

**Level 3 Project Study Plan**

***2023 East Side Tributaries Environmental Monitoring***

**Table of Contents**

List of Acronyms.....	2
(1) Objectives .....	3
(2) Point/Nonpoint Sources .....	4
(3) Sampling Locations .....	5
<b>Figure 1.</b> Map of Study Area.....	10

List of Acronyms

DVT	Doan Valley Tunnel System
DEIRS	Dugway East Interceptor Relief System
DSCRS	Dugway South Relief and Consolidation Sewer
DST	Dugway Storage Tunnel System
DWIRS	Dugway West Interceptor Relief System
EAST 140 <sup>th</sup> RCS	East 140 <sup>th</sup> St Relief and Consolidation Sewer
ECT	Euclid Creek Storage Tunnel System
EPA	Environmental Protection Agency
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LBRS	Lakeshore Boulevard Relief System
MIwb	Modified Index of Well-Being
MLK	Martin Luther King Conveyance Tunnel
NEORS	Northeast Ohio Regional Sewer District
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
USGS	United States Geological Survey
WCT	Woodhill Conveyance Tunnel
WQIS	Water Quality & Industrial Surveillance

March 31, 2023

(1) Objectives

One of the objectives of this project is to conduct environmental monitoring on several direct tributaries to Lake Erie (Euclid Creek, Dugway Brook, Doan Brook, Green Creek, Nine-Mile Creek, and Shaw Brook) to provide post-construction data related to the completion of several Northeast Ohio Regional Sewer District (NEORSD) Project Clean Lake projects: specifically, the Euclid Creek Storage Tunnel Project System (ECT), Doan Valley Tunnel Project System (DVT), and the Dugway Storage Tunnel Project System (DST). This monitoring is also required by the Ohio Environmental Protection Agency (Ohio EPA) National Pollution Discharge Elimination System (NPDES) Permit No. 3PA00002\*JD. The ECT System includes the Lakeshore Boulevard Relief Sewer (LBRS) and regulator upgrades. The DST System includes: Dugway West Interceptor Relief System (DWIRS), Dugway East Interceptor Relief System (DEIRS), the East 140<sup>th</sup> Street Relief and Consolidation Sewer (EAST 140<sup>th</sup> RCS), the Dugway South Relief and Consolidation Sewer (DSRCS) and regulator upgrades. The DVT System includes the Martin Luther King Conveyance Tunnel (MLK) and the Woodhill Conveyance Tunnel (WCT).

The tunnel systems are integral parts of the larger gray infrastructure capital improvements of Project Clean Lake. The project also includes significant investments in large-scale green infrastructure. The project is aimed at reducing combined sewer overflow (CSO) events and increasing the storage capacity of the collection system. The ECT, DVT, and DST Systems focus specifically on these impacts in the central and east sides of the service area including Cleveland, East Cleveland, Shaker Heights, and Bratenahl. Construction of this portion of Project Clean Lake began in 2009 and was completed in 2021.

The results of this study will be compared to environmental monitoring completed from 2009-2022. Data collected prior to the construction and implementation of Project Clean Lake control measures will be compared to post-construction data to evaluate how a reduction of bacterial loading and CSO volumes might have impacted the water quality of the receiving waters.

A second objective of this study is to provide pre-project environmental monitoring data for Doan Brook for work related to the removal of the Horseshoe Lake Dam and associated stream restoration activities and reconstruction of the Lower Shaker Lake Dam. These projects may result in positive changes in the environmental health of the brook.

Some of the sites in this project are also being assessed as part of NEORSD's general watershed monitoring program. The purpose of this monitoring is to determine the attainment and appropriateness of existing aquatic life use designations. Results will be compared to past studies to determine any changes that have occurred over time.

Finally, post-construction monitoring will also be conducted at Euclid Creek RM 0.40 where a restoration project was completed 10 years ago in January 2013. The purpose of that project was to restore coastal and lacustrine wetlands, increase fish habitat and

increase overall ecological function in the lower Euclid Creek. Monitoring at RM 0.40 was last completed in 2018.

Data collection will consist of wet and dry weather water chemistry samples at all sites to assess the chemical and bacteriological water quality conditions. Samples will be collected at least three times and analyzed for all parameters. Additional samples may be collected and analyzed for *Escherichia coli* and total phosphorus to ensure that at least five samples each are collected under both wet and dry weather conditions. These additional samples will be collected at the sites associated with the tunnel construction projects.

Fish, macroinvertebrate, and habitat assessments will also be conducted at select sites where the streams are not culverted and are accessible to field monitoring equipment (see below). These results will be evaluated using the Ohio EPA’s Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb) and Invertebrate Community Index (ICI). An examination of the individual metrics that comprise these indices will be used in conjunction with water quality data to identify impacts to the biotic communities. Water chemistry data will also be compared to the Ohio Water Quality Standards to determine attainment of applicable uses (Ohio EPA, 2022b)<sup>1</sup>. The sampling will be conducted by the NEORSD’s Environmental Assessment group in the Water Quality and Industrial Surveillance (WQIS) Division. Samples will be collected by NEORSD Level 3 Qualified Data Collectors (QDC) certified by Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment. Sampling will occur from June 15 through September 30, 2023 (through October 15 for fish sampling assessments), as required by the OEPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b)<sup>1</sup>.

Please see “2023 NEORSD Watershed Monitoring Study Plan” for further details regarding study activities and supporting documentation.

(2) Point/Nonpoint Sources

<b>Table 1. Point and Nonpoint Sources</b>	
Point Sources	Nonpoint Sources
Storm Sewer Outfalls	Urban runoff
Combined Sewer Overflows	Spills
Sanitary Sewer Overflows	Stormwater surface runoff
Illicit Discharges	Landfill Leachate
Failing Septic Systems	Agricultural Runoff

<sup>1</sup> See Appendix H for a list of references.

March 31, 2023

A map has been provided to show point sources that may be influencing the water quality at each sample location (Figure 1). These sources of pollution, along with the nonpoint sources listed in Table 1 above, may be impacting the health of the fish and benthic macroinvertebrate communities in the target streams and will need to be considered when evaluating changes to these communities with respect to the impact of the Euclid Creek, Doan Valley, and Dugway Storage Tunnel Systems including associated interceptors and regulators.

(3) Sampling Locations

The following sample locations will be surveyed during the 2023 field season (Table 2). Locations will be assessed for water chemistry, habitat, fish, and macroinvertebrates. Macroinvertebrate and water chemistry collection sites are located within each electrofishing zone, indicated by river mile, unless otherwise noted. GPS coordinates are recorded at the downstream end of each electrofishing zone.

2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

**Table 2.** 2023 Sample Locations

Waterbody	Latitude	Longitude	River Mile	Station ID	Location Information	USGS HUC 8	Purpose
Doan Brook	41.5330	-81.6296	0.75	301428	Downstream of St. Clair Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, & macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DVT construction
Doan Brook	41.5092	-81.6140	3.10	200137	Upstream of Martin Luther King Jr. Drive	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates pre-Horseshoe Lake/Lower Shaker Lake construction
Doan Brook	41.4900	-81.5856	5.45	301696	Downstream of Coventry Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates pre-Horseshoe Lake/Lower Shaker Lake construction
Doan Brook	41.4838	-81.5643	6.70	F01G52	Upstream of Lee Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD, post-DVT construction, and pre-Horseshoe Lake construction
Doan Brook, South Branch	41.4800	-81.5742	0.50	TBD	Downstream of S. Woodland Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Doan Brook, South Branch	41.4739	-81.5593	1.40	301429	Upstream of Green Lake	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DVT Alignment

2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

**Table 2.** 2023 Sample Locations

Waterbody	Latitude	Longitude	River Mile	Station ID	Location Information	USGS HUC 8	Purpose
Euclid Creek	41.5196	-81.5115	6.90	F01G47	Downstream of Mayfield Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Euclid Creek	41.5612	-81.5315	3.30	F01G48	Upstream of confluence with East Branch	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Euclid Creek	41.5658	-81.5358	2.70	200138	Upstream of Euclid Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-ECT construction
Euclid Creek	41.5738	-81.5470	1.65	504250	Upstream of St. Clair Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-ECT construction
Euclid Creek	41.5828	-81.5552	1.00	F01A48	Concrete structure upstream of Lakeshore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Euclid Creek	41.5833	-81.5594	0.55	F01A47	Downstream of Lakeshore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-ECT construction
Euclid Creek	41.5857	-81.5622	0.40	F01A46	Upstream of Wildwood Marina	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates post-wetland restoration project

2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

**Table 2.** 2023 Sample Locations

Waterbody	Latitude	Longitude	River Mile	Station ID	Location Information	USGS HUC 8	Purpose
Euclid Creek MB Unnamed Tributary	41.5320	-81.4970	1.50	302508	Upstream of Richmond Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Euclid Creek East Branch	41.5743	-81.4948	2.80	303283	Downstream of Richmond Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Euclid Creek East Branch	41.5618	-81.5277	0.25	300602	Upstream of Highland Road	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates
Green Creek	41.5578	-81.5470	2.50	302510	Upper Valley Drive, South of Euclid Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-ECT construction
Green Creek	41.5799	-81.5737	0.01	N/A	At outfall to Lake Erie	04110003 Ashtabula-Chagrin	Evaluate water chemistry in support of Ohio EPA Permit #3PA00002*JD and post-ECT construction
Nine-Mile Creek	41.5457	-81.5523	3.34	301435	South of Belvoir Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Nine-Mile Creek	41.5429	-81.5552	0.05	301436	South of Belvoir Boulevard on Nela Park Branch	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction



2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

**Table 2.** 2023 Sample Locations

Waterbody	Latitude	Longitude	River Mile	Station ID	Location Information	USGS HUC 8	Purpose
Nine-Mile Creek	41.5575	-81.5991	0.40	301432	Upstream of Lakeshore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Shaw Brook	41.5554	-81.6018	0.40	302509	Upstream of Lakeshore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Dugway Brook East Branch	41.5218	-81.5850	N/A	N/A	Forest Hills Park Forest Hills Blvd. and Forest Hills Ave. Upstream of DEIRS	04110003 Ashtabula-Chagrin	Evaluate water chemistry in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Dugway Brook East Branch	41.5479	-81.6076	N/A	N/A	East 110 <sup>th</sup> Street Salt Dome Downstream of DEIRS	04110003 Ashtabula-Chagrin	Evaluate water chemistry in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Dugway Brook Main Branch	41.5509	-81.6086	0.37	301430	North of Lakeshore Boulevard North of NEORSD Netting facility	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
Dugway Brook West Branch	41.5122	-81.5905	2.40	301431	Lakeview Cemetery downstream of NEORSD flood control dam Upstream of DWIRS	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, habitat, and macroinvertebrates in support of Ohio EPA Permit #3PA00002*JD and post-DST construction

2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

**Table 2.** 2023 Sample Locations

Waterbody	Latitude	Longitude	River Mile	Station ID	Location Information	USGS HUC 8	Purpose
10658 Dupont Ave	41.5446	-81.6118	N/A	N/A	*Dugway Brook, West Branch	04110003 Ashtabula-Chagrin	Evaluate water chemistry post in support of Ohio EPA Permit #3PA00002*JD and post-DST construction
<p>*This is the furthest downstream access location of all regulators tributary to the West Branch of Dugway Brook. It should be noted that there are two regulators (D-61 &amp; D-03A) downstream of this location that will not be captured during sample collection as there is no access to the culvert downstream of this location.</p>							

2023 Euclid/Dugway/Doan Storage Tunnels Post-Construction Monitoring  
 March 31, 2023

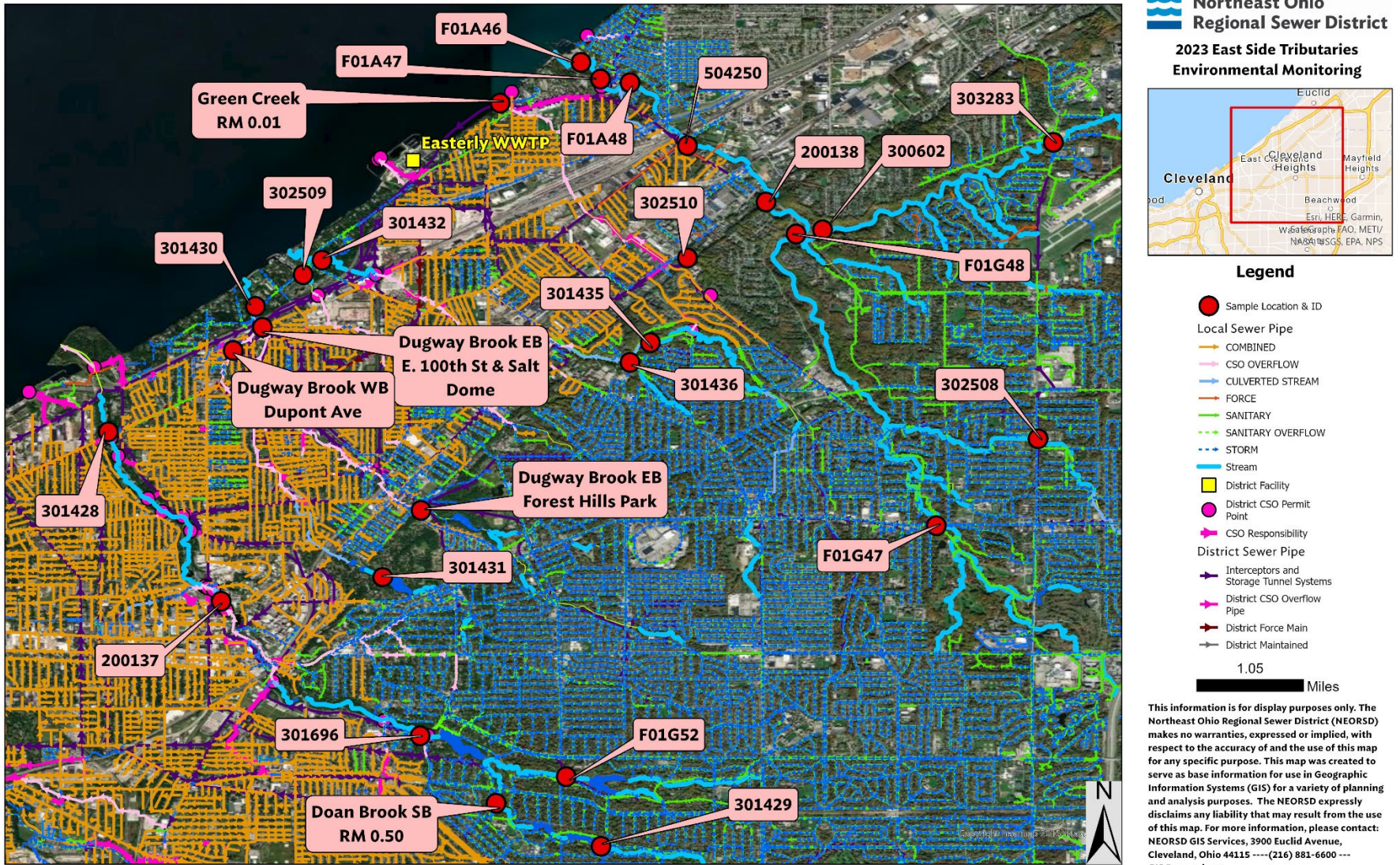


Figure 1. Map of Study Area

**Table of Contents**

List of Acronyms..... 2

(3) Parameters Covered ..... 3

(4) Field Collection and Data Assessment Techniques..... 4

(5) Stream Flow Measurement..... 6

(7) Schedule..... 6

(8) QA/QC..... 7

(9) Work Products..... 9

(10) Qualified Data Collectors ..... 9

(11) Contract laboratory contact information ..... 11

(12) Copy of ODNR collector’s permit ..... 11

(13) Digital Catalog Statement..... 11

(14) Voucher Specimen Statement ..... 12

(15) Sample Location Statement..... 12

(16) Additional L3 Data Collector Statement..... 12

(17) Trespassing Statement ..... 13

Appendix A. Field Forms..... 14

Appendix B. Parameter Information..... 25

Appendix C. Meter Specifications ..... 29

Appendix D. Chlorophyll *a* Field Form..... 41

Appendix E. Laboratory Certifications ..... 44

Appendix F. Acknowledgement Letters..... 54

Appendix G. Wild Animal Collector’s Permit..... 57

Appendix H. References..... 61

Appendix I. Laboratory Quality Manual and Standard Operating Procedures..... 64

List of Acronyms

DELTs	Deformities, Eroded Fins, Lesions & Tumors
EPA	Environmental Protection Agency
GPS	Global Positioning System
HD	Hester-Dendy
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LIBI	Lacustrary Index of Biotic Integrity
LICI	Lacustrary Invertebrate Community Index
L-QHEI	Lacustrary Qualitative Habitat Evaluation Index
MIwb	Modified Index of Well-Being
NEORSD	Northeast Ohio Regional Sewer District
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
QDC	Qualified Data Collector
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
USGS	United States Geological Survey
WQIS	Water Quality & Industrial Surveillance

(3) Parameters Covered

Fish specimens will be identified to species level, weighed, counted and examined for the presence of external anomalies including DELTs (deformities, eroded fins, lesions and tumors). An Ohio EPA Fish Data Sheet (Appendix A) will be completed during each assessment. Quantitative fish sampling is expected to be conducted at all locations.

Macroinvertebrate community assemblages will be collected from each location. An external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification will identify and enumerate the specimens collected from each site<sup>1</sup>. All specimens will be identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b)<sup>2</sup>. The NEORSD Macroinvertebrate Field Sheet (Appendix A) will be completed at each site during sample retrieval or when qualitative sampling is conducted.

Stream habitat will be measured by scoring components of the QHEI at all locations, including the substrate, instream cover, channel morphology, riparian zone, bank erosion, pool/glide and riffle/run quality and gradient. The Lacustrary QHEI (L-QHEI) will be performed at sites that are affected by the water level of Lake Erie. Examples of the Ohio EPA field sheets for the QHEI and the L-QHEI can be found in Appendix A.

Water chemistry samples will be collected at each electrofishing/macroinvertebrate sampling site included in the study. Water chemistry samples will be analyzed by NEORSD's Analytical Services Division. Appendix B lists the parameters to be tested along with the detection limits and practical quantitation limits. Field measurements for dissolved oxygen, pH, temperature, conductivity and turbidity will also be performed. A Surface Water Condition Sampling Field Data Form will be completed at each site during each sampling event (Appendix A).

Benthic and water column chlorophyll *a* samples may be collected from stream locations. Chemical and physical water quality parameters to be measured in conjunction with the chlorophyll *a* samples include total phosphorus, dissolved reactive phosphorus, nitrate+nitrite, ammonia, alkalinity, turbidity and suspended solids. In the Cuyahoga River, YSI EXO2 data sondes may be installed around the time that this sampling is conducted to more frequently monitor dissolved oxygen, temperature, conductivity, specific conductance and pH.

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<sup>1</sup> The contractor responsible for doing this work as not been identified yet. Once this contract is awarded, their contact information will be submitted.

<sup>2</sup> See Appendix H for a list of all references.

(4) Field Collection and Data Assessment Techniques

Field collections for fish will be conducted at all stream locations unless noted in the sample location table for each study. Sampling will be conducted using longline, tote barge, backpack, or boat electrofishing techniques and will consist of shocking all habitat types within a sampling zone. Headwater and wading sites, which are 0.15 and 0.20 kilometers in length, respectively, will be surveyed by moving from downstream to upstream. Boat sites, which are 0.50 kilometers in length, will be surveyed by moving from upstream to downstream. The stunned fish will be collected and placed into a live well for later identification. The longline, tote barge, backpack, and boat electrofishing zones will be assessed one to three times during the field season (June 15 - October 15).

Fish will be identified to the species level, weighed, counted, and examined for the presence of external anomalies including DELTs. Fish easily identified (commonly collected from year to year) will be returned to the site from which they are collected. Fish species difficult to identify will be brought back to the laboratory for verification by NEORSD Level 3 Fish Qualified Data Collectors (QDC). If necessary, vouchers will be sent to The Ohio State University Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Voucher specimens will be collected as described in section (14). Endangered species and those too large for preservation will not be collected as voucher specimens but will instead be photographed. Photographed vouchers will include features that permit definitive identification of the particular species.

Fish will be preserved in 10 percent formalin in the field, soaked in tap water for 24 to 48 hours after 5 to 7 days, then transferred to solutions of 30 and 50 percent ethanol for 5 to 7 days each and, finally, to 70 percent ethanol for long-term storage. Specimens larger than six inches will be slit along the right side and then soaked in formalin for approximately 10 to 14 days before being transferred to water and solutions of 30, 50 and 70 percent ethanol. Label information will include location (description and coordinates), date, time, collectors' names and sample identification code for each specimen collected.

Macroinvertebrate sampling will be conducted using quantitative and qualitative sampling techniques. Quantitative sampling will be done using a modified Hester-Dendy multi-plate artificial substrate sampler (HD) that is colonized for a six-week period. Multiple HD samplers may be installed at one or all sampling locations in case samplers are lost due to vandalism, burial, etc. or for the purposes of providing a replicate sample. Qualitative sampling will be conducted using a D-frame dip net when HD samplers are retrieved. The NEORSD Macroinvertebrate Field Sheet will be completed during each HD retrieval.

Macroinvertebrate voucher specimens for both quantitative and qualitative sampling will be collected as described in section (14). Macroinvertebrate community assemblages collected will be shipped to an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification for identification and enumeration. The Level 3

QDC will identify specimens to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b).

A detailed description of the sampling and analysis methods utilized in the fish community and macroinvertebrate surveys, including calculations of the IBI, MIwb, and ICI, can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Methods for assessing fish and macroinvertebrate communities in lacustrine zones can be found in Ohio EPA's draft *Biological Criteria for the Protection of Aquatic Life, Volume IV* (1997).

The QHEI, as described in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006) will be used to assess aquatic habitat conditions at each sample location. The L-QHEI will be used where appropriate and will follow Ohio EPA's *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)* (2010).

Water chemistry sampling may occur across a variety of flow conditions. Techniques used for water chemistry sampling and chemical analyses will follow the *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2021a). Chemical water quality samples from each site will be collected with at least one 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. Water samples collected for analysis of dissolved reactive phosphorus will be filtered using a 0.45- $\mu\text{m}$  PVDF syringe filter and will be collected in a 125-mL plastic bottle. Bacteriological samples will be collected in a sterile plastic bottle preserved with sodium thiosulfate. All water quality samples will be collected as grab samples. Duplicates and replicates will together comprise not less than 5% of total samples collected for each study plan. Field blanks will also comprise not less than 5% of the total samples collected for each study plan, for a total frequency of quality control samples of not less than 10% of the total samples collected. With the exception of bacteriological duplicate/replicate samples, the acceptable percent RPD will be based on the ratio of the sample concentration and detection limit (Ohio EPA, 2019):  $\text{Acceptable \% RPD} = [(0.9465X^{-0.344}) * 100] + 5$ , where X = sample/detection limit ratio. For bacteriological samples, duplicate/replicate samples more than 5x apart from one another (%RPD > 133.3%) will be rejected in accordance with the Ohio EPA approved method for data validation of bacteriological samples outlined in Section F of the *Ohio 2022 Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2022). Those RPDs that were higher than acceptable may indicate potential problems with sample collection and, as a result, the data will not be used for comparison to the water quality standards. Acid preservation of the samples, as specified in the NEORSW laboratory's standard operating procedure for each parameter, will occur in the field. Appendix B lists the analytical method, method detection limit and practical quantitation limit for each parameter analyzed. Field analyses include the use of either a YSI EXO1 sonde or YSI 600XL sonde to measure dissolved oxygen (DO), water temperature, conductivity and pH; and when necessary, a Hanna HI 98129 meter to measure pH and a



Hach HQ30d meter with LDO101 probe to measure DO. Field turbidity will be measured using a Hach 2100Q Turbidimeter. Specifications for these meters have been included in Appendix C.

Benthic and water column chlorophyll *a* samples may be collected if time and resources allow. Sampling methods will follow those detailed in the NEORSD *Chlorophyll a Sampling and Field Filtering Standard Operating Procedure* (SOP-EA001-02). A Chlorophyll *a* Sampling Field Sheet will be completed for each site where benthic chlorophyll *a* samples are collected (Appendix D). Water chemistry grab samples will be collected at the same time using the methods discussed previously and will be analyzed for nutrients, turbidity, alkalinity and suspended solids. Additionally, in the Cuyahoga River, approximately 24-hours prior to each chlorophyll *a* sampling event, YSI EXO2 data sondes may be deployed at sampling locations. If installed, each data sonde will record, at fifteen-minute intervals, dissolved oxygen concentration, pH, temperature, and conductivity from the time the data sonde is deployed until the time it is retrieved. These data sondes will be placed in the stream by inserting each one into a 4.5-inch PVC pipe with holes drilled into the sides of the lower third of the pipe to allow water to pass through it. The data sondes will remain in the river for approximately 24-hours or longer following collection of the chlorophyll *a* samples.

Where possible, data assessment will include an analysis of temporal and spatial trends in the collected data. Species assemblages and individual metrics will be analyzed. Graphs that show current and historic QHEI, L-QHEI, IBI, LIBI, MIwb, ICI, and LICl scores and how these scores compare to attainment status of biocriteria will be prepared. Water chemistry data collected will be compared to Ohio water quality standards to determine whether any excursions from the applicable water quality criteria have occurred. It will also be used to determine any relationships among individual parameters and chlorophyll *a* concentrations. Comparisons between water quality and biological community health will only be made if at least three water quality samples have been collected from that site.

(5) Stream Flow Measurement

Stream flow will be recorded for all locations during each electrofishing pass utilizing data from the United States Geological Survey (USGS) gauge station nearest the stream location, if applicable.

Stream flow will be measured with a HACH FH950 Flow Meter or Ott MF Pro Meter, which measure flow in feet per second, when HD samplers are installed and retrieved. The specifications for the flow meters can be found in Appendix C.

(7) Schedule

One to three electrofishing surveys will be conducted at each site between June 15 and October 15, 2023. Surveys will be conducted at least three weeks apart. Specific dates

have not been scheduled. River flow and weather conditions will be assessed weekly to determine when each electrofishing pass will be conducted.

Artificial substrate samplers will be installed at stream locations between June 15 and August 19, 2023, and retrieved six weeks later. Qualitative macroinvertebrate sampling will be conducted one time at all sites. Specific dates have not been scheduled. River flow and weather conditions will be assessed weekly to determine when the HD sampler installations and retrievals and qualitative sampling will be conducted.

QHEI, and, if necessary, L-QHEI habitat evaluations will be conducted one time between June 15 and October 15, 2023. QHEI evaluations will be conducted around the same time as one of the electrofishing surveys.

Water chemistry samples will be collected a minimum of three times from stream locations between June 15 and October 15, 2023.

Benthic and water column chlorophyll *a* samples may be collected at least one time from stream locations between June 15 and October 15, 2023. These samples will be collected under low-flow conditions.

(8) QA/QC

Quality assurance and quality control of sampling and analysis methods for habitat, fish, and macroinvertebrate evaluations will follow Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II (1987a) and III (1987b)*, *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI) (2006)*, draft *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustraries (1997)* and *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1) (2010)*

Electrofishing equipment will be used according to the guidelines listed in the operation and maintenance manual provided by Smith-Root, Inc. Malfunctioning equipment will not be used to collect data. Proper steps will be taken to correct any problems as soon as possible, whether by repairing in the field, at the NEORSD Environmental & Maintenance Services Center, or by contacting the supplier or an appropriate service company.

Fish species difficult to identify will be brought back to the laboratory for verification by Level 3 Fish QDC's, and if necessary, sent to The Ohio State University Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Voucher specimens will be collected as described in section (14). Endangered species and those too large for preservation will not be collected as voucher specimens but will instead be photographed. Photographed vouchers will include features that permit definitive identification of the particular species.

All macroinvertebrate community assemblages from stream locations, except for any replicate samples, will be collected and shipped to an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification for identification and enumeration. All specimens will be identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b). All macroinvertebrate specimens will be returned to NEORSD. At least two voucher specimens of each species, when available, will be separated into individual vials and kept as described in section (14). The remaining specimens for each site will be returned in a single container labeled with the site number and collection method and date. All specimens and accompanying chain-of-custody documentation will be retained by NEORSD and stored at the Environmental & Maintenance Services Center for a period not less than ten years.

Water samples obtained for chemical analyses will be collected, preserved (see Section 4), labeled and then placed on ice inside the field truck. The field truck will remain locked at all times when not occupied/visible. Sampling activities, including sample time and condition of surface water sampled, will be entered in a field logbook and on the Surface Water Condition Sampling Field Data Form. The samples will then be delivered immediately to the NEORSD Analytical Services cooler, after which the door to the cooler will be locked, and the samples will be transferred to the custody of Analytical Services. The NEORSD Analytical Services Quality Manual and associated Standard Operating Procedures are provided in Appendix I. Updates, revisions and any information on document control will be sent to Ohio EPA as needed.

For benthic and water column chlorophyll *a* sampling, three filtrations will be performed for each sample. A field filtration blank will be submitted for every 20 samples.

Calibration of YSI 600XL, EXO1, and EXO2 data sondes will be done according to the YSI Environmental Operations Manual. The conductivity will be calibrated first using a 1.413 mS/cm standard. Second, the pH will be calibrated using two different buffers (7 and 10 s.u.). The DO will be calibrated last with an acceptable error of 0.2 mg/L.

If EXO2 sondes are installed in the Cuyahoga River, once they are removed, the accuracy of the data that has been collected will be checked by comparing readings taken by the sondes to known standards. If the measurements taken at this time meet quality control goals, all of the data collected since the last calibration will be considered accurate. The acceptable differences for pH and conductivity will be  $\pm 0.3$  with pH 7 buffer and  $\pm 10\%$  of the conductivity standard, respectively (EPA New England- Region 1, 2005). The acceptable difference for DO will be  $\pm 0.2$  mg/L. If the measurements do not meet quality control goals, best professional judgment will be used to decide if any of the data collected during that period may still be accurate. For example, the data collected from the four locations may be plotted on the same graph, and if it appears that the data points are

following similar trends, they may be considered accurate. If any data that do not meet quality control goals are used, a rationale for their inclusion will be provided when the data are submitted.

(9) Work Products

Within one year of completion of the project, fish data (species, numbers, weights, pollution tolerances, the incidence of DELT anomalies, IBI or LIBI, MIwb scores), macroinvertebrate data (types and numbers of macroinvertebrates collected and ICI or LICI scores), habitat data (QHEI or L-QHEI raw data and scores) and water chemistry results will be submitted to the Ohio EPA or an Ohio EPA approved data warehouse. Additionally, reports summarizing, interpreting, graphically presenting and discussing the IBI (LIBI, where applicable), MIwb, ICI (LICI, where applicable) and QHEI (L-QHEI, where applicable) scores, chlorophyll *a* results, and any excursions from water quality standards may be prepared for internal use.

(10) Qualified Data Collectors

The following Level 3 Qualified Data Collectors (QDC) will be involved with this study:

Name	Address	Email Address	Phone Number	QDC Specialty(s)
Seth Hothem <sup>1</sup>	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	hothems@neorsd.org	216-641-6000	QDC - 00010 CWQA/FCB/SHA/BMB
Jillian Knittle	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	knittlej@neorsd.org	216-641-6000	QDC - 00512 CWQA/BMB
Ron Maichle	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	maichler@neorsd.org	216-641-6000	QDC - 00145 CWQA/BMB
Mark Matteson	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	mattesonm@neorsd.org	216-641-6000	QDC - 01020 CWQA/FCB/SHA
Denise Phillips	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	phillipsd@neorsd.org	216-641-6000	QDC - 01203 CWQA
Francisco Rivera <sup>2</sup>	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	riveraf@neorsd.org	216-641-6000	QDC - 00262 CWQA
Eric Soehnlen	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	soehnlene@neorsd.org	216-641-6000	QDC - 01030 CWQA/BMB
Justin Telep	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	telepj@neorsd.org	216-641-6000	QDC - 01304 CWQA/FCB/SHA
John Rhoades	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	rhoadesj@neorsd.org	216-641-6000	QDC - 00008 CWQA
Kelsey Amidon <sup>2</sup>	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	amidonk@neorsd.org	216-641-6000	QDC - 01091 CWQA

<sup>1</sup> NEORSD Lead Project Manager

<sup>2</sup> See acknowledgement letter for conducting water chemistry sampling (Appendix F)

The following is a list of persons not qualified as Level 3 QDCs who may be involved in the project. Prior to the start of sampling, the project managers will explain to each individual the proper methods for sampling. Sampling will only be completed under the direct observation of a QDC. The lead project manager will be responsible for reviewing all reports and data analysis prepared by qualified personnel prior to completion.

Name	Address	Email Address	Phone Number
Chris Abraham	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	abrahamc@neorsd.org	216-641-6000
Laurel Cope	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	copel@neorsd.org	216-641-6000
Brittany Dalton	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	daltonb@neorsd.org	216-641-6000
Laura Ferguson	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	fergusonl@neorsd.org	216-641-6000
Rae Grant	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	grantr@neorsd.org	216-641-6000
Jeff Harrison	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	harrisonj@neorsd.org	216-641-6000
Margaret Hodgkiss-Lilly	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	hodgkiss-lillym@neorsd.org	216-641-6000
Matthew Johnson	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	johnsonmatthew@neorsd.org	216-641-6000
Ryan Parrish	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	parrishr@neorsd.org	216-641-6000
Shawn Robinson	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	robinsons@neorsd.org	216-641-6000
Emma Routh	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	routhe@neorsd.org	216-641-6000
Brandon Saner	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	sanerb@neorsd.org	216-641-6000
Frank Schuschu	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	schuschuf@neorsd.org	216-641-6000
Wolfram von Kiparski	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	vonkiparskiw@neorsd.org	216-641-6000
Jack King	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	kingjack@neorsd.org	216-641-6000
Tyler Sagi	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	sagit@neorsd.org	216-641-6000
Paraprofessional Intern (TBD)	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	_____@neorsd.org	216-641-6000
Paraprofessional Intern (TBD)	4747 East 49 <sup>th</sup> Street Cuyahoga Hts., Ohio 44125	_____@neorsd.org	216-641-6000

(11) Contract laboratory contact information

All bacteriological and/or chemical sample analysis will be completed by NEORSD's Analytical Services Division. Evidence of NEORSD's Analytical Services current accreditation and method dates can be found in Appendix E. The contact information for NEORSD's Analytical Service Division is:

NEORSD Analytical Services  
Cheryl Soltis-Muth, Manager  
4747 E. 49th Street  
Cuyahoga Heights, Ohio 44056  
soltis-muthc@neorsd.org  
216-641-6000

Any fish that is not positively identified in the field, or at NEORSD, will be sent to The Ohio State University Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Fish will be identified to the species level.

Mr. Marc Kibbey, Associate Curator of Fish  
1315 Kinnear Road, Columbus, Ohio 43212  
cavender.1@osu.edu / kibbey.3@osu.edu  
614-292-7873

Identification of macroinvertebrates for stream locations will be completed by an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification <sup>3</sup>. Benthic macroinvertebrates will be identified to the lowest practical level as recommended by Ohio EPA (1987b). Contact information for this contractor will be submitted once the contract is awarded.

(12) Copy of ODNR collector's permit  
See Appendix G.

(13) Digital Catalog Statement

A digital photo catalog of all sampling locations will be maintained for 10 years and will include photos of the specific sampling location(s), the riparian zone adjacent to the sampling location(s) and the general land use in the immediate vicinity of the sampling location(s).

Print/Signature: Seth Hothem/  Date: 3/28/23

<sup>3</sup> A letter of acknowledgement of the macroinvertebrate identification responsibilities will be added as an addendum to this study plan, in Appendix F, upon finalization of the macroinvertebrate identification contract.

(14) Voucher Specimen Statement

NEORSD will maintain a benthic macroinvertebrate and fish voucher collection which includes two specimens, or appropriate photo vouchers, of each species or taxa collected during the course of biological sampling from any stream within the NEORSD's service area. When benthic macroinvertebrates from multiple surface waters are collected within the same year and identified by the same QDC, one voucher collection will be created to represent the specimens collected from those streams. When fish specimens from multiple surface waters are collected within the same year, one voucher collection will be created to represent the specimens collected from those streams. A separate collection for each sampling event will not be maintained.

NEORSD will provide specimens or photo vouchers to the Director upon request. This collection will be stored at the NEORSD laboratory in the Environmental and Maintenance Services Center.

Print/Signature: Seth Hothem/  Date: 3/28/23

(15) Sample Location Statement

I attest that I will make available any and all sampling location information, including but not limited to; the name of the water body sampled, sampling location latitude and longitude, sampling location river mile where possible, general location information, the U.S. geological survey HUC 8 number and name, and the purpose for data collection at each sampling location.

Print/Signature: Seth Hothem/  Date: 3/28/23

(16) Additional L3 Data Collector Statement

The Lead Project Manager for all stream locations is approved for all project data types.

Print/Signature: Seth Hothem/  Date: 3/28/23

(17) Trespassing Statement

I have not been convicted or pleaded guilty to a Violation of section 2911.21 of the Revised Code (criminal trespass) or a substantially similar municipal ordinance within the previous five years.

Print/Signature: Seth Hothem/ 	Date: 3/28/23
Print/Signature: Jillian Knittle/ 	Date: 3/28/23
Print/Signature: Ron Maichle/ 	Date: 4-5-23
Print/Signature: Mark Matteson/ 	Date: 3/28/23
Print/Signature: Denise Phillips/ 	Date: 4/24/23
Print/Signature: John Rhoades/ 	Date: 03/28/23
Print/Signature: Eric Soehnlen/ 	Date: 03/28/23
Print/Signature: Justin Telep/ 	Date: 3/29/23



## Appendix A. Field Forms



FISH DATA SHEET

Sheet ID For Office Use Only

[Empty box for Sheet ID]

New Station (requires lat/long & county)

[Empty checkbox]

Mix Zone

[Empty checkbox]

Page \_\_\_ of \_\_\_

Station ID \_\_\_\_\_ River Code \_\_\_\_\_ RM \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_

Stream \_\_\_\_\_ Location \_\_\_\_\_

Comments \_\_\_\_\_

Lat \_\_\_\_\_ Long \_\_\_\_\_ County \_\_\_\_\_ ALP \_\_\_\_\_ Time Fished \_\_\_\_\_

Crew \_\_\_\_\_ Netter \_\_\_\_\_ Others \_\_\_\_\_ Sampler Type \_\_\_\_\_

Distance \_\_\_\_\_ Flow \_\_\_\_\_ Temp. C \_\_\_\_\_ Secchi \_\_\_\_\_ Source \_\_\_\_\_ Project \_\_\_\_\_

Number	Total	Total	Weights		DELT ANOMALIES					
Fins Code	Weighed	Counted	Weight	Counts	Deformities, Erosions, Lesions, Tumors					
					Multiple DELTs on one fish					

1										D	E	L	T	M	*
	V	10x													
2										D	E	L	T	M	*
	V	10x													
3										D	E	L	T	M	*
	V	10x													
4										D	E	L	T	M	*
	V	10x													
5										D	E	L	T	M	*
	V	10x													
6										D	E	L	T	M	*
	V	10x													
7										D	E	L	T	M	*
	V	10x													
8										D	E	L	T	M	*
	V	10x													
9										D	E	L	T	M	*
	V	10x													

\* A-anchor worm; B-black spot; C-licees; F-fungus; N-blind; P-parasites; S-emaciated, W-swirled scales Y-popeye; Z-other



# NEORSD Macroinvertebrate Field Sheet

Stream: \_\_\_\_\_ River Mile: \_\_\_\_\_ Year: \_\_\_\_\_

Location: \_\_\_\_\_ Project: \_\_\_\_\_

River Code: \_\_\_\_\_ Station ID: \_\_\_\_\_

Drainage Area (mi<sup>2</sup>): \_\_\_\_\_ Latitude (°N)/Longitude (°W): \_\_\_\_\_

Site Type: WWH EWH Coldwater Lacustrary Other: \_\_\_\_\_ Eco-Region: \_\_\_\_\_

## Hester-Dendy Deployment Information

Install Date: \_\_\_\_\_ Crew (QDC Circled): \_\_\_\_\_

Current at HD (fps): \_\_\_\_\_ Depth (cm): \_\_\_\_\_ Pictures Obtained: Yes No

Replicate/Reinstall Date: \_\_\_\_\_ Crew (QDC Circled): \_\_\_\_\_

Current (fps): \_\_\_\_\_ Depth (cm): \_\_\_\_\_ Reason: \_\_\_\_\_

## Sampling/Retrieval Information

Sampling Method: Hester-Dendy Dipnet Ekman (6x6) Other: \_\_\_\_\_

Sampling Date: \_\_\_\_\_ Crew (QDC Circled): \_\_\_\_\_

OEPA Comment Field Codes: \_\_\_\_\_ Water Temp: \_\_\_\_\_ °C / °F

HD Condition- Current (fps): \_\_\_\_\_ Depth (cm): \_\_\_\_\_ Comments: \_\_\_\_\_

Number of HD Blocks Obtained: \_\_\_\_\_

Disturbed: Yes No Debris: Yes No

Silt/Solids: None Slight Moderate Heavy Sample ID: \_\_\_\_\_

Replicate: Current (fps): \_\_\_\_\_ Depth (cm): \_\_\_\_\_ Comments: \_\_\_\_\_

Number of HD Blocks Obtained: \_\_\_\_\_

Disturbed: Yes No Debris: Yes No

Silt/Solids: None Slight Moderate Heavy Sample ID: \_\_\_\_\_

Dipnet- Time Sampled (min): \_\_\_\_\_ X Number of Crew: \_\_\_\_\_ = Total (min): \_\_\_\_\_

Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_ Sample ID: \_\_\_\_\_

Habitats Sampled: Pool Riffle Run Margin Backwater

## River Sampling Conditions

Weather: Clear Partly Cloudy Overcast Light Rain Other: \_\_\_\_\_

Canopy (over HD): Open 75 % 50 % 25 % Closed

Flow Condition: Dry Intermittent Interstitial Low Normal Above Normal Flood

Current Velocity: Non-detect Slow Moderate Fast

Channel Morphology: Natural Channelized Channelized (Recovered) Impounded

Bank Erosion: None Slight Moderate Extensive

Water Clarity: Clear Muddy Tea Milky Other: \_\_\_\_\_

Water Color: None Green Brown Grey Other: \_\_\_\_\_

Evidence of Pollution: \_\_\_\_\_

Potential Pollution Sources: \_\_\_\_\_

Comment Section: \_\_\_\_\_

Samples Analyzed By: \_\_\_\_\_ QDC #: \_\_\_\_\_ Date: \_\_\_\_\_

Company/Entity: \_\_\_\_\_

# NEORSD Macroinvertebrate Field Sheet

↓

Cobble is up to 10 in

Coarse Gravel

Fine Gravel

sand

### Substrate Characteristics

	Riffle Units	Run Units	Pool Units
Bedrock			
Boulder			
Cobble/Rubble			
Gravel Course			
Gravel Fine			
Sand			
Silt			
Clay/Hardpan			
Detritus			
Peat			
Muck			
Other			
Macrophytes			
Algae- Note Color			
Artifacts			
Compaction (F,M,S)			
Depth (Avg)			
Width (Avg)			

### Physical Characteristics

**Predominant Land Use** (Indicate *Left*, *Right* or *Both*)

Forest	Urban	Open Pasture
Shrub	Residential/Park	Closed Pasture
Old Field	Mining/Construction	Wetland
Rowcrop	Industrial	Other _____

Predominant Riparian Vegetation			Riffle Habitat	
Left	Right	Type	Embedded: Yes No	
		Large Trees	Development:	
		Small Trees		Extensive
		Shrubs		Moderate
		Grass/Weeds		Sparse
		None		Absent
		Riparian Width	Quality:	
			Good	Fair
			Poor	

**Margin Habitat**

Margin Quality:      Good      Fair      Poor      \_\_\_\_\_ %

Types Present:

Root Mats	Undercut Banks	Rip Rap
Tree Roots	Shallows	Bulkhead
Woody Debris	Soft Clay	
Macrophytes/Grass	Other _____	

### Overall Collection

(V=>151; A= 150-101; C= 100-11; R= 10-1)

Est. Amt	
/	Porifera, Bryozoa
/ /	Turbellaria, Oligochaeta, Hirudinea
/	Isopoda, Amphipoda
/	Decapoda, Hydracarina
	Ephemeroptera
	Baetidae
/ /	Heptageniidae, Leptohiphidae, Caenidae
	Other _____
/	Zygoptera, Anisoptera
	Plecoptera
	Hemiptera
/	Megaloptera, Neuroptera
	Trichoptera
	Hydropsychidae
/	Hydroptilidae, Leptoceridae
	Other _____
	Coleoptera
	Elimidae
	Other _____
	Diptera
	Chironomidae
/	Tipulidae, Simuliidae
	Other _____
/	Gastropoda, Bivalvia
	Other _____

V= Very Abundant; A= Abundant; C= Common; R= Rare

### Biological Characteristics

**Habitat Specific Organisms**

*Riffle*: \_\_\_\_\_ %

Predominant Organism: \_\_\_\_\_

Other Common Organisms: \_\_\_\_\_

Density:      High      Moderate      Low

Diversity:      High      Moderate      Low

*Run*: \_\_\_\_\_ %

Predominant Organism: \_\_\_\_\_

Other Common Organisms: \_\_\_\_\_

Density:      High      Moderate      Low

Diversity:      High      Moderate      Low

*Pool*: \_\_\_\_\_ %

Predominant Organism: \_\_\_\_\_

Other Common Organisms: \_\_\_\_\_

Density:      High      Moderate      Low

Diversity:      High      Moderate      Low

*Margin*:

Predominant Organism: \_\_\_\_\_

Other Common Organisms: \_\_\_\_\_

Density:      High      Moderate      Low

Diversity:      High      Moderate      Low

Other Notable Collections: \_\_\_\_\_

---

E      VG      G      MG      F      P      VP

**Field Narrative Rating:**

# NEORSD Macroinvertebrate Field Sheet

## Field Sketch

Stream: \_\_\_\_\_ River Mile: \_\_\_\_\_ Year: \_\_\_\_\_

River Code: \_\_\_\_\_ Station ID: \_\_\_\_\_ Date: \_\_\_\_\_



Can place a copy of the sketch from your Field Notebook or the QHEI sketch (indicating HD) on page.

**Comment Section (2):** \_\_\_\_\_  
\_\_\_\_\_

Stream & Location: \_\_\_\_\_ RM: \_ \_ Date: \_ / \_ / \_

Scorers Full Name & Affiliation: \_\_\_\_\_ Northeast Ohio Regional Sewer District

River Code: - - STORET #: \_\_\_\_\_ Lat./Long.: \_\_\_\_\_ Office verified location [ ]

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present Check ONE (Or 2 & average)

Substrate assessment section with categories: BEST TYPES, OTHER TYPES, ORIGIN, and QUALITY. Includes checkboxes for various substrate types and a score box for Substrate (Maximum 20).

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts

Instream Cover assessment section with categories: UNDERCAT BANKS, OVERHANGING VEGETATION, SHALLOWS, ROOTMATS, POOLS, ROOTWADS, BOULDERS, OXBOWS, BACKWATERS, AQUATIC MACROPHYTES, LOGS OR WOODY DEBRIS. Includes checkboxes and a score box for Cover (Maximum 20).

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

Channel Morphology assessment section with categories: SINUOSITY, DEVELOPMENT, CHANNELIZATION, STABILITY. Includes checkboxes and a score box for Channel (Maximum 20).

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

Bank Erosion and Riparian Zone assessment section with categories: EROSION, RIPARIAN WIDTH, FLOOD PLAIN QUALITY, CONSERVATION TILLAGE, URBAN OR INDUSTRIAL, MINING / CONSTRUCTION. Includes checkboxes and a score box for Riparian (Maximum 10).

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

Pool / Glide and Riffle / Run Quality assessment section with categories: MAXIMUM DEPTH, CHANNEL WIDTH, CURRENT VELOCITY. Includes checkboxes and a score box for Pool / Current (Maximum 12).

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: [ ] NO RIFFLE [metric=0]

Riffle / Run Quality assessment section with categories: RIFFLE DEPTH, RUN DEPTH, RIFFLE / RUN SUBSTRATE, RIFFLE / RUN EMBEDDEDNESS. Includes checkboxes and a score box for Riffle / Run (Maximum 8).

6] GRADIENT (ft/mi) [ ] VERY LOW - LOW [2-4] %POOL: [ ] %GLIDE: [ ] DRAINAGE AREA (mi^2) [ ] MODERATE [6-10] %RUN: [ ] %RIFFLE: [ ] [ ] HIGH - VERY HIGH [10-6] Gradient Maximum 10

*A/ SAMPLED REACH*

Check ALL that apply

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

METHOD	STAGE
<input type="checkbox"/> BOAT	1st -sample pass- 2nd
<input type="checkbox"/> WADE	<input type="checkbox"/> HIGH <input type="checkbox"/>
<input type="checkbox"/> L. LINE	<input type="checkbox"/> UP <input type="checkbox"/>
<input type="checkbox"/> OTHER	<input type="checkbox"/> NORMAL <input type="checkbox"/>
	<input type="checkbox"/> LOW <input type="checkbox"/>
	<input type="checkbox"/> DRY <input type="checkbox"/>

**DISTANCE**

0.5 Km  
 0.2 Km  
 0.15 Km  
 0.12 Km  
 OTHER

**CLARITY**

1st --sample pass-- 2nd

< 20 cm

20-<40 cm

40-70 cm

> 70 cm/ CTB

SECCHI DEPTH

\_\_\_\_\_ meters

**CANOPY**

1st \_\_\_\_\_ cm

pass

2nd \_\_\_\_\_ cm

> 85%- OPEN

55%-<85%

30%-<55%

10%-<30%

<10%- CLOSED

*B/ AESTHETICS*

NUISANCE ALGAE

INVASIVE MACROPHYTES

EXCESS TURBIDITY

DISCOLORATION

FOAM / SCUM

OIL SHEEN

TRASH / LITTER

NUISANCE ODOR

SLUDGE DEPOSITS

CSOs/SSOs/OUTFALLS

*D/ MAINTENANCE*

PUBLIC / PRIVATE / BOTH / NA

ACTIVE / HISTORIC / BOTH / NA

YOUNG-SUCCESSION-OLD

SPRAY / SNAG / REMOVED

MODIFIED / DIPPED OUT / NA

LEVEED / ONE SIDED

RELOCATED / CUTOFFS

MOVING-BEDLOAD-STABLE

ARMOURED / SLUMPS

ISLANDS / SCoured

IMPOUNDED / DESICCATED

FLOOD CONTROL / DRAINAGE

Circle some & COMMENT

*E/ ISSUES*

WWTP / CSO / NPDES / INDUSTRY

HARDENED / URBAN / DIRT&GRIME

CONTAMINATED / LANDFILL

BMPs-CONSTRUCTION-SEDIMENT

LOGGING / IRRIGATION / COOLING

BANK / EROSION / SURFACE

FALSE BANK / MANURE / LAGOON

WASH H<sub>2</sub>O / TILE / H<sub>2</sub>O TABLE

ACID / MINE / QUARRY / FLOW

NATURAL / WETLAND / STAGNANT

PARK / GOLF / LAWN / HOME

ATMOSPHERE / DATA PAUCITY

*F/ MEASUREMENTS*

$\bar{x}$  width

$\bar{x}$  depth

max. depth

$\bar{x}$  bankfull width

bankfull  $\bar{x}$  depth

W/D ratio

bankfull max. depth

floodprone x<sup>2</sup> width

entrench. ratio

*Legacy Tree:*

*C/ RECREATION* AREA DEPTH

POOL:  >100ft<sup>2</sup>  >3ft

*Stream Drawing:*



# Lake / Lacustrary (Lentic) QHEI Field Sheet



Environmental Protection Agency

QHEI Score:

RIVERCODE \_\_\_\_\_ RIVERMILE \_\_\_\_\_ WATERBODY \_\_\_\_\_ DISTANCE ASSESSED (m): \_\_\_\_\_  
 DATE \_\_\_\_\_ LOCATION \_\_\_\_\_  
 SCORER \_\_\_\_\_ LAT. \_\_\_\_\_ LONG. \_\_\_\_\_ COMMENT \_\_\_\_\_

1) **SUBSTRATE** (Check *ONLY* Two Substrate TYPE BOXES; Estimate % or note every type present); LAKE: \_\_\_\_\_ LACUSTRARY: \_\_\_\_\_

TYPE	SHORE	BOTTOM	SHORE	BOTTOM	SUBSTRATE ORIGIN	SUBSTRATE QUALITY
<input type="checkbox"/> BLDR/SLABS [7] <input type="checkbox"/> BOULDER [10] <input type="checkbox"/> COBBLE [8] <input type="checkbox"/> GRAVEL [7] <input type="checkbox"/> SAND [6]			<input type="checkbox"/> HARDPAN [4] <input type="checkbox"/> BEDROCK [3] <input type="checkbox"/> DETRITUS [3] <input type="checkbox"/> SILT [2] <input type="checkbox"/> MUCK [2]		Check ONE (or 2 & AVERAGE) <input type="checkbox"/> LIMESTONE [1] <input type="checkbox"/> TILLS [1] <input type="checkbox"/> WETLANDS [1] <input type="checkbox"/> LACUSTRARINE [1] <input type="checkbox"/> SANDSTONE [1] <input type="checkbox"/> RIPRAP [1] <input type="checkbox"/> HARDPAN [0] <input type="checkbox"/> SHALE [1] <input type="checkbox"/> COAL/ORE [-2]	Check ONE (or 2 & AVERAGE) SILT: <input type="checkbox"/> SILT HEAVY [-2] <input type="checkbox"/> SILT MODERATE [-1] <input type="checkbox"/> SILT NORMAL [0] <input type="checkbox"/> SILT FREE [1] SILT ORIGIN: <input type="checkbox"/> CLAY [-2] <input type="checkbox"/> INDUSTRIAL [-1] <input type="checkbox"/> ORGANIC [1] <input type="checkbox"/> NONE [1]

NOTE: Ignore sludge that originates from point-sources, score on natural substrates

NUMBER OF SUBSTRATE TYPES  5 or More [2]  4 or Less [0]

Substrate

Max 20

COMMENTS: \_\_\_\_\_

2) **COVER TYPES** TYPE: (Check All That Apply) AMOUNT: (Check *ONLY* One or check 2 and AVERAGE)

<input type="checkbox"/> OFF-SHORE SAND BARS [4] <input type="checkbox"/> OVERHANGING VEGETATION [1] <input type="checkbox"/> SHALLOWS (ON BEACH) [1] <input type="checkbox"/> ROOTMATS [1]	<input type="checkbox"/> DEEPWATER > 1 M [1] <input type="checkbox"/> ROOTWADS [1] <input type="checkbox"/> BOULDERS [1] <input type="checkbox"/> SAND BEACH [1]	<input type="checkbox"/> WETLAND POOLS [1] <input type="checkbox"/> SUBMERGED AQUATIC VEG. [4] <input type="checkbox"/> LOGS OR WOODY DEBRIS [1] <input type="checkbox"/> GRAVEL BEACH [1]	<input type="checkbox"/> EXTENSIVE > 75% [9] <input type="checkbox"/> MODERATE 25-75% [7] <input type="checkbox"/> SPARSE 5-25% [3] <input type="checkbox"/> NEARLY ABSENT < 5% [1]
--	---	---	--

Cover

Max 20

COMMENTS: \_\_\_\_\_

3) **SHORELINE MORPHOLOGY** (Check *ONLY* one PER category or check 2 and AVERAGE)

SHORE SINUOSITY	DEVELOPMENT	MODIFICATION	STABILITY
<input type="checkbox"/> HIGH [2] <input type="checkbox"/> MODERATE [4] <input type="checkbox"/> LOW [3] <input type="checkbox"/> NONE [1]	<input type="checkbox"/> EXCELLENT [6] <input type="checkbox"/> GOOD [5] <input type="checkbox"/> FAIR [3] <input type="checkbox"/> POOR [1]	<input type="checkbox"/> NONE [7] <input type="checkbox"/> RECOVERED [5] <input type="checkbox"/> RECOVERING [3] <input type="checkbox"/> RECENT OR NO RECOVERY [1]	<input type="checkbox"/> HIGH [3] <input type="checkbox"/> MODERATE [2] <input type="checkbox"/> LOW [1]

**SHORE to BOTTOM SLOPE MORPHOLOGIES**

<input type="checkbox"/> SLOPE < 15 deg. [0]	<input type="checkbox"/> SLOPE > 45 deg. [2]
<input type="checkbox"/> SLOPE < 25 deg. [1]	<input type="checkbox"/> SLOPE 90 deg. [0]
<input type="checkbox"/> SLOPE > 25 deg. [3]	

**AVERAGE DEPTH (of 5 measures)**

<input type="checkbox"/> < 50 cm [0]	<input type="checkbox"/> > 400 - 500 cm [4]
<input type="checkbox"/> 50 - < 100 cm [1]	<input type="checkbox"/> > 500 - 900 cm [2]
<input type="checkbox"/> ≥ 100 - 200 cm [2]	<input type="checkbox"/> > 900 cm [1]
<input type="checkbox"/> > 200 - 4 00 cm [3]	

**MODIFICATIONS OF SAMPLED SHORELINE**

<input type="checkbox"/> CEMENTED [-1]	<input type="checkbox"/> STEEL BULKHEADS [-2]
<input type="checkbox"/> RIP RAPPED [1]	<input type="checkbox"/> ISLANDS [1]
<input type="checkbox"/> RAILROAD TIES [-1]	<input type="checkbox"/> DIKES [-1]
<input type="checkbox"/> DREDGED [-1]	<input type="checkbox"/> BANK SHAPING [-1]
<input type="checkbox"/> TWO SIDE CHANNEL	<input type="checkbox"/> WOOD PILING [1]
MODIFICATIONS [-1]	
<input type="checkbox"/> SHIP CHANNEL [-2]	

Shore Line

Max 20

COMMENTS: \_\_\_\_\_

4) **RIPARIAN ZONE AND BANK EROSION** (Check *ONE* box PER bank or 2 and AVERAGE)

★ Shore Right Looking East or South on Lake ★  
 ★ Shore Right Looking Toward Lake in Lacustrary ★

RIPARIAN WIDTH	SHORE LINE QUALITY (PAST 100 FOOT RIPARIAN)	BANK EROSION
L R (Per Bank) <input type="checkbox"/> WIDE > 50 m [4] <input type="checkbox"/> MODERATE 10-50 m [3] <input type="checkbox"/> NARROW 5-10 m [2] <input type="checkbox"/> VERY NARROW < 5 m [1] <input type="checkbox"/> NONE [0]	L R (Most Predominant Per Bank) <input type="checkbox"/> FOREST, WETLAND, LAKE [3] <input type="checkbox"/> SHRUB OR OLD FIELD [2] <input type="checkbox"/> VINEYARD, ORCHARD [2] <input type="checkbox"/> FENCED PASTURE [1] <input type="checkbox"/> RESIDENTIAL, PARK, NEW FIELD [1]	L R (Per Bank) <input type="checkbox"/> CONSERVATION TILLIAGE [1] <input type="checkbox"/> URBAN OR INDUSTRIAL [0] <input type="checkbox"/> OPEN PASTURE, ROWCROP [0] <input type="checkbox"/> MINING CONSTRUCTION [0] <input type="checkbox"/> DIKED WETLAND [0]
		<input type="checkbox"/> NONE/LITTLE [3] <input type="checkbox"/> MODERATE [-1] <input type="checkbox"/> HEAVY/SEVERE [-3]

Riparian

Max 10

COMMENTS: \_\_\_\_\_

5) **AQUATIC VEGETATION QUALITY: PLANT SPECIES OBSERVED** (Sum All Scores)

(Score all for observed abundance: ABUNDANT = [3]; COMMON = [5]; FEW = [1]; UNCOMMON = [0]) \_\_\_\_\_ NO AQUATIC VEGETATION = 0

<input type="checkbox"/> Pond Lilies (NYMPHAEA)	<input type="checkbox"/> Sedge (CYPERACEAE)	<input type="checkbox"/> Wild Celery (VALLISNERIA)
<input type="checkbox"/> Pond Weed (POTAMOGETON)	<input type="checkbox"/> Bulrush (SCIRPUS)	<input type="checkbox"/> Waterweed (ELODEA)
<input type="checkbox"/> Wild Rice (ZIZANIA)		

Vegetation

Max 30



(Score all for observed abundance: ABUNDANT = [-2]; COMMON = [-1]; FEW = [0])

<input type="checkbox"/> Purple Loosestrife	<input type="checkbox"/> Reed Grass	<input type="checkbox"/> Eurasian Milfoil	<input type="checkbox"/> Cattails	<input type="checkbox"/> Algae (mats)	<input type="checkbox"/> Algae (planktonic)
---	-------------------------------------	---	-----------------------------------	---------------------------------------	---

COMMENTS: \_\_\_\_\_

Is the Sampling Reach Representative of Area Habitat? (Y/N) \_\_\_\_ If Not, Explain: \_\_\_\_\_

Depth measures: \_\_\_\_\_  
Zebra Mussel/Quagga Mussel Coverage  >60%  60-25%  25-10%  <10-1%  1-0%

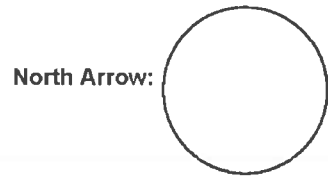
	Gear	Distance	Water Clarity	Wave Height		
First Sampling Pass:	_____	_____	_____	_____		
Second Sampling Pass:	_____	_____	_____	_____		
Third Sampling Pass:	_____	_____	_____	_____		

Subjective Rating (1-10)      Aesthetic Rating (1-10)

Photos: \_\_\_\_\_

WATERBODY MEASUREMENTS:      AVERAGE WIDTH: \_\_\_\_\_      AVERAGE DEPTH: \_\_\_\_\_      Maximum Depth: \_\_\_\_\_

**DRAWING OF SITE:**



## NEORSD Surface Water Condition Sampling Field Data Form

Stream: \_\_\_\_\_ Date: \_\_\_\_\_ Collectors: \_\_\_\_\_

Gage Station and ID: \_\_\_\_\_ Daily Mean Discharge: \_\_\_\_\_ ft<sup>3</sup>/sec

Was this sample taken during or following a wet weather event? YES / NO

Water Quality Meters Used: \_\_\_\_\_

Time (hrs): \_\_\_\_\_ River Mile (Site): \_\_\_\_\_

Weather: Clear Partly Cloudy Overcast Light Rain/Showers Heavy Rain  
Steady Rain Heavy Snow Melt Other: \_\_\_\_\_

Flow: Dry Intermittent Minimal Baseline/Normal Elevated Flood

HD Status: OK Other: \_\_\_\_\_

Color: Clear Muddy Tea Milky Other: \_\_\_\_\_

Odor: Normal Petroleum Anaerobic Sewage Chemical Other: \_\_\_\_\_

Surface Coating: None Foam Oily Scum Other: \_\_\_\_\_

Field Parameters: Conductivity (µmhos/cm): \_\_\_\_\_ Sp. Cond. (µmhos/cm): \_\_\_\_\_

Dissolved Oxygen (mg/L): \_\_\_\_\_ D.O. (%): \_\_\_\_\_

Temperature (°C): \_\_\_\_\_ pH (s.u.): \_\_\_\_\_

Turbidity 1 (NTU): \_\_\_\_\_ Turbidity 2 (NTU): \_\_\_\_\_ Average (NTU): \_\_\_\_\_

General Comments: \_\_\_\_\_

Sample ID: \_\_\_\_\_

Reporting sig figs: (Cond and DO% - 1) (pH, DO mg/L, and Chlor/BGA-PC - 0.1) (Temp- 0.01)

Time (hrs): \_\_\_\_\_ River Mile (Site): \_\_\_\_\_

Weather: Clear Partly Cloudy Overcast Light Rain/Showers Heavy Rain  
Steady Rain Heavy Snow Melt Other: \_\_\_\_\_

Flow: Dry Intermittent Minimal Baseline/Normal Elevated Flood

HD Status: OK Other: \_\_\_\_\_

Color: Clear Muddy Tea Milky Other: \_\_\_\_\_

Odor: Normal Petroleum Anaerobic Sewage Chemical Other: \_\_\_\_\_

Surface Coating: None Foam Oily Scum Other: \_\_\_\_\_

Field Parameters: Conductivity (µmhos/cm): \_\_\_\_\_ Sp. Cond. (µmhos/cm): \_\_\_\_\_

Dissolved Oxygen (mg/L): \_\_\_\_\_ D.O. (%): \_\_\_\_\_

Temperature (°C): \_\_\_\_\_ pH (s.u.): \_\_\_\_\_

Turbidity 1 (NTU): \_\_\_\_\_ Turbidity 2 (NTU): \_\_\_\_\_ Average (NTU): \_\_\_\_\_

General Comments: \_\_\_\_\_

Sample ID: \_\_\_\_\_

## Appendix B. Parameter Information

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Alkalinity	Alkalinity	EPA 310.2	mg/L	16	5.076
Mercury	Hg	EPA 245.1	µg/L	0.020	0.05
Ammonia <sup>1</sup>	NH <sub>3</sub>	EPA 350.1	mg/L	0.01	0.05
Nitrite	NO <sub>2</sub>	EPA 353.2	mg/L	0.005	0.04
		ASTM D7781-14	mg/L	TBD	0.04
Nitrite + Nitrate	NO <sub>2</sub> + NO <sub>3</sub>	EPA 353.2	mg/L	0.02	0.04
		ASTM D7781	mg/L	0.02	0.04
Total Kjeldahl Nitrogen	TKN	EPA 351.2	mg/L	0.276	0.75
Dissolved Reactive Phosphorus	DRP	EPA 365.1	mg/L	0.0113	0.025
Low Level Dissolved Reactive Phosphorus	LLDRP	EPA 365.1	µg/L	2.51	7.5
Total Phosphorus	Total-P	EPA 365.1	mg/L	0.0156	0.03125
Chloride	Chloride by IC	EPA 300.0	mg/L	2.27	5
Sulfate	Sulfate by IC	EPA 300.0	mg/L	1.89	5
Silver	Ag	EPA 200.8 <sup>3</sup>	µg/L	0.0239	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0196	0.5
Aluminum	Al	EPA 200.8 <sup>3</sup>	µg/L	1.71	10
		EPA 200.8 <sup>4</sup>	µg/L	15.8	50
Arsenic	As	EPA 200.8 <sup>3</sup>	µg/L	0.311	1
		EPA 200.8 <sup>4</sup>	µg/L	0.12	1
Barium	Ba	EPA 200.8 <sup>3</sup>	µg/L	0.102	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0243	0.5
Beryllium	Be	EPA 200.8 <sup>3</sup>	µg/L	0.0257	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0375	0.5
Calcium	Ca	EPA 200.8 <sup>3</sup>	µg/L	21.5	125
		EPA 200.8 <sup>4</sup>	µg/L	58.7	500
Cadmium	Cd	EPA 200.8 <sup>3</sup>	µg/L	0.0282	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0416	0.5
Cobalt	Co	EPA 200.8 <sup>3</sup>	µg/L	0.009	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0251	0.5
Chromium	Cr	EPA 200.8 <sup>3</sup>	µg/L	0.469	1.25
		EPA 200.8 <sup>4</sup>	µg/L	1.65	5
Copper	Cu	EPA 200.8 <sup>3</sup>	µg/L	0.177	0.5
		EPA 200.8 <sup>4</sup>	µg/L	0.203	1.5
Iron	Fe	EPA 200.8 <sup>3</sup>	µg/L	3.175	12.5
		EPA 200.8 <sup>4</sup>	µg/L	53.5	150

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Potassium	K	EPA 200.8 <sup>3</sup>	µg/L	28.75	125
		EPA 200.8 <sup>4</sup>	µg/L	161	1250
Magnesium	Mg	EPA 200.8 <sup>3</sup>	µg/L	4.095	62.5
		EPA 200.8 <sup>4</sup>	µg/L	9.94	100
Manganese	Mn	EPA 200.8 <sup>3</sup>	µg/L	0.705	2.5
		EPA 200.8 <sup>4</sup>	µg/L	0.147	5
Molybdenum	Mo	EPA 200.8 <sup>3</sup>	µg/L	0.119	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.0619	0.5
Sodium	Na	EPA 200.8 <sup>3</sup>	µg/L	27.25	125
		EPA 200.8 <sup>4</sup>	µg/L	36.7	250
Nickel	Ni	EPA 200.8 <sup>3</sup>	µg/L	0.0745	1
		EPA 200.8 <sup>4</sup>	µg/L	0.0579	0.5
Lead	Pb	EPA 200.8 <sup>3</sup>	µg/L	0.139	0.5
		EPA 200.8 <sup>4</sup>	µg/L	0.0302	0.5
Antimony	Sb	EPA 200.8 <sup>3</sup>	µg/L	0.109	2.5
		EPA 200.8 <sup>4</sup>	µg/L	0.0442	0.5
Selenium	Se	EPA 200.8 <sup>3</sup>	µg/L	0.307	1
		EPA 200.8 <sup>4</sup>	µg/L	0.165	2
Tin	Sn	EPA 200.8 <sup>3</sup>	µg/L	5	20
		EPA 200.8 <sup>4</sup>	µg/L	0.824	2
Strontium	Sr	EPA 200.8 <sup>3</sup>	µg/L	0.0466	0.5
		EPA 200.8 <sup>4</sup>	µg/L	0.0324	0.5
Titanium	Ti	EPA 200.8 <sup>3</sup>	µg/L	0.059	1
		EPA 200.8 <sup>4</sup>	µg/L	0.233	1
Thallium	Tl	EPA 200.8 <sup>3</sup>	µg/L	0.0545	0.25
		EPA 200.8 <sup>4</sup>	µg/L	0.888	5
Vanadium	V	EPA 200.8 <sup>3</sup>	µg/L	0.258	2.5
		EPA 200.8 <sup>4</sup>	µg/L	1.96	10
Zinc	Zn	EPA 200.8 <sup>3</sup>	µg/L	2.48	5
		EPA 200.8 <sup>4</sup>	µg/L	1.07	5
Hardness	Hardness (calc.)	SM 2340B <sup>2</sup>	mg/L	CaCO <sub>3</sub> mg/L = (2.497*Ca mg/L)+(4.118*Mg mg/L)	
<i>Escherichia coli</i>	<i>E. coli</i>	SM9223 Colilert QT (18 & 24 Hour)	MPN/100mL	1 MPN	1 MPN
Chlorophyll <i>a</i>	Chlorophyll <i>a</i>	EPA 445.0	µg/L	0.02	1
Chemical Oxygen Demand	COD	EPA 410.4	mg/L	8.4	20

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Biological Oxygen Demand	BOD	SM 5210 <sup>2</sup>	mg/L	2	N/A
Total Solids	TS	SM 2540 B <sup>2</sup>	mg/L	5	10
Total Suspended Solids	TSS	SM 2540 D <sup>2</sup>	mg/L	0.86	2
Total Dissolved Solids	TDS	SM 2540 C <sup>2</sup>	mg/L	0.86	2
Turbidity **		EPA 180.1	NTU	0.2	1
Field Parameter	Additional Name	Test	(Value Reported in)		
pH		SM 4500 H+B	s.u.		
Conductivity		SM 2510A <sup>2</sup>	µs/cm		
Specific Conductivity		SM 2510B <sup>2</sup>	µs/cm		
Dissolved Oxygen	DO	SM 4500-0 G <sup>2</sup>	mg/L		
Temperature	Temp	EPA 1701.1 <sup>2</sup>	°C		
Turbidity **		EPA 180.1	NTU		

<sup>1</sup> Listed MDL/PQL is for undistilled samples. Any samples that require distillation will have a MDL = 0.065 mg/L, PQL = 0.150 mg/L

<sup>2</sup> Standard Methods for the Examination of Water and Wastewater, Method approved by Standard Methods Committee, 1997. Editorial revisions, 2011.

<sup>3</sup> MDLs and PQLs specific to ICP-MS Xseries instrument

<sup>4</sup> MDLs and PQLs specific to ICP-MS qNOVA instrument

\*\* Turbidity will either be completed in the field or at the laboratory.

## Appendix C. Meter Specifications





## YSI 600XL and 600XLM Sondes

### **Measure multiple parameters simultaneously**

The YSI 600XL and YSI 600XLM compact sondes measure eleven parameters simultaneously:

Temperature	TDS
Conductivity	pH
Specific Conductance	ORP
Salinity	Depth or Level
Resistivity	Rapid Pulse™ DO (% and mg/L)



The YSI 600XL and 600XLM

### **Connect with Data Collection Platforms**

Either sonde can easily connect to the YSI 6200 DAS (Data Acquisition System), YSI EcoNet™ or your own data collection platform, via SDI-12 for remote and real-time data acquisition applications.

### **Economical Logging System**

The YSI 600XLM is an economical logging system for long-term, *in situ* monitoring and profiling. It will log all parameters at programmable intervals and store 150,000 readings. At one-hour intervals, the instrument will log data for about 75 days utilizing its own power source. The 600XL can also be utilized in the same manner with user-supplied external power.

- Either sonde fits down 2-inch wells
- Horizontal measurements in very shallow waters
- Stirring-independent Rapid Pulse® dissolved oxygen sensor
- Field-replaceable sensors
- Easily connects to data collection platforms
- Available with detachable cables to measure depth up to 200 feet
- Compatible with YSI 650 Multiparameter Display System
- Use with the YSI 5083 flow cell for groundwater applications

Pure  
Data for a  
Healthy  
Planet.®

*Economical, multiparameter  
sampling or logging in a  
compact sonde*

### **Sensor performance verified\***

The 6820 VZ and 6920 VZ sondes use sensor technology that was verified through the US EPA's Environmental Technology Verification Program (ETV). For information on which sensors were performance-verified, turn this sheet over and look for the ETV logo.





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ISO 9001  
ISO 14001

Yellow Springs, Ohio Facility

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\*Sensors sold with the ETV logo were submitted into the ETV  
program on the 1st of 2007. Information on the full range  
characteristics of YSI water quality sensors can be found at  
www.ysi.com or call YSI at 800 897 4151 for the ETV verification  
report. Use of the ETV name or logo does not imply approval or  
certification of this product nor does it make any explicit or  
implied warranties or guarantees as to product performance.

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Who's Minding  
the Planet?

## YSI 600XL & 600XLM Sensor Specifications

	Range	Resolution	Accuracy
Dissolved Oxygen % Saturation 6562 Rapid Pulse™ Sensor* <b>ETV</b>	0 to 500%	0.1%	0 to 200%: ±2% of reading or 2% air saturation, whichever is greater; 200 to 500%: ±6% of reading
Dissolved Oxygen mg/L 6562 Rapid Pulse™ Sensor* <b>ETV</b>	0 to 50 mg/L	0.01 mg/L	0 to 20 mg/L: ±0.2 mg/L or 2% of reading, whichever is greater; 20 to 50 mg/L: ±6% of reading
Conductivity* 6560 Sensor* <b>ETV</b>	0 to 100 mS/cm	0.001 to 0.1 mS/cm (range dependent)	±0.5% of reading + 0.001 mS/cm
Salinity	0 to 70 ppt	0.01 ppt	±1% of reading or 0.1 ppt, whichever is greater
Temperature 6560 Sensor* <b>ETV</b>	-5 to +50°C	0.01°C	±0.15°C
pH 6561 Sensor* <b>ETV</b>	0 to 14 units	0.01 unit	±0.2 unit
ORP	-999 to +999 mV	0.1 mV	±20 mV
Depth & Level Medium Shallow Vented Level	0 to 200 ft, 61 m	0.001 ft, 0.001 m	±0.4 ft, ±0.12 m
	0 to 30 ft, 9.1 m	0.001 ft, 0.001 m	±0.06 ft, ±0.02 m
	0 to 30 ft, 9.1 m	0.001 ft, 0.001 m	±0.01 ft, 0.003 m

\* Report outputs of specific conductance (conductivity corrected to 25°C), resistivity, and total dissolved solids are also provided. These values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (ed 1989).

## YSI 600XL & 600XLM Sonde Specifications

Medium		Fresh, sea or polluted water
Temperature	Operating	-5 to +50°C
	Storage	-10 to +60°C
Communications		RS-232, SDI-12
Software		EcoWatch*
Dimensions 600XL   600XLM	Diameter	1.65 in, 4.19 cm   1.65 in, 4.9 cm
	Length	16 in, 40.6 cm   21.3 in, 54.1 cm
	Weight	1.3 lbs, 0.59 kg   1.5 lbs, 0.69 kg
Power	External	12 V DC
	Internal (600XLM only)	4 AA-size alkaline batteries

YSI model 5083  
flow cell and  
600XL. This is an  
ideal combination  
for groundwater  
applications.



# HI 98129

## Combo pH/EC/TDS/Temperature Tester with Low Range EC



### Description

The HI 98129 Combo waterproof tester offer high accuracy pH, EC/TDS and temperature measurements in a single tester! No more switching between meters for your routine measurements. The waterproof Combo (it even floats) has a large easy-to-read, dual-level LCD and automatic shut-off. pH and EC/TDS readings are automatically compensated for the effects of temperature (ATC). This technologically advanced tester has a replaceable pH electrode cartridge with an extendable cloth junction as well as an EC/TDS graphite electrode that resists contamination by salts and other substances. This gives these meters a greatly extended life. Your tester no longer needs to be thrown away when the pH sensor is exhausted.

The EC/TDS conversion factor is user selectable as is the temperature compensation coefficient ( $\beta$ ). Fast, efficient, accurate and portable, the Combo pH, EC/TDS and temperature tester brings you all the features you've asked for and more!

### Specifications

Range	pH	0.00 to 14.00 pH
Range	EC	0 to 3999 $\mu\text{S}/\text{cm}$
Range	TDS	0 to 2000 ppm
Range	Temperature	0.0 to 60.0°C / 32 to 140.0°F
Resolution	pH	0.01 pH
Resolution	EC	1 $\mu\text{S}/\text{cm}$
Resolution	TDS	1 ppm
Resolution	Temperature	0.1°C / 0.1°F
Accuracy	pH	$\pm 0.05$ pH
Accuracy	EC/TDS	$\pm 2\%$ F.S.
Accuracy	Temperature	$\pm 0.5^\circ\text{C}$ / $\pm 1^\circ\text{F}$
Temperature Compensation		pH: automatic; EC/TDS: automatic with $\beta$ adjustable from 0.0 to 2.4% / °C
Calibration	pH	automatic, 1 or 2 points with 2 sets of memorized buffers (pH 4.01 / 7.01 / 10.01 or 4.01 / 6.86 / 9.18)
Calibration	EC/TDS	automatic, 1 point
TDS Conversion Factor		adjustable from 0.45 to 1.00
pH Electrode		HI 73127 (replaceable; included)
Environment		0 to 50°C (32 to 122°F); RH max 100%
Battery Type / Life		4 x 1.5V / approx. 100 hours of continuous use; auto-off after 8 minutes of non-use
Dimensions		163 x 40 x 26 mm (6.4 x 1.6 x 1.0")
Weight		100 g (3.5 oz.)



## HQ30d Portable pH, Conductivity, Dissolved Oxygen (DO), ORP, and ISE Multi-Parameter Meter



Product #: HQ30D53000000 Quantity  
 USD Price: \$750.00

★★★★★ 5/5

[Read 1 review](#) [Write a review](#) [Follow this product](#)

Portable meter measures critical water quality parameters - without the need for multiple instruments

Single input channel for flexible measurement of pH, Conductivity, Dissolved Oxygen (DO), BOD, ORP, Ammonia, Ammonium, Fluoride, Chloride, Sodium, and temperature - any INTELiCAL™ smart probe

Intuitive user interface for simple operation and accurate results

Guided calibration and check standard reviews reduce calibration errors. Stabilization alerts and visual measurement lock ensure that you can trust the accuracy of the results.

Trust your measurements - INTELiCAL™ smart probes store all calibrations in the probe

Calibration history allows quick and easy change out of probes without re-calibrating. The HCD™ smart system records serial numbers, current calibration data, user ID, sample ID time, and date automatically in the data log for complete GLP traceability.

Designed for demanding conditions

Rugged, waterproof (IP67) meter provides worry-free, reliable operation in lab or field environments

Convenient kit includes everything you need to start testing

Meter kit includes 4 AA batteries, quick-start guide, user manual and documentation CD

### Specifications

AC and USB Operation	optional
Automatic Buffer Recognition	Color-coded: 4.01, 7.00, 10.01 pH IUPAC: 1.070, 4.005, 7.000, 10.012, 12.45 DIN: 1.00, 4.05, 6.323 User-defined custom buffer sets
Barometric Pressure Measurement	For automatic compensation of DO when using an LDO or LBOD probe
Battery Requirements	4 AA
Benchtop	with stand
BOD5/CBOD resolution	Available when used with Hach WIMS BOD Manager software
Cable resistance correction	Digital - not needed
Calibration curves display	Calibration summary data logged and displayed
Calibration Intervals/Alerts/Reminder	2 hours to 7 days
Compliance	CE, WEEE
Conductivity Accuracy	± 0.5 % from (1µS/cm - 200 mS/cm)
Conductivity measurement	5 different stability modes
Conductivity Measurement Range	0.01 µS/cm to 200 mS/cm
Conductivity resolution	0.01 µS/cm with 2 digits
Custom Calibration Standards	User-defined standard sets
Data Export	Download via USB connection to PC or flash stick Automatically transfer entire data log or as readings are taken
Data Memory	500 results
Digital (Intelligent) electrode inputs	2
Dimensions (H x W x D)	7.8 in x 3.7 in x 1.4 in (197 mm x 95 mm x 36 mm)
Display	Display readings from one or two probes Simultaneous readings from two probes (HQ40d only) pH, pH, mV, temperature Conductivity, Conductivity, TDS, salinity, resistivity, temperature LDO, dissolved oxygen, pressure, temperature LBOD, dissolved oxygen, pressure, temperature ORP/Redox, mV, temperature Sodium, Sodium, mV, temperature
Display Lock Function	Continuous measurement or press to read mode available with averaging function for LDO measurement.
Display Type	240 x 160 pixel Display readings from one or two probes pH, pH, mV, temperature Conductivity, Conductivity, TDS, salinity, resistivity, temperature LDO, dissolved oxygen, pressure, temperature ORP/Redox, mV, temperature Sodium, Sodium, mV, temperature
DO Measurement Range	0.01 to 20 mg/L (0 to 200%)
DO Resolution	0.01 mg/L
Fixed Buffer Selection	(IUPAC standards [DIN 19286] or Technical buffer [DIN 19287] or 4-7-10 series or user defined)
Inputs	M12 digital (1) for INTELiCAL probes
Interface Languages	13**
Internal Data Storage	500
IP Rating	IP67
Languages:	English, French, German, Italian, Spanish, Danish, Dutch, Polish, Portuguese, Turkish, Swedish, Czech, Russian
mV Accuracy	± 0.1 mV
mV Measurement at Stable Reading	5 (auto) stabilization settings
mV Resolution	0.1 mV
Operating Error Messages	Text messages displayed
Operating Humidity	90 % relative humidity (non-condensing)
Operating Interface	Keypad
Operating Temperature	5 to 45 °C
ORP Electrode Calibration	Predefined ORP standards (including Zobell's solution)
Outputs	USB to PC / flash stick
PC Data Transfer Software	Included
pH Measurement at stable reading	5 stabilization settings
Printer	Optional accessory
Salinity Resolution	0.01 ppt
Warranty	3 years
Water Resistance	Meter Casing: 1 meter submersion for 30 minutes (IP67)
Weight	0.74 lbs (0.335 kg)

# 2100P and 2100P IS Portable Turbidimeter

Turbidimetry

## Features and Benefits

### Laboratory Quality in a Portable Unit

The Hach 2100P and 2100P IS Portable Turbidimeters offer a level of performance previously possible only with laboratory instruments. Microprocessor-controlled operation and Hach's unique Ratio™ optics bring great accuracy, sensitivity, and reliability to field and in-plant testing.

### Two Models for Specific Requirements

- **2100P Turbidimeter**—Get fast, accurate turbidity testing in the field or the lab, over a wide range of samples. Compliant with USEPA Method 180.1 design criteria.
- **2100P IS Turbidimeter**—Designed to meet international standards that mandate measurement using an LED light source.

### Two-detector Optical System

The two-detector optical system compensates for color in the sample, light fluctuation, and stray light, enabling analysts to achieve laboratory-grade performance on a wide range of samples, even under difficult, onsite conditions.



The Hach 2100P and 2100P IS Portable Turbidimeters bring laboratory-level performance on-site, offering fast, accurate results and the ease-of-use analysts demand in the field.

With a measurement range of 0 to 1000 NTU and a resolution of 0.01 NTU, the 2100P turbidimeter is ideal for regulatory monitoring, process control or field studies.

## Specifications\*

	2100P	2100P IS
<b>Measurement Method</b>	Nephelometric Ratio	
<b>Regulatory</b>	Meets EPA Method 180.1	Meets EN ISO 7027
<b>Light Source</b>	Tungsten lamp	Light-emitting diode (LED) @ 860 nm
<b>Range</b>		
<i>Automatic Range Mode</i>	0 to 1000 NTU	0 to 1000 FNU
<i>Manual Range Selection</i>	0 to 9.99, 0 to 99.9 and 0 to 1000 NTU	0 to 9.99, 0 to 99.9 and 0 to 1000 FNU
<b>Accuracy</b>	±2% of reading plus stray light	
<b>Repeatability</b>	±1% of reading, or 0.01 NTU, whichever is greater	±1% of reading, or 0.01 FNU, whichever is greater
<b>Resolution</b>	0.01 on lowest range	
<b>Signal Averaging</b>	Selectable on/off	
<b>Power Requirement</b>	4 AA alkaline batteries or optional battery eliminator	
<b>Battery Life, Typical</b>	300 tests with signal average mode off 180 tests with signal average mode on	
<b>Operating Temperature</b>	0 to 50°C (32 to 122°F)	
<b>Sample Required</b>	15 mL (0.5 oz.)	
<b>Sample Cells</b>	60 x 25 mm (2.36 x 1 in.) borosilicate glass with screw caps	
<b>Dimensions</b>	22.2 x 9.5 x 7.9 cm (8.75 x 3.75 x 3.12 in.)	
<b>Weight</b>	0.5 kg (1.1 lb.); shipping weight 2.7 kg (6 lb.)	
<b>Warranty</b>	2 years	

\*Specifications subject to change without notice.

DW = drinking water WW = wastewater municipal PW = pure water / power  
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™



## 2100Q and 2100Q is Portable Turbidimeter



*The Hach 2100Q and 2100Q is Portable Turbidimeters offer unsurpassed ease of use and accuracy in turbidity measurement. Only Hach offers this unique combination of advanced features, such as assisted calibration and simplified data transfer, and measurement innovation, giving you accurate results every time.*

D

W

P

I

F

### Features and Benefits

#### Easy Calibration and Verification

Hach 2100Q and 2100Q is Portable Turbidimeters provide confidence your measurements are right every time. On-screen assisted calibration and verification save you time and ensure accuracy. With an easy-to-follow interface, complicated manuals are not needed to perform routine calibrations. Single-standard RapidCal™ calibration offers a simplified solution for low level measurements.

#### Simple Data Transfer

Data transfer with the optional USB + Power Module is simple, flexible, and doesn't require additional software. All data can be transferred to the module and easily downloaded to your computer with a USB connection, providing superior data integrity and availability. With two different module options, you can customize connectivity and power to meet your unique needs.

#### Accurate for Rapidly Settling Samples

The Hach 2100Q Portable Turbidimeter incorporates an innovative Rapidly Settling Turbidity™ mode to provide accurate, repeatable measurements for difficult to measure, rapidly settling samples. An exclusive algorithm that

calculates turbidity based on a series of automatic readings eliminates redundant measurements and estimating.

#### Convenient Data Logging

Up to 500 measurements are automatically stored in the instrument for easy access and backup. Stored information includes: date and time, operator ID, reading mode, sample ID, sample number, units, calibration time, calibration status, error messages and the result.

#### Optical System for Precision in the Field

The two-detector optical system compensates for color in the sample, light fluctuation, and stray light, enabling analysts to achieve laboratory-grade performance on a wide range of samples, even under difficult site conditions.

#### Two Models for Specific Requirements

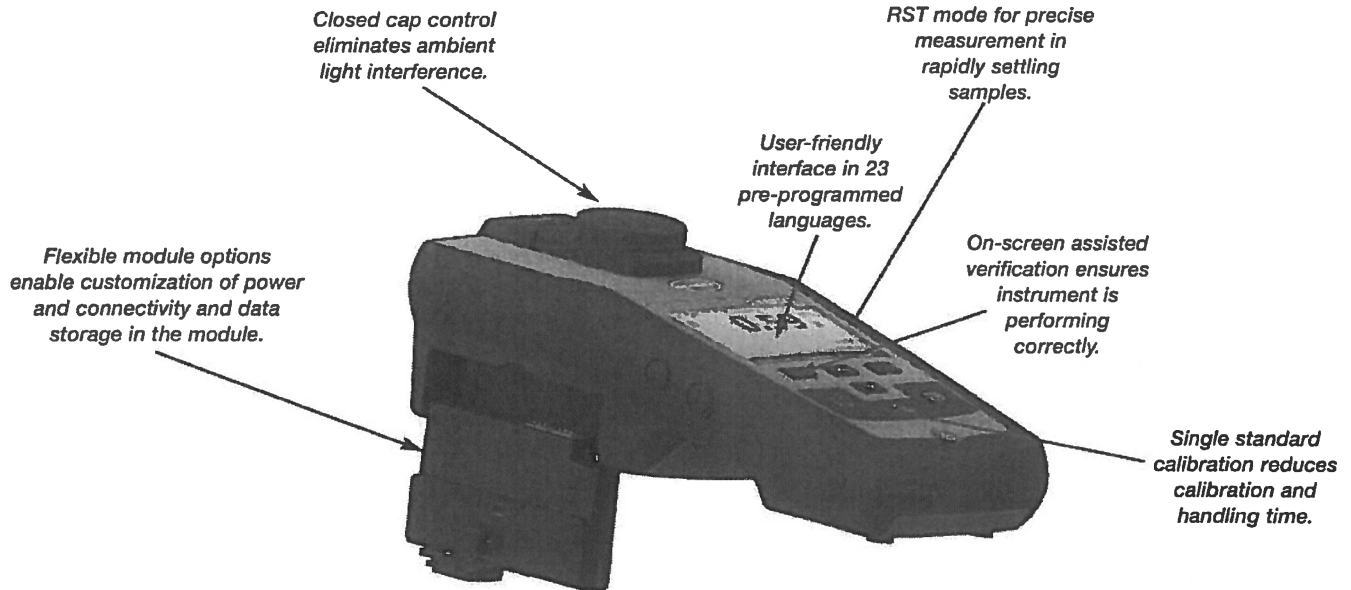
- **2100Q Turbidimeter**—Compliant with USEPA Method 180.1 design criteria.
- **2100Q is Turbidimeter**—Compliant with ISO 7027 design criteria.

DW = drinking water WW = wastewater municipal PW = pure water / power  
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™

## Key Features



## Specifications\*

### Measurement Method

Ratio turbidimetric determination using a primary nephelometric light scatter signal (90°) to the transmitted light scatter signal.

### Regulatory

2100Q: Meets EPA Method 180.1  
2100Q is: Meets ISO 7027

### Light Source

2100Q: Tungsten filament lamp  
2100Q is: Light-emitting diode (LED) @ 860 nm

### Range

0 to 1000 NTU (FNU)

### Accuracy

±2% of reading plus stray light from 0 to 1000 NTU

### Repeatability

±1% of reading, or 0.01 NTU (FNU), whichever is greater

### Resolution

0.01 NTU on lowest range

### Stray Light

<0.02 NTU (FNU)

### Signal Averaging

Selectable on/off

### Detector

Silicon photovoltaic

### Reading Modes (user selectable)

Normal (Push to Read)  
Signal Averaging  
Rapidly Settling Turbidity

### Data Logger

500 records

### Power Requirement

110-230 Vac, 50/60 Hz (with Power or USB+Power Module)  
4 AA alkaline batteries  
Rechargeable NiMH (for use with USB+Power Module)

### Operating Conditions

Temperature: 0 to 50°C (32 to 122°F)  
Relative Humidity: 0 to 90% @ 30°C,  
0 to 80% @ 40°C, 0 to 70% @ 50°C, noncondensing

### Storage Conditions

-40 to 60°C (-40 to 140°F), instrument only

### Languages

English, French, German, Italian, Spanish, Portuguese (BR), Portuguese (PT), Bulgarian, Chinese, Czech, Danish, Dutch, Finnish, Greek, Hungarian, Japanese, Korean, Polish, Romanian, Russian, Slovenian, Swedish, Turkish

### Interface

Optional USB

### Instrument Enclosure Rating

IP67 (closed lid, battery compartment excluded)

### Protection Class

Power Supply: Class II

### Certification

CE certified

### Sample Required

15 mL (0.3 oz.)

### Sample Cells

60 x 25 mm (2.36 x 1 in.) borosilicate glass with screw cap

### Dimensions

22.9 x 10.7 x 7.7 cm (9.0 x 4.2 x 3.0 in.)

### Weight

527 g (1.16 lb) without batteries  
618 g (1.36 lb) with four AA alkaline batteries

### Warranty

1 year

\*Specifications subject to change without notice.

# Sondes: EXO1 EXO2

Removable Bail

6-Pin Cable Connector

High-impact Xenoy Housing

Pressure Transducer Opening

Red LED Indicator - Status

Blue LED Indicator - Bluetooth

On/Off Magnetic Switch for Power and Bluetooth

4-Pin Wet-Mateable Connectors

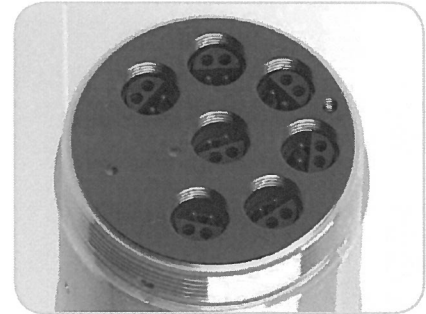
Port Plug

Anti-fouling Wiper

# EXO2



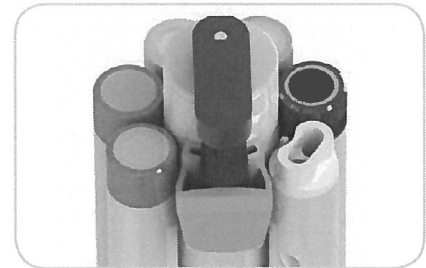
Cable connector, battery valve, and expansion port for an additional sensor



EXO2 sonde contains 6 universal sensor ports plus a central port for an anti-fouling wiper

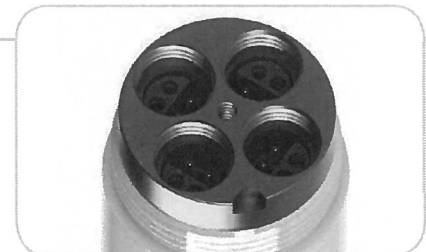
Battery Compartment

Cutaway: Reinforced internal structure



Anti-fouling wiper keeps sensors clear of biofouling and lengthens deployment times by 25%

Welded Titanium Housing



EXO1 sonde contains 4 universal sensor ports



## Instrument Specifications\*

<b>EXO1 Sonde</b>		
Ports	4 sensor ports Peripheral port: 1 power communication port	
Size	Diameter: 4.70 cm (1.85 in) Length: 64.77 cm (25.50 in)	
Weight	1.42 kg (3.15 lbs) with 4 probes, guard and batteries installed	
<b>EXO2 Sonde</b>		
Ports	7 sensor ports (6 ports available when central wiper used) Peripheral ports: 1 power communication port; 1 auxiliary expansion port	
Size	Diameter: 7.62 cm (3.00 in) Length: 71.10 cm (28.00 in)	
Weight	3.60 kg (7.90 lbs) with 5 probes, guard and batteries installed	
<b>Sondes</b>		
Operating Temperature	-5 to 50°C	
Storage Temperature	-20 to 80°C (except 0 to 60°C for pH and pH/ORP sensors)	
Depth Rating	0 to 250 m (0 to 820 ft)	
Communications	Computer Interface: Bluetooth wireless technology, RS-485, USB Output Options: USB with signal output adapter (SOA); RS-232 & SDI-12 with DCP-SOA	
Sample Rate	Up to 4 Hz	
Battery Life	90 days**	
Data Memory	512 MB total memory; >1,000,000 logged readings	
<b>Sensors</b>		<b>Calculated Parameters</b>
Ammonium	ORP	Salinity
Chloride	pH	Specific Conductance
Conductivity	Temperature	Total Dissolved Solids
Depth	Total Algae (Chlorophyll + BGA-PC or PE)	Total Suspended Solids
Dissolved Oxygen	Turbidity	
Fluorescent Dissolved Organic Matter (fDOM)	Vented Level	
Nitrate		
<b>EXO Handheld</b>		
Size	Width: 12.00 cm (4.72 in) Height: 25.00 cm (9.84 in)	
Weight	0.71 kg (1.56 lbs) without batteries	
Operating System	Windows CE 5.0	
Operating Temperature	-10 to 50°C	
Storage Temperature	-20 to 80°C	
IP Rating	IP-67	
Data Memory	2 GB total memory; >2,000,000 data sets	
<b>Accessories</b>		
Cables (vented and non-vented)	Flow cells	Sonde/sensor guard
Carrying case	KOR software	Calibration cup
DCP Signal Output Adapter	USB Signal Output Adapter	Anti-fouling components
<b>Warranty</b>		
3 months	Replaceable reagent modules for ammonium, chloride, and nitrate	
1 Year	Optical DO membranes and replaceable reagent modules for pH and pH/ORP	
2 Years	Cables; sonde bulkheads; handheld; conductivity, temperature, depth, and optical sensors; electronics base for pH, pH/ORP, ammonium, chloride, and nitrate sensors; and accessories	

\* Specifications indicate typical performance and are subject to change. Please check EXOwater.com for up-to-date information.

\*\* Typically 90 days at 20°C at 15-minute logging interval; temperature/conductivity, pH/ORP, DO, and turbidity sensors installed on EXO1; or temperature/conductivity, pH/ORP, DO, total algae, and turbidity sensors installed with central wiper that rotates once per logging interval on EXO2. Battery life is heavily dependent on sensor configuration.

EXO Bluetooth modules comply with Part 15C of FCC Rules and have FCC, CE Mark and C-tick approval. Bluetooth-type approvals and regulations can be country specific. Check local laws and regulations to insure that the use of wireless products purchased from Xylem are in full compliance.

## Sensor Specifications\*

Sensor	Range	Accuracy*	Response	Resolution
Ammonium <sup>11</sup> (ammonia with pH sensor)	0 to 200 mg/L <sup>1</sup>	±10% of reading or 2 mg/L-N, w.i.g.	-	0.01 mg/L
Barometer	375 to 825 mmHg	±1.5 mmHg from 0 to 50°C	-	0.1 mmHg
Blue-green Algae Phycocyanin (PC) (part of Total Algae sensor)	0 to 100 RFU; 0 to 100 µg/L PC	Linearity: R <sup>2</sup> > 0.999 for serial dilution of Rhodamine WT solution from 0 to 100 µg/mL PC equivalents	T63<2 sec	0.01 RFU; 0.01 µg/L PC
Blue-green Algae Phycoerythrin (PE) (part of Total Algae sensor)	0 to 100 RFU; 0 to 280 µg/L PE	Linearity: R <sup>2</sup> > 0.999 for serial dilution of Rhodamine WT solution from 0 to 280 µg/mL PE equivalents	T63<2 sec	0.01 RFU; 0.01 µg/L PE
Chloride <sup>11</sup>	0 to 1000 mg/L-Cl <sup>2</sup>	±15% of reading or 5 mg/L-Cl, w.i.g.	-	0.01 mg/L
Chlorophyll (part of Total Algae sensor)	0 to 400 µg/L Chl; 0 to 100 RFU	Linearity: R <sup>2</sup> > 0.999 for serial dilution of Rhodamine WT solution from 0 to 400 µg/L Chl equivalents	T63<2 sec	0.01 µg/L Chl; 0.01 RFU
Conductivity <sup>3</sup>	0 to 200 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading	T63<2 sec	0.0001 to 0.01 mS/cm (range dependent)
Depth <sup>4</sup> (non-vented)	0 to 10 m (0 to 33 ft)	±0.04% FS (±0.004 m or ±0.013 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
	0 to 100 m (0 to 328 ft)	±0.04% FS (±0.04 m or ±0.13 ft)		
	0 to 250 m (0 to 820 ft)	±0.04% FS (±0.10 m or ±0.33 ft)		
Vented Level	0 to 10 m (0 to 33 ft)	±0.03% FS (±0.003 m or ±0.010 ft)		
Dissolved Oxygen Optical	0 to 500% air saturation	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading <sup>5</sup>	T63<5 sec <sup>6</sup>	0.1% air saturation
	0 to 50 mg/L	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading <sup>5</sup>		0.01 mg/L
fDOM	0 to 300 ppb Quinine Sulfate equivalents (QSE)	Linearity: R <sup>2</sup> > 0.999 for serial dilution of 300 ppb QS solution Detection Limit: 0.07 ppb QSE	T63<2 sec	0.01 ppb QSE
Nitrate <sup>11</sup>	0 to 200 mg/L-N <sup>1</sup>	±10% of reading or 2 mg/L-N, w.i.g.	-	0.01 mg/L
ORP	-999 to 999 mV	±20 mV in Redox standard solutions	T63<5 sec <sup>7</sup>	0.1 mV
pH	0 to 14 units	±0.1 pH units within ±10°C of calibration temp; ±0.2 pH units for entire temp range <sup>8</sup>	T63<3 sec <sup>9</sup>	0.01 units
Salinity (Calculated from Conductivity and Temperature)	0 to 70 ppt	±1.0% of reading or 0.1 ppt, w.i.g.	T63<2 sec	0.01 ppt
Specific Conductance (Calculated from Cond. and Temp.)	0 to 200 mS/cm	±0.5% of reading or .001 mS/cm, w.i.g.	-	0.001, 0.01, 0.1 mS/cm (auto-scaling)
Temperature	-5 to 50°C	-5 to 35°C: ±0.01°C <sup>10</sup> 35 to 50°C: ±0.05°C <sup>10</sup>	T63<1 sec	0.001 °C
Total Dissolved Solids (TDS) (Calculated from Conductivity and Temperature)	0 to 100,000 g/L Cal constant range 0.30 to 1.00 (0.64 default)	Not Specified	-	variable
Total Suspended Solids (TSS) (Calculated from Turbidity and user reference samples)	0 to 1500 mg/L	Not Specified	T63<2 sec	variable
Turbidity <sup>11</sup>	0 to 4000 FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, w.i.g.; 1000 to 4000 FNU: ±5% of reading <sup>12</sup>	T63<2 sec	0 to 999 FNU: 0.01 FNU; 1000 to 4000 FNU: 0.1 FNU

All sensors have a depth rating to 250 m (820 ft), except shallow and medium depth sensors and ISEs. EXO sensors are not backward compatible with 6-Series sondes.

\* Specifications indicate typical performance and are subject to change. Please check EXOwater.com for up-to-date information. Accuracy specification is attained immediately following calibration under controlled and stable environmental conditions. Performance in the natural environment may vary from quoted specification.

<sup>1</sup> 0-30°C    <sup>2</sup> 0-40°C    w.i.g. = whichever is greater

<sup>3</sup> Outputs of specific conductance (conductivity corrected to 25°C) and total dissolved solids are also provided. The values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (Ed. 1989).

<sup>4</sup> Accuracy specifications apply to conductivity levels of 0 to 100,000 µS/cm.

<sup>5</sup> Relative to calibration gases

<sup>6</sup> When transferred from air-saturated water to stirred deaerated water

<sup>7</sup> When transferred from water-saturated air to Zobell solution

<sup>8</sup> Within the environmental pH range of pH 4 to pH 10

<sup>9</sup> On transfer from water-saturated air to rapidly stirred air-saturated water at a specific conductance of 800 µS/cm at 20°C; T63<5 seconds on transfer from water-saturated air to slowly-stirred air-saturated water.

<sup>10</sup> Temperature accuracy traceable to NIST standards

<sup>11</sup> Calibration: 1-, 2-, or 3-point, user-selectable

<sup>12</sup> Specification is defined in AMCO-AEPA Standards



## FH950 Portable Velocity Meter with 20' Cable



Product #: FH950.10020      Quantity  
 USD Price: \$4,585.00  
 Ships within 2 weeks

### Reduce manhours 50%

The step-by-step user interface simplifies programming, delivers real-time data, and downloads directly to PC allowing a single person to take the readings and eliminating post site visit manual data transfer from logbook to PC

### Automatically calculates total discharge based on USGS and ISO methods

Reduces time to manually calculate and likelihood of errors

### Real-time velocity graphed on color display

Visualize velocity trends quickly

### Lowest maintenance solution on the market

Electromagnetic velocity sensor with no moving parts never requires mechanical maintenance

### Lightweight, rugged portable meter

Only 1.5 pounds

### What's in the box

#### FH950.1 System Includes:

- Portable Velocity Meter
- Electromagnetic Sensor with 20' cable
- Fabric Carrying Case
- Adjustable Meter Rod Mount
- Universal Sensor Mount
- Battery Charger with Domestic/International Plug Adapters
- USB Cable
- Lanyard
- Sensor Screw Kit
- Absorbent Wipe

### Specifications

Accuracy 2:	$\pm 2\%$ of reading $\pm 0.05$ ft/s ( $\pm 0.015$ m/s) through the range of 0 to 10 ft/s (0 to 3.04 ms/s); $\pm 4\%$ of reading from 10 to 16 ft/s (3.04 to 4.87 m/s)
Battery Life:	heavy typical day use; 68°F (20°C)
Display: LCD:	Color, LCD 3.5 QVGA transfective (readable in direct sunlight)
Keypad:	Alpha-numerica
Operating Temperature Range:	-20 to 55 °C
Range:	to ft/s
Resolution:	Measurement Resolution - <10: 0.001; <100: 0.01; >100: 0.1
Storage Conditions:	-20 °C to 60 °C

## Appendix D. Chlorophyll *a* Field Form

## NEORSD Chlorophyll a Sampling Field Sheet

Stream: \_\_\_\_\_  
 Location: \_\_\_\_\_  
 RM: \_\_\_\_\_  
 Lat/Long: \_\_\_\_\_

Collectors: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Time: \_\_\_\_\_

Number of Rocks: \_\_\_\_\_

Total Area Scraped: \_\_\_\_\_ cm<sup>2</sup>

Diameter of individual scrape

- 1 \_\_\_\_\_
- 2 \_\_\_\_\_
- 3 \_\_\_\_\_
- 4 \_\_\_\_\_
- 5 \_\_\_\_\_
- 6 \_\_\_\_\_
- 7 \_\_\_\_\_
- 8 \_\_\_\_\_
- 9 \_\_\_\_\_
- 10 \_\_\_\_\_
- 11 \_\_\_\_\_
- 12 \_\_\_\_\_
- 13 \_\_\_\_\_
- 14 \_\_\_\_\_
- 15 \_\_\_\_\_
- 16 \_\_\_\_\_
- 17 \_\_\_\_\_
- 18 \_\_\_\_\_
- 19 \_\_\_\_\_
- 20 \_\_\_\_\_
- 21 \_\_\_\_\_
- 22 \_\_\_\_\_
- 23 \_\_\_\_\_
- 24 \_\_\_\_\_
- 25 \_\_\_\_\_

Area of individual scrape

- 1 \_\_\_\_\_
- 2 \_\_\_\_\_
- 3 \_\_\_\_\_
- 4 \_\_\_\_\_
- 5 \_\_\_\_\_
- 6 \_\_\_\_\_
- 7 \_\_\_\_\_
- 8 \_\_\_\_\_
- 9 \_\_\_\_\_
- 10 \_\_\_\_\_
- 11 \_\_\_\_\_
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- 13 \_\_\_\_\_
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- 15 \_\_\_\_\_
- 16 \_\_\_\_\_
- 17 \_\_\_\_\_
- 18 \_\_\_\_\_
- 19 \_\_\_\_\_
- 20 \_\_\_\_\_
- 21 \_\_\_\_\_
- 22 \_\_\_\_\_
- 23 \_\_\_\_\_
- 24 \_\_\_\_\_
- 25 \_\_\_\_\_
- Total: \_\_\_\_\_

Diameter to Area Conversion	
Diameter (cm)	Area (cm <sup>2</sup> )
1.6	2.011
1.7	2.27
1.8	2.545
1.9	2.835
2.0	3.142
2.1	3.464
2.2	3.801
2.3	4.155

Total Sample Volume \_\_\_\_\_ ml

Filter 1 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

Filter 2 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

Filter 3 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

Water Column Chlorophyll Sample

Filter 1 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

Filter 2 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

Filter 3 LABLynx ID \_\_\_\_\_  
 Vol \_\_\_\_\_ ml

**Flow:**    None        Low        Normal        Elevated        High

**Turbidity:** Clear        Low        Moderate\*        High\*

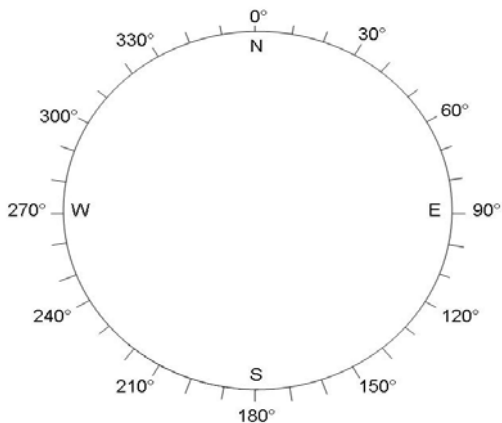
\*Explain \_\_\_\_\_

**Sky:**        Overcast    Cloudy        Partly Cloudy    Mostly Clear        Clear

**Canopy:**    Open        Mostly Open    Partly Closed    Closed

**Riparian**    None        Narrow L R    Moderate L R    Wide L R

Downstream Channel Direction



Clinometer

Left Bank \_\_\_\_\_°

Right Bank \_\_\_\_\_°

Left Bank \_\_\_\_\_°

Right Bank \_\_\_\_\_°

Left Bank \_\_\_\_\_°

Right Bank \_\_\_\_\_°

Stream Widths

\_\_\_\_\_m \_\_\_\_\_m \_\_\_\_\_m

Record two most predominate substrates with an X, and check all present.

	Riffle	Run	Reach
Boulder/Slabs	_____	_____	_____
Bedrock	_____	_____	_____
Boulder/Slabs	_____	_____	_____
Cobble	_____	_____	_____
Gravel	_____	_____	_____
Sand	_____	_____	_____
Silt	_____	_____	_____
Hardpan	_____	_____	_____
Detritus	_____	_____	_____
Artificial	_____	_____	_____

Substrate Origin

Limestone     Tills     Rip-rap  
 Sandstone     Shale     Wetlands  
 Lacustrine     Hardpan     Coal Fines

Silt

Heavy     Moderate     Normal     None

Embeddedness

Extensive     Moderate     Normal     None

Notes: \_\_\_\_\_

Length of Reach: \_\_\_\_\_m

Stream Drawing