



# Missouri Department of Natural Resources

**Cooperative Stream Investigation Project Plan:  
Missouri Department of Natural Resources;  
Missouri Botanical Garden  
Stream Teams 4149 and 5099**

**Two-mile Creek  
St. Louis County**

**April 2023 – April 2024**

Prepared for:

Missouri Department of Natural Resources  
Division of Environmental Quality  
Water Protection Program  
Water Pollution Control Branch

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## 1.0 Introduction

To assist the Missouri Department of Natural Resources (**Department**), Water Protection Program (**WPP**) and the Missouri Botanical Garden, Deer Creek Watershed Alliance Project; Randy Sarver of the Department's Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) initiated a Cooperative Stream Investigation (**CSI**) project to collect total nitrogen (**TN**), total phosphorus (**TP**), total suspended solids (**TSS**), *E. coli* and chloride samples along with discharge measurements from the upper Two-mile Creek watershed in St. Louis County, Missouri.

The Two-mile Creek watershed is in the western part of the Deer Creek watershed. The main stem of Two-mile Creek is assigned Waterbody Identification Number (**WBID**) 4079. Additionally one tributary in the northwest part of the Two-mile Creek watershed is assigned WBID 4080; and three unnamed tributaries in the Two-mile Creek watershed have not been assigned a unique WBID and are temporarily assigned WBID 3960. The Missouri Use Designation Dataset (**MUDD**) Version 1.0 includes WBID 3960 as a temporary waterbody code that will be replaced with unique WBIDs in the future.

Designated recreational uses for Two-mile Creek WBIDs 4079, 4080, and 3960 are listed as Whole Body Contact – Class B (**WBC-B**) and Secondary Contact Recreation (**SCR**). The Missouri Water Quality Standard (**WQS**) *E. coli* criterion for WBC-B is 206/100 ml Most Probable Number (**MPN**); and SCR is 1134/100 ml MPN. The *E. coli* criterion is based on a geometric mean of at least five samples collected during the recreational season (April 1 – October 31).

The (3) Two-mile Creek tributaries (WBID 3960) and tributary WBID 4080 are not currently on the impaired waterbody list (**303d list**). However, the main stem of Two-mile Creek WBID 4079 was placed on the United States Environmental Protection Agency (**USEPA**) approved Missouri 303(d) list for impairment by *E. coli* in 2016. The source of *E. coli* is listed as Urban Runoff/Storm Sewers.

A Total Maximum Daily Load (**TMDL**) for *E. coli* pollution of Two-mile Creek (WBID 4079) is planned to begin in 2026. TMDLs are developed by the Department in accordance with Section 303(d) of the federal Clean Water Act (**CWA**). Section 303(d) of the CWA and federal regulations in 40 Code of Federal Regulations, Part 130.7 require TMDL development for waters not meeting designated beneficial uses under technology-based controls for pollutants of concern. The purpose of a TMDL is to determine the maximum amount of a pollutant (the load) that a water body can assimilate without exceeding the Missouri WQS for that pollutant. The TMDL determines the pollutant loading capacity necessary to meet the Missouri WQS established for each water body based on the relationship between pollutant sources and in-stream water quality conditions. The goal of the TMDL program is to restore designated beneficial uses to water bodies. Therefore, identification of sources and implementation of Best Management Practices (**BMP**) to address the sources are critical to watershed restoration.

Historical monitoring results have documented high nutrients, *E. coli* and chloride concentrations in the Deer Creek watershed. Approximately 20% - 60% of the sources of *E. coli* in the watershed are from wildlife and other animals. The St. Louis Metropolitan Sewer District has progressed in reducing sanitary sewer overflows into area creeks and storm water permits are addressing other human sources of *E. coli*. However, it is not feasible to remove wildlife and animal excrement as a source. Therefore an emphasis on voluntary, plant-based solutions to reduce storm water runoff is the most effective way to address these additional non-point sources of nutrients and *E. coli* in the watershed and is key to reducing pollutant loads from storm water runoff in the watershed. According to a 2010 USGS study of Metropolitan St. Louis streams, *E. coli* densities and loads typically were many times greater in storm events than at base flow; primarily because loading increased as a result of runoff that contain bacteria contributions from the numerous combined and sanitary sewer overflows within the study area, as well as contributions from nonpoint source runoff. [Occurrence and Sources of *Escherichia* in Metropolitan St. Louis Streams, October 2004 <https://pubs.usgs.gov/sir/2010/5150/pdf/sir2010-5150.pdf> ]

To assist in improving water quality, a project through the Missouri Botanical Garden's Deer Creek Watershed Alliance has been funded by the 319 Nonpoint Source Implementation Grant Program. The project was designed in five phases, which include: Phase I (subgrant #G09-NPS-13); Phase II (subgrant #G11-NPS-15); Phase III (subgrant G14-NPS-04); Phase IV (subgrant G19-NPS-11); and Phase V (subgrant number G22-NPS-09). All phases implement BMPs that help address the stream bacteria impairment and improve the water quality of Deer Creek. BMP implementation will include practices like rain gardens, bioswales, woodland and riparian corridor restoration, permeable pavers, rain barrels, etc. Since the Deer Creek Watershed Initiative planning efforts began, there have been 466 BMP installations completed in the watershed to date, currently resulting in load reductions of 187.5 tons of sediment, 109 lbs. of nitrogen, and 21.5 lbs. of phosphorus per year from Deer Creek. When possible, pre-implementation and post-implementation water quality data will be collected to satisfy the monitoring components of the 319 Grants.

Two-mile Creek has been identified by the Deer Creek Watershed Alliance as a priority area for BMP implementation. Figure 1 shows the upper Two-mile Creek watershed and priority areas TM\_01 and TM\_02 that are the focus of this CSI Project.

## 2.0 Project Objectives

This project will focus on the collection of current water quality data from the upper Two-mile Creek watershed in St. Louis County, Missouri.

The following objectives have been established for the Two-mile Creek CSI project:

1. Collect monthly samples for TP, TN, and TSS from April 2023 through April 2024.
2. Collect monthly *E. coli* samples during the 2023 recreational season (April 1, 2023 – October 31, 2023).

3. Collect monthly chloride samples during November 2023 through April 2024.
4. Measure stream discharge in association with each sampling event.
5. Send TN, TP, TSS, and chloride samples to the Department's ESP for analyses using USEPA approved/accepted standard methods.
6. Deliver *E. coli* samples to the St. Louis Regional Office (**SLRO**) for analyses.
7. Analyze temperature, conductivity, and water transparency as field parameters in conjunction with monthly samples. Analyses will use Missouri Stream Team, Volunteer Water Quality Monitoring (**VWQM**) Program procedures.
8. Use resulting nutrient, TSS, and *E. coli* bacteria data to establish concentrations and loading prior to implementation of BMPs.
9. Use resulting chloride data to assess water quality.

### **3.0 Project Planning**

Beginning in November 2022, Mr. Randy Sarver, VWQM Coordinator with the Department, and Ms. Stacy Arnold began discussion to investigate the possibility of a CSI Project on Two-mile Creek. Ms. Arnold is a Stream Team, Level 3, VWQM volunteer; a member of Stream Team's 2926 & 4149; serves on the Board of Stream Teams United; works as the Deer Creek Watershed Alliance Planning Coordinator for Missouri Botanical Garden; and was a VWQM cooperator in the 2020-2021 Deer Creek CSI Project and the 2021-2022 Windrush Creek CSI Project. Additionally, Mr. Steven McCarthy a Stream Team, Level 3, VWQM volunteer and member of Stream Team 5099 was asked to participate in the Two-mile Creek monitoring project and has agreed to assist. Mr. McCarthy was a VWQM cooperator in the 2020-2021 Deer Creek CSI Project and the 2021-2022 Windrush Creek CSI Project.

In December 2022, Ms. Arnold performed field reconnaissance of the upper Two-mile Creek watershed to look for access and to obtain landowner permission to monitoring locations.

On February 8, 2023, Mr. Sarver and Ms. Arnold further discussed the details of the Two-mile Creek CSI Project and confirmed the plan to sample at four locations.

### **4.0 Sampling Location**

Sampling will be focused at four locations in the upper Two-mile Creek watershed. See Figure 1 for a map of the sampling locations.

Site 4079/3.7/0.1 (WBID 3960) is located immediately downstream from Fawnvalley Drive. GIS map derived UTM coordinates are: 723915 Easting and 4277069 Northing in Zone 15.

Site 4079/3.7/0.3/0.5 (WBID 3960) is located immediately downstream from Jerrilen Court. GIS map derived UTM coordinates are: 723845 Easting and 4276009 Northing in Zone 15.

Site 4079/3.95 (WBID 4079) is located immediately downstream from Oak Drive. GIS map derived UTM coordinates are: 723687 Easting and 4277381 Northing in Zone 15.

Site 4079/4.05 (WBID 4079) is located approximately 25 meters upstream from Oak Drive and immediately upstream from the mouth of tributary WBID 4080. GIS map derived UTM coordinates are: 723639 Easting and 4277412 Northing in Zone 15.

## **5.0 Sampling Method**

USEPA approved/accepted standard method (hereafter referred to as standard method) samples for TP, TN, TSS, and chloride parameters, will be collected according to standard operating procedures (SOP) MDNR-ESP-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations; and MDNR-ESP-005: General Sampling Consideration Including the Collection of Grab, Composite, and Modified Composites from Streams and Wastewater Flows.

Each sample will be accompanied by an appropriate Chain-of-Custody, as detailed in MDNR-ESP-002: Field Sheets and Chain-of-Custody Record. Sample collection and chain-of custody training will be provided to the volunteers by the ESP, VWQM Coordinator.

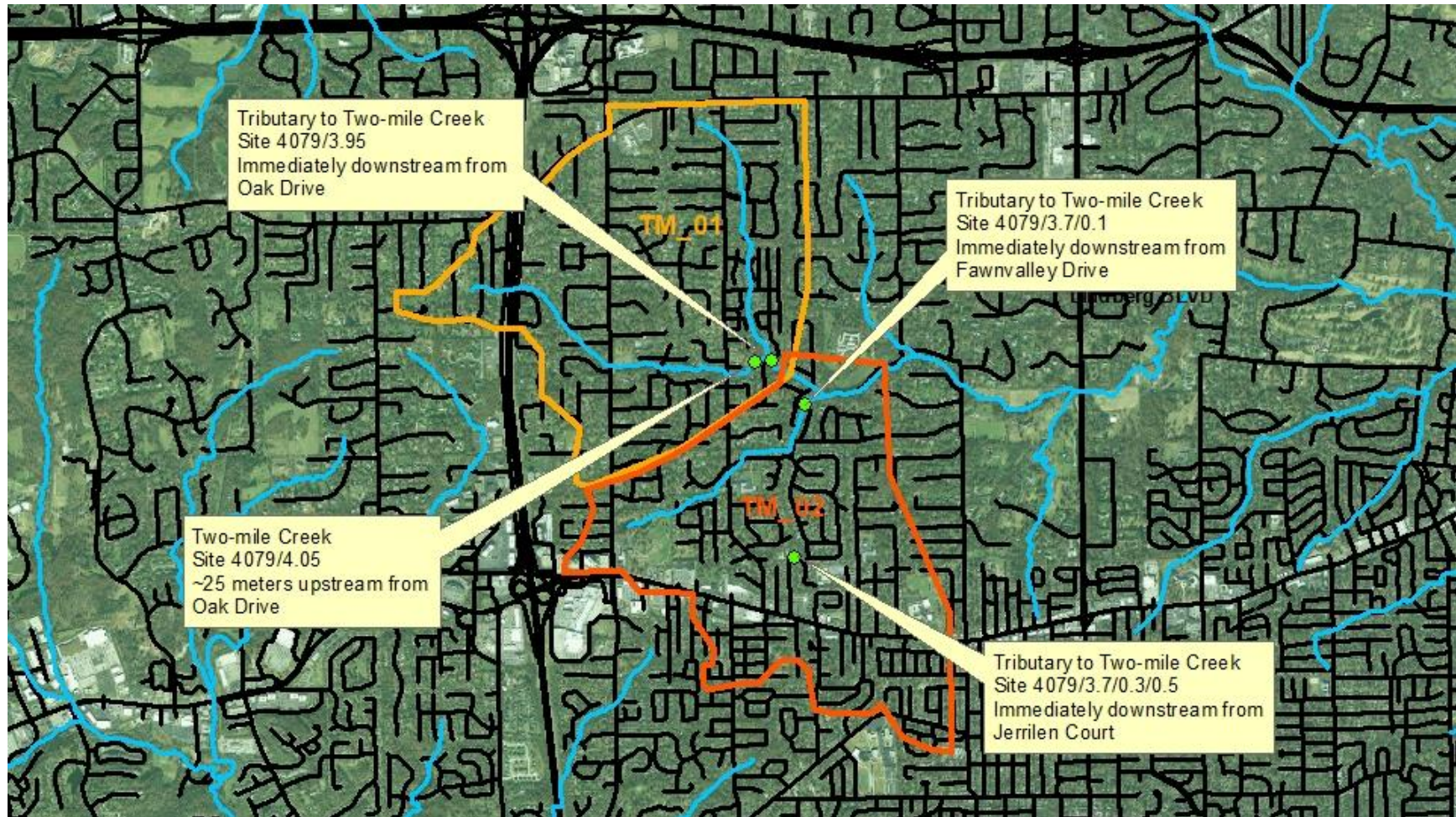
Discharge will be measured following the SOP MDNR-ESP-113: Flow Measurement in Open Channels, and will be reported on the Chain-of-Custody. Training will be provided to the volunteers by the ESP, VWQM Coordinator.

On the day of collection, properly preserved and packaged nutrient, TSS, and chloride samples will be delivered to a drop-off location for shipment to the Department's ESP for analyses. A memorandum of understanding has been developed between the Missouri Department of Health and Human Services to facilitate sample shipment to Jefferson City from sites throughout the state. Information concerning the most applicable drop-off location is as follows:

Facility: St. Luke's Hospital  
Address: 232 South Woodsmill Road, Chesterfield  
Phone: (314) 205-6984  
Contact Person: Don Darren  
Location: 2nd Floor Lab  
Pick-up Time: 1:40 p.m.  
Hours of Operation: 7:00 am - 5:30 pm

Also on the day of collection, *E. coli* samples will be relinquished to the SLRO. The SLRO has a complete set of IDEXX equipment, and will analyze the samples prior to the 8-hour holding time limit.

**Figure 1**  
**Map of Sampling Locations and Two-mile Creek Priority Watersheds**



## 5.1 Sampling Schedule

Standard method TP, TN, and TSS samples, accompanied by discharge measurements, will be collected once per month from April 2023 – April 2024. Additionally, standard method *E. coli* samples will be collected once per month from April 2023 – October 2023; and standard method chloride samples will be collected once per month from November 2023 – March 2024.

VWQM field analyses will occur in conjunction with each standard method sample collections (hereafter referred to as VWQM methods).

Duplicate samples will be randomly collected from one sampling station during each sampling event (see Table 1 –Sample Collection Schedule).

## 5.2 Stream Team Sampling Responsibilities

- Use appropriate methods to collect and preserve monthly TP, TN, TSS, *E. coli*, and chloride water samples for standard method analyses.
- Prepare equipment and perform field analyses of temperature, conductivity, and water transparency using VWQM methods. Record the data in a field notebook.
- Fill out appropriate sample information on the Department's Chain-of-Custody.
- On the same day as collection, and prior to the designated pickup time, deliver the TP, TN, TSS, and chloride samples at the courier locations for shipment to the Department's ESP.
- On the same day of collection, deliver the *E. coli* samples to the St. Louis Regional Office within 6 hours of collection.

## 5.3 Department Sampling Responsibilities

- Provide sample containers
- Provide chain-of-custodies for samples.
- Provide training for TP, TN, TSS, *E. coli*, and chloride sample collection and preservation.
- Provide H<sub>2</sub>SO<sub>4</sub> preservative for TP and TN sample preservation.
- Provide training for performing stream discharge measurements.
- Provide training for proper chain-of-custody use.
- Provide sample labels
- Provide shipping containers for shipping samples.
- Pick up shipped samples at the Health Department Laboratory in Jefferson City.

## **6.0 Stream Flow Measurements**

When possible, monthly stream flow measurements will be taken during each sampling event (see Table 1). Flow measurement training will be provided to Ms. Arnold and Mr. McCarthy following the SOP MDNR-ESP-113, Flow Measurements in Open Channels.

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**Table 1 Sample Collection Schedule (2023 – 2024)**

[illegible]

## **6.1 Stream Team Flow Measurement Responsibilities**

- Provide the flow meter and associated equipment.
- Attend training provided by the ESP, VWQM Program Coordinator.
- Follow Department Standard Operating Procedure for measuring open channel flow.
- Collect discharge measurement in association with water samples.
- Record discharge measurements on the Department's Chain-of-Custody form.

## **6.2 Department Flow Measurement Responsibilities**

- Provide flow measurement training.
- Provide the Department's SOP MDNR-ESP-113.
- Provide flow measurement data collection forms.

## **7.0 Sample Analysis**

Analyses of samples will follow two general approaches. One approach will use USEPA approved/accepted standard methods; the other will use VWQM volunteer methods.

### **7.1 Standard Method Nutrient Analyses**

The standard analytical methods used by ESP for TP and TN analyses are:

- Total Phosphorus (USGS I-2650-03 – Modified by ESP)
- Total Nitrogen (USGS I-2650-03 – Modified by ESP)

### **7.2 Standard Method TSS Analyses**

The standard analytical methods used by ESP for TSS analysis is:

- Method #2540, part D; Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017

### **7.3 Standard Method *E. coli* Analyses**

The standard analytical method used by ESP for *E. coli* analysis is:

- The Department's Standard Operating Procedure MDNR-ESP-109, Analysis of *E. coli* and Total Coliforms Using IDEXX Colilert and Quanti-Tray Test Method, based on Standard Method SM9223B.

## 7.4 Standard Method Chloride Analyses

The standard analytical method used by ESP chloride analysis is:

- SM 4500 Cl- G; Mercuric Thiocyanate Flow Injection Analysis.

## 7.5 VWQM Method Analyses

At the time of sample collection for standard method analyses, water will be analyzed streamside using VWQM Program SOPs. Parameters to be collected include temperature, conductivity, and water transparency. Temperature and conductivity will be analyzed using a Hach Pocket Pro model meter; and water transparency will be analyzed using a VWQM water transparency tube. Applicable VWQM Program SOPs can be found at <http://www.mostreamteam.org/training-materials-and-resources.html>.

## 8.0 Data Reporting

Standard method data generated from CSI projects are collected for specific purposes. In order to meet the objectives of this project, data must be available for assessment purposes. The Two-mile Creek CSI Project data will be entered and housed in the ESP Laboratory Information Management System (**LIMS**).

### 8.1 Stream Team Data Reporting Responsibilities

- Results from discharge measurements will be reported as a field parameter on the appropriate Department Chain-of-Custody.
- Since analyses for temperature, conductivity, and water transparency will utilize VWQM methods, the results will be reported on an Excel spreadsheet at the end of the project.

### 8.2 Department Data Reporting Responsibilities

- Analytical results for TP, TN, TSS, *E. coli*, and chloride will be reported via the ESP LIMS.
- Analytical results for temperature, conductivity, and water transparency will be reported via an Excel spreadsheet.
- Analysis will be charged to Labor Distribution Profile (**LDPR**) code, Volunteer Monitoring (**FEVLM**) and will automatically be provided to the Project Manager in the WPP. After receipt by the WPP, data will be entered into the Water Quality Assessment (**WQA**) database.
- A final report will be written by the ESP, VWQM Coordinator.

## **9.0 Quality Assurance/Quality Control (QA/QC)**

Accurate and precise data is needed in any monitoring project. As part of quality assurance, one field audit will be conducted by the VWQM Coordinator. Additionally, standard QA/QC procedures incorporated into specific SOPs will be followed during the project and one duplicate sample will be collected for all sampling dates (see Table 1 Sample Collection Schedule).


### **9.1 Stream Team QA/QC Responsibilities**

- Follow SOP for field analyses, sample collection and sample preservation.
- Collect one duplicate sample for nutrients, TSS, chloride and *E. coli* during each sampling event (see Table 1 – Sampling Collection Schedule).

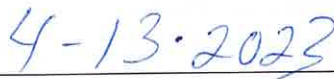
### **9.2 Department QA/QC Responsibilities**

- Review chemical parameter data for values outside QC limits.
- Review training with volunteers if necessary.
- Make one yearly field audit during the life of the project.
- Update the project plan as necessary.

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