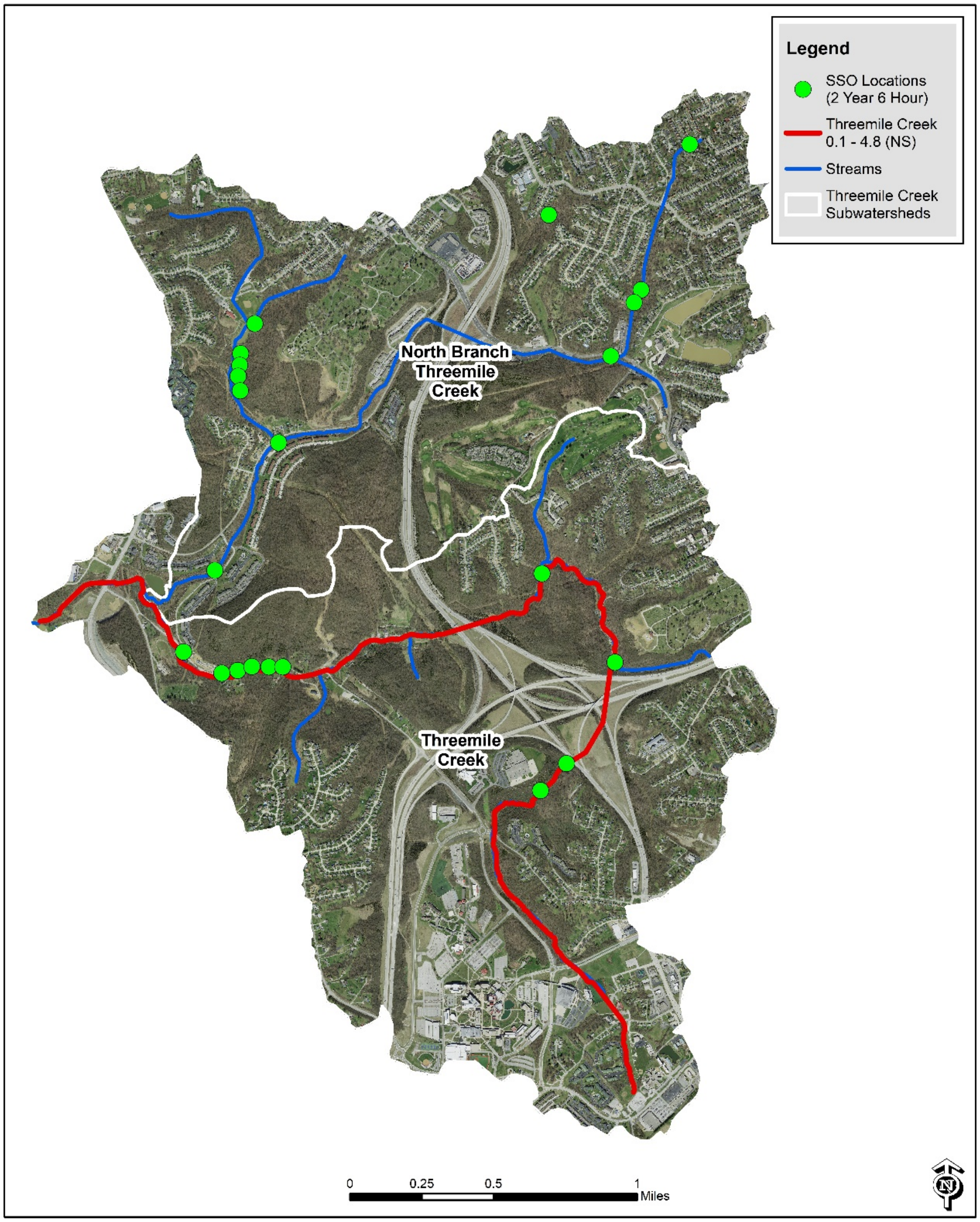

Figure 4.1 Centralized Wastewater and Locations of SSOs

4.2 Onsite Wastewater

Only 32 individual parcels within the watershed have septic systems and are not connected to the centralized sanitary sewer system (Figure 4.2). Since 1982, the Northern Kentucky Health

Department (NKHD) has reviewed and permitted septic systems for property owners in the Northern Kentucky Area.

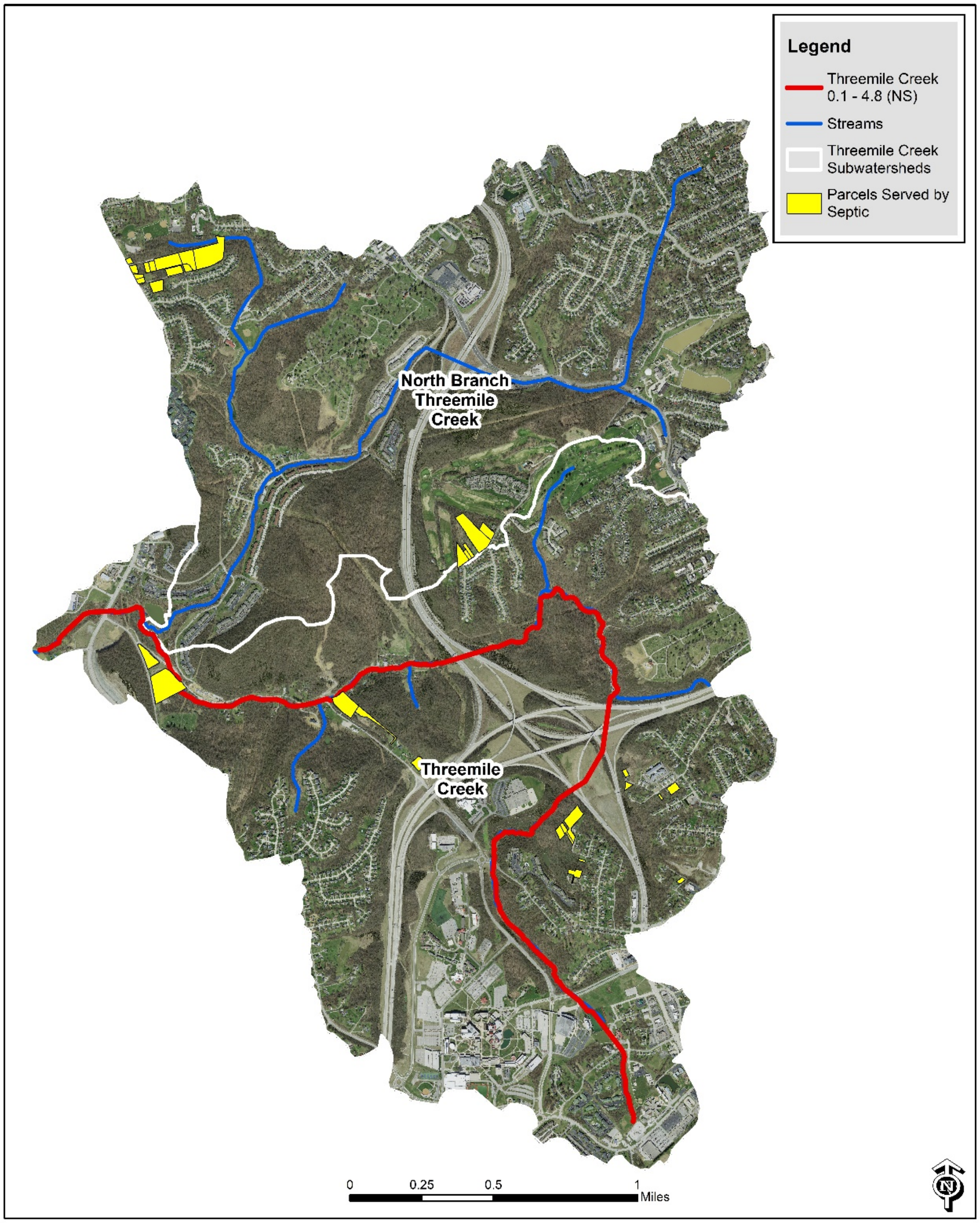

Figure 4.2 Potential Septic System Locations

NKHD also inspects existing septic systems and works with property owners to maintain and repair failing systems. Over the years, NKHD has also identified areas served by septic systems that do not have the proper conditions (soils, adequate leach field areas, etc.) to support a traditional septic system design. Currently NKHD has not identified any of these problematic areas within the watershed.

4.3 Municipal Separate Storm Sewer Systems (MS4)

The entire Threemile Creek watershed is designated as a Phase II Municipal Separate Storm Sewer System (MS4) area. SD1 manages the MS4 program in the majority of the watershed with the City of Cold Spring managing the small portion within its city boundary in the southern part of the watershed (Figure 4.3). As part of the MS4 program, SD1 and Cold Spring must implement programs to inspect storm sewer outfalls for the presence of illicit discharges.

If illicit discharges are identified, the MS4 permit requires the permittee to implement plans to identify the source and eliminate the discharge. Examples of illicit discharges related to wastewater management systems include issues such as broken laterals, illegal connections of sanitary laterals to the storm system or failing septic systems entering the storm system. All of these can be sources of *E. coli* to surrounding streams.

Through the illicit discharge investigation process, SD1 has identified 32 wastewater related discharges within the SD1 MS4 area in the watershed. Five of these were discharges to the MS4, that were eliminated through the illicit discharge enforcement process, 21 were surface discharges associated with broken laterals and addressed by SD1’s Collection Systems Department, four were surface discharges turned over to the NKHD for enforcement and two were direct discharges to streams turned over to KDOW.

It is not likely that illicit discharges are a main source of the water quality impairments in the Threemile Creek, however through the continued implementation of the Illicit Discharge and Detection and Elimination (IDDE) program, all detected and eliminated discharges will be reported and used to target future implementation and success monitoring.

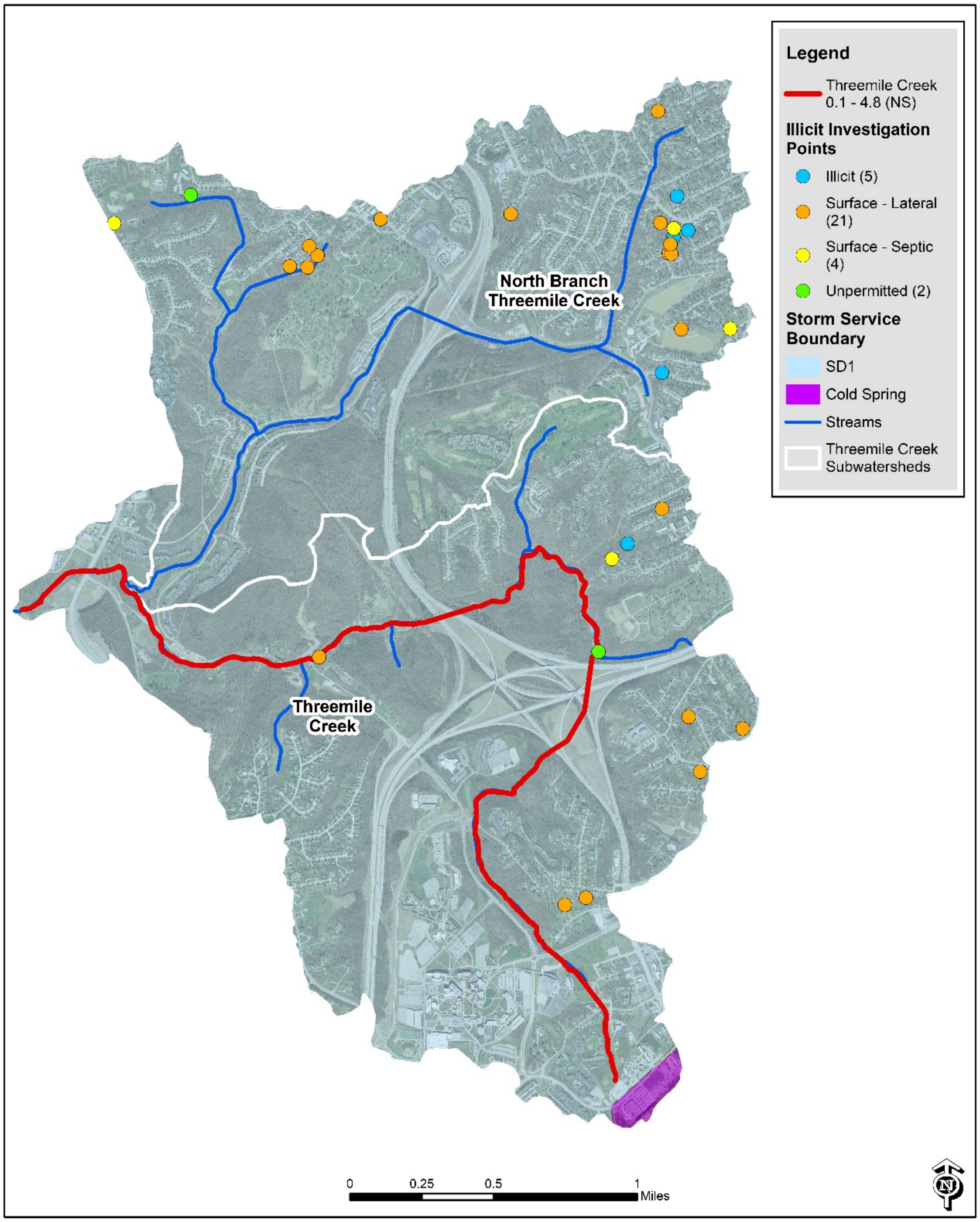

Figure 4.3 MS4 Areas and Illicit Discharge Investigations Associated with Wastewater

4.4 Agriculture

The Threemile Creek watershed is predominately developed land with areas of deciduous forest (Figure 4.4). The 2019 NLCD shows small pockets of hay and pastureland, however the Campbell County Conservation District confirmed that no active agriculture production, including livestock farming is occurring in the watershed. Based on this, agriculture is not suspected as a contributing source to the impairment.

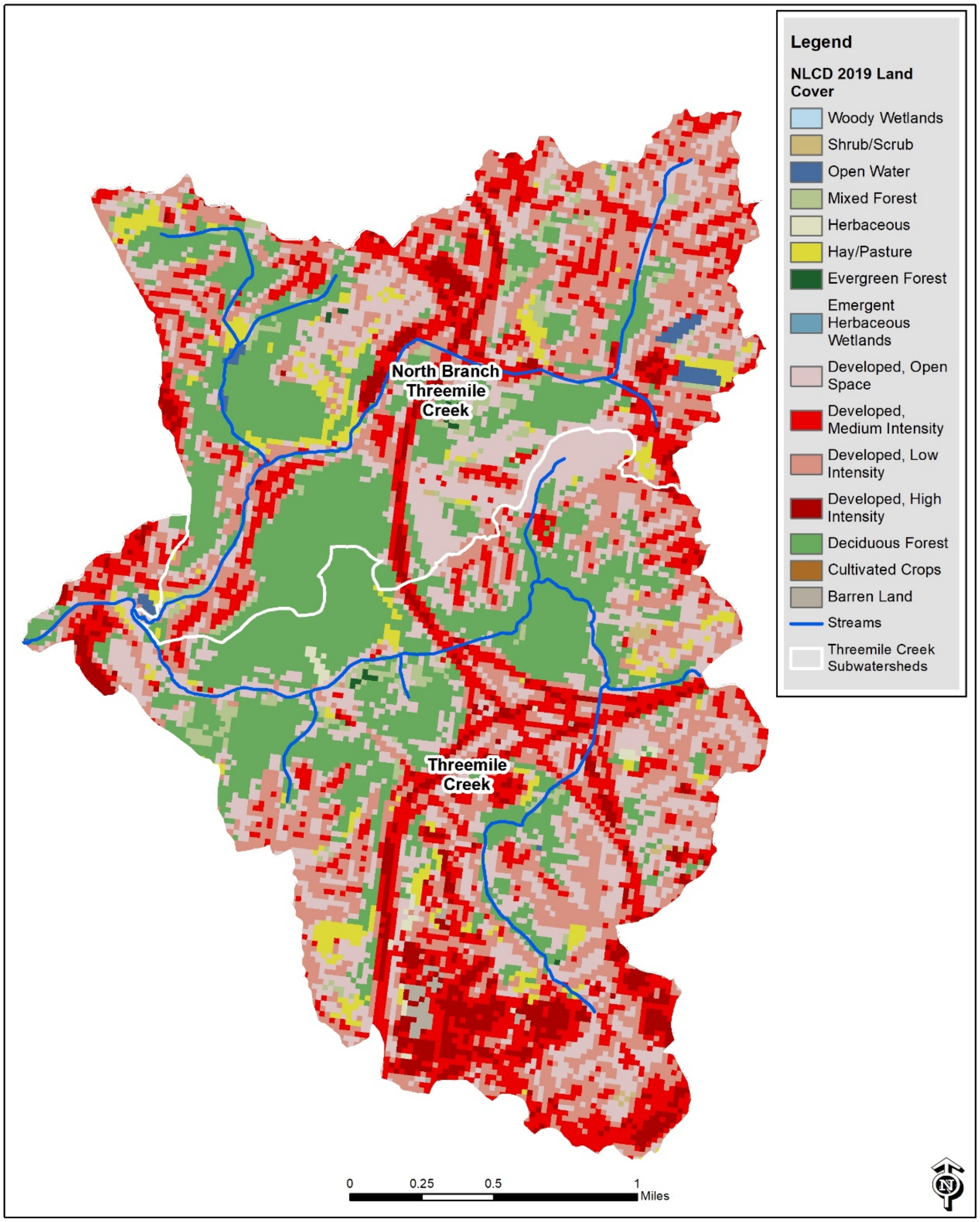

Figure 4.4 2019 National Land Cover Data in the Threemile Creek Watershed

4.5 Wildlife and Pets

With the concentration of more residential development throughout the watershed and larger tracts of woodland areas in the central portion (Figure 4.4), it's likely that pet waste and wildlife may be other contributors to the PCR impairments. Continued education about proper pet waste disposal will be helpful throughout the watershed.

5.0 Implementation to Address Sources of PCR Impairments

As outlined in Section 4.0, SSOs are likely a major source contributing to the PCR impairments. Due to this, the implementation is focused on eliminating these SSOs through the amended Northern Kentucky Consent Decree (https://www.sd1.org/DocumentCenter/View/592/Amended-Consent-Decree---2019-PDF) and the projects outlined in SD1's Updated Watershed Plan for Northern Kentucky (UWSP) (https://www.sd1.org/599/Updated-Watershed-Plan). The following is an overview of the currently proposed projects and progress to date. Figure 5.1 identifies the locations of the proposed projects and the SSOs reduced or eliminated by the improvements.

2022-2026

The Licking River Siphon (LRS) EQ tank project includes a 6.6 million gallon above ground tank near Andrews Way and Threemile Creek, to store flows in excess of the Licking River Siphon downstream. The tank is currently under construction with an expected completion date of 2023 (see Section 6.2.1.2 of the UWSP). Sewer improvements including 6,050 feet of 24-inch through 48-inch sanitary sewer upsizing are planned for completion by 2026. This conveyance upsizing will convey additional flow to the LRS EQ Tank and is sized for additional upstream improvements to be constructed by 2040 (see Section 6.2.1.2 of the UWSP). The model predicts that one SSO on the North Branch and six SSOs on the mainstem will be reduced or eliminated through these improvements (Figure 5.1).

2026-2034

Sewer improvements including 12-inch through 24-inch sanitary sewer upsizing are planned for completion by 2034. This conveyance upsizing will convey additional flow to the LRS EQ Tank (see Section 7.2.2 of the UWSP). The model predicts that four SSOs on the mainstem will be reduced or eliminated through these improvements (Figure 5.1).

2038-2040

Additional sewer improvements including 10-inch through 24-inch sanitary sewer upsizing are planned for completion by 2040. This conveyance upsizing will convey additional flow to the LRS EQ Tank (see Section 8.2.1 of the UWSP). The model predicts that eleven SSOs in the North Branch will be reduced or eliminated through these improvements (Figure 5.1).

Based on developing information, new projects may be constructed in lieu of the projects defined in the plan and summarized above, but only after approval from regulatory agencies. Updated information related to planned and constructed projects as well as updated modeling predictions will be submitted to KDOW for review.

Appendix A includes tables outlining the SSO elimination efforts as well as other proposed bacteria reduction activities recommended for each subwatershed. This includes proper pet waste disposal education, especially in public park areas. Upon completion of the projects by 2040, SD1 will eliminate typical-year SSOs to meet the requirements of Northern Kentucky's amended consent decree.

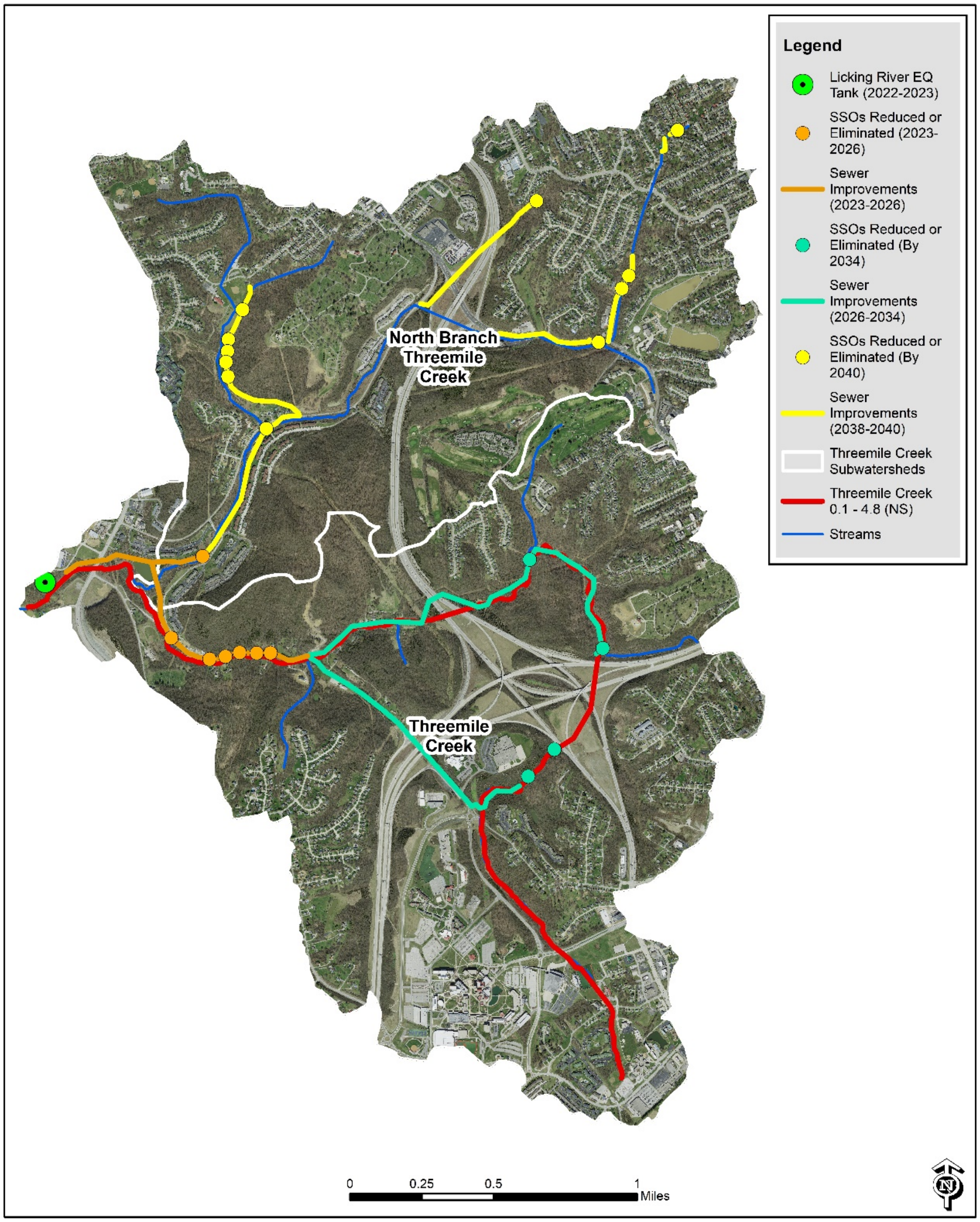

Figure 5.1 SD1's Updated Watershed Plan for Northern Kentucky - Proposed Improvements

6.0 Success Monitoring and Reporting

All activities identified in the tables for each subwatershed will be tracked annually and submitted to KDOW. As noted in section 3.2, SD1 is in the process of updating the monitoring approach within the region. As a result, all three established sites in the watershed will be sampled ten times from April through October in 2022. Beginning in 2023, Site THC 0.7 will be sampled 10 times every year. Sites NBT 0.8 and THC1.4 will be sampled 10 times every four years, with the next planned year in 2026 unless a more effective monitoring strategy is identified. Each year, SD1 will analyze and report the results of these events to KDOW. These results will serve as a screening tool for in-stream water quality improvements.

SD1 will review the results following each sample year with KDOW and periodically evaluate whether the plan is on track for achieving water quality standards. As projects are implemented and the results show a trend towards improvement, SD1 will coordinate with KDOW to determine the appropriate monitoring plan for determining attainment of water quality standards.

7.0 Appendices

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix A: Implementation Tables

Focus Subwatershed	BMP Category (Activity Description)	Action Items	Key Partners *	Potential Funding Mechanism	Proposed Implementation Timeframe
Threemile Creek	Consent Decree - SSO Elimination Projects**	1. Implementation of the Licking River EQ Tank	SD1	Sanitary Utility Budget	2022 - 2023
		2. Sewer improvements in lower watershed			2023 - 2026
		3. Sewer improvements in upper watershed			2026 - 2034
	Other Sanitary Improvements	1. Continue to implement the CMOM program in the SD1 service area	SD1	Sanitary Utility Budget	Ongoing
		2. Document all repairs, improvements and upgrades for the sanitary system within the watershed			
	IDDE Program Implementation	1. Continue to implement the MS4 IDDE programs in SD1 Storm Water Service Areas	SD1	Storm Water Utility Budget	Ongoing with MS4 permit renewals
		2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.)			
	Pet Waste Management	1. Develop educational materials and programing to inform and encourage the public to properly manage pet waste	SD1/ Campbell County - UK Cooperative Extension/ Cities and County Parks Dept.	Storm Water Utility Budget, Other Grants	2022-2025
		2. Establish pet waste disposal stations in key locations such as parks and community areas			
		4. Integrate the information into Campbell County Cooperative Extension programing			
	Incremental Improvement Monitoring	1. Collect E.coli grab samples from established sites at and additional sites (if needed) based on implementation sites	SD1	SD1	Ongoing
		2. Review results and document any improvement			
	Success Monitoring for 303(d) Delisting	1. Coordinate with KDOW to determine delisting monitoring approach	SD1	SD1	Determined by results of Incremental Improvement Monitoring
		2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP			
		3. Collect E.coli grab samples and submit data results to DOW for Integrated Report			
Delist 303(d) segment - Threemile Creek 0.1 to 4.7 for PCR					

*SD1 - Sanitation District No. 1 of Northern Kentucky

**SSO Elimination Projects are based on the projects and timeline outlined in SD1's Updated Watershed Plan for Northern Kentucky. Any future updates to the watershed plan that may impact the projects or timeline will be reported on in the annual progress report.

Appendix A: Implementation Tables (cont.)

Focus Subwatershed	BMP Category (Activity Description)	Action Items	Key Partners *	Potential Funding Mechanism	Proposed Implementation Timeframe
North Branch Threemile Creek	Consent Decree - SSO Elimination Projects**	1. Sewer improvements in the watershed	SD1	Sanitary Utility Budget	2038-2040
	Other Sanitary Improvements	1. Continue to implement the CMOM program in the SD1 service area	SD1	Sanitary Utility Budget	Ongoing
		2. Document all repairs, improvements and upgrades for the sanitary system within the watershed			
	IDDE Program Implementation	1. Continue to implement the MS4 IDDE programs in SD1 Storm Water Service Areas.	SD1	Storm Water Utility Budget	Ongoing with MS4 permit renewals
		2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.)			
	Pet Waste Management	1. Develop educational materials and programing to inform and encourage the public to properly manage pet waste	SD1/ Campbell County - UK Cooperative Extension/ Cities and County Parks Dept.	Storm Water Utility Budget, Other Grants	2022 - 2025
		2. Establish pet waste disposal stations in key locations such as parks and community areas			
		4. Integrate the information into Campbell County Cooperative Extension programing			
	Incremental Improvement Monitoring	1. Collect E.coli grab samples from established sites and additional sites (if needed) based on implementation sites	SD1	SD1	Ongoing
		2. Review results and document any improvement			

*SD1 - Sanitation District No. 1 of Northern Kentucky

**SSO Elimination Projects are based on the projects and timeline outlined in SD1's Updated Watershed Plan for Northern Kentucky. Any future updates to the watershed plan that may impact the projects or timeline will be reported on in the annual progress report.

Appendix B

BASE FLOW CHARACTERIZATION
FIELD MONITORING & SAMPLING PLAN
FOR NORTHERN KENTUCKY WATERSHEDS
PHASE 3
2016-2019

Managing Northern Kentucky's Wastewater and Storm Water • SD1

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

April 2016

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APPENDICES

1. INTRODUCTION

Sanitation District No. 1 (SD1) a clean water agency that serves over 30 communities in Campbell, Kenton, and Boone Counties, Kentucky as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sewer overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that includes Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

An initial element of the Plan is to establish baseline conditions throughout the three county area. Initial surveys were conducted in 2006 and continued through 2010. The 2006 surveys included two rounds of sampling at approximately 50 sites; where as in 2007 and 2008, the program was expanded to include 75 sites to be sampled once annually. In 2009-2010 the program was expanded to include 77 total sites. The 2011 season was a ‘catch-up’ year, with only five sites sampled. In the 2012 season, only sites within the East Basin were sampled. The 2012 sampling year marked the beginning of the Phase 2 portion of the monitoring program. Sites in the East Basin were originally sampled in 2007, and were resampled in 2012. During the 2013 season, only sites in the Central Basin were sampled and during the 2014 season, sites were sampled in the North Basin. During the 2015 sampling season the West Basin was sampled.

Beginning in 2016, sampling will be back in the East Basin and will then rotate each year to a separate basin: 2017 Central Basin, 2018 North Basin and 2019 West Basin.

The following base flow characterization *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled. Dry weather water quality sampling will be conducted to characterize current base flow stream conditions.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

1.1 Program Overview

This FMSP describes the water quality monitoring program for the base flow watershed characterization of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)
- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

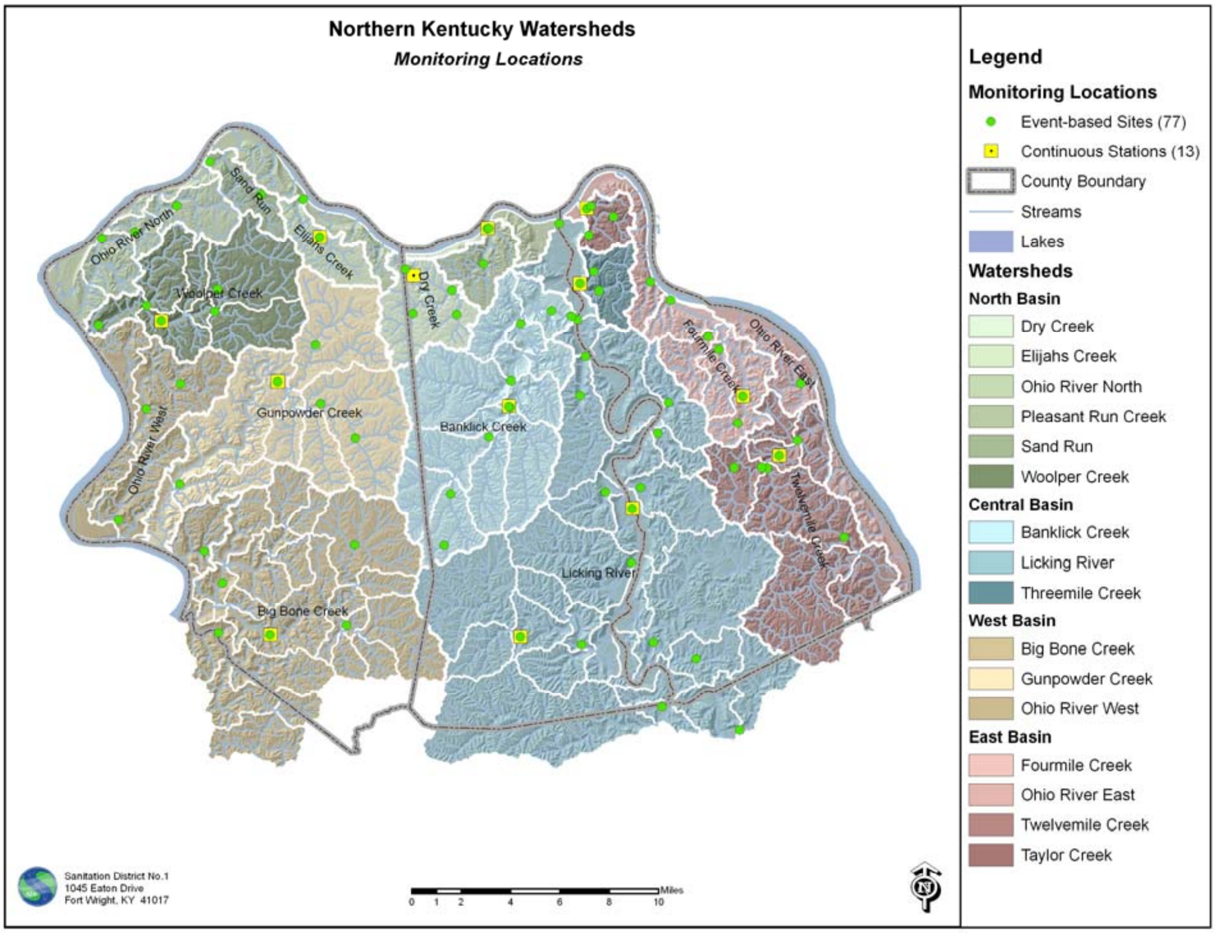
The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess base flow water quality concerns identified in Northern Kentucky watersheds. The base flow data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification. The monitoring and sampling program will be conducted during the contact recreation season May 1st – October 31st.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

Figure 1 Monitoring and Sampling Stations



1.2 Monitoring Team

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

Table 1 Team Member Responsibilities

Position	SD1 Team Member	Responsibilities
Project Manager	Mindy Scott	• Assess suitability of sampling events • Perform System Audits • Circulation of reports and results • Staff Training • Review Reporting • Ensure necessary resources are available • Creation of event reports • QA/QC review
Field Manager	Elizabeth Fet	• Implementation of FMSP • Initiate sampling events • Coordinate with laboratory • Mobilize field crews • Collection and review of field logs, lab results, and other program documentation • Ongoing management of field staff and equipment

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, pager, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

2. MONITORING AND SAMPLING CRITERIA

The objective of the base flow monitoring and sampling program is to characterize water quality during the contact recreational season under dry weather conditions by providing current background data in each watershed.

The criteria used to define a dry weather monitoring and sampling event include:

- No precipitation in the watershed 72 hours before the event; and,
- Dry weather conditions must prevail throughout the monitoring and sampling event.
- Sampling must take place during the contact recreational season beginning May 1st and ending October 31st.

One round of dry weather monitoring will be completed each year. The goal will be to conduct the sampling by basin. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during typical base flow conditions.

The dry weather criteria will serve as the minimum requirements for initiating sampling. Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular dry weather sampling event.

3. STREAM CHARACTERIZATION

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- One round of water quality monitoring will be sampled at all sites in the designated basin during base flow conditions according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

Table 2 Base Flow Sampling Locations

Station ID	Stream	Location	Study Basin
BLC0.3	Banklick	Route 177 at Banklick	Central
BLC1.2	Banklick	Route 16 bridge on Winston Avenue	Central
BLC3.9	Banklick	Eaton Drive bridge	Central
BLC8.1	Banklick	Richardson Road bridge	Central
BLC11.6	Banklick	Independence Station Road	Central
BLC15.6	Banklick	Maher Road bridge	Central
BPC0.1	Bullock Pen	Bridge on Bullock Pen Road	Central
FWC0.1	Fowler	Bridge on Marshall Road	Central
BMC0.7	Bowman	Bridge on 177, park on Conley Rd.	Central
CRC2.5	Cruises	Bridge on Hempfling Road	Central
CRC8.1	Cruises	USGS Station on Route 17 near Piner, KY	Central
DCC0.4	DeCoursey	Locust Pike Road	Central
DCC2.2	DeCoursey	Bridge on Porter Rd off Rt 177	Central
GRC0.5	Grassy	Bridge on Rt 177, just passed the Pendleton Co. line	Central
LIR0.5	Licking	5th St Bridge in Covington	Central
LIR4.9	Licking	Kenton County Water Intake	Central
LIR19.3	Licking	Visalia Bridge on Rt 536	Central
LIR35.5	Licking	Bridge @ Butler, KY	Central
PHC2.3	Phillips	Gravel pull off on side of Morningview Rd.	Central
PLC1.8	Plum	Bridge @ intersection of Hissem and Aulick Rd	Central
POC0.9	Pond	Bridge on Indian Trace @ intersection with Joann Ln	Central
RFC0.9	Riffle	Rt 915 south of Licking Valley Baptist Church	Central
SCC0.6	Scaffold	Bridge on Rifle Range Rd off Rt 915	Central
STC1.2	Steep	Bridge on Case Rd off Steep Cr. Rd	Central
THC0.4	Threemile	USGS Station on Johns Hill Rd	Central
THC0.5-NBT0.8	North Branch Threemile	Moock Rd, bridge to Woodland Hills Condos	Central
THC1.4	Threemile	Gibson Lane	Central
FMC0.5	Fourmile	Silver Grove Pump Station off Rt 8	East
FMC6.9	Fourmile	USGS Gage Station on Poplar Ridge Rd	East
FMC8.2	Fourmile	Off 547, bridge on Appleblossom Ln	East
OWC0.4	Owl	Rt 547 to Owl Creek Road	East
TUC0.4	Tug	Bridge on Darlington Road	East
TEC1.3	Tenmile	Intersection of Ten Mile and Fender Rd	East
TIC0.2	Threemile	Upstream of Highland Heights PS on Blangey Rd	East
TYC0.6	Taylor	USGS Station on Donnermeyer Dr under I-471	East
TYC1.6-UNT0.4	Taylor	Alexandria Pike in Southgate, KY	East
TYC0.9-WLC1.3	Woodlawn	Waterworks Road	East
TYC0.7-CVR0.2	Covert Run	Across from Ben Flora Gym on Tiger Lane	East
TMC1.9	Twelvemile	Bridge @ intersection of 1566 & 2921	East
TMC3.0	Twelvemile	USGS Gage Station on 1997	East
TMC3.9	Twelvemile	Bridge on Route 10	East
TMC9.3	Twelvemile	Intersection of Route 10 and California Cross Rds	East

Table 2 continued

BRC0.3	Brush	Bridge on Route 10	East
BRC2.0	Brush	Eastern Regional Water Reclamation Facility	East
DRC1.4	Dry	Bridge @ Dry Creek WWTP	North
DRC4.4	Dry	On Eubanks Rd of Anderson Rd off Buttermilk	North
DRC5.9	Dry	Bridge on Shinkle Rd in residential area	North
DRC3.0-WFD1.5	Dry	Bridge on Erlanger Rd off Houston Rd	North
EJC0.3	Elijah	Bridge on Rt 8	North
EJC2.8	Elijah	USGS gage station on Elijah Creek Rd	North
GAC1.7	Garrison	First bridge on Garrison Cr. Rd.	North
PRC0.3	Pleasant	Bridge on Oak St	North
PRC2.0	Pleasant	Bridge over Bromley Crescent Springs Rd @ Amsterdam	North
PRC0.4-UNT0.0	Pleasant	Oak Street behind the BINGO hall	North
SDR0.6	Sand	End of Rt 8, beyond end of state maintenance	North
SDR4.0	Sand	Thornwilde Subdivision	North
SEC1.6	Second	End of Second Creek Road	North
TAC0.5	Taylor	Lawrenceburg Ferry Rd	North
WPC1.4	Woolper	Bridge on Rt 20	North
WPC5.0	Woolper	USGS station on Woolper Rd	North
WPC8.8	Woolper	Bridge on Rt 338	North
ALF0.1	Allen Fork	Huffman-Clifford Bridge on Easton Lane from Rt 338	North
ASF0.0	Ashbys Fork	Intersection of Ashby & Woolper Rd	North
BBC3.9	Big Bone	Off Rt 1925 to Bender Rd	West
MLC3.0	Mud Lick	USGS Station, bridge @ US 42	West
MLC12.0	Mud Lick	Richwood pump station, on Rt 338	West
BSF1.8	Big South Fork	US 42 to bridge on South Fork Church Rd	West
MCF1.7	McCoys Fork	I-75 to Walton-Verona exit	West
GPC4.6	Gunpowder	Sullivan road; path by bus turn around	West
GPC14.7	Gunpowder	USGS gage station and SD1 pump station	West
GPC17.9	Gunpowder	Oakbrook Rd and Limaburg Rd	West
SFG2.6	South Fork Gunpowder	Woodcreek Rd bridge off Pleasant Valley	West
SFG5.3	South Fork Gunpowder	Bridge on Gunpowder Rd to Grace Fellowship Church	West
LAC1.4	Landing	Bridge on Rt 338 at inter.of Big Bone Church/Ryle Rd	West
LIC1.6	Lick	Bridge on Rt 338, near East Bend Power Plant	West
MDC1.8	Middle	Bridge on Waterloo Road	West
MDC5.5	Middle	Middle Creek Road by barn	West

3.1 On-Site Water Quality Measurements

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

3.2 Dry Weather Sampling

Most sampling locations are accessible by bridges or by wading during dry weather. A minimum of 72 hours without precipitation will be required prior to the beginning of a sampling event, and dry weather conditions must prevail throughout sampling.

Table 3 presents the monitoring schedule for the surface water sampling program for dry weather monitoring. All sampling will be performed by SD1 staff. Base flow samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples.* Dry weather sampling events will be completed by basin, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to dry weather sampling is designed to collect a representative sample of base flow conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

Table 3 Base Flow Monitoring Schedule

Study Basin	Watershed		Base flow (1 Basin/year)			
		# of Sites	2016	2017	2018	2019
Central	**Licking**	4		X		
Central	**Banklick**	8		X		
Central	**Threemile**	3		X		
Central	Bowman	1		X		
Central	Cruises	2		X		
Central	Decoursey	2		X		
Central	Grassy	1		X		
Central	Phillips	1		X		
Central	Plum	1		X		
Central	Pond	1		X		
Central	Riffle	1		X		
Central	Scaffold	1		X		
Central	Steep	1		X		
		27		**27**		
East	**Fourmile**	5	X			
East	**Twelvemile**	6	X			
East	**Taylor**	4	X			
East	Tenmile	1	X			
East	Threemile	1	X			
		17	**17**			
North	**Woolper**	5			X	
North	**Elijahs**	2			X	
North	**Dry Creek**	4			X	
North	**Pleasant Run**	3			X	
North	**Sand Run**	2			X	
North	Garrison	1			X	
North	Second	1			X	
North	Taylor	1			X	
		19			**19**	
West	**Gunpowder**	5				X
West	**Big Bone**	5				X
West	Landing	1				X
West	Lick	1				X
West	Middle	2				X
		14				**14**

3.3 Summary

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

Table 4 Summary of Water Quality Monitoring and Sampling Program

Type	Locations	Description	Parameters
Base flow Sampling	77 total locations, throughout Northern Kentucky 4 basins (North, Central, West, East)	***<u>Dry Weather</u>*** ♦ 1 basin per year ♦ 1 grab sample per site	♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.*** ♦ Water quality parameters will include: ***bacteria (EC and FC), nitrogen (TKN, NH_3, NO_3-NO_2), phosphorus (total and ortho), total suspended solids, and $CBOD_5$.***

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

Table 5 Summary of Number of Samples to be Collected

Task	East Basin	Central Basin	North Basin	West Basin
Year Sampled	2016	2017	2018	2019
No. of Events	1	1	1	1
No. of Sites	17	27	19	14
Bacteria				
E. coli	17	27	19	14
Nutrients				
NH_3	17	27	19	14
NO_3- NO_2	17	27	19	14
TKN	17	27	19	14
Total Phosphorus	17	27	19	14
Ortho Phosphate (field filtered)	17	27	19	14
Solids				
TSS	17	27	19	14
Other				
$CBOD_5$	17	27	19	14
Total Sample Load	**136**	**216**	**152**	**112**
QA/QC Samples are not included.				

4. *FIELD MEASUREMENTS*

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

Table 6. Field Measurements

Parameter	Location of Measurement	Method
Temperature	Mid-channel, mid-depth where possible	Hydrolab
Conductivity		
pH		
Dissolved Oxygen		
Turbidity		

5. SAMPLING HANDLING AND CUSTODY

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

5.1 Sample Labeling

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

5.2 Sampling Collection, Handling and Transport

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4^o C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

5.3 Chain-of-Custody

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

5.4 Field Logs and Records

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

In addition, the recreational use survey form (also provided in Appendix A) will be completed at each site and submitted to the Field Manager at the conclusion of each monitored event. The recreational use survey should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Photo file name and corresponding description;
- Description of recreational uses observed at the site; and,
- Description of other human evidence of use.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

5.5 Sample Containers and Preservation

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

Table 7 Guidelines for Sample Container Preparation and Preservation

Parameter	Container	Recommended Sample Volume	Preservation	Maximum Storage Time
Bacteria				
E. coli	Pre-Sterilized Polyethylene or Glass	120 ml	Add $Na_2S_2O_7$ [1] Refrigerate to 4°C	12 hours[2]
Nutrients				
NH_3 TKN NO_3-NO_2 Total Phosphorus	Polyethylene or Glass	1000 ml	Add H_2SO_4, pH<2 Refrigerate to 4°C	28 days
Ortho Phosphate	Polyethylene or Glass	120 ml	Field filter Refrigerate to 4°C	48 hours
Conventional				
TSS	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	7 days
$CBOD_5$	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	48 hours

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

6. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

6.1 Training

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive

training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

6.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

6.3 Equipment Cleaning Protocol

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

6.4 QA/QC Samples

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

Table 8 QA/QC Sample Schedule

Crew	**Dry Weather / Base Flow Sampling**			
	East Basin	Central Basin	North Basin	West Basin
Day 1	BEB*,Dup, FB, MB, AEB*	BEB*, Dup, FB, MB, AEB*	BEB*, Dup, FB, MB, AEB*	BEB*, Dup, FB, MB, AEB*
Day 2	BEB*, FB, MB, AEB*	BEB*, FB, MB, AEB*	BEB*, FB, MB, AEB*	BEB*, FB, MB, AEB*
Day 3		BEB*, FB, MB, AEB*		

BEB = Before Equipment Blank MB= Method Blank Dup = Duplicate

AEB = After Equipment Blank FB = Field Blank * = As needed

Table 9 Number of QA/QC Samples

Base Flow Sampling	Field Blanks[2]	Equipment Blanks[3]	Method Blanks[4]	Duplicate Samples[5]	Total per Event
Day 1	1	6	1	1	18
Day 2	1	4	1	0	8
Day 3			1	0	
Totals	**6**	**10**	**6**	**4**	**26**

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the event.
3. Two sets of equipment blanks (BEB, AEB) per day will be collected during each day of the event only if a bucket was used during sampling.
4. One set of method blanks (at one site) per day will be collected during each day of the event.
5. One set of duplicates (at one site) will be collected during each sampling event.

6.4.1 *Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

6.4.2 *Equipment Blanks*

Equipment blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to assess potential cross-contamination of samples by the equipment, including intermediate sample containers. These blanks will be taken before each sampling shift (BEB) and at the conclusion of each sampling shift (AEB) by each crew.

6.4.3 *Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

6.4.4 *Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

6.5 Equipment Calibration

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter’s precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter’s performance during the sampling event.

7. PROGRAM SAFETY

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

7.1 General Safety Practices

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.
- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

7.2 Health Hazards

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING

Standard Operating Procedures

for the

Collection of Discrete Water Samples

Northern Kentucky Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017

Revision Number: 1
September 2006

Introduction

This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand (BOD_5 , $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Blank Water Rinse

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – Sample Collection

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
    a) If using a sample bottle, place in the cooler.
    b) If using a transfer bottle, discard when finished.

3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

Step 2 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

  a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
  b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
  c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Weak Acid (Optional)

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Stainless Steel Bucket

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Sampling Pole

- The method for this device does not require a blank.

Kemmerer Bottle

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Unpreserved Parameters Utilizing the Glove Method

Introduction

This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

1.0 Field Equipment

The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

Attachment 2
Collection of Orthophosphate Samples

Introduction

This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment

The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures

A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures

The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures

Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

Fill the syringe filtration unit with sample from the appropriate collection device.
Place the plunger into the syringe.
Purge a small amount of sample volume through the filter.
Discharge water through the filtration unit into a sample bottle.
Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
Discard the syringe filtration unit.

3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

Standard Operating Procedures

for

Hydrolab Series 5
Water Quality Instrumentation

Sanitation District No. 1 of Northern Kentucky
1045 Eaton Drive
Fort Wright, KY 41017
(859) 578-7460

Revision Number: 1
August 2006

Introduction

This document contains information and directions on using Hydrolab water quality instrumentation (DS5 Water Quality Multiprobe and Surveyor® 4a Water Quality Data Display). This standard operating procedures document (SOP) has been developed to maintain properly functioning equipment, and to ensure the quality of the data collected.

1.0.0 Instrumentation Maintenance

The following procedures are to be utilized to maintain the Hydrolab instrumentation.

1.1.0 DS5 Multiprobe

The outside housing of the sonde should be kept free of sediments, bio-films, oils, etc. by cleaning with soap and water. The storage cup must be installed (filled with tap water) at all times when the unit is not in use to protect the sensors from damage and from drying out. Refer to section 6.1.1 of the *DS5 User's Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 5.1.2 of the *DS5 User's Manual*. The DS5 contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

1.1.1 Temperature Sensor

The temperature sensor should be kept clean from deposits, otherwise it does not require any scheduled maintenance. Refer to section 6.9 of the *DS5 User's Manual*.

1.1.2 Luminescent Dissolved Oxygen (LDO) Sensor

LDO sensor is not affected by fouling or other debris, unless the growth is an organism that locally consumes or produces oxygen, such as barnacles, or algae growing on the sensor cap. Nevertheless, the manufacturer recommends periodic maintenance to remove contaminates such as oil, biological growth, dirt, etc. Sensor maintenance should be conducted after every deployment cycle. Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*. Yearly maintenance of the sensor should include the replacement of the sensor cap.

1.1.3 pH Sensor

The pH reference electrolyte and porous reference junction should be replaced at least twice a year. Refer to section 6.8 of the *DS5 User's Manual* for these procedures. The pH glass electrode can be generally cleaned with a cotton ball/"Q" tip using mild detergent and water; while a cotton ball/"Q" tip with methanol can be used to remove any oil, sediment or biological growth on the glass, as needed. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in tap water before it is calibrated, especially if methanol has been used. If the 12-hour re-equilibrate period cannot be met, record the estimated re-equilibrate time in the Comments section of the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet and note if stable "instream" readings are achievable before calibration.

1.1.4 Conductivity Sensor

The annular rings inside the slot in the sensor housing of the conductivity sensor should be cleaned with a small bottle brush using a mild detergent and water, as needed. Methanol and a cotton swab should be used to remove any films or deposits on the electrodes. Refer to section 6.6 of the *DS5 User's Manual* for these procedures.

1.1.5 Self –Cleaning Turbidity Sensor

The self-cleaning turbidity sensor offers higher accuracy turbidity measurements and a wiper mechanism to reduce the effects of fouling. An internal motor automatically wipes the optical face at the start of every measurement. Turbidity sensor maintenance is required when any of the optical surfaces have a coating, or when a zero check using Hach StablCal <0.1 reads>0.9 NTU. Refer to the Instruction Sheet – **Self-Cleaning Turbidity Sensor** in the *DS5 User's Manual*. During unattended deployment, the turbidity wiper should be replaced every 3 months, or as needed (a gap should not be present between the wiper and the lens after reattachment).

1.1.6 Depth Sensor

The depth sensor generally does not need maintenance. If deposits (calcium, biological growth, etc.) begin forming in the port rinse with a very weak acid, such as acetic. Refer to the Sensor Specific Instruction Sheet of the *DS5 User's Manual*.

1.1.7 Circulator

The circulator is used during deployment to ensure adequate flow across the sensors for reliable readings. Refer to section 6.1.3 of the *DS5 User's Manual*.

1.1.8 Internal Battery Power

The DS5 contains an optional internal battery pack that is installed during manufacturing that consists of 8 "C" alkaline batteries that provide 12 volts when fully charged. When the battery pack becomes exhausted (below 6.4 volts) the batteries should be replaced in order for the logger to continue unattended monitoring. Refer to section 6.2 of the *DS5 User's Manual* for replacement procedures. The DS5 also contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

1.2.0 Surveyor® 4a Data Display

The data display should be protected from mechanical shock and excessive vibrations. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 3.1 of the *Surveyor 4 User's Manual* for maintenance and cleaning procedures.

1.2.1 Surveyor® 4a Internal Battery Power

The Surveyor 4a contains an internal 7.2-volt rechargeable nickel metal hydride battery. The battery power is exhausted at 6.5 volts and should be recharged for approximately 3.5 hours to ensure a full charge. The Surveyor 4a also contains an internal lithium system battery that is good for approximately two years. Refer to section 3.1 of the *Surveyor 4 User's Manual* for charging and replacement procedures.

1.2.2 Internal Barometer

The barometric pressure sensor does not require any scheduled maintenance. The sensor should be calibrated every six months and checked monthly with an accurate mercury barometer or the barometric pressure provided by the local weather service, corrected to site altitude. Refer to appendix 3 of the *Surveyor 4 User's Manual*.

1.3.0 External Rechargeable Battery Pack

The external rechargeable battery pack provides 12 volts when fully charged. The battery pack is exhausted below 9 volts and should be recharged for 12 hours to ensure a full charge. To prevent "charge memory", recharge the battery pack only when the battery power is exhausted. Refer to section 3.3 of the *DS5 User's Manual*.

1.4.0 Cables

Cables should be kept clean and protected from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (such as a bridge railing). Connections that plug into terminals are not waterproof and should be kept dry at all times. When cables are not in use, be sure to insert all dummy plugs and dust caps to protect the electrical connectors. Refer to section 6.3.2 of the *DS5 User's Manual*.

1.5.0 Flow Cell

The pressure in the flow cell should not exceed 15psi. Refer to section 5.2.5 of the *DS5 User's Manual*.

2.0.0 Instrumentation Setup

Communication to the *DS5* for setup or calibration can be established via the *Surveyor 4a* or a computer using Hydras 3LT software. The following settings should be configured for normal operation.

2.1.0 Parameter Display

For routine monitoring the following parameter display should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Date/Time Format – MDY/HMS
- Temperature – Celsius
- LDO – mg/L
- LDO – Percent Saturation
- pH – units
- Specific Conductance – μS/cm
- Turbidity – NTU
- Depth25 – Feet
- Battery – Choose appropriate display (internal vs. external and/or volts vs. % remaining)
- Radix – Decimal Point
- Interval – 000001

2.2.0 Parameter Setup

For routine monitoring, the following sensor setup should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Specific Conductance – mS/cm, Fresh Water Temperature Compensation, Autorange
- Salinity – ppt, Method 2311

2.2.1 Using the Surveyor for Parameter Setup

Refer to section 4.1.1 of the *DS5 User's Manual.*

2.2.2 Using Hydras 3 LT for Parameter Setup

Refer to section 4.1.2 of the *DS5 User's Manual.*

2.2.0 System Setup

For routine monitoring the following system setup should be utilized. Refer to *DS5 User's Manual* for additional information.

- Circulator – On during use, Off during calibration
- Audio – Off during normal profiling use, On during logging runs
- Terminal Baud Rate – 19200
- Autolog – Off during normal profiling use, On during logging runs

2.3.0 SDI-12 Setup

For SDI-12 communications with an external data logger the following setup should be utilized. Refer to **Appendix B External Communications** of the *DS5 User's Manual.*

- SDI Address – 1
- SDI Delay – 120 (Note: multiprobe has 5 second built in delay, thus actual delay = 125)

3.0.0 Instrumentation Calibration

Refer to section 4.2 of the *DS5 Users Manual* for sensor calibration procedures. The multiprobe and the standards must be at thermal equilibrium before the calibration procedures are performed. If a stand is used to hold the sonde during calibration, secure the sonde only around the end caps, **never** around the housing. Use either distilled or deionized water as rinse water during the calibration procedures. The multiprobe should be calibrated and post checked after each use to track any electronic drift. Record all calibration information on the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet – Attachment A.

3.1.0 Procedures

Multiprobe calibration is performed using the stated procedures for each parameter as described. If calibration fails, refer to the appropriate section under Multiprobe Maintenance, Section 6.1 of the *DS5 User's Manual.* After performing the recommended maintenance, reattempt the calibration procedure.

The multiprobe sensor accuracy for each parameter (utilizing certified standards) is stated as follows:

LDO: ± 0.1 mg/L (0 - 8 mg/L)
± 0.2 mg/L (>8 mg/L)
pH: ± 0.2 units

Conductivity: ± 1% of reading (± 10 µS/cm for a 1000 standard)
Turbidity: ± 1 % (0 - 100 NTUs)
± 5 % (400 – 3,000 NTUs)

3.2.0 Temperature

The temperature sensor is factory-set and does not require further calibration. Refer to section 4.2.4 of the *DS5 User's Manual*. The accuracy of the sensor is ± 0.1°C.

3.3.0 Luminescent Dissolved Oxygen (LDO)

There are three standard methods for calibrating the LDO sensor. Each method requires a single point calibration for measurement of concentration in mg/l. In order to calibrate the sensor for percent saturation reading, the local barometric pressure (corrected to local altitude above sea level) must be determined independently by the user and input into the software during calibration. Once calibrated, the sensor reading is verified to an oxygen solubility calculation as a QA/QC check. Refer to the Sanitation District No.1 Multiprobe Instrumentation Dissolved Oxygen Calibration Technical Sheet (Attachment B) for the elevation correction factors and the oxygen solubility calculation. In order to retain calibration accuracy between multiple deployments, store with sensor fully immersed in water at all times. Calibration will be completed by using of Method 1 – **Air Saturated Water.** Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual.*

3.4.0 pH

Refer to section 4.2.8 of the *DS5 User's Manual* for pH calibration procedures. Since in-stream pH levels are generally above 7.0, the pH sensor is calibrated using a standard of 10.0 to determine the slope. If levels below 7.0 are expected, calibrate using a standard of 4.0 to determine the slope.

3.5.0 Conductivity

Refer to section 4.2.5 of the *DS5 User's Manual* for specific conductance calibration procedures. Since in-stream conductivity concentrations are generally below 1000µS/cm the specific conductance sensor is calibrated using a standard of 1000µS/cm to determine the slope. If lower concentrations are expected, calibrate using a standard of 500µS/cm to determine the slope.

3.6.0 Turbidity

Refer to the Instruction Sheet – **Self-Cleaning Turbidity** Sensor in the *DS5 User's Manual* for turbidity calibration procedures. Since in-stream turbidity readings can be highly variable the turbidity sensor is calibrated using a standard of 800 NTUs to determine the slope. If the sensor fails to properly calibrate, reset the sensor.

3.7.0 Depth

Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* for depth calibration procedures. The depth sensor is zeroed in air at the monitoring site to account for the current barometric pressure.

3.8.0 Time

Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* to enter the correct time (HHMMSS) and date (MMDDYY).

3.9.0 Quality Assurance/Quality Control

The following procedures are to be utilized to preserve and maintain QA/QC for the calibration of the Hydrolab instrumentation.

3.9.1 QA Standards

Calibration standards may be reused between calibration periods by employing procedures that prevent contamination. Only the quantity of standard used during the actual sensor calibration is saved for reuse. The quantity of standard used for the sensor rinse should always be discarded. Refer to the appropriate calibration section for each sensor in the *DS5 User's Manual.* Standard that is retained for reuse is kept in clean polyethylene bottles with Teflon sealed caps. Used standard is never remixed with the certified standard in the original container. Fresh or "certified" standard is continually added to the polyethylene bottles during the calibration steps to replenish the quantity used for the sensor rinses.

The standards original container is identified with date received and date opened using a permanent marker. Standards that have exceeded the manufacturer's expiration date are discarded.

3.9.2 QC Calibration Sheets

Calibration sheets are retained as quality control records and are reviewed to address individual multiprobe/sensor issues that may arise, such as electronic "drift".

4.0.0 Data Logging Setup & Data Retrieval

Refer to Section 4.3.3.1 & 4.3.3.2 of the *DS5 User's Manual* for logging and data retrieval.

4.1.0 Logging Setup

Before the DS5 is setup for an unattended logging run, check the logging status in regards to available memory and remove any nonessential files, if needed. In addition, make sure the status of the audio, circulator, and enabled parameters are correct before the logging run is setup. Enable Autolog if desired.

Make sure the DS5 is correctly deployed before the logging run begins.

4.2.0 Retrieval

Once the DS5 has been retrieved from an unattended logging run, check the logging status in regards to the created log file. The log file should be transferred from the DS5 as soon as practicable (refer to Section 4.3.3.2 of the *DS5 User's Manual*). Transfer the log file from the DS5 to a computer in spreadsheet importable form by utilizing the Hydras 3LT software (when specifying a file name for the transfer, save the log file with a .csv extension, this will allow the log file to be directly opened in Microsoft Excel).

5.0.0 Attended Profiling

The DS5 can be utilized for discrete profiling at different stream depths or equipped with a flow cell for continuous profiling (e.x. surface profiling on a boat utilizing a pitot tube) or pumping.

5.1.0 Quality Assurance

- The unit should be recalibrated after each use to assess sensor drift.
- The unit should be cleaned periodically to maintain sensor performance.

6.0.0 Unattended Deployment

The DS5 can be positioned upright (probes pointing down) or horizontally for deployment. Avoid placing the unit in areas of swift currents, areas that might receive deep deposits of sediment during periods of heavy rainfall, or areas where potential vandalism may occur. Attempt to use any available protection that a site may provide (e.x. attach to downstream of bridge piling to protect from floating debris).

6.1.0 Temporary/Portable Installations

PVC piping can be utilized as a protective capsule to house the multiprobe at unsecured locations.

6.1.1 Specifications

- Cut 4” diameter PVC pipe to the desired length (approximately 3’) to create protective sleeve.
- Drill approximately 1” diameter holes throughout the sleeve to allow adequate water flow through the capsule.
- Drill approximately 3/4” diameter holes throughout the top of the end caps.
- Glue one end cap to the bottom of the sleeve.
- Place the other end cap on the open end of the sleeve and drill 5/8” hole through the end cap and the sleeve.
- Place a ½” bolt through the end cap and the sleeve and secure with two nuts.

6.1.2 Deployment

- Wrap the DS5 with duct insulation (keeping away from the probes).
- Place the DS5 into the PVC capsule (probes pointing down).
- Place the top end cap on the PVC capsule and align the 5/8” holes.
- Suspend the DS5 inside of the PVC capsule with the ½” bolt passing through the capsule and the DS5 bail.
- Secure the PVC capsule to an appropriate structure with heavy-duty cables and locks.

6.1.3 Quality Assurance

- The unit should be cleaned and recalibrated at least once a week depending on water quality conditions (i.e. solids loading and biological growth – bio-films).
    - Download the logging file and check the battery status.
    - Clean and recalibrate the sensors.
    - Setup the next logging file.
- Use portable unit to check permanent station readings before and after calibration.
- Use portable unit to check temporary station readings (logged data) between calibration schedules to assess sensor drift.

7.0.0 References

Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes, User Manual. February 2006 Edition 3. Hach Company.

Surveyor® 4 Water Quality Data Display, User’s Manual. Revision D. Hydrolab Corporation. April 1999.

Hydras 3 LT Quick Start, Software Manual. December 2005 Edition 2. Hach Company.

Attachment A: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION CALIBRATION & QA SHEET

Instrument Model ____________________
Serial Number ____________________
Date ____________ Analyst(s) ____________
Instrument I.D. ____________________
Site Location ____________________
Note ____________________

CALIBRATION READINGS

1) Dissolved Oxygen (DO)

Elevation (ft) ⇒ Correction Factor ________
Uncorrected BP Conversion (mmHg) ________
Temperature (°C) ________
Probe DO Reading (mg/L) ________
Percent Saturation ________
O_2 Solubility Calculation (mg/L) ________
Comments: Air Saturated Water

2) Conductivity

Standard (µS/cm)	Reading	Adjusted

Comments: Specific Conductance

3) pH

Buffer	Reading	Adjusted
4.00		
7.00		
10.00		

Comments: ________

4) Turbidity

Standard (NTU)	Reading	Adjusted

Comments: ________

POST CHECK READINGS

1) Dissolved Oxygen (DO)

Elevation (ft) ⇒ Correction Factor ________
Uncorrected BP Conversion (mmHg) ________
Temperature (°C) ________
Probe DO Reading (mg/L) ________
Percent Saturation ________
O_2 Solubility Calculation (mg/L) ________
Comments: ________

2) Conductivity

Standard (µS/cm)	Reading

Comments: Specific Conductance

3) pH

Buffer	Reading
4.00	
7.00	
10.00	

Comments: ________

4) Turbidity

Standard (NTU)	Reading

Comments: ________

NOTE: Do NOT make adjustments during Post Check. Simply record values observed.

Attachment B: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

Pressure Conversions

1. Inches to Metric Conversion
   1in = 25.4mm
   Example: 30.15in * (25.4mm/1in) = 765.8mm

2. Corrected to Uncorrected Pressure Conversion
   Obtain the corrected pressure from the National Weather Service.
   Corrected Pressure - (2.5 * (Elevation/100)) = Uncorrected Pressure
   Example: 765.8mm - (2.5 * (455/100)) = 754.4mm

Table 1: Barometric pressure correction factors for selected monitoring sites.

Stream	Site	Gage Datum	Correction
Banklick Creek	KY Route 1829	540.3	13.5
Cruises Creek	KY Route 17	656.9	16.4
Elijahs Creek	Elijahs Creek Road	759.1	19.0
Four Mile Creek	Popular Ridge Road	535.2	13.4
Gunpowder Creek	Camp Ernest Road	683.1	17.1
Mud Lick Creek	KY Route 14	487.7	12.2
Twelve Mile Creek	KY Route 1997	505.9	12.6
Woolper Creek	Woolper Road	490.7	12.3
Note: Gage Datum = feet above mean sea level Note: Correction = mm Hg			

Table 2: Barometric pressure correction factors for selected sites.

Stream	Site	Elevation	Correction
Ohio River	Markland Normal Pool	455	11.4
Licking River	12th Street	460	11.5
District Office	Prep Room	505	12.6
Note: Elevation = approximate feet above mean sea level Note: Correction = mm Hg			

SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

Oxygen Solubility Calculation

To verify the probe DO reading, utilize the following steps.

1. Determine the DO solubility of the standard's temperature at 760mm

   Example: Stable Temperature = 20.7°C
   From Table 2 -- 20.7°C at 760mm = 8.96mg/L

2. Determine the DO solubility of the standard's temperature at the current pressure

   Example: 20.7°C, 754.4mm Hg
   DOsol(760mm Hg) * Current Pressure / 760mm Hg
   = DOsol(Current Pressure)
   8.96 * (754.4/760) = 8.89mg/L

Table 2: Solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity (EAWAG 1973). Units = mg/L

(°C)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	14.60	14.56	14.52	14.48	14.44	14.40	14.36	14.33	14.29	14.25
1	14.21	14.17	14.13	14.09	14.05	14.02	13.98	13.94	13.90	13.87
2	13.83	13.79	13.75	13.72	13.68	13.64	13.61	13.57	13.54	13.50
3	13.46	13.43	13.39	13.36	13.32	13.29	13.25	13.22	13.18	13.15
4	13.11	13.08	13.04	13.01	12.98	12.94	12.91	12.88	12.84	12.81
5	12.78	12.74	12.71	12.68	12.64	12.61	12.58	12.55	12.52	12.48
6	12.45	12.42	12.39	12.36	12.33	12.29	12.26	12.23	12.20	12.17
7	12.14	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.90	11.87
8	11.84	11.81	11.78	11.76	11.73	11.70	11.67	11.64	11.61	11.58
9	11.56	11.53	11.50	11.47	11.44	11.42	11.39	11.36	11.34	11.31
10	11.28	11.25	11.23	11.20	11.17	11.15	11.12	11.10	11.07	11.04
11	11.02	10.99	10.97	10.94	10.91	10.89	10.86	10.84	10.81	10.79
12	10.76	10.74	10.72	10.69	10.67	10.64	10.62	10.59	10.57	10.55
13	10.52	10.50	10.47	10.45	10.43	10.40	10.38	10.36	10.34	10.31
14	10.29	10.27	10.24	10.22	10.20	10.18	10.15	10.13	10.11	10.09
15	10.07	10.04	10.02	10.00	9.98	9.96	9.94	9.92	9.89	9.87
16	9.85	9.83	9.81	9.79	9.77	9.75	9.73	9.71	9.69	9.67
17	9.65	9.63	9.61	9.59	9.57	9.55	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.36	9.34	9.32	9.30	9.28
19	9.26	9.24	9.23	9.21	9.19	9.17	9.15	9.13	9.12	9.10
20	9.08	9.06	9.05	9.03	9.01	8.99	8.98	8.96	8.94	8.92
21	8.91	8.89	8.87	8.86	8.84	8.82	8.81	8.79	8.77	8.76
22	8.74	8.72	8.71	8.69	8.67	8.66	8.64	8.63	8.61	8.59
23	8.58	8.56	8.55	8.53	8.51	8.50	8.48	8.47	8.45	8.44
24	8.42	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.30	8.29
25	8.27	8.26	8.24	8.23	8.21	8.20	8.18	8.17	8.16	8.14
26	8.13	8.11	8.10	8.08	8.07	8.06	8.04	8.03	8.01	8.00
27	7.99	7.97	7.96	7.94	7.93	7.92	7.90	7.89	7.88	7.86
28	7.85	7.84	7.82	7.81	7.80	7.78	7.77	7.76	7.74	7.73
29	7.72	7.70	7.69	7.68	7.66	7.65	7.64	7.63	7.61	7.60
30	7.59	7.57	7.56	7.55	7.54	7.52	7.51	7.50	7.49	7.47

APPENDIX B

NORTHERN KY SANITATION DISTRICT NO.1
CHAIN OF CUSTODY

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

Chain Of Custody Record

Page ______ of ______

Managing Northern Kentucky's Wastewater and Storm Water
SD1

Project Name	**Watershed**	**Survey Location**

Contact Person	**Sampler(s) Signature**	**Survey Type (Circle One)** Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli	TSS	CBOD5	TP, N-N, TKN, NH3	Orthophosphate					

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

APPENDIX C

NORTHERN KY SANITATION DISTRICT NO.1
FIELD DATA SHEET

SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: ______________________ DATE: ______________________

SITE / STREAM NAME: ______________________ START TIME: ______________________

SITE LOCATION: ______________________ END TIME: ______________________

LABORATORY: ______________________ SAMPLERS: ______________________

EQUIPMENT ID: MULTIPROBE SONDE: ______________________

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT WATER

CIRCLE ONE

STREAM CONDITIONS: ______________________

SITE CONDITIONS: ______________________

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW AIR TEMP (F): __________

(CIRCLE APPROPRIATE CONDITIONS)

PROJECT DESCRIPTOR: ______________________

SITE / SAMPLE ID (BANK & DEPTH)	TEMP. (C)	pH	D.O. (mg/L)	SP. COND. (µS/cm)	TURBIDITY (NTU)	FLOW	SAMPLE TIME

FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

Appendix C

BIWEEKLY SAMPLING
FIELD MONITORING & SAMPLING PLAN
FOR NORTHERN KENTUCKY WATERSHEDS
2015-2017

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

2015

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APPENDICES

1. INTRODUCTION

Sanitation District No. 1 (SD1), a clean water agency that serves over 30 communities in Campbell, Kenton and Boone Counties, Kentucky, as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sanitary overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that identifies Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

SD1 initiated a comprehensive watershed wide monitoring program in 2006 that involved the collection of in-stream water quality data in each of the sixteen watersheds in Northern Kentucky to characterize background conditions in the region. These sixteen watersheds represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as “exceptional” waters by the State, while other watersheds are more highly developed and are identified as “impaired” by the State. As a result of the vast differences between these watersheds, SD1 has implemented a biweekly sampling program over a two year period to further characterize stream conditions under a wide range of environmental conditions at 20 locations throughout Northern Kentucky.

The following biweekly sampling *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

1.1 Program Overview

This FMSP describes the water quality monitoring program for the biweekly sampling of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)

- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

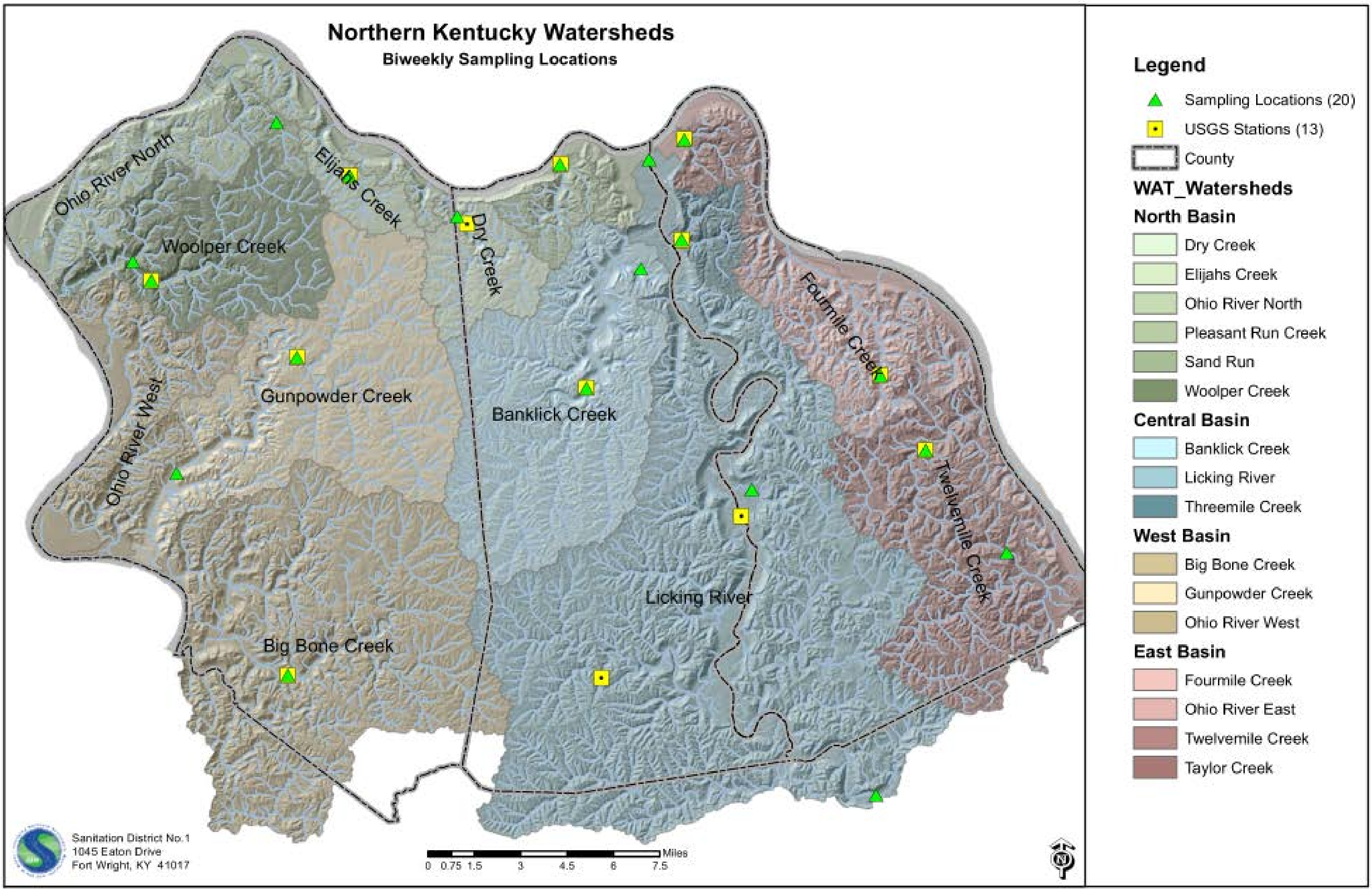
The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess variation of water quality concerns identified in Northern Kentucky watersheds. The biweekly data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification. The monitoring and sampling program will be conducted from July 2015 - November 2015, April 2016 – November 2016, and April 2017 – June 2017.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

Figure 1 Monitoring and Sampling Stations



1.2 Monitoring Team

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

Table 1 Team Member Responsibilities

Position	**SD1 Team Member**	**Responsibilities**
Project Manager	Mindy Scott	• Assess suitability of sampling events • Perform System Audits • Circulation of reports and results • Staff Training • Review Reporting • Ensure necessary resources are available • Creation of event reports • QA/QC review
Field Manager	Elizabeth Fet	• Implementation of FMSP • Initiate sampling events • Coordinate with laboratory • Mobilize field crews • Collection and review of field logs, lab results, and other program documentation • Ongoing management of field staff and equipment

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

2. MONITORING AND SAMPLING CRITERIA

The objective of the biweekly monitoring and sampling program is to represent varying conditions with respect to the amount of development, as well as sources of stream pollution in each watershed. SD1 is implementing this program over a two year period to further characterize stream conditions under a wide range of environmental conditions.

The criteria used to define the biweekly weekly sampling include:

- Once sampling starts, it will occur every two weeks
- Weather conditions will vary, but sampling will be conducted unless deemed unsafe

The goal will be to conduct the sampling in varying weather conditions. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during fluctuating flow conditions.

Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular biweekly sampling event.

3. STREAM CHARACTERIZATION

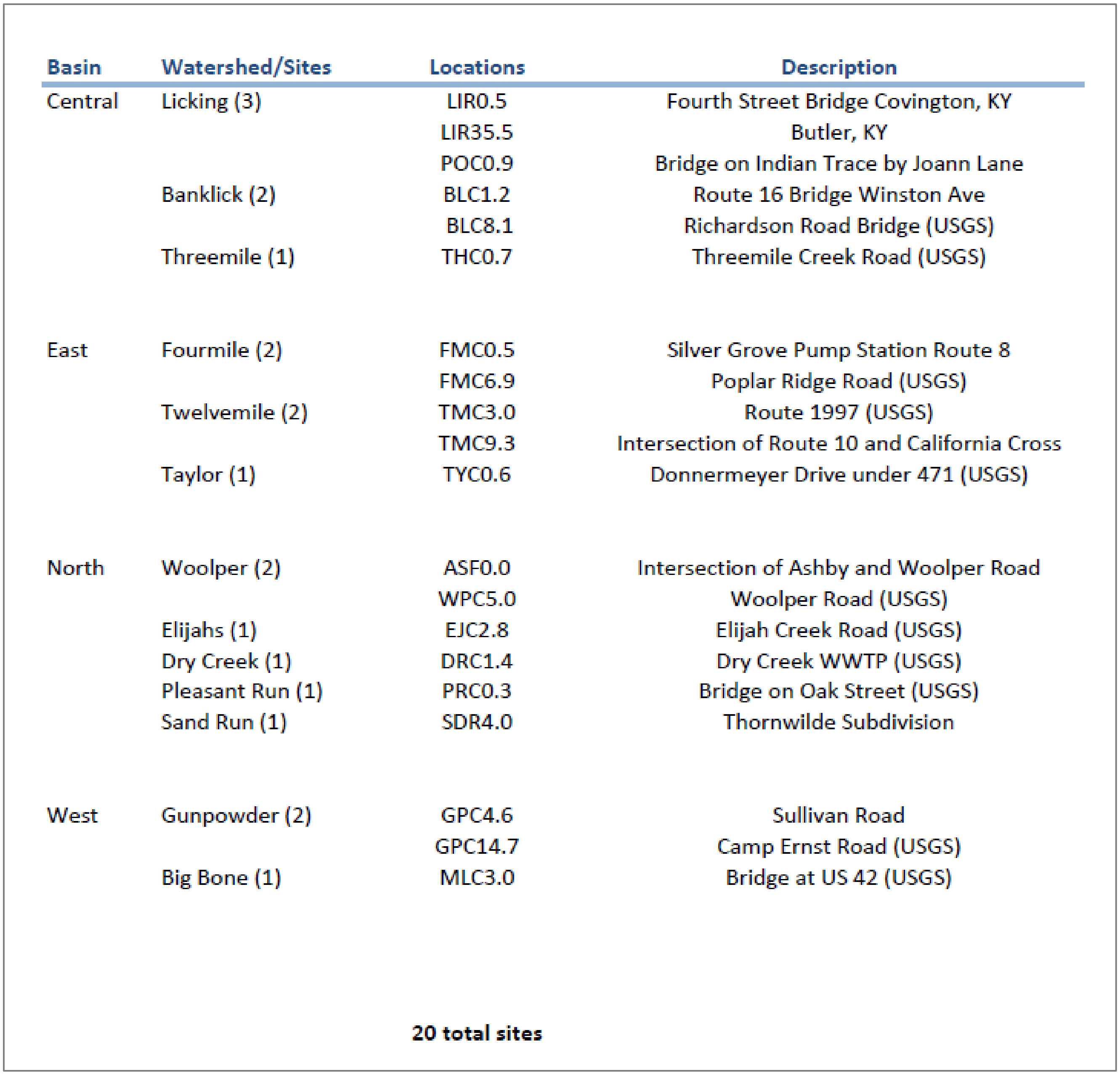
Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- Samples will be collected at all sites on the designated day every other week according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

Table 2 Biweekly Monitoring Locations



Basin	Watershed/Sites	Locations	Description
Central	Licking (3)	LIR0.5	Fourth Street Bridge Covington, KY
		LIR35.5	Butler, KY
		POC0.9	Bridge on Indian Trace by Joann Lane
	Banklick (2)	BLC1.2	Route 16 Bridge Winston Ave
		BLC8.1	Richardson Road Bridge (USGS)
	Threemile (1)	THC0.7	Threemile Creek Road (USGS)
East	Fourmile (2)	FMC0.5	Silver Grove Pump Station Route 8
		FMC6.9	Poplar Ridge Road (USGS)
	Twelvemile (2)	TMC3.0	Route 1997 (USGS)
		TMC9.3	Intersection of Route 10 and California Cross
	Taylor (1)	TYC0.6	Donnermeyer Drive under 471 (USGS)
North	Woolper (2)	ASF0.0	Intersection of Ashby and Woolper Road
		WPC5.0	Woolper Road (USGS)
	Elijahs (1)	EJC2.8	Elijah Creek Road (USGS)
	Dry Creek (1)	DRC1.4	Dry Creek WWTP (USGS)
	Pleasant Run (1)	PRC0.3	Bridge on Oak Street (USGS)
	Sand Run (1)	SDR4.0	Thornwilde Subdivision
West	Gunpowder (2)	GPC4.6	Sullivan Road
		GPC14.7	Camp Ernst Road (USGS)
	Big Bone (1)	MLC3.0	Bridge at US 42 (USGS)
		20 total sites	

3.1 On-Site Water Quality Measurements

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

3.2 Biweekly Sampling

Most sampling locations are accessible by bridges or by wading. Table 3 presents the monitoring schedule for the surface water sampling program for biweekly sampling. All sampling will be performed by SD1 staff. Biweekly samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples.* Biweekly sampling events will be completed by day, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to biweekly sampling is designed to collect a representative sample of current conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

Table 3   Biweekly Monitoring Schedule

Day One

Watershed	Site	Description
Big Bone	MLC3.0	Bridge at US 42 (USGS)
Gunpowder	GPC4.6	Sullivan Road
	GPC14.7	Camp Ernst Road (USGS)
Woolper	WPC5.0	Woolper Road (USGS)
	ASF0.0	Intersection of Ashby and Woolper Road
Elijahs	EJC2.8	Elijah Creek Road (USGS)
Sand Run	SDR4.0	Thornwilde Subdivision

Day Two

Watershed	Site	Description
Licking River	POC0.9	Bridge on Indian Trace by Joann Lane
	LIR35.5	Butler, KY
Twelvemile	TMC9.3	Intersection of Route 10 and California Crossroads
	TMC3.0	Route 1997 (USGS)
Fourmile	FMC6.9	Poplar Ridge Road (USGS)
	FMC0.5	Silver Grove Pump Station Route 8

Day Three

Watershed	Site	Description
Banklick	BLC8.1	Richardson Road Bridge
	BLC1.2	Route 16 Bridge Winston Avenue
Threemile	THC0.7	Threemile Creek Road (USGS)
Taylor	TYC0.6	Donnermeyer Drive under 471 (USGS)
Licking	LIR0.5	Fourth Street Bridge
Pleasant Run	PRC0.3	Bridge on Oak Street
Dry Creek	DRC1.4	Dry Creek WWTP (USGS)

3.3 Summary

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

Table 4 Summary of Water Quality Monitoring and Sampling Program

Type	Locations	Description	Parameters
Biweekly Sampling	20 total locations, throughout Northern Kentucky 4 basins (North, Central, West, East)	♦ Samples collected every two weeks at the same locations ♦ 1 grab sample per site	♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.*** ♦ Water quality parameters will include: ***bacteria (EC), nitrogen (TKN, NH_3, NO_3-NO_2), phosphorus (total and ortho), total suspended solids, and $CBOD_5$.***

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

Table 5 Summary of Number of Samples to be Collected

Task	Day One	Day Two	Day Three
Day Sampled	Tuesday	Wednesday	Thursday
No. of Events per week	1	1	1
No. of Sites	7	6	7
Bacteria			
E. coli	7	6	7
Nutrients			
NH_3	7	6	7
NO_3- NO_2	7	6	7
TKN	7	6	7
Total Phosphorus	7	6	7
Ortho Phosphate (field filtered)	7	6	7
Solids			
TSS	7	6	7
Other			
$CBOD_5$	7	6	7
Total Sample Load	**56**	**48**	**56**

4. FIELD MEASUREMENTS

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

Table 6. Field Measurements

Parameter	Location of Measurement	Method
Temperature	Mid-channel, mid-depth where possible	Hydrolab
Conductivity		
pH		
Dissolved Oxygen		
Turbidity		

5. SAMPLING HANDLING AND CUSTODY

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

5.1 Sample Labeling

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

5.2 Sampling Collection, Handling and Transport

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4^{o} C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

5.3 Chain-of-Custody

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

5.4 Field Logs and Records

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

5.5 Sample Containers and Preservation

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

Table 7 Guidelines for Sample Container Preparation and Preservation

Parameter	Container	Recommended Sample Volume	Preservation	Maximum Storage Time
Bacteria				
E. coli	Pre-Sterilized Polyethylene or Glass	120 ml	Add $Na_2S_2O_7$ [1] Refrigerate to 4°C	12 hours[2]
Nutrients				
NH_3 TKN NO_3-NO_2 Total Phosphorus	Polyethylene or Glass	1000 ml	Add H_2SO_4, pH<2 Refrigerate to 4°C	28 days
Ortho Phosphate	Polyethylene or Glass	120 ml	Field filter Refrigerate to 4°C	48 hours
Conventional				
TSS	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	7 days
$CBOD_5$	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	48 hours

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

6. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

6.1 Training

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

6.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

6.3 Equipment Cleaning Protocol

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

6.4 QA/QC Samples

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

Table 8 QA/QC Sample Schedule

Biweekly Sampling			
Day	Tuesday	Wednesday	Thursday
	Dup*, FB, MB	Dup*, FB, MB	BEB, Dup, FB, MB, AEB

BEB = Before Equipment Blank MB= Method Blank Dup = Duplicate

AEB = After Equipment Blank FB = Field Blank * = Dup will rotate between days

Table 9 Number of QA/QC Samples

Base Flow Sampling	**Field Blanks[2]**	**Equipment Blanks[3]**	**Method Blanks[4]**	**Duplicate Samples[5]**	**Total per Event**
Day 1	1	0	1	1	3
Day 2	1	0	1	0	2
Day 3	1	2	1	0	4
Totals	**3**	**2**	**3**	**1**	**9**

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the week.
3. Two sets of equipment blanks (BEB, AEB) per day will be collected during each day of the event only if a bucket was used during sampling (Thursday).
4. One set of method blanks (at one site) per day will be collected during each day of the event.
5. One set of duplicates (at one site) will be collected during each week.

6.4.1 *Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

6.4.2 *Equipment Blanks*

Equipment blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to assess potential cross-contamination of samples by the equipment, including intermediate sample containers. These blanks will be taken before each sampling shift (BEB) and at the conclusion of each sampling shift (AEB) by each crew.

6.4.3 Method Blanks

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

6.4.4 Field Blanks

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

6.5 Equipment Calibration

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter's precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter's performance during the sampling event.

7. PROGRAM SAFETY

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

7.1 General Safety Practices

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.
- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

7.2 Health Hazards

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING

Standard Operating Procedures

for the

Collection of Discrete Water Samples

Northern Kentucky Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017

Revision Number: 1
September 2006

Introduction

This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand (BOD_5 , $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Blank Water Rinse

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – Sample Collection

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
  - a) If using a sample bottle, place in the cooler.
  - b) If using a transfer bottle, discard when finished.

3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

Step 2 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

    a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
    b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
    c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Weak Acid (Optional)

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Stainless Steel Bucket

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Sampling Pole

- The method for this device does not require a blank.

Kemmerer Bottle

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Unpreserved Parameters Utilizing the Glove Method

Introduction

This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

1.0 Field Equipment

The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

Attachment 2
Collection of Orthophosphate Samples

Introduction

This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment

The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures

A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures

The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures

Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

Fill the syringe filtration unit with sample from the appropriate collection device.
Place the plunger into the syringe.
Purge a small amount of sample volume through the filter.
Discharge water through the filtration unit into a sample bottle.
Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
Discard the syringe filtration unit.

3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

Standard Operating Procedures

for

Hydrolab Series 5
Water Quality Instrumentation

Sanitation District No. 1 of Northern Kentucky
1045 Eaton Drive
Fort Wright, KY 41017
(859) 578-7460

Revision Number: 1
August 2006

Introduction

This document contains information and directions on using Hydrolab water quality instrumentation (DS5 Water Quality Multiprobe and Surveyor® 4a Water Quality Data Display). This standard operating procedures document (SOP) has been developed to maintain properly functioning equipment, and to ensure the quality of the data collected.

1.0.0 Instrumentation Maintenance

The following procedures are to be utilized to maintain the Hydrolab instrumentation.

1.1.0 DS5 Multiprobe

The outside housing of the sonde should be kept free of sediments, bio-films, oils, etc. by cleaning with soap and water. The storage cup must be installed (filled with tap water) at all times when the unit is not in use to protect the sensors from damage and from drying out. Refer to section 6.1.1 of the *DS5 User's Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 5.1.2 of the *DS5 User's Manual*. The DS5 contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

1.1.1 Temperature Sensor

The temperature sensor should be kept clean from deposits, otherwise it does not require any scheduled maintenance. Refer to section 6.9 of the *DS5 User's Manual*.

1.1.2 Luminescent Dissolved Oxygen (LDO) Sensor

LDO sensor is not affected by fouling or other debris, unless the growth is an organism that locally consumes or produces oxygen, such as barnacles, or algae growing on the sensor cap. Nevertheless, the manufacturer recommends periodic maintenance to remove contaminates such as oil, biological growth, dirt, etc. Sensor maintenance should be conducted after every deployment cycle. Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*. Yearly maintenance of the sensor should include the replacement of the sensor cap.

1.1.3 pH Sensor

The pH reference electrolyte and porous reference junction should be replaced at least twice a year. Refer to section 6.8 of the *DS5 User's Manual* for these procedures. The pH glass electrode can be generally cleaned with a cotton ball/"Q" tip using mild detergent and water; while a cotton ball/"Q" tip with methanol can be used to remove any oil, sediment or biological growth on the glass, as needed. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in tap water before it is calibrated, especially if methanol has been used. If the 12-hour re-equilibrate period cannot be met, record the estimated re-equilibrate time in the Comments section of the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet and note if stable "instream" readings are achievable before calibration.

1.1.4 Conductivity Sensor

The annular rings inside the slot in the sensor housing of the conductivity sensor should be cleaned with a small bottle brush using a mild detergent and water, as needed. Methanol and a cotton swab should be used to remove any films or deposits on the electrodes. Refer to section 6.6 of the *DS5 User's Manual* for these procedures.

1.1.5 Self –Cleaning Turbidity Sensor

The self-cleaning turbidity sensor offers higher accuracy turbidity measurements and a wiper mechanism to reduce the effects of fouling. An internal motor automatically wipes the optical face at the start of every measurement. Turbidity sensor maintenance is required when any of the optical surfaces have a coating, or when a zero check using Hach StablCal <0.1 reads>0.9 NTU. Refer to the Instruction Sheet – **Self-Cleaning Turbidity Sensor** in the *DS5 User's Manual*. During unattended deployment, the turbidity wiper should be replaced every 3 months, or as needed (a gap should not be present between the wiper and the lens after reattachment).

1.1.6 Depth Sensor

The depth sensor generally does not need maintenance. If deposits (calcium, biological growth, etc.) begin forming in the port rinse with a very weak acid, such as acetic. Refer to the Sensor Specific Instruction Sheet of the *DS5 User's Manual*.

1.1.7 Circulator

The circulator is used during deployment to ensure adequate flow across the sensors for reliable readings. Refer to section 6.1.3 of the *DS5 User's Manual*.

1.1.8 Internal Battery Power

The DS5 contains an optional internal battery pack that is installed during manufacturing that consists of 8 "C" alkaline batteries that provide 12 volts when fully charged. When the battery pack becomes exhausted (below 6.4 volts) the batteries should be replaced in order for the logger to continue unattended monitoring. Refer to section 6.2 of the *DS5 User's Manual* for replacement procedures. The DS5 also contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

1.2.0 Surveyor® 4a Data Display

The data display should be protected from mechanical shock and excessive vibrations. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 3.1 of the *Surveyor 4 User's Manual* for maintenance and cleaning procedures.

1.2.1 Surveyor® 4a Internal Battery Power

The Surveyor 4a contains an internal 7.2-volt rechargeable nickel metal hydride battery. The battery power is exhausted at 6.5 volts and should be recharged for approximately 3.5 hours to ensure a full charge. The Surveyor 4a also contains an internal lithium system battery that is good for approximately two years. Refer to section 3.1 of the *Surveyor 4 User's Manual* for charging and replacement procedures.

1.2.2 Internal Barometer

The barometric pressure sensor does not require any scheduled maintenance. The sensor should be calibrated every six months and checked monthly with an accurate mercury barometer or the barometric pressure provided by the local weather service, corrected to site altitude. Refer to appendix 3 of the *Surveyor 4 User's Manual*.

1.3.0 External Rechargeable Battery Pack

The external rechargeable battery pack provides 12 volts when fully charged. The battery pack is exhausted below 9 volts and should be recharged for 12 hours to ensure a full charge. To prevent "charge memory", recharge the battery pack only when the battery power is exhausted. Refer to section 3.3 of the *DS5 User's Manual*.

1.4.0 Cables

Cables should be kept clean and protected from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (such as a bridge railing). Connections that plug into terminals are not waterproof and should be kept dry at all times. When cables are not in use, be sure to insert all dummy plugs and dust caps to protect the electrical connectors. Refer to section 6.3.2 of the *DS5 User's Manual*.

1.5.0 Flow Cell

The pressure in the flow cell should not exceed 15psi. Refer to section 5.2.5 of the *DS5 User's Manual*.

2.0.0 Instrumentation Setup

Communication to the *DS5* for setup or calibration can be established via the *Surveyor 4a* or a computer using Hydras 3LT software. The following settings should be configured for normal operation.

2.1.0 Parameter Display

For routine monitoring the following parameter display should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Date/Time Format – MDY/HMS
- Temperature – Celsius
- LDO – mg/L
- LDO – Percent Saturation
- pH – units
- Specific Conductance – µS/cm
- Turbidity – NTU
- Depth25 – Feet
- Battery – Choose appropriate display (internal vs. external and/or volts vs. % remaining)
- Radix – Decimal Point
- Interval – 000001

2.2.0 Parameter Setup

For routine monitoring, the following sensor setup should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Specific Conductance – mS/cm, Fresh Water Temperature Compensation, Autorange
- Salinity – ppt, Method 2311

2.2.1 Using the Surveyor for Parameter Setup

Refer to section 4.1.1 of the *DS5 User's Manual.*

2.2.2 Using Hydras 3 LT for Parameter Setup

Refer to section 4.1.2 of the *DS5 User's Manual.*

2.2.0 System Setup

For routine monitoring the following system setup should be utilized. Refer to *DS5 User's Manual* for additional information.

- Circulator – On during use, Off during calibration
- Audio – Off during normal profiling use, On during logging runs
- Terminal Baud Rate – 19200
- Autolog – Off during normal profiling use, On during logging runs

2.3.0 SDI-12 Setup

For SDI-12 communications with an external data logger the following setup should be utilized. Refer to **Appendix B External Communications** of the *DS5 User's Manual.*

- SDI Address – 1
- SDI Delay – 120 (Note: multiprobe has 5 second built in delay, thus actual delay = 125)

3.0.0 Instrumentation Calibration

Refer to section 4.2 of the *DS5 Users Manual* for sensor calibration procedures. The multiprobe and the standards must be at thermal equilibrium before the calibration procedures are performed. If a stand is used to hold the sonde during calibration, secure the sonde only around the end caps, **never** around the housing. Use either distilled or deionized water as rinse water during the calibration procedures. The multiprobe should be calibrated and post checked after each use to track any electronic drift. Record all calibration information on the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet – Attachment A.

3.1.0 Procedures

Multiprobe calibration is performed using the stated procedures for each parameter as described. If calibration fails, refer to the appropriate section under Multiprobe Maintenance, Section 6.1 of the *DS5 User's Manual.* After performing the recommended maintenance, reattempt the calibration procedure.

The multiprobe sensor accuracy for each parameter (utilizing certified standards) is stated as follows:

LDO: ± 0.1 mg/L (0 - 8 mg/L)
± 0.2 mg/L (>8 mg/L)
pH: ± 0.2 units

Conductivity: ± 1% of reading (± 10 μS/cm for a 1000 standard)
Turbidity: ± 1 % (0 - 100 NTUs)
± 5 % (400 – 3,000 NTUs)

3.2.0 Temperature

The temperature sensor is factory-set and does not require further calibration. Refer to section 4.2.4 of the *DS5 User's Manual*. The accuracy of the sensor is ± 0.1°C.

3.3.0 Luminescent Dissolved Oxygen (LDO)

There are three standard methods for calibrating the LDO sensor. Each method requires a single point calibration for measurement of concentration in mg/l. In order to calibrate the sensor for percent saturation reading, the local barometric pressure (corrected to local altitude above sea level) must be determined independently by the user and input into the software during calibration. Once calibrated, the sensor reading is verified to an oxygen solubility calculation as a QA/QC check. Refer to the Sanitation District No.1 Multiprobe Instrumentation Dissolved Oxygen Calibration Technical Sheet (Attachment B) for the elevation correction factors and the oxygen solubility calculation. In order to retain calibration accuracy between multiple deployments, store with sensor fully immersed in water at all times. Calibration will be completed by using of Method 1 – **Air Saturated Water.** Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual.*

3.4.0 pH

Refer to section 4.2.8 of the *DS5 User's Manual* for pH calibration procedures. Since in-stream pH levels are generally above 7.0, the pH sensor is calibrated using a standard of 10.0 to determine the slope. If levels below 7.0 are expected, calibrate using a standard of 4.0 to determine the slope.

3.5.0 Conductivity

Refer to section 4.2.5 of the *DS5 User's Manual* for specific conductance calibration procedures. Since in-stream conductivity concentrations are generally below 1000μS/cm the specific conductance sensor is calibrated using a standard of 1000μS/cm to determine the slope. If lower concentrations are expected, calibrate using a standard of 500μS/cm to determine the slope.

3.6.0 Turbidity

Refer to the Instruction Sheet – **Self-Cleaning Turbidity** Sensor in the *DS5 User's Manual* for turbidity calibration procedures. Since in-stream turbidity readings can be highly variable the turbidity sensor is calibrated using a standard of 800 NTUs to determine the slope. If the sensor fails to properly calibrate, reset the sensor.

3.7.0 Depth

Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* for depth calibration procedures. The depth sensor is zeroed in air at the monitoring site to account for the current barometric pressure.

3.8.0 Time

Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* to enter the correct time (HHMMSS) and date (MMDDYY).

3.9.0 Quality Assurance/Quality Control

The following procedures are to be utilized to preserve and maintain QA/QC for the calibration of the Hydrolab instrumentation.

3.9.1 QA Standards

Calibration standards may be reused between calibration periods by employing procedures that prevent contamination. Only the quantity of standard used during the actual sensor calibration is saved for reuse. The quantity of standard used for the sensor rinse should always be discarded. Refer to the appropriate calibration section for each sensor in the *DS5 User's Manual.* Standard that is retained for reuse is kept in clean polyethylene bottles with Teflon sealed caps. Used standard is never remixed with the certified standard in the original container. Fresh or "certified" standard is continually added to the polyethylene bottles during the calibration steps to replenish the quantity used for the sensor rinses.

The standards original container is identified with date received and date opened using a permanent marker. Standards that have exceeded the manufacturer's expiration date are discarded.

3.9.2 QC Calibration Sheets

Calibration sheets are retained as quality control records and are reviewed to address individual multiprobe/sensor issues that may arise, such as electronic "drift".

4.0.0 Data Logging Setup & Data Retrieval

Refer to Section 4.3.3.1 & 4.3.3.2 of the *DS5 User's Manual* for logging and data retrieval.

4.1.0 Logging Setup

Before the DS5 is setup for an unattended logging run, check the logging status in regards to available memory and remove any nonessential files, if needed. In addition, make sure the status of the audio, circulator, and enabled parameters are correct before the logging run is setup. Enable Autolog if desired.

Make sure the DS5 is correctly deployed before the logging run begins.

4.2.0 Retrieval

Once the DS5 has been retrieved from an unattended logging run, check the logging status in regards to the created log file. The log file should be transferred from the DS5 as soon as practicable (refer to Section 4.3.3.2 of the *DS5 User's Manual*). Transfer the log file from the DS5 to a computer in spreadsheet importable form by utilizing the Hydras 3LT software (when specifying a file name for the transfer, save the log file with a .csv extension, this will allow the log file to be directly opened in Microsoft Excel).

5.0.0 Attended Profiling

The DS5 can be utilized for discrete profiling at different stream depths or equipped with a flow cell for continuous profiling (e.x. surface profiling on a boat utilizing a pitot tube) or pumping.

5.1.0 Quality Assurance

- The unit should be recalibrated after each use to assess sensor drift.
- The unit should be cleaned periodically to maintain sensor performance.

6.0.0 Unattended Deployment

The DS5 can be positioned upright (probes pointing down) or horizontally for deployment. Avoid placing the unit in areas of swift currents, areas that might receive deep deposits of sediment during periods of heavy rainfall, or areas where potential vandalism may occur. Attempt to use any available protection that a site may provide (e.x. attach to downstream of bridge piling to protect from floating debris).

6.1.0 Temporary/Portable Installations

PVC piping can be utilized as a protective capsule to house the multiprobe at unsecured locations.

6.1.1 Specifications

- Cut 4” diameter PVC pipe to the desired length (approximately 3’) to create protective sleeve.
- Drill approximately 1” diameter holes throughout the sleeve to allow adequate water flow through the capsule.
- Drill approximately 3/4” diameter holes throughout the top of the end caps.
- Glue one end cap to the bottom of the sleeve.
- Place the other end cap on the open end of the sleeve and drill 5/8” hole through the end cap and the sleeve.
- Place a ½” bolt through the end cap and the sleeve and secure with two nuts.

6.1.2 Deployment

- Wrap the DS5 with duct insulation (keeping away from the probes).
- Place the DS5 into the PVC capsule (probes pointing down).
- Place the top end cap on the PVC capsule and align the 5/8” holes.
- Suspend the DS5 inside of the PVC capsule with the ½” bolt passing through the capsule and the DS5 bail.
- Secure the PVC capsule to an appropriate structure with heavy-duty cables and locks.

6.1.3 Quality Assurance

- The unit should be cleaned and recalibrated at least once a week depending on water quality conditions (i.e. solids loading and biological growth – bio-films).
  - Download the logging file and check the battery status.
  - Clean and recalibrate the sensors.
  - Setup the next logging file.
- Use portable unit to check permanent station readings before and after calibration.
- Use portable unit to check temporary station readings (logged data) between calibration schedules to assess sensor drift.

7.0.0 References

Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes, User Manual. February 2006 Edition 3. Hach Company.

Surveyor® 4 Water Quality Data Display, User’s Manual. Revision D. Hydrolab Corporation. April 1999.

Hydras 3 LT Quick Start, Software Manual. December 2005 Edition 2. Hach Company.

Attachment A: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION CALIBRATION & QA SHEET

Instrument Model ____________________ Serial Number ____________________
Date __________ Analyst(s) __________ Instrument I.D. ____________________
Site Location ____________________ Note ____________________

CALIBRATION READINGS

1) Dissolved Oxygen (DO)

Elevation (ft) ⇒ Correction Factor __________
Uncorrected BP Conversion (mmHg) __________
Temperature (°C) __________
Probe DO Reading (mg/L) __________
Percent Saturation __________
O_2 Solubility Calculation (mg/L) __________
Comments: Air Saturated Water

2) Conductivity

Standard (µS/cm)	Reading	Adjusted

Comments: Specific Conductance

3) pH

Buffer	Reading	Adjusted
4.00		
7.00		
10.00		

Comments: __________

4) Turbidity

Standard (NTU)	Reading	Adjusted

Comments: __________

POST CHECK READINGS

1) Dissolved Oxygen (DO)

Elevation (ft) ⇒ Correction Factor __________
Uncorrected BP Conversion (mmHg) __________
Temperature (°C) __________
Probe DO Reading (mg/L) __________
Percent Saturation __________
O_2 Solubility Calculation (mg/L) __________
Comments: __________

2) Conductivity

Standard (µS/cm)	Reading

Comments: Specific Conductance

3) pH

Buffer	Reading
4.00	
7.00	
10.00	

Comments: __________

4) Turbidity

Standard (NTU)	Reading

Comments: __________

NOTE: Do NOT make adjustments during Post Check. Simply record values observed.

Attachment B: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

Pressure Conversions

1. Inches to Metric Conversion

   1in = 25.4mm

   Example: 30.15in * (25.4mm/1in) = 765.8mm

2. Corrected to Uncorrected Pressure Conversion

   Obtain the corrected pressure from the National Weather Service.

   Corrected Pressure - (2.5 * (Elevation/100)) = Uncorrected Pressure

   Example: 765.8mm - (2.5 * (455/100)) = 754.4mm

Table 1: Barometric pressure correction factors for selected monitoring sites.

Stream	Site	Gage Datum	Correction
Banklick Creek	KY Route 1829	540.3	13.5
Cruises Creek	KY Route 17	656.9	16.4
Elijahs Creek	Elijahs Creek Road	759.1	19.0
Four Mile Creek	Popular Ridge Road	535.2	13.4
Gunpowder Creek	Camp Ernest Road	683.1	17.1
Mud Lick Creek	KY Route 14	487.7	12.2
Twelve Mile Creek	KY Route 1997	505.9	12.6
Woolper Creek	Woolper Road	490.7	12.3

Note: Gage Datum = feet above mean sea level
Note: Correction = mm Hg

Table 2: Barometric pressure correction factors for selected sites.

Stream	Site	Elevation	Correction
Ohio River	Markland Normal Pool	455	11.4
Licking River	12th Street	460	11.5
District Office	Prep Room	505	12.6

Note: Elevation = approximate feet above mean sea level
Note: Correction = mm Hg

SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION
DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

Oxygen Solubility Calculation

To verify the probe DO reading, utilize the following steps.

1. Determine the DO solubility of the standard's temperature at 760mm
   Example: Stable Temperature = 20.7°C
   From Table 2 -- 20.7°C at 760mm = 8.96mg/L

2. Determine the DO solubility of the standard's temperature at the current pressure
   Example: 20.7°C, 754.4mm Hg
   DOsol(760mm Hg) * Current Pressure / 760mm Hg
   = DOsol(Current Pressure)
   8.96 * (754.4/760) = 8.89mg/L

Table 2: Solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity (EAWAG 1973). Units = mg/L

(°C)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	14.60	14.56	14.52	14.48	14.44	14.40	14.36	14.33	14.29	14.25
1	14.21	14.17	14.13	14.09	14.05	14.02	13.98	13.94	13.90	13.87
2	13.83	13.79	13.75	13.72	13.68	13.64	13.61	13.57	13.54	13.50
3	13.46	13.43	13.39	13.36	13.32	13.29	13.25	13.22	13.18	13.15
4	13.11	13.08	13.04	13.01	12.98	12.94	12.91	12.88	12.84	12.81
5	12.78	12.74	12.71	12.68	12.64	12.61	12.58	12.55	12.52	12.48
6	12.45	12.42	12.39	12.36	12.33	12.29	12.26	12.23	12.20	12.17
7	12.14	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.90	11.87
8	11.84	11.81	11.78	11.76	11.73	11.70	11.67	11.64	11.61	11.58
9	11.56	11.53	11.50	11.47	11.44	11.42	11.39	11.36	11.34	11.31
10	11.28	11.25	11.23	11.20	11.17	11.15	11.12	11.10	11.07	11.04
11	11.02	10.99	10.97	10.94	10.91	10.89	10.86	10.84	10.81	10.79
12	10.76	10.74	10.72	10.69	10.67	10.64	10.62	10.59	10.57	10.55
13	10.52	10.50	10.47	10.45	10.43	10.40	10.38	10.36	10.34	10.31
14	10.29	10.27	10.24	10.22	10.20	10.18	10.15	10.13	10.11	10.09
15	10.07	10.04	10.02	10.00	9.98	9.96	9.94	9.92	9.89	9.87
16	9.85	9.83	9.81	9.79	9.77	9.75	9.73	9.71	9.69	9.67
17	9.65	9.63	9.61	9.59	9.57	9.55	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.36	9.34	9.32	9.30	9.28
19	9.26	9.24	9.23	9.21	9.19	9.17	9.15	9.13	9.12	9.10
20	9.08	9.06	9.05	9.03	9.01	8.99	8.98	8.96	8.94	8.92
21	8.91	8.89	8.87	8.86	8.84	8.82	8.81	8.79	8.77	8.76
22	8.74	8.72	8.71	8.69	8.67	8.66	8.64	8.63	8.61	8.59
23	8.58	8.56	8.55	8.53	8.51	8.50	8.48	8.47	8.45	8.44
24	8.42	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.30	8.29
25	8.27	8.26	8.24	8.23	8.21	8.20	8.18	8.17	8.16	8.14
26	8.13	8.11	8.10	8.08	8.07	8.06	8.04	8.03	8.01	8.00
27	7.99	7.97	7.96	7.94	7.93	7.92	7.90	7.89	7.88	7.86
28	7.85	7.84	7.82	7.81	7.80	7.78	7.77	7.76	7.74	7.73
29	7.72	7.70	7.69	7.68	7.66	7.65	7.64	7.63	7.61	7.60
30	7.59	7.57	7.56	7.55	7.54	7.52	7.51	7.50	7.49	7.47

APPENDIX B

NORTHERN KY SANITATION DISTRICT NO.1
CHAIN OF CUSTODY

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

Chain Of Custody Record

Page _____ of _____

Project Name	**Watershed**	**Survey Location**

Contact Person	**Sampler(s) Signature**	**Survey Type (Circle One)** Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli	TSS	CBOD5	TP, N-N, TKN, NH3	Orthophosphate					

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

APPENDIX C

NORTHERN KY SANITATION DISTRICT NO.1
FIELD DATA SHEET

SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: ______________________ DATE: ______________________

SITE / STREAM NAME: ______________________ START TIME: ______________________

SITE LOCATION: ______________________ END TIME: ______________________

LABORATORY: ______________________ SAMPLERS: ______________________

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT WATER

CIRCLE ONE

EQUIPMENT ID: MULTIPROBE SONDE: ______________________

STREAM CONDITIONS: ______________________

SITE CONDITIONS: ______________________

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW AIR TEMP (F): ____________

(CIRCLE APPROPRIATE CONDITIONS)

PROJECT DESCRIPTOR: ______________________

SITE / SAMPLE ID (BANK & DEPTH)	TEMP. (C)	pH	D.O. (mg/L)	SP. COND. (µS/cm)	TURBIDITY (NTU)	FLOW	SAMPLE TIME

FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

Appendix D

AMBIENT SAMPLING
FIELD MONITORING & SAMPLING PLAN
FOR NORTHERN KENTUCKY WATERSHEDS

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

2017

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APPENDICES

1. INTRODUCTION

Sanitation District No. 1 (SD1) a clean water agency that serves over 30 communities in Campbell, Kenton and Boone Counties, Kentucky, as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sanitary overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that identifies Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

SD1 initiated a comprehensive watershed wide monitoring program in 2006 that involved the collection of instream water quality data in each of the sixteen watersheds in Northern Kentucky to characterize background conditions in the region. These sixteen watersheds represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as “exceptional” waters by the State, while other watersheds are more highly developed and are identified as “impaired” by the State. As a result of the vast differences between these watersheds, SD1 has implemented a biweekly sampling program over a two year period to further characterize stream conditions under a wide range of environmental conditions at 20 locations throughout Northern Kentucky.

After the biweekly sampling program was concluded in June 2017, the ambient sampling program began in July 2017. This sampling program has the same sampling protocol, but the schedule and sites have changed. Instead of 20 locations there are 15.

The following ambient sampling *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

1.1 Program Overview

This FMSP describes the water quality monitoring program for the ambient sampling of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)
- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

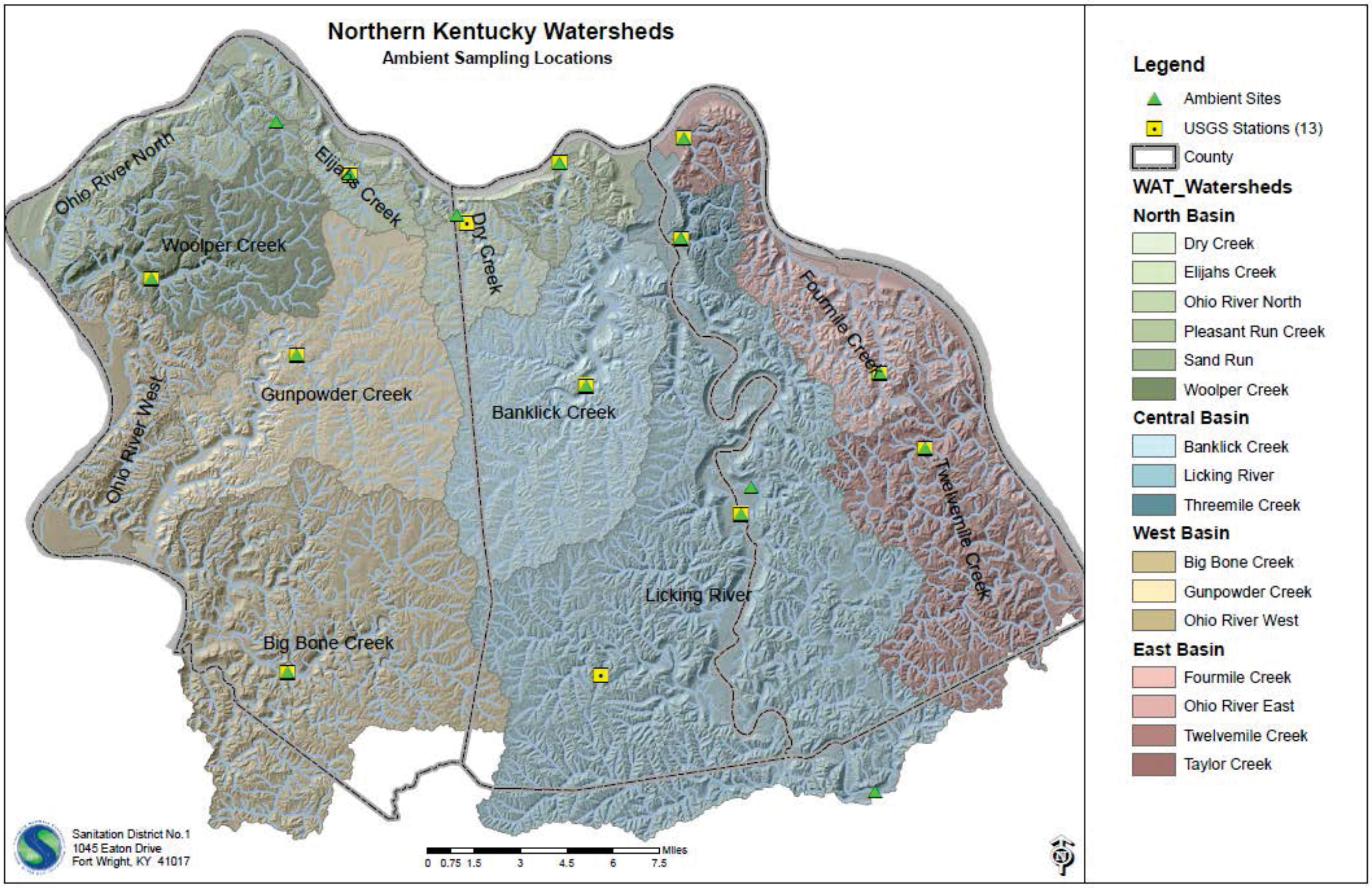
The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess variation of water quality concerns identified in Northern Kentucky watersheds. The ambient data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

Figure 1 Monitoring and Sampling Stations



1.2 Monitoring Team

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

Table 1 Team Member Responsibilities

Position	SD1 Team Member	Responsibilities
Project Manager	Mindy Scott	• Assess suitability of sampling events • Perform System Audits • Circulation of reports and results • Staff Training • Review Reporting • Ensure necessary resources are available • Creation of event reports • QA/QC review
Field Manager	Elizabeth Fet	• Implementation of FMSP • Initiate sampling events • Coordinate with laboratory • Mobilize field crews • Collection and review of field logs, lab results, and other program documentation • Ongoing management of field staff and equipment

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

2. MONITORING AND SAMPLING CRITERIA

The objective of the ambient monitoring and sampling program is to represent varying conditions with respect to the amount of development, as well as sources of stream pollution in each watershed. SD1 is implementing this program to further characterize stream conditions under a wide range of environmental conditions.

The criteria used to define the ambient sampling include:

- Weather conditions will vary, but sampling will be conducted unless deemed unsafe

The goal will be to conduct the sampling in varying weather conditions. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during fluctuating flow conditions.

Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular biweekly sampling event.

3. STREAM CHARACTERIZATION

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- Samples will be collected at all sites on the designated day as shown on the corresponding schedule according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

Table 2 Ambient Monitoring Locations

Basin	Watershed/Sites	Locations	Description
Central	Licking (3)	LIR19.3	Visalia Bridge 536 (USGS)
		LIR35.5	Butler, KY
		POC0.9	Bridge on Indian Trace by Joann Lane
	Banklick (1)	BLC8.1	Richardson Road Bridge (USGS)
	Threemile (1)	THC0.7	Threemile Creek Road (USGS)
East	Fourmile (1)	FMC6.9	Poplar Ridge Road (USGS)
	Twelvemile (1)	TMC3.0	Route 1997 (USGS)
	Taylor (1)	TYC0.6	Donnermeyer Drive under 471 (USGS)
North	Woolper (1)	WPC5.0	Woolper Road (USGS)
	Elijahs (1)	EJC2.8	Elijah Creek Road (USGS)
	Dry Creek (1)	DRC1.4	Dry Creek WWTP (USGS)
	Pleasant Run (1)	PRC0.3	Bridge on Oak Street (USGS)
	Sand Run (1)	SDR4.0	Thornwilde Subdivision
West	Gunpowder (1)	GPC14.7	Camp Ernst Road (USGS)
	Big Bone (1)	MLC3.0	Bridge at US 42 (USGS)
		15 total sites	

3.1 On-Site Water Quality Measurements

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

3.2 Ambient Sampling

Most sampling locations are accessible by bridges or by wading. Table 3 presents the monitoring schedule for the surface water sampling program for biweekly sampling. All sampling will be performed by SD1 staff. Biweekly samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of*

Discrete Water Samples. Biweekly sampling events will be completed by day, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to biweekly sampling is designed to collect a representative sample of current conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

Table 3   Ambient Monitoring Schedule

Day One

Watershed	Site	Description
Big Bone	MLC3.0	Bridge at US 42 (USGS)
Gunpowder	GPC14.7	Camp Ernst Road (USGS)
Woolper	WPC5.0	Woolper Road (USGS)
Elijahs	EJC2.8	Elijah Creek Road (USGS)
Sand Run	SDR4.0	Thornwilde Subdivision

Day Two

Watershed	Site	Description
Licking River	POC0.9	Bridge on Indian Trace by Joann Lane
	LIR19.3	Visalia Bridge 536 (USGS)
	LIR35.5	Butler, KY
Twelvemile	TMC3.0	Route 1997 (USGS)
Fourmile	FMC6.9	Poplar Ridge Road (USGS)

Day Three

Watershed	Site	Description
Banklick	BLC8.1	Richardson Road Bridge (USGS)
Threemile	THC0.7	Threemile Creek Road (USGS)
Taylor	TYC0.6	Donnermeyer Drive under 471 (USGS)
Pleasant Run	PRC0.3	Bridge on Oak Street (USGS)
Dry Creek	DRC1.4	Dry Creek WWTP (USGS)

3.3 Summary

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

Table 4 Summary of Water Quality Monitoring and Sampling Program

Type	Locations	Description	Parameters
Ambient Sampling	15 total locations, throughout Northern Kentucky 4 basins (North, Central, West, East)	♦ Samples collected one week per month (March, April, June, August, October and November) ♦ Samples collected twice per month (May, July, and September) ♦ 1 grab sample per site	♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.*** ♦ Water quality parameters will include: ***bacteria (EC), nitrogen (TKN, NH_3, NO_3-NO_2), phosphorus (total and ortho), total suspended solids, and $CBOD_5$.***

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

Table 5 Summary of Number of Samples to be Collected

Task	Day One	Day Two	Day Three
Day Sampled	Tuesday	Wednesday	Thursday
No. of Events per week	1	1	1
No. of Sites	5	5	5
Bacteria			
E. coli	5	5	5
Nutrients			
NH_3	5	5	5
NO_3- NO_2	5	5	5
TKN	5	5	5
Total Phosphorus	5	5	5
Ortho Phosphate (field filtered)	5	5	5
Solids			
TSS	5	5	5
Other			
$CBOD_5$	5	5	5
Total Sample Load	**45**	**45**	**45**

4. FIELD MEASUREMENTS

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

Table 6. Field Measurements

Parameter	Location of Measurement	Method
Temperature	Mid-channel, mid-depth where possible	Hydrolab
Conductivity		
pH		
Dissolved Oxygen		
Turbidity		

5. SAMPLING HANDLING AND CUSTODY

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

5.1 Sample Labeling

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

5.2 Sampling Collection, Handling and Transport

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4^o C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

5.3 Chain-of-Custody

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

5.4 Field Logs and Records

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

5.5 Sample Containers and Preservation

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

Table 7 Guidelines for Sample Container Preparation and Preservation

Parameter	Container	Recommended Sample Volume	Preservation	Maximum Storage Time
Bacteria				
E. coli	Pre-Sterilized Polyethylene or Glass	120 ml	Add $Na_2S_2O_7$ [1] Refrigerate to 4°C	12 hours[2]
Nutrients				
NH_3 TKN NO_3-NO_2 Total Phosphorus	Polyethylene or Glass	1000 ml	Add H_2SO_4, pH<2 Refrigerate to 4°C	28 days
Ortho Phosphate	Polyethylene or Glass	120 ml	Field filter Refrigerate to 4°C	48 hours
Conventional				
TSS	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	7 days
$CBOD_5$	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	48 hours

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

6. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

6.1 Training

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

6.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

6.3 Equipment Cleaning Protocol

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

6.4 QA/QC Samples

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

Table 8 QA/QC Sample Schedule

Ambient Sampling			
Day	Tuesday	Wednesday	Thursday
	Dup*, FB, MB	Dup*, FB, MB	Dup*, FB, MB

MB= Method Blank Dup = Duplicate

FB = Field Blank * = Dup will rotate between days

Table 9 Number of QA/QC Samples

Ambient Sampling	Field Blanks[2]	Method Blanks[3]	Duplicate Samples[4]	Total per Event
Day 1	1	1	1	3
Day 2	1	1	0	2
Day 3	1	1	0	2
Totals	**3**	**3**	**1**	**7**

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the week.
3. One set of method blanks (at one site) per day will be collected during each day of the event.
4. One set of duplicates (at one site) will be collected during each week.

6.4.1 *Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

6.4.2 *Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

6.4.3 *Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

6.5 Equipment Calibration

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter's precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter's performance during the sampling event.

7. PROGRAM SAFETY

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

7.1 General Safety Practices

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.
- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

7.2 Health Hazards

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING

Standard Operating Procedures

for the

Collection of Discrete Water Samples

Northern Kentucky Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017

Revision Number: 1
September 2006

Introduction

This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand (BOD_5 , $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Blank Water Rinse

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – Sample Collection

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
    a) If using a sample bottle, place in the cooler.
    b) If using a transfer bottle, discard when finished.

3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

Step 2 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

    a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
    b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
    c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Weak Acid (Optional)

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Stainless Steel Bucket

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Sampling Pole

- The method for this device does not require a blank.

Kemmerer Bottle

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Unpreserved Parameters Utilizing the Glove Method

Introduction

This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

1.0 Field Equipment

The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

Attachment 2
Collection of Orthophosphate Samples

Introduction

This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment

The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures

A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures

The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures

Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

Fill the syringe filtration unit with sample from the appropriate collection device.
Place the plunger into the syringe.
Purge a small amount of sample volume through the filter.
Discharge water through the filtration unit into a sample bottle.
Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
Discard the syringe filtration unit.

3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

APPENDIX B

NORTHERN KY SANITATION DISTRICT NO.1
CHAIN OF CUSTODY

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859) 578-7460 Fax: (859) 331-2436

Chain Of Custody Record

Page ____ of ____

Project Name Ambient Monitoring	**Watershed** Various	**Survey Location** Ambient Monitoring Tuesday Sites
Contact Person Mindy Scott	**Sampler(s) Signature**	**Survey Type (Circle One)** Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli	TSS	CBOD5	TP, N-N, TKN, NH3	Orthophosphate					
	MLC3.0			G		Bridge at US42 (USGS)	5	X	X	X	X	X					
	GPC14.7			G		Camp Ernst Road (USGS)	5	X	X	X	X	X					
	WPC5.0			G		Woolper Road (USGS)	5	X	X	X	X	X					
	EJC2.8			G		Elijah Creek Road (USGS)	5	X	X	X	X	X					
	SDR4.0			G		Thornwilde Subdivision	5	X	X	X	X	X					
	DUP			G	▨	duplicate	5	X	X	X	X	X					
	FB					Field Blank	5	X	X	X	X	X					
	MB					Method Blank	1					X					

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

Chain Of Custody Record

Page ______ of ______

Project Name Ambient Monitoring

Watershed Various

Survey Location Ambient Monitoring Wednesday Sites

Contact Person Mindy Scott

Sampler(s) Signature

Survey Type (Circle One) Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli	TSS	CBOD5	TP, N-N, TKN, NH3	Orthophosphate					
	POC0.9			G		Bridge on Indian Trace by Joann Lane	5	X	X	X	X	X					
	LIR19.3			G		USGS Gage Station Visalia bridge	5	X	X	X	X	X					
	LIR35.5			G		Butler,KY	5	X	X	X	X	X					
	TMC3.0			G		Route 1997 (USGS)	5	X	X	X	X	X					
	FMC6.9			G		Poplar Ridge Road (USGS)	5	X	X	X	X	X					
	DUP			G		duplicate	5	X	X	X	X	X					
	FB					Field Blank	5	X	X	X	X	X					
	MB					Method Blank	1					X					

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

Chain Of Custody Record

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Project Name Ambient Monitoring	**Watershed** Various	**Survey Location** Ambient Monitoring Thursday Sites

Contact Person Mindy Scott	**Sampler(s) Signature**	**Survey Type (Circle One)** Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli	TSS	CBOD5	TP, N-N, TKN, NH3	Orthophosphate					
	BLC8.1			G		Richardson Road Bridge	5	X	X	X	X	X					
	THC0.7			G		Threemile Creek Rd (USGS)	5	X	X	X	X	X					
	TYC0.6			G		Donnermeyer Dr under 471 (USGS)	5	X	X	X	X	X					
	PRC0.3			G		Bridge on Oak Street	5	X	X	X	X	X					
	DRC1.4			G		Dry Creek WWTP (USGS)	5	X	X	X	X	X					
	DUP			G		duplicate	5	X	X	X	X	X					
	FB					Field Blank	5	X	X	X	X	X					
	MB					Method Blank	1					X					

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

APPENDIX C

NORTHERN KY SANITATION DISTRICT NO.1
FIELD DATA SHEET

SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: Ambient
SITE / STREAM NAME:
SITE LOCATION: Various
LABORATORY: Dry Creek

DATE:
START TIME:
END TIME:
SAMPLERS:

SAMPLE TYPE
GRAB COMPOSITE
CIRCLE ONE

SAMPLE MATRIX
SEDIMENT **WATER**
CIRCLE ONE

EQUIPMENT ID: MULTIPROBE SONDE:
STREAM CONDITIONS:
SITE CONDITIONS:
WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW
(CIRCLE APPROPRIATE CONDITIONS)
AIR TEMP (F):

PROJECT DESCRIPTOR: Ambient Monitoring - Thursday Locations

SITE / SAMPLE ID (BANK & DEPTH)	TEMP. (C)	pH	D.O. (mg/L)	SP. COND. (μS/cm)	TURBIDITY (NTU)	FLOW (Feet/sec)	SAMPLE TIME
BLC8.1							
THC0.7							
TYC0.6							
PRC0.3							
DRC1.4							
FB							
MB							
DUPLICATE:							

FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

AMBIENT SAMPLING
FIELD MONITORING & SAMPLING PLAN
FOR NORTHERN KENTUCKY WATERSHEDS

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

2021

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1. INTRODUCTION

Sanitation District No. 1 (SD1) a clean water agency that serves over 30 communities in Campbell, Kenton and Boone Counties, Kentucky, as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sanitary overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that identifies Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

SD1 initiated a comprehensive watershed wide monitoring program in 2006 that involved the collection of instream water quality data in each of the sixteen watersheds in Northern Kentucky to characterize background conditions in the region. These sixteen watersheds represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as “exceptional” waters by the State, while other watersheds are more highly developed and are identified as “impaired” by the State. As a result of the vast differences between these watersheds, SD1 implemented a biweekly sampling program over a two year period to further characterize stream conditions under a wide range of environmental conditions at 20 locations throughout Northern Kentucky.

After the biweekly sampling program concluded in June 2017, the ambient sampling program began in July 2017 as on ongoing sampling program. This sampling program has the same sampling protocol, but the schedule and sites have changed, instead of 20 locations there are 15. In 2020 after three years of sampling and an evaluation of the data, it was decided to add four reference sites to the schedule. In 2021 there was the decision to add core basin sites to the schedule. Each year beginning in the East Basin in 2021, the core sites in that basin will be added. These sites will then rotate by basin each year.

The following ambient sampling *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

1.1 Program Overview

This FMSP describes the water quality monitoring program for the ambient sampling of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)
- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess variation of water quality concerns identified in Northern Kentucky watersheds. The ambient data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

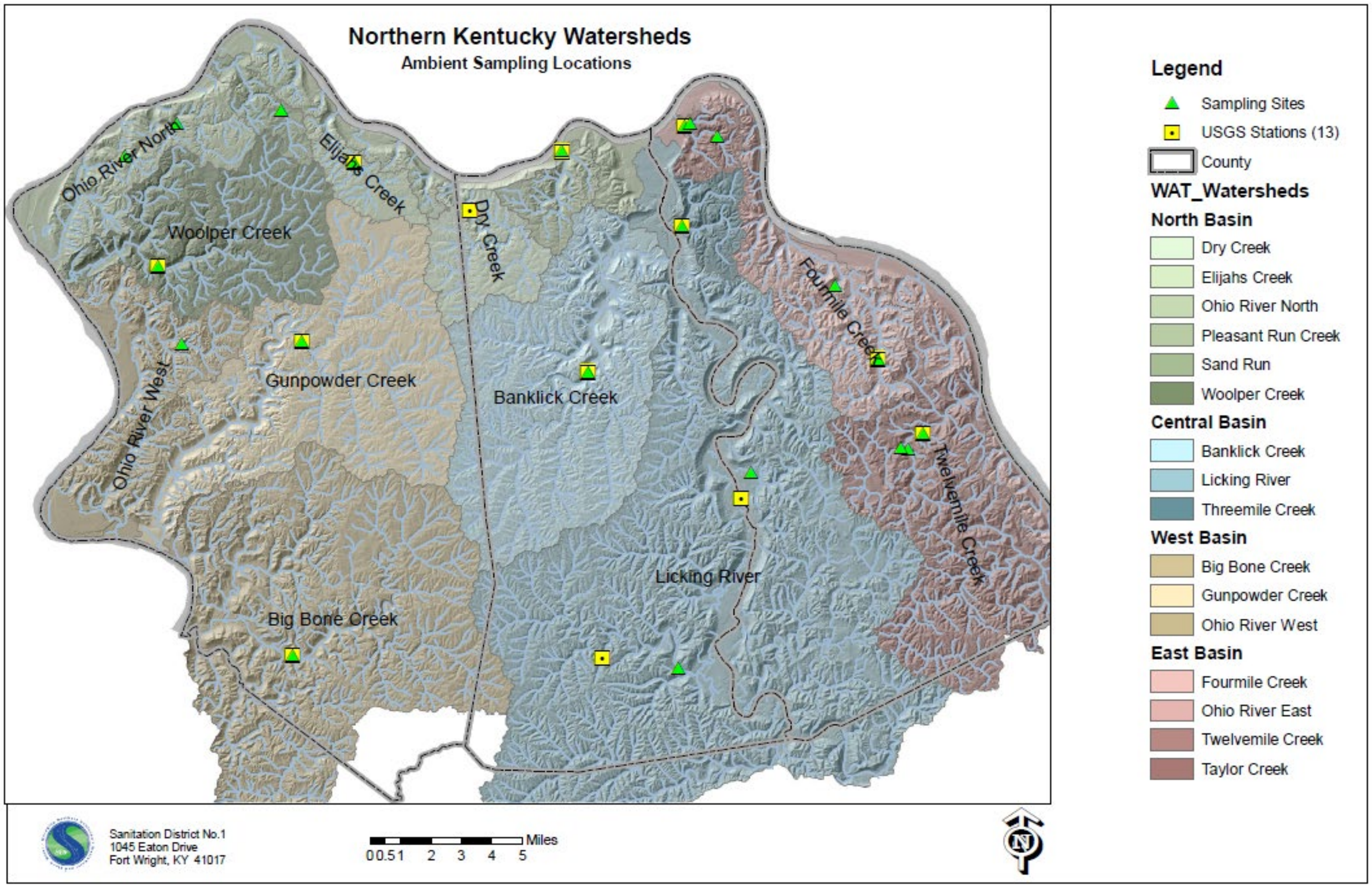

Figure 1 *Monitoring and Sampling Stations*

1.2 Monitoring Team

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

Table 1 Team Member Responsibilities

Position	SD1 Team Member	Responsibilities
Project Manager	Mindy Scott	• Assess suitability of sampling events • Perform System Audits • Circulation of reports and results • Staff Training • Review Reporting • Ensure necessary resources are available • Creation of event reports • QA/QC review
Field Manager	Elizabeth Fet	• Implementation of FMSP • Initiate sampling events • Coordinate with laboratory • Mobilize field crews • Collection and review of field logs, lab results, and other program documentation • Ongoing management of field staff and equipment

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

2. *MONITORING AND SAMPLING CRITERIA*

The objective of the ambient monitoring and sampling program is to represent varying conditions with respect to the amount of development, as well as sources of stream pollution in each watershed. SD1 is implementing this program to further characterize stream conditions under a wide range of environmental conditions.

The criteria used to define the ambient sampling include:

- Weather conditions will vary, but sampling will be conducted unless deemed unsafe

The goal will be to conduct the sampling in varying weather conditions. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during fluctuating flow conditions.

Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular Ambient sampling event.

3. STREAM CHARACTERIZATION

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- Samples will be collected at all sites on the designated day as shown on the corresponding schedule according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

Table 2 Ambient Monitoring Locations

Basin	Watershed/Sites	Locations	Description
Central	Banklick (1)	BLC8.1	Richardson Road Bridge (USGS)
	Threemile (1)	THC0.7	Threemile Creek Road (USGS)
	Cruises (1)	CRC2.5	Cruises Creek
East	Fourmile (5)	FMC0.5	Silver Grove pump station
		FMC6.9	Poplar Ridge Road (USGS)
		OWC0.4	Owl Creek Road
	Twelvemile (3)	TMC3.0	Route 1997 (USGS)
		TMC3.9	Bridge on Route 10
		BRC0.3	Bridge on Route 10
	Taylor (3)	TYC0.6	Donnermeyer Drive under 471 (USGS)
		TYC0.9-WLC1.3	Waterworks Road
		TYC0.7-CVR0.2	Tiger Lane, across from Ben Flora gym
North	Woolper (1)	WPC5.0	Woolper Road (USGS)
	Elijahs (1)	EJC2.8	Elijah Creek Road (USGS)
	Dry Creek (1)	DRC1.4	Dry Creek WWTP (USGS)
	Pleasant Run (1)	PRC0.3	Bridge on Oak Street (USGS)
	Sand Run (1)	SDR4.0	Thornwilde Subdivision
	Garrison (1)	GAC1.7	Garrison Creek Road (Reference Site)
	Second (1)	SEC1.6	Second Creek Road (Reference Site)
West	Gunpowder (1)	GPC14.7	Camp Ernst Road (USGS)
	Big Bone (1)	MLC3.0	Bridge at US 42 (USGS)
	Middle (1)	MDC5.5	Middle Creek Road (Reference Site)
		22 total sites	
		🟩	Baseflow core sites
		In 2021 the baseflow trend locations were added into the ambient schedule and the Licking River sites were removed.	
		2021 = East	
		2022 = Central	
		2023 = North	
		2024 = West	

3.1 On-Site Water Quality Measurements

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

3.2 Ambient Sampling

Most sampling locations are accessible by bridges or by wading. Table 3 presents the monitoring schedule for the surface water sampling program for ambient sampling. All sampling will be performed by SD1 staff. Ambient samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples.* Ambient sampling events will be completed by day, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to ambient sampling is designed to collect a representative sample of current conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

Table 3   Ambient Monitoring Schedule

Day One

Watershed	Site	Description
Big Bone	MLC3.0	Bridge at US 42 (USGS)
Gunpowder	GPC14.7	Camp Ernst Road (USGS)
Middle	MDC5.5	Middle Creek Road (Reference Site)
Woolper	WPC5.0	Woolper Road (USGS)
Second	SEC1.6	Second Creek Road (Reference Site)
Garrison	GAC1.7	Garrison Creek Road (Reference Site)
Elijahs	EJC2.8	Elijah Creek Road (USGS)
Sand Run	SDR4.0	Thornwilde Subdivision

Day Two

Watershed	Site	Description
Brush Creek	BRC0.3	Bridge on Route 10
Twelvemile	TMC3.9	Bridge on Route 10
Twelvemile	TMC3.0	Route 1997 (USGS)
Fourmile	FMC6.9	Poplar Ridge Road (USGS)
Owl Creek	OWC0.4	Owl Creek Road
Fourmile	FMC0.5	Silver Grove pump station

Day Three

Watershed	Site	Description
Banklick	BLC8.1	Richardson Road Bridge (USGS)
Cruises	CRC2.5	Hempfling Road
Threemile	THC0.7	Threemile Creek Road (USGS)
Taylor	TYC0.9-WLC1.3	Waterworks Road
Taylor	TYC0.7-CVR0.2	Tiger Lane, across from Ben Flora gym
Taylor	TYC0.6	Donnermeyer Drive under 471 (USGS)
Pleasant Run	PRC0.3	Bridge on Oak Street (USGS)
Dry Creek	DRC1.4	Dry Creek WWTP (USGS)

3.3 Summary

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

Table 4 Summary of Water Quality Monitoring and Sampling Program

Type	Locations	Description	Parameters
Ambient Sampling	22 total locations, throughout Northern Kentucky 4 basins (North, Central, West, East)	♦ Samples collected one week per month (April, June, August, October) ♦ Samples collected twice per month (May, July, and September) ♦ 1 grab sample per site	♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.*** ♦ Water quality parameters will include: ***bacteria (EC), nitrogen (TKN, NH_3, NO_3-NO_2), phosphorus, total suspended solids.***

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

Table 5 Summary of Number of Samples to be Collected

Task	**Day One**	**Day Two**	**Day Three**
Day Sampled	Tuesday	Wednesday	Thursday
No. of Events per week	1	1	1
No. of Sites	8	6	8
Bacteria			
E. coli	8	6	8
Nutrients			
NH_3	8	6	8
NO_3- NO_2	8	6	8
TKN	8	6	8
Total Phosphorus	8	6	8
Ortho Phosphate (field filtered)	3	4	3
Solids			
TSS	8	6	8
Total Sample Load	**51**	**40**	**51**

4. FIELD MEASUREMENTS

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

Table 6. Field Measurements

Parameter	Location of Measurement	Method
Temperature	Mid-channel, mid-depth where possible	Hydrolab
Conductivity		
pH		
Dissolved Oxygen		
Turbidity		

5. *SAMPLING HANDLING AND CUSTODY*

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

5.1 Sample Labeling

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5:	Sample Site ID
Example:	FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

5.2 Sampling Collection, Handling and Transport

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4° C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

5.3 Chain-of-Custody

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

5.4 Field Logs and Records

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

5.5 Sample Containers and Preservation

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

Table 7 Guidelines for Sample Container Preparation and Preservation

Parameter	Container	Recommended Sample Volume	Preservation	Maximum Storage Time
Bacteria				
E. coli	Pre-Sterilized Polyethylene or Glass	120 ml	Add $Na_2S_2O_7$ [1] Refrigerate to 4°C	12 hours[2]
Nutrients				
NH_3 TKN NO_3-NO_2 Total Phosphorus	Polyethylene or Glass	1000 ml	Add H_2SO_4, pH<2 Refrigerate to 4°C	28 days
Ortho Phosphate	Polyethylene or Glass	120 ml	Field filter Refrigerate to 4°C	48 hours
Conventional				
TSS	Polyethylene or Glass	1000 ml	Refrigerate to 4°C	7 days

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

6. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

6.1 Training

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive

training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

6.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

6.3 Equipment Cleaning Protocol

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

6.4 QA/QC Samples

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

Table 8 QA/QC Sample Schedule

Ambient Sampling			
Day	Tuesday	Wednesday	Thursday
	Dup*, FB, MB	Dup*, FB, MB	Dup*, FB, MB

MB= Method Blank Dup = Duplicate

FB = Field Blank * = Dup will rotate between days

Table 9 Number of QA/QC Samples

Ambient Sampling	Field Blanks[2]	Method Blanks[3]	Duplicate Samples[4]	Total per Event
Day 1	1	1	1	3
Day 2	1	1	0	2
Day 3	1	1	0	2
Totals	**3**	**3**	**1**	**7**

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the week.
3. One set of method blanks (at one site) per day will be collected during each day of the event.
4. One set of duplicates (at one site) will be collected during each week.

6.4.1 *Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

6.4.2 *Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

6.4.3 *Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

6.5 Equipment Calibration

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter’s precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter’s performance during the sampling event.

7. PROGRAM SAFETY

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

7.1 General Safety Practices

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.

- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

7.2 Health Hazards

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING

Standard Operating Procedures for the Collection of Discrete Water Samples

Northern Kentucky Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017
Revision Number: 1
September 2006

Introduction

This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand (BOD_5 , $CBOD_{5,}$ COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Blank Water Rinse

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – Sample Collection

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
    - a) If using a sample bottle, place in the cooler.
    - b) If using a transfer bottle, discard when finished.

3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

Step 2 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).
  a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
  b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
  c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).
- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Weak Acid (Optional)

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Stainless Steel Bucket

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Sampling Pole

- The method for this device does not require a blank.

Kemmerer Bottle

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the “Blank Water Rinse” (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Unpreserved Parameters Utilizing the Glove Method

Introduction

This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

1.0 Field Equipment

The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker. Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet. After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

Attachment 2
Collection of Orthophosphate Samples

Introduction

This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment

The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures

A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures

The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures

Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

Fill the syringe filtration unit with sample from the appropriate collection device.

Place the plunger into the syringe.

Purge a small amount of sample volume through the filter.

Discharge water through the filtration unit into a sample bottle.

Repeat the previous three bullets until enough sample has been filtered into the sample bottle.

Discard the syringe filtration unit.

3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

APPENDIX B

NORTHERN KY SANITATION DISTRICT NO.1
CHAIN OF CUSTODY

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859) 578-7460 Fax: (859) 331-2436

Chain Of Custody Record

Page ______ of ______

Project Name	**Watershed**	**Survey Location**
Ambient Monitoring	Various	Ambient Monitoring

Contact Person	**Sampler(s) Signature**	**Survey Type (Circle One)**
Mindy Scott		Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli [1,3]	TSS [1]	TP, N-N, TKN, NH3, TN [1,2]	Orthophosphate [1]	Enterococci [1,3]					
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #
																	Cooler #

Preservation Used: 1= Ice 2 = H_2SO_4 3 = Na_2SO_4

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	**Date**	**Time**	**Received By: Laboratory**	**Date**	**Time**	**Remarks**

APPENDIX C

NORTHERN KY SANITATION DISTRICT NO.1
FIELD DATA SHEET

SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: Ambient

DATE:

SITE / STREAM NAME:

START TIME:

SITE LOCATION: Various

END TIME:

LABORATORY: Dry Creek

SAMPLERS:

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT **WATER**

CIRCLE ONE

EQUIPMENT ID: MULTIPROBE SONDE:

STREAM CONDITIONS:

SITE CONDITIONS:

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW

(CIRCLE APPROPRIATE CONDITIONS)

AIR TEMP (F):

PROJECT DESCRIPTOR: Ambient Monitoring - Thursday Locations

SITE / SAMPLE ID (BANK & DEPTH)	TEMP. (C)	pH	D.O. (mg/L)	SP. COND. (µS/cm)	TURBIDITY (NTU)	FLOW (Feet/sec)	SAMPLE TIME
FB							
MB							
DUPLICATE:							

FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

AMBIENT SAMPLING
FIELD MONITORING & SAMPLING PLAN
FOR NORTHERN KENTUCKY WATERSHEDS

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

2021

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APPENDICES

1. INTRODUCTION

Sanitation District No. 1 (SD1) a clean water agency that serves over 30 communities in Campbell, Kenton and Boone Counties, Kentucky, as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sanitary overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that identifies Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

SD1 initiated a comprehensive watershed wide monitoring program in 2006 that involved the collection of instream water quality data in each of the sixteen watersheds in Northern Kentucky to characterize background conditions in the region. These sixteen watersheds represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as “exceptional” waters by the State, while other watersheds are more highly developed and are identified as “impaired” by the State. As a result of the vast differences between these watersheds, SD1 implemented a biweekly sampling program over a two year period to further characterize stream conditions under a wide range of environmental conditions at 20 locations throughout Northern Kentucky.

After the biweekly sampling program concluded in June 2017, the ambient sampling program began in July 2017 as on ongoing sampling program. This sampling program has the same sampling protocol, but the schedule and sites have changed, instead of 20 locations there are 15. In 2020 after three years of sampling and an evaluation of the data, it was decided to add four reference sites to the schedule. In 2021 there was the decision to add core basin sites to the schedule. Each year beginning in the East Basin in 2021, the core sites in that basin will be added. These sites will then rotate by basin each year.

The following ambient sampling *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

1.1 Program Overview

This FMSP describes the water quality monitoring program for the ambient sampling of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)
- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess variation of water quality concerns identified in Northern Kentucky watersheds. The ambient data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

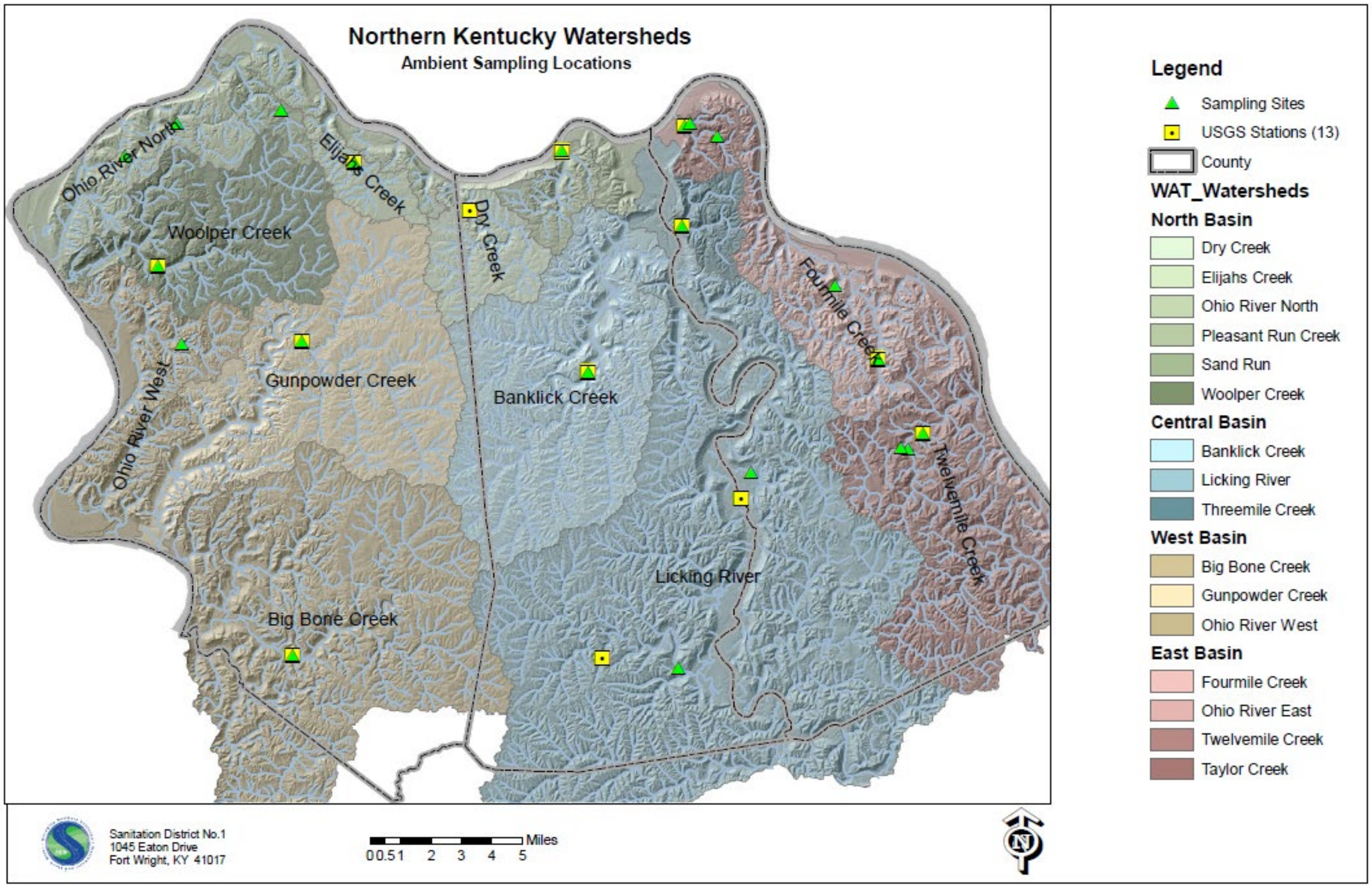

Figure 1 Monitoring and Sampling Stations

1.2 Monitoring Team

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

Table 1 Team Member Responsibilities

Position	**SD1 Team Member**	**Responsibilities**
Project Manager	Mindy Scott	• Assess suitability of sampling events • Perform System Audits • Circulation of reports and results • Staff Training • Review Reporting • Ensure necessary resources are available • Creation of event reports • QA/QC review
Field Manager	Elizabeth Fet	• Implementation of FMSP • Initiate sampling events • Coordinate with laboratory • Mobilize field crews • Collection and review of field logs, lab results, and other program documentation • Ongoing management of field staff and equipment

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

2. *MONITORING AND SAMPLING CRITERIA*

The objective of the ambient monitoring and sampling program is to represent varying conditions with respect to the amount of development, as well as sources of stream pollution in each watershed. SD1 is implementing this program to further characterize stream conditions under a wide range of environmental conditions.

The criteria used to define the ambient sampling include:

- Weather conditions will vary, but sampling will be conducted unless deemed unsafe

The goal will be to conduct the sampling in varying weather conditions. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during fluctuating flow conditions.

Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular Ambient sampling event.

3. STREAM CHARACTERIZATION

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- Samples will be collected at all sites on the designated day as shown on the corresponding schedule according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

Table 2 Ambient Monitoring Locations

Basin	Watershed/Sites	Locations	Description
Central	Banklick (1)	BLC8.1	Richardson Road Bridge (USGS)
	Threemile (1)	THC0.7	Threemile Creek Road (USGS)
	Cruises (1)	CRC2.5	Cruises Creek
East	Fourmile (5)	FMC0.5	Silver Grove pump station
		FMC6.9	Poplar Ridge Road (USGS)
		OWC0.4	Owl Creek Road
	Twelvemile (3)	TMC3.0	Route 1997 (USGS)
		TMC3.9	Bridge on Route 10
		BRC0.3	Bridge on Route 10
	Taylor (3)	TYC0.6	Donnermeyer Drive under 471 (USGS)
		TYC0.9-WLC1.3	Waterworks Road
		TYC0.7-CVR0.2	Tiger Lane, across from Ben Flora gym
North	Woolper (1)	WPC5.0	Woolper Road (USGS)
	Elijahs (1)	EJC2.8	Elijah Creek Road (USGS)
	Dry Creek (1)	DRC1.4	Dry Creek WWTP (USGS)
	Pleasant Run (1)	PRC0.3	Bridge on Oak Street (USGS)
	Sand Run (1)	SDR4.0	Thornwilde Subdivision
	Garrison (1)	GAC1.7	Garrison Creek Road (Reference Site)
	Second (1)	SEC1.6	Second Creek Road (Reference Site)
West	Gunpowder (1)	GPC14.7	Camp Ernst Road (USGS)
	Big Bone (1)	MLC3.0	Bridge at US 42 (USGS)
	Middle (1)	MDC5.5	Middle Creek Road (Reference Site)
		22 total sites	
		🟩	Baseflow core sites
		In 2021 the baseflow trend locations were added into the ambient schedule and the Licking River sites were removed.	
		2021 = East	
		2022 = Central	
		2023 = North	
		2024 = West	

3.1 *On-Site Water Quality Measurements*

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

3.2 Ambient Sampling

Most sampling locations are accessible by bridges or by wading. Table 3 presents the monitoring schedule for the surface water sampling program for ambient sampling. All sampling will be performed by SD1 staff. Ambient samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples.* Ambient sampling events will be completed by day, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to ambient sampling is designed to collect a representative sample of current conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

Table 3   Ambient Monitoring Schedule

Day One

Watershed	Site	Description
Big Bone	MLC3.0	Bridge at US 42 (USGS)
Gunpowder	GPC14.7	Camp Ernst Road (USGS)
Middle	MDC5.5	Middle Creek Road (Reference Site)
Woolper	WPC5.0	Woolper Road (USGS)
Second	SEC1.6	Second Creek Road (Reference Site)
Garrison	GAC1.7	Garrison Creek Road (Reference Site)
Elijahs	EJC2.8	Elijah Creek Road (USGS)
Sand Run	SDR4.0	Thornwilde Subdivision

Day Two

Watershed	Site	Description
Brush Creek	BRC0.3	Bridge on Route 10
Twelvemile	TMC3.9	Bridge on Route 10
Twelvemile	TMC3.0	Route 1997 (USGS)
Fourmile	FMC6.9	Poplar Ridge Road (USGS)
Owl Creek	OWC0.4	Owl Creek Road
Fourmile	FMC0.5	Silver Grove pump station

Day Three

Watershed	Site	Description
Banklick	BLC8.1	Richardson Road Bridge (USGS)
Cruises	CRC2.5	Hempfling Road
Threemile	THC0.7	Threemile Creek Road (USGS)
Taylor	TYC0.9-WLC1.3	Waterworks Road
Taylor	TYC0.7-CVR0.2	Tiger Lane, across from Ben Flora gym
Taylor	TYC0.6	Donnermeyer Drive under 471 (USGS)
Pleasant Run	PRC0.3	Bridge on Oak Street (USGS)
Dry Creek	DRC1.4	Dry Creek WWTP (USGS)

3.3 Summary

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

Table 4 Summary of Water Quality Monitoring and Sampling Program

Type	Locations	Description	Parameters
Ambient Sampling	22 total locations, throughout Northern Kentucky 4 basins (North, Central, West, East)	♦ Samples collected one week per month (April, June, August, October) ♦ Samples collected twice per month (May, July, and September) ♦ 1 grab sample per site	♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.*** ♦ Water quality parameters will include: ***bacteria (EC), nitrogen (TKN, NH_3, NO_3-NO_2), phosphorus, total suspended solids.***

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

Table 5 Summary of Number of Samples to be Collected

Task	**Day One**	**Day Two**	**Day Three**
Day Sampled	Tuesday	Wednesday	Thursday
No. of Events per week	1	1	1
No. of Sites	8	6	8
Bacteria			
E. coli	8	6	8
Nutrients			
NH_3	8	6	8
NO_3- NO_2	8	6	8
TKN	8	6	8
Total Phosphorus	8	6	8
Ortho Phosphate (field filtered)	3	4	3
Solids			
TSS	8	6	8
Total Sample Load	**51**	**40**	**51**

4. FIELD MEASUREMENTS

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

Table 6. Field Measurements

Parameter	Location of Measurement	Method
Temperature	Mid-channel, mid-depth where possible	Hydrolab
Conductivity		
pH		
Dissolved Oxygen		
Turbidity		

5. *SAMPLING HANDLING AND CUSTODY*

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

5.1 Sample Labeling

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

5.2 Sampling Collection, Handling and Transport

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4^{o} C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

5.3 Chain-of-Custody

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

5.4 Field Logs and Records

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

5.5 Sample Containers and Preservation

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

Table 7 Guidelines for Sample Container Preparation and Preservation

Parameter	Container	Recommended Sample Volume	Preservation	Maximum Storage Time
Bacteria				
E. coli	Pre-Sterilized Polyethylene or Glass	120 ml	Add $Na_2S_2O_7$ [1] Refrigerate to 4^oC	12 hours[2]
Nutrients				
NH_3 TKN NO_3-NO_2 Total Phosphorus	Polyethylene or Glass	1000 ml	Add H_2SO_4, pH<2 Refrigerate to 4^oC	28 days
Ortho Phosphate	Polyethylene or Glass	120 ml	Field filter Refrigerate to 4^oC	48 hours
Conventional				
TSS	Polyethylene or Glass	1000 ml	Refrigerate to 4^oC	7 days

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

6. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

6.1 Training

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive

training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

6.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

6.3 Equipment Cleaning Protocol

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

6.4 QA/QC Samples

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

Table 8 QA/QC Sample Schedule

Ambient Sampling			
Day	Tuesday	Wednesday	Thursday
	Dup*, FB, MB	Dup*, FB, MB	Dup*, FB, MB

MB= Method Blank Dup = Duplicate

FB = Field Blank * = Dup will rotate between days

Table 9 Number of QA/QC Samples

Ambient Sampling	Field Blanks^2	Method Blanks^3	Duplicate Samples^4	Total per Event
Day 1	1	1	1	3
Day 2	1	1	0	2
Day 3	1	1	0	2
Totals	**3**	**3**	**1**	**7**

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the week.
3. One set of method blanks (at one site) per day will be collected during each day of the event.
4. One set of duplicates (at one site) will be collected during each week.

6.4.1 *Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

6.4.2 *Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

6.4.3 *Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

6.5 Equipment Calibration

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter's precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter's performance during the sampling event.

7. PROGRAM SAFETY

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

7.1 General Safety Practices

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.

- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

7.2 Health Hazards

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING

Standard Operating Procedures for the Collection of Discrete Water Samples

Northern Kentucky Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017
Revision Number: 1
September 2006

Introduction

This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand (BOD_5 , $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Blank Water Rinse

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – Sample Collection

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
  - a) If using a sample bottle, place in the cooler.
  - b) If using a transfer bottle, discard when finished.

3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

Step 2 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).
  a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
  b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
  c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).
- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

Step 1 – Alconox Detergent Wash (Optional)

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

Step 2 – Chemical Rinse – Weak Acid (Optional)

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

Step 3 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Stainless Steel Bucket

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Sampling Pole

- The method for this device does not require a blank.

Kemmerer Bottle

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Unpreserved Parameters Utilizing the Glove Method

Introduction

This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

1.0 Field Equipment

The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker. Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet. After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

Attachment 2
Collection of Orthophosphate Samples

Introduction

This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment

The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures

A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures

The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures

Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

Fill the syringe filtration unit with sample from the appropriate collection device.

Place the plunger into the syringe.

Purge a small amount of sample volume through the filter.

Discharge water through the filtration unit into a sample bottle.

Repeat the previous three bullets until enough sample has been filtered into the sample bottle.

Discard the syringe filtration unit.

3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

APPENDIX B

NORTHERN KY SANITATION DISTRICT NO.1
CHAIN OF CUSTODY

SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859) 578-7460 Fax: (859) 331-2436

Chain Of Custody Record

Page _____ of _____

Project Name Ambient Monitoring	**Watershed** Various	**Survey Location** Ambient Monitoring

Contact Person Mindy Scott	**Sampler(s) Signature**	**Survey Type (Circle One)** Wet or Dry

Lab ID	Sample ID Code	Date	Time	Composite / Grab	Pole / Bucket / Glove	Sample Location	No. of Containers	Analysis Required									Remarks
								E. coli [1,3]	TSS [1]	TP, N-N, TKN, NH3, TN [1,2]	Orthophosphate [1]	Enterococci [1,3]					
																	Cooler #
																	Cooler #
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																	Cooler #
																	Cooler #
																	Cooler #

Preservation Used: 1= Ice 2 = H_2SO_4 3 = Na_2SO_4

Relinquished By: Sampler	Date	Time	Accepted By: Lab Runner	Date	Time	Remarks
Relinquished By: Lab Runner	Date	Time	Received By: Laboratory	Date	Time	Remarks

APPENDIX C

NORTHERN KY SANITATION DISTRICT NO.1
FIELD DATA SHEET

SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: Ambient

SITE / STREAM NAME:

SITE LOCATION: Various

LABORATORY: Dry Creek

DATE:

START TIME:

END TIME:

SAMPLERS:

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT **WATER**

CIRCLE ONE

EQUIPMENT ID: MULTIPROBE SONDE:

STREAM CONDITIONS:

SITE CONDITIONS:

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW

(CIRCLE APPROPRIATE CONDITIONS)

AIR TEMP (F):

PROJECT DESCRIPTOR: Ambient Monitoring - Thursday Locations

SITE / SAMPLE ID (BANK & DEPTH)	TEMP. (C)	pH	D.O. (mg/L)	SP. COND. (µS/cm)	TURBIDITY (NTU)	FLOW (Feet/sec)	SAMPLE TIME
FB							
MB							
DUPLICATE:							

FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

Appendix E: Monitoring Results of SD1 Sampling in Threemile Creek (2007-2021)

Survey_Desc	Coll_Agency	Station_ID	Date	Time	Par_Name	Result	Meas_Units
2007 SD1 Dry Weather Survey All Watersheds	SD1	NBT0.8	7/3/2007	2:21:00 PM	Ecoli	107.6	#/100ml
2007 SD1 Dry Weather Survey All Watersheds	SD1	THC0.7	7/3/2007	2:55:00 PM	Ecoli	445	#/100ml
2007 SD1 Dry Weather Survey All Watersheds	SD1	THC1.4	7/3/2007	1:40:00 PM	Ecoli	342.8	#/100ml
2008 SD1 Central Basin Base Flow (6/24-25/08)	SD1	NBT0.8	6/25/2008	2:50:00 PM	Ecoli	880	#/100ml
2008 SD1 Central Basin Base Flow (6/24-25/08)	SD1	THC0.7	6/25/2008	2:35:00 PM	Ecoli	393	#/100ml
2008 SD1 Central Basin Base Flow (6/24-25/08)	SD1	THC1.4	6/25/2008	2:10:00 PM	Ecoli	146	#/100ml
2009 SD1 Dry Weather Survey All Watersheds	SD1	NBT0.8	7/8/2009	12:13:00 PM	Ecoli	1102	#/100ml
2009 SD1 Dry Weather Survey All Watersheds	SD1	THC0.7	7/8/2009	12:38:00 PM	Ecoli	373	#/100ml
2009 SD1 Dry Weather Survey All Watersheds	SD1	THC1.4	7/8/2009	1:04:00 PM	Ecoli	257.6	#/100ml
2010 SD1 Dry Weather Survey All Watersheds	SD1	NBT0.8	8/11/2010	11:05:00 AM	Ecoli	225	#/100ml
2010 SD1 Dry Weather Survey All Watersheds	SD1	THC0.7	8/11/2010	11:45:00 AM	Ecoli	92	#/100ml
2010 SD1 Dry Weather Survey All Watersheds	SD1	THC1.4	8/11/2010	11:30:00 AM	Ecoli	58	#/100ml
2013 SD1 Dry Weather Survey All Watersheds	SD1	NBT0.8	8/19/2013	10:05:00 AM	Ecoli	98	#/100ml
2013 SD1 Dry Weather Survey All Watersheds	SD1	THC0.7	8/19/2013	9:40:00 AM	Ecoli	136	#/100ml
2013 SD1 Dry Weather Survey All Watersheds	SD1	THC1.4	8/19/2013	9:15:00 AM	Ecoli	92	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	7/9/2015	10:05:00 AM	Ecoli	2596	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	7/23/2015	10:40:00 AM	Ecoli	464	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	8/6/2015	9:45:00 AM	Ecoli	1548	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	8/20/2015	11:10:00 AM	Ecoli	8660	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	9/3/2015	10:05:00 AM	Ecoli	184	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	9/17/2015	10:15:00 AM	Ecoli	188	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	10/1/2015	10:30:00 AM	Ecoli	404	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	10/15/2015	10:35:00 AM	Ecoli	264	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	10/29/2015	9:50:00 AM	Ecoli	1444	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	5/12/2016	10:30:00 AM	Ecoli	432	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	5/26/2016	9:55:00 AM	Ecoli	324	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	6/9/2016	9:45:00 AM	Ecoli	104	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	6/23/2016	11:10:00 AM	Ecoli	14140	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	7/7/2016	10:40:00 AM	Ecoli	344	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	7/21/2016	10:00:00 AM	Ecoli	1952	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	8/4/2016	10:50:00 AM	Ecoli	944	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	8/18/2016	10:10:00 AM	Ecoli	1040	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	9/1/2016	10:15:00 AM	Ecoli	184	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	9/15/2016	10:40:00 AM	Ecoli	456	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	9/29/2016	9:35:00 AM	Ecoli	1304	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	10/13/2016	10:20:00 AM	Ecoli	112	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	10/27/2016	10:20:00 AM	Ecoli	44	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	5/11/2017	9:55:00 AM	Ecoli	272	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	5/25/2017	10:15:00 AM	Ecoli	12030	#/100ml
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	6/8/2017	9:45:00 AM	Ecoli	280	#/100ml

Survey_Desc	Coll_Agency	Station_ID	Date	Time	Par_Name	Result	Meas_Units
2015-2017 SD1 Biweekly Watershed Sampling	SD1	THC0.7	6/22/2017	9:20:00 AM	Ecoli	488	#/100ml
2017 SD1 Central Basin Base Flow (6/27 - 29/17)	SD1	NBT0.8	6/27/2017	12:05:00 PM	Ecoli	612	#/100ml
2017 SD1 Central Basin Base Flow (6/27 - 29/17)	SD1	THC0.7	6/27/2017	11:40:00 AM	Ecoli	220	#/100ml
2017 SD1 Central Basin Base Flow (6/27 - 29/17)	SD1	THC1.4	6/27/2017	11:40:00 AM	Ecoli	208	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/13/2017	10:15:00 AM	Ecoli	200	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/27/2017	9:40:00 AM	Ecoli	2316	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	8/17/2017	9:45:00 AM	Ecoli	420	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/7/2017	10:00:00 AM	Ecoli	912	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/21/2017	10:15:00 AM	Ecoli	92	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	10/19/2017	10:05:00 AM	Ecoli	80	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/10/2018	10:00:00 AM	Ecoli	444	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/24/2018	9:50:00 AM	Ecoli	1380	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	6/14/2018	10:12:00 AM	Ecoli	416	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/12/2018	9:40:00 AM	Ecoli	240	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/26/2018	10:20:00 AM	Ecoli	452	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	8/23/2018	9:15:00 AM	Ecoli	460	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/13/2018	9:45:00 AM	Ecoli	432	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/27/2018	9:25:00 AM	Ecoli	108	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	10/18/2018	10:30:00 AM	Ecoli	8	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/9/2019	9:30:00 AM	Ecoli	128	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/23/2019	10:15:00 AM	Ecoli	1460	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	6/13/2019	9:45:00 AM	Ecoli	992	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/11/2019	9:50:00 AM	Ecoli	432	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/25/2019	9:15:00 AM	Ecoli	384	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	8/15/2019	10:50:00 AM	Ecoli	72	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/12/2019	9:50:00 AM	Ecoli	52	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/26/2019	9:55:00 AM	Ecoli	352	#/100ml
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	10/24/2019	9:55:00 AM	Ecoli	16	#/100ml
2021-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/7/2020	10:00	Ecoli	16	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	5/21/2020	09:40	Ecoli	820	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	6/11/2020	09:35	Ecoli	172	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/16/2020	09:40	Ecoli	172	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	7/30/2020	09:30	Ecoli	204	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	8/13/2020	09:55	Ecoli	176	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/10/2020	09:25	Ecoli	104	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	9/24/2020	09:35	Ecoli	116	mpn/100mL
2016-Present SD1 Ambient Watershed Sampling	SD1	THC0.7	10/8/2020	10:05	Ecoli	40	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	5/6/2021	10:15	Ecoli	224	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	5/20/2021	09:30	Ecoli	208	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	6/10/2021	09:40	Ecoli	168	mpn/100mL

Survey_Desc	Coll_Agency	Station_ID	Date	Time	Par_Name	Result	Meas_Units
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	7/8/2021	10:00	Ecoli	432	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	7/22/2021	10:05	Ecoli	250	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	8/12/2021	09:10	Ecoli	292	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	8/26/2021	09:05	Ecoli	408	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	9/16/2021	09:35	Ecoli	60	mpn/100mL
2021 SD1 Ambient Watershed Sampling	SD1	THC0.7	10/21/2021	09:40	Ecoli	144	mpn/100mL