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Norfolk Southern Railway Company

Appendix H2 – Leslie Run and Downstream Creeks Characterization Work Plan

East Palestine Train Derailment

Columbiana County, Ohio

Rev: 2

Rev Date: July 31, 2023

Attachment H2 – Leslie Run and Downstream Creeks Characterization Work Plan

East Palestine Train Derailment
Columbiana County, Ohio

July 31, 2023

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0	July 12, 2023		Initial Plan
1	July 26, 2023	All	Plan revised to address US EPA and OH EPA comments received July 19, 2023 and incorporate sheen sampling
2	July 31, 2023	All	Plan revised to address US EPA and OH EPA comments received July 29, 2023

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Attachments

Attachment A. Field Standard Operating Procedures

- Standard Operating Procedure #1: Sediment Characterization via Probing and Sampling
- Standard Operating Procedure #2: Pore Water Sampling
- Standard Operating Procedure #3: Surface Water Sheen Sampling

1 Introduction

This Sediment Characterization Work Plan (Plan) was developed on behalf of Norfolk Southern Railway Company (NSRC) by Arcadis U.S., Inc. (Arcadis) in response to the derailment in East Palestine, Ohio, and pursuant to the United States Environmental Protection Agency (USEPA) February 21, 2023 Unilateral Administrative Order for Removal Actions (UAO), which became effective on February 27, 2023. This Plan supports the response, characterization, and any needed remediation activities related to the derailment specific to Leslie Run and the downstream creeks starting at the confluence with Sulphur Run and continuing to the confluence with Little Beaver Creek (Figure 1). This Plan is an appendix to the Quality Assurance Project Plan (QAPP), complements the Sulphur Run Sediment Characterization Work Plan (Arcadis 2023b, QAPP Appendix H1), and also replaces the previous Sediment Sampling Work Plan submitted in March 2023 as Appendix H to the Removal Work Plan (Arcadis 2023a).

The purpose of this Plan is to provide details on sampling activities proposed to delineate the extent of potential environmental impacts from contaminants of potential concern (COPCs) in Leslie Run, Bull Creek, and North Fork Little Beaver Creek, consistent with Paragraphs 36 and 38 of the UAO. The list of COPCs to inform delineation of the extent of sediment contamination, as required by the UAO, represents what was on the train, what was subsequently detected in surface water and sediment, and what is potentially toxic to human health. Associated degradation products and combustion products were also considered. The investigation questions to be addressed by the actions outlined herein are identified in the QAPP Worksheet #11: Project Data/Quality Objectives. Sediment investigation activities in these creeks were initially performed in February and March 2023. Qualitative stream sediment assessments were conducted in Leslie Run by EnviroScience in March and May 2023. These investigation and assessment activities are summarized in Section 2 and the results guide the investigation efforts proposed herein. Sections 3 and 4 outline the investigation scope, locations, and procedures and Section 5 identifies the analytical testing for the COPCs. Section 6 provides a target schedule for implementation of the sampling activities outlined herein, and Section 7 lists references used throughout the Plan.

The results from the sampling efforts will be incorporated into the Conceptual Site Model (CSM) – QAPP Worksheet #10 and may lead to additional investigation activities and/or evaluation of future potential work.

Additional sampling may be directed by the Agencies/Unified Command and the Agencies may take split or co-located samples. Notifications and logistics will accommodate these requests as needed.

2 Completed Sediment Investigations

Sediment characterization activities were performed in Leslie Run, Bull Creek, and North Fork Little Beaver Creek in February, March, and May 2023, and included the following:

- Sediment sampling on February 15, 2023 (4 samples). Samples were collected co-located with water monitoring stations W-9, W1R, and W-4 in Leslie Run and W-11 in a tributary to Leslie Run. W-9 is located in Leslie Run upstream of the confluence with Sulphur Run and the others are located downstream. W-11 was collected from the tributary to the east of Leslie Run about 1,000 feet downstream of the confluence with Sulphur Run.
- Sediment sampling on February 22, 2023 (8 samples). Samples were collected at the 4 locations sampled on February 15, 2023, including W-9, W-1R, W-4, and W-11 and at 4 additional downstream locations (SED-5 though SED-8). SED-5 and SED-6 are located within Leslie Run, SED-7 within Bull Creek, and SED-8 within North Fork Little Beaver Creek.
- Sediment sampling on March 16, 2023 (8 samples). Sediment were collected at the 8 locations sampled on February 22, 2023.
- Qualitative stream sediment assessment surveys (EnviroScience 2023a) of Leslie Run were performed on March 16, 2023 and May 18-19, 2023 to visually characterize areas of potentially impacted sediments. The May 2023 follow-up survey was performed following implementation of the clean-up tactic completed between May 10-13, 2023 that included stream bed washing from just downstream of the confluence of Sulphur and Leslie Runs to downstream of the East Palestine Wastewater Treatment Plant outfall.

The February and March 2023 Leslie Run, Bull Creek, and North Fork Little Beaver Creek sediment sampling analytical results are provided in Table 2-1 and Figure 2 presents the sampling locations. Note that a sediment sample was also collected from Sulphur Run (station W-2 located 500 feet upstream of the confluence with Leslie Run) during each of the events identified in the bullets above; these data are included in the Sulphur Run Characterization Work Plan (Arcadis 2023b). All February and March 2023 characterization efforts and corresponding results are summarized in a summary report to be provided under separate cover; submittal of this report is targeted for August 2023.

3 Sediment Investigation Scope

This section outlines the investigation activities for Leslie Run, Bull Creek, and North Fork Little Beaver Creek proposed to answer the investigative questions identified in the QAPP. Additional investigation efforts will be identified and proposed as necessary pending receipt and evaluation of the data generated through the activities outlined in this section.

3.1 Sediment Sampling

Sediment sampling is proposed for Leslie Run, Bull Creek, and North Fork Little Beaver Creek to assess COPC concentrations primarily in surface sediment as well as obtain information in the biologically active zone (assumed to be the top 6 inches, but could be deeper or shallower). The primary focus for sampling in these downstream creeks is Leslie Run; fewer samples are identified for collection in Bull Creek and North Fork Little Beaver Creek given the decreasing observations of sheens moving downstream (small strings of sheen found sporadically from Bull Creek to the rail bridge – see Figure 2). Future additional sampling may be proposed pending results of the work outlined herein.

Target sampling locations within Leslie Run were primarily guided by the results of the May 2023 qualitative stream sediment assessment. This assessment was performed from the confluence with Sulphur Run to the confluence with Bull Creek; the assessment was not completed from just north of Carbon Hill Road to the rail bridge south of Bye Road due to pending access. During these efforts, the stream was qualitatively categorized with scores of 0 through 3 based on the sheens observed by the field team considering speed of release from the disturbed sediment, horizontal expanse of sheen, and presence of odor. The sheen criteria included the following: Score 0 = no sheen; Score 1 = light sheen; Score 2 = medium sheen; and Score 3 = heavy sheen. Figure 2 provides the results of the sheen assessment. In general, Leslie Run areas were scored as 2, 1, and/or combinations thereof with one small area located upstream of a log jam near the East Palestine Park parking lot along Route 170 scored as 3. The stretch pending access was assumed to be scored 1 based on upstream and downstream observations. Based on this qualitative sheen assessment, sediment sampling will be performed at select locations to provide data from the range of sheen scores, but will target the area with a score of 3 and stream extents with scores of 2 and 1 & 2 as these areas would be anticipated to potentially contain COPCs. In addition, where possible considering the sheen categories, sampling locations were selected to coincide with the locations sampled in February/March 2023 and the locations targeted for biological (biocriteria) monitoring (EnviroScience 2023b). Sampling locations were also selected to provide coverage for the length of Leslie Run as possible considering creek access and to avoid sampling in similarly scored areas immediately adjacent to each other. A sample will also be collected from Leslie Run upstream of any potential derailment impacts.

Sample locations within Bull Creek and North Fork Little Beaver Creek will target locations sampled in February/March 2023 and the locations targeted for biological monitoring (EnviroScience 2023b). Note that two of the sample locations (L01S07 and L01S04) are approximately 1 mile from the portions of the creeks primarily under investigation, but these are included to coincide with all targeted biological monitoring locations. The biological monitoring plan is under review and modifications to monitoring locations may result in adjustments to sediment sampling locations; any adjustments will be communicated to the Agencies/Unified Command. An additional location will also be targeted within Bull Creek near the confluence with North Fork Little Beaver Creek based on probing efforts in March 2023 that indicated this area represented the downstream extent for presence of sheens at the time of this effort (i.e., no sheens were observed at probing in North Fork Little Beaver Creek 400 feet downstream of confluence with Bull Creek and at Carmel Achor Road Bridge).

The sampling location will initially target the approximate mid-point of the stream width as a starting point for probing efforts. Probing will be performed around this target location (towards the banks and up to 50 feet upstream and downstream or as limited by the particular targeted sheen category) to identify locations with recoverable sediment (i.e., fine grained materials) that exhibit the greatest sheens when disturbed (i.e., bias sample collection towards sediment that visually appears to be impacted). Sampling will then be performed at the location identified to contain fine-grained materials and the greatest sheen in the vicinity of the target location (i.e., sampling will not be constrained to the mid-point of the stream but will be guided by probing results). A total of 20 locations have been selected for sampling. The proposed locations are provided on Figure 2.

Sampling will target the surface interval (up to 6 inches) of recoverable material (e.g., silt and sand, no or minimal gravel). If less than 6 inches are present, a single grab of the material will be sampled as long as an adequate volume can be obtained for the required analytical testing. If adequate material is not available with a single grab, multiple grab samples may be collected and composited to form a single sample with an adequate volume; however, this composite sample will not be submitted for analysis of volatile organic compounds (VOCs). For VOC testing, an additional single grab sample will be collected from one of the grab sample locations used to form the composite. Since the biologically active zone could be deeper or shallower than the assumed 6 inches, samples will also be collected from deeper sediment (target 6 to 12 inches below the sediment surface) as possible in areas identified to contain sheens during the May 2023 stream assessment. Deeper sampling is focused in the areas identified to contain medium to heavy sheen categories. Collection of materials at depth (greater than 6 inches) may be challenging given the nature of the stream channel but will be performed through core collection using a steel sampling barrel with slide hammer or hand auger (see Attachment A for additional details).

All sediment sampling will be performed in accordance with the Standard Operating Procedure (SOP) #1 provided in Attachment A. The SOP describes probing efforts and sediment sampling using various collection methods (e.g., methods range using a stainless-steel trowel to coring with steel sampling barrel and slide hammer). Table 3-1 summarizes the proposed sediment sample locations, selection rationale, and sampling interval(s).

Table 3-1 Sample Locations

Sample ID	Basis	Sheen Score	Sample Type	Sediment Sample Interval
Leslie Run				
W009	Background location, existing February/March 2023 location	Not assessed	Sediment and pore water	Surface and deeper sediment
L01S11	Biocriteria location	Not assessed	Sediment	Surface
L01S10	Biocriteria location and sheen presence	1	Sediment	Surface
W011	Existing February/March 2023 location	Not assessed	Sediment	Surface
LR-01	Sheen presence	1 & 2	Sediment and pore water	Surface and deeper sediment
LR-02	Sheen presence	1 & 2	Sediment and pore water	Surface and deeper sediment

Sample ID	Basis	Sheen Score	Sample Type	Sediment Sample Interval
W001R	Existing February/March 2023 location and sheen presence	2	Sediment, pore water, and sheen	Surface and deeper sediment
LR-03	Sheen presence	3	Sediment, pore water, and sheen	Surface and deeper sediment
L01S09	Biocriteria location and sheen presence	1 & 2	Sediment and pore water	Surface and deeper sediment
W004	Existing February/March 2023 location and sheen presence	1 / 1 & 2	Sediment	Surface and deeper sediment
LR-04	Sheen presence	1 & 2	Sediment and pore water	Surface and deeper sediment
SED-05	Existing February/March 2023 location	Assumed 1	Sediment	Surface
602010	Biocriteria location	0 & 1	Sediment	Surface
SED-06	Existing February/March 2023 location	0 & 1	Sediment	Surface
Bull Creek				
L01S07	Biocriteria location	Not assessed	Sediment	Surface
L01S06/SED-07	Biocriteria location and existing February/March 2023 location	Not assessed	Sediment	Surface
BC-01	March 2023 probing most downstream sheen presence	Not assessed	Sediment	Surface
North Fork Little Beaver Creek				
L01S04	Biocriteria location	Not assessed	Sediment	Surface
SED-08	Biocriteria location and existing February/March 2023 location	Not assessed	Sediment	Surface
612010	Biocriteria location	Not assessed	Sediment	Surface

Note: Samples listed upstream to downstream (see Figure 2).

3.2 Pore Water Sampling

Pore water sampling is proposed to provide sediment pore water COPC concentrations near the groundwater and surface water interface. Pore water sampling will be performed in Leslie Run co-located with the sediment sample locations identified in Section 3.1 to coincide with areas assessed to include scores of 3 and 2 (medium to heavy sheen) during the May 2023 qualitative assessment. This includes LR-01, LR-02, W001R, LR-03, L01S09, and LR-04. Location W009 is included to understand background conditions. A total of 7 locations are proposed for pore water sampling as shown on Figure 2 and summarized in Table 3-1.

Sampling will be performed in accordance with SOP #2 provided in Attachment A. Additional locations may be proposed in a later plan based on evaluation of results obtained in Leslie Run.

3.3 Sheen Sampling

Sampling is proposed to provide a qualitative mechanism to identify if COPCs related to the train derailment are present in sheens observed on the water surface. Sheen for the purpose of this sampling plan may be defined as a substance that when released from sediment, organic material, or physical entrainment, produces a color, sheen, film, or other temporary or permanent non-aqueous phased substance on the surface of the water. The Ohio Environmental Protection Agency (Ohio EPA) has documented the presence of rainbow sheens and a translucent film when the sediment is disturbed in the streams. Efforts will be made to capture both sheen types separately to allow for individual analysis.

Stream sheen assessment procedures will include sample collection using Teflon® (polytetrafluorethylene [PTFE]-fluorocarbon polymer) nets in accordance with SOP #3 provided in Attachment A. Sample locations will initially target areas identified to contain include scores of 3 and 2 (medium to heavy sheen) during the May 2023 qualitative sheen assessment and will be co-located with the sediment sample locations identified in Section 3.1 and pore water samples identified in Section 3.2. These locations include LR-01 and W001R as shown on Figure 2 and summarized in Table 3-1.

Sheen samples will also be collected in Sulphur Run. Sediment and pore water characterization activities for Sulphur Run are included under a separate Work Plan (Arcadis 2023b). Sampling will target the 5 areas in Sulphur Run scored as 3 (heavy sheen) during the May 2023 qualitative sheen assessment and will be co-located with sediment sample locations. These locations include SR- 4, SR-5, SR-6, SR-8, and SR-9 as illustrated on Figure 3.

At each target location, the field team will disturb the surface of the sediment bed to attempt to generate a sheen for sample collection. Field teams will initially target the lateral center point and then work outward (i.e., upstream, downstream, and toward the banks) to generate and capture sheens. Multiple collection efforts with each net will be made within each extent to capture adequate sheens for analytical testing. Up to two samples may be collected from each location if field teams observe and can capture individually both sheen types.

4 Sample Processing

Samples for laboratory analysis will be collected per the procedures described in Attachment A. All samples will be preserved in accordance with analytical method requirements, sealed in coolers, and shipped to the selected laboratory under chain-of-custody protocol and analyzed within required holding times in accordance with the QAPP.

Samples will be labeled using the nomenclature listed below.

Sediment samples:

- Media sampled (SED)
- Location of sample (i.e., see sample ID in Table 3-1 as shown on Figure 2)
- Sample depth in inches
- Sample Date in YYYYMMDD
- **Example: SED- L01S10(0-6)-20230717**
- Field duplicate samples
    - SFD (for Sediment Field Duplicate)
    - Sequential number
    - Sample Date in YYYYMMDD
    - Example: **SFD-1-20230717**

Pore water samples:

- Media sampled (PW)
- Location of sample (i.e., LR-01, LR-02, W001R, LR-03, L01S09, and LR-04 as shown on Figure 2)
- Sample Date in YYYYMMDD
- Example: **PW-W001R-20230717**
- Field duplicate samples
    - PFD (for Pore Water Field Duplicate)
    - Sequential number
    - Sample Date in YYYYMMDD
    - Example: **PFD-1-20230717**

Sheen samples:

- Media sampled (SHN)
- Location of sample (e.g., LR-01 as shown on Figure 2 or SR-5 as shown on Figure 3)
- Sheen type (i.e., R for rainbow or F for translucent film)
- Sample Date in YYYYMMDD
- Example: **SHN-W001R-R-20230717**

- Trip blank samples
    - SHNTB (for Sheen Sample Trip Blank)
    - Sequential number
    - Sample Date in YYYYMMDD
    - Example: **SHNTB-1-20230717**

5 Laboratory Analysis and QA/QC

Required laboratory analysis and QA/QC for each medium are described below.

5.1 Sediment and Pore Water

Sediment and pore water samples will be couriered or shipped to the laboratory under standard chain-of-custody procedures and analyzed for the parameters listed in Table 5-1. If composite sediment samples are collected, these samples will be submitted for non-VOC analysis only, with separate distinct grab samples collected for VOC analysis. All sediment samples will also be submitted for total organic carbon analysis and grain size analysis.

Table 5-1 Analyte List

Analyte	CAS#	Analytical Method
Acenaphthene	83-32-9	SVOCs (USEPA Method 8270)
Acenaphthylene	208-96-8	SVOCs (USEPA Method 8270)
Anthracene	120-12-7	SVOCs (USEPA Method 8270)
Benzo[a]anthracene	56-55-3	SVOCs (USEPA Method 8270)
Benzo[a]pyrene	50-32-8	SVOCs (USEPA Method 8270)
Benzo[b]fluoranthene	205-99-2	SVOCs (USEPA Method 8270)
Benzo[g,h,i]perylene	191-24-2	SVOCs (USEPA Method 8270)
Benzo[k]fluoranthene	207-08-9	SVOCs (USEPA Method 8270)
Benzoic Acid	65-85-0	SVOCs (USEPA Method 8270)
Benzyl Alcohol	100-51-6	SVOCs (USEPA Method 8270)
2-Butyloxyethanol (Ethylene Glycol Monobutyl Ether)	111-76-2	SVOCs (USEPA Method 8270)
Chrysene	218-01-9	SVOCs (USEPA Method 8270)
2,4-Dinitrophenol	51-28-5	SVOCs (USEPA Method 8270)
2,6-Dinitrotoluene	606-20-2	SVOCs (USEPA Method 8270)
4,6-Dinitro-2-Methylphenol	534-52-1	SVOCs (USEPA Method 8270)
Fluoranthene	206-44-0	SVOCs (USEPA Method 8270)
Fluorene	86-73-7	SVOCs (USEPA Method 8270)
Indeno[1,2,3-cd]pyrene	193-39-5	SVOCs (USEPA Method 8270)
Isophorone	78-59-1	SVOCs (USEPA Method 8270)
1-Methylnaphthalene	90-12-0	SVOCs (USEPA Method 8270)
2-Methylnaphthalene	91-57-6	SVOCs (USEPA Method 8270)
3 & 4-Methylphenol (M, P-Cresols)	65794-96-9	SVOCs (USEPA Method 8270)
Naphthalene	91-20-3	SVOCs (USEPA Method 8270)
2-Nitrophenol	88-75-5	SVOCs (USEPA Method 8270)

Analyte	CAS#	Analytical Method
4-Nitrophenol	100-02-7	SVOCs (USEPA Method 8270)
Phenanthrene	85-01-8	SVOCs (USEPA Method 8270)
Phenol	108-95-2	SVOCs (USEPA Method 8270)
Pyrene	129-00-0	SVOCs (USEPA Method 8270)
Acetone	67-64-1	VOCs (USEPA Method 8260)
Benzene	71-43-2	VOCs (USEPA Method 8260)
Carbon Disulfide	75-15-0	VOCs (USEPA Method 8260)
2-Ethylhexyl acrylate	103-11-7	VOCs (USEPA Method 8260)
Ethylbenzene	100-41-4	VOCs (USEPA Method 8260)
2-Hexanone	591-78-6	VOCs (USEPA Method 8260)
Methyl Acrylate	96-33-3	VOCs (USEPA Method 8260)
Methyl Ethyl Ketone (2-Butanone)	78-93-3	VOCs (USEPA Method 8260)
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	108-10-1	VOCs (USEPA Method 8260)
m-Xylene & p-Xylene	179601-23-1	VOCs (USEPA Method 8260)
n-Butyl acrylate	141-32-2	VOCs (USEPA Method 8260)
Nitrobenzene	98-95-3	VOCs (USEPA Method 8260)
o-Xylene (1,2-Dimethylbenzene)	95-47-6	VOCs (USEPA Method 8260)
Styrene	100-42-5	VOCs (USEPA Method 8260)
1,2,4-Trimethylbenzene	95-63-6	VOCs (USEPA Method 8260)
Toluene	108-88-3	VOCs (USEPA Method 8260)
Vinyl chloride	75-01-4	VOCs (USEPA Method 8260)
Diethylene Glycol	111-46-6	Glycols (USEPA Method 8015)
Ethylene Glycol	107-21-1	Glycols (USEPA Method 8015)

Equipment blanks (consisting of rinsate from sampling equipment), field duplicates, and matrix spike/matrix spike duplicates (MS/MSDs) will be collected and analyzed as outlined in the QAPP.

Deliverables will be requested from the laboratory for work conducted under this Plan, and data validation consistent with USEPA guidelines will be completed on each sample data group per the QAPP requirements.

All analytical results will be uploaded into NRSC’s EQuIS database in accordance with the QAPP.

5.2 Sheens

The nets will be couriered or shipped to the laboratory under standard chain-of-custody procedures and analyzed for the parameters provided in Table 5-1. Analytical testing will be performed to identify analytes present in the samples, and results will be reported as mass per net, or similar. If possible and based on measured masses, the laboratory or NSRC will provide a percent of total sample for each analyte identified in the results.

6 Schedule

Each of the investigation activities described in this Plan[1] are proposed as a one-time event. Sampling efforts are targeted for early August 2023, pending QAPP and Plan approval by Unified Command and following completion of the Sulphur Run sediment/pore water sampling activities targeted to commence late July 2023. Sampling efforts will be coordinated with the aquatic biocriteria sampling efforts (EnviroScience 2023b) to align timing such that the activities outlined herein would be performed first and as soon as possible followed by the first round of biocriteria monitoring with the data from each effort collected in reasonable temporal proximity, as conditions and schedule permit.

The duration of sediment and pore water sampling field activities is anticipated as 1-2 weeks. The need and timing for any additional sampling events will be determined based on results from the initial event as outlined in QAPP Worksheet #11: Project Data/Quality Objectives. The pore water sampling setup (i.e., screen, tubing, etc. as outlined in SOP #2) will remain in place pending review of the COPC results from the initial sampling in the event that future sampling is determined to be necessary. If additional sampling is not necessary, the equipment will be removed from the receiving streams.

[1] This Leslie Run and Downstream Creeks Sediment Characterization Plan supplements the Sulphur Run Sediment Characterization Plan (Arcadis 2023b). Both documents replace the Sediment Sampling Work Plan included as Appendix H to the March 2023 Removal Work Plan. Future plans developed to address creeks downstream of the extent identified herein or those proposing additional sampling in Sulphur Run and/or the extent identified herein will supplement this Plan and also replace Appendix H.

7 Reporting

A brief summary report will be prepared following completion of the field efforts and receipt/validation of the analytical results with a discussion regarding next steps. This report will include data summary tables, figures illustrating results, and a discussion as to how the findings may impact the CSM.

8 References

Arcadis. 2023a. Removal Work Plan, East Palestine Train Derailment Site, East Palestine, Ohio, Norfolk Southern Railway Company. March 6.

Arcadis. 2023b. Sulphur Run Characterization Work Plan, East Palestine Train Derailment Site, East Palestine, Ohio, Norfolk Southern Railway Company. July 11. Appendix H1 to the East Palestine Train Derailment Site Sediment Sampling Work Plan Quality Assurance Project Plan.

EnviroScience. 2023a. Qualitative Stream Sediment Assessment Sampling Summary Report, East Palestine, Ohio. May 24.

EnviroScience. 2023b. Draft Aquatic Biocriteria and Stream Assessment Plan of East Palestine Streams: Sulphur Run, Leslie Run, Bull Creek, and North Fork Little Beaver Creek. June 16.

Tables

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID:		SED 05	SED 05	SED 06	SED 06	SED 07	SED 07	SED 08	SED 08	W 1R	W 1R	W 1R
Sample Depth(ft):		0 0.2	0 0.2	0 0.6	0 0.6	0 0.7	0 0.7	0 0.4	0 0.9	0 0.4	0 0.6	0 0.6
Date Collected:		02/22/23	03/16/23	02/22/23	03/16/23	02/22/23	03/16/23	03/16/23	02/22/23	03/16/23	02/15/23	02/22/23
Lab Sample ID:	Units	240 180811 13	240 182042 4	240 180811 18	240 182042 3	240 180811 17	240 182042 2	240 182042 1	240 180811 16	240 182042 5	240 180445 2	240 180811 20
Volatile Organics												
1,1,1-Trichloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,1,2,2-Tetrachloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076 *3	<0.30	<0.0075 *3	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,1,2-trichloro-1,2,2-trifluoroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,1,2-Trichloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,1-Dichloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,1-Dichloroethene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,2,4-Trichlorobenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076 *3	<0.30	<0.0075 *3	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,2-Dibromo-3-chloropropane	mg/kg	<1.5 *- [<1]	<0.015	<0.37	<0.015 *3	<0.61	<0.015 *3	<0.013	<0.65	<0.011	<0.54 [<0.5]	<0.24
1,2-Dibromoethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,2-Dichlorobenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076 *3	<0.30	<0.0075 *3	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,2-Dichloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,2-Dichloropropane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,3-Dichlorobenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076 *3	<0.30	<0.0075 *3	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
1,4-Dichlorobenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076 *3	<0.30	<0.0075 *3	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
2-Butanone	mg/kg	<2.9 [<2]	**0.016 J**	<0.74	**0.023 J**	<1.2	<0.030	<0.026	<1.3	<0.023	<1.1 [<1]	<0.49
2-Ethylhexyl acrylate	mg/kg	<7.3 [<5]	<0.074	<1.9	<0.076 *3	<3.0	<0.075 *3	<0.066 F1	<3.2	<0.056	**2.3 J [2.3 J]**	<1.2
2-Hexanone	mg/kg	<2.9 [<2]	<0.030	<0.74	<0.030	<1.2	<0.030	<0.026	<1.3	<0.023	<1.1 [<1]	<0.49
4-Methyl-2-pentanone	mg/kg	<2.9 [<2]	<0.030	<0.74	<0.030	<1.2	<0.030	<0.026	<1.3	<0.023	<1.1 [<1]	<0.49
Acetone	mg/kg	<2.9 [<2]	**0.064**	<0.74	**0.11**	<1.2	**0.070**	**0.033**	<1.3	<0.028	<1.1 [<1]	<0.49
Benzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Bromodichloromethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Bromoform	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Bromomethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Butyl Acrylate	mg/kg	<7.3 [<5]	<0.074	<1.9	<0.076	<3.0	<0.075	<0.066	<3.2	<0.056	<2.7 [<2.5]	<1.2
Carbon Disulfide	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Carbon Tetrachloride	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Chlorobenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Chloroethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Chloroform	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Chloromethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066 F2	<0.32	<0.0056	<0.27 [<0.25]	<0.12
cis-1,2-Dichloroethene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
cis-1,3-Dichloropropene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Cyclohexane	mg/kg	<1.5 [<1]	<0.015	<0.37	<0.015	<0.61	<0.015	<0.013	<0.65	<0.011	<0.54 [<0.5]	<0.24
Dibromochloromethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Dichlorodifluoromethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Ethanol	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.85 [<0.79]	NA
Ethylbenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Isopropylbenzene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Methyl acetate	mg/kg	**4.1 [3.5]**	<0.037	<0.93	<0.038	<1.5	<0.037	<0.033	**0.33 J**	<0.028	<1.3 [<1.2]	<0.61
Methyl Acrylate	mg/kg	<1.5 [<1]	<0.015	<0.37	<0.015	<0.61	<0.015	<0.013 F1	<0.65	<0.011	<0.54 [<0.5]	**0.22 J**
Methyl tert-butyl ether	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Methylcyclohexane	mg/kg	<1.5 [<1]	<0.015	<0.37	<0.015	<0.61	<0.015	<0.013	<0.65	<0.011	<0.54 [<0.5]	<0.24
Methylene Chloride	mg/kg	<1.5 [<1]	<0.037	<0.37	<0.038	<0.61	<0.037	<0.033	<0.65	<0.028	<0.54 [<0.5]	<0.24
Styrene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Tetrachloroethene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Toluene	mg/kg	<0.73 [<0.5]	**0.015**	<0.19	**0.0016 J**	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
trans-1,2-Dichloroethene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
trans-1,3-Dichloropropene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Trichloroethene	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Trichlorofluoromethane	mg/kg	<0.73 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Vinyl Chloride	mg/kg	<0.0074 [<0.5]	<0.0074	<0.19	<0.0076	<0.30	<0.0075	<0.0066 F2	<0.32	<0.0056	<0.27 [<0.25]	<0.12
Xylenes (total)	mg/kg	<1.5 [<1]	<0.015	<0.37	<0.015	<0.61	<0.015	<0.013	<0.65	<0.011	<0.54 [<0.5]	<0.24

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID:		SED 05	SED 05	SED 06	SED 06	SED 07	SED 07	SED 08	SED 08	W 1R	W 1R	W 1R
Sample Depth(ft):		0 0.2	0 0.2	0 0.6	0 0.6	0 0.7	0 0.7	0 0.4	0 0.9	0 0.4	0 0.6	0 0.6
Date Collected:		02/22/23	03/16/23	02/22/23	03/16/23	02/22/23	03/16/23	03/16/23	02/22/23	03/16/23	02/15/23	02/22/23
Lab Sample ID:	Units	240 180811 13	240 182042 4	240 180811 18	240 182042 3	240 180811 17	240 182042 2	240 182042 1	240 180811 16	240 182042 5	240 180445 2	240 180811 20
Semivolatile Organics												
1,1'-Biphenyl	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	**0.036 J**	**0.024 J**	<0.059	<0.057 [<0.054]	**0.028 J**
2,2'-Oxybis(1-Chloropropane)	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14	<0.16	<0.15	<0.13	<0.12	<0.11 [<0.11]	<0.11
2,4,5-Trichlorophenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
2,4,6-Trichlorophenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
2,4-Dichlorophenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
2,4-Dimethylphenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
2,4-Dinitrophenol	mg/kg	<1.8 [<1.2]	<1.1	<0.38	<0.51	<0.47 F2	<0.54	<0.49	<0.42	<0.39	<0.38 [<0.36]	<0.38
2,4-Dinitrotoluene	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
2,6-Dinitrotoluene	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
2-Butoxyethanol	mg/kg	<0.38 [<0.26]	**0.34**	<0.080	**0.13**	<0.10	<0.11	<0.10	<0.090	**0.12**	NA	<0.080
2-Butoxyethyl acetate	mg/kg	<0.38 [<0.26]	NA	<0.080	NA	<0.10	NA	NA	<0.090	NA	NA	<0.080
2-Chloronaphthalene	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
2-Chlorophenol	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
2-Methylnaphthalene	mg/kg	**0.51 [0.28]**	**0.21**	**0.054**	**0.055**	**0.021**	**0.039**	**0.37**	**0.25**	**0.10**	**0.097 [0.041]**	**0.28**
2-Methylphenol	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
2-Nitroaniline	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
2-Nitrophenol	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
3,3'-Dichlorobenzidine	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14 F2F1	<0.16	<0.15 F2	<0.13	<0.12	<0.11 [<0.11]	<0.11
3-Methylphenol, 4-Methylphenol	mg/kg	**<2.2 [0.14 J]**	**1.4**	<0.46	**0.78**	<0.57	**0.19 J**	**0.057 J**	<0.51	<0.47	<0.46 [<0.43]	<0.46
3-Nitroaniline	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
4,6-Dinitro-2-methylphenol	mg/kg	<1.8 [<1.2]	<1.1	<0.38	<0.51	<0.47 F2	<0.54	<0.49	<0.42	<0.39	<0.38 [<0.36]	<0.38
4-Bromophenyl-phenylether	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
4-Chloro-3-Methylphenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
4-Chloroaniline	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21 F2F1	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
4-Chlorophenyl-phenylether	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
4-Nitroaniline	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29 F2	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
4-Nitrophenol	mg/kg	<1.8 [<1.2]	<1.1	<0.38	<0.51	<0.47	<0.54	<0.49	<0.42	<0.39	<0.38 [<0.36]	<0.38
Acenaphthene	mg/kg	**0.33 [0.06]**	**0.051**	<0.017	<0.023	<0.021	<0.025	**0.018 J**	**0.0079 J**	**0.017 J**	**<0.017 [0.0043 J]**	**0.011 J**
Acenaphthylene	mg/kg	**0.23 [0.055 J]**	**0.051**	<0.017	<0.023	<0.021	<0.025	<0.022	**0.0064 J**	**0.0047 J**	<0.017 [<0.016]	<0.017
Acetophenone	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14	<0.16	<0.15	<0.13	<0.12	<0.11 [<0.11]	<0.11
Anthracene	mg/kg	**0.70 [0.21]**	**0.21**	**0.0074 J**	**0.0099 J**	**0.0061 J**	**0.011 J**	**0.10**	**0.0080 J**	**0.034**	**<0.017 [0.017]**	**0.022**
Atrazine	mg/kg	<1.1 [<0.75]	<0.67	<0.23	<0.31	<0.29	<0.33	<0.30	<0.26	<0.24	<0.23 [<0.22]	<0.23
Benzaldehyde	mg/kg	**0.15 J [<0.37]**	**0.091 J**	<0.11	<0.15	<0.14	<0.16	**0.058 J**	**0.039 J**	<0.12	<0.11 [<0.11]	<0.11
Benzo(a)anthracene	mg/kg	**2.9 [0.96]**	**0.94**	**0.047**	**0.059**	**0.032**	**0.056**	**0.26**	**0.046**	**0.23**	**0.012 J [0.064]**	**0.11**
Benzo(a)pyrene	mg/kg	**2.6 [1]**	**0.91**	**0.051**	**0.073**	**0.035**	**0.066**	**0.21**	**0.047**	**0.25**	**<0.017 [0.059]**	**0.11**
Benzo(b)fluoranthene	mg/kg	**3.6 [1.7]**	**1.2**	**0.095**	**0.12**	**0.056**	**0.095**	**0.23**	**0.077**	**0.34**	**0.027 [0.1]**	**0.22**
Benzo(g,h,i)perylene	mg/kg	**1.2 [0.27]**	**0.38**	**0.025**	**0.046**	**0.018 J**	**0.041**	**0.12**	**0.031**	**0.12**	**0.011 J [0.029]**	**0.050**
Benzo(k)fluoranthene	mg/kg	**1.4 [0.75]**	**0.46**	**0.037**	**0.042**	**0.018 J**	**0.040**	**0.10**	**0.023**	**0.14**	**<0.017 [0.037]**	**0.075**
bis(2-Chloroethoxy)methane	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14	<0.16	<0.15	<0.13	<0.12	<0.11 [<0.11]	<0.11
bis(2-Chloroethyl)ether	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14	<0.16	<0.15	<0.13	<0.12	<0.11 [<0.11]	<0.11
bis(2-Ethylhexyl)phthalate	mg/kg	**0.35 J [<0.26]**	<0.24	<0.080	**0.091 J**	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Butylbenzylphthalate	mg/kg	<0.38 [<0.26]	<0.24	<0.080	<0.11	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Caprolactam	mg/kg	<1.8 [<1.2]	<1.1	<0.38	<0.51	<0.47	<0.54	<0.49	<0.42	<0.39	<0.38 [<0.36]	<0.38
Carbazole	mg/kg	**0.21 J [0.11 J]**	**0.095 J**	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	**0.080**	<0.057 [<0.054]	<0.057
Chrysene	mg/kg	**3.0 [1.2]**	**1.0**	**0.057**	**0.082**	**0.034**	**0.065**	**0.29**	**0.067**	**0.35**	**0.035 [0.087]**	**0.14**
Dibenzo(a,h)anthracene	mg/kg	**0.35 [0.082]**	**0.13**	<0.017	<0.023	<0.021	**0.019 J**	**0.036**	<0.019	**0.039**	**<0.017 [0.0077 J]**	**0.011 J**
Dibenzofuran	mg/kg	**0.32 [0.13 J]**	**0.096 J**	**0.016 J**	**0.024 J**	<0.072	<0.082	**0.12**	**0.076**	**0.045 J**	**0.034 J [0.02 J]**	**0.070**
Diethylphthalate	mg/kg	<0.38 [<0.26]	<0.24	<0.080	<0.11	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Dimethylphthalate	mg/kg	**<0.38 [0.19 J]**	<0.24	<0.080	<0.11	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Di-n-Butylphthalate	mg/kg	<0.38 [<0.26]	<0.24	<0.080	<0.11	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Di-n-Octylphthalate	mg/kg	<0.38 [<0.26]	<0.24	<0.080	<0.11	<0.10	<0.11	<0.10	<0.090	<0.082	<0.080 [<0.076]	<0.080
Fluoranthene	mg/kg	**6.2 [2.2]**	**2.1**	**0.11**	**0.17**	**0.058**	**0.13**	**0.63**	**0.083**	**0.82**	**0.029 [0.15]**	**0.24**
Fluorene	mg/kg	**0.30 [0.079]**	**0.064**	<0.017	**0.0059 J**	<0.021	<0.025	**0.039**	**0.0097 J**	**0.024**	**0.0097 J [0.0071 J]**	**0.020**
Hexachlorobenzene	mg/kg	<0.082 [<0.056]	<0.050	<0.017	<0.023	<0.021	<0.025	<0.022	<0.019	<0.018	<0.017 [<0.016]	<0.017
Hexachlorobutadiene	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075 F2	<0.064	<0.059	<0.057 [<0.054]	<0.057
Hexachlorocyclopentadiene	mg/kg	<1.8 [<1.2]	<1.1	<0.38	<0.51	<0.47 F1	<0.54	<0.49 F1	<0.42	<0.39	<0.38 [<0.36]	<0.38

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID:		SED 05	SED 05	SED 06	SED 06	SED 07	SED 07	SED 08	SED 08	W 1R	W 1R	W 1R
Sample Depth(ft):		0 0.2	0 0.2	0 0.6	0 0.6	0 0.7	0 0.7	0 0.4	0 0.9	0 0.4	0 0.6	0 0.6
Date Collected:		02/22/23	03/16/23	02/22/23	03/16/23	02/22/23	03/16/23	03/16/23	02/22/23	03/16/23	02/15/23	02/22/23
Lab Sample ID:	Units	240 180811 13	240 182042 4	240 180811 18	240 182042 3	240 180811 17	240 182042 2	240 182042 1	240 180811 16	240 182042 5	240 180445 2	240 180811 20
Hexachloroethane	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075 F2	<0.064	<0.059	<0.057 [<0.054]	<0.057
Indeno(1,2,3-cd)pyrene	mg/kg	**1.2 [0.29]**	**0.37**	**0.023**	**0.046**	**0.016 J**	**0.043**	**0.098**	**0.022**	**0.11**	**<0.017 [0.025]**	**0.046**
Isophorone	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	**0.028 J**
Naphthalene	mg/kg	**0.34 [0.16]**	**0.11**	**0.029**	**0.028**	**0.013 J**	**0.023 J**	**0.19**	**0.18**	**0.043**	**0.025 [0.023]**	**0.15**
Nitrobenzene	mg/kg	<0.55 [<0.37]	<0.34	<0.11	<0.15	<0.14	<0.16	<0.15	<0.13	<0.12	<0.11 [<0.11]	<0.11
N-Nitroso-di-n-propylamine	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
N-Nitrosodiphenylamine	mg/kg	<0.27 [<0.19]	<0.17	<0.057	<0.077	<0.072	<0.082	<0.075	<0.064	<0.059	<0.057 [<0.054]	<0.057
Pentachlorophenol	mg/kg	<0.82 [<0.56]	<0.50	<0.17	<0.23	<0.21	<0.25	<0.22	<0.19	<0.18	<0.17 [<0.16]	<0.17
Phenanthrene	mg/kg	**3.4 [1.1]**	**0.91**	**0.066**	**0.10**	**0.049**	**0.072**	**0.50**	**0.16**	**0.52**	**0.11 [0.11]**	**0.23**
Phenol	mg/kg	<0.27 [<0.19]	**0.049 J**	**0.017 J**	**0.041 J**	<0.072	**0.014 J**	**0.013 J**	<0.064	<0.059	<0.057 [<0.054]	<0.057
Pyrene	mg/kg	**5.7 [1.9]**	**1.8**	**0.098**	**0.14**	**0.054**	**0.11**	**0.53**	**0.087**	**0.69**	**0.031 [0.13]**	**0.20**
Miscellaneous												
Carbon	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	**9300 [3500]**	NA
Corrosivity	pH Units	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.1 HF [8.1 HF]	NA
Oil & Grease	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	**210 [180]**	NA
pH	pH Units	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.1 HF [8.1 HF]	NA
Total Organic Carbon	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	**9300 [3500]**	NA

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID:		W-4	W-4	W-4	W-9	W-9	W-9	W-11	W-11	W-11
Sample Depth(ft):		0 - 0.6	0 - 0.6	0 - 0.6	0 - 0.4	0 - 0.4	0 - 0.4	0 - 0.2	0 - 0.2	0 - 0.2
Date Collected:		02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23
Lab Sample ID:	Units	240-180445-1	240-180811-21	240-182042-6	240-180445-4	240-180811-19	240-182042-8	240-180445-3	240-180811-14	240-182042-9
Volatile Organics										
1,1,1-Trichloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,1,2,2-Tetrachloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,1,2-trichloro-1,2,2-trifluoroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,1,2-Trichloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,1-Dichloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,1-Dichloroethene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,2,4-Trichlorobenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,2-Dibromo-3-chloropropane	mg/kg	<0.51	<0.31	<0.013	<0.62	<0.47	<0.010	<0.75	<0.46 *-	<0.012
1,2-Dibromoethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,2-Dichlorobenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,2-Dichloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,2-Dichloropropane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,3-Dichlorobenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
1,4-Dichlorobenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
2-Butanone	mg/kg	<1.0	<0.62	<0.026	<1.2	<0.94	<0.020	<1.5	<0.93	<0.024
2-Ethylhexyl acrylate	mg/kg	<2.5 F1	<1.6	<0.064	<3.1	<2.3	<0.051	<3.8	<2.3	<0.060
2-Hexanone	mg/kg	<1.0	<0.62	<0.026	<1.2	<0.94	<0.020	<1.5	<0.93	<0.024
4-Methyl-2-pentanone	mg/kg	<1.0	<0.62	<0.026	<1.2	<0.94	<0.020	<1.5	<0.93	<0.024
Acetone	mg/kg	<1.0	<0.62	**0.030 J**	<1.2	<0.94	<0.026	<1.5	<0.93	**0.038**
Benzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Bromodichloromethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Bromoform	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Bromomethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Butyl Acrylate	mg/kg	<2.5	<1.6	<0.064	<3.1	<2.3	<0.051	<3.8	<2.3	<0.060
Carbon Disulfide	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Carbon Tetrachloride	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Chlorobenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Chloroethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Chloroform	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Chloromethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
cis-1,2-Dichloroethene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
cis-1,3-Dichloropropene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Cyclohexane	mg/kg	<0.51	<0.31	<0.013	<0.62	<0.47	<0.010	<0.75	<0.46	<0.012
Dibromochloromethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Dichlorodifluoromethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Ethanol	mg/kg	<0.84	NA	NA	<0.97	NA	NA	<0.86	NA	NA
Ethylbenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Isopropylbenzene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Methyl acetate	mg/kg	<1.3	<0.78	<0.032	**0.40 J**	<1.2	<0.026	<1.9	<1.2	<0.030
Methyl Acrylate	mg/kg	<0.51	<0.31	<0.013	<0.62	<0.47	<0.010	<0.75	<0.46	<0.012
Methyl tert-butyl ether	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Methylcyclohexane	mg/kg	<0.51	<0.31	<0.013	<0.62	<0.47	<0.010	<0.75	<0.46	<0.012
Methylene Chloride	mg/kg	<0.51	<0.31	<0.032	<0.62	<0.47	<0.026	<0.75	<0.46	<0.030
Styrene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Tetrachloroethene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Toluene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
trans-1,2-Dichloroethene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
trans-1,3-Dichloropropene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Trichloroethene	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Trichlorofluoromethane	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Vinyl Chloride	mg/kg	<0.25	<0.16	<0.0064	<0.31	<0.23	<0.0051	<0.38	<0.23	<0.0060
Xylenes (total)	mg/kg	<0.51	<0.31	<0.013	<0.62	<0.47	<0.010	<0.75	<0.46	<0.012

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

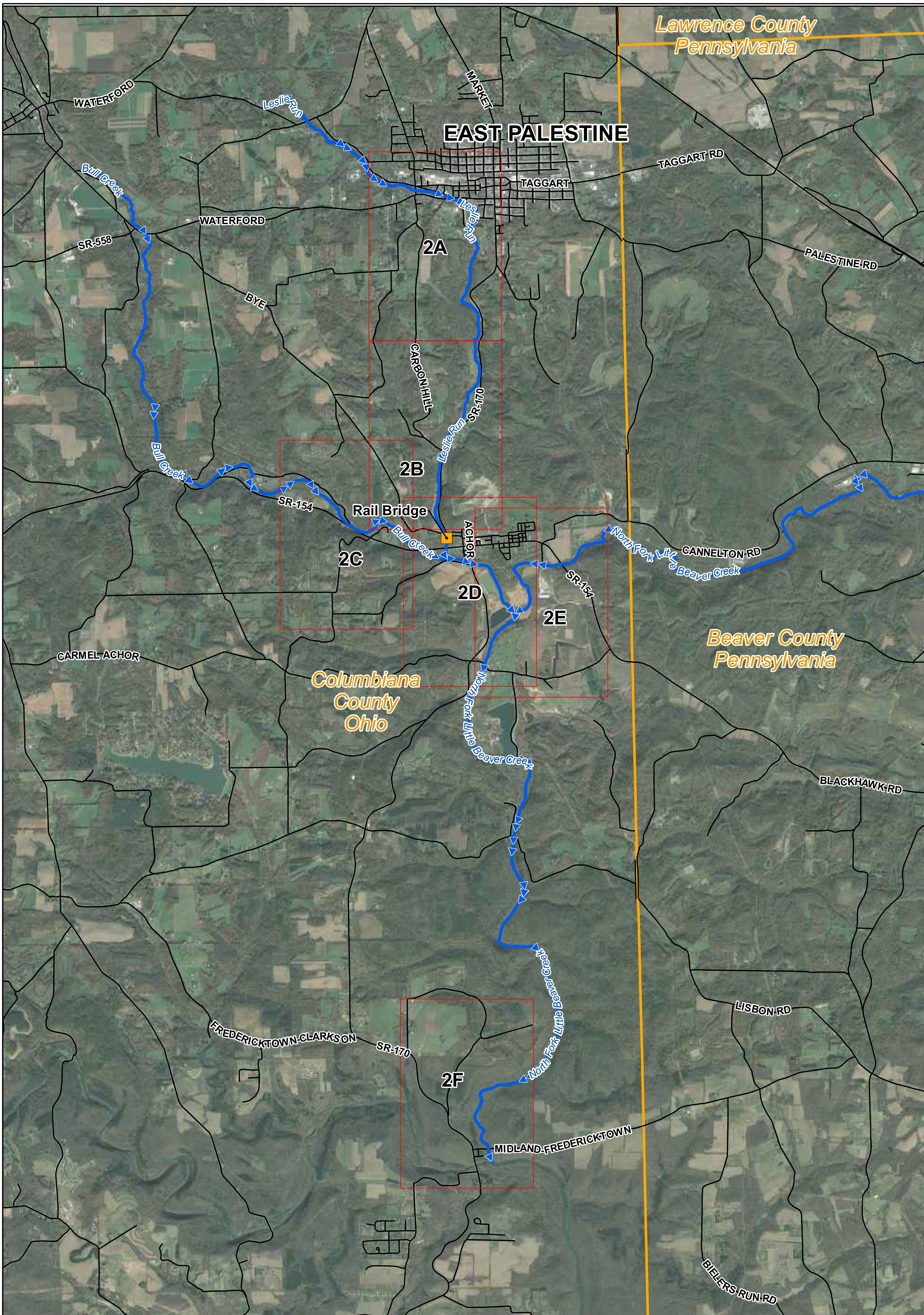
Location ID:		W-4	W-4	W-4	W-9	W-9	W-9	W-11	W-11	W-11
Sample Depth(ft):		0 - 0.6	0 - 0.6	0 - 0.6	0 - 0.4	0 - 0.4	0 - 0.4	0 - 0.2	0 - 0.2	0 - 0.2
Date Collected:		02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23
Lab Sample ID:	Units	240-180445-1	240-180811-21	240-182042-6	240-180445-4	240-180811-19	240-182042-8	240-180445-3	240-180811-14	240-182042-9
Semivolatile Organics										
1,1'-Biphenyl	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
2,2'-Oxybis(1-Chloropropane)	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
2,4,5-Trichlorophenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
2,4,6-Trichlorophenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
2,4-Dichlorophenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
2,4-Dimethylphenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
2,4-Dinitrophenol	mg/kg	<0.37	<0.40	<0.47	<0.42	<0.37	<0.42	<0.39	<0.37	<0.51
2,4-Dinitrotoluene	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
2,6-Dinitrotoluene	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
2-Butoxyethanol	mg/kg	NA	<0.085	**0.27**	NA	<0.078	<0.088	NA	<0.079	<0.11
2-Butoxyethyl acetate	mg/kg	NA	<0.085	NA	NA	<0.078	NA	NA	<0.079	NA
2-Chloronaphthalene	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
2-Chlorophenol	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
2-Methylnaphthalene	mg/kg	**0.15**	**0.12**	**0.16**	**0.022**	**0.017**	**0.027**	**0.071**	**0.048**	**0.17**
2-Methylphenol	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
2-Nitroaniline	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
2-Nitrophenol	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
3,3'-Dichlorobenzidine	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
3-Methylphenol, 4-Methylphenol	mg/kg	<0.45	<0.48	**0.84**	<0.51	<0.44	<0.50	<0.47	<0.45	<0.62
3-Nitroaniline	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
4,6-Dinitro-2-methylphenol	mg/kg	<0.37	<0.40	<0.47	<0.42	<0.37	<0.42	<0.39	<0.37	<0.51
4-Bromophenyl-phenylether	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
4-Chloro-3-Methylphenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
4-Chloroaniline	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
4-Chlorophenyl-phenylether	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
4-Nitroaniline	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
4-Nitrophenol	mg/kg	<0.37	<0.40	<0.47	<0.42	<0.37	<0.42	<0.39	<0.37	<0.51
Acenaphthene	mg/kg	<0.017	**0.017 J**	**0.0091 J**	<0.019	<0.017	<0.019	**0.023**	<0.017	**0.023**
Acenaphthylene	mg/kg	<0.017	<0.018	<0.021	<0.019	<0.017	<0.019	**0.0054 J**	<0.017	**0.011 J**
Acetophenone	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
Anthracene	mg/kg	<0.017	**0.061**	**0.0091 J**	**0.0094 J**	**0.0051 J**	**0.0046 J**	**0.10**	**0.0065 J**	**0.055**
Atrazine	mg/kg	<0.22	<0.24	<0.28	<0.26	<0.22	<0.25	<0.24	<0.22	<0.31
Benzaldehyde	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
Benzo(a)anthracene	mg/kg	**0.0081 J**	**0.17**	**0.058**	**0.073**	**0.030**	**0.025**	**0.37**	**0.036**	**0.31**
Benzo(a)pyrene	mg/kg	<0.017	**0.16**	**0.065**	**0.075**	**0.038**	**0.037**	**0.34**	**0.041**	**0.35**
Benzo(b)fluoranthene	mg/kg	**0.024**	**0.27**	**0.12**	**0.13**	**0.077**	**0.056**	**0.54**	**0.074**	**0.53**
Benzo(g,h,i)perylene	mg/kg	**0.017**	**0.056**	**0.039**	**0.036**	**0.017**	**0.020**	**0.16**	**0.023**	**0.15**
Benzo(k)fluoranthene	mg/kg	<0.017	**0.097**	**0.036**	**0.047**	**0.030**	**0.024**	**0.18**	**0.020**	**0.17**
bis(2-Chloroethoxy)methane	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
bis(2-Chloroethyl)ether	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
bis(2-Ethylhexyl)phthalate	mg/kg	<0.079	<0.085	**0.076 J**	<0.090	<0.078	<0.088	<0.082	<0.079	**0.098 J**
Butylbenzylphthalate	mg/kg	<0.079	<0.085	<0.099	<0.090	<0.078	<0.088	<0.082	<0.079	**0.065 J**
Caprolactam	mg/kg	<0.37	<0.40	<0.47	<0.42	<0.37	<0.42	<0.39	<0.37	<0.51
Carbazole	mg/kg	<0.056	**0.024 J**	<0.071	<0.064	<0.055	<0.063	**0.036 J**	<0.056	**0.059 J**
Chrysene	mg/kg	**0.021**	**0.21**	**0.081**	**0.091**	**0.046**	**0.031**	**0.41**	**0.059**	**0.44**
Dibenzo(a,h)anthracene	mg/kg	<0.017	**0.013 J**	**0.014 J**	**0.0098 J**	<0.017	<0.019	**0.041**	<0.017	**0.048**
Dibenzofuran	mg/kg	**0.037 J**	**0.043 J**	**0.047 J**	<0.064	<0.055	<0.063	**0.036 J**	**0.016 J**	**0.072 J**
Diethylphthalate	mg/kg	<0.079	<0.085	<0.099	<0.090	<0.078	<0.088	<0.082	<0.079	<0.11
Dimethylphthalate	mg/kg	<0.079	<0.085	<0.099	<0.090	<0.078	<0.088	<0.082	<0.079	<0.11
Di-n-Butylphthalate	mg/kg	<0.079	<0.085	<0.099	<0.090	<0.078	<0.088	<0.082	<0.079	<0.11
Di-n-Octylphthalate	mg/kg	<0.079	<0.085	<0.099	<0.090	<0.078	<0.088	<0.082	<0.079	<0.11
Fluoranthene	mg/kg	**0.022**	**0.43**	**0.16**	**0.14**	**0.11**	**0.054**	**0.84**	**0.081**	**0.84**
Fluorene	mg/kg	**0.0088 J**	**0.022**	**0.013 J**	<0.019	<0.017	<0.019	**0.025**	**0.0039 J**	**0.025**
Hexachlorobenzene	mg/kg	<0.017	<0.018	<0.021	<0.019	<0.017	<0.019	<0.018	<0.017	<0.023
Hexachlorobutadiene	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
Hexachlorocyclopentadiene	mg/kg	<0.37 F1	<0.40	<0.47	<0.42	<0.37	<0.42	<0.39	<0.37	<0.51

Table 2-1: Leslie Run, Bull Creek, and North Fork Little Beaver Creek Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID: Sample Depth(ft): Date Collected: Lab Sample ID:	Units	W-4 0 - 0.6 02/15/23 240-180445-1	W-4 0 - 0.6 02/22/23 240-180811-21	W-4 0 - 0.6 03/16/23 240-182042-6	W-9 0 - 0.4 02/15/23 240-180445-4	W-9 0 - 0.4 02/22/23 240-180811-19	W-9 0 - 0.4 03/16/23 240-182042-8	W-11 0 - 0.2 02/15/23 240-180445-3	W-11 0 - 0.2 02/22/23 240-180811-14	W-11 0 - 0.2 03/16/23 240-182042-9
Hexachloroethane	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
Indeno(1,2,3-cd)pyrene	mg/kg	<0.017	**0.053**	**0.037**	**0.033**	**0.014 J**	**0.020**	**0.15**	**0.019**	**0.14**
Isophorone	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
Naphthalene	mg/kg	**0.084**	**0.058**	**0.057**	**0.012 J**	**0.0088 J**	**0.014 J**	**0.028**	**0.035**	**0.087**
Nitrobenzene	mg/kg	<0.11	<0.12	<0.14	<0.13	<0.11	<0.13	<0.12	<0.11	<0.16
N-Nitroso-di-n-propylamine	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
N-Nitrosodiphenylamine	mg/kg	<0.056	<0.060	<0.071	<0.064	<0.055	<0.063	<0.059	<0.056	<0.078
Pentachlorophenol	mg/kg	<0.17	<0.18	<0.21	<0.19	<0.17	<0.19	<0.18	<0.17	<0.23
Phenanthrene	mg/kg	**0.089**	**0.33**	**0.14**	**0.068**	**0.049**	**0.046**	**0.45**	**0.068**	**0.43**
Phenol	mg/kg	<0.056	<0.060	**0.022 J**	<0.064	<0.055	<0.063	<0.059	**0.017 J**	<0.078
Pyrene	mg/kg	**0.026**	**0.36**	**0.14**	**0.14**	**0.092**	**0.054**	**0.83**	**0.084**	**0.72**
Miscellaneous										
Carbon	mg/kg	**3800 F1F2**	NA	NA	**6400**	NA	NA	**17000**	NA	NA
Corrosivity	pH Units	7.9 HF	NA	NA	7.9 HF	NA	NA	8.1 HF	NA	NA
Oil & Grease	mg/kg	**170 J**	NA	NA	**160 J**	NA	NA	**280**	NA	NA
pH	pH Units	7.9 HF	NA	NA	7.9 HF	NA	NA	8.1 HF	NA	NA
Total Organic Carbon	mg/kg	**3800 F1F2**	NA	NA	**6400**	NA	NA	**17000**	NA	NA

Notes:
F1 = MS and/or MSD recovery exceeds control limits.
F2 = MS/MSD RPD exceeds control limit
HF = Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J = Estimated value
NA = Not applicable/analyzed
*3 = STD response or retention time outside acceptable limits

Figures



Map Date: 7/20/2023

Legend

- Map Set Locations
- Ohio/Pennsylvania State Line
- NHD Stream Layer and Flow Direction
- Rail Bridge

0 1 2
Miles

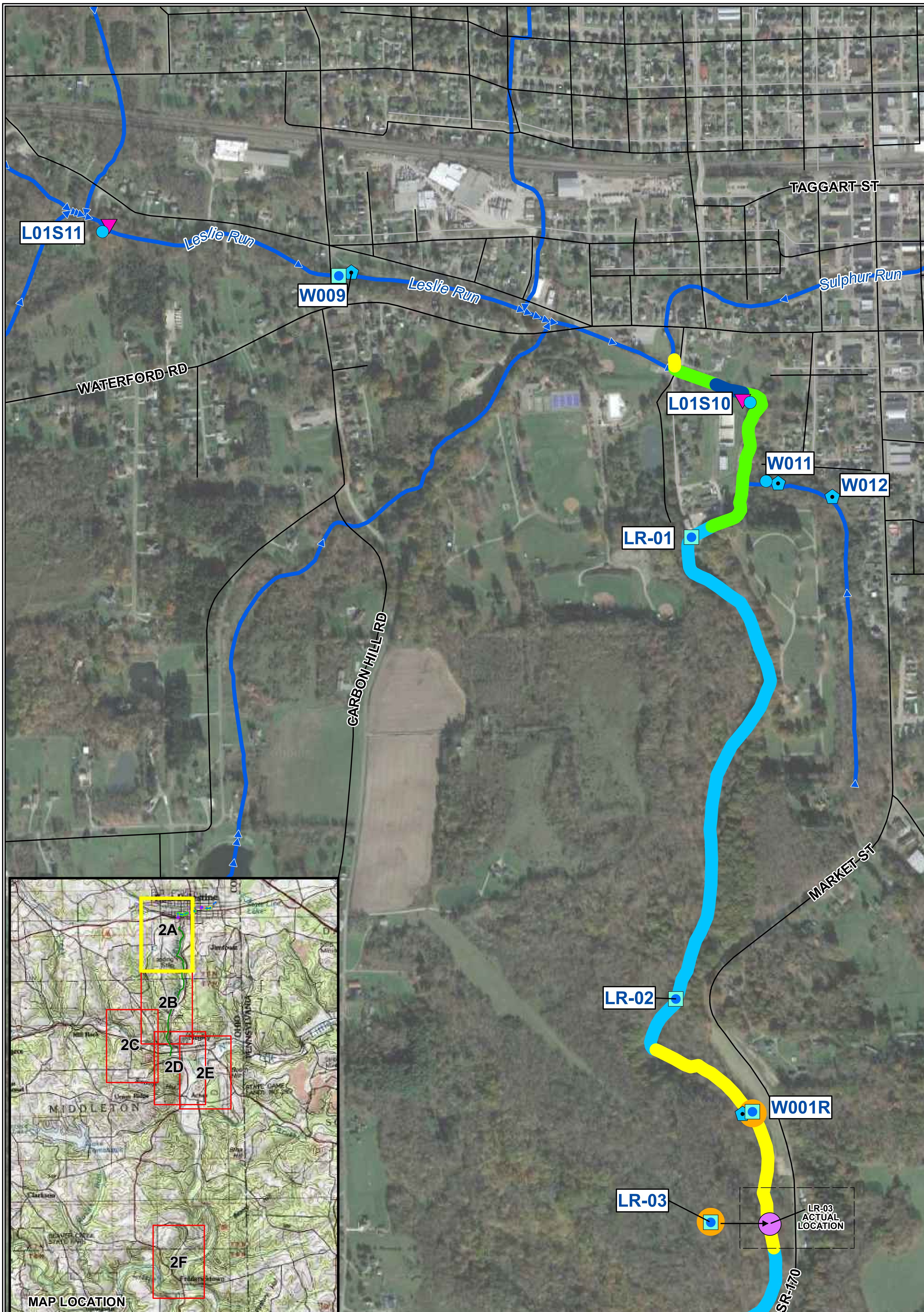
NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK INVESTIGATION EXTENT

ARCADIS

FIGURE
1

Document Path: T:_ENV\NorfolkSouthern\EastPalestine\EastPalestine_Feb3_2023\MXD\SedimentSampling\NS_East Palestine_F1 Leslie Run_Bull Creek_and North Fork Little Beaver Creek Investigation Extent.mxd



Legend

- Sediment Sample
- Sediment/Pore Water Sample
- Biocriteria Location
- Water Column Sample
- Sheen Sample
- Sheen Score 3 at Log Jam

Qualitative Sheen Observations

- 0 & 1
- 1
- 1 & 2
- 2

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

0 600 1,200
Feet

Map Date: 7/25/2023

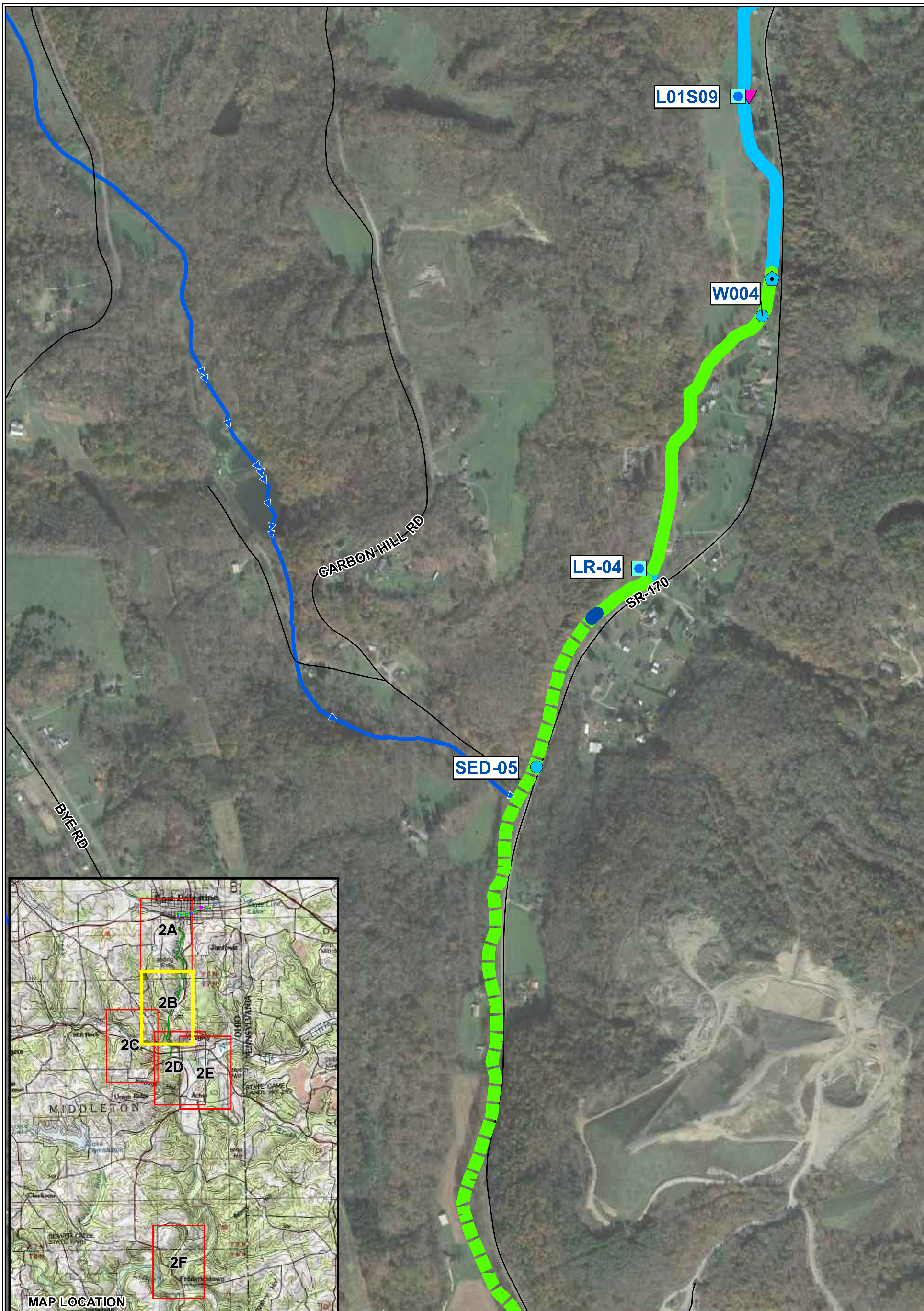
NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2A

Document Path: T:_ENV\NorfolkSouthern\EastPalestine_Feb5_2023\MXD\SedimentSampling\NS_East Palestine_F2 - 2A_2F Leslie Run Sheen Investigation Locations.mxd



Legend

- Sediment Sample
- Sediment/Pore Water Sample
- Biocriteria Location
- Water Column Sample

Qualitative Sheen Observations

- 0 & 1
- Assumed 1
- 1
- 1 & 2

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

0 600 1,200
Feet

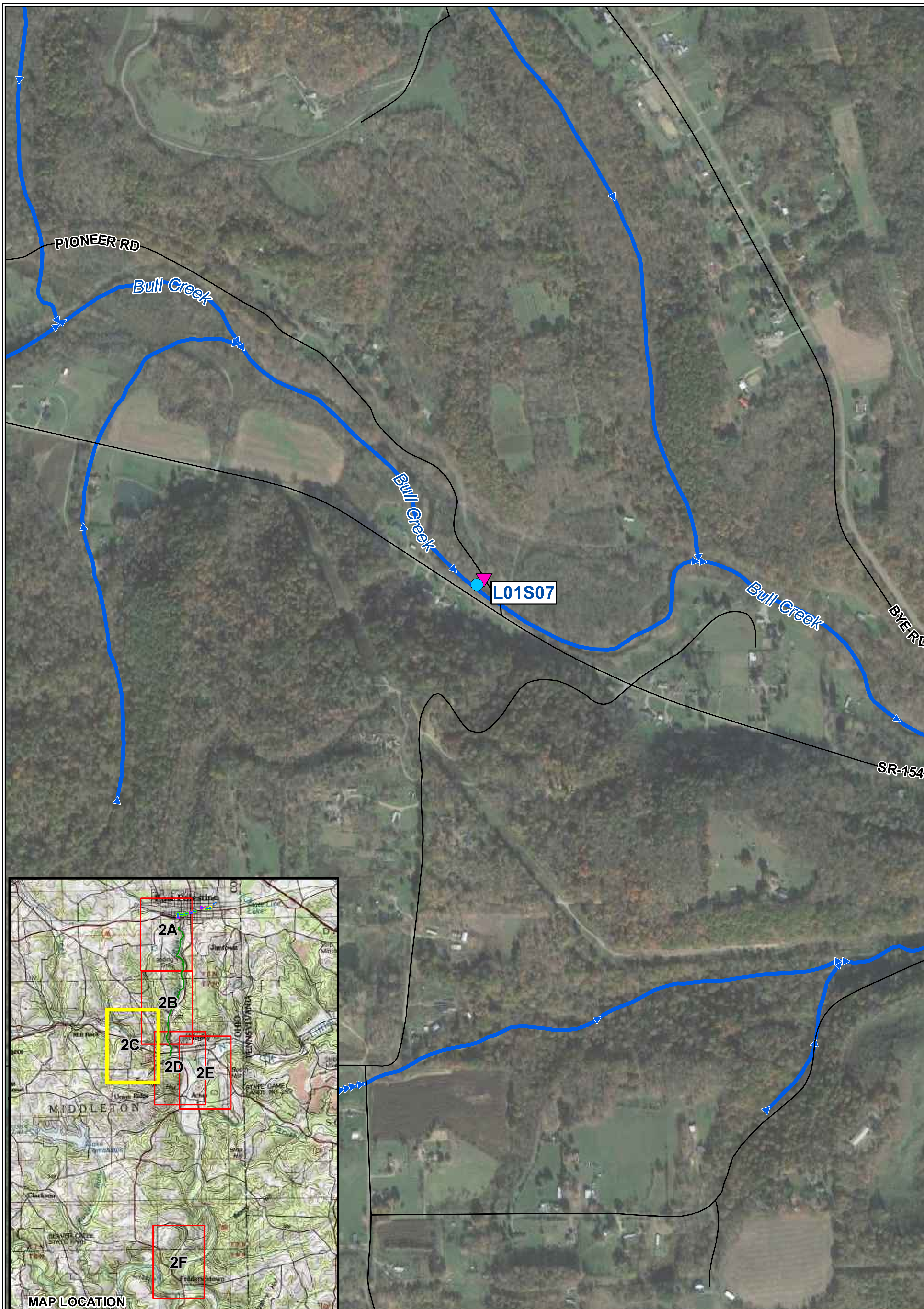
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2B



Legend

Sediment Sample

Biocriteria Location

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

0 600 1,200
Feet

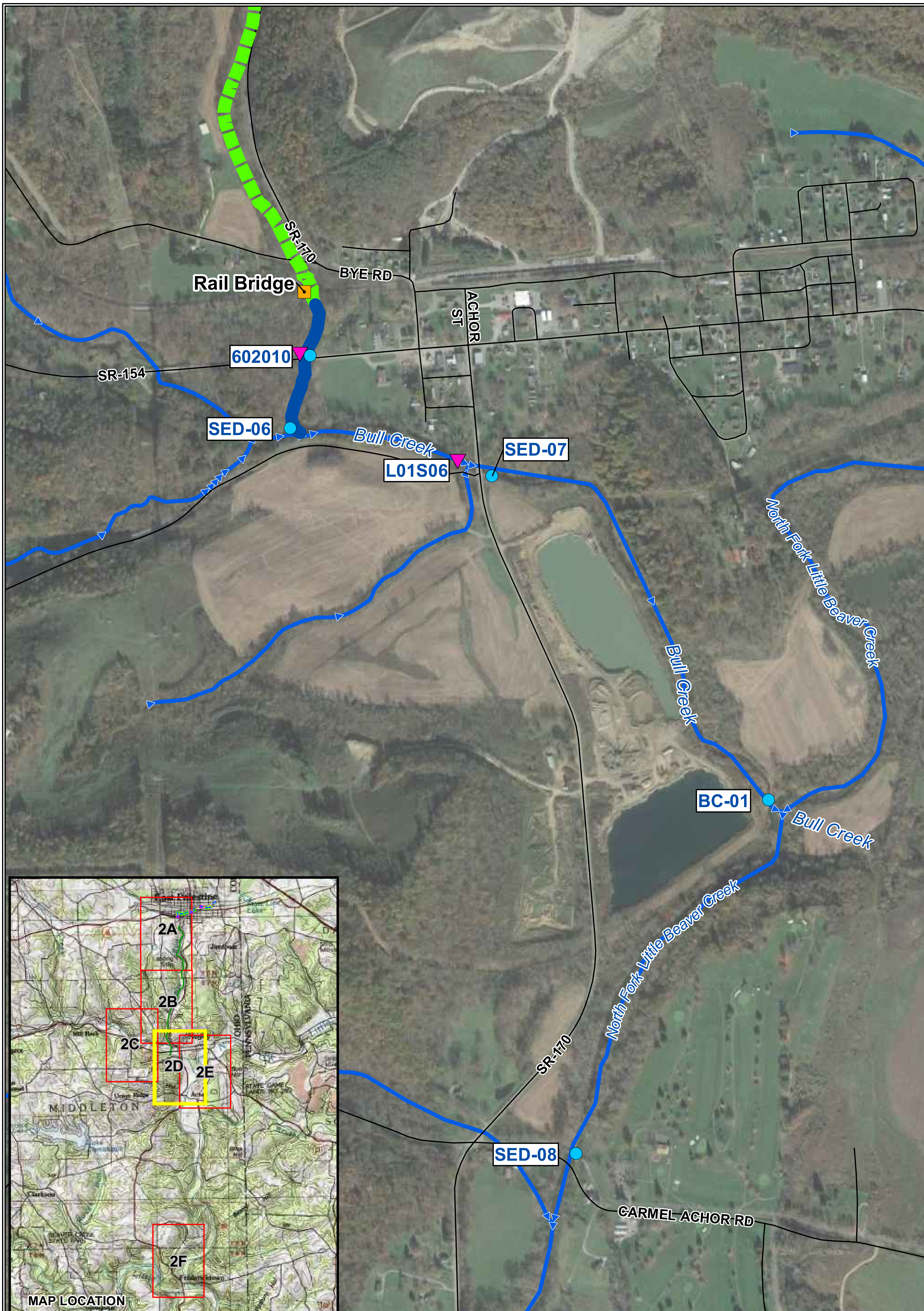
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2C



Legend

- Sediment Sample
- Biocriteria Location
- Rail Bridge

Qualitative Sheen Observations

- 0 & 1
- Assumed 1

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

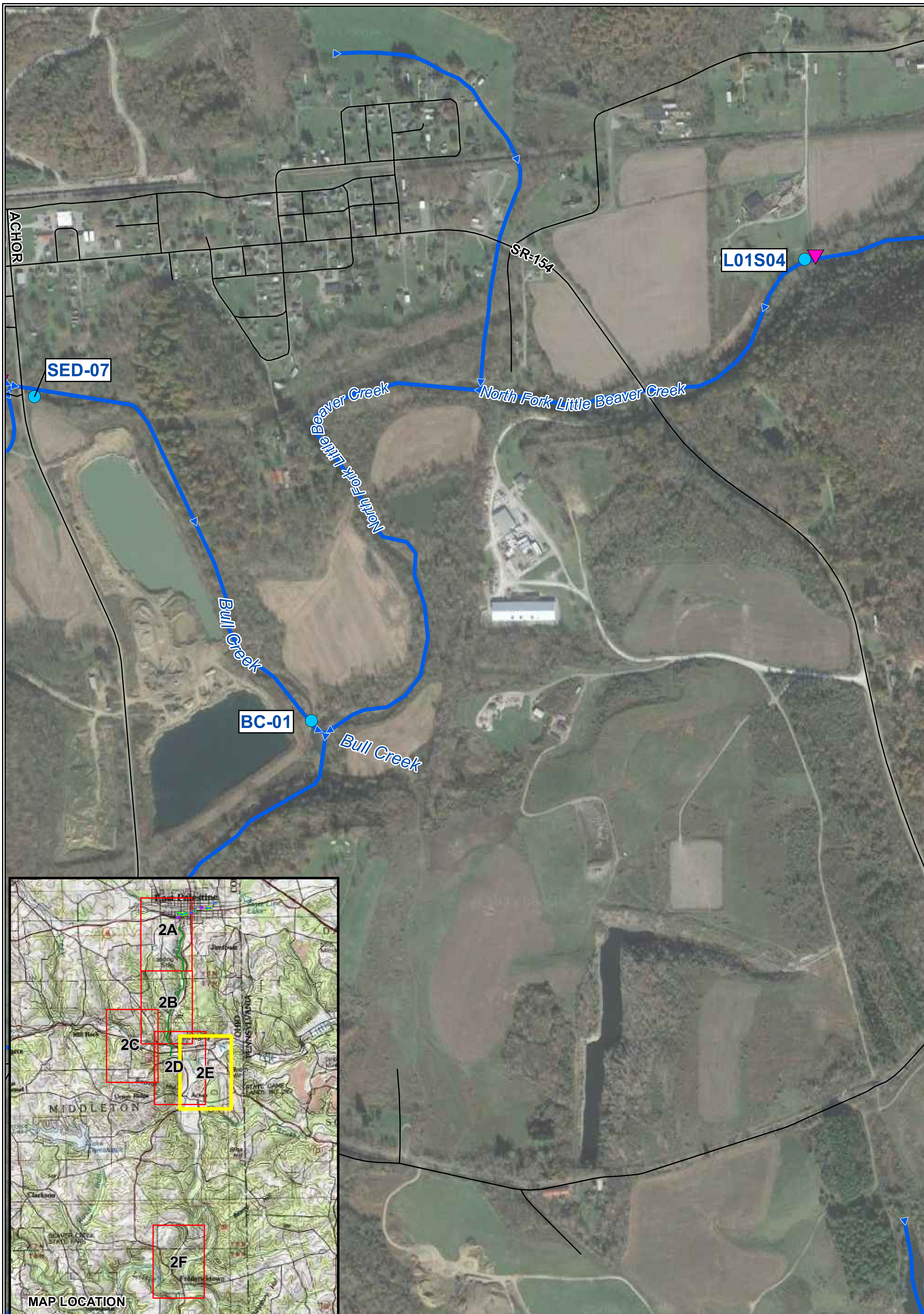
0 600 1,200
Feet
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2D



Legend

- Sediment Sample
- Biocriteria Location

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

0 600 1,200
Feet

Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2E

Document Path: T:_ENV\NorfolkSouthern\EastPalestine\EastPalestine_Feb5_2023\MXD\SedimentSampling\NS_East Palestine_F2 - 2A_2F Leslie Run Sheen Investigation Locations.mxd

Legend

Sediment Sample

Biocriteria Location

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

0 600 1,200
Feet

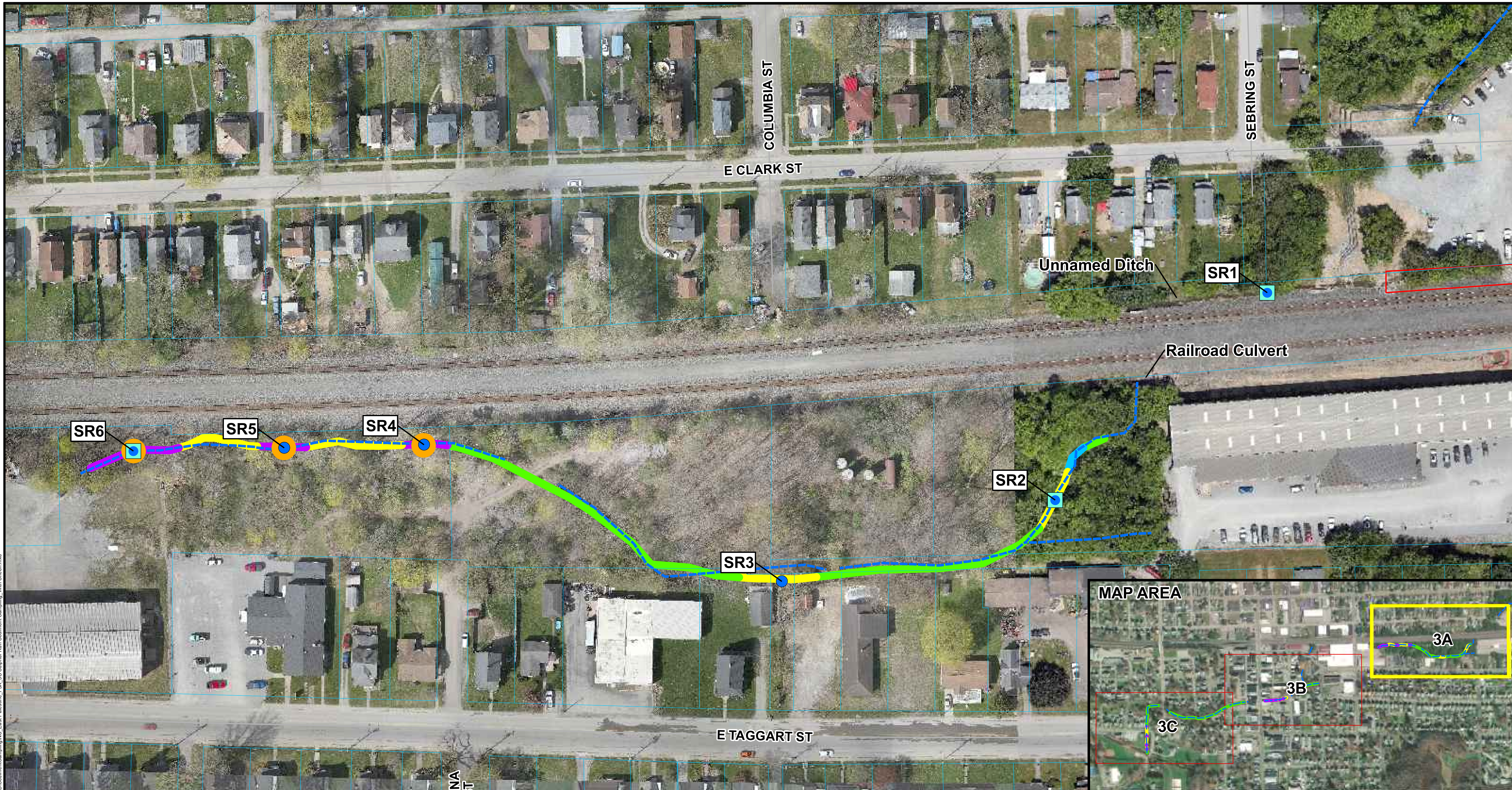
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

LESLIE RUN, BULL CREEK, AND NORTH FORK LITTLE BEAVER CREEK SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2F



Legend
- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location
- Sheen Sample
- North Ditch Removal Extent West of North Pleasant Drive

Qualitative Sheen Observations
- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

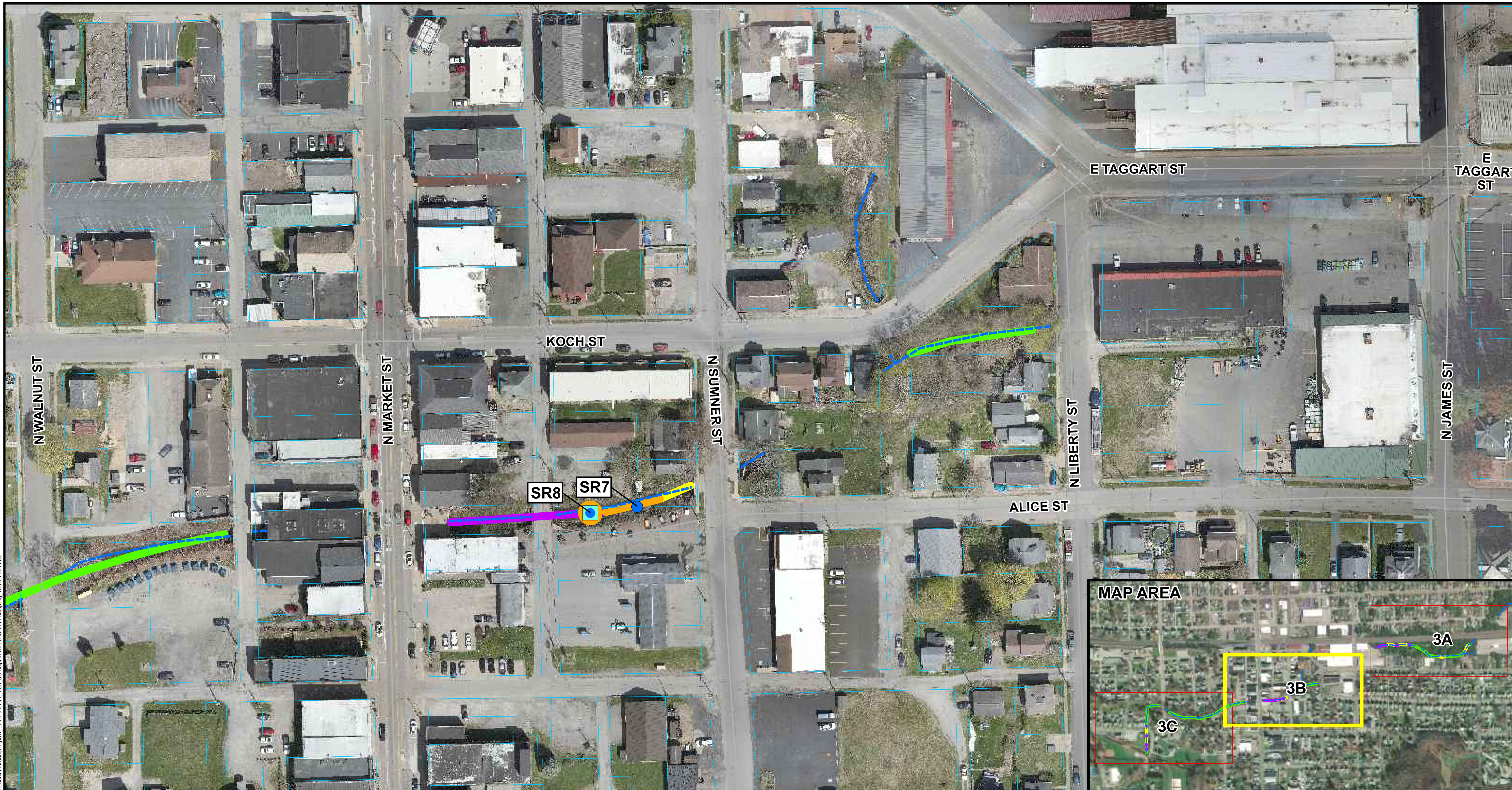
0 100 200
Feet
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
3A



Legend
- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location
- Sheen Sample

Qualitative Sheen Observations
- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

0 100 200
Feet
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
3B

Legend

- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location
- Water Column Sample
- Sheen Sample

Qualitative Sheen Observations

- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

0 100 200
Feet
Map Date: 7/25/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
3C

Attachment A

Field Standard Operating Procedures

Standard Operating Procedure #1: Sediment Characterization via Probing and Sampling

Rev: 2

Rev Date: July 2023

1 Introduction

This Standard Operating Procedure (SOP) describes the general methods and procedures to characterize the stream via probing and sediment collection. This SOP may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Certified Project Manager (CPM) as well as a Technical Expert and reviewed with Incident Command and agreed upon prior to implementing. In addition, any changes will be documented through field notes and photographed as appropriate.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document.

It is the responsibility of the Arcadis CPM to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Related Documents

- Sediment Characterization Work Plan
- Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)

4 Description of the Procedure

4.1 Pre-Collection

Arcadis field personnel will be versed in the relevant SOPs and will possess the skills and experience necessary to successfully complete the desired field work. Staff assigned the responsibility of collecting cores, samples, and probing information will be provided with the following information:

- Work documents;
- Site maps;
- Collecting and processing procedures; and
- Special instructions (if any).

4.2 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (as required by the HASP)
- Real-Time Kinematic (RTK) survey equipment
- Appropriate sample containers, labels, and forms
- Chest waders/personal floatation device
- Decontamination supplies
- Surveyor's rod
- Calibrated probe rod (⅝-inch outside-diameter metal pipe with maximum graduations of tenths of feet)
- Shovel
- Trowel
- Post-hole digger
- Steel sampling barrel (fitted with a clear PVC liner), slide hammer, and/or use of a jackhammer attachment
- Six-foot rule
- Plastic sealable bags
- Trash bags
- Indelible ink markers
- Digital camera
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice
- Field notebook

4.3 Field Notes

Field notes will be recorded during probing and/or sediment sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel if present;

- General weather conditions;
- Date, time, and sampling locations;
- Total water depth, probing depth, and material descriptions; and
- Any general observations.

Field crews will primarily record field information in a field notebook.

4.4 Stream Bed Probing Procedures

Probing efforts will be performed either as a stand-alone effort or in combination with sediment collection efforts. The following procedures describe the probing efforts.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target location using RTK surveying techniques and identify the proposed probing location in the field notebook.
3. Measure the total depth of the water column using a surveyor's rod to the nearest 0.1 foot and record. Record the water surface elevation using RTK surveying techniques (i.e., elevation above sea level of the water's surface at the target location).
4. Lower the calibrated probing rod through the water column slowly to the stream bed surface.
5. Advance the rod vertically through the stream bottom materials to refusal using reasonable human force (e.g., arm strength and body weight). The depth of refusal will be interpreted as the interface between soft material (e.g., cap material or sediment) and rock or stiff bottom. Record depth, type, and presence of debris or obstructions.
6. Estimate the material thickness and type of material present. The thickness will be determined based on the water depth and the depth of refusal (i.e., depth of refusal minus water depth). The type of material present will be determined by feel of the probe rod as it advances (e.g., soft material, sand, clay, gravel, rock).

4.5 Sediment Collection Procedures

Sediment sampling efforts will be performed in combination with probing as described in Section 4.4. If probing indicates little to no sediment present, expand the probing efforts to an area around the sampling target location in accordance with the plan in an effort to identify a location with recoverable sediment. The following procedures describe the sediment sampling efforts.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target sample location using RTK surveying techniques and identify the proposed sample location in the field notebook.
3. Identify the proposed sample location in the field notebook, including other appropriate information collected during sampling activities.
4. Conduct steps outlined in Section 4.4. Determine the appropriate sampling equipment based on the results of the probing efforts (i.e., sediment thickness present and creek bed conditions including conditions at probe rod refusal such as rocks or clay) and sediment type present (i.e., finer-grained versus coarser materials).

Sampling options include a decontaminated stainless-steel trowel, post-hole digger, coring using a steel sampling barrel with slide hammer, or coring using a hand auger. Attempt collection using the selected option and adjustment selected method as needed based on sample recovery. Document the selected sampling techniques and rationale for its selection.

5. Lower the selected sampling equipment until it just reaches the stream bottom. Collect the sample from the stream bottom to the depth targeted in the plan or to refusal pending sub-surface conditions as determined through probing. The trowel and post-hole digger will primarily be used to collect sediment from the top 6 inches through scooping or grabbing. Collection of sediment up to 12 inches will be performed by coring using the sampling barrel with slide hammer or a hand auger – see steps a-b below for additional details.
    a. Coring will be performed using the steel sampling barrel with slide hammer. Insert the expendable liner into the sampling barrel. Drive the sampling barrel into the stream bottom to the targeted depth using a slide hammer. If refusal is met prior to target sample depth, reposition the sampling barrel readvance using the same method. Coring efforts will be considered complete and at refusal once several uses of the slide hammer does not advance the core further into the stream bed. (Note: previous sediment work at the site was successful using this method to depths beyond 1 foot below sediment surface.)
    b. Coring may also be performed using a soil recovery hand auger. Insert an expendable liner in the recovery auger body. Advance the hand auger using manual methods through rotation to the target depth. If refusal is met prior to target sample depth, reposition the sampling barrel readvance using the same method. Coring efforts will be considered complete and at refusal once the auger cannot longer be advanced further into the stream bed.
6. Record thickness of recovered material to determine the sample depth.
7. Slowly recover the sampling equipment from the stream bed and secure material as needed before it breaks the water surface.
8. Observe the sediment surface during sampling for evidence of impacts; record observations on the field form.
9. Photograph the sample location and general area (upstream, downstream, and each bank) to document conditions. Record observations of major landmarks or features of the channel morphology, adjacent bank conditions, and vegetative zones.
10. Document the appearance and recovery of the sample to confirm acceptability of the sample; sample finer-grained material (such as silt and sand, no to minimal gravel) only. Samples containing primarily gravel, stone, or rocks are not acceptable for analytical testing and will be rejected, placed back in the stream, and a new sample will be collected.
11. Photograph the sample. Describe sediment sample according to color, texture and grain size and document other observations such as type of organic material present, odor, sheen, staining, etc. and document.
12. Process samples for submittal to the laboratory. As appropriate, sediment samples will be collected in laboratory supplied and pre-preserved containers for the specified testing method. Collect ample volume of sediment for the proposed analysis. If adequate volume is not available from a single grab sample, multiple grab samples may be collected, composited and thoroughly homogenized to form a single sample for non-VOC analysis. If the event of compositing, document the area samples and number of grab samples collected and collect an additional grab sample for VOC analysis. Fill containers intended for volatile analysis with sediment sample as soon as possible and prior to homogenization (except for composite samples) in

accordance with the QAPP. Homogenize the sample and fill bottleware intended for non-VOC analysis in accordance with the QAPP.

13. Label sample containers in accordance with the procedures presented in the work plan.
14. Once the sample is collected in the appropriate container(s), place on ice in a cooler.
15. Thoroughly decontaminate reusable sampling equipment between each sample using Alconox® or similar product and triple rinse utilizing distilled water. Repeat the above procedures until all samples are collected.
16. Fill out the chain of custody form and handle, pack, and ship the samples in accordance with the procedures described in the QAPP.

5 Waste Management

Investigative-derived waste generated during the sampling activities and disposable equipment will be transported for offsite disposal in accordance with the site-specific Waste Management Plan.

6 Data Recording and Management

All sample and location measurements and observations will be maintained in a field notebook or log. Upon project completion, field notebooks will be forwarded to the Project Manager for storage in the project files.

7 Quality Assurance

Samplers will forward copies of field notes and chains of custody to the CPM for quality assurance checks during project implementation at a frequency determined by the CPM.

Field duplicates and other quality assurance samples (e.g., rinse blanks, trip blanks) will be collected at the frequency presented in the QAPP. Sample quality will be achieved by complying with the procedures outlined in this SOP and by following site-specific plans. Cross-contamination will be prevented by following the protocols described in the QAPP or SOP for Field Equipment Decontamination. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific QAPP.

- END OF PROCEDURE

Standard Operating Procedure #2: Pore Water Sampling

Rev: 1

Rev Date: July 2023

1 Introduction

This Standard Operating Procedure (SOP) describes the procedures for collecting pore water samples. The procedure described herein was field tested in Leslie Run with Arcadis, United States Environmental Protection Agency (USEPA), and Ohio Environmental Protection Agency (OEPA) staff on May 22, 2023. Substantive modification to this SOP will be approved in advance by the Certified Project Manager (CPM) as well as a Technical Expert and reviewed with Incident Command and agreed upon prior to implementing. In addition, any changes will be documented through field notes and photographed as appropriate.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document.

It is the responsibility of the Arcadis CPM to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Related Documents

- Sediment Characterization Work Plan
- Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)

4 Description of the Procedure

4.1 Pre-Collection

Arcadis field personnel will be versed in the relevant SOPs and will possess the skills and experience necessary to successfully complete the desired field work. Staff assigned the responsibility of collecting samples will be provided with the following information:

- Work documents;
- Site maps;
- Collecting and processing procedures; and
- Special instructions (if any).

4.2 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary. Additional equipment may be required, pending field conditions.

- Personal protective equipment (as required by the HASP)
- Real-Time Kinematic (RTK) survey equipment
- Appropriate sample containers, labels, and forms
- Chest waders and/or muck boots and personal floatation device
- Three-inch stainless steel screens (approximately 7/16-inch outside diameter)
- Stainless steel sampling barrel, slide hammer, and PVC expendable liner
- Bentonite chips and granular
- Peristaltic pump with appropriate power source.
- Polyethylene tubing of an appropriate size for the pump being used.
- Two multi-parameter water-quality meters capable of reading temperature, pH, specific conductivity, oxidation-reduction potential, turbidity, and dissolved oxygen. One meter to be used to monitor surface water parameters and one meter to be used to monitor pore water parameters.
- Silica sand
- Surveyor's rod (or other applicable water depth measuring device)
- Trash bags
- Indelible ink markers
- Digital camera
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice
- Field notebook

4.3 Field Notes

Field notes will be recorded during sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel if present;

- General weather conditions;
- Date, time, and sampling locations;
- Total water depth, probing depth, and material descriptions;
- Screen installation depths; and
- Any general observations.

Field crews will primarily record field information in a field notebook.

4.4 Procedures

The following steps provide the procedure for pore water sampling. If the stream bed cannot be penetrated to the desired depth due to large cobbles, boulders, or bedrock, the sample location will be relocated to an adjacent location and a note made in the field notebook about the refusal and location.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target sample location using RTK surveying techniques. Identify the proposed sample location in the field notebook.
3. Assess the sediment bed composition and soft sediment depth using a probe rod and document conditions in the field notebook.
4. Load the expendable liner into the stainless steel sampling barrel. Attach the slide hammer and place the sample barrel at the sediment surface. Use the slide hammer to advance the sampling barrel 6 inches into the sediment.
5. Prepare a length of tubing adequate to reach the shoreline and attach one end to a stainless steel screen. Mark the tubing 3 inches above the screen to identify how far to insert the sampler into the sediment.
6. Remove the sample barrel from the sediment bed and immediately place the screen into the hole up to the marker line on the tubing. The screen will be placed into the hole by hand unless water depths (approximately greater than 2 feet of water). If the surface water is greater than two feet deep, a small diameter PVC pipe may be used to guide the screen and tubing into the pilot hole. The screen will now be positioned 3-6 inches below the sediment surface.
7. Fill the interannual space around the screen prior with appropriately sized silica sand prior to collapsing the hole.
8. Place 2-3 handfuls of bentonite chips followed by 2-3 handfuls of granular bentonite in an approximate 6-inch radius around the protruding tubing and inserted sampler and smooth the bentonite over to ensure that surface water does not intrude into the sampler. If necessary, in deeper water an oversized section of Lexan© (larger diameter than the pilot hole) may be used to install the sand annulus and bentonite seal at the sediment surface.
9. Attach the open end of the tubing to a low flow peristaltic pump (50 to 500 milliliters per minute). Slowly draw the water up into the tubing. The initial volume of pore water may be turbid. Purge the location for approximately 5 minutes.

10. Deploy water quality meters to measure parameters in surface water and pore water. It is anticipated that pore water parameters (specifically temperature, dissolved oxygen, and conductivity) will be different than surface water parameters. Surface water parameters will be measured by placing a sonde in the creek water approximately 2-3 feet upstream of the sample location. Pore water parameters will be measured by pumping water through a flow through cell. Review the parameter values to assess if a difference is observed. If observed, the location has been successfully established and developed for future sampling. If not observed, it is possible that the pore water has not been isolated from the surface water and another attempt to establish a location will be made by the field team. Up to 3 attempts will be made at the location to install a sampling set up that exhibits differences in water quality. It is possible that under certain conditions, the parameters measured in pore water and surface water will be similar or indistinguishable from each other in spite of a proper installation. If after the 3 attempts water quality parameters do not show a difference, the pore water be collected at the third location, and the effort will be document in the field notes.
11. Once the location has been determined to be successfully established, cut and cap the tubing in the river approximately 12 inches from the river bottom and allow the location to sit for a minimum of 24 hours before sampling.
12. Once the appropriate time has passed, representative samples can be collected. Attach new tubing to the tubing in the creek. Attach the open end of the tubing to a low flow peristaltic pump (50 to 200 milliliters per minute). Slowly draw the water up into the tubing. Discard the small slug of water sitting in the line above the sediment surface and then immediately sample the water below by filling the bottleware intended for analysis. Do not purge the location.
    a. Avoid overfilling sample containers to prevent preservatives, if present, in sample container from being lost.
    b. When sampling for VOCs, make sure no headspace or air bubbles remain in the sample vial after the collected sample is capped.
13. Document the appearance and recovery of the sample to confirm acceptability of the sample.
14. Label sample containers in accordance with the procedures presented in the work plan.
15. Once the sample is collected in the appropriate container(s), place on ice in a cooler.
16. Record appropriate information in the field notebook.
17. Repeat the above procedures until all pore water samples are collected.
18. Fill out the chain of custody form and handle, pack, and ship the samples in accordance with the procedures described in the QAPP.

5 Waste Management

Investigative-derived waste generated during the sampling activities and disposable equipment will be transported for offsite disposal in accordance with the site-specific Waste Management Plan.

6 Data Recording and Management

All sample and location measurements and observations will be maintained in a field notebook or log. Upon project completion, field notebooks will be forwarded to the Project Manager for storage in the project files.

7 Quality Assurance

Samplers will forward copies of field notes and chains of custody to the CPM for quality assurance checks during project implementation at a frequency determined by the CPM.

Field duplicates and other quality assurance samples (e.g., rinse blanks, trip blanks) will be collected at the frequency presented in the QAPP. Sample quality will be achieved by complying with the procedures outlined in this SOP and by following site-specific plans. Cross-contamination will be prevented by following the protocols described in the QAPP. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific QAPP.

- END OF PROCEDURE -

Standard Operating Procedure #3: Surface Water Sheen Sampling

Rev: 0

Rev Date: July 2023

1 Introduction

This Standard Operating Procedure (SOP) describes the general methods and procedures for collection of surface water sheen samples. This SOP may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Certified Project Manager (CPM) as well as a Technical Expert and reviewed with Incident Command and agreed upon prior to implementing. In addition, any changes will be documented through field notes and photographed as appropriate.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document.

It is the responsibility of the Arcadis CPM to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Related Documents

- Sediment Characterization Work Plan
- Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)

4 Description of the Procedure

4.1 Pre-Collection

The sampling nets will be purchased from the vendor. Arcadis field personnel will be versed in the relevant SOPs and will possess the skills and experience necessary to successfully complete the desired field work. Staff assigned the responsibility of collecting samples will be provided with the following information:

- Work document;

- Site maps;
- Collecting and processing procedures; and
- Special instructions (if any).

4.2 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (as required by the HASP)
- Real-Time Kinematic (RTK) survey equipment
- Appropriate sample containers, labels, and forms
- Chest waders/personal floatation device
- Calibrated probe rod (⅝-inch outside-diameter metal pipe with maximum graduations of tenths of feet)
- Teflon® (tetrafluorethylene [TFE]-fluorocarbon polymer) sheen sampler net, 4-inch diameter (vendor: https://www.generaloceanics.com/net-oil-sampling-4-dia-teflon-5080-250.html)
- Polarizing filter
- Plastic pipe
- Zip ties
- Indelible ink markers
- Digital camera
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice
- Field notebook

4.3 Field Notes

Field notes will be recorded during sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel if present;
- General weather conditions;
- Date, time, and sampling locations;
- Sheen observations; and
- Any general observations.

Field crews will primarily record field information in a field notebook.

4.4 Sampling Procedures

The following procedures describe the collecting sheen samples from surface water.

1. Don personal protective equipment (as required by the HASP), including nitrile gloves.
2. Prepare the nets for use to collect the sheen. Start with the decontaminated nets received from the laboratory. Attach the net to the sampling ring.
3. Mobilize to the sampling location. Locate the target location using RTK surveying techniques and identify the proposed location in the field notebook.
4. While maintaining careful footing and balance, disturb the surface of the sediment bed with feet, by turning over rocks, or using probe rod to attempt to generate a sheen that can be visually observed on the water surface.
5. Photograph the sheen using a digital camera with standard photographic polarizing filter. Prior to taking the photo, hold the filter between your eye and the sheen, and rotate through 90 degrees to optimize the polarization by maximizing or minimizing admission of polarized light. The rotation of polarizing filter will screen out glare from reflective water surface in order to allow the true colors of sheen to pass through the camera sensor. Once the optimum orientation of the polarizing filter is determined, hold the filter in the optimum orientation between the camera lens and the area to be photographed. Take a photo with the polarizing filter looking down on the fluid surface (i.e., when the polarization is parallel to the fluid surface). Take a second a photo with the polarizing filter looking along the fluid surface (i.e., when the polarization is perpendicular to the fluid surface). Record the use of the polarizing filter, approximate photo direction (north, east, northeast, etc.), and photo number for each photo in the field book.
6. Observe and document the color (i.e., silver/gray, rainbow, metallic, or dark/true color – see table below) and structure of the sheen (i.e., streamers, patches, spots, or no structure).

Color	Code	Description
Sheen (Silver/Gray)	**S**	Near **transparent** for thinnest layers to **silver/gray** for slightly thicker.
Rainbow	**R**	Rainbow colors are visible.
Metallic	**M**	The sheen reflects/mirrors the color of the sky with some element of oil color, often between light gray and dull brown.
Dark (or True) Color	**D**	The sheen is a continuous true oil color.

7. Pass the net through the oil sheen to collect the sample. Get as much of the net in contact with the surface sheen as possible. The net is used in a mop-like manner, not straining. Hold the net so that the opening of the ring is perpendicular to the surface of the water. Submerge the ring so that about half of the ring is above the surface of the water and half is below the surface of the water. Move the ring parallel to the surface of the water and through the sheen, back and forth. The sheen will stick to the net.
8. Repeat Steps 5 and 7 throughout the extent of the target area. A minimum of three passes will be made with the same net to capture an adequate quantity of sheen for analytical analysis.

9. Remove the net from the ring by unsnapping the ring and rotating the net off the ring.
10. Place the net in a laboratory supplied sample container.
11. Secure the sample jar cap tightly.
12. Label the sample container in accordance with the tactic using indelible ink.
13. Place filled sample containers on ice in a cooler.

5 Cautions

Vendor purchased Teflon® nets often are not sufficiently decontaminated to prevent false positives from laboratory analysis. Coordinate with the selected laboratory to analyze trip blanks or other approved method to confirm no decontamination.

Do not touch the sheen sample net with bare hands, as oils from the skin can be detected in the analysis and will interfere with the sheen analytical results.

Typically, either a large sheen or a number of small sheens need to be sampled with one net to get sufficient mass on the net for adequate laboratory reporting limits. If the sheen is blossoming in single drops, approximately ten drops are needed to have sufficient mass. If there is not enough mass on the net, there may be elevated reporting limits because of laboratory analytical challenges.

6 Waste Management

Investigative-derived waste generated during the sampling activities and disposable equipment will be transported for offsite disposal in accordance with the site-specific Waste Management Plan.

7 Data Recording and Management

All sample and location measurements and observations will be maintained in a field notebook or log. Upon project completion, field notebooks will be forwarded to the Project Manager for storage in the project files.

8 Quality Assurance

Samplers will forward copies of field notes and chains of custody to the CPM for quality assurance checks during project implementation at a frequency determined by the CPM. Sample quality will be achieved by complying with the procedures outlined in this SOP and by following the site-specific tactic. Cross-contamination will be prevented by following the protocols described in the SOP. Field activities will be supervised by appropriate experienced field supervisors.

- END OF PROCEDURE

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