cleveland water alliance

and Lake Erie Volunteer Science Network

Present

Lake Erie Baseline Assessment Framework Standard Operating Procedures (LEBAF SOP)

What You Need to Know to Join Our Effort to

Create Greater Collective Impact

VERSION 7.30.22

July 30th, 2022

Revision History

7/30/2022 - All Sections and SOP's revised, finalized and formatted - Andrea Paine, Ric Lawson, Barb Horn, Sara Guiher, Max Herzog

The authoritative copy of this document is housed in the [LEBAF SOPs & User Resources Google Drive Folder]

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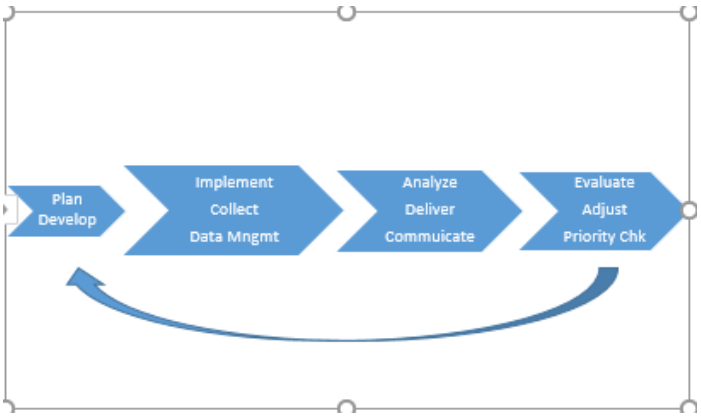
Chapter 1 – Introduction

1.1 LEBAF Objectives and How to Use This Document

LEBAF is a process for standardizing data collection, analysis and communication that empowers volunteer water quality monitoring ("volunteer science") groups to elevate the credibility of their data and tell a regional story about the condition of Lake Erie watersheds. It was created by the Lake Erie Volunteer Science Network (LEVSN), a regional collaboration of local monitoring programs, to unlock the potential of volunteer science to address gaps in regional water quality data collection.

- ***Monitoring Purpose:*** Describe a common set of measures that support assessment of the baseline conditions and trends in the health of Lake Erie watersheds at various scales.
- ***Intended Data Use:*** Data collected using the LEBAF SOP is intended to be used primarily as a water quality screening tool that drives 1) benchmarking of watershed health, 2) interoperability of results across watersheds, 3) education and engagement of local communities. It is secondarily intended for use in resource prioritization and decision making (e.g. use support, advocacy, policy, resource management, and adaptive management).
- ***Target Data Users:*** Data collected using the LEBAF SOP is primarily intended for use by LEVSN and its partners. Use by Federal, State and local decision makers is a priority, but secondary to the needs of the volunteer science groups implementing LEBAF.
- ***Expected Outcomes and Impacts:*** The implementation of LEBAF will 1) Provide a regional condition assessment of Lake Erie streams over time. 2) Identify potential problem areas to be investigated for impairment identification. 3) Establish a shared lexicon to communicate program elements, shared goals, and watershed status to volunteers and the public. 4) Demonstrate the capacity of regional volunteer science collaboration. 5) Create an iterative process for expanding the scope of shared standardizations and collaborations over time.

The LEBAF process began by standardizing collection protocols for chemical surrogates of watershed condition including conductivity, dissolved oxygen, pH, and water temperature. The details of these standardizations are recorded in this document along with a general framework for data management, analyses, visualization, communication and evaluation that serve LEBAF objectives across all parameters. In addition to standardized protocols, LEBAF includes training, equipment, outreach and communication support. Extensive input from LEVSN and external partners identified additional parameters, planning elements, and messaging components that could be standardized. These components have been recorded in a "standardization menu".



This menu tracks the source of each area of potential standardization, why it could drive collective impact, and its priority to the group. Each year, the collaboration will re-rank its priorities and select new focus areas in light of changes in technology, policy, resources, and water quality issues. Through this process, LEBAF participants will not only collect and analyze high-quality data but will annually identify and execute continuous improvement of this SOP.

How to Use this Document - This document is LEBAF's **Standard Operating Procedures (SOP).** It provides a framework for serving the information needs of targeted data users to advance LEBAF's stated purpose and desired outcomes (see above). LEBAF supporting documents, such as a guide for new groups or specific workflows may be created for different users but all content should map back to this SOP.

This SOP is primarily composed of 1) monitoring purpose, data use and users, 2) technical design and 3) information and evaluation design. **If you are new to LEBAF and want to get involved**, it will be helpful to review Chapter 1 first to grasp the bigger picture. As you read, remember that LEBAF is not trying to serve all monitoring purposes, data uses and users' information needs. This is essential context to keep in mind as you evaluate your group's alignment with LEBAFs strategy to create collective impact. After understanding LEBAFs monitoring purpose, data use and targeted data users, review the rest of the standard framework and assess your capacity, needs and questions. In the Technical Design, you will notice that the set of questions we answer for each parameter are identical. Responses to some questions may be mundane or not relevant for one parameter but critical to another. Keeping the same framework provides consistency, credibility and transparency.

As you navigate this document, please note that certain elements have been standardized across ALL parameters and are thus separated out from, but referenced in, each parameter section. For example, Data Management standards that apply to all parameters are described in Chapter 3, whereas specific data management needs for each parameter are detailed under the relevant section in Chapter 4.

1.2 Overview

The success of this monitoring collaboration is built upon the shared values, principles and goals of its participants. What are these principles and how did we get here?

Our Water Quality is Threatened - The Lake Erie Basin is more significantly impacted by human activity than that of any other Great Lake. These impacts are fueled by longstanding challenges like harmful algal blooms and heavy metal pollution as well as emerging contaminants such as microplastics and PFAS. At the same time, State and Provincial monitoring programs are challenged by limited staffing and budgets that curtail the scope and granularity of water quality data collected across the Basin.

And People are Ready to Help - Lake Erie residents feel a powerful sense of connection to their water resources. Local orgs have been harnessing this energy to power "Citizen" or "Volunteer" science groups that monitor water quality across the Basin for years. These groups are essential contributors to our understanding of the Basin, but their data are often challenging to access and use across watershed, state, or national boundaries. As a result, decision makers and communities struggle to fully leverage volunteer science data to address their most pressing water governance, management, research and advocacy needs. *See Appendix for a word on choosing terminology RE "Citizen" vs "Volunteer" Science

In Response, We Have Organized into a Movement for Collective Impact - To address these challenges, the Lake Erie Volunteer Science Network (LEVSN), a collaboration of local water quality monitoring programs convened by Cleveland Water Alliance (CWA), created the Lake Erie Baseline Assessment Framework (LEBAF). LEBAF is a process for standardizing data collection, analysis and communication that empowers local groups to elevate the credibility of their data and tell a regional story about the health of Lake Erie watersheds. This standardization makes volunteer science data easier to collect, access and use. LEVSN aims to support volunteer science groups across the region in adopting LEBAF, and engaging in a broad range of other collaborative activities, to increase individual and collective impact toward our common goal of clean and accessible water for all Lake Erie Basin communities.

Why Standardize? In general, standardization is a strategy to achieve a goal or solve a problem. When a critical mass of people do the same thing the same way for a sufficient time period, they can produce an impact greater than the sum of their individual efforts. This strategy can also improve the predictability, expectation management, and credibility of a program. With clear context, an appropriate process, and sufficient participation over time, standardization can be an effective strategy to create greater collective impact. However, standardization can also be an overwhelming or threatening prospect. The key to success lies in context, process and stakeholder buy-in. For standardization to be successful, participants must spend time formulating shared definitions of the undertaking. If there is not a common understanding of what is being standardized and why, the effort will likely not sustain. LEVSN created shared goals, guiding principles and decision making processes. This provided a foundation for when the process becomes challenging, messy or sluggish. Below is a summary of these inquiries. Perhaps you can find something that resonates with you.

What benefits or values do we hope to get from Standardization?

- *Standardization could help transform our data into actionable information* by aligning the policy objectives of regional stakeholders, developing a consistent communication approach and enabling integration of a variety of data sources to help tell the full environmental story.
- *Standardization could increase the credibility, consistency, and compatibility of our data* by helping us align around shared goals, protocols and best practices.
- *Standardization could make our data easier to use* by establishing shared collection and reporting protocols that align with the current state of science, creating consistency in types of data collected, and normalizing approaches to common data elements (Site ID, metadata etc.)
- *Standardization could increase our organizational capacity* by opening opportunities to grow the network, make collective funding asks, and be a louder voice in watershed policy.
- *Standardization could enable us to tell a new regional story* by improving our monitoring coverage, understanding of trends, and ability to connect data to larger Lake Erie objectives.
- These factors all indicate that *Standardization could help our data be used for decision making*
- Additionally, *Standardization could provide a framework for students to graduate high school with marketable skills in data collection*

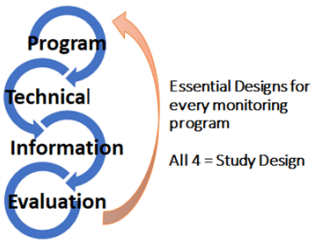
What risks, barriers or drawbacks should we consider as we pursue Standardization?

- Standardization could require equipment, training, and skills beyond the capacity of many groups, creating a barrier to entry for new or under-resourced programs.
- Standardization may prompt conflict between partners whose goals or methods are not aligned.
- Standardization may require changes that undermine historical data records or current funding.
- Standardization may threaten the autonomy of existing programs with excessive bureaucracy.
- Standardization may not maintain momentum or relevancy over time.

Organizing Principles - These values guided LEBAF's origination. They should be evaluated annually.

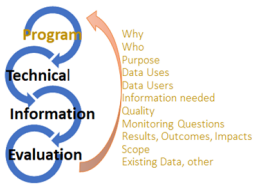
- Inclusive & Participatory, but not all standardization efforts may be a fit for all partners.
- Consider the capacity of all partners, where, when appropriate include strategies and resources to raise capacity (training, equipment, etc.)
- Connect "sets" of standardized components to collective purpose and outcomes
- Start with small wins, maybe behind the scenes not as visible, building up to bigger wins
- Streamline and simple, minimize bureaucracy, understanding some may be necessary
- Retain autonomy and individuality while creating synergy
- Consider value of legacy datasets
- Actively seek support for groups to maintain or increase capacity to participate.

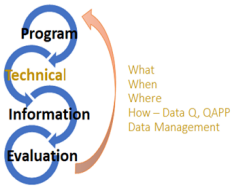
1.3 Study Design Buckets - A Common Communication Tool

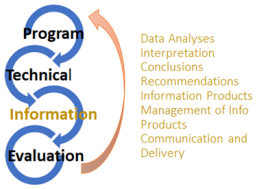


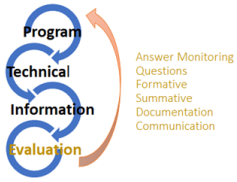
A significant challenge to creating a shared standardization is that no common language or framework exists for communicating what is being done or what is needed. It is difficult to understand, much less compare apples to apples when assessing what groups are doing when, why, how and the like to inform what could be leveraged by standardization and meeting groups where they are.

To address this challenge, LEBAF employed a proven framework to characterize and compare each participating program. This framework describes universal elements of monitoring study design using four buckets. LEBAF participants were asked to answer high level questions in each bucket for their own programs to help develop a shared understanding of the network's current activities. Shared program elements and priorities from which to build a strong collaborative foundation were identified from these common communication tools. This process also highlighted a high degree of alignment around "low hanging fruit" for possible standardization.









These key observations informed the initial focus of standardization:

- No geographical overlap in monitoring (niche, value added) among groups
- All groups are working in rivers primarily
- 6 groups collect DO and temperature
- 5 groups collected Conductivity, pH, Turbidity/Transparency
- 4 groups collect Nitrate and TSS
- 5 collecting some form of phosphorus - an important parameter for Lake Erie

Additionally, every group collected data for the purpose of "A1 - condition, status, trend for the use of education/ engagement". This is an effective "lane" for LEBAF and could be leveraged proactively in terms of metrics measured and communication to agencies to help them achieve their mission. This is a different class of indicators than chemical, biological or physical data. Many groups also collected data for the purpose of Planning (A6) and Advocacy (A5).

As a result of this work, LEBAF's monitoring purpose was identified as "condition and trend" and its data use was identified as "screening" with a focus on rivers. It was determined that the best course of action for LEVSN to support this purpose and use while meeting participating groups where they were was to develop an initial standardization for dissolved oxygen, temperature, pH and conductivity. These parameters are well established indicators of river health, have relatively simple sample collection and analyses methods, and were already being collected by all participants. They were well positioned to create a baseline framework upon which additional, more complex parameters could be added. Relevance of this approach and parameters to External Partners was explored in a "data users survey." External Partners expressed that these were key parameters already in use to characterize condition and health. Each parameter provides a unique element of biological functions for plants and animals, as well as surrogates for stress, disturbances or impairments in a waterway.

1.4 Conditions for Collective Impact and Evolution

It is imperative to understand, LEBAF is not trying to directly improve any one individual program or data users capacity. It is through the synergy of working together on a mutual effort that everyone benefits, individually and collectively. For the anticipated benefits to be realized, a critical mass of participants need to use comparable methods over a critical number of stations and time to generate the minimum amount of data required to tell a story.

In order to retain and recruit the needed critical mass of groups, the collaborative must work to both demonstrate and document its capacity to collect credible data, turn it into information, and communicate that information so it can be utilized for impact. Building this critical mass is an iterative process that will require participants to adapt in a manner that is feasible for their individual efforts. This initial pilot intentionally focused on a process that was inclusive, relevant and transparent in order to build a solid foundation, systems and infrastructure that could evolve, be trustworthy and credible.

1.4.1 Conditions for Collective Impact

LEBAF was designed to meet the five conditions of collective impact through extensive stakeholder engagement. These elements are:

- The common agenda is the monitoring purpose and data use that all standardization of data collection, management, analyses and information production serve. Construction of this agenda was vertically and horizontally inclusive to identify who and what this is for, what it takes to join and what results, impacts and outcomes are desired.
- Shared measurement is embedded in the standards themselves, for each parameter, data management, and information and evaluation design. It is also addressed in how the network assists Local Hubs in training, equipment, support, messaging and outreach, process workflows that are inclusive and evaluation that is comprehensive.
- Mutually Reinforcing Activities is achieved by meeting groups where they are. Helping them join this effort as added value rather than wholesale change provides a collaborative (regional) result while also expanding local impact.
- Continuous Communication – is embedded in processes that are guided by values and principles, revisited and updated during evaluation and participants are tracked and engaged in priorities, implementation, messaging and results.
- Backbone support is also embedded in the process, CWA had a vision they have funded allowing the development of LEBAF and within LEBAF are the principles and workflows to remain relevant, generate resources and support for this work.

1.4.2 Foundation and Expansion (Process and Menu)

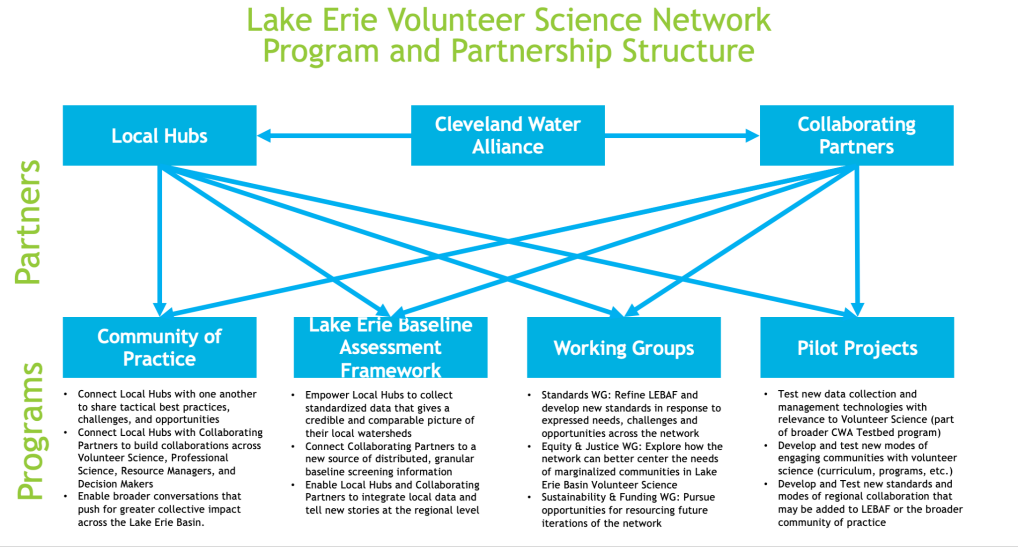
A menu of possible items to standardize was produced from the Local Hub Common Communication Tool exercise as well as survey outreach to external partners. The process thus far has identified additional chemical parameters, such as total phosphorus, e-coli, nitrate and total suspended solids, as valuable targets for standardization in the next iteration of LEBAF. Physical habitat parameters such as water level or biological parameters such as macroinvertebrates are also being considered. Chemical, physical habitat and biological parameters are unique indicators of condition, health as well as stresses and impairments. Together they help identify overall biological integrity and stream health. The menu tracks the source of each potential element for standardization, rational for standardizing it and a prioritization ranking for that year. Each year the leadership will evaluate this menu for relevancy and changes in prioritization as part of the Evaluation Design described in Chapter 8.

1.5 Participants

1.5.1 Lake Erie Volunteer Science Network

LEBAF is one the core programs advanced by the broader Lake Erie Volunteer Science Network (LEVSN). A database of participants and background information on the collaboration is being maintained to track the involvement and performance of current and past participants. You can find the most up-to-date list of current participants, information about their programs, and a shared visualization of their data on the LEVSN page of the CWA website.

Partnership and Program Structure - The graphic below illustrates the relationship between the stakeholders and the various program areas organized by LEVSN (Including LEBAF).



For those interested in getting involved, see below for the two primary roles for participants in LEBAF:

1.5.2 Collaborating Partners (Supporter)

Collaborating Partners leverage the standardized data and tools produced by LEBAF to answer research and management questions, activate residents, and catalyze collective impact across the Lake Erie Basin. They are a diverse collection of educators, researchers, innovators, and agencies that value collaborating with volunteer science groups and are committed to helping shape their priorities and evaluating the effectiveness of their programs.

Benefits - Working with volunteer science groups and their data can have a host of benefits for your Lake Erie Basin research, management, or engagement efforts. Participation as a Collaborating Partner will support and accelerate your existing work through:

- Access to credible and relevant volunteer-collected data that supplements "expert" monitoring capacity and fills data gaps to inform planning and policy at the local, state, and regional level.
- Access to educational tools through three curriculum modules, developed in partnership with Lake Erie Basin teachers, that use the lens of volunteer science to engage with climate change, watershed health, and 3-D fabrication respectively.
- Increased visibility through inclusion in regional press releases, communications materials, and a shared LEVSN web page (organizational bio, logo linking to your website, and map of standardized data collected by all participating Hubs)

- Opportunity to provide direction and accountability for a community of practice through annual group calls, a shared Slack channel and options to participate in joint pilot programs, funding opportunities, and working groups focused on tackling common challenges.
- Capacity to create greater collective impact through development of collaborations that leverage existing efforts and expand the capacity of both volunteer scientists and decision makers. What does it take to be a 2022-2023 Collaborating Partner? To gain the benefits of a LEVSN Collaborating Partner, a partner organization is expected to:

Commitment

- Participate in monthly meetings as feasible to stay abreast, review drafts, provide knowledge, feedback and resources and engage in data analyses and program evaluation. Assist with LEBAF outreach and communication. Estimated 2-8 hours a month.
- Participate in annual calls to contribute to ongoing coordination conversations, identify opportunities for collaboration and provide oversight for volunteer science activities.
- Designate a website landing area with relevant calls to action, allowing interested community members to easily navigate to your webpage from the shared LEVSN site to learn more about your local watershed and get involved in monitoring, restoration, and advocacy for your local water resources.
- Provide Direction, feedback, resources, knowledge, or other input in between calls.

1.5.3 Local Hub (Core Member)

Local Hubs organize community volunteers to engage in critical monitoring efforts that keep a finger on the pulse of local water quality and answer locally relevant scientific questions about water resources. They are a diverse collection of conservation districts, watershed groups, parks systems, and government entities that serve as boots on the ground, protecting local water resources across the Lake Erie Basin.

Benefits - Organizing a volunteer science group has a host of benefits for your community ranging from resident engagement to production of actionable environmental information. If you are currently, or hope to become, engaged in this critical work, you should consider participating in the Lake Erie Volunteer Science Network and implementing LEBAF as a “Local Hub.” As a Local Hub, you gain access to:

- Data management and visualization services through pre-paid access to Water Reporter (WR).
- LEBAF SOP that standardizes all study design elements to serve common monitoring objectives.
- data manager manual (DMM): A user guide for data and metadata management in WR.
- Technical support through Fondriest (for YSI water meters) and The Commons (for WR)
- General program support through CWA and the Lake Erie Volunteer Science Network (LEVSN)
- Validated data, analyses, messaging, and outreach products shared across the network.
- Annual program evaluation and evolution process to facilitate and grow greater collective impact

Commitment - See Appendices for the 2022 agreement between CWA and Local Hubs

1.6. How to Participate

If your organization is interested in participating in LEBAF as a Local Hub, please reach out to Max Herzog (mherzog@clewa.org), Program Manager with Cleveland Water Alliance. Open registration (for new Local Hubs) and re-registration (for existing Local Hubs) will run January- May of each calendar year. If a group wants to join in the middle of the field season, participation will be evaluated on a case by case basis by CWA to determine eligibility.

Chapter 2 – Study Design, Data Recording and Reporting

This section will address broad *study design elements that apply to all parameters* and the overall implementation of the collaboration. It explores many topics (such as information and evaluation design) that are defined in greater detail in subsequent chapters.

2.1 Monitoring Purpose and Why

2.1.1 Project Name/ID

Lake Erie Baseline Assessment Framework (LEBAF). This project was developed and is maintained by Cleveland Water Alliance and members of the Lake Erie Volunteer Science Network (LEVSN).

2.1.2 Collaborators

The standards were developed by the LEVSN Standardization Work Group with robust feedback and input from Local Hubs and External Partners (data users). The Working Group, Local Hubs and Collaborating Partners comprise the roles and ways to participate in the collaboration. Chapter 1 provides more information on benefits and responsibilities of these roles and a link to participating entities. Local Hubs agree to implement standards to the best of their ability. Entities will renew their participation each year in order to track and serve participating organizations effectively.

2.1.3 Goals

1. Identify a *common set of measures* to indicate conditions across the Lake Erie **Region**, for broader benchmarking, comparability of data and results across collectors, analyses and use for resource prioritization and decision making (natural resource, policy, water management or adaptive management as examples). See Chapter 1 for more information on LEBAF Objectives, Monitoring Purpose, and Intended Outcomes.
2. Select indicators that 1) are effective at identifying water's ability to support aquatic life, 2) are commonly used, easy to measure and have a number of currently comparable methods, 3) are feasible for volunteer scientists to implement.
3. Use initial standards as a template for other parameters in a wider and more robust standardization effort.
4. Provide screening data as part of a broader suite of parameters to identify potential problem areas that can be further investigated for possible impairment identification.
5. Increase volunteer science groups relevancy, credibility, and capacity.
6. Facilitate adopting a common lexicon or way to communicate monitoring program elements.
7. Provide a consistent message (WHY) to volunteers and the public – goal, value and significance of this/our efforts.
8. Increase culture of collaboration and ownership as a standard practice.

2.1.4 Vision

All rivers, tributary streams, and Lake Erie have chemical metrics within ranges that support aquatic life, and if not, are identified and on a path toward restoration.

2.1.5 Monitoring Purpose

The LEBAF SOP describes a common set of measures that support assessment of the baseline conditions and trends in the health of Lake Erie watersheds at various scales.

2.1.6 Data Use

Data collected using LEBAF is intended to be used primarily as a water quality screening tool that drives:

- Benchmarking of watershed health
- Interoperability of results across watersheds
- Education and engagement of local communities

It is secondarily intended for use in resource prioritization and decision making (e.g. use support, advocacy, policy, resource management, and adaptive management).

2.1.7 Data Users

Data collected using the LEBAF SOP is primarily intended for use by LEVSN (the collaborative of the volunteer science groups implementing LEBAF) and their constituents (which will vary depending on locality). Secondary Users include Federal and state Clean Water Act Agencies, other community stakeholders, other volunteer science groups and other agencies.

2.1.8 Monitoring Questions

1. What is the general condition of water chemistry in tributaries to Lake Erie?
2. Where are potential problem areas for further investigation?
3. How are chemical parameters changing over time at sites? Has remediation worked?

2.1.9 Results, Outcomes or Impacts

As a result of standardizing water chemistry parameters we hope to:

1. Provide a regional condition assessment of water chemistry in Lake Erie streams over time.
2. Identify potential problem streams for further investigation by volunteer science or local or state agencies or areas deserving of protection.
3. Establish a shared lexicon to communicate program elements, shared goals, and watershed status to volunteers and the public.
4. Demonstrate the capacity and credibility of regional volunteer science collaboration.
5. Create an iterative process for expanding the scope of shared standardizations and collaborations over time

2.1.10 Scope / Scale

Initially, the US Lake Erie Basin including Michigan, Ohio, Pennsylvania and New York. Eventually also to include the Canadian side of the Basin. ***The story we want to tell is a regional Great Lake Basin-based story that can be taken to a smaller scale such as state or watershed.***

2.1.11 Duration

The expected annual cycle of study design element (program, technical, information and evaluation) implementation is:

1. ***Program and Technical Design*** (AKA Field Season, Spring-Summer): Conduct standardized volunteer science to generate, validate, and manage water monitoring data.
2. ***Information Design*** (Fall): Transform data into information via analyses and communicate results to stakeholders and decision makers through information products.
3. ***Evaluation Design*** (Winter): Evaluate successes and failures of program structure, documented needed adjustments and select new elements to standardize in preparation for next field season.

Evaluation Design may include changes to all four study design buckets for example, adding a data use, modifying an aspect of a parameters collection or QA, changes in data recording or management, adding or deleting parameters. This annual cycle is repeated keeping LEBAF relevant, evolving and sustainable.

2.1.12 Parameter Type

Currently all parameters standardized by LEBAF are Chemical. Chapters 5 and 6 are place holders for biological and physical habitat parameters that may be developed and adopted as part of annual evaluation design and the ongoing efforts of the LEVSN Standards Working Group.

2.1.13 Data Quality Objectives Summary

Data quality objectives will differ by parameter but are generally designed to meet Local Hub and decision makers' information needs, primarily screening and inquiry at this time.

In general, the four parameters are collected using a sensor or meter technology and should follow manufacturer calibration methods and frequency. LEBAF requests that participants calibrate sensors before each monthly sampling event (which may include multiple sites and related sampling events) using recommended current standard solutions for calibration (not expired). If a participant has a calibration frequency and method in place, they can modify or employ existing protocols if they meet this minimum requirement. Documentation of calibration frequency and protocols is required.

If a specific sensor does not pass calibration (eg. does not accurately read a QA standard within acceptable range), participants must follow the manufacturer's guidance to correct the error or issue. This may include changing standard solution, cleaning sensor, probe or other elements, changing membranes, and recalibrating. Participants agree to follow all QA steps until a successful, accurate QA sample reading for each sensor is obtained. If that is not possible, volunteers can record that a particular reading was not possible to collect due to equipment in the comments field of their data sheet.

Annual QA includes comparative testing of each sensor against another approved sensor with an 80-120 percent recovery (meter 1 result / meter 2 result x 100 is within 80-120%) at least once per year. If results are outside of this range, investigation must be completed to diagnose differences and rectify until comparability is within this percent recovery range. A path of investigation can be to repeat sample reading 5-10 times and if percent recovery is within range 9 of 10 readings it passes. Alternatively, comparative testing can be repeated with 5 different standards. For this approach, a sensor passes if 4 of 5 are within range. Other fixes include replacement of standard solutions or service/replacement of sensors and equivalent membranes.

In addition, each organization will follow manufacturer's recommendations for annual sensor servicing and those groups using LEBAF's equipment will coordinate with LEBAF for this element. Participants are required to record the last calibration date and if calibration passed or failed for each sampling event.

2.1.14 Assumptions

1. Critical mass of volunteer science groups participate at a minimum level to create a consistent effort in collection and thus results to tell a regional story and demonstrate the impact of collaboration and its potential.
2. Equipment and QA/QC protocols are used that will detect chemical parameters accurately and precisely to meet data quality objectives.
3. Data Management is conducted consistently using the Water Reporter Application.
4. Data analyses, delivery, and communication designs reach intended decision makers.
5. Evaluation design is effective in adjusting and evolving program elements and designs.

6. Data Users utilize the data for desired decisions, planning and action and LEBAF captures that use and impact of that use toward results, impacts and outcomes.

2.2 Program Administration

2.2.1 Program Leadership

LEBAF was initiated and is led by Cleveland Water Alliance who over several years led multiple efforts to build our LEVSN, one of which coalesced into LEBAF. Information about who is involved, roles and participation is in Chapter 1. The appendix also includes an agreement that details the minimum participation and performance criteria for LEBAF participants related to the technical, information and evaluation designs, tracking databases and documentation.

2.3 Technical Design Overview

LEBAF Technical Design is described in detail in Chapters 3 and 4. Technical Design includes the how, what, when, where, quality assurance and control and data management necessary to generate data that will address LEBAF monitoring questions, monitoring purpose and data use for targeted data users information needs, in order to achieve progress towards desired results, outcomes and impacts.

Please refer to Chapter 3 for Data Management design including what is to be recorded (data and information collected during sampling and analyses), reported (data and information available to export), minimum data elements, naming conventions and LEBAF data dictionary. Chapter 4 covers all technical design SOPs that apply to all parameters and then a section on each parameter to address specific information to that parameter.

2.3.1 Participation and Minimum Criteria

All participants are asked to follow LEBAF sample operating procedures in this framework. Local Hubs are asked to perform a minimum set of criteria summarized below in a table, expressed in the MOU, with more detail below in each section SOP. These minimum performance criteria are tracked by LEBAF and provide an overall standard way to measure engagement and performance so that the program can be responsive, improve and ensure use of equipment and resources are maximized.

Design Element	Item
Technical - What & How	Collect all four parameters, DO, Temperature, pH and Conductivity, using approved sensor technology ranges. Participants can use their own equipment once appropriately vetted. LEBAF may provide sensors for participants as needed.
Technical - When & Where	Sampling season is April through October, weather permitting. Each group will commit to sampling at least one station, at a minimum of once per month at a representative location and flow. More stations and a higher sampling frequency are encouraged.
Quality Assurance and Control	Any sensors, probe(s) or meters employed for LEBAF must be approved by CWA before data is entered into Water Reporter. The participant will calibrate any probes using the instrument manufacturer's recommendations and follow LEBAF guidelines for

	documenting calibrations and take appropriate steps for unsuccessful calibrations. Calibration will occur before each sampling event unless other protocols or frequencies are comparable. Once calibrated, a sensor can be used at multiple sites. Each sensor will be compared to a second sensor or method of equal resolution annually. See above for more detail on sensor or equipment QA/QC. A calibration and equipment care log will be kept for each meter/parameter that includes monthly calibration, annual maintenance, a replicate and other relevant information. See next category for how calibration information is transferred to each event. **Sample Validation** - After calibration and equipment care, sample validation is first and foremost the responsibility of the lead volunteer during the sampling event. Volunteers should ask "Does the result seem reasonable for these conditions and this time of year?". If it does not, volunteers should check the instrument for mechanical or operational errors, repeat retaking a measurement several times and record all results. These additional steps should be characterized in the "other comments" field on the sheet. Volunteers don't have to necessarily solve the issue but note what actions were taken and the result. Program Managers can determine what number to report, the low or high, or an average or no result, and add additional comments. Participating groups are responsible for helping volunteers understand reasonable results.
Information to collect and record per sample event	The following fields are required to complete per event, adjust field data collection data sheets, applications and work flows accordingly. The red elements are automated by Water Reporter once input one time. Example field sheet documenting these elements. –**Organization, station(s), kit type, calibration completion check box (verified by equipment log), lead volunteer, date, time and result for each parameter** The following fields are encouraged but optional in this beta year: **–comments, site condition (menu), weather (menu), calibration** A calibration and equipment care log will be kept for each meter/parameter and rectified by the program manager that for each sampling event, each meter/probe/parameter has indeed been calibrated. Example of that log as a template for participants.
Data Management	LEBAF employs the platform Water Reporter for standardizing data recording (in) and reporting (out). LEBAF data manager manual, including data dictionary and best management practices are in the LEBAF data manager manual developed by Water Reporter. This is also a QAQC element. LEBAF participating organizations must have a Water Reporter ID. This includes providing a minimum set of information regarding organization, station, event and quality control and assurance. Data entry after each event or monthly is requested, by the end of October is required to be part of analyses. This includes assigning each station a standard LEBAF ID without losing individual organization station names. This also includes parameters, units and other standard naming conventions. Water Reporter maps existing naming conventions to LEBAF's for consistency in exporting and to meet FAIR data standards. **Data entry validation.** These steps are designed to eliminate or reduce human errors in sample validation from collection through data management into the final data repository.

	Moving the result from a meter directly to a database via a direct import eliminates errors that occur via manual data entry. If an organization is entering field or laboratory results by hand, a data entry validation protocol is provided in Chapter 3.
Information - Communication	Each organization will have information on their website and materials regarding LEBAF, what it is and how it compliments organizations' work. In addition, standard messaging developed by LEBAF will be utilized by organizations for communication and outreach.
Program Implementation	Each organization will provide a primary contact responsible for implementing LEBAF. Each organization will also participate in onboarding training (3 webinars for pilots, one each sampling season), and monthly cadence calls, as well as annual information and evaluation summits (in fall after sampling season). Each organization will modify procedures, work flows, training and communication to integrate LEBAF. Communication regarding changes in staff, equipment, participation or capacity will be timely and follow requirements on MOU.

2.3.2 Communication and Documentation

Communication and messaging about LEBAF in general and regarding results, interpretations, recommendations, conclusions, success stories, impact and outcomes is and will be standardized each year as part of implementing the information and evaluation design. Participants agree to utilize that messaging in their outreach and communication.

LEBAF documentation includes this SOP, a Data Managers Manual, Participant Agreement and user friendly spin off manuals and FAQs. These will be updated each year for participating organizations. This includes documentation of success stories and messaging of program and data collection results.

2.3.3 Additional information

This effort drew from efforts established in participating Local Hub groups, their SOPs and goals as well as information, SOPs, etc. from agencies and other decision makers

2.4 Information Design Overview

Information Design is the process of transforming "Data" (quantitative records that are generated, validated and managed in the technical design) *into "Information"* (analyzed and interpreted recommendations and/or conclusions) as well as how that information is delivered, communicated and used for intended purpose/uses. The end point is the result of that use toward desired results, outcomes and impacts (not data or use itself). Information Design elements that apply to all parameters are detailed in Chapter 7, with per parameter information needs covered in that relevant parameter chapter.

LEBAF participants will convene each Fall to implement Information Design. This process will be executed collectively with messaging, decisions and actions developed as a network. Initial data analyses will be conducted by the LEVSN Standards Working Group before this convening so that results are able to be interpreted appropriately. Output of the Information Design process will also be considered as part of a Winter Evaluation Design process so that associated implications such as training and fundraising can occur before the start of next field season in April.

LEBAF's Information Design includes the following tasks, work flows or elements:

2.4.1 Data Analyses/ Findings

Data analyses are analytic processes, such as calculating metrics and summary statistics or creating graphs and visualizations, that glean a set reproducible "findings" from the raw data. An example of a finding is "x exceeded y benchmark, z times, during g months". LEBAF's Data Analyses focus on illuminating findings across multiple geographic scales that can then be "interpreted" to tell a regional story and answer the monitoring questions when interpreted. At a high level, standardized metrics will be calculated and benchmarks selected likely by state or region before moving on to interpretation, recommendations and conclusions, all of which will be compiled into a messaging and set of information products for LEBAF that individual groups can also utilize.

For each parameter at each location, key metrics include the mean, maximum, minimum and number of samples collected. These metrics can be graphed and compared to state or LEBAF-generated benchmarks to show the percentage of exceedances. They can further be compared on an annual basis to show changes and trends. If reporting trends, regression or ANOVA can be used to determine if a trend is significant. Analysis of trends should follow standard methods, such as this U.S. EPA source. Data from individual sites should be evaluated first, but then data from multiple sites on the same stream, river, or watershed can be combined to report metrics on broader geographic ranges, with means from different sites reported as a range.

Many groups confuse data analyses with sample analyses. Sample analyses are the steps and methods used to collect, analyze and generate a valid result and are addressed in the Technical Design. Data analyses are the steps and methods employed to explore those results and turn them into information for use and progress toward desired outcomes and are addressed in the Information Design. It is not until all results are analyzed, validated via QA/QC, and stored in a data repository that data analyses can begin. Data analysis takes the data and runs it through calculations, visualizations and the like to interpret a story from the sample analyzed results.

2.4.2 Interpretation

Interpretation is the activity of making meaning of the data analyses and findings. For example, just because a parameter exceeds a benchmark does not mean harm was caused, a regulation was violated, or a water body is impaired. Interpretation is the leap from objective to subjective and it is important to document assumptions and limitations of the dataset.

Interpretation is the process of looking for patterns in the analyses, integrating ancillary information, and asking more questions than often there are answers. It is the process of asking "did the data answer our monitoring questions, what story does it tell, and what doesn't it say?" Interpretation is subjective and through the lens of the interpreter. Interpretations can lead to conclusions and recommendations. The process is credible when it is consistent, transparent and scientifically based.

Interpretation includes an evaluation of data analyses. Here you identify assumptions being made and limitations of the data set as well. How does this parameter behave daily, seasonally or temporally? Was variation captured sufficiently for data purpose and use? If exceedances of thresholds occur can you decipher magnitude, duration and frequency? Over what period of time or space? For LEBAF's monitoring purpose (condition/trend) and primary data use (screening for regional benchmarking) - did the data set and analyses fulfill this?

For LEBAF, a single measure below an impairment standard (for example those that state agencies or others employ) should not be used to report the stream segment as impaired. The monitoring purpose and data use for LEBAF is screening, not the assessment of use attainment or impairment required of

Clean Water Act agencies. At this time, LEBAF chooses to report % and # of exceedances and not formally interpret those exceedances with a label, grade or color until more data is collected.

However, a stream with multiple measures not meeting the selected standard can be reported as potentially impaired and in need of further investigation or equivalent messaging. How this will be reported and messaged via LEBAF is laid out in Chapter 7 and will be modified after each field season. Local groups are free to use this data for their own purposes in addition to LEBAFs approach.

Not every targeted decision maker will want LEBAF's interpretation; they may only want the data itself. LEBAF participants will be conducting interpretation and developing standard messaging for groups and others to hear and use. Questions and answers in this section help inform the degree of confidence in developing recommendations, conclusions and subsequent messaging. LEBAF will provide data exports via Water Reporter that will fulfill FAIR data standards as an information product. In the future, LEBAF plans to export data into other data portals such as the National Water Quality Data Portal.

2.4.3 Minimum Data Reporting Elements

Reporting refers to delivering, communicating and providing data or results to decision makers, often through an information product such as a report card, website, report, presentation or story board as some examples. For LEBAF, this includes a standard messaging and publications framework. LEBAF desires to meet FAIR data standards as a best management practice (data is findable, accessible, interoperable and reusable). This requires standardization of minimum data elements to report as well other elements such as naming conventions. LEBAF is using Water Reporter as an application to manage data and the vehicle to provide the data. Further details can be found in Chapter 3.

2.4.4 Recommendations and Conclusions

Recommendations and conclusions are developed for a target audience based on interpretations, analyses and findings. It is important to consider the audience, their role and information needs but also how and if this step moves LEBAF and participants closer to desired results, outcomes and impacts. Not all targeted decision makers will want you to provide a recommendation or conclusion, they may want to develop their own. However, if LEBAF does take this step, standardized messages will be developed for groups to utilize.

2.4.5 Information Products

Information products are the tools, platforms, applications and reports that package results, analyses, findings, interpretations, recommendations and/or conclusions into an accessible service or package that can be delivered, communicated, consumed and/or used by the target audience to move the bar on desired results, outcomes or impacts in service of LEBAF's monitoring purpose, data uses and targeted decision makers. In general, information products fall into four major categories:

a) Validated data - available for export, import, that meet FAIR data standards, actual exports to other data repositories such as the National WQ Portal, state or regional data portals
b) Reports - report cards, "State of Lake Erie" or equivalent, FAQ, flyers that summarize information
c) Presentations - Webinar, social media, PR event or equivalent that communicate information
d) Interactive platform - Mapping software, storyboards, graphics, or equivalent that allow user to interact with data and other information
e) Combination

Similar information products can be adjusted for scale, regional, state or local as well as for audience. Once information products are generated they move to the next step - Communication/Delivery.

2.4.6 Communication, Delivery, Messaging and Publication Standards

Communication is the actions that get data and information products into the hands, eyes, ears and decision processes of targeted decision makers. Consideration of format, timing, relationships, protocols and other considerations mean this is a plan of its own. It is important that LEBAF identify standard metrics, templates or language for sharing data, results, information or recommendations to be delivered through products. Reporting guidelines are being developed separately.

2.5 Evaluation Design Overview

Evaluation Design is the process of determining the degree to which LEBAF has succeeded or not. Evaluation processes provide a framework for reviewing, adjusting, adapting and evolving the program keeping it relevant and therefore sustainable and allows celebration of achievements. It includes review of all design buckets (program, technical, information and evaluation). It also includes looking at broader elements outside of implementation such as changes in technology or resources. Products of evaluation include programmatic adjustments to ensure structure still serves function, capturing success stories, updating documentation and communication of program elements (not just results).

LEBAF will be planning and hosting the equivalent of a 2 day event in the fall, one to implement its information design and the other to conduct results and program evaluation. Both require engagement and participation by LEBAF members. Key elements of evaluation design include the following:

2.5.1 Results and Information

Results and Information evaluation assesses whether technical design workflows were effective in answering monitoring questions and generating the quantity and quality of data needed. Did the data analysis, interpretation, recommendation and conclusion plan generate what we needed? Were the information products we developed adequate for targeted decision makers' needs? Was our delivery and communication of data and results effective? How and what was the result, outcome or impact? What do we need to change and where to improve the effectiveness and impact of these components?

2.5.2 Programmatic

Programmatic evaluation includes questions such as: Were the right participants involved? Did they engage? How was their performance? Did we effectively train, communicate, engage, include and support groups? Did our messaging about the program and results reach and impact who we wanted? Were our systems to manage participants and the program effective? Did the workload, roles and responsibilities work or does something need adjusting? What needs to change and where?

2.5.3 Changes & Documentation

Evaluation includes a review of current documentation that support the program and development of appropriate updates based on the output of other elements of Evaluation Design. Documentation to be reviewed and updated may include this SOP, training manuals, datasheets, tracking databases, FAQ's, messaging, and website content.

2.5.3 Success Stories

Too many groups don't capture, curate, cultivate, or use success stories. Every evaluation produces changes and every change is a success story. Outputs (# of stations, sample events, groups, training, etc.) are important, but do not replace outcomes. Who is using the data, how they use and most important the result of that use as progress toward LEBAFS desired results, outcomes and impacts must be captured and told. This is critical for collaborations - otherwise individual groups forget the value of the

collaboration as staff turnover, missions change, etc. The data itself is never the endpoint and neither is its use. The impact of the use is the ultimate success story to capture, even if vague and less concise.

2.5.4 Priorities / Future / Menu Prioritization

This is the broader evaluation, that transcends program implementation. It looks at changes in technology, resources, capacity, regulations, events, opportunities and threats to evaluate what LEBAF needs to change in any or all study design buckets. LEBAF has a standardization menu developed by participants, external partners, data users and decision makers that can be 'reprioritized' each year to determine which additional parameters should be added to LEBAF's monitoring purpose and data use.

Chapter 3 – Data Management

3. Data Management of Raw to Verified Data and Information Generated

This Chapter refers to the systems and work flows that take data from its creation through validation and quality control and assurance to a final data repository ready for analyses, including all meta-data. LEBAF employs the Water Reporter Application and its full data standards can be found in a separate document found in this same google folder. An overview is provided below and minimum data elements are in the above table. This manual also provides the data dictionary, schema and platform for management of LEBAF field and laboratory data.

3.1 Data Mapping

Data can be recorded from field observations on hard-copy and transferred to digital records or captured electronically in the field to reduce data entry error. Quality control should be built into the data recording process by fixing reasonable parameter ranges (i.e. 0 - 15 mg/l for DO). Water Reporter is the data entry and storage and retrieval tool for the LEBAF. As we build up a historical data record, a workflow will need to be developed to review possible outliers over different hydrologic seasons and years of monitoring. Reference page 12 of the Data Manager Manual for information on how to add each parameter to your Water Reporter data source.

3.2 Data Recording (Minimum Data Elements)

Recording data is equivalent to what is documented on physical datasheets, recorded on a device or application and then electronically imported or manually entered into Water Reporter as the final data repository. Each organization needs to review LEBAF minimum data elements and make proper adjustments to their data recording tools and workflows.

Participants will use the Water Reporter data entry and upload template and include the master list of fields. After the set up of your organization, station and data source in Water Reporter, as described on page 7 of the Data Manager Manual, the data can be recorded in Water Reporter in one of two ways: (1) individually record or batch imported using your custom created template or (2) entered via individual sample recording within the system. Data can be imported via a web or mobile application. Steps to record and verify data can be found in the Data Manager Manual on page 13.

Groups that employ Water Reporter for other projects, stations are parameters that may overlap with LEBAF can still enter data one time after some up front steps. Contact Water Reporter with the list of stations that overlap and or data and each respective station/results can be identified and tied to multiple projects as well as legacy data added to a project or site.

3.2.1 How and Where to record results

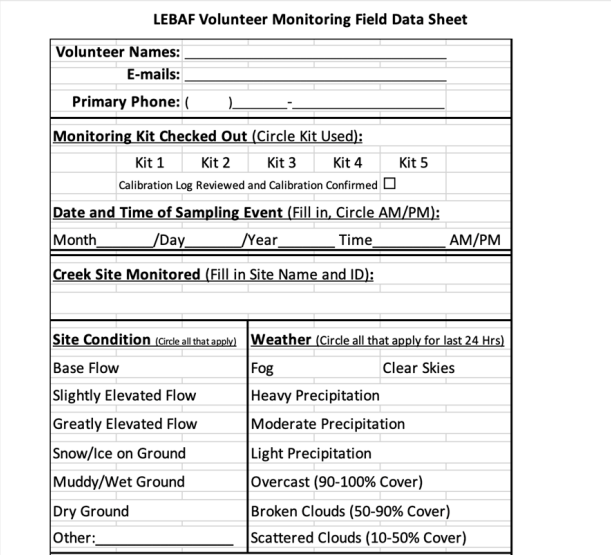
For each sampling Event, data, including metadata, can be recorded on a field datasheet, on the meter or device, or a combination of these two approaches. After respective QAQC is conducted, data can either be manually entered or batch imported to Water Reporter. The Data Manager Manual provides guidance on entering or uploading data, including legacy or additional project data.

3.2.2 What to report

Reporting standards are specified in the Data Manager Manual. Some metadata is included as well as instructions on how to handle non-detections, null data, and other qualifiers. An example field datasheet is provided to use or integrate into an existing field datasheet and/or use in combination with what is recorded on devices. A definition and source is provided for each of the Field data sheet fields in section 3.2.2.1 below. For the 2022 pilot year, groups are permitted to not collect metadata but are encouraged to investigate how they could capture that information next season.

3.2.2.1 Minimum Field Data elements

LEBAF provides a field datasheet template designed to customize to your organization and station without losing any of the information. For example, each participant can fill in their org name, kit type and information that is specific and consistent for their group. If some fields are captured elsewhere they could be removed from this template and/or added to another template for efficiency. These fields map to Water Reporter, LEBAF's data repository and management application.



LEBAF Volunteer Monitoring Field Data Sheet

Volunteer Names: _____

E-mails: _____

Primary Phone: ( )_____-_____

Monitoring Kit Checked Out (Circle Kit Used):

Kit 1 Kit 2 Kit 3 Kit 4 Kit 5

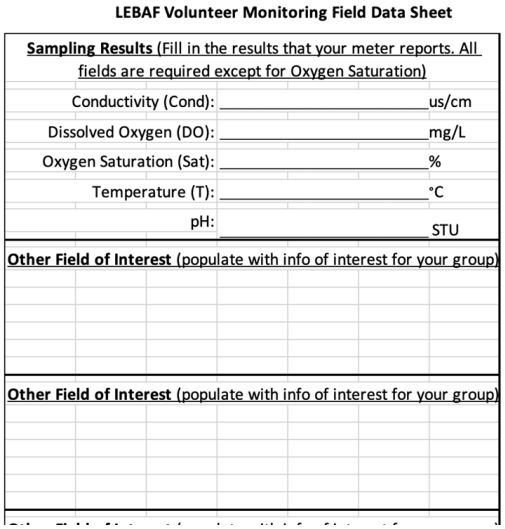
Calibration Log Reviewed and Calibration Confirmed ☐

Date and Time of Sampling Event (Fill in, Circle AM/PM):

Month_____/Day_____/Year_____ Time_____ AM/PM

Creek Site Monitored (Fill in Site Name and ID):

Site Condition (Circle all that apply)	**Weather** (Circle all that apply for last 24 Hrs)
Base Flow	Fog / Clear Skies
Slightly Elevated Flow	Heavy Precipitation
Greatly Elevated Flow	Moderate Precipitation
Snow/Ice on Ground	Light Precipitation
Muddy/Wet Ground	Overcast (90-100% Cover)
Dry Ground	Broken Clouds (50-90% Cover)
Other:_____	Scattered Clouds (10-50% Cover)



LEBAF Volunteer Monitoring Field Data Sheet

Sampling Results (Fill in the results that your meter reports. All fields are required except for Oxygen Saturation)

Conductivity (Cond): _____us/cm

Dissolved Oxygen (DO): _____mg/L

Oxygen Saturation (Sat): _____%

Temperature (T): _____°C

pH: _____STU

Other Field of Interest (populate with info of interest for your group)

Other Field of Interest (populate with info of interest for your group)

Here are definitions of those fields.

Area 1: Volunteer Name, email and primary phone.

Lead volunteer information for credibility and tracking if anyone has questions about the event.

Area 2: Monitoring Kit and Calibration Log check box

Monitoring Kit - Lead Volunteer or Program Manager should identify which Kit is being used for this event. This ensures that specific equipment is associated with specific sampling events in case review of results requires referencing. This also helps CWA track the use of equipment they provide.

Water Reporter contains a list of makes and models of the equipment each participant uses for each parameter. In WR, each group will have identified the equivalent of “kits” for their organization. Some groups may have one set of equipment that they use consistently for all sampling events. Some groups might have several meters in their inventory, the equivalent of Kit 1, Kit 2, Kit or Kit 4. What meters, make and models are associated with each kit will be stored in Water Reporter as part of the pre-set up. In the field datasheet, each volunteer identifies the equivalent organizational kit being used for this sample event, the place holder in this example is Kit 1, etc.

Log Check box: Lead Volunteer completes after completing calibration for all parameter probes / devices or verification or communication with Program Manager from equipment log, Check if the instrument if calibration status is confirmed, do not check if calibration status cannot be verified before sampling.

Area 3: Date/Time/Year and Site

Date, time (am/pm) and year is self explanatory. Site is the station being sampled. Participants should edit this form to list their specific station IDs.

Area 4: Site Condition

This is meant to help characterize the site when being sampled and its condition relative to what is expected for that time of year. This is subjective and somewhat based on the volunteers' exposure to that site, many visits over various conditions or first visit, as an example. These terms are then relative and for this pilot year (2022) groups will do their best to assess and include this section. *A stretch goal is to provide more specific categories for flow in relation to fullbank, including a below base flow option and a bit more training for volunteers.*

Base Flow, slightly or greatly elevated - Selection should be based on the flow that is expected for that time of year. For example, if snow is melting, expected base flows would be higher than later in the season. Expectations will vary depending on the size of the river, use of the water and surrounding land uses. Volunteers should ask “does the flow seem normal (base flow), a bit higher (slightly elevated) or wow, a lot higher (greatly elevated)?” These categorizations are subjective and should be accompanied by qualitative observations as “Other Comments.” *Note in the comments if flow seems below what you would expect.*

Snow/Ice of Ground, Muddy/Wet Ground, Dry Ground - Similarly, volunteers should consider conditions on the ground around the site. They should ask “as we walk to the site and sample, what do we notice about the ground conditions? Volunteers should select all conditions that apply. Any additional observations (e.g. heavy leaf cover, evidence of erosion etc.) should be noted as “Other Comments.”

Area 5: Weather

This is meant to help characterize the dominant weather the past 24 hours. Again, this is subjective to what is normal for that time of year in the experience of the volunteer. Select heavy, moderate or light precipitation if one of these dominated that past 24 hours at this site. If no precipitation occurred do not check a box. Light is a drizzle perhaps on and off, moderate is consistent but could run through it from the car to a building and not be soaked. Heavy, you are soaked and it is as if the storm has stopped over the site.

Overcast, broken or scattered clouds, again the dominant cloud cover the past 24 hours subjectively. If you look up and cannot see blue sky anywhere, horizon to horizon = 100%. If your view horizon to

horizon is covered by more that 50% clouds (less that ½ blue sky), the broken is the choice. Not clear blue skies but some clouds then scattered.

Area 6: Results by Parameter

As you take a reading for each parameter, place the results in the appropriate field. Note units and correct if your device is in another unit. If you cannot measure a parameter for whatever reason, note in the comments so users are not looking for a result that doesn't exist.
Note: DO % Saturation is available on some meter. If possible, this parameter should be recorded.

Sample validation occurs here by the volunteer. A volunteer should check the reading for each parameter and ask "Does this make sense?" "Am I in a representative flow?" "Did the meter calibrate and behave as expected?" If a reading is suspect, take another reading or multiple readings, turn the meter on and off for example. Record what you experienced and did in noties. Volunteers don't have to solve an odd reading but do need to take steps and note that they noticed and responded to suspect reading.

Area 7: Other Fields of interest and Event Comments

These first two are for custom use, to add whatever else a participant might be collecting or measuring. For example if you collect E.coli or macroinvertebrates at that site that day, that could be listed.
The comments fields are important to provide any observations about the site or sampling event (e.g. if a parameter couldn't be measured) or simply to note that all went as expected. The latter is a great note to record as it captures that the volunteer knew what to look for regarding errors or issues and could take appropriate action.

3.2.2.2 Mapping Minimum Data Elements to Data Management (WR and Tracking Tool):

This table provides a list of minimum data elements to be captured in Water Reporter, participant tracking database or both. Items that are in Water Reporter will be in the database manual and LEBAF data dictionary, a best management practice and facilitator of producing FAIR data standards. *Excel* refers to LEBAF program tracking Excel spreadsheet used to track participation and performance criteria during 2022 field season as a pilot to determine what information needs tracking and what platform will serve this purpose in future

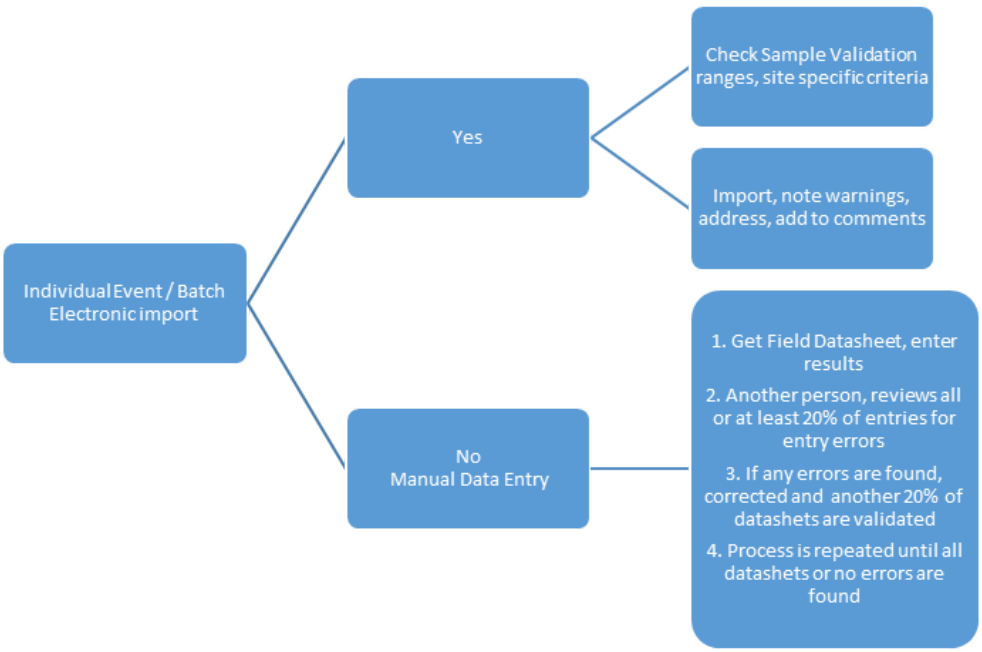
3.2.3 When to record

Participants should enter data within a month of collection if possible and by the end of October for data to be included in the information design analyses. Data collected but not entered with LEBAF owned equipment will be considered a violation of the MOU unless LEBAF has made an exception. Data must be entered into Water Reporter, the standardized data platform LEBAF is using, independent of any other database that individual groups may simultaneously employ. Laboratory results can be uploaded when they become available, monthly if possible and by September with the same needs and expectations as field analyzed results. If other data management systems are used in addition to Water Reporter, data should be uploaded on a regular basis (at least monthly) during the data collection season.

3.3 Data Validation

Data validation ensures a valid sample result is not compromised in any way as it moves through the workflow from collection to final data repository. Sample validation consists of the quality control and assurance steps taken to provide desired data quality, including rectifying, qualifying or deleting results based on quality assurance and control results - to produce a "valid" and high quality result. Data validation includes steps taken to eliminate or reduce error in moving a valid result to the final data

repository and ready for analyses, information creation and data use. The following decision tree guides the user into the appropriate data validation steps per parameter.



Here is an example of a manual data entry validation. If you can validate all results for all datasheets, if volume is too large follow this protocol this mathematical rule that is a standard best management 20% rule, where 20% of data entry is reviewed, if any errors are discovered, an additional 20% of data entry / sheets are reviewed, repeated until no entry errors are discovered. For example, if there are 20 stations or events to be entered, 4 (20% of 20) events would be randomly checked for all data entry, meta-data and results. If a data entry error is found, another 4 events would be reviewed. If no errors were found, complete. If errors are found, another 4 are reviewed and so on.

3.4 Data Reporting

Data reporting refers to communicating and delivering validated results and any findings, recommendations or conclusions from data analyses, etc. This is covered in the Information Design. Elements of the information design that impact data management need to be tracked and documented. For example, if analysis includes the data management application to go through a large river analysis, the station table in the database needs a field or way to label that station a larger river station. Data Management is Technical Design, Data Reporting is Information Design and all relevant SOPs requiring Water Reporter in either design are in the data manager manual.

Chapter 4 – Chemical Technical Design

Technical standards for chemical parameters will be addressed in this chapter. Specifications that are identical for all chemical parameters are described in Section 4.1. Following that, specific considerations for four parameters (dissolved oxygen, temperature, pH and conductivity) are detailed. These parameters can be collected in situ, either individually or using a single multi-parameter unit.

4.1 Technical Standards to Apply to All Parameters

4.1.1 Data Quality and Information Needs of Targeted Decision Makers

The technical design must collect and analyze data to meet the data quality and information needs of the primary targeted decision makers for LEBAF, the participants of LEBAF and their constituents, which will vary. LEVSN will determine which thresholds and benchmarks will be used for data analyses. Precision and accuracy specs of sample collection and analyses are the same as most secondary decision makers such as state agencies. Other technical design elements such as where and when to sample, quality assurance or training may not align with state agency information requirements but might be sufficient for regional condition screening.

Standards, methods and benchmarks employed by respective state Clean Water Act Standards are captured in a separate table, in this same Google Drive. The table covers a range of qualitative and quantitative needs for the data to be used in identifying potential impairments. In the future, LEVSN aims to provide guidance for volunteer science groups who are interested in bridging the gap between LEBAF and their state standards.

4.1.2 Standard Operating Procedures for Sample Collection and Analyses

Here we answer the “what” and “how” questions regarding sample collection and analyses methods, often referred to as Standard Operating Procedures or SOPs. Since we are employing meters or sensors for all four parameters, LEBAF participants will use SOPs provided by equipment manufacturers. In some cases groups may also employ SOPs provided by state environmental agencies or partner volunteer monitoring programs.

The technical design elements for these four parameters were drawn from Lake Erie respective State’s standards and prescriptions, which are summarized in a separate State Standards table. The technical design below reflects the minimum standards or criteria to meet the previously stated LEBAF goals. Suggestions are provided for acceptable deviations from the minimum. The following Technical Design elements apply to all four parameters.

4.1.2.1 Summary Sensor criteria and example of sensors used by participants and approved by LEBAF.
NOTE: if a meter can measure and record % Saturation of DIssolved Oxygen, then record both measurements for LEBAF. It is optional and helpful information for analyses and the information design.

Parameter	**Conductivity**
Resolution	0.001 mS (0 to 0.500 mS); 0.01 mS (0.501 to 50.00 mS); 0.1 mS (50.01 to 200mS)
Accuracy	Between ±0% and ±1% of reading
Range	At Least 0 to 200 mS/cm

Parameter	Dissolved Oxygen
Resolution	Not Greater Than 0.01 mg/L
Accuracy	For 0 to 200% Saturation: Between ±0% and ±2% of the reading [OR] Between ±0% and ±2% air saturation, whichever is greater For 200% to 500% Saturation: Between ±0% and ±6% of the reading [AND/OR] For 0 to 20 mg/L: Between ±0% and ±2% of the reading [OR] Between ±0 mg/L and ±0.2 mg/L; whichever is greater For 20 mg/L to 50 mg/L: Between ±0% and ±6% of the reading
Range	At Least 0 to 50 mg/L [OR] 0 to 500% Saturation
Parameter	pH
Resolution	Not Greater Than 0.01 pH units
Accuracy	Between ±0% and ±0.2 pH units
Range	0-14 pH units
Parameter	Water Temperature
Resolution	Not Greater Than 0.1° C
Accuracy	Between ±0° and ±0.3° C of reading
Range	At Least 0° to 50° C

Examples of compatible sensor kits (four sensor configurations currently being used by LEVSN Local Hubs to meet LEBAF specifications for Conductivity, DO, pH and Water Temperature as of 2022) -

Kit	Sensor Kit #1	Sensor Kit #2	Sensor Kit #3	Sensor Kit #4
Parameter	Conductivity	Conductivity	Conductivity	Conductivity
Method	YSI ProQuatro	YSI ProDSS	Eureka Manta 20+ Multiprobe	Hach Pocket Pro+ Multi 2 Tester
Resolution	0.001 mS (0 to 0.500 mS); 0.01 mS (0.501 to 50.00 mS); 0.1 mS (50.01 to 200mS)	0.001 mS (0 to 0.500 mS); 0.01 mS (0.501 to 50.00 mS); 0.1 mS (50.01 to 200mS)	0.1 µS/cm	0.1 µS/cm from 0.0 to 199.9 µS/cm; 1 µS/cm from 200 to 1999 µS/cm; 0.01 mS/cm from 2.00 to 19.99 mS/cm
Accuracy	±1% of reading	±0.5% of reading	±0.5% of reading or ±1 w.i.g., 0 to 5000 µS/cm	±1%
Range	0 to 200 mS/cm	0 to 200 mS/cm	0 to 275 mS/cm	Auto-ranging (0.0 to 199.9 µS/cm; 200 to 1999 µS/cm; 2.00 to 19.99 mS/cm)
Parameter	DO	DO	DO	DO
Method	YSI ProQuatro	YSI ProDSS	Eureka Manta 20+ Multiprobe	Handheld YSI 20 Dissolved Oxygen Meter
Resolution	0.01 mg/L	0.01 mg/L	0.01 mg/l	0.1 or 0.01 mg/L, selectable

Accuracy	0 to 200% (±2% of the reading or ±2% air saturation, whichever is greater), 200% to 500% (±6% of the reading) -OR- 0 to 20 mg/L (±2% of the reading or 0.2 mg/L; whichever is greater), 20 mg/L to 50 mg/L (±6% of the reading)	1% of reading	±0.1 mg/l (0-20 mg/l), ±0.15 mg/l (20-30 mg/l) and ±5% of reading (30-50 mg/l)	0 to 200% air saturation, ±2% of the reading or ±2% air saturation, whichever is greater; 200 to 500% air saturation, ±6% of the reading
Range	0-50 mg/L -OR- 0 to 500% Saturation	0-50 mg/L -OR- 0 to 500% Saturation	0 to 50 mg/l -OR- 0 to 500% saturation	0 to 500%
Parameter	**pH**	**pH**	**pH**	**pH**
Method	YSI ProQuatro	YSI ProDSS	Eureka Manta 20+ Multiprobe	Hach Pocket Pro+ Multi 2 Tester
Resolution	0.01 pH units	0.01 pH units	0.01 pH	0.01 pH
Accuracy	±0.2 pH units	±0.2 pH units	±0.1 within 10 degrees C of calibration; 0.2 otherwise	±0.01 pH
Range	0-14 pH units	0-14 pH units	0 to 14 pH units	0.00 to 14.00
Parameter	**Water Temp**	**Water Temp**	**Water Temp**	**Water Temp**
Method	YSI ProQuatro	YSI ProDSS	Eureka Manta 20+ Multiprobe	YSI 20 Dissolved Oxygen Meter
Resolution	0.1 C	0.1 C	0.01 C	0.1°C
Accuracy	0.3 C of reading	0.2 C of reading	±0.1	±0.3°C
Range	Neg 5 to +55 C	Neg 5 to +70 C	-5 to 50 deg C	–5 to 55°C

4.1.3 Minimum Participation

Section 2.3.1 displays the minimum participation requirements for LEBAF. These are embedded in an annual MOU for transparency and expectation management. Participants need to collect all four parameters at suggested frequency at a minimum of one site during the sample period April to October, weather permitting. Suggested additions to this minimum are covered further in this Chapter. Participants will employ data management standards in data recording using Water Reporter, and employ data analyses and data to information, delivery, communication, publishing and messaging standards. Participants must also engage in the evaluation protocols and processes.

4.1.4 Number of locations per group, river, unit if relevant

A minimum of sampling one station per organization is required to participate in LEBAF. However, more stations are always helpful to better characterize a particular waterbody and or watershed. Thus, more stations are encouraged if they can be sampled at the minimum monthly frequency for all four parameters. Depending upon the size of the watershed and scope capacity, in general as a river changes

stream order or HUC sizes, it is helpful to have another station to represent that downstream shift. In addition, there are other features, such as a reservoir, land-use, geology or groundwater influx, that change what a representative site would be. In such cases, adding another site would be informative and refine our ability to characterize conditions.

When geomorphological, hydrological or physical habitat features are similar, chemical and biological elements are often similar and comparable. For example, sites can be considered similarly if their stream order/size is similar, widths, depths, stream to width ratios (a surrogate for stream order or size), flows, substrate, elevation, ecosystem, temperature and average gradient are similar. When these geomorphological parameters or physical habitat features change, then the site is in another category to be compared. Part of annual evaluation will review gaps in sample locations or frequencies.

4.1.5 Where to Sample

4.1.5.1 Site Selection Criteria

All surface waters are required to meet the state's water chemistry standards, depending on each water's designated use. Sites should be selected using a number of relevant criteria, including position in stream network, accessibility and safety for volunteers, representativeness, and use of the site by other sampling programs.

Here are some general site selection elements to consider when selecting a station. You can find more information on each item through research and a network of professionals. Remember - for condition characterization, LEBAF needs a representative site. Other monitoring purposes might require different site characteristics, requirements or conditions.

- Bridge. If sampling on a bridge or by a bridge sample upstream of the bridge - research has documented bridges can influence representation and quality.
- Access. Is the site safe to access? Can it be accessed during anticipated weather conditions? Is it on private or public property? Does it require special permissions to access (locked gate, etc.)? Will it be accessible over many years to allow historical record to be built up?
- Additional Information. Is there a flow gauge? What is surrounding land use and is that important? Is the flow representative, mixed, deadzone, etc.? Is there a discharge or withdrawal upstream from the site relatively close?

Additional site selection criteria are described in section 4.1.5.5.1 and in parameter specific sections.

4.1.5.2 Site Naming Convention

Water Reporter generally uses each organization's site ID and the organization's acronym in its unique site ID (e.g. HRWC-SR05 or TMP-SC21). A master list of these are tracked in Water Reporter and CWA's participant database. Further, each organization provides a station name that is meaningful for their organization. For data users unfamiliar with individual locations and watersheds, it is useful to have a naming convention, along with meta-data, that makes the site easy to identify, find and use the data.

LEBAF will be using a site naming convention that is a combination of the unique station ID assigned by Water Reporter, the station name given by organization and the water body name, all with standard naming conventions. For example, **24-Hwy 180 Br- Huron R**, would be site ID 24, station name Highway 180 Bridge, and water body Huron River. Station names should be as descriptive to universal features as possible (for example not "Abv Smith Barn". Other information will be available such as organization tied to that site, latitude and longitude and elevation for example.

Water Reporter will create this LEBAF site name from existing fields and information provided by the organization. A list of naming conventions and abbreviations are provided in the data manager manual and include using no periods.

Br- Bridge

Hwy- Hwy	Abv- Above	R - River
Rd - Rd	Blw - Blw	Cr- Creek
Pk - Park	CR - County Road	Lk - Lake
Pkwy - Parkway	Conf - confluence	Res - Reservoir

4.1.5.3 Where in waterbody

In general, all chemical parameters should be sampled from the same relative representative location in a waterbody at each sample event. The exact location may depend on the parameter with the greatest specificity of location.

4.1.5.4 When to Sample

4.1.5.4.1 Sampling Season.

The sampling season for the first four parameters will be April through October, weather permitting. All parameters need to be sampled at each site at least once per month. That constitutes a minimum of seven sampling events. This frequency has limitations on characterizing conditions, because parameters fluctuate daily, seasonally, up-to-downstream, and across the region given variations in geology and land use, but can tell a story over time if consistent. The story it will tell is an abridged version of a novel.

4.1.5.4.2 Frequency.

All parameters must be collected simultaneously a minimum of one time per month at each station. A minimum of one station must be sampled. However, the more sampling that can occur, the better the story and more valuable the collaborative. As a general rule of thumb, capturing the diurnal cycle and how that cycle changes throughout the year is helpful for parameters that fluctuate daily like DO, temperature and pH. Other parameters are influenced more by flow, seasonal or other changes and the frequency is adjusted to capture that change. In general, an increase in sampling frequency to bi-monthly, weekly or biweekly would increase the value of the data.

Note: An exception for dissolved oxygen characterization. LEBAF asks participants to sample dissolved oxygen two times a day to help characterize the diurnal fluctuations. This is requested one-two times per season if possible. See details in the Dissolved Oxygen Chapter.

4.1.5.4.3 Time of Day.

It is optimal for some parameters to consider time of day. These specifics will be in each parameter's respective chapters. In these cases, it is helpful if sampling can occur at the same time of day each event and if possible the critical time of day.

4.1.5.5 Sample Preparation - Sample container, preservative, labeling, filtration, etc.

No preparation is needed for the in-situ method for any of the four parameters beyond routine calibration, just sensor monitoring equipment and data recording paperwork.

4.1.5.5.1 Sample Collection Method

No collection is necessary for the in-situ method. Simply record the measured value once it is stable. However, site selection for measurements is important, as is sensor placement. See respective parameters for specifics. Selected sites should be representative of the predominant characteristics of that stream in the area. Thus, if the stream is generally free flowing, the head of a riffle, before the water becomes visibly turbulent, is a good location. Likewise, if good riparian cover is generally available, a wide, slow, open stretch of creek should not be selected. Multiple sites in a stream segment can be selected, however, to provide a better sampling of the range of conditions. Replicate readings can be taken from different parts of the stream, but if moving water is present, that is what should be measured. Section 4.1.5.1 provides more tips on sample selection criteria to consider.

4.1.5.5.2 Sample Handling - transfer, shipping, storage, chain of custody

No sample handling is needed for the in-situ method.

4.1.5.5.3 Information to collect and record at sample event

This section covers the minimum information to be recorded at each sampling visit.

- Station ID: Identify which pre-established site is being sampled from a drop-down menu
- Sampling Time: Time of Day (UTC Time Stamp) – automatically logged by Water Reporter
- Sampling Date: Calendar Date - automatically logged by Water Reporter
- Sampling Kit Used: Select in drop-down which Sampling Kit is used to conduct sampling
- Sampling Volunteer: Indicate name of collecting volunteer(s)
- Sampling Results: Cond (ums/s), DO (mg/L), Saturation (%), T (C*), pH (STU)
- Weather: Use WR check boxes to document dominant weather over past 24 hours
- QA/QC: Date of last calibration (mm/day/yyyy) and pass/fail (Y/N) for each sensor used
- Other Comments: Relevant observations about sampling event (e.g. construction upstream, site same as usual, duplicated sampling to check outlier, couldn't sample pH b/c sensor malfunction)

4.1.5.6 Sample Analyses – method, calibrations, O/M, etc.

No lab analysis is necessary with the in-situ method, however, the comparison laboratory should have analytical methods and quality control procedures available.

4.1.5.7 Safety– for sampler and sample

Samplers should follow standard "safe access" guidelines established by each CS organization and covered in SOPs. Safety always supersedes other sampling event considerations. QA samples are all ambient water, so do not pose additional risk.

4.1.5.8 Quality Control and Assurance

4.1.5.8.1 Measuring Device Preparation

Probes for all four parameters and respective manufacturers have calibration procedures and standards to employ. Equipment will be calibrated before each sampling event if the meter/probe is only used once per month at one station. If equipment is being used more frequently, organizations can determine an appropriate calibration frequency. LEBAF also requires organizations to follow equipment manufacturer recommendations if a specific calibration effort fails and until calibration passes consistently.

LEBAF requires for every event, the last date a specific probe was calibrated before each sample event and if calibration passed, yes or no. On an annual basis LEBAF requires each group to compare sensor

readings for all four sensors with a comparable sensor and results come within 80-120% recovery or use the manufacturers recommendation for each standard. Furthermore LEBAF requires all sensors to be serviced once a year and that service date is reported. In some cases LEBAF will be facilitating that service. Each organization should maintain an equipment log for every meter/ parameter that records sensor calibrations, volunteer training, calibration, replicates, annual maintenance and other relevant equipment care procedures. LEBAF provides a template for those groups who are not currently using an equipment care log, to be modified to fit each organization's equipment and needs.

4.1.5.9 Field Protocols

The sensor (in its housing) should be lowered into the water at a sample point upstream or to the side of the sampler. The sensor needs to be fully submerged and should not contact the bottom substrate. Strive to measure at the middle of the water column depth. In low depth environments, the probe can be laid on its side so that the stream flows over the sensor. The stirring of sediments should be avoided or given ample time to clear. Enough time should be allowed that the sensor reaches a stable reading.

Field readings should be performed as field replicate measures (using the same equipment) with experienced and novice users on 5-10% of readings until error is within sensor precision range. Novice users could then be considered experienced. Error should be calculated by computing the absolute difference between experienced and novice readings. A percent error can be calculated by dividing the absolute error by the value of the experienced reading.

4.1.5.9.1 Sample Frequency - required by decision maker, function of purpose, e.g. if fluctuates daily may need real time device, if fluctuates seasonally,

LEBAF requires one measurement per station per month during the sampling season. More data is always more effective especially to characterize conditions, variations and trends. LEBAF's goal for this pilot year is to build a foundation from which to build and add frequencies, stations and parameters. There will be limitations to the story this data set can tell but it will tell a story. For example, single measurements repeated over a field season can be used to determine if a stream site may be outside of state impairment standards and in need of further investigation. Sites should be visited at least monthly during the active season (April-September or May-October).

Ideally, sites that appear close to impairment levels should be visited more frequently and at least once each in the early morning and late afternoon to provide a range of daily photosynthetic and respiratory conditions. Potentially impaired sites should be evaluated using a continuous data logger, following methods not included here, or by working with partner agencies.

LEBAF's primary data users are its participants. Secondarily it may be other decision makers or data users. If that is important to a group, that group might consider understanding the sample frequency (and other technical design elements) needed to satisfy both LEBAF and other users' information needs.

4.1.5.9.2 Sampling Conditions – to include/avoid, storms, bridges, culverts, slow/fast water

These four parameters can be measured with an in situ method can just about anywhere. If flowing water is present, the downstream "V" or center flow point of a riffle should be the sample point to be fairly representative of normal conditions. If stagnant water is the normal or usual condition, that can be measured. Contributing waters from outfalls, dams, etc., can also be measured. Regularly scheduling sampling events at different times should provide for a somewhat random sampling of conditions.

4.1.5.10 Laboratory Protocols

No laboratory protocols are necessary for in-situ measurement. QA samples should be handled following laboratory protocols provided by the laboratory.

4.1.5.11 Other Data to Capture At Sample Event

Minimum data elements are listed in section 2.3.1, some of which apply to org., station or event.

4.15.11.1 Who– (organization, volunteer, training, etc.)

See Chapter 1 for information about participants and roles. Each organization will track volunteers per sample event. LEBAF maintains a database tracking participants and performance criteria.

4.1.5.12 Data Management

All participants agree to use Water Reporter, collect and record required minimum data elements and do their best regarding optional data elements. The data manager manual serves as all data management SOPs and best management practices associated with LEBAF that participants agree to be familiar with, attend the training webinar and help LEBAF troubleshoot and improve this application.

4.2 Dissolved Oxygen (DO)

4.2.1 What is DO?

Dissolved oxygen is the amount of oxygen (O2) dissolved in the water. This does not include air bubbles, but rather oxygen dissolved at the molecular level in the water. The amount of oxygen that can be dissolved in water is governed by temperature, salinity, and atmospheric pressure and is typically near or at equilibrium with that expected for the given temperature. Waters with dissolved oxygen levels at or near equilibrium with temperatures typical for the waterbody are capable of supporting aquatic life adapted to those sets of conditions.

4.2.2 Why care about DO?

Oxygen is necessary for all living things and for many of the chemical processes that take place in water. Most aquatic animals breathe the oxygen dissolved in water. The necessary amount of dissolved oxygen varies with species, age and activity. For example, brown trout tolerate levels down to 3 mg/l and beyond supersaturated levels up to 25 mg/l in all life stages, but the optimal range is between 9-12 mg/l.

Oxygen can be both added and removed from water. Water gains oxygen from plants and algae as a result of photosynthesis. The churning of running water adds dissolved oxygen through diffusion. Respiration (breathing) by aquatic animals, decomposition (i.e., breathing by bacteria), and various chemical reactions, consume oxygen from the water body. If more oxygen is consumed than produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken or die. In extreme cases, 0 oxygen “dead zones” can form and large die-off events of many (hundreds or thousands) fish can occur. This can significantly disrupt ecosystems and also lead to health impacts on other aquatic and terrestrial animals, including humans.

Oxygen percent saturation can be calculated with elevation and temperature information or many probes provide that information when properly calibrated (see calibration section below). Saturation refers to how much oxygen a given volume of water is able to hold. Generally, healthy flowing rivers and streams should maintain dissolved oxygen levels within a few mg/l of saturation, though there may be pools with lower levels.

How does DO change in the environment naturally?

Here we look at three common ways dissolved oxygen might fluctuate naturally in a river environment. Understanding what DO is and how it behaves in nature informs the best study design to capture representative, accurate, precise, consistent and reproducible monitoring results.

Daily – Dissolved oxygen fluctuates over a 24-h period, influenced primarily by the amount of photosynthesis occurring during the daytime, and the amount of respiration occurring at night. Highly enriched waters have high levels of photosynthesis and respiration, and consequently experience wide swings in the DO concentrations over a 24-h cycle.

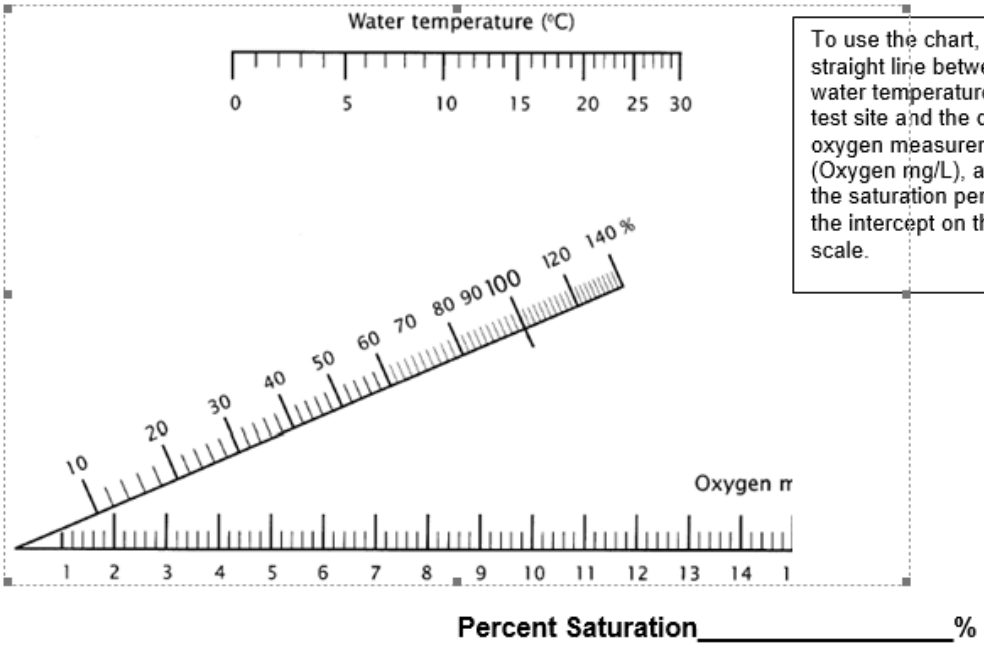
Seasonally – Dissolved oxygen will vary with winter and summer seasons, or if water management regimes alter temperature with, for example, diversions or return flows.

River Continuum – Dissolved oxygen, in general, decreases downstream with lower elevations, lower gradients and slower velocities, larger volumes, warmer temperatures and increased biological activities.

What is % Saturation?

Oxygen is in the air and when it enters water, the water (H20) also has oxygen in it and can hold a certain amount of oxygen, just like air. When you are walking in higher elevations you have a harder time breathing because their air holds less oxygen at higher elevations than lower. Colder water holds more oxygen than warmer. The ability of a river or lake or waterbody to hold oxygen is a factor of elevation (barometric pressure, etc.). A metric to measure how much oxygen a water body 'can' hold versus how much it may be holding during a sample event is *% dissolved oxygen saturation.*

At sea level water generally holds 100% dissolved oxygen and that is the baseline bar to measure % saturation. As one moves higher in elevation that 100% saturation metric will decrease, but is still 100% for that elevation. For example, at an elevation of 8000 feet, 100% dissolved oxygen saturation is 74%. You can estimate dissolved saturation using this standard curve below if you have the temperature and dissolved oxygen concentration in mg/l. Many dissolved oxygen meters measure this as well.



This can provide multiple lines of evidence for more information about the waterbody in addition to a dissolved oxygen concentration. If a low DO concentration is measured, % saturation is often below 100% for that elevation

What influences levels of DO?

Dissolved oxygen levels vary with water temperature, altitude, depth, daily and seasonal cycles, and discharge. For example, water at high altitudes holds less oxygen due to lower atmospheric pressure. Warm water holds less oxygen than cold water. Dissolved oxygen levels change with the seasons as the temperature of the water changes. DO also varies depending on how many organisms are producing oxygen vs how many are using/respiring oxygen.

4.2.3 Information Needs of Targeted Decision Makers

Described in section 4.1

4.2.4 Other

This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details

4.2.5 Technical Design

Described in section 4.1

4.2.5.1 What / How

4.2.5.1.1 Standard Operating Procedures (SOPs)

Described in section 4.1

4.2.5.1.2 Equipment

Use of a dissolved oxygen membrane sensor probe dedicated for DO measurement or in a multiple sensor probe housing is acceptable using the in-situ direct measurement method. This is the preferred equipment for ease of use by volunteers. I*f the meter measures dissolved oxygen % saturation please record this parameter during each sample event as well.*

4.2.5.1.2.1 Precision, Accuracy, Range. Reporting/Detection Limit, Etc.

To be able to detect DO impairment, any method would need to have a detection limit of less than the relevant state's impairment standard, if it has a numeric standard. Generally, biological response will require a detection limit of at least 1 mg/l, but at minimum, each program should be explicit about the detection limit and accuracy of their sensors as reported by the manufacturer. See below for LEBAF's required minimum specifications for DO. Any participating Local Hub must use a sensor-based method that is at least as robust as these specs in order for their data to be considered as part of LEBAF's data set, visualizations, and analyses.

Parameter	Dissolved Oxygen
Resolution	Not Greater Than 0.01 mg/L

Accuracy	For 0 to 200% Saturation: Between ±0% and ±2% of the reading [OR] Between ±0% and ±2% air saturation, whichever is greater For 200% to 500% Saturation: Between ±0% and ±6% of the reading [AND/OR] For 0 to 20 mg/L: Between ±0% and ±2% of the reading [OR] Between ±0 mg/L and ±0.2 mg/L; whichever is greater For 20 mg/L to 50 mg/L: Between ±0% and ±6% of the reading
Range	At Least 0 to 50 mg/L [OR] 0 to 500% Saturation

Examples of compatible sensors include:

- YSI ProQuatro Multiparameter Meter
- YSI ProDSS Multiparameter Meter
- Eureka Manta 20+ Multiprobe Unit
- Handheld YSI 20 Dissolved Oxygen Meter

4.2.5.1.2.2 Calibration

See calibration frequency recommended for all parameters in Section 4.1. A calibration SOP, along with potential errors and corrections, can be taken from the probe manufacturer's user guide. DO membrane probes need to be calibrated prior to every use and any time the sensor is moved to an environment with significantly different characteristics (i.e. temperature, humidity, elevation, etc.). Sensors are generally calibrated to saturation. Percent saturation has an inverse relationship with temperature. The hotter the temperature the less capacity water has to hold oxygen, conversely cold water can hold more oxygen than warm or hot water. Saturation has an inverse relationship with elevation or altitude. The higher in elevation the “thinner” air feels because it is holding less oxygen, it is less saturated. Thus, both temperature and elevation are necessary for calibration and accurate measurement of DO.

4.2.5.1.2.3 Operation and Maintenance

O&M instructions can be found in the manufacturer's user guide. Key items for membrane probes are to:

A. Keep the probe in a high humidity environment at all times
B. Replace membranes if they tear or break, if the sensor does not calibrate to within calibration limits, or does not compare within limits to a check against a titration method (see table above)
C. Keep the sensor fully submerged in water
D. Move the sensor continuously in the water to generate an accurate reading if stagnant.

4.2.5.2 Preparation - Sample container, preservative, labeling, filtration, etc.

No preparation is needed for the in-situ method.

4.2.5.3 Collection – method

No collection is necessary for the in-situ method. Simply record the measured value once it is stable. However, site selection for measurements is important, as is sensor placement. Selected sites should be representative of the predominant conditions/characteristics of that stream in the area. Thus, if the stream is generally free flowing, the head of a riffle, before the water becomes visibly turbulent, is a good location. Likewise, if good riparian cover is generally available, a wide, slow, open stretch of creek should not be selected. Multiple sites in a stream segment can be selected, however, to provide a better sampling of the range of conditions. Replicate readings can be taken from different parts of the stream, but if moving water is present, that is what should be measured.

4.2.5.3.1 Sample Handling – transfer, shipping, storage, chain of custody

Described in section 4.1.

4.2.5.3.2 Quality Control/Assurance Samples -

Periodically, at least once per year, the sensor should be compared to results from testing a replicate (or better, a split) sample using a lab titration, such as the Winkler method, or side-by-side with a second DO probe. Samples should be collected from a randomly selected ambient stream site using standard water sample collection, storage and transport methods (see SOPs in Chapter 2). DO should be initially measured in-situ on-site and from the sample bottle prior to transport. Sample comparison is best accomplished by bringing the sensor and sample(s) to a state/municipal/professional laboratory to ensure proper precision and accuracy. Sensor and titration results should not vary by more than a data quality objective of 5%. Ideally, in-situ, on-site and lab sensor readings should also all be within 5% of each other. If a solution with known low or zero DO can be obtained, it can also be used for a "blank" comparison.

Once or twice during the sample period, each participant should visit each site two times during the same day to help characterize daily fluctuations. Record both events.

4.2.5.4 Analyses

Described in section 4.1.

4.2.5.4.1 Safety

Described in section 4.1.

4.2.5.5 Quality Control and Assurance

4.2.5.5.1 Field Protocols

Described in section 4.1. Field readings should be performed as field replicates with experienced and novice users (those collecting their initial readings) on 5-10% of readings until error is within sensor precision range, using the same equipment. Error should be calculated by computing the absolute difference between experienced and novice readings. A percent error can be calculated by dividing the absolute error by the value of the experienced reading.

4.2.5.5.2 Laboratory Protocols

Described in section 4.1.

4.2.5.6 Other data to capture at sample event

The minimum sampling visit information is included in Section 4.1. For DO, the following data are especially important:

- % dissolved oxygen saturation if meter measures, please record
- Elevation in feet above sea level is needed for sensor calibration
- Water temperature in degrees Celsius should also be recorded to help interpret saturation readings as low temperatures can create super-saturated conditions or conditions that read >100% saturation
- If possible some measure of sediment or turbidity, or note, can help determine if sensor fowling occurred in extra turbid water, high turbidity can affect meters reading
- Water level from a fixed gauge is helpful, especially if measuring in low flow conditions

- Noting general flow conditions (i.e. flowing or stagnant water) is important for determining conditions that may lead to low DO conditions, hence, site condition check boxes.

4.2.5.6.1 Minimum Data Elements to Capture about method - who/org/name/training level, units, method, etc.)
Described in section 4.1.

4.2.5.6.2 Frequency – required by decision maker, function of purpose, e.g. if fluctuates daily may need real time device, if fluctuates seasonally,
Described in section 4.1.

4.2.5.6.3 Conditions – to include/avoid, storms, bridges, culverts, slow/fast water
Described in section 4.1.

4.2.5.6.4 Minimum Data Elements to Capture about when (time, date, etc.)
Described in section 4.1. Date and time should be recorded as standard data elements.

4.2.5.7 Who – (organization, volunteer, training, etc.)
The volunteer collecting data at each event is the first point of quality assurance. The program manager that calibrates instruments and ensures they are in good operating condition is the second point of quality assurance. The program manager or staff that validates the data post-collection is the third point of quality assurance. The training or support materials and experiences given to volunteers are the fourth point of quality assurance. Water Reporter provides a fifth point of quality assurance through built-in thresholds, notifications, and standard formatting. LEBAF itself provides a sixth point of quality assurance through standard operating procedures and a community of practice for troubleshooting.

4.2.5.8 Data Management
Data management is broadly addressed in Chapter 3 and described for all parameters in section 4.1. Additional aspects that are particular to managing DO data are described in the subsections below.

4.2.5.8.1 Data Mapping - identify data generating (all types, results, meta, QA, etc.) and map
Through birth, analyses, recording, validation, into repository work flows. Data mapping elements and workflow are addressed in Data Management Section and Manual.

4.2.6 Information Design

4.2.6.1 Analyses and Findings (summary statistics, benchmarks, finding the story)
This parameter will be called “Dissolved Oxygen” and results recorded in mg/l. Specific metrics will be listed here. Percent dissolved saturation will be called “% DO Saturation” recorded in %.

State standards were evaluated and similar across all Lake Erie states to identify a cold and warm water regional standard that can be applied at the local, large river and regional scale. The cold water standard will be 6 mg/l and warm water 5 mg/l. This standard can be used for local, large river and regional analyses. Sites will be identified as large (based on HUC at this time) and direct tributary to Lake Erie. Stations will be identified as warm or cold and all results will be compared to respective standards and identifying exceedances. # and % exceedance will be calculated per station per sampling season.

When more data is available, averages can be calculated and comparisons across seasons and if appropriate between stations on the same river.

4.2.6.2 Data To Information (Interpretation, recommendations and conclusions)

All parameter analyses and findings will be compiled and reviewed in context with each other, against ancillary data at the local, large river and regional level. Standard messaging for interpretation, recommendations and conclusions will be developed in the post sample season information workshop. See Chapter 7 for details that apply to all parameters, including information products.

4.2.6.3 Results Delivery and Communication (of the story)

LEBAFs plan for all parameters is in Chapter 7.

4.2.6.4 Management of Information Products

Included in Chapter 7 plan.

4.2.7 Evaluation Design

4.2.7.1 When and how do we know the answer to monitoring questions?

Evaluation plan is detailed in Chapter 8. No specific evaluation applies to dissolved oxygen, except the ability to measure and utilize dissolved oxygen saturation.

4.2.8 Training – standard approach, list of things to include, timing, elements to help groups train consistently

LEVSN provides a pre-sample season kickoff training that includes database management and equipment training and data analyses and exports.

4.2.8.1 Minimum or specialized experience, ability

No pre-training experience or ability is necessary.

4.2.8.2 Other

This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details

4.3 Temperature

4.3.1 What is temperature?

Temperature is the degree or intensity of thermal energy in water.[1] Temperature measures the average kinetic energy of the water molecules. It is commonly measured on a linear scale of degrees Celsius, degrees Fahrenheit, or Kelvin.

4.3.2 Why care about temperature?

Temperature affects the chemical and physical properties of water, and in turn, other elements within an aquatic system. Aquatic temperature regimes drive the metabolism, growth, behavior, and reproduction of aquatic biology, determining the type and kinds of aquatic life present in rivers and lakes.

[1] Utah State Extension, "Temperature," Temperature, accessed January 31, 2022, https://extension.usu.edu/waterquality/learnaboutsurfacewater/propertiesofwater/temperature.

Many factors influence the temperature of an aquatic system. Daily air temperature changes and weather govern diurnal fluctuations in aquatic temperature with regional climate driving seasonal temperature changes. Within the same water body there can be temperature variation due to localized discrepancies in riparian vegetation and physical features, including the depth, velocity, turbidity, land use, and impervious surface area. Anthropogenic activities also influence aquatic temperature, including industrial and municipal discharges, urban development, water withdrawals, and dam operations.

Acceptable water temperature ranges are usually based on the aquatic ecosystem and corresponding species in question. Cold water stream ecosystems are waters that generally stay below 68 °F (20 °C) whereas warm water streams generally do not exceed 89 °F (~32 °C). In addition, any chemical and biological processes within an aquatic ecosystem have preferred temperature ranges. As temperatures stray outside these ranges, local aquatic ecology can be impacted. Often, ecological or species specific temperature ranges inform the development of localized temperature standards.

This table illustrates temperature's influence on aquatic life.

Temperature	**Examples of Life**
Greater than 68° F, 20° C	Much plant life and warm water fish diseases. Most bass, crappie bluegill, carp and catfish.
Upper range (55-68° F) (13-20° C) Less than 68° F or 20° C (Cold water)	Some plant life and fish diseases. Salmon, trout. Stonefly nymphs, mayfly nymphs, caddis fly larvae, water beetles and water striders.
Lower range (Less than 55° F)	Trout, caddis fly larvae, stonefly nymphs and mayfly nymphs.

Like pH and dissolved oxygen, organisms might require different temperatures at different life stages. The chart below illustrates that for brown trout.

	Egg	**Fry**	**Juvenile**	**Adult**
Tolerant T in Celsius	**0-15**	**5-25.5**	**0-27**	**0-27**
Optimal T in	**2-13**	**7-15**	**7-19**	**12-19**

Celsius				

How does temperature change in the environment naturally?

Here we look at three common ways temperature might fluctuate naturally in an aquatic environment. Understanding what temperature is and how it behaves in nature informs the best study design to capture representative, accurate, precise, consistent and reproducible monitoring results.

Daily – Temperature fluctuates over a 24-hour period, influenced by the surrounding air temperature, groundwater inputs, solar radiation, precipitation, and other meteorological events.
Seasonally – Temperature will vary with winter and summer seasons. For example, some lakes experience a "turning over" of waters during the change of season.
River Continuum – Water temperature can vary along the length of a river. In general, temperature increases downstream with lower elevations, lower gradients, and slower velocities.

What influences levels of temperature?

Temperature will fluctuate daily due to the influence of the sun and daylight versus thermal conditions overnight. Seasonally winter months are colder than summer and spring and fall provide transition temperatures and sometimes larger daily fluctuations. In addition, in rivers and streams elevation can provide a thermal gradient with higher elevations colder and lower elevations warmer. Source can also influence temperature with groundwater, release from dams or holding structures or lakes driving temperatures. Land Use and climate change also influence temperatures in river ecosystems. A denuded bank without any riparian vegetation for example may allow higher temperatures in a river than a vegetated bank that covers the open water. The amount of sediment or solids in the water column can influence temperature. Here as a list of some items that influence temperature:

-temperature of the air -cloudiness of the water or -inflows to the river

-amount of shading -stormwater runoff -warm or cold water discharges

-soil erosion - summer urban storm runoff -Improper logging practices

-removing trees or riparian vegetation/shade - storm runoff

4.3.3 Information Needs of Targeted Decision Makers

Described in section 4.1.

4.3.4 Other

This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

4.3.5 Technical Design

Described in section 4.1.

4.3.5.1 What / How

4.3.5.1.1 Standard Operating Procedures (SOPs)

Described in section 4.1.

4.3.5.1.2 Equipment – meters, titration, chemicals, standards, if relevant what is not acceptable, etc.

Use of a dedicated temperature sensor probe or a multiple sensor probe is acceptable using the in-situ direct measurement method. This is the preferred equipment for ease of use by volunteers. If the meter is not working or available a handheld thermometer could be used and noted in the comments.

4.3.7.1.2.1 Precision, Accuracy, Range. Reporting/Detection Limit, Etc.

To be able to detect temperature impairment, any method would need to have a detection limit that is above the relevant state's impairment standard, if it has a numeric standard. Generally, water temperature probes have a detection range from -40/50 °C to +50/80 °C which is usually within the range of ambient surface waters. Accuracy is usually ±0.2 °C.

See below for LEBAF's required minimum specifications for Water Temperature. Any participating Local Hub must use a sensor-based method that is at least as robust as these specs in order for their data to be considered as part of LEBAF's data set, visualizations, and analyses.

Parameter	Water Temperature
Resolution	Not Greater Than 0.1° C
Accuracy	Between ±0° and ±0.3° C of reading
Range	At Least 0° to 50° C

Examples of compatible sensors include:

- YSI ProQuatro Multiparameter Meter
- YSI ProDSS Multiparameter Meter
- HACH HQ40D with LDO Dissolved Oxygen Sensor
- YSI 20 Dissolved Oxygen Meter
- Vernier Go Direct Temperature Probe

4.3.5.1.2.2 Calibration- steps, errors, remedy, documentation, etc.

A calibration SOP, along with potential errors and corrections, can be taken from the probe manufacturer's user guide. Temperature probes generally do not require any specific routine calibration.

4.3.5.1.2.3 Operation and Maintenance

O&M instructions can also be found in the sensor manufacturer's user guide. Temperature probes do not generally require any special provisions for calibration, storage, or maintenance. However, it is recommended that users routinely compare the values of handheld temperature probes to a standard thermometer to confirm accuracy. During operation, ensure the sensor is fully submerged in water.

4.3.5.2 Preparation - Sample container, preservative, labeling, filtration, etc.

Described in section 4.1.

4.3.5.3 Collection – method

No collection is necessary for the in-situ method. Simply record the measured value once it is stable. However, site selection for measurements is important, as is sensor placement. Selected sites should be representative of the predominant conditions/characteristics of that stream in the area. Thus, if the stream is generally free flowing, the head of a riffle, before the water becomes visibly turbulent, is a good location. Likewise, if good riparian cover is generally available, a wide, slow, open stretch of creek should not be selected. Multiple sites in a stream segment can be selected, however, to provide a better sampling of the range of conditions. Replicate readings can be taken from different parts of the stream, but if moving water is present, that is what should be measured.

4.3.5.3.1 Sample Handling – transfer, shipping, storage, chain of custody
Described in section 4.1.

4.3.5.3.2 Quality Control/Assurance Samples -
In general, it is recommended that temperature sensors be tested annually using a traceable thermometer to ensure proper operation. If any discrepancies are identified, it is recommended that the probe be removed and replaced or sent back to the manufacturer since most temperature probes do not have calibration potential.

4.3.5.4 Analyses – method, calibrations, O/M, etc.
Described in section 4.1.

4.3.7.4.1 Safety – for sampler and sample
Described in section 4.1.

4.3.5.5 Quality Control and Assurance
This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details

4.3.7.5.1 Field Protocols
Described in section 4.1.

4.3.7.5.2 Laboratory Protocols
Described in section 4.1.

4.3.5.6 **Other data to capture at sample event**
The minimum sampling visit information is included in Section 4.1. For temperature, the following data are important:

- Air temperature and current and recent (24 hour) weather conditions are helpful in evaluating meteorological influence on water temperature, at this point record in the comments section of the field datasheet.
- Water level from a fixed gauge is helpful, especially if measuring in low flow conditions, site conditions provide a subjective assessment.
- Noting general flow conditions (i.e. flowing or stagnant water) is important for determining conditions that may lead to extreme temperature conditions.

4.3.5.6.1 Minimum Data Elements to Capture about method (who/org/name/training level, units, method, etc.)
Described in section 4.1.

4.3.5.6.2 Frequency – required by decision maker, function of purpose, e.g. if fluctuates daily may need real time device, if fluctuates seasonally,
Described in section 4.1.

4.3.5.6.3 Conditions – to include/avoid, storms, bridges, culverts, slow/fast water
Temperature can be measured anywhere that is a representative flow. Further described in section 4.1.

4.3.5.6.4 Minimum Data Elements to Capture about when (time, date, etc.)
Described in section 4.1. Date and time should be recorded as standard data elements.

4.3.5.7 Who – (organization, volunteer, training, etc.)
Described in section 4.1.

4.3.5.8 Data Management
Data management is broadly addressed in Chapter 3 and described for all parameters in section 4.1. Additional aspects that are particular to temperature data are described in the subsections below.

4.3.5.8.1 Data Mapping - identify data generating (all types, results, meta, QA, etc.) and map through birth, analyses, recording, validation, into repository work flows.
Data mapping elements and workflow are addressed in the Data Management Section and Manual.

4.3.6 Information Design

4.3.6.1 Analyses (summary statistics, benchmarks, finding the story)
Results are recorded in Celsius. State standards were evaluated and it was concluded that a region wide standard across all Lake Erie states could be employed for these categories and following assumptions… Placeholder for standards.
OR
…..concluded that a region wide standard was not applicable and ambient data will be compared to each individual state temperature standards. Placeholder for what may need to be integrated into LEBAF database, for example identifying a station as NY, PA, OH or MI and respective standards and may need to identify a cold or warm category and then provide standards.

4.3.6.2 Data To Information (Interpretation, recommendations and conclusions)
All parameter analyses and findings will be compiled and reviewed in context with each other, against ancillary data at the local, large river and regional level. Standard messaging for interpretation, recommendations and conclusions will be developed in the post sample season information workshop. See Information Design Chapter 7 for details that apply to all parameters, including information products

4.3.6.3 Results Delivery and Communication (of the story)
LEBAFs plan for all parameters is in Chapter 7.

4.3.6.4 Management of Information Products
Included in Chapter 7 .

4.3.7 Evaluation Design

4.3.7.1 When and how do we know the answer to the monitoring question
Evaluation plan and details are in Chapter 8. No specific evaluation applies to temperature unless the standard moves to continuous monitoring technology.

4.3.8 Training – standard approach, list of things to include, timing, elements to help groups train consistently
LEVSN provides a pre-sample season kickoff training that includes database management and equipment training and data analyses and exports.

4.3.8.1 Minimum or specialized experience, ability
No pre-training experience or ability is necessary.

4.3.8.2 Other
This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

4.4 pH

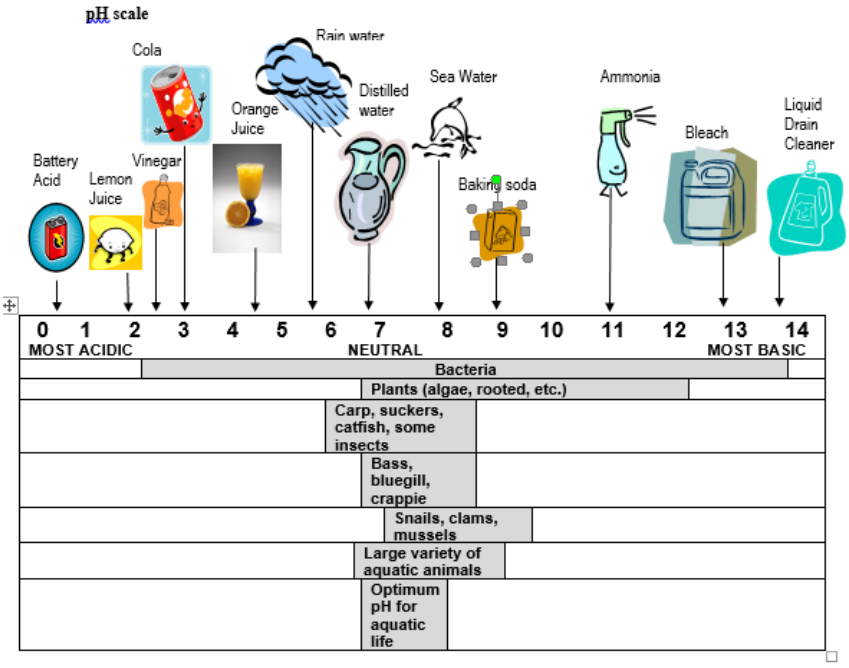
4.4.1 What is pH?
pH is a measure of how acidic/basic water is. In other words, pH measures hydrogen and hydroxyl ion activity in water.[2] It is measured on a logarithmic scale from 0 to 14, with values below 7 indicating acidity, values above 7 indicating basicity, and 7 as neutral. Given pH is calculated using a logarithmic scale, pH values are unitless.

4.4.2 Why care about pH?
pH affects many chemical and biological processes in surface water.[3] pH influences the solubility, biological availability, and transport of heavy metals (cadmium, copper, lead) and nutrients (carbon, nitrogen, phosphorus) aquatic pollutants. pH determines whether aquatic life can use nutrients and the degree of toxicity of heavy metals.

The pH of aquatic systems is affected by both internal and external factors. Photosynthesis, respiration, and decomposition within aquatic systems drive pH fluctuations in water, resulting in daily and seasonably pH variation.[4] The mineral composition of soil and bedrock within an aquatic system also govern water pH. Chemical contaminants and other pollutants transported via rain, stormwater, or

[2] U.S. Geological Survey, "PH and Water | U.S. Geological Survey," October 22, 2019, accessed February 24, 2022, https://www.usgs.gov/special-topics/water-science-school/science/ph-and-water.
[3] US. Environmental Protection Agency, "pH," accessed February 24, 2022, https://www.epa.gov/caddis-vol2/caddis-volume-2-sources-stressors-responses-ph.
[4] Fondriest Environmental Learning Center, "pH of Water," November 19, 2013, accessed February 24, 2022, https://www.fondriest.com/environmental-measurements/parameters/water-quality/ph/.

wastewater can cause changes in water pH. These changes are driven by anthropogenic causes such as industrial or agricultural runoff, mining drainage, and fossil fuel emissions, and wastewater discharges.



Acceptable water pH ranges that promote aquatic life usually fall between 6.5 to 8. However, different aquatic species can thrive in different pH ranges. The U.S. Environmental Protection Agency suggests a pH range of 6.5 to 9 for freshwater systems. If pH values stray outside these ranges, aquatic ecology may experience stress, resulting in disease, death, stunted growth, and decreased reproduction. Unlike temperature or dissolved oxygen, pH requirements across different life stages remains consistent for most aquatic organisms. The figure above illustrates pH ranges from 0 to 14 with everyday items and the range that supports aquatic life.

How does pH change in the environment naturally?

Here we look at three common ways pH might fluctuate naturally in an aquatic environment. Understanding what pH is and how it behaves in nature informs the best study design to capture representative, accurate, precise, consistent and reproducible monitoring results.

Daily – Aquatic systems experience changes in pH over a 24-hour period due to respiration and photosynthesis. The scope of these diurnal changes depend on the eutrophication and alkalinity of the water body.
Seasonally – pH also varies across seasons based on changes in decomposition, photosynthesis, and respiration.
River Continuum – pH can vary along the length of a river due to changes in surrounding groundwater seepage, bedrock, soils, plants, and animals.

What influences pH level?

Since pH is the concentration of hydrogen and hydroxyl ions (H+ and OH-), anything that influences those elements can alter pH levels. For example, the carbon dioxide cycle in respiration, photosynthesis and decomposition, organic inputs from waste water treatment, nonpoint source or tributaries for example. Acid mine drainage, industrial discharges, wetlands and swamps can alter pH.

4.4.3 Information Needs of Targeted Decision Makers

Described in section 4.1.

4.4.4 Other
This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

4.4.5 Technical Design
Described in section 4.1.

4.4.5.1 What / How

4.4.5.1.1 Standard Operating Procedures (SOPs)
Described in section 4.1. Programs can use SOPs provided by equipment manufacturers, state environmental agencies or partners CS programs.

4.4.5.1.2 Equipment – meters, titration, chemicals, standards, what is not acceptable
Use of a single, dedicated pH sensor probe or in a multiple sensor probe housing is acceptable using the in-situ direct measurement method. This is the preferred equipment for ease of use by volunteers.

See below for LEBAF's required minimum specifications for pH. Any participating Local Hub must use a sensor-based method that is at least as robust as these specs in order for their data to be considered as part of LEBAF's data set, visualizations, and analyses.

Parameter	**pH**
Resolution	Not Greater Than 0.01 pH units
Accuracy	Between ±0% and ±0.2 pH units
Range	0-14 pH units

Examples of compatible sensors include:
- YSI ProQuatro Multiparameter Meter
- YSI ProDSS Multiparameter Meter
- Hach Pocket Pro+ Multi 2 Tester
- HACH Pocket Pro+ pH Tester
- Vernier Go Direct pH Sensor

4.4.5.1.2.1 Precision, Accuracy, Range. Reporting/Detection Limit, Etc.
To be able to detect pH impairment, any method would need to have a detection limit that is outside of the relevant state's impairment standards window, if it has numeric standards. pH probes usually have a detection range from 0 to 14 units which is within the range of ambient surface waters. Accuracy is usually ±0.2 units and resolution is 0.01 units.

4.4.5.1.2.2 Calibration- steps, errors, remedy, documentation, etc.
A calibration SOP, along with potential errors and corrections, can be taken from the probe manufacturer's user guide. Most manufacturers recommend pH probes be calibrated at least every several days to ensure functionality. To calibrate, use between 2-6 calibrations points with different pH buffer solutions. Prior to calibration, ensure buffer solutions are not expired and that you are using a clean, dry or pre-rinsed calibration cup or vessel to hold the solutions. A pH 7 buffer should be used

regardless of the number of calibration points. Calibrate the pH sensor by immersing the probe end of the sonde into the solution. Allow at least 1 minute for temperature equilibration prior to beginning the manufacturer's instructions for calibration.

4.4.5.1.2.3 Operation and Maintenance

O&M instructions can also be found in the sensor manufacturer's user guide. The typical life of pH sensors lasts approximately 12-24 months, but is dependent on maintenance and the degree of use. If pH sensors begin lagging and responding slowly, it recommended the sensor be cleaned and reconditioned to restore functionality. To clean the sensor, use a moist soft cloth, lens cleaning tissue, or cotton swab and remove any deposits or contaminants from the glass bulb or platinum button. Keep the sensor moist at all times. To recondition a dried out pH sensor, soak the sensor in a pH 4 buffer overnight. Store the pH sensor in an electrode storage solution such as a potassium chloride (KCl) solution or a pH 4 or 7 buffer when not in routine use.

4.4.5.2 Preparation - Sample container, preservative, labeling, filtration, etc.

No preparation is needed for the in-situ method.

4.4.5.3 Collection – method

No collection is necessary for the in-situ method. Simply record the measured value once it is stable. However, site selection for measurements is important, as is sensor placement. Selected sites should be representative of the predominant conditions/characteristics of that stream in the area. Thus, if the stream is generally free flowing, the head of a riffle, before the water becomes visibly turbulent, is a good location. Likewise, if good riparian cover is generally available, a wide, slow, open stretch of creek should not be selected. Multiple sites in a stream segment can be selected, however, to provide a better sampling of the range of conditions. Replicate readings can be taken from different parts of the stream, but if moving water is present, that is what should be measured.

4.4.5.3.1 Sample Handling – transfer, shipping, storage, chain of custody

No sample handling is needed for the in-situ method.

4.4.5.3.2 Quality Control/Assurance Samples -

Calibrate the pH sensor at least every several days to ensure functionality and accuracy. If errors or out-of-range warnings are encountered during calibration, first attempt cleaning and conditioning the sensor (see above). If additional errors or out-of-range warnings are encountered, it is recommended that the pH sensor be removed and replaced or sent back to the manufacturer.

4.4.5.4 Analyses – method, calibrations, O/M, etc.

Described in section 4.1. No lab analysis is necessary with the in-situ method, however, the comparison laboratory should have analytical methods and quality control procedures available.

4.4.5.4.1 Safety – for sampler and sample

Described in section 4.1. Samplers should follow standard "safe access" guidelines established by each CS organization and covered in SOPs. QA samples are all ambient water, so do not pose additional risk.

4.4.5.5 Quality Control and Assurance

4.4.5.5.1 Field Protocols

The sensor (in its housing) should be lowered into the water at a sample point upstream or to the side of the sampler. The sensor needs to be fully submerged and should not contact the bottom substrate. Strive to measure at the middle of the water column depth. In low depth environments, the probe can be laid on its side so that the stream flows over the sensor. In all cases, the stirring of sediments should be avoided or given ample time to clear. Enough time should be provided to allow sensor readings to reach a stable reading.

Field readings should be performed as field replicate measures (using the same equipment) with experienced and novice users on 5-10% of readings until error is within sensor precision range. Novice users could then be considered experienced. Error should be calculated by computing the absolute difference between experienced and novice readings. A percent error can be calculated by dividing the absolute error by the value of the experienced reading.

4.4.5.5.2 Laboratory Protocols

Described in section 4.1. No laboratory protocols are necessary for in-situ measurement. QA samples should be handled following laboratory protocols provided by the laboratory.

4.4.5.6 Other data to capture at sample event

The minimum sampling visit information is included in Section 4.1. pH fluctuates with temperature so it is particularly important to collect these two parameters together.

4.4.5.6.1 Minimum Data Elements to Capture about method (who/org/name/training level, units, method, etc.)

Described in section 4.1

4.4.5.6.2 Frequency – required by decision maker, function of purpose, e.g. if fluctuates daily may need real time device, if fluctuates seasonally,

Described in section 4.1 Single measurements repeated over a field season can be used to determine if a stream site may be outside of state impairment standards and in need of further investigation. Sites should be visited at least monthly during the active season (April - October). Sites that appear close to impairment levels should be visited more frequently and at least once each in the early morning and late afternoon to provide a range of daily photosynthetic and respiratory conditions. Potentially impaired sites should be evaluated using a continuous data logger, following methods not included here, or by working with partner agencies.

4.4.5.6.3 Conditions – to include/avoid, storms, bridges, culverts, slow/fast water

Covered in multi-parameter section above, 4.1.

4.4.5.6.4 Minimum Data Elements to Capture about when (time, date, etc.)

Described in section 4.1. Date and time should be recorded as standard data elements.

4.4.5.7 Who – (organization, volunteer, training, etc.)

The volunteer collecting data at each event is the first point of quality assurance. The program manager that calibrates instruments and ensures they are in good operating condition is the second point of quality assurance. The program manager or staff that validates the data post-collection is the third point

of quality assurance. The training or support materials and experiences given to volunteers are the fourth point of quality assurance. Water Reporter provides a fifth point of quality assurance through built-in thresholds, notifications, and standard formatting. LEBAF itself provides a sixth point of quality assurance through standard operating procedures and a community of practice for troubleshooting.

4.4.5.8 Data Management

Data management is broadly addressed in Chapter 3 and described for all parameters in section 4.1. Additional aspects that are particular to managing pH data are described in the subsections below.

4.4.7.8.1 Data Mapping - Identify data generating (all types, results, meta, QA, etc.) and map through birth, analyses, recording, validation, into repository work flows.

Data mapping elements and workflow are addressed in the Data Management Section and Manual.

4.4.6 Information Design

4.4.6.1 Analyses (summary statistics, benchmarks, finding the story)

Results are recorded in meter standard units. State standards were evaluated and were the same, plus or minus .05 standard units, across all Lake Erie states which allows LEBAF to use that pH range for all three analyses scales. The standard range will be 6.5-9.0 pH standard units. This standard can be used for local, large river and regional analyses. Sites will be identified as large (based on HUC at this time) and direct tributary to Lake Erie. Station ambient results will be compared to respective standards and identifying exceedances. A # and % exceedance will be calculated per station per sampling season. When more data is available, averages can be calculated and comparisons across seasons and if appropriate between stations on the same river.

4.4.6.2 Data To Information (Interpretation, recommendations and conclusions)

All parameter analyses and findings will be compiled and reviewed in context with each other, against ancillary data at the local, large river and regional level. Standard messaging for interpretation, recommendations and conclusions will be developed in the post sample season information workshop. See Chapter 7 for details that apply to all parameters, including information products.

4.4.6.3 Results Delivery and Communication (of the story)

LEBAFs plan for all parameters is in Chapter 7.

4.4.6.4 Management of Information Products

Included in Chapter 7.

4.4.7 Evaluation Design

4.4.7.1 When and how do we know the answer to the monitoring question

Evaluation plan and details are in Chapter 8. No specific evaluation applies to pH.

4.4.8 Training – standard approach, list of things to include, timing, elements to help groups train consistently

LEVSN provides a pre-sample season kickoff training that includes database management and equipment training and data analyses and exports.

4.4.8.1 Minimum or specialized experience, ability
No pre-training experience or ability is necessary.

4.4.8.2 Other
This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

4.5 Conductivity

4.5.1 What is Conductivity?
Conductivity or specific conductance is an indirect measure of the collective concentration of dissolved ions in a solution.[5] Conductivity is sometimes also called electrical conductivity. Conductivity is a general term, while specific conductance is, well, specific. It refers to the measure of electrical conductance in 1 cubic cm of a 25°C solution. Conductivity can vary in different temperatures in the same solution. However, conductivity measured at a different temperature can be corrected to what it would be at 25°C as long as the temperature is recorded as well. Electrical conductance is measured in siemens (S) or microsiemens (µS) and is the inverse of electrical resistance measured in ohms (Ω).

4.5.2 Why care about Conductivity?
For the practical use in measuring the quality of freshwater chemistry, conductivity is a broad indicator of general water quality. It increases with the amount of dissolved ions, such as salts or metals. Therefore, it is a broad measure of the amount of ionically charged pollution in ambient water, as natural river and stream water is generally low in ionic content, though it can vary depending on the types of minerals in the stream banks and substrate. There are many studies that link higher conductivity levels to high concentrations of salts used in road deicing. These salt concentrations can impact stream biota and reduce biodiversity in streams. High conductivity may indicate the presence of toxic substances, but it can also be high due to naturally occurring ions. Non-ionic toxins, such as oils, are also not detected by conductivity measures. A high conductivity measurement signals a need for further investigation to better determine the cause and potential sources.

Conductivity is also highly correlated with Total Dissolved Solids (TDS), which include anything dissolved in water including minerals, salts, metal, cations, anions and organic molecules. Though a more accurate measurement for expressing the chemical constituents of water, TDS is a more expensive and complicated measurement to make, and thus Conductivity is often used in lieu of TDS. Some sondes on the market will directly translate conductivity and report results for both specific conductance and TDS.

How does Conductivity change in the environment naturally?
Each water body tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could be an indicator that a discharge or other source of pollution has entered the water body. Below are three ways conductivity might fluctuate naturally in an aquatic environment.

[5] Specific Conductance, USGS. Revised 2019. Chapter 6.3 of Section A, National Field Manual for the Collection of Water-Quality Data. Book 9, Handbooks for Water-Resources Investigations

Daily – Aquatic systems can experience very small changes in conductivity over a 24-hour period due to respiration and photosynthesis. As trees respire and draw up groundwater, mineral content in the water may be higher than that of surface water resulting in higher ionic concentrations and therefore higher conductivity. Understanding geology around the site can help interpret results.
Seasonally – Conductivity can naturally vary across seasons. Snowmelt can flush salts (unnatural ion source). As organic material breaks down, minerals can be released throughout the season. As low flow periods approach, conductivity can increase as less fresh water is available to dilute mineral content.
River Continuum – Conductivity can vary as rivers grow from headwater streams to rivers that exit into Lake Erie. Streams that form from wetland outflow may be considerably higher in conductivity from those that export oligotrophic lake water or begin from bedrock seeps. Larger waters should generally have lower conductivity measures than smaller streams on average due to ionic dilution. Exact differences depend on surrounding groundwater seepage, bedrock, soils, plants, and animals.

What influences levels of conductivity?
Conductivity in essence measures what is 'in' the water that can pass electrical conductance. Many elements can do that, sediment, metals, suspended solids, and particulates for example. Conductance doesn't determine what those elements are but how much is available. Therefore any natural or anthropogenic (human made) sources can introduce elements into the water, storms and runoff, tributaries, erosion, discharges and land uses.

4.5.3 Information Needs of Targeted Decision Makers
Described in section 4.1.

4.5.4 Other
This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

4.5.5 Technical Design
Described in section 4.1.

4.5.5.1 What / How

4.5.5.1.1 Standard Operating Procedures (SOPs)
Described in section 4.1. Programs can use SOPs provided by equipment manufacturers, state environmental agencies or partners CS programs.

4.5.5.1.2 Equipment – meters, titration, chemicals, standards, what is not acceptable, etc.
Use of a single, dedicated conductivity sensor probe or in a multiple sensor probe housing is acceptable using the in-situ direct measurement method. This is the preferred equipment for ease of use by volunteers. See below for LEBAF's required minimum specifications for Conductivity. Any participating Local Hub must use a sensor-based method that is at least as robust as these specs in order for their data to be considered as part of LEBAF's data set, visualizations, and analyses.

Parameter	Conductivity
Resolution	0.001 mS (0 to 0.500 mS); 0.01 mS (0.501 to 50.00 mS); 0.1 mS (50.01 to 200mS)
Accuracy	Between ±0% and ±1% of reading

Range	At Least 0 to 200 mS/cm

Examples of compatible sensors include:

- YSI ProQuatro Multiparameter Meter
- YSI ProDSS Multiparameter Meter
- Hach Pocket Pro+ Multi 2 Tester
- HACH Pocket Pro+ pH Tester

4.5.5.1.2.1 Precision, Accuracy, Range. Reporting/Detection Limit, Etc.

To be able to detect conductivity impairment, any method would need to have a detection limit that brackets the relevant state's impairment standards window, if it has numeric standards. Most states do not have standards for conductivity, but they may for TDS (see State Standards Table). Conductivity probes that have been approved by LEBAF have a detection range from 0.01 to 200 mS/cm, which is well within the range of ambient surface waters. Accuracy is within 1% of the reading at lower values and 1 µS/cm for higher values. Resolution is 0.0001 to 0.1 mS/cm.

4.5.5.1.2.2 Calibration

A calibration SOP, along with potential errors and corrections, can be taken from the probe manufacturer's user guide. Most manufacturers recommend conductivity probes be calibrated at least every several days to ensure functionality. To calibrate, a conductivity calibration solution with a known, traceable value within the ambient measurement range should be used. Prior to calibration, ensure the solution(s) are not expired and that you are using a clean, dry or pre-rinsed calibration cup or vessel to hold the solution. Calibrate the pH sensor by immersing the probe end of the sonde into the solution. Allow at least 1 minute for temperature equilibration prior to beginning the manufacturer's instructions for calibration. Enter the solution value for the given temperature in the location you are calibrating.

4.5.5.1.2.3 Operation and Maintenance

O&M instructions can also be found in the sensor manufacturer's user guide for all four parameters. All sensors should be checked for obvious buildup of any type of foreign material. The typical life of conductivity sensors is unspecified, but is dependent on maintenance and the degree of use. If the conductivity sensor begins lagging and responding slowly or erratically, it recommended the temperature sensor be cleaned to restore functionality by scrubbing off (with a toothbrush) any buildup. The conductivity sensor openings should be cleaned of any buildup as well. The sensors can be stored clean and dry when not in routine use.

4.5.5.2 **Preparation** - Sample container, preservative, labeling, filtration, etc.

No preparation is needed for the in-situ method.

4.5.5.3 **Collection** – method

No collection is necessary for the in-situ method. Simply record the measured value once it is stable. However, site selection for measurements is important, as is sensor placement. Selected sites should be representative of the predominant conditions/characteristics of that stream in the area. Thus, if the stream is generally free flowing, the head of a riffle, before the water becomes visibly turbulent, is a good location. Likewise, if good riparian cover is generally available, a wide, slow, open stretch of creek should not be selected. Multiple sites in a stream segment can be selected, however, to provide a better

sampling of the range of conditions. Replicate readings can be taken from different parts of the stream, but if moving water is present, that is what should be measured.

4.5.5.3.1 Sample Handling
No sample handling is needed for the in-situ method.

4.5.5.3.2 Quality Control/Assurance Samples -
Calibrate the conductivity sensor at least every several days to ensure functionality and accuracy. If errors or out-of-range warnings are encountered during calibration, first attempt cleaning and conditioning the sensor (see above). If additional errors or out-of-range warnings are encountered, it is recommended that the conductivity sensor be removed and replaced or sent back to the manufacturer.

4.5.5.4 Analyses
Described in section 4.1. No lab analysis is necessary with the in-situ method, however, any comparison laboratory should have analytical methods and quality control procedures available.

4.5.5.4.1 Safety – for sampler and sample
Described in section 4.1. Volunteers should follow standard "safe access" guidelines established by each CS organization and covered in SOPs. QA samples are all ambient water, so do not pose additional risk.

4.5.5.5 Quality Control and Assurance

4.5.5.5.1 Field Protocols
Described in section 4.1. The sensor (in its housing) should be lowered into the water at a sample point upstream or to the side of the sampler. The sensor needs to be fully submerged and should not contact the bottom substrate. Strive to measure at the middle of the water column depth. In low depth environments, the probe can be laid on its side so that the stream flows over the sensor. In all cases, the stirring of sediments should be avoided or given ample time to clear. Enough time should be provided to allow sensor readings to reach a stable reading.

Field readings should be performed as field replicate measures (using the same equipment) with experienced and novice users on 5-10% of readings until error is within sensor precision range. Novice users could then be considered experienced. Error should be calculated by computing the absolute difference between experienced and novice readings. A percent error can be calculated by dividing the absolute error by the value of the experienced reading.

4.5.5.5.2 Laboratory Protocols
No laboratory protocols are necessary for in-situ measurement. QA samples should be handled following laboratory protocols provided by the laboratory.

4.5.5.6 Other data to capture at sample event
The minimum sampling visit information is included in Section 4.1. For conductivity, the following data are particularly important:

- Water temperature is needed to translate specific conductance. Many recommended conductivity sensors also have a temperature sensor included.

- Current and recent (24 hour) weather conditions are helpful in evaluating meteorological influence on conductivity, see weather condition check boxes and comments field is open as well.
- Water level from a fixed gauge is helpful, especially if measuring in low flow conditions or general flow conditions (i.e. flowing or stagnant water) is important for determining conditions that may lead to extreme temperature conditions. See site condition check boxes for flow information and comments field is open as well.

4.5.5.6.1 Minimum Data Elements to Capture about method (who/org/name/training level, units, method, etc.)
Described in section 4.1.

4.5.5.6.2 Frequency – required by decision maker, function of purpose, e.gif fluctuates daily may need real time device, if fluctuates seasonally,
Described in section 4.1.

4.5.5.6.3 Conditions – to include/avoid, storms, bridges, culverts, slow/fast water
Described in section 4.1.

4.5.5.6.4 Minimum Data Elements to Capture about when (time, date, etc.)
Described in section 4.1. Date and time should be recorded as standard data elements.

4.5.5.7 Who – (organization, volunteer, training, etc.)
Described in section 4.1.

4.5.5.8 Data Management
Data management is broadly addressed in Chapter 3 and described for all parameters in section 4.1. Additional aspects that are particular to conductivity data are described in the subsections below.

4.5.5.8.1 Data Mapping
Identify data generating (all types, results, meta, QA, etc.) and map through birth, analyses, recording, validation, into repository work flows. Data mapping elements and workflow are addressed in the Data Management Section and Manual.

4.5.6 Information Design

4.5.6.1 Analyses (summary statistics, benchmarks, finding the story)
Results are recorded in ohms. State standards do not exist for conductivity. However, correlations can be may from other parameters and that is being researched. If a regional standard can be extrapolated like D.O. and pH, then it will be applied across all Lake Erie. If it cannot, and a translation to either a state or regional standard is not possible, conductivity will be used as a surrogate for chloride or other pollutants.

Stations' ambient results will be compared to respective standards and identifying exceedances, if a standard is developed or identified, a # and % exceedance will be calculated per station per sampling season. When more data is available, averages can be calculated and comparisons across seasons and if appropriate between stations on the same river.

4.5.6.2 Data To Information (Interpretation, recommendations and conclusions)

All parameter analyses and findings will be compiled and reviewed in context with each other, against ancillary data at the local, large river and regional level. Standard messaging for interpretation, recommendations and conclusions will be developed in the post sample season information workshop. See Information Design Chapter 7 for details that apply to all parameters, including information products.

4.5.6.3 Results Delivery and Communication (of the story)

LEBAFs plan for all parameters is in Chapter 7.

4.5.6.4 Management of Information Products

Included in Chapter 7.

4.5.7 Evaluation Design

4.5.7.1 When and how do we know the answer to monitoring question

Evaluation plan and details are in Chapter 8. Efficacy of using a surrogate or translation standard for conductivity will be included.

4.5.8 Training – standard approach, list of things to include, timing, elements to help groups train consistently

LEVSN provides a pre-sample season kickoff training that includes database management and equipment training and data analyses and exports.

4.5.8.1 Minimum or specialized experience, ability

No pre-training experience or ability is necessary.

4.5.8.2 Other

This parameter does not require specifications for this section. It is included for consistency with other parameters that may require additional details.

Chapter 5 – Biological Technical Design

Ecosystem health, integrity and biological diversity occur when chemical, biological and physical habitat ecosystem elements are sufficiently abundant and functioning together. Monitoring programs that focus on the purpose of condition and trend assessment are most effective, or tell the most comprehensive story if parameters from all three vectors are monitored. Since LEBAF is designed to evaluate existing parameters and possible additions each year, this chapter is a placeholder for the Summit to communicate:

- LEBAF has a solid foundation and a process in place to expand
- LEBAF desires to be relevant and holistic and tell the best story possible

LEBAF maintains a standardization "menu" that identifies possible areas, parameters and program elements to standardize that participants, local hubs and external decision makers identified. This standardization menu is evaluated each year against current priorities, opportunities, threats and changes in technology, policies, and methods to list a few examples. Each year participants "re-rank" priorities and determine what would be of value to standardize next. That could mean adding a parameter to the LEBAF program or developing another standardization program to serve a different combination of purpose and data use.

The current standardization menu ranked macroinvertebrates high and that is why it is provided here as an example. The framework for what questions to answer to standardized biological parameters would need to be developed.

5.1 **Macroinvertebrates** (a possibility and example)

Chapter 6 – Physical Habitat Technical Design

As with biological parameters, physical habitat parameters are important to measure.

The current standardization menu ranked water levels high and that is why it is provided here as an example. The framework for what questions to answer to standardized biological parameters would need to be developed.

6.1 **Water Level** (a possibility and example)

Chapter 7 - Information Design

It is imperative that LEBAF participants understand that developing, implementing and revising an information design is critical to the existence, relevance and sustainability of this collective effort. Without information design, data production becomes the ultimate goal of the program rather than producing results, outcomes or impacts. This sort of structure makes it difficult for groups to see or articulate the difference between their efforts and LEBAF and can thus impact commitment, engagement, performance and LEBAF's ability to create greater collective impact. LEBAF does not exist to replicate or improve individual programs; it exists to elevate and generate greater impact from collective efforts. LEBAF will indirectly improve individual programs at a local level and provide greater impact at a regional level that loops back to local level impact. Information Design is about *doing something with the data* and is thus essential to LEBAF's success. Participants who view LEBAF as *only* helping them do their work better and do not commit to a larger vision and collective are not an effective cultural fit for LEBAF.

LEBAF participants will meet annually in October or November to implement this information design. This will likely involve the equivalent of four to six hours of time and occur virtually or in-person depending on the time and budget available. Execution of this study design element is part of the participant agreement. It is important for each program to assess their capacity to implement this information design for LEBAF and for further individual organization work. The workload to implement this element may vary depending on each participating groups' structure, number of sites, experience with LEBAF, and internal capacity.

7.1 Analyses & Findings (summary statistics, benchmarks, finding the story)

Analyses and findings are *repeatable* calculations and actions with valid results. Anyone should be able to conduct the same analyses and repeatedly produce the same results. Example elements of analysis include calculating metrics or graphing results over space or time as well as comparing results and associated metrics to standards or benchmarks.

This information design was determined through feedback in the 2022 Lake Erie Citizen Science Summit and a series of virtual workshops in May and June 2022. This plan is dynamic and iterative and updated when any SOP changes. As of July 2022, a few elements are still being researched to finalize for the fall information and evaluation work sessions. This plan applies to dissolved oxygen, temperature, pH and conductivity. Specifics to each of those parameters that are unique will be addressed in that parameter section. If parameters are added to this SOP, this section will be updated.

To meet its data objectives, monitoring purpose and data uses for targeted data users, LEBAF will conduct the following analyses and tell stories at three scales:

1. **Local River by each site**
2. **Large Rivers and direct tributaries to Lake Erie**
3. **Lake Erie Region**

The following information plan addresses all three scales for all four parameters.

7.1.1 By Site

7.1.1.2 Metrics by site.

The following metrics will be calculated for each parameter, at each station for each sampling season. We expect up to 480 results per season (15 groups x 1 station per group x 8 events x 4 parameters) to contribute to this analysis. These metrics support the analyses we want to conduct. Water Reporter will automatically conduct these calculations and produce a table.

- ☐ Total N (# of samples)
- ☐ Maximum
- ☐ Minimum
- ☐ Average
- ☐ Mean (50th %tile)
- ☐ 25th %tile
- ☐ 75th %tile
- ☐ N >= standard
- ☐ %ofN >= standard

In addition, summary statements can be made about the quantity and quality of data for LEBAF monitoring purpose, data use and objectives, limitations of the data and assumptions about the study design. These statements will be presented in a standardized format and used to inform the remaining information design steps. Data summary statements will be developed for all three scales.

This also includes summary statements about the QA/QC data and methods used to verify results and program outputs such as number of organizations, volunteers, stations and results monitored each season. For example, a QA statement could say “calibration was completed and passed for X out of Y events and if calibration issue was rectified or sample was not collected, data was qualified or removed from analyses.”

7.1.1.3 Graphs by site

For each site, Water Reporter will generate a graph for each parameter to illustrate parameter results over the sampling season (time). These graphs will include:

- ☐ Maximum, minimum and mean
- ☐ Box and whisker with 25, 50 (mean) and 75th percentile
- ☐ Each result against respective thresholds/benchmarks,
    - ☐ pH will be compared to upper/lower limits
    - ☐ Temperature will be either cold or warm water criteria
- ☐ Dissolved oxygen results with % saturation and temperature results per event
- ☐ pH with temperature
- If more than one site exists on a water body, all sites will be graphed (time and space)
- If a flow gauge data is available (future), conductivity will be graphed with flow data

7.1.1.4 LEBAF Standards (benchmarks, regulations, etc.)

This section provides the approach LEBAF took to determine what standards or benchmarks to compare ambient data to meet their purpose and data use.

Each state has respective standards for all four parameters, except conductivity. All state Clean Water Act standards are derived from scientific studies, vetted in literature as well as biological and toxicological experiments. These studies generate or review threshold metrics, such as LC50's (the lowest concentration that kills 50% of the organisms) that are translated into standards. Very often the resulting benchmark represents the most sensitive species, or a combination of thresholds via a mathematical process to generate a state standard that becomes the regulated standard. Followed by an assessment policy to assess ambient data against those standards. This is the role and mandate of Clean Water Act agencies funded by EPA. In essence, the Clean Water Act is a set of policies that are risk probabilities. The approach assumes that if a conglomerate of the most sensitive species is protected by a threshold or standard then so are the rest of the organisms. Established chemical standards can thus serve as surrogates to measuring actual organism exposure and employing biological threshold, such as a macroinvertebrate multiindex method meant to integrate community structure and function health.

The Clean Water Act is a process where science and data meet policy to create a consistent and predictable set of rules for managers. The need to be predictable can dilute what actually happens in reality, for example, acute and chronic exposure can be quantified if monitoring was perfectly able to capture the magnitude, duration and frequency an organism was exposed to concentrations above a known threshold. However, it is impossible to measure all organisms' exposure to all pollutants everywhere at all times. Thus, a standard is adopted and assessment protocols attempt to capture exposure and provide a conservative framework that drives action to prevent, eliminate or reduce exposure. Chronic and acute standards for example, often criteria used to indicate potential exposure and impairment of a use, usually cannot be exceeded more than one time in a three year period at a given site. This does not capture reality in science but provides a predictable and consistent process to administer pollutants via policy.

The science and research behind each parameter or potential pollutant varies in availability and age as well as the methods and technology used to produce a fully confident result (confidence in accuracy, precision, reproducibility and comparability). The science behind dissolved oxygen, pH, temperature and conductivity is generally very confident relative to different forms of nitrogen, organic chemicals or biological communities. As such, many states utilize the **same standards** for these parameters with varying assessment protocols to address variations within the states.

Each state's Clean Water Act must have regulations that are at least as stringent as the Federal EPA's recommendations but have the flexibility to develop uses, standards and assessment processes that fit their needs within the same framework. This allows EPA to tell a national story about the health and condition of the Nation's waters while states have the flexibility to address their needs and unique resources, economies, capacities and the like.

LEBAF, much like EPA, desires to tell a regional story as states and local groups are telling the local story. Like EPA then, **LEBAF's approach is to identify where the science supports one standard for each parameter to use in analyses at all three levels. If that is not possible, a hybrid approach will be employed where parameters that cannot be analyzed with a regional standard will be analyzed using each state's standard or an equivalent valid standard**. Unlike states, LEBAF is not responsible for creating a predictable assessment or policy, so LEBAF can focus on capturing biological reality and comparing it to the mandated story states tell about the condition or health of a waterbody.

Based on this approach, the standards LEBAF will employ are presented below. These parameters are used to indicate aquatic life use and will frame interpretation from this assumption. LEBAF assumes all waters monitored are currently capable of meeting aquatic life uses,

Parameter	Rationale	Standard and Assessment Protocol
DO	All states have cold and warm water criteria. Many states had additional standards for trout or spawning, many also used a daily average versus a concentration	Conservative approach, mg/l rather than daily average Cold water <=7 Warm water <=5
pH	All four states, NY, PA, OH and MI use this range, with a few exceptions. NY uses 6.0-8.5, and PA has 6.0 for specific uses	6.5 - 9.5
Temperature	Most states have standards for cold and warm water species as well as river versus lake species	July 2022 - Research each states' SOPs to identify a temp standard, or set of standards. If alignment is not found, LEBAF will employ each states' standard and identify stations accordingly.
Conductivity	No state has a standard, but some correlate with salinity or chloride	July 2022 - Research into each states' correlations, surrogates and use of conductivity data. If a regional threshold or equivalent can be identified it will be used. If not, a state by state approach or perhaps another approach as an indirect indicator for other pollutant exceedances will be adopted.

Ambient data for all parameters will be compared to the above standards, result to standard, not averages or other metrics at this time. Number and % exceedance will be the metric or result reported.

A regional standard means one standard for all three levels of analyses, local, large river/direct tributary and regional, one analyses, three stories. A hybrid approach will be adopted if a regional standard is not possible, meaning that two analyses will be conducted. For DO and pH, a regional standard will be used for all scales. For temperature and conductivity, state by state analyses will be conducted at local and large river/direct tributary scales which will be amplified and extrapolated to tell a regional story. If a standard cannot be identified, Conductivity may provide a different type of story as a surrogate screen for other pollutants.

What additional information is needed in Water Reporter to conduct this analysis at all three scales?

- ☐ DO standards of 8 and 5
- ☐ pH standards of 6.5 and 9.0
- ☐ A way to identify a station as warm or cold (use respective states designation)
- ☐ A way to identify a station as a large river site (HUC size of X) and/or direct tributary to Lake Erie
- ☐ Placeholder for temperature standards and possible station ID categories
- ☐ Placeholder for conductivity standard or possible station ID categories
- ☐ A place to store N and % exceedances for each parameter

For future discussion and transparency, it is noted that LEBAF considered the following standards. Each of these requires more research, monitoring and capacity that LEBAF has to generate a threshold but could be considered in the future. Other ideas for benchmarks to considered:

- Reference site means (need to obtain for each site)
- Numeric references (EPA study or information)
- Typical range for the area and parameter, historical averages/ranges (need to obtain)

7.1.2 Larger Watershed / Direct Tributary (benchmarks, regulations, etc.)

LEBAF's site level benchmarks and standards, described in Section 7.1.1.4, are also applied to the Larger Watershed/Direct Tributary level of analysis. In the future LEBAF would like to identify large rivers by drainage size. Water Reporter is in a beta testing project and might be able to bring that to LEBAF soon. Until then, HUC size will be used. Number and percent exceedance is the primary reported metric.

LEBAF will use this HUC size as the large river cut off and use the following as the station identifier:

- ☐ HUC Size
- ☐ Station Identifier

LEBAF will identify direct tributaries to Lake Erie by this station identifier

- ☐ Direct Tributary

The analyses and findings metrics and standards are explained in section 7.1.1.

7.1.3 Regional Standards (benchmarks, regulations, etc.)

LEBAF's site level benchmarks and standards, described in Section 7.1.1.4, are also applied to the Regional Standards level of analysis. Metrics will be the same as site level. The approach for DO and pH is to employ a regional standard. A regional standard will also be explored for temperature and conductivity. If one cannot be identified then a state by state approach will be used. Conductivity might have a different story than % exceedance, which is the primary reported metric.

7.1.3.1 Site Metrics and Graphs across the region

Site metrics and graphs will be the same as the site level for DO and pH. Specific outputs may need to be uniquely generated at the regional level to support hybrid analysis of parameters which do not have a clear benchmark that can be applied regionally such as conductivity and temperature.

7.1.4 Metrics and Graphs across years

This is a placeholder for when more data is available. This can continue to be developed beyond the initial scope of this SOP by telling the above site and or regional story over time. The same metrics can be illustrated in table form, adding each year's individual metrics and then calculating the same metrics across sample years. This is true for graphs, individual years per station, per parameter and then aggregate metrics graphed over time and against benchmarks. This will set the foundation for trend analyses informal and maybe formal. Water Reporter can combine sites on the same water body and or within the same state or recommended 'boundary' if sub-regionalizing is helpful.

If the data set becomes robust and sufficient, a regression or ANOVA can be used to determine if a trend is significant. Analysis of trends should follow standard methods, such as this U.S. EPA source. This can be determined every year during the information design summit and evaluation process. As the dataset grows and more robust analyses become possible, LEBAF may require a different capacity than Water Reporter currently has. At this time, Water Reporter wull provide all data and meta-data to an external application via Application Programming Interface (API). It will be important for LEBAF to lead this type of analysis across the region for consistency.

7.2 Interpretation

Interpretation is the leap from objective and repeatable analysis and findings to the subjective function of the interpreter. It is thus important to design interpretation and the remaining elements up front for transparency. LEBAF is not collecting data to prove an existing outcome. It is instead collecting data to tell a story about the condition of Lake Erie watersheds using aquatic health indicators as a screening tool for local creeksheds, larger watersheds, and the complete Lake Erie Basin.

The key is to have a systematic and defendable process that supports interpretation of the story from the analyses and findings. Here we identify assumptions about the data set and bring in local and other knowledge and meta-data. Then we must determine how the story will unfold at the local, larger watershed and regional scale. Interpretation is organic and the plan provided here will be updated based on the actual data, analyses, interpretation and evaluation of all of this against LEBAF's ability to fulfill its monitoring purpose or data use or make progress.

Individual groups may use and interpret the data on their own and add to LEBAF's process to meet their own goals. Secondary to LEBAF's goals, groups are interested in helping volunteers understand and even conduct analyses, findings and interpretation processes, what to expect and its relationship to what is found, assumptions and limitations on what we can and can't express.

This interpretation process integrates in a stepwise manner, from site analyses and larger river influence to the regional scale story.

What do you have?

- ☐ Metrics from each site for each parameter as listed above, produced by WR
- ☐ Graphs from each site for each parameter as listed above, produced by WR
- ☐ A list of ancillary data and information to consider defined in Section 7.2.1

- ☐ Ambiguous terms defined in Section 7.2.2
- ☐ Regardless of the analysis approach (e.g. regional or hybrid standard) for a given parameter, LEBAF will only report number and % exceedances without any labels, grades or color interpretations at this time.
- ☐ Information products described in Section 7.4
- ☐ A series of statements, recommendations or conclusions that LEBAF participants would like to make using the data, to meet their shared monitoring purpose, data uses and progress toward their intended results, outcomes and impacts (health of Lake Erie and its watersheds).
- ☐ A postseason workshop date where all data is entered, validated and analyses and findings completed, participants come together and facilitate interpretation, recommendations, conclusions, communication and delivery.

7.2.1 Ancillary data to consider

Below is the master list of additional considerations to use during interpretation. LEBAF participants should consider whether some of the elements not currently included should be added during each annual Information Design and Evaluation Design meetings.

LEBAF Has Information via database or within participants:

- Event date, time
- Station information such as lat/long, elevation, ecoregion, HUC's
- Creek/River name and location
- Weather, dominate weather pattern previous 24 hours
- Field notes - visual observations, general site observations
- Water level or flow is requested
- Volunteer Group name / Organization Name
- Level of Training (once determine definitions)

LEBAF Does Not Have Information

- Watershed size other than HUC 8, 10, and 12
- Surrounding Land Use, trends in that land use (more development, less, deforestation, etc.)
- River Miles
- Creek drainage area
- Percentage Impervious Surface
- Major river creek flows into (large basin analyses)
- Is segment on the respective States TMDL list for impairment, developed TMDL?
- Response: set grade scores, min/max limits.
- Response: can set annual mean color coding
- Could it compile across a given scale (i.e. watersheds and LE basin). Max, mean, min

7.2.2 Definitions and Assumptions

It is important that key terms used across all elements of this SOP's design are consistently defined, based on LEBAF's purpose, goals and desired use, to provide a baseline for shared understanding and operations. Ambiguous terms make for ambiguous analysis, interpretation, recommendations and further action. Terms such as healthy and impaired are ambiguous in that the definition will vary depending on the purpose of its use. Some definitions may be qualitative or semi-qualitative combined with subjectivity that allow for regional differences.

THIS LIST WILL GROW AND DEFINITIONS CAN BE FINALIZED AFTER DESIGN IS FINALIZED

- **Health**
- **Impairment**
- **High Quality**
- **Local watershed**
- **Larger River (direct tributary to LK, HUC, drainage basin filter?)**
- **Region**
- **Screening**

7.2.3 Interpretation Method Steps

It is tempting to go straight from analysis and findings to recommendations and conclusions by using results from existing tools such as State reports or watershed report cards. It is important to remember that these products were developed to advance recommendations and conclusions that serve the mission of the groups that developed them and are thus colored by assumptions and interests that may not align with LEBAF. What is documented in this Information Design is an exploratory process aimed specifically at serving LEBAF's intended monitoring purpose, data uses, outcomes, and impacts.

7.2.3.1 Site State Standards Assessment

LEBAF's method for assessing condition at **Site level** will be the following (more work might need to be done over summer to generate this scale interpretation). The following steps are a guideline for transparency and will likely be modified as the process unfolds but will be documented and communicated. Remember when following these steps that the data use is primarily screening for further monitoring, review, and perhaps restoration or protection.

1. Postseason information and evaluation workshop dates will be set early in the monitoring season. Some of the information products listed above can be used for this effort.
2. Groups will have all data entered or uploaded by the end of October.
3. The Standards Workgroup will use Water Reporter to execute the analyses and findings process.
4. Analyses and findings will be shared with all LEBAF participants for review and the information workshop agenda/logistics will be designed to facilitate next steps.
5. At a site level, the number and percentage (against a total N) of exceedances will be reviewed and ancillary data and other information known by participants will be integrated. Notes will be recorded in context with LEBAF standard statements or messaging, including:
    a. Analyses and findings will be reviewed and any repeatable observations (events and patterns) illustrated therein identified. This is NOT an interpretation of why you found what you found, just what you found at this point. A review of when exceedances occurred will be noted including time of year, limitations and assumptions of data and knowledge. When a threshold exceedance is discovered, the next task will be to understand the *magnitude, frequency and duration* of that exceedance over space and time, if the data set is sufficient. Record both what you can say and what you can't say.
6. The method for interpreting analyses and findings regarding assessing condition at **site level** will be the following:
    a. Gather ancillary data. Note you can use some of thethe charts, metrics and graphs produced in Analyses and Findings.
    b. At the site level, review each parameter's overall results and patterns against how that parameter is expected to behave at that elevation, baseline behavior for this parameter for a river of that size, during that time of year, day, etc. Write a characterization.

c. Ancillary data is reviewed and considered as possible explanations of patterns, results and exceedances observed.
d. A story can be crafted based on all the above that include, that includes assumptions, limitations. For example: "We would expect _____, found _____, believe it might be related to_____ and if we had more data we could make _____ statements." LEBAF can make a statement about frequency, duration and magnitude of exceedances for each parameter. For Example: "DO tells us_____, pH tells us _____, temperature tells us _____, and conductivity tells us _____ regarding this site's condition. Together these results tell a story of_____ at this site." This series of interpretations moves to Recommendations and Conclusions.
e. Identify gaps in representation on this river or creek. For example: "If we had _____ sites at _____ locations we could better determine and monitor this creek's condition" OR "If we had more _____ data for_____ parameter we could better determine this creek's condition." Conversely the statement might be: "We have sufficient data in location and frequency to determine this creek's condition (can quality from x to y or as a HUC y) in support of our recommendations." This is noting gaps you found at this stage in the process.
f. Bring in the respective State's interpretation. Ask: "Would this data put this site on a list for a parameter or not?" Bring in a respective report card process if it is of interest and ask "What does that interpretation apply to parameter, site and condition label?" Bring this into the story crafted with above interpretation.
g. An individual group can identify their state's assessment for use attainment methodology for each parameter (required N, what metric is used to compare ambient data to standard and resulting interpretation or label). This can be added to a local story but not LEBAF's messaging.

7.2.3.2 Larger River / Direct Tributary Assessment.

LEBAF's method for assessing condition at **Larger River level** will be the following (more work might need to be done over summer to generate this scale interpretation):

1. Each site is assigned the appropriate larger river and compiled. Note you can use some of the charts, metrics and graphs produced in Analyses and Findings.
2. Take the output of the site analyses for each site identified as a large river and/or a direct tributary of Lake Erie. Interpret the analyses/metrics from the lens of a large river system and/or direct tributary and its impact on Lake Erie. The goal here is to look at the analyses and findings from the lens of a larger river system and its influence on Lake Erie.
3. From the larger river basin lens, ask: "Do the ancillary information review, perhaps including each respective states 'condition' assessment for that larger river (aquatic life use perhaps in this case due to LEBAF parameters), craft an interpretation of what the condition of this smaller creek's contribution is to the condition of the larger river?" Identify and document data limitations and assumptions being made.
4. Note what larger basins and subbasins are missing from this review as gaps to identify and review in evaluation. Make statements such as: "If we had _____ subbasins or greater frequency of data collection for parameter _____ , we could better determine_____ ." This is noting gaps you found at this stage in the process.
5. Upon completing steps b-d for one larger river, repeat this process for each other key direct tributaries. The results are summary statements about direct tributaries' influence on Lake Erie, gaps, data limitations and assumptions.

7.2.3.3 Regional State Standards Assessment.

LEBAF's method for assessing condition at **Regional level** will be the following (more work might need to be done over summer to generate this scale interpretation):

1. For DO and pH, the site level metrics and analyses will be interpreted at a regional scale. The same metrics generated for each site are now being used to tell a regional story. Just like you used the local metrics to tell the large river story, you are now using the local metrics to tell a regional story. If we identify a regional standard for conductivity and temperature, this approach will also apply to these parameters. If not, a workflow will be provided to interpret these parameters at a regional scale. The following steps apply to DO, pH, and any other parameters with a regional standard:
2. Follow the general assessment process for large rivers and direct tributaries. Note you can use some of the Charts and Metrics listed and generated for this effort.
3. Bring in ancillary information at regional level, even if it is the same as other two levels just scaled. Highlight variations in regions. Identify gaps, limitations and assumptions.
4. For DO and pH make regional statements. For temperature and conductivity, compile state by state and make regional statements.
5. Use the statement templates (Sections 7.2.3.1 Step 6. d & e and 7.2.3.2 Step 4) to formulate the same messages used at local and larger river scales at the regional level. Provide statements on what is good as well as what needs more work, protection and prevention is cheaper and more effective than restoration.

7.3 Recommendations and Conclusions

This is the task of deriving recommendations and/or conclusions from the output of the interpretation process. During the post monitoring season workshop, groups will facilitate a process where all three scales of analyses/findings and interpretations are translated into a set of LEBAF recommendations and (if confidence is high enough) conclusions for all three scales. These outputs will be integrated into information products and plans for communication and delivery. LEBAF participants generated a list of considerations to make when developing recommendations that formed the basis for the process below.

7.3.1 From the Data Itself

A set of recommendations and conclusions that would serve LEBAF's monitoring purpose, data use and targeted users is for ***data screening*** and thus would include:

<u>At a local level:</u>

- "_____ site appears to be meeting standards and in a condition that supports aquatic life uses as per parameter(s) _____. Further data and management actions should protect this functioning condition. Further monitoring might include biological and physical habitat parameters to confirm their condition and if they reflect the same conclusion. Include information about ancillary information relevant to recommendation for example regarding land use, a recent flood, etc." *Note: This statement should be adjusted if the benchmark is a TMDL in order to integrate with existing efforts aimed at bringing this site into use attainment*.

- "_____ site does not appear to be meeting standards and may not be in a condition that supports aquatic life uses as per parameter(s) _____. Further monitoring should be conducted to confirm. In addition, _____ can be inferred from ancillary information."

Note: This statement should be adjusted if the benchmark is a TMDL in order to integrate with existing efforts aimed at bringing this site into use attainment.

- "_____ site has mixed results; some parameters indicate healthy conditions and others oppose. Follow _____ formats and recommendations.

<u>At A Larger River Influence and Direct Tributary:</u>

- At a larger lake scale, where relevant and for what parameters make a recommendation about overall condition at these scales. What can you say and what can't you say?

<u>At a Regional Scale:</u>

- "The quality and conditions of rivers feeding LE, include _____ % that are meeting aquatic life uses. Efforts to protect these watersheds should be retained. They include _____. Conversely, _____ % are not meeting aquatic life uses." Provide a characterization of DO, T, pH and conductivity and develop information products that will illustrate these stories to support recommendations (e.g. actions in this region for further monitoring, restoration, etc.)

7.3.2 Items to consider making recommendations or conclusions:

- Consider generating overall recommendations that then are custom messaged for target audiences, including what information products might be most effective. In addition, consider what actions those data can users employ to help LEBAF move closer to its goals. Primary data users are LEBAF participants. Secondary data users include state agencies, port authorities, Federal EPA, special districts and other stakeholder groups.
- Consider who the recommendations are for and call out specific recommendations for specific target audiences. For LEBAF that is first the participants' constituents, thus recommendations may be to increase their effort and/or actions they can take at local level to protect, restore, etc. Secondary are other decision makers and LEBAF could make a statement as a group to each specific larger basin and state managers within their authority as land or water managers. This message could be used by local groups as well and begins to establish LEBAF as a credible source of information.
- In all recommendations and conclusions it is helpful to integrate why it matters to the target audience of LEBAF groups constituents and language that is appropriate. This might include educating and information on relationships between land uses, water management practices, regulations or similar and their influence on condition or these parameters. Communication and delivery integrates this element but here you might already begin to develop as part of recommendations.
- Conclusions follow the same workflow and need to be transparent about assumptions and limitations in a way recommendations often don't. Each year, LEBAF participants should ask: "What conclusions can we make with what degree of confidence? Are Lake Erie watersheds overall maintaining health, declining, improving, good in this region, not so good over here?"
- Consider bringing other experts, data users, agencies and universities into the interpretation, recommendations and conclusion and messaging process. At a minimum others can review interpretation, recommendations and conclusions if they cannot participate in the process.
- Even if utilizing external partners to help understand the data, LEBAF participants need to be involved and engaged and strategize to utilizing the volunteers to be advocates for the river/watershed "Watershed Leaders"
- Develop a way to involve and engage students in this process, formally or informally

7.3.3 Recommendations LEBAF Participants want to be able to make

These questions and standatements can be reviewed during the Fall information design workshop to explore what recommendations can/should be made within the scope of LEBAFs' purpose and goals.

1. What possible sources and solutions could be investigated or implemented? Create a list of "Stewardship actions" or sources to track/investigate.
2. What is the map of stakeholders (local, state, and regional) and leverage points that LEBAF can target for education, data use and action?
3. What new understanding of rivers' health or condition is appropriate to share with data users, volunteers, etc.?
4. Utilize monitoring as part of Nine Element Nonpoint Source Implementation Strategy (NPSIS) for "Shovel ready" restoration projects.
5. Local interpretations are valuable to integrate into site assessments. Messaging addresses the leap when taking local results to a regional level with credibility and regional assessments to local level. Local and broader trends will vary in significance at the other scale, local groups can make that determination.
6. Gaps and data limitations will be disclosed in interpretation and evaluated in evaluation with recommendations for study design changes next season. This might include overall program changes and/lor recommendations for a specific watershed and/or organization.
7. If possible, in watersheds that have a clear solution that can be implemented on a regional scale, make those recommendations. For example, nutrients in agricultural areas could feed into state policies. Volunteer groups could call for more research into problem areas or comparative studies between areas with rain gardens vs. no gardens. Stronger collaboration with research institutions might be easier to achieve with a larger group. Lawn care policies with no mow months and make native plants available.
8. Places to go to learn more, begin to develop a FAQ or library of actions, or links to stressors and actions, etc. . Maybe a progression from identification of potential problems to potential source evaluation and then activities. Next steps guidance. Steps the public can take to improve water quality/mitigate impacts
9. Identify drivers impacting watershed health (e.g. land use changes, industry).
10. Local, state or other agency could implement additional sampling in watersheds of interest; inform any necessary revisions to sampling protocols.
11. Recommendations to agencies and the public could lead to better protection, restoration, stewardship.

7.4 Information Products and Management (Process and Products to tell the story)

This overlaps with both analyses and interpretation as a particular application might help do the latter and also visualize and communicate results. Information products to employ include the following:

7.4.1 Data Exports

LEBAF made the decision to provide data exports via Water Reporter for LEBAF participants and other data users. Exports include FAIR data standards, naming conventions, standardized recording and reporting protocols, data dictionary and similar best management practices for users to explore what data exists where and export entire the LEBAF database or subsets. In the near future LEBAF desires to import their dataset to other data user portals such as the National Water Quality Portal. Current data

management SOP's and development of an open API for Water Reporter will make providing data to other portals very feasible.

LEBAF will implement the analyses, interpretation, recommendations and conclusions process in the fall at a joint summit after each sampling season. This is when all data will be available for LEBAf participants and other data users.

7.4.2 GIS Station Map Display

LEBAF will produce these two map displays for two different purposes. The first is to find what data exists where and facilitate accessing that data. Second, is to display results (analysis and findings) to support interpretation, recommendations and conclusion**s.**

Display and Access What Exists

- Water Reporter already displays locations, what data is available at each location, when that data was collected and who the collecting organization was.
- Via the map or export menu, offer results by organization, river, LEBAF as a project, parameter, other station ID like HUC or county or ?

Display and Access analyses (not data) - N/% exceedances, metrics, graphs

- Display sites N/% exceedances, by query or not (parameter, all values > X, or?)
- Provide a large river, direct tributary view of results
- Provide a regional view of results
- Download analyses, results, and graphs (vs raw data) with the same GIS interface as above?

7.4.3 Report

- LEBAF will produce a simple annual report, pdf or FAQ that summarizes analysis, findings, interpretation, recommendations, conclusions, methods, assumptions, limitations and gaps each year at all three scales and program information. This format can evolve over time. It will be available on each participant's website as well as LEBAF's. This report outline can be developed over the sample season and populated at fall summit each year.
- Content from the report will be available in bite-size subreport pieces for groups to use in their communication efforts.
- An illustration that shows LEBAF purpose/why, use, users, ROI and summary SOP for technical and information and evaluation designs exist and then how results are making progress toward LEBAF program. This graphic should connect individual groups' work with LEBAF as a whole.
- Spin off FAQ's, smaller information bites could be developed for social media and other uses, by parameter, watershed, group, etc.

7.4.4 Presentation

- LEBAF will host a recorded annual webinar that will serve as a press event to share the results and next steps each season. This is a way to capture and tell success and can include questions and answers for the target audiences.
- A media package with standard elements will be compiled for groups to use in postseason communication outreach, including results, recommendations, program summary and next steps. A standard media packet will be developed with co-branding, images, messaging, communication tools for press release, social media, presentations, etc., with suggestions for World Water Day, Earth Day, other local or state special events or messaging to be identified and put into this plan/packet. This will be developed and disseminated in a way its use can be tracked and evaluated.

- MEDIA blitz for groups that can and do this level of outreach, some have access to billboards and local TV or radio stations.

7.4.5 Coloration, Grade, Report Card or State of condition or state of Lake Erie

LEBAF will not initially pursue any coloration, grading, report cards or qualitative statements about the comparative condition of Lake Erie or its watersheds at this time. Consider the purpose of such an approach, its complimentary or duplication of existing efforts, effort to produce and maintain and what communication needs to accompany this type of system. In general the larger the geography the more challenging it is to find a meaningful label that applies across the region but is not so general it doesn't mean much. Below are thoughts captured by participants at the March 2022 Summit that might prove valuable later.

A local, state and/or regional system could provide a grade and/or color code system that communicates doing well, fair, poor or a similar gradient. This could be achieved in multiple ways:

a. A regional LEBAF determination, gradient system that is applied universally, even if it integrates regional differences.
b. Local analyses based on state standards. For example, LEBAF decides all individual determinations of not meeting DO standards made using state assessment protocols will be the color red, or grade D or equivalent.
c. Using existing report card or coloration schemas and either standardizing their conclusions like b above, or just communicating them without trying to regionalize their findings. This would require creation of multiple report cards and color coding methods.

Other general takeaways from the conversation:

- Report cards produce annual grades or colorations. Report cards are a familiar framework and effective in communicating overall condition, but not so effective in communicating action steps to take or subtle changes happening that show improvement or degradation without changing the grade. They are most effective at the local level or perhaps across a basin with consistent conditions but less useful across a more variable region.
- A more robust regional story method can be developed over time with more data and could be a goal for the future and incentive to collect more data over space and time. This would be an 'annual'' grade, or statement of condition.
- Storyboards are an effective tool. They can take a lot of resources to develop and maintain but are robust with results, graphics, data visualizations, maps and images and text. This may be a more useful approach at the regional scale and a future goal for LEBAF.
- Display sites on map– Does map show summary statistics for each site automatically?

7.4.6 Items to consider from workshop that might be added to 'telling' LEBAF story for greater relevance, connection, use and engagement with target audience:

- Allow space for community messages (almost like a "watershed" letter to the editor)
- Discuss impacts from climate change on a regional scale.
- How do you compare watersheds? Is it important, or even possible, to directly compare watersheds if they are not similar? Perhaps LEBAF should focus on telling each river's story with primary data and ancillary information. This is where report card grades or color ratings are tricky as the conditions that justify an A in one place may or may not be relevant in another. LEBAF could perhaps use grades or colors at local level but tell more of an overall story at the regional scale.

- Atip sheet for local groups on how to use the data further in their states, beyond the direct focus of LEBAF, would be very helpful and could be developed over time.
- Any data products shouldn't become too wordy for the average user. People don't read stuff but they like pictures.
- Russian Nesting Doll of high level to localized information could be a good approach. Utilizing Water Reporter to create region-wide messages on metadata, improved data analysis capacity, and story mapping capabilities that don't duplicate local reporting information could be impactful. Create a temporal benchmark for data and status reporting (e.g. every 5 years).

7.5 Result Delivery and Communication (of the story)

This is the development of messaging that standardizes and delivers results, recommendations and information products to targeted audiences. Just because you have results or products does not mean who you want to use them will indeed use them. This plan allows LEBAF to track the use of results and ROI attributed to that use. Participants are a key component of this plan.

Whatever messages are developed will be integrated into the information products above and made available accordingly. LEBAF participants need to feel they are empowered to own and champion LEBAF's results in addition to building up LEBAF itself as a credible source of information.

7.5.1 Communication and Delivery Plan

1. LEBAF will identify target data users. Primary users are LEBAF participants and secondary users are other decision makers. This sets the stage for measurable results. Current list from workshop includes
    - Primary: LEBAF Organizations
    - Primary: LEBAF Organizations constituents
        - Watershed residents/landowners
        - public officials
        - resources managers/science
        - teachers
        - volunteers
        - program partners
    - Secondary: Clean Water Act Agencies
    - Secondary: EPA Regions
    - Secondary: Port Authorities
    - Secondary: Special Districts: Soil, Water
    - Secondary: Academic Institutions
    - Secondary: International Joint Commission
    - Secondary: Canadian Provinces
2. LEBAF participants will take the accumulated information (data, analyses, interpretation, recommendations and conclusions) generated at all three scales, and create a standard LEBAF message. Credible, consistent and predictable (timing and format) messaging from LEBAF will help local groups have more credibility and leverage in their work. This message will also include:
    a. Program Information: outputs, who participated, number of participants, stations, samples, river miles, etc. metrics.
    b. Monitoring purpose/why, data uses and data users - telling users what LEBAF is doing and what LEBAF is not doing
    c. Methods in technical design including QA/QC
    d. Assumptions and limitations

3. Integrate the message into LEBAF website, annual report and webinar, media package and Water Reporter exports. Messaging can and likely will include results from annual evaluation workshop.
4. Design a communication and outreach plan for the Message based on targeted data users' information needs. The outcomes of this plan should be tracked to document any use of the message and results of that use, helping to build stakeholder relationships if possible. LEBAF's goal is to get regional messages to state and local decision makers and a local message to the state and regional level while communicating the value of data and community science. At a minimum outreach will include:
    a. A message to external partners on results, conclusions, next steps, and how to stay involved at each scale of analysis. This should include the fact that that data is available and instructions on how to access it.
    b. A message to participants on their successes, contributions to greater collective impact, and role in advancing the health of Lake Erie watersheds. Suggestions for how participants share success stories (e.g. post a report on a website with this message, use FAQ, etc.) that highlight how LEBAF is driving progress towards shared goals (e.g. As a screening tool LEBAFs results suggest….). This could include a template presentation of sources/solutions that everyone can pull from.
    c. Program Managers can take 'a' above and use it to create a message for volunteers, students, farmers, and other community members. Identify target community groups and develop standard messaging as part of the fall workshop. This message can focus on the regional story and local groups focus on local story
    d. Messages should be able to integrate into local groups existing information products for easy communication to their own constituents.
    e. A message to (potential) funders on the impact and value proposition of the work.
    f. Consider a predictable credible messaging event (press release day and/or an annual meeting) for LEBAF to release reports that others can look forward to each year.
    g. A standard media packet with co-branding, images, messaging, communication tools for press release, social media, presentations, etc. , with suggestions for World water Day, Earth Day, other local or state special events or messaging to be identified and put into this plan/packet. This will be developed and disseminated in a way its use can be tracked and evaluated.
5. Ideas from workshop
    a. Have a summit for participants to develop recommendations and/or a public summit to either integrate feedback on recommendations OR to communicate results that folks from the region could participate
    b. Fold message into existing messaging efforts like annual algae bloom forecast, identify those and make part of plan
6. Relevance Check
    a. Now that we have a list of Information products, ask yourself does this combination of products serve the range of data users LEBAF wants to reach?
    b. Is there a delivery plan for each target data user?
    c. How will you measure each data users 'use' and the result of their use?
    d. What resources are available to implement this plan, staff at CWE, LEBAF workgroup and among participants?

7.6 Data Attribution

LEBAF will acknowledge the volunteers and organizations providing the data. LEBAF will do this via:

1. Water Reporter exports and data visualization products tie all results to organization, in that way every result is attributed to the provider of that result who is responsible for its quality.
2. Water Reporter generates a real time aggregation dashboard. Once set up, it auto-populates with QA data. What is illustrated here is a summary of data generated by organization, a performance report from MOU criteria or perhaps something else. This might be a future goal.

7.7 Roles and Responsibilities

Each participating organization, as part of their agreement, will enter and validate their data in Water Reporter, following all data management and system SOPs. Each organization also agrees to participate in the fall information design summit to support development of messaging and outreach based on analyses, interpretation, recommendation and conclusions steps at local, larger river and regional scales. Furthermore, each organization is encouraged to use the data for data purposes and uses to meet their own organization ROI's appropriately and share those stories with LEBAF as part of joint success.

Chapter 8 - Evaluation Design

8.1 Roles, Responsibilities and Capacity of all participants

Every post monitoring season, in addition to the information design workshop, LEBAF participants will gather to implement this evaluation design. This process is part of all participants' ownership of LEBAF and will be organized and facilitated by the Standards Working Group.

In addition to evaluating each sample event for accuracy, precision, reproducibility and consistency, this annual workshop will evaluate the overall results of that sampling season and program implementation. In addition, participants will engage in evaluation of priorities and additional parameters or standardization elements to develop for the next season. These changes will be documented in a revised edition of this document (LEBAF SOP) and communicated to participants by the Working Group.

The following provides an outline for the evaluation workshop that can be further refined as the actual agenda is developed. This can happen in person or virtually in one session or over several. It is important to identify what needs to be completed when and by whom so this step does not sneak up on the group during field season. Participation is integrated into the participant agreement and is an important element for all participants to engage in to retain the ownership, relevancy and direction of the program.

8.2 Implementation Evaluation

This focuses on evaluating the success of this year's implementation of the current study design. It should assess how well the technical and information designs served LEBAF's monitoring purpose, data uses, and targeted data users to make progress towards intended outcomes and impacts.

8.2.1 Purpose /Why Design - Monitoring purpose, data use, data users, results, outcomes and impacts, including monitoring questions.

Steps LEBAF will move through at the summit include the following.

1. From previous SOP sections gather the answers to the above categories - what was the monitoring purpose, etc.
2. Do these program elements capture our goals as a collaboratives? What changes or alterations (if any) should be made?

8.2.2 Technical Design - Did we generate sufficient data and manage that data effectively?

3. Gather statistics for the technical design. How many orgs, stations, sample events, etc,?
4. Gather a summary of performance criteria per organization.
5. In small groups, participants review the implementation elements and answer the following questions:
    a. Was training for each parameter adequate? What needs to change?
    b. What issues were experienced with the tools and equipment? What went well?
    c. What issues did we have with site access and sample frequency? What went well? Was it too much? Should we do more (frequency, sites)?
    d. Was QA sufficient? Did we catch sampling, equipment and data management errors and effectively respond (fix, qualify, delete, etc.)?
    e. Was data recording effective? What issues, workflow improvements, missing or erroneous information should we address?
6. Summarize recommendations for improvements to the existing technical design

8.2.3 Information Design - Did we answer our monitoring question, produce, deliver and communicate Information?

7. Data was analyzed and interpreted at three scales. Reflect on that process and result and summarize any challenges, barriers, needs, etc. (can be technical, data limitations, system limitations or needs, etc.)
8. Recommendations and conclusions were developed. Reflect on that process in the context of our shared purpose, data uses, users and intended impact. Summarize any aspects that went well or should be improved.
9. Data was transformed into information products and then communicated/delivered to stakeholders. Review the effectiveness of **each** information product and communication process against a list of targeted users and the intended LEBAF purpose, data uses, data users, and impacts. Did the users get information? How do I know? Summarize what needs to change.
10. Review how data/information was used. What was the result? Go through a list of targeted users and summarize success stories. If information was not used, why not? What is missing that LEBAF could change? How did we answer our monitoring questions by scale, by user/use and result? Summarize.
11. ID sites found for protection, further restoration, monitoring or equivalent based on information design results, recommendations, etc.
12. Summarize recommendations for improvements to the existing technical design

8.2.4 Evaluation of Implementation

13. Combine all summaries in context with Program/Why and evaluate what components needs to evolve (i.e. different purpose, different use, users and or ROI's). Document.
14. Craft an overall summary of implementation including successes, failures, and changes. Update program assumptions and changes that occurred over the year, expected and unexpected. This is a standard message for LEBAF to communicate about the program.

8.3 Program Evaluation - Participation, engagement, performance, structure, outputs, outcomes, gaps

Steps and metrics LEBAF will gather to communicate program participation, performance and growth.

1. Number of organizations that year and geographic gaps in coverage
2. Number of sites sampled that year and geographic gaps in coverage
3. Number of samples / results generated that year and gaps in coverage
4. Number of repeat organizations that year
5. A metric of coverage in the LE Region, river miles, % of watersheds, etc. identify a metric that expressed spatial coverage, gaps
6. ID sites found for protection, further restoration, monitoring or equivalent based on information design results, recommendations, etc. Bring forth information from design buckets relevant here.
7. Evaluation of organization performance, what did all groups miss, what needs to be adjusted, etc, document, adjust MOU, SOP, etc.
8. Each organization reports how they used the data within the LEBAF plan and beyond. What went well, didn't, needs?
9. Evaluation of organization experience, do you feel more confident in data, data matters more, identify questions and ask
10. Evaluation of organization structure, workgroups, responsibility, roles and capacity and workflows, meeting frequency, length, topics, training, documentation, etc. Note what went well and what needs adjustment.
11. Overall statements about LEBAF and its progress toward its mission and ROI's.

8.4 Success Stories

This is a separate document which can be an appendix to the SOP and is a list of LEBAF success stories within each Study Design Bucket and participating organization. The goal is to capture stories for each measurable data use impact as well as overall progress toward LEBAF goals. This "diary" of success stories can include statistics as well as anecdotal or text characterizations that accumulate over progessive years of program operation. LEBAF could choose to develop a template of categories to include, drawing from the above sections and more.

8.5 Prioritization, Threats and Opportunity and System Review Evaluation

Steps LEBAF will take at evaluation workshop include:

1. Before the workshop, gather a list of threats and opportunities from LEBAF participants and external partners that cover changes in technology, funding, partnerships, capacity, resources, policy, events and other elements that impact program operation.
2. Compile and bring this list to the workshop so that participants can consider and evaluate each category in context with LEBAF goals and capacity. The result of this process should be a set of adaptations to these new factors for LEBAF to consider integrating into Study Design.
3. A separate workshop session will include reviewing the standardization menu and devising a review and input process to identify LEBAF's next priority for additional standardizations to develop over the winter. The result will be adding new items and a re-ranking of existing items with inclusion of new items.

8.6 Messaging and Outreach - Capturing and Telling Success

This message and outreach can be integrated into the Communication and Delivery plan but it is important to distinguish the difference. This message is not just about results but about the broader collaboration and its overall goals, desired results, outcomes and impacts. At the workshop, groups can brainstorm and capture the kind of messaging and outreach needed to:

1. Update existing partners on all LEBAF Study Design and program changes (see above section)

2. Communication to key participants and key stakeholders on the overall program

Update and share with LEBAF participants and external partners about LEBAF as a program. This is a combination of the above sections' stories, spun into a communications plan that is targeted more toward recruitment, retention and establishing LEBAF as a viable credible resource. **This should be integrated with the Communication and Delivery plan as well as all relevant information products.**

8.7 Design Adjustment, Documentation and Master Task Timeline

1. This task takes summaries and recommendations from all previous sections and decides what will actually be updated and changed in the LEBAF Study Design. This will be summarized and documented as an SOP appendix including updating assumptions.
2. A final review of LEBAF systems and structures. If the functions of LEBAF evolve, then its structure, roles, and workflows may need to evolve as well. Review and make recommendations.
3. A master plan and timeline of tasks, will be developed with deadlines and responsibilities, including updating all relevant documentation, tools and information. All components and documentation of this plan will be housed in THIS GOOGLE DRIVE. This checklist is a start:
    a. SOP and associated user manuals
    b. Data Manager Manual
    c. State Standards and Benchmarks
    d. Participant Agreement
    e. Performance Tracking Metrics
    f. Onboarding trainings
    g. Webpage links and content
    h. Water Reporter software, functions, content
    i. Information products, processes
    j. Outreach and messaging
    k. LEBAF structure, communication and decision process
4. Messaging, communication plan to update LEBAF participants and key external partners

Chapter 9 - Appendices

9.1 A Word on "Citizen" vs. "Community" vs. "Volunteer" Science

Since its inception, the movement of scientific research led or supported by nonprofessional volunteers has been referred to by many names. Over the years, this movement has contributed significant findings in fields as diverse as ornithology, epidemiology, and art history. The advent of modern digital tools has dramatically expanded the movement, prompting increased interest from professional researchers, government officials, and private industry. Increased institutional engagement has resulted in exciting opportunities for growth across the movement, as well as a growing consensus around the term "Citizen Science," which became enshrined in US federal law by the "Crowdsourcing and Citizen Science Act" of 2016.

Given the charged nature of citizenship in US public discourse, many participants in the movement have begun to criticize the term "Citizen Science" as a barrier to inclusive participation, resulting in a growing trend of rebranding the work as "Community Science". This debate was further complicated by the 2021 publication of "Inclusion in Citizen Science: The Conundrum of Rebranding" which observes that "Community Science" is already an established term that refers to research that is not only executed by local residents, but is directly led by them and shaped by their priorities/challenges (for example a health study precipitated by grassroots activism in response to a local environmental injustice). This draws a

critical distinction between "Community Science" and our movement, which is typically organized by an institution, whether academic, nonprofit, or governmental.

While there is no “correct” approach to naming our movement, the members of LEVSN feel it is important to approach branding with intentionality, both signaling our commitment to equity and ensuring we are not co-opting terms used by more grassroots work. For these reasons, we have opted to refer to our work as “Volunteer Science” and the participants in the work as “Volunteer Scientists.” We assert that this work is fully aligned with common definitions of “Citizen Science” used in existing policy, programs, and funding opportunities. We also acknowledge that branding, no matter how well positioned, is far from sufficient to ensure a truly community-centric movement. For this reason, LEVSN commits to creating an “Equity Working Group” that will explore how we can more substantively center the needs and voices of marginalized communities in our programming and decision making. Our goal is to contribute to a more just, equitable, and inclusive future for all Lake Erie residents.

9.2 Lake Erie Baseline Assessment Framework – Participant Agreement

Cleveland Water Alliance and **_____** enter into an agreement for participation in the Lake Erie Baseline Assessment Framework for the time period of: 05/01/2022 to 01/31/2023

To enable the participating group named above (“participant”) to take part in LEBAF, CWA will furnish the set of resources described in List A. In exchange, the participant will fulfill the expectations outlined in Lists B, C, and D. The participant acknowledges its intent to meet all the responsibilities described and understands that failure may jeopardize program eligibility in future years. The allotted resources will remain accessible to the participant so long as; 1) Items in Lists B, C, and D are satisfactorily completed and 2) this agreement and its future iterations are renewed by both parties annually.

This Agreement shall be governed by and enforced in accordance with the laws of Ohio without regard to conflicts of law principles or either party being domiciled in a state other than Ohio. The activities defined herein will positively impact the State of Ohio by filling key data gaps needed to accelerate efforts to advance the health of the Lake Erie Basin and its communities.

List A – The Participant will receive the following for the agreement year:

1. **X** (number to be determined based on participants’ needs and availability) YSI ProDSS Multiparameter Water Quality Meters or YSI ProQuattro Handheld Multiparameter Meters with associated cables and water quality sensors to be loaned to the participant for the duration of this agreement and its future iterations. Participant may use loaned meters for any other monitoring purposes so long as the expectations of this agreement are fulfilled. Responsible care and operation of loaned meters is the full responsibility of the participant, though CWA may provide limited assistance in the form of calibration materials, insurance coverage, and annual servicing.

2. Data management and visualization services through pre-paid access to Water Reporter Pro.

3. Lake Erie Baseline Assessment Framework (LEBAF): A Standard Operating Procedure Manual that provides standardization across all study design elements to serve the network’s common monitoring objectives.

4. data manager manual (DMM): A user guide for data and metadata management in Water Reporter.

5. Technical support through Fondriest (for YSI water meters) and The Commons (for Water Reporter)

6. General program support through CWA and the Lake Erie Volunteer Science Network (LEVSN)

7. Validated data, analyses, messaging, and outreach at the Lake Erie scale shared across the network.

8. Annual program evaluation and evolution to facilitate and grow greater collective impact

List B – Core Performance Criteria:

1. Site Identification: Participant will select and register all intended monitoring stations for 2022 in Table 1 below and document relevant details and metadata in Water Reporter as described in LEBAF.

Table 1: Participant will monitor the following station(s) at the indicated frequency throughout the 2022 field season (a minimum of one station sampled one time per month from Aug- Oct is required for participation)

Station Name	Station ID	River Name	Sample Frequency/month (March-Oct.)
1.			Min 1 time per month per station
2.			1, 2, 3, other_____
3.			1, 2, 3, other_____
4.			1, 2, 3, other_____
5			1, 2, 3, other_____
6			1, 2, 3, other_____
7			1, 2, 3, other_____
8			1, 2, 3, other_____

2. Data Collection: Participant will collect conductivity, dissolved oxygen, pH and water temperature readings ("standardized results") at each registered station at least once per month from July to October 2022. Flexibility will be allowed depending on weather and availability of monitoring equipment.

3. Quality Assurance: Participant will collect standardized results using probe-based methods that meet the LEBAF standards. Any probe(s) used must be approved by CWA before data is entered into Water Reporter.

4. Quality Control: Participant will calibrate any probes used to collect standardized results using the instrument manufacturer's recommendations and follow LEBAF guidelines for documenting calibrations and taking appropriate steps for unsuccessful calibrations.

5. Data Validation and Management: Participant will record all standardized results in Water Reporter within one week of each sampling trip. Each standardized result must follow LEBAF data validation steps for data entry and workflow to the repository, including recording all metadata standards detailed in LEBAF and DMM. This provides predictable quality of information in a consistent format validated and ready for analyses.

6. Group Calls: Participant will attend monthly calls to contribute to ongoing coordination conversations as well as post monitoring season information and evaluation sessions designed to evolve the program for 2023.

7. Kick-Off Training: Three live virtual training sessions (1. Kickoff and Study Design 2. Data Management and Visualization 3. Sampling Method and QA/QC) will be made available to participants throughout June and July of 2022. Participant will attend at least two of three virtual trainings live and review the recording of any missed trainings before monitoring begins.

8. Transparency: Participant agrees to maintain a primary contact responsible for this agreement and will notify CWA of any change in activity status (access or damage to equipment, name or address change, and station location or frequency changes) within 30 days and keep a current agreement with CWA.

9. Communications: Participant will coordinate with CWA on any related media engagement and designate a website landing area to allow for easy navigation from the shared LEVSN web page.

List C - Compliance and Accountability:

1. Participant's performance will be evaluated annually based on the above criteria. Failure to fulfill all required responsibilities may jeopardize participation in the program as determined by CWA.

2. Optional renewal of this agreement will be requested on an annual basis between Nov and Jan.

3. Fulfillment of performance criteria may be subject to audit by CWA within the duration of this agreement.

4. Participant must notify CWA within 30 days of being unable to accomplish any of the above criteria.

5. This agreement may be terminated by either party, with cause, with at least 30 days advance written notice.

6. Participants will arrange for any loaned equipment to be returned to CWA upon termination by either party. Failure to comply within 30 days may result in the participant being invoiced for full value of the equipment.

7. This agreement does not supersede any other agreement between the Participant and CWA.

List D – Waiver & Indemnification:

Participant understands and acknowledges that participation in LEBAF poses risk for personal injury and property damage due physical activities which may be strenuous. Participant hereby assumes any and all of the risks of participating in LEBAF. Participants acknowledge that the personnel participating in LEBAF from the participant group are physically and psychologically fit for the activities of LEBAF and have not been advised otherwise.

In consideration of the participant's involvement with LEBAF:

(A) Participant waives, releases, and discharges CWA, and its stakeholders, from any and all liability for any personal injury, property damage, or damages of any kind which may arise out of participation in LEBAF; and

(B) Participant shall reimburse CWA, and its stakeholders, for any and all losses, damages, injury, expenses (including reasonable attorneys' fees), or claim arising from or related to participation in LEBAF or this Agreement, including without limitation, damage beyond insurance coverage caused by the participant to equipment described in List A - except those caused solely by the negligence or willful misconduct of CWA.

The obligations under List D shall survive for a period of two years from the expiration or termination of this agreement.

By signing below, CWA certifies that they will furnish the benefits described in List A and the participant certifies that they will fulfill the duties described in Lists B and C as well as the provisions in List D.

_____ _____

For Participant Date For Cleveland Water Alliance (CWA) Date

Participant Organization Mailing Address:

_____

Participant Organization General Email and Phone Number

_____

Participant Point of Contact Email, and Phone Number

Please return form with required signatures to Cleveland Water Alliance 6815 Euclid Ave, Cleveland, OH 44103