



MassDEP

**Massachusetts Department of Environmental Protection
Bureau of Water Resources
Division of Watershed Management
Watershed Planning Program**

STANDARD OPERATING PROCEDURE

Targeted Assessment Monitoring Program
Field Operations Manual
Lakes

CN 584.1

06/09/25 – 06/09/27

Revision Date: 02/25/25

Prepared and

Approved by:

/s/ James Meek

James Meek, Environmental Analyst

Date: 2/25/25

Approved by:

Jasper Sha

Jasper Sha, Quality Assurance Analyst

Date: 6/9/25

Approved by:

Shervon DeLeon

Shervon DeLeon, Water Quality Monitoring Section Chief

Date: 5/5/25



List of Revisions

Revision Date	Revision	Pages #s	CN / (Old CN if applicable)	Initials
01/28/25	Minor revisions to account for SOP adjustments over the last two years.	Multiple pages	CN 584.1/584.0	JM
02/19/25	Minor revisions based on staff (TB) comments or suggested edits.	Multiple pages	CN 584.1/584.1	JM

Note: This Field Operations Manual is adapted from the field operating procedures developed and followed in the 2012 National Lakes Assessment conducted by USEPA (USEPA, 2011). The formatting of this manual is modeled on USEPA manual and some sections (e.g., Benthic Macroinvertebrate Assemblage) where technical details (e.g., operational procedures) are relevant are taken nearly verbatim from the USEPA manual.



Table of Contents

LIST OF TABLES	8
LIST OF FIGURES.....	8
ACRONYMS.....	9
1. BACKGROUND.....	10
1.1. PRIORITIZATION OF WATERBODIES	10
1.2. SELECTION AND DESCRIPTION OF SURVEY INDICATORS	12
1.2.1. <i>Aquatic Life Use</i>	12
1.2.1.1. Phytoplankton Assemblage	12
1.2.1.2. Macroinvertebrate Assemblage	12
1.2.1.3. Vertical Profile Measurements	13
1.2.1.4. Chlorophyll-a	13
1.2.1.5. Non-native Species	13
1.2.1.6. Water Chemistry (including nutrients)	13
1.2.2. <i>Recreational Uses</i>	13
1.2.2.1. Macrophyte Cover and Biovolume	14
1.2.2.2. Secchi Disk Transparency.....	14
1.2.2.3. Pathogens	14
1.2.2.4. Cyanobacteria	14
1.2.2.5. Aesthetic Condition.....	15
1.2.3. <i>Fish Consumption Use</i>	15
1.2.3.1. Metals	15
1.2.4. <i>Lake and Habitat Characterizations</i>	15
1.2.4.1. Physical Littoral Habitat	16
1.2.4.2. Human Disturbance	16
1.2.4.3. Bathymetry	16
2. LOGISTICS.....	17
2.1. ROLES AND CONTACT INFORMATION	17
2.2. KEY INFORMATION AND SUPPLIES	19
2.2.1. <i>Lake Dossiers</i>	19
2.2.2. <i>Survey Schedule</i>	19
2.2.3. <i>Forms</i>	19
2.2.3.1. Field Sheets	19
2.2.3.2. Chain of Custody	20
2.2.3.3. Field Operations Manual.....	21
2.2.4. <i>Electronic Field Data</i>	21
3. SAFETY AND HEALTH	22
3.1. GENERAL CONSIDERATIONS.....	22



3.1.1.	<i>Recommended Training</i>	22
3.1.2.	<i>Communications</i>	22
3.1.3.	<i>Personal Safety</i>	22
3.2.	SAFETY EQUIPMENT	23
3.3.	SAFETY GUIDELINES FOR FIELD OPERATIONS	23
4.	BASE SITE ACTIVITIES	25
4.1.	PRE-SURVEY PREPARATION	25
4.1.1.	<i>Equipment</i>	25
4.1.1.1.	Check Lists	25
4.1.1.2.	Multiprobes	30
4.1.1.3.	Deployment Sondes	30
4.1.1.4.	Survey Kits	30
4.1.1.5.	Boats and Motors	31
4.1.1.6.	Quality Assurance and Quality Control Sampling for Field Activities	31
4.2.	POST-SURVEY ACTIVITIES	32
4.2.1.	<i>Sample Handling</i>	32
4.2.2.	<i>Field sheets and COC Forms</i>	33
4.2.3.	<i>Cleaning & Decontamination</i>	34
4.2.3.1.	Post-Survey Equipment Cleaning/Decontamination (non-pressure washing)	34
4.2.3.2.	Post-Survey Equipment Cleaning/Decontamination (using pressure washing)	34
4.2.3.3.	Shipping Samples	34
5.	INDEX SITE SURVEYS	34
5.1.	LOCATING THE INDEX SITE	35
5.2.	CONTINUOUS TEMPERATURE AND DO VERTICAL PROFILES	35
5.2.1.	<i>Summary of Method</i>	35
5.2.2.	<i>Equipment and Supplies</i>	36
5.2.2.1.	Deployment Sondes	37
5.2.3.	<i>Vertical Profile Deployment Procedure</i>	37
5.3.	DISCRETE TEMPERATURE, DO, PH AND CONDUCTIVITY VERTICAL PROFILES	39
5.3.1.	<i>Summary of Method</i>	39
5.3.2.	<i>Equipment and Supplies</i>	39
5.3.2.1.	Multiprobe Sonde	40
5.3.3.	<i>Discrete Vertical Profile (No Sondes Deployed)</i>	40
5.3.3.1.	Index Site and Index Site Profile Field Sheets	40
5.3.3.2.	Vertical Profile Procedure	41
5.3.4.	<i>Discrete Vertical Profile (Sondes Deployed QA/QC Check)</i>	42
5.3.4.1.	Lake Vertical Deployment Field Sheet	42
5.3.4.2.	Vertical Profile Procedure	43
5.4.	SECCHI DISK TRANSPARENCY	44
5.4.1.	<i>Summary of Method</i>	44



5.4.2.	<i>Equipment and Supplies.....</i>	45
5.4.3.	<i>Procedure for Determining Secchi Disk Transparency.....</i>	45
5.5.	WATER SAMPLE COLLECTION AND PRESERVATION	46
5.5.1.	<i>Summary of Method.....</i>	46
5.5.2.	<i>Equipment and Supplies.....</i>	47
5.5.3.	<i>Sampling Procedure.....</i>	48
5.6.	CHLOROPHYLL-A AND PHYTOPLANKTON ASSEMBLAGE.....	50
5.6.1.	<i>Summary of Method.....</i>	50
5.6.2.	<i>Equipment and Supplies.....</i>	50
5.6.3.	<i>Sampling Procedures</i>	51
5.7.	CONDITION OBSERVATIONS	53
5.7.1.	<i>Summary of Method.....</i>	53
5.7.2.	<i>Equipment and Supplies.....</i>	53
5.7.3.	<i>Sampling Procedures</i>	53
6.	LITTORAL SURVEYS.....	55
6.1.	LOCATING AND ESTABLISHING THE LITTORAL ZONE PLOTS.....	55
6.1.1.	<i>Ambiguous Shorelines.....</i>	56
6.1.2.	<i>Altered Shoreline.....</i>	56
6.1.3.	<i>Littoral Zone Station Inaccessible</i>	57
6.2.	PHYSICAL LITTORAL HABITAT CHARACTERIZATION.....	57
6.2.1.	<i>Summary of Method.....</i>	57
6.2.2.	<i>Equipment and Supplies.....</i>	57
6.2.3.	<i>General Observations</i>	57
6.2.4.	<i>Substrate Characteristics</i>	58
6.2.5.	<i>Macrophyte Cover.....</i>	59
6.2.6.	<i>Fish Cover.....</i>	59
6.2.7.	<i>Human Influences</i>	60
6.3.	BENTHIC MACROINVERTEBRATE ASSEMBLAGE	60
6.3.1.	<i>Summary of Methods</i>	60
6.3.2.	<i>Equipment and Supplies.....</i>	61
6.3.3.	<i>Sampling Procedure.....</i>	61
6.3.3.1.	Site Selection and Sample Collection.....	61
6.3.3.2.	Sample Processing in the Field	62
6.3.3.3.	Benthic Macroinvertebrate Sampling.....	62
6.3.3.4.	Preparing Composite Samples	63
7.	SHORELINE SITE SURVEYS	64
7.1.	SELECTING AND LOCATING THE SHORELINE SITE	64
7.2.	WATER SAMPLE COLLECTION AND PRESERVATION	65
7.2.1.	<i>Summary of Method.....</i>	65



7.2.2.	<i>Equipment and Supplies</i>	65
7.2.3.	<i>Sampling Procedures</i>	65
7.3.	CONDITION OBSERVATIONS	66
7.3.1.	<i>Summary of Method</i>	66
7.3.2.	<i>Equipment and Supplies</i>	66
7.3.3.	<i>Sampling Procedures</i>	67
8.	WHOLE LAKE SURVEYS	68
8.1.	MACROPHYTE SURVEY	68
8.1.1.	<i>Summary of Method</i>	68
8.1.2.	<i>Equipment and Supplies</i>	69
8.1.3.	<i>Depth, Biovolume and Percent Cover Measurement Procedure</i>	69
8.1.4.	<i>Dominant Macrophyte Species Identification Procedures</i>	71
8.2.	GENERAL LAKE ASSESSMENT	73
8.2.1.	<i>Lake/Catchment Site Activities and Disturbances</i>	73
8.2.2.	<i>Overall Waterbody Character</i>	74
8.3.	FISH TISSUE	75
8.3.1.	<i>Summary of Method</i>	75
8.3.2.	<i>Equipment and Supplies</i>	75
8.3.3.	<i>Sampling Procedures</i>	76
8.3.3.1.	Electroshocking Boat.....	77
8.3.3.2.	Gill Net	77
8.3.3.3.	Trotlines	77
8.3.3.4.	Traps.....	77
8.3.3.5.	Angling	78
8.3.4.	<i>Sample Processing</i>	78
8.3.4.1.	Sample Login	78
8.3.4.2.	Filleting.....	78
8.3.4.3.	Partitioning, Packaging, and Labeling	78
9.	DECONTAMINATION FOR INVASIVE SPECIES	79
9.1.	OVERVIEW	79
9.2.	WATERCRAFT (BOATS, MOTORS, AND TRAILERS).....	79
9.2.1.	<i>Summary of Method</i>	79
9.2.2.	<i>Equipment and Supplies</i>	79
9.2.3.	<i>Decontamination Procedures</i>	80
9.3.	OTHER EQUIPMENT	80
9.3.1.	<i>Summary of Method</i>	80
9.3.2.	<i>Equipment and Supplies</i>	80
9.3.3.	<i>Decontamination Procedures</i>	80
10.	LITERATURE CITED	82



APPENDIX A: SEVEN-YEAR FLEXIBLE WATERSHED MONITORING SCHEDULE	83
APPENDIX B: EXAMPLE LAKE DOSSIER	92
APPENDIX C: EXAMPLE WEEKLY SCHEDULE	99
APPENDIX D: FIELD SHEET	101
APPENDIX E: CHAIN OF CUSTODY FORMS	128
APPENDIX F: QUICKGUIDE FOR FIELD USE OF YSI EXO SONDE AND LOGGER	130
APPENDIX G: BIOBASE QUICK REFERENCE	133
APPENDIX H: SONAR TRANSDUCER MOUNTING GUIDANCE	137



LIST OF TABLES

Table 1.1 Prioritization categories for Targeted Assessment Monitoring.....	11
Table 1.2 Summary of indicators	16
Table 1.3 Contact information	18
Table 2.1 Electronic field data uploads and devices.....	21
Table 4.1 Equipment checklist – All surveys	26
Table 4.2 Equipment and supplies – continuous temperature and DO vertical profiles – Index Site	26
Table 4.3 Equipment checklist – Index site surveys – Water Sample Collection	27
Table 4.4 Equipment checklist – Shoreline site surveys	28
Table 4.5 Equipment checklist – Littoral surveys (macroinvertebrate, littoral habitat) surveys	28
Table 4.6 Equipment checklist – Whole Lake (Macrophyte) surveys.....	29
Table 4.7 Equipment checklist – Whole Lake (Fish tissue) surveys.....	29
Table 4.8 post-survey sample handling	32
Table 5.1 Equipment and supplies – continuous temperature and DO vertical profiles	36
Table 5.2 Equipment and supplies – discrete temperature, DO, pH and conductivity vertical profiles	39
Table 5.3 Equipment and supplies – Secchi disk transparency	45
Table 5.4 Equipment and supplies – water sample collection	47
Table 5.5 Equipment and supplies – chlorophyll-a and phytoplankton sample collection	51
Table 5.6 Equipment and supplies – visual semi-quantitative observations (Index site)	53
Table 6.1 Equipment and supplies – visual semi-quantitative observations	57
Table 6.2 Equipment and supplies – benthic macroinvertebrate collection	61
Table 7.1 Equipment and supplies – <i>E. coli</i> samples	65
Table 7.2 Equipment and supplies – visual semi-quantitative observations (shoreline site)	66
Table 8.1 Equipment and supplies - aquatic macrophyte survey	69
Table 8.2 Site activities and disturbances observed during macrophyte survey	73
Table 8.3 Aesthetic score descriptions	75
Table 8.4 Equipment and supplies – fish tissue collection and processing.....	75
Table 8.5 Target species list.....	76

LIST OF FIGURES

Figure 5.1 Diagram of a vertical profile deployment (Stamp 2020)	36
Figure 5.2 Secchi disk diagram (USEPA 1991).....	45
Figure 5.3 Van Dorn samplers.....	47
Figure 5.4 Depth integrated samplers	51
Figure 6.1 Location of the littoral plot in relation to the shoreline, drawdown zone and riparian zone. ..	55
Figure 6.2 Standard kick net (500 µm) used for collecting benthic macroinvertebrates.....	61
Figure 6.3 Example of label to be placed in containers with benthos samples	62
Figure 8.1 Sonar transducer mounting clamps.....	70



ACRONYMS

Acronyms	Definition	Acronyms	Definition
° C	Degrees Celsius	MassDEP	Massachusetts Department of Environmental Protection
° F	Degrees Fahrenheit	MDFW	Massachusetts Division of Fisheries and Wildlife
AED	Automated Electronic Defibrillation	mL	milliliters
AU	Assessment Unit	NHD	National Hydrographic Dataset
CALM	Consolidated Assessment and Listing Methodology	NLA	National Lake Assessment
cm	centimeters	NM	Narrow mouth
CN	Control Number	NPDES	National Pollutant Discharge Elimination System
COC	Chain of Custody	OWMID	Office of Water Management Identification
CPR	Cardiopulmonary Resuscitation	PC	Personal Computer
CWF	Coldwater Fishery	PCB	Polychlorinated biphenyl
DDT	Dichloro-diphenyl-trichloroethane	PFD	Personal floatation device
DI	Deionized	POI	Point of interest
DO	Dissolved oxygen	PPE	Personal protective equipment
DOC	Dissolved organic carbon	PSI	Pressure per square inch
<i>E. coli</i>	<i>Escherichia coli</i>	PVC	Polyvinyl chloride
EDGE	EQulS Data Gathering Engine	QA	Quality assurance
EQulS	Environmental Quality Information System	QAPP	Quality Assurance Project Plan
GIS	Geographic Information Systems	QC	Quality control
GPS	Global Positioning System	RMN	Regional Monitoring Networks
GRTS	Generalized Random Tessellation Stratified	SOP	Standard operating procedures
HAZMAT	Hazardous material	SWQS	Surface water quality standards
H ₂ SO ₄	Sulfuric acid	TAM	Targeted Assessment Monitoring Program
H ₃ PO ₄	Phosphoric acid	TMDL	Total Maximum Daily Load
HDPE	High-density polyethylene	µm	micron
HNO ₃	Nitric acid	UPS	United Parcel Service
HS	Hydrogen sulfide	USEPA	United States Environmental Protection Agency
ID	Identification	USGS	United States Geological Survey
L	liters	WES	Senator William X. Wall Experiment Station
LIMS	Laboratory Information Management System	WM	Wide mouth
m	meters	WPP	Watershed Planning Program
MassDCR	Massachusetts Department of Conservation and Recreation		



1. BACKGROUND

This manual describes field protocols and daily operations for crews to use when monitoring lakes as part of the Massachusetts Targeted Assessment Monitoring Program (TAM). TAM is a component of the Massachusetts Department of Environmental Protection (MassDEP) Watershed Planning Program (WPP) surface water monitoring strategy that uses deterministic sampling designs to assess designated uses in priority assessment units (AU) or waterbodies. TAM is implemented on a seven-year rotating basin (watershed) schedule and includes both lake and river components. This manual is specific to the lake component of TAM; the river component is discussed in other documents. Additional information regarding the seven-year rotating basin schedule is provided in Appendix A. The primary objectives of the TAM include:

- Prioritize AUs or waterbodies for monitoring.
- Assess designated uses (*Aquatic Life Use*, *Recreational Use*, and *Fish Consumption Use*) in priority lakes.
- Assess potential stressors impairing aquatic life, recreation, and fish consumption uses in priority lakes.

TAM was designed to be completed during the summer (May through September). Staff will collect a variety of measurements and indicators from: an index site located at the maximum depth point of the lake; a shoreline site located at a point of public access (e.g., beach or boat access); multiple sites in the littoral zone; and the entire lake for certain indicators. All the indicators and measurements, as well as their associated sampling and analysis methodologies, were selected to meet the primary assessment objectives of TAM.

1.1. Prioritization of Waterbodies

Lakes within each river basin rotation cohort are evaluated to determine the appropriate prioritization category as described in Table 1.1. The evaluation is based on several sources of information including historical monitoring data, landscape data (e.g., land use, impervious cover), assessment methodology, and pollution control strategies. Based on the assigned priority categories and other factors (e.g., access, resources), approximately 6 – 12 lakes will be selected each year from the prioritization list for monitoring. Additional information regarding the prioritization scheme is provided in Appendix A.



Table 1.1 Prioritization categories for Targeted Assessment Monitoring

Priority	Priority Order	General Category	Category Descriptions ¹
High	1	Delisting	Assessment units currently listed in Categories 4c or 5 where there are indications it <u>should not</u> be listed for at least one impairment cause (indications can be environmental improvement or listing/assessment methodology changes or errors).
High	2	Listing	Assessment units NOT listed in Categories 4c or 5 where there are indications it <u>should be</u> listed for at least one impairment cause (indications can be environmental degradation or listing/assessment methodology changes or errors).
Medium	3	Unassessed (suspect impairment)	Assessment units listed in Category 3 or waters without an assessment unit where there are indications it could listed in Categories 4c or 5 for at least one impairment cause (i.e., unassessed waters suspected to be impaired).
Medium	4	Stressor Identification	Assessment units listed in Category 5 for a non-pollutant (i.e., Fishes Bioassessment, Aquatic Macroinvertebrate Bioassessment) with no stressor impairment causes.
Medium	5	CWF Determination	Assessment units or waters without an assessment unit thought to be an undesignated or poorly documented coldwater fishery (CWF).
Low	6	Unassessed (suspect support)	Assessment units listed in Category 3 or waters without an assessment where there are indications it could listed in Category 1 or 2 (i.e., unassessed waters likely to support uses).
Low	7	Priority NPDES ²	Assessment units or most sensitive receiving waters with a prioritized NPDES permit development (i.e., situations where a <u>reassessment</u> of the targeted assessment unit would be of value).
Low	8	TMDL Effectiveness	Assessment units currently listed in Category 4a where the TMDL was potentially successful in removing the use impairment or the original listing of the impairment cause was potentially <u>in error</u> .
Low	9	Priority TMDL	Assessment units in Category 5 prioritized for TMDL development (i.e., situations where a <u>reassessment</u> of the listed assessment unit would be of value).

¹ Assessment units placed in prioritization categories based on available information (indications) from multiple sources (monitoring data, landscape data, assessment methodology, pollution control, assessment methodologies, etc.).

² NPDES: National Pollutant Discharge Elimination System



1.2. Selection and Description of Survey Indicators

As part of the indicator selection process, WPP evaluated indicators used in the 2022 Massachusetts Consolidated Assessment and Listing Methodology (CALM), historic WPP lake monitoring, the National Lake Assessments (NLA) conducted by USEPA in 2007 and 2012, Regional Monitoring Networks (RMN) coordinated by EPA and lake monitoring conducted by other states (MassDEP 2022; USEPA 2011; USEPA 2020). Key indicator screening and evaluation criteria included applicability to the target population, utility in achieving the monitoring objectives, cost/resource effectiveness, available assessment methodologies, and ability to reflect various aspects of ecological condition.

The remainder of this section briefly describes the indicators that the TAM will use to assess designated uses, identify key stressors impairing uses and describe various physiochemical or habitat characteristics of each lake. Some indicators provide a basis for evaluating more than one category. For example, an assessment of phytoplankton is useful for assessing both aquatic life and recreation uses as well as identifying stressors (e.g., nutrients). A summary of the indicators is presented in Table 1.2.

1.2.1. Aquatic Life Use

Waters supporting the *Aquatic Life Use* should be suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. This use includes reproduction, migration, growth, and other critical functions. Results from all the indicators (biological, habitat, and physiochemical) are considered in assessing the *Aquatic Life Use*. However, the biological community data, in many cases, outweigh all other types in the decision-making process since they are considered to reflect an integration of the effects of pollutants and other conditions over time (MassDEP 2022).

1.2.1.1. Phytoplankton Assemblage

Phytoplankton are organisms that can produce their own food using light, water, carbon dioxide, or other chemicals (i.e., autotrophs) and represent the plant portion of suspended material in a lake. They primarily drift and move passively in the water column based on water currents and temperature differences. Phytoplankton communities provide oxygen to the water through photosynthesis and are an important component of the food web for fish and zooplankton. Overabundance of algae can lead to oxygen deficits via respiration and subsequent decomposition. The phytoplankton assemblage and abundance will change over the summer months with changing environmental conditions, both natural and human induced. Analyzing these changes will contribute to our understanding of the trophic status and ecological health of the lake.

1.2.1.2. Macroinvertebrate Assemblage

Benthic macroinvertebrates are relatively large (>200 – 500 microns) organisms that lack a backbone and inhabit the bottom areas and substrates of water bodies. Since many macroinvertebrates are sensitive to pollution, somewhat immobile, and have relatively long-life cycles within an aquatic system, the composition, structure, and function of the macroinvertebrate populations are responsive to both



acute and chronic stressors and integrate multiple stressors. The TAM Lake assessment will focus on the benthic macroinvertebrate assemblage occupying the littoral habitat of the lake (USEPA 2011).

1.2.1.3. Vertical Profile Measurements

Vertical or depth profiles are measurements of temperature, dissolved oxygen (DO), pH and conductivity from different depths at the index site (i.e., location of max depth) in each lake. Vertical profiles are collected using both discrete and continuous probe measurements. These measurements are used to determine the presence or absence of temperature stratification, the extent of the epilimnion, metalimnion and hypolimnion (if stratified), stratification patterns through the summer, and the compliance with DO and temperature criteria and guidance for the support of aquatic life.

1.2.1.4. Chlorophyll-a

Chlorophyll is a pigment found in plants that allows the organism to use radiant energy for converting carbon dioxide into organic compounds in a process called photosynthesis. Several types of chlorophyll exist and these and other pigments are used to characterize algae. One type, chlorophyll-a, is most widely used for biomass estimates since it is found in all algae. Knowledge of chlorophyll-a concentration provides qualitative and quantitative estimates of algal biomasses and lake trophic status (MassDEP 2022).

1.2.1.5. Non-native Species

A non-native (or exotic) species is an organism occupying an area outside of its natural range or distribution due to introduction by human activity. Non-native species, unlike the natural biota, have few or no population controls, are often extremely invasive (dominating and/or eliminating native biota), and can displace a healthy and desirable aquatic community resulting in economically and recreationally severe impacts even though no other change has occurred in the watershed (MassDEP 2022).

1.2.1.6. Water Chemistry (including nutrients)

Water chemistry measurements (total phosphorus, total nitrogen, chloride, dissolved organic carbon, total alkalinity, total hardness, color, turbidity) are used to analyze buffering capacity, nutrient availability, trophic status and nutrient enrichment, and water chemistry classification (e.g., alkaline lake, soft water lake, etc.). These measurements, excluding chloride, will not be used directly or definitively to indicate the condition of aquatic life but will be used with or provide context to the other indicators in the TAM lake assessments (MassDEP 2022).

1.2.2. Recreational Uses

Recreational Use is divided into two separate contact scenarios for analysis. Waters supporting the *Primary Contact Recreational Use* are suitable for any recreation or other water use during the annual recreation season (1 April to 15 October) in which there is prolonged and intimate contact with the



water with a significant risk of ingestion. Waters supporting the *Secondary Contact Recreational Use* are suitable for any recreation or other water use during any time of year in which contact with the water is either incidental or accidental. The assessment of the *Recreational Use* is based on sanitary issues (i.e., bacteria), safety (e.g., Secchi depth) considerations, and/or the aesthetic condition of the lake (MassDEP 2022).

1.2.2.1. *Macrophyte Cover and Biovolume*

Aquatic macrophytes provide important functions to a healthy ecosystem (e.g., nutrient cycling, habitat for fish and macroinvertebrates, food source). However, overabundant growth of aquatic macrophytes can physically impair swimming, boating, and fishing recreational activities. The percent of the lake surface area covered by macrophytes (surface cover), the percent of lake volume filled with macrophytes (biovolume), the growth habit and type of species, and the dominance of the species within the plant community are measurements used to evaluate the impact of aquatic macrophyte growth (MassDEP 2022).

1.2.2.2. *Secchi Disk Transparency*

A Secchi disk is an opaque disk with alternating black and white quadrants used to estimate the transparency of the water in the lake by measuring the depth where the disk can no longer be seen when lowered into the water column. Low transparency can obscure hazardous objects and impair swimming as a recreational use. Secchi disk transparency can also be used to estimate the euphotic zone and trophic conditions in the lake (MassDEP 2022).

1.2.2.3. *Pathogens*

Most pathogens (bacteria, viruses, protozoan, fungi, or parasites) originate from the gastrointestinal tract of warm-blooded animals and when transported to waterbodies through feces can contaminate the water and result in gastrointestinal disorders and infections for those who ingest or come in contact with the water. *Escherichia coli* is used as an indicator of fecal contamination thus high concentrations of *E. coli* would indicate an impairment of recreational uses (MassDEP 2022).

1.2.2.4. *Cyanobacteria*

Cyanobacteria are microscopic organisms found naturally at low concentrations in freshwater systems but can form blooms (dense aggregations of cells) under optimal conditions. Cyanobacteria blooms can potentially impair recreational uses through decreased transparency, poor aesthetic conditions, and the production of toxins (e.g., microcystin, anatoxin-a) by the cyanobacteria. Microcystin is a hepatotoxin that can damage the liver and cause gastroenteritis, vomiting, convulsion/seizures depending upon the dose and length of exposure. Microcystin is considered to be the most commonly found cyanobacterial toxin in water and is the toxin most responsible for human and animal poisonings. Anatoxin-a is a potent neurotoxin (toxins that affect the nervous system) and ingestion of cells containing anatoxin-a can result



in memory impairment, seizures, and respiratory or cardiac arrest. Cyanobacteria counts will be used to evaluate the potential impairments due to cyanobacteria (MassDEP 2022).

1.2.2.5. Aesthetic Condition

Aesthetic condition is a subjective measure of how pleasing the water body is to the senses for both active (e.g., swimming) and passive recreational activities (e.g., fishing, boating, wading, walking, or resting near the water). The narrative aesthetics criterion in the Massachusetts Surface Water Quality Standards (SWQS) states that surface waters should be “free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life” (MassDEP 2021). Qualitative evaluations of aesthetic conditions (e.g., objectionable deposits) are used to assess their impact on recreational uses (MassDEP 2022).

1.2.3. Fish Consumption Use

Human consumption of fish (*Fish Consumption Use*) is included in the definition of *Secondary Contact Recreation Use* in the Massachusetts Surface Water Quality Standards (SWQS) (MassDEP 2021).

Chemical contaminants enter the food chain and biologically accumulate in tissues of aquatic organisms with each successive level of the food chain potentially having higher contaminant levels (much higher than the surrounding water). Contaminant levels in the fish tissue are compared to available criteria to determine if the levels potentially pose a risk to human health (MassDEP 2022).

1.2.3.1. Metals

Mercury is the most common cause of impairment to fish consumption. Mercury is a natural highly toxic element and can be present at low levels in most places. While naturally occurring, human activities (e.g., coal burning, trash incineration) have significantly increased mercury levels in the environment. In lakes, mercury can be transformed by natural processes into methylmercury, an organic form of mercury that is the most dangerous to human health and biologically accumulated through the food chain. Humans are most commonly exposed to methylmercury through the consumption of fish and the concentrations within edible portions of the fish (filets) can indicate how safe the fish are to consume (MassDEP 2025). In addition to mercury, the levels of other metals (arsenic, selenium, cadmium, and lead) will also be used to evaluate the safety of fish consumption.

1.2.4. Lake and Habitat Characterizations

General characterization of the lake morphology, physical littoral habitat and human disturbance (watershed and lake scale) serves two primary purposes. It can help identify potential stressors that may be impairing uses and provide context for the interpretation of other indicators.



1.2.4.1. Physical Littoral Habitat

Physical littoral habitat includes the substrate bottom, aquatic macrophyte, and fish cover habitat categories. Semi-quantitative evaluations of the available habitat types (e.g., cobble, emergent macrophytes) and densities within each of the habitat categories will be used to characterize the overall physical littoral habitat. In addition, map variables derived from Geographic Information Systems (GIS) such as shoreline land use, length, and complexity can be used to supplement the semi-quantitative field measurements of physical littoral habitat.

1.2.4.2. Human Disturbance

The list of potential human disturbances is extensive and in the case of lakes can include hydraulic and shoreline alteration, urbanization, residential development, stormwater, etc. Qualitative field evaluations of the types and severity of human disturbances and/or pollution sources will be recorded at multiple scales (e.g., whole lake, littoral). In addition, multi-scale map derived variables based on GIS data such as land use (e.g., residential, agriculture), impervious cover, NDPDES discharges, etc. can be used to supplement the qualitative field observations of disturbance.

1.2.4.3. Bathymetry

Bathymetry is the measurement of the lake depth in relation to the lake surface and if a sufficient number of measurements are taken, a bathymetric or contour map of the lake can be generated. Measurements will be taken at a sufficient resolution using transects or other methods (e.g., shoreline tracing) to create a bathymetric map for each lake. These maps will provide context and interpretation to some of the other indicators (e.g., percent of lake volume with DO < 5 mg/L).

Table 1.2 Summary of indicators

Indicator Type	Indicator	Location
Aquatic Life Use	Discrete vertical profile measurements (DO, temperature, pH, and conductivity), Continuous vertical profile measurements (DO and temperature)	Index site
	Water chemistry (total alkalinity, total hardness, color, turbidity, chloride, dissolved organic carbon)	Index site
	Nutrients (total phosphorus and total nitrogen)	Index site
	Phytoplankton assemblage	Index site
	Chlorophyll-a	Index site
	Macroinvertebrate assemblage	Littoral zone
	Non-native species	Whole lake
Recreation Use	Pathogens (<i>E. coli</i>)	Shoreline site
	Macrophyte cover and biovolume	Whole lake
	Secchi Disk transparency	Index site
	Cyanobacteria	Index site
	Aesthetic conditions	All



Table 1.2 Summary of indicators

Indicator Type	Indicator	Location
Fish Consumption Use	Fish tissue contaminants (mercury and other metals)	Whole lake
Lake and Habitat Characterization	Physical littoral habitat	Littoral zone
	Human disturbance	Whole lake
	Bathymetry	Whole lake

2. LOGISTICS

2.1. Roles and Contact Information

Effective communication between TAM field crews, TAM coordinators, and laboratory staff at Wall Experiment Station (WES) and/or contracted laboratories is essential for the program to proceed with maximum efficiency and to ensure collection of high-quality data. This section provides:

1. A general description of the roles and responsibilities of key WPP personnel in providing logistical and technical support for the collection and processing of samples by TAM field crews
2. Flow of communication between TAM field crews, TAM coordinators and laboratory staff (i.e., who to call for specific types of questions or support needs)
3. Contact information

The **TAM Management Team** consists of the WPP Water Quality Monitoring Section Chief, WPP QA/QC Coordinator, Field and Laboratory Operations Coordinator, and TAM Coordinator. This team is responsible for overseeing all aspects of TAM and ensuring technical and quality assurance requirements are properly conducted. The team is the final authority on all decisions regarding lake selection, field sampling, and laboratory analysis.

The **Water Quality Monitoring Section Chief** is responsible for the planning and coordination of all environmental monitoring by WPP including TAM. This includes technical oversight, survey scheduling, and staff assignments. The **QA/QC Coordinator** is responsible for the overall quality assurance and quality control of environmental monitoring and data handling at WPP including TAM. This includes standard operating procedures (SOP) development, training, data review and validation, Quality Assurance Project Plan (QAPP) development, QC reporting, coordination, and communication with labs. The **Field and Laboratory Operations Coordinator** is responsible for coordination of activities in WPP labs (instrument calibration, chlorophyll-a, color/turbidity, *E. coli*) used for the TAM project as well as some aspects of employee safety and training. The **TAM Coordinator** is responsible for lake selection and the general day to day coordination of field activities including the preparation of all bottles, field sheets, chains of custody (COC), etc.

The **Indicator Coordinators** are responsible for assisting with the development and correct implementation (i.e., training) of standard operating procedures (SOP) associated with their indicator or area of responsibility. They are a primary contact for the field crews regarding questions or other issues



involving the collection, transportation or processing of samples associated with their indicators of responsibility.

The **Field Crew Leads** with the assistance of WPP seasonal staff are responsible for all aspects of survey preparation, sample and data collection, and post survey activities on assigned surveys using techniques and procedures detailed in this field operations manual. A summary of roles and contacts is provided in Table 1.3.

Table 1.3 Contact information

Role		Name	Contact Information
TAM Management Team	Water Quality Monitoring Section Chief	Shervon DeLeon	Shervon.DeLeon@mass.gov 617-780-1074
	QA/QC Coordinator	Jasper Sha	Jasper.Sha@mass.gov 857-274-0905
	TAM Coordinator	Therese Beaudoin	Therese.Beaudoin@mass.gov 857-278-6478
	Field and Laboratory Operations Coordinator	Sue Flint	Suzanne.Flint@mass.gov 508-688-5062
Indicator Coordinators	<i>E. coli</i> bacteria	Sue Flint	Suzanne.Flint@mass.gov 508-688-5062
	Color/turbidity	Sue Flint	Suzanne.Flint@mass.gov 508-688-5062
	Chlorophyll-a/Algae	Joan Beskenis	Joan.Beskenis@mass.gov 617-894-5696
	Fish	Dan Davis	Daniel.Davis@mass.gov 617-529-5630
		Pete Mitchell	Peter.Mitchell@mass.gov 617-780-4281
	Macroinvertebrate	Steve Bittner Pete Mitchell	Steven.M.Bittner@mass.gov 781-613-5730 Peter.Mitchell@mass.gov 617-780-4281
Field Crew Leads	Macrophyte/Bathymetric Mapping	Dan Davis	Daniel.Davis@mass.gov 617-529-5630
	All Indicators	James Meek	James.Meek@mass.gov 617-780-4149
	All Indicators	Therese Beaudoin	Therese.Beaudoin@mass.gov 857-278-6478
	All Indicators	Pete Mitchell	Peter.Mitchell@mass.gov 617-780-4281
	All Indicators	Dan Davis	Daniel.Davis@mass.gov 617-529-5630
	All Indicators	Steve Bittner	Steven.M.Bittner@mass.gov 781-613-5730



2.2. Key Information and Supplies

2.2.1. Lake Dossiers

Dossiers will be created for each lake in TAM by the **TAM Coordinator**. The dossiers will contain information regarding access permissions, equipment requirements (e.g., engine, boat), waterbody impairments (e.g., non-natives), relevant lake characteristics, sampling locations and management histories (e.g., herbicide treatments). In addition, the dossiers will contain maps indicating the surrounding environment (United States Geological Survey topographic and aerial maps), sampling locations (index site, shoreline site and littoral habitat stations) and access points. An example of a lake dossier is provided in Appendix B. All lake dossiers will be organized in a binder and multiple copies will be available.

2.2.2. Survey Schedule

A survey schedule containing all planned TAM surveys occurring during the defined field season will be created by the **Water Quality Monitoring Section Chief** prior to the initiation of any sampling activities. The survey schedule will include details regarding the lakes and indicators to be sampled by the field crews and the Field Crew Leads assigned to each survey. The schedule will be reviewed and approved by the **TAM Coordinator** and **Field Crew Leads**. On a weekly basis during the field season, the **Water Quality Monitoring Section Chief** will assign additional staff, typically WPP seasonal staff, as necessary to complete the field crews (typically 2 individuals) for each survey and provide the weekly field assignments to the staff. An example weekly schedule is provided in Appendix C.

2.2.3. Forms

Forms are the key to successful and consistent data collection and sample tracking. The forms used for lakes in TAM fall into two general categories: field sheets and COC forms. In general, the forms are on paper but, beginning in 2025, some forms may be in electronic format. The database used by WPP, EQUIS (Environmental Quality Information System) has associated software, EDGE (EQUIS Data Gathering Engine), with electronic forms developed to capture field data and observations in a manner that supports the database efficiently. Some electronic data gathering may be implemented in 2025. The standard operating procedures for the EDGE electronic forms are currently in development, and additional information or revisions will be added to this document when completed.

2.2.3.1. Field Sheets

Field sheets are the primary documents where we record measurements, observations, and sample collection information during a survey or sampling event. For most surveys, an individual field sheet is used for each station per sampling event. Field sheets for lakes in TAM include:

- Lake Field Sheet (Index Site & Shoreline Site) – EDGE
- Lake Field Sheet (Index Site & Shoreline Site) – paper
- Lake Vertical Profile Deployment – paper



- Macroinvertebrate/Littoral Habitat – paper
- Macrophyte/Whole Lake Assessment – paper
- Macrophyte Identification/Voucher – paper

Waterproof (e.g., Rite-in-the-Rain) paper is used exclusively for the paper field sheets. These forms will be reviewed annually and updated as appropriate. Samples of TAM field sheets can be found in Appendix D. While each field sheet type is unique, common information recorded on field sheet forms can include, but is not limited to:

- Site name and watershed location
- Station Description (including Global Positioning System (GPS) coordinates)
- Station Access Information
- Sample Name and ID #
- Personnel on-site performing the sampling
- Dates and times of sample collection
- Pertinent observations regarding uses (aquatic life, recreation, etc.)
- Summary of weather conditions
- Site observations and any aberrant sample handling comments
- Sample collection information (sample collection methods and devices, sample collection depth, sample preservation, matrix sampled, etc.).

Certain information (e.g., site ID, sample IDs) that will not change can be pre-filled out on the field sheets prior to the survey to save time in the field. The **TAM Coordinator** prepares all field sheets with any pre-filled information in advance and provides them to the **Field Crew Leads**. Other information that is time-, location- and/or condition-specific is filled out at the station ONLY. Upon completion of the survey, each completed field sheet is submitted to the **QA/QC Coordinator** or designated representative for scanning and hard copy filing.

2.2.3.2. Chain of Custody

Standard chain-of-custody (COC) forms are used to track and transfer sample custody from WPP staff to the appropriate laboratories (i.e., WES, WPP lab, and contract labs). The proper procedure for completing a COC form and transferring sample custody are documented in the QAPPs for the respective laboratories. COC forms for the labs supporting the TAM lakes project include:

- Contract Laboratories (phytoplankton, macroinvertebrates, chloride)
- WPP Laboratory (color, turbidity, *E. coli*)
- WES (nutrients, total alkalinity, total hardness)

Waterproof (e.g., Rite-in-the-Rain) paper is used exclusively for the COC forms. These forms will be reviewed annually and updated as appropriate. Samples of TAM COC forms can be found in Appendix E.



While COC forms from different labs vary to some degree, common information recorded on COC forms can include, but is not limited to:

- Site identification
- Sample identification
- Collection date/time/sampling staff
- Analyses requested
- Sample matrix
- Sample preservation
- Delivery person(s)/ date/time

The **TAM Coordinator** prepares all the COC forms automatically using the WES Laboratory Information System (LIMS) pre-login procedures (for WES samples) and/or via personal computer/manual (for all other labs) and provides the forms to the **Field Crew Leads**. Once prepared, the COC forms are checked for errors prior to use. Upon completion of the survey and sample delivery, a copy of each completed and signed field COC form is submitted to the QA/QC Coordinator or designated representative for scanning and hard copy filing.

2.2.3.3. Field Operations Manual

This Field Operations Manual for field activities shall be available in the field if needed, and to ensure consistency between field crews. The **TAM Coordinator** or other designated WPP staff will review the Field Operations Manual annually and with assistance from the **Field Crew Leads** and **QA/QC Coordinator** make necessary revisions to standard operating procedures.

2.2.4. Electronic Field Data

Relevant electronic field data (e.g., site name, latitude and longitude coordinates) will be uploaded to the appropriate electronic field devices (e.g., field GPS units, auto GPS units) by the **TAM Coordinator** prior to the initiation of any sampling activities. Table 2.1 summarizes the type of electronic data to be uploaded to each type of field device.

Table 2.1 Electronic field data uploads and devices

Electronic Device	Electronic Data Uploads
Field GPS Units	Index Site location (<i>if known</i>) Shoreline Site locations Boat Access locations Littoral Plot locations
Sonar Unit (Macrophyte Mapping)	Sampling Transects Rake Throw locations Littoral Plot locations



Table 2.1 Electronic field data uploads and devices

Electronic Device	Electronic Data Uploads
Auto GPS Unit	Shoreline Site locations Boat Access locations Parking locations (<i>if required</i>)
Note: Locations are uploaded as latitudes and longitudes in decimal degrees and sampling transects are loaded in a .gpx format.	

3. SAFETY AND HEALTH

3.1. General Considerations

It is the responsibility of the **Field Crew Lead** to ensure that the safety precautions, policies, and procedures outlined in this manual are followed by survey field personnel.

3.1.1. Recommended Training

Prior to engaging in field work, all survey crew members should take the following recommended training:

- First aid, Cardiopulmonary Resuscitation (CPR) and Automated Electronic Defibrillator (AED)
- Boating and water safety [NOTE: This course is required for all crew leads and boat operators]
- Lake field sampling, including safety issues and protocols for WPP sampling activities.

3.1.2. Communications

Effective communication is a key ingredient in safe fieldwork. To ensure smooth communications, each field survey will follow these guidelines:

- Adherence to all safety guidelines contained in this manual, which collectively comprise the standard “Safety Plan” for TAM lake surveys
- Adherence to sampling itinerary (scheduled date, vehicle used, time of departure, etc.)
- Use readily available contacts for police, ambulance, hospitals, and fire departments in the auto GPS units or cell phone maps (e.g., Google Maps) when necessary
- Weather forecasts are tracked by the **Field Crew Lead**, who is the final arbiter for go/no-go decisions
- Keep lists of personal and work contacts (telephone numbers, etc.)

3.1.3. Personal Safety

Personal safety will be ensured by following these actions prior to and during each survey (as applicable):

- Use of proper field clothing and personal protective equipment (PPE) (e.g., hats, sunglasses, sunscreen, extra glasses, proper footwear)



- Use of personal floatation devices (PFD)/lifejackets for all team members, and in accordance with safety procedures (e.g., one extra throwable life preserver)
- Knowledge of medical and personal information (e.g., allergies and personal health conditions and abilities)

3.2. Safety Equipment

Minimum equipment and materials for ensuring safety and to be readily available IN THE BOAT during each lake survey include the following:

- PPE as required (including raingear if rain is forecasted)
- Use of PFD/lifejackets for all team members, and in accordance with safety procedures (e.g., one extra throwable life preserver)
- Oars and oar locks
- Fire extinguisher (for boats w/ gas motors)
- Cell phone and important contacts (e.g., fish kill or spill notification, work contacts)
- Chemical reagent/waste container(s)
- Flare gun, boat horn and/or safety whistle (one or more based on need, e.g., for isolated lakes, a flare gun may be more appropriate to signal for help)
- Food & drink

Additional safety equipment and materials to be available ON SHORE/IN VEHICLE include:

- Waders
- Field and First Aid kit
- Boating toolbox
- Extra boat plugs
- Assorted gloves
- Extra clothes

3.3. Safety Guidelines for Field Operations

The following safety guidelines shall be adhered to for all lake surveys:

- Two persons must be present during all sample collection activities. No one should be left alone while in the field.
- Personnel participating in field activities on a regular or infrequent basis should be in sound physical condition.
- Field personnel should have a check-in procedure for safety, including a departure safety checklist to ensure secure fastenings for trailer, motor(s), boats, etc.
- Persons using sampling equipment should become familiar with the hazards involved and establish appropriate safety practices prior to use. Make sure all equipment is in safe working condition. If boats are used to access sampling sites, personnel must consider and prepare for hazards associated with the operation of motor vehicles, boats, winches, tools, and other incidental equipment.



- Boat operators should be familiar with United States Coast Guard (USCG) rules and regulations for safe boating. These are illustrated in a pamphlet, "A Boater's Guide to the Federal Requirements for Recreational Boats", available online (USCG 2023).
- All boats with motors should have fire extinguishers (gas motors), boat horn/flare gun/safety whistle, life jackets or flotation cushions, and flares or communication devices.
- Field personnel should be able to swim safely to the nearest safe shoreline point, and PFDs must be worn.
- If needed, chest waders made of rubberized, neoprene, or breathable material and suitable footwear must always be worn with a wading belt to prevent them from filling with water in case of a fall.
- All electrical equipment must bear the approval seal of Underwriters Laboratories and must be properly grounded to protect against electric shock.
- Proper PPE, including footwear, must be worn at all times. Many hazards lie out of sight on lake, river, and stream bottoms. Broken glass, sharp pieces of metal or plastics, et cetera embedded in the substrate can cause serious injury unless staff use care when walking or working with their hands in such environments.
- When appropriate, wear gloves to protect from exposure to harmful materials (e.g., chemicals, toxins) that can be absorbed through the skin. Infectious agents and toxic substances may be present in the water or sediments; thus, all media should be viewed as potential health hazards. Wash exposed body parts as soon as possible after contact.
- Use appropriate PPE (e.g., gloves, safety glasses) when handling and using hazardous chemicals.
- Handle and dispose of chemical wastes properly. Persons must become familiar with the health hazards associated with using chemical fixing and/or preserving agents. Chemical wastes can be hazardous due to flammability, explosiveness, toxicity, causticity, or chemical reactivity. All chemical wastes must be discarded according to standardized health and hazards procedures. Do not dispose any chemicals in the field.
- Persons working in areas where poisonous snakes may be encountered must check with the local Drug and Poison Control Center for recommendations on what should be done in case of a bite from a poisonous snake.
- Any person allergic to bee stings, other insect bites, or plants (i.e., poison ivy, oak, sumac, etc.) must take proper precautions and have any needed medications (e.g., Benadryl) handy.
- Field personnel should protect themselves against deer and wood tick bites due to the risks posed by tick-borne pathogens (e.g., Rocky Mountain spotted fever, Lyme disease).
- All field personnel should be familiar with the symptoms of hypothermia and know what to do in case symptoms occur. Hypothermia can be fatal at temperatures above freezing (up to 10 °C or 50 °F) if he or she is exposed to wind or becomes wet.
- Field personnel should be familiar with the symptoms of heat/sun stroke and be prepared to treat an affected individual by moving them into cooler surroundings and providing hydration.
- Protect against the sun by using sunglasses, hats, sunscreen, etc.



- Benthic macroinvertebrate sampling (only): When appropriate, use heavy gloves when hands are used to agitate the substrate during collection of benthic macroinvertebrate samples.
- Electrofishing (only): Follow directions of **Field Crew Lead** exactly; wear insulated gloves.
- Keep a low center of gravity while in the boat. Standing and other movements can cause the boat to become unstable and possibly capsize.

4. BASE SITE ACTIVITIES

Field crews will need to conduct some activities at the WPP office and laboratory (base station) in preparation for a survey and after returning from a survey. The specifics of these activities will vary depending on the type of survey. There are multiple types of surveys for TAM lakes: **Index Site**, **Lake Vertical Profile Deployment**, **Shoreline Site**, **Littoral** (macroinvertebrates, littoral habitat) and **Whole-Lake** (fish tissue, macrophytes, and non-natives). Close attention to these activities is required to ensure that the field crews know:

- locations and nature of activities
- access conditions for each lake (e.g., is early access notification required?)
- equipment and supplies needed for each survey and lake
- how samples are to be stored at the base station and/or transported to the lab

4.1. Pre-survey Preparation

Survey preparation for the assigned field crews typically occurs a day (at least) prior to the survey and/or the morning of the survey. The weekly monitoring schedule (Section 2.2.2) will indicate the survey type, and possibly which lakes are assigned to the survey thus dictating the necessary preparation activities. In general, preparation for each survey by the field crews involves:

- Identifying the lakes that are part of the survey.
- Notifying landowners of our sampling (where required).
- Reserving a vehicle (appropriate vehicle must be reserved in advance)
- Preparing and loading
 - Boats and motors as required.
 - Equipment used in all surveys (e.g., GPS)
 - Equipment specific to the lakes (e.g., bottles, field sheets, guidebooks)
 - Equipment specific to the survey type (e.g., Van Dorn)
 - Decontamination equipment as needed.
 - Personal equipment (e.g., rain gear, sunscreen)

4.1.1. Equipment

4.1.1.1. Check Lists

Checklists are very useful when preparing for a survey and help ensure that required activities are completed and all needed equipment for a particular survey type is prepared and loaded into the vehicle



or boat. The following tables provide checklists for each survey type. **Quantities should be revised as necessary to meet decontamination objectives (see Section 9), which may require the use of duplicate equipment (to avoid using items on more than 1 lake per trip), depending on the item.**

Table 4.1 Equipment checklist – All surveys

Type	Item	Quantity
Lake Information	Survey guidebook (<i>Shoreline site surveys only</i>)	1
	Lake dossiers binder	1
General Equipment	Vehicle book (w/gas card and information)	1
	Boats and motors (<i>not needed for Shoreline site surveys</i>)	1 per lake
	Auto GPS unit	1
	Field GPS unit	1
	Clipboard and pens/pencils	2
	Safety kit	1
	Cell phone (work and personal)	1
	First aid kit	1
	Traffic cone	1
	Personal protective equipment (e.g., sunglasses, hat)	As needed
	Personal tools and supplies (e.g., food, water, Leatherman)	As needed

Table 4.2 Equipment and supplies – continuous temperature and DO vertical profiles – Index Site

Type	Item	Quantity
Field Sheet	Vertical Profile Deployment	1 per lake
Collection: Continuous Temperature Dissolved Oxygen	Sonar unit	1 per lake
	Onset HOBO DO and temperature data logger (DO/T)	2 per lake
	Onset HOBO Tidbits MX data logger (Temp)	As needed
	Instrument rope line – length based on lake depth (e.g., ¼" solid braided polyester rope, ½" braided poly rope, 3/8" Potwarp)	1 per lake
	Floating line (grab line)	As needed
	Primary buoy (sub-surface)	1 per lake
	Secondary buoy (surface)	1 per lake
	Primary anchor (instrument line)	1 per lake
	Secondary anchor (grab line)	1 per lake
	Supplemental floats for grab line	2 per lake



Table 4.2 Equipment and supplies – continuous temperature and DO vertical profiles – Index Site

Type	Item	Quantity
	Multiprobe - YSI EXO Sonde and Logger (temperature, DO, pH, conductivity)	1
	1 m metallic ruler	1 per lake
	Sounding line w/weighted grappler	1 per lake
	Deploy toolkit (adjustable wrench, screwdriver, work gloves)	1

Table 4.3 Equipment checklist – Index site surveys – Water Sample Collection

Type	Item	Quantity
Field sheets	Lakes Field Sheet (Index Site)	1 per lake
	Vertical Profile Deployment	1 per lake
	Macrophyte Identification/Voucher	1 per lake
	EDGE tablet (pre-loaded with survey information)	1
Collection: Water column depth Profile Measurements Secchi Disk transparency Water Sample Depth Integrated Sample Visual Observations	Sonar unit	1 per lake
	Multiprobe - YSI EXO Sonde and Logger (temperature, DO, pH, conductivity)	1
	Secchi Disk (20 cm)	1 per lake
	Viewscope	1 per lake
	Van Dorn sampler 2.2 L (Beta)	1 per lake
	Disposable syringe (60 mL)	1 per lake
	Syringe filter (0.45 um)	1 per lake
	Depth integrated sampler (10 – 30 m)	1 per lake
	Sample composite container (2L)	1 per lake
	Funnel	1
	Deionized (DI) water (4 L)	1
	Macrophyte key (non-natives)	1
	1 m metallic ruler	1 per lake
	Sounding line w/weighted grappler	1 per lake
	Deploy toolkit (adjustable wrench, screwdriver, work gloves)	1
Storing & Preservation	HDPE bottle (250 mL, amber, rectangle) Phytoplankton	1 per lake
	HDPE bottles (250 mL, amber, round) Chlorophyll-a	1 per lake
	HDPE bottle (500 mL, natural, NM) Total alkalinity	1 per lake
	HDPE bottle (500 mL, natural, NM)	1 per lake



Table 4.3 Equipment checklist – Index site surveys – Water Sample Collection

Type	Item	Quantity
	Total hardness	
	HDPE bottles (120 mL, natural, WM) Color/turbidity	1 per lake
	HDPE bottles (250 mL, natural, WM) Nutrients (surface), nutrients (near bottom)	2 per lake
	HDPE bottles (60 mL, natural, WM) Chloride	1 per lake
	Amber glass vials (40 mL, glass vial pre-preserved with H ₃ PO ₄) Dissolved organic carbon	2 per lake
	1 mL 9N H ₂ SO ₄ vials – nutrients	2 per lake
	2 mL 1:1 HNO ₃ vial – total hardness (Added post-survey in WPP lab)	1 per lake
	Lugol's solution (6 mL) (Added post-survey in WPP lab)	1 per lake
	Wet ice	As needed
	Cooler	1

Table 4.4 Equipment checklist – Shoreline site surveys

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Shoreline Site)	1 per lake
	EDGE tablet (pre-loaded with survey information)	1
	Macrophyte Identification/Voucher	1 per lake
Collection: Water Samples Visual Observations	Gloves (latex/nitrile, non-powdered)	As needed
	Sampling pole	2
	Macrophyte key (non-natives)	1
Storing and preserving	IDEXX bottle (120 mL, clear, round, sterile) <i>E. coli</i>	1 per lake
	Wet ice	As needed
	Cooler	1
	Hip boots or chest waders	1 per person

Table 4.5 Equipment checklist – Littoral surveys (macroinvertebrate, littoral habitat) surveys

Type	Item	Quantity
Field sheet	Macroinvertebrate Littoral Habitat	1
	Macrophyte Identification/Voucher	1
	Site Map	1



Table 4.5 Equipment checklist – Littoral surveys (macroinvertebrate, littoral habitat) surveys

Type	Item	Quantity
Collection: Visual Observations Benthic macroinvertebrate	Macrophyte key (non-natives)	1
	Viewscope	1 per lake
	Sonar Unit	1 per lake
	Medium reclosable plastic bags	As needed
	Large reclosable plastic bags	As needed
	Standard Kick net (500 μ m) with 4-foot handle	1 per lake
	Bucket (5-gallon capacity, plastic)	1 per lake
	Tote (14-gallon, plastic, white)	1 per lake
	Sieve bucket (500 μ m)	1 per lake
	Forceps	1
	Squirt bottle (1 L Nalgene) – lake water	1
	Chest waders/hip boots	1 per person
Storing and preserving	HDPE bottle (2 L, white, wide mouth)	1-5 per lake
	Reagent alcohol (100%)	As needed
	Labels: Benthic macroinvertebrate samples	As needed
	Grease pen	1

Table 4.6 Equipment checklist – Whole Lake (Macrophyte) surveys

Type	Item	Quantity
Field sheet	Macrophyte Survey	1
	Macrophyte Identification/Voucher	1
	Site Maps (included in field sheets)	1
Collection: Bathymetry/Biovolume	Sonar unit (with microSD loaded with transects/sites)	1 per lake
	Underwater camera (AquaView)	1 per lake
Collection: Aquatic plants	Aquatic plant rake	1 per lake
	Macrophyte key (non-natives)	1
	Field GPS unit (<i>if rake throw sites are not in sonar unit</i>)	1
	Sonar Unit	1 per lake
Storing	Medium reclosable plastic bags	As needed
	Large reclosable plastic bags	As needed
	Wet ice	As needed
	Cooler	1

Table 4.7 Equipment checklist – Whole Lake (Fish tissue) surveys

Type	Item	Quantity
Field sheet	Macrophyte Identification/Voucher	1
Collection: Electrofishing Boat	Coffelt 18-foot electrofishing boat	1 per lake
	40-inch Wisconsin ring and droppers	1 per lake



Table 4.7 Equipment checklist – Whole Lake (Fish tissue) surveys

Type	Item	Quantity
	Honda EG 5000™ Generator	1
	Dip nets	3 per lake
	Rubber gloves	3
	Novelty bat	1
	Depth sounder	1
Collection: Gillnets	Gillnets (various size and configurations)	As needed
	Floats	As needed
	Novelty bat	1
	Depth sounder	1 per lake
Storing and preserving	Cooler	1
	Wet ice	As needed

4.1.1.2. Multiprobes

Multiprobes are primarily used during index site surveys to measure the vertical profiles of DO, temperature, pH, and conductivity and conduct QA/QC checks on the vertical profile deployment. If a calibrated multiprobe is needed for a survey, the **TAM Coordinator** submits a probe request (Deployment and/or Multiprobe Request Form) to the **Field and Laboratory Operations Coordinator** at least one week prior to each survey. The multiprobes will be calibrated by the **Field and Laboratory Operations Coordinator** or designee the day before or morning of the survey and available for the field crew in the instrumentation lab on the morning of the survey.

4.1.1.3. Deployment Sondes

Deployment sondes are used to continuously measure DO and temperature at multiple depths on a vertical instrument line. If calibrated deployment sondes are needed for a survey, the **TAM Coordinator** submits a probe request (Deployment Sonde Request Form) to the **Field and Laboratory Operations Coordinator** at least one week prior to the survey. The deployment sondes will be calibrated and set to launch by the **Field and Laboratory Operations Coordinator** or designee before the survey date and can be picked up by the field crew from the instrumentation lab on the morning of the survey.

4.1.1.4. Survey Kits

Survey kits for the index site and shoreline surveys will be prepared on a monthly basis by the **TAM Coordinator**. The shoreline site survey kits will be organized by site groups (i.e., a group of sites scheduled to be sampled on the same day by the same crew) and the index site survey kits will be organized by lake. **The survey kits will contain paper field sheets and/or EDGE tablets with known information pre-filled (e.g., site ID, town), COC forms for the analytical laboratories, and labeled sample bottles.** The kits will be located in the equipment storage room.



4.1.1.5. Boats and Motors

A boat and motor will be needed for all surveys excluding the shoreline site surveys. WPP currently has three types of boats (an electroshocking boat, a Boston Whaler, and jon boats) and two engine types (gas and electric). If appropriate, oars can be used in place of a motor. The lake dossiers will indicate a suggested boat and motor combination based on the lake. The **Field Crew Lead** will select the appropriate boat and motor for the survey, based on the following factors.

- Survey type – the electroshocking boat is used primarily on fish tissue surveys.
- Boat access – the absence of a boat ramp will necessitate the use of a jon boat, as it is the only type in the WPP fleet that can be hand-carried and -launched.
- Size of the lake – the Whaler with its larger motor will be advantageous on larger lakes to save time.
- Distance to the index site – when the boat launch point is close to the index site electric motors or oars may be advantageous considering decontamination procedures.
- Non-natives and decontamination – a different boat and motor/oars combination will be used on each lake in a multi-lake survey (e.g., index site surveys) to avoid decontamination of the boat and motor in the field. See Section 9.0 for more information on boat and motor decontamination. Example 1 – the survey plan for the day includes two lakes with boat ramps, but at one lake, the index site is very close to the launch point. In this situation, the best option may be to bring two jon boats and one motor. A different boat would be used at each lake but oars instead of a motor would be used at the lake with the close index site. This will decrease the potential transmission of non-natives, eliminate the need for in field decontamination of the boat and motor and reduce post-survey effort (one less motor to decontaminate).
- Time since last use – drying of the equipment is often a component in effective decontamination so when faced with a choice between two equally viable boats or motors, select the one that has been drying the longest.

4.1.1.6. Quality Assurance and Quality Control Sampling for Field Activities

Only a portion of the surveys will be selected for the collection of quality control samples (field blanks, equipment blanks, and field duplicates). These surveys will be indicated in the field sheets, COC forms and the sampling schedule.

Field Blanks and Equipment Blanks: In preparation for the blank samples, the field crew will acquire an appropriate volume of deionized (DI) water from the Barnstead filter system in the instrumentation laboratory. The DI water can be prepared the day before or the morning of the survey. Follow the instructions posted on the wall adjacent to the Barnstead.

Field Duplicates: The collection of field duplicates for water quality surveys will be based on an approximate rate of 10% of the total number of samples and will be distributed among the various



crews at a rate of one set of QC samples every two surveys by the **TAM Coordinator**. Crews will know to collect QC samples if the QC sample containers are included in the prepared sampling kits for the survey.

Other QA/QC precautions to ensure data validity are:

- Pre-rinsing sample containers (except for dissolved organic carbon (DOC) and *E. coli*)
- Pre-rinsing samplers (e.g., Van Dorn, Tygon tubes)
- Duplicate Secchi readings

4.2. Post-survey Activities

Post-survey activities are critical to maintain functioning and efficient monitoring. Post-survey activities primarily involve the proper handling of samples, paper field sheets and COC forms, EDGE tablets and electronic field sheets, and the decontamination, cleaning, and storage of all field equipment including boats, motors, and sampling collection devices. Completing these activities correctly will support sample transportation to contract labs, sample analysis in the WPP laboratory and future field crews.

4.2.1. Sample Handling

Samples have two potential destinations following the completion of a survey: direct transportation to a laboratory (including the WPP laboratory) or storage at the base station for future delivery to a laboratory. Color, turbidity, chlorophyll-a, and *E. coli* samples will be delivered to and analyzed at the WPP laboratory. Other samples will be stored at the base station prior to delivery to a laboratory (WES or Contract Lab). Fish tissue samples require processing at the base station prior to storage (see Section 8.3.4 Sample Processing for details). Table 4.8 summarizes the handling of each sample type.

Table 4.8 post-survey sample handling

Survey	Sample	Storage	Delivery Location
Index Site	Total alkalinity HDPE bottle (500 mL, natural, narrow mouth)	Refrigerator Survey Prep Area	WES Contract Lab Weekly
	Total hardness HDPE bottle (500 mL, natural, narrow mouth)		
	Nutrients (surface) HDPE bottles (250 mL, natural, wide mouth)		
	Nutrients (near bottom) HDPE bottles (250 mL, natural, wide mouth)		
	Chloride HDPE bottles (60 mL, natural, wide mouth)		
	Dissolved organic carbon Amber glass bottles (40 mL x 2)		
	Color/turbidity		WPP Lab



Table 4.8 post-survey sample handling

Survey	Sample	Storage	Delivery Location
	HDPE bottles (120 mL, natural, wide mouth)		
	Chlorophyll-a (filtered at WPP Lab) HDPE bottles (250 mL, amber, round)	Refrigerator Survey Prep Area (water sample) Freezer (filter) Biological Lab	WPP Lab
	Phytoplankton HDPE bottles (250 mL, amber, rectangle)	Refrigerator Biological Lab	Contract Lab Weekly
Shoreline Site	<i>E. coli</i> IDEXX bottle (120 mL, clear, round)	None	WPP Lab
Fish Tissue	Mercury/metals HDPE bottles	Freezer Biological Lab	WES Weekly
Macroinvertebrate Macrophyte	Macroinvertebrate HDPE bottle (2 L, natural, round)	Flame Cabinet Biological Lab	Contract Lab Season End
	Macrophyte Voucher Medium Ziploc bag	Refrigerator Biological Lab	WPP Lab

4.2.2. Field sheets and COC Forms

The appropriate COC forms must be completed during or immediately following the survey for all water quality samples (i.e., day of the survey). The proper procedure for completing COC forms is documented in the QAPPs of the respective laboratories. Upon returning to the base station and completing any needed sample processing (e.g., fish tissue), check the samples against the COC forms and transfer them to storage or the WPP laboratory (i.e., *E. coli* samples). Any missing samples should be crossed off the COC forms with a corresponding note in the comment sections of the COC forms. The completed and signed COC forms are placed in the COC In-transit inbox attached to the sample storage refrigerator in the survey preparation area.

The macroinvertebrates and macrophytes samples or vouchers do not have COC forms and are tracked differently than other samples. The **Macrophyte Identification/Voucher** field sheets are used as a sample tracking form for macrophyte vouchers and placed in the Plant Identification/Voucher Forms manila envelope attached to the refrigerator in the biological laboratory. Upon arrival at the biological laboratory, the macroinvertebrate samples are recorded in the Laboratory Sample Log-in notebook. Each sample is assigned a sample identification number (BenSampID#) and habitat data identification number (HabSampID#).

All paper field sheets are reviewed for completeness by the **Field Crew Lead** following the survey and placed in the Field Sheet inbox attached to the sample storage refrigerator in the survey preparation area. It is not required that field sheet review occurs immediately after the survey, although preferable, and could occur in the days following the survey. The SOPs for the EDGE electronic field sheets are



currently in development and additional information, or revisions will be added to this document when completed.

4.2.3. Cleaning & Decontamination

4.2.3.1. Post-Survey Equipment Cleaning/Decontamination (non-pressure washing)

The following equipment, at a minimum, will require “gentle” (non-pressure washed) cleaning or rinsing with soap, tap water and/or DI water:

- Van Dorn bottles
- Multiprobes (to be done in Instrumentation Lab)
- Secchi disk
- Integrated tube sampler
- Viewscope
- Sonar transducer

Refer to Section 9 Decontamination for Non-native Species for the appropriate decontamination procedures using non-pressurized water.

4.2.3.2. Post-Survey Equipment Cleaning/Decontamination (using pressure washing)

The following equipment, at a minimum, will require “rigorous” (pressure washed) cleaning or rinsing with tap water:

- Boats and trailers
- Motors with propellor detached
- Propellers
- Oars

Refer to Section 9 Decontamination for Non-native Species for the appropriate decontamination procedures using pressurized water.

4.2.3.3. Shipping Samples

Samples for algae and cyanobacteria analysis (not chlorophyll-a) will need to be mailed via United Parcel Service (UPS) to the designated contract lab on a weekly basis.

5. INDEX SITE SURVEYS

Several different measurements and indicators are collected at the index site (as described in Table 1.2): temperature, DO, conductivity and pH depth profile, Secchi transparency, chlorophyll-a, phytoplankton, water chemistry, and nutrients. In addition, several semi-quantitative visual observations of weather, aesthetics, pollution sources and macrophyte composition and density are recorded to provide a general description of the conditions at the lake at the time samples were



collected. A detailed description of the individual tasks are provided below in the general order in which they should be completed (however, there may be some concurrent tasks).

5.1. Locating the Index Site

The index site is located at the point of the maximum depth within a lake. There are three potential scenarios in locating the index site:

- 1) If the location of the index site was previously identified, use a field or sonar GPS unit to navigate to the site. Use the depth readings of the sonar or the buoy of the vertical probe deployment to confirm that you are located at the index site.
- 2) If only the general location of the index site is known due to an existing bathymetric map, use a sonar unit to search that area of the lake for the maximum depth. When the point of maximum depth is identified, record the latitude and longitude on the **Lakes Field Sheet (Index Site)** and conduct sampling. Spend no more than 30 minutes searching for the point of maximum depth.
- 3) In situations where the location of the maximum depth is completely unknown, use a sonar unit to search in areas expected to be the deepest (e.g., near the dam in an impoundment). When the point of maximum depth is identified, record the latitude and longitude on the **Lakes Field Sheet (Index Site)** and conduct sampling. Spend no more than 30 minutes searching for the point of maximum depth.

It may not be possible to sample at the exact point of maximum depth (e.g., deepest area is very small) but the depth at the index site should be within 0.5 meters (m) of the known maximum depth.

5.2. Continuous Temperature and DO Vertical Profiles

5.2.1. Summary of Method

Deploy water quality sondes on a vertical instrument line to continuously measure temperature and DO at predefined fixed depths (e.g., 1 m intervals). The instrument line is vertically suspended below a buoy and attached to the lake bottom using an anchor system. On the instrument line, Onset DO/T sondes are deployed near the surface (approximately 0.75 – 1.0 m down from the water surface) and near the bottom (approximately 0.75 – 1.0 m above the lake bottom). Temperature sondes are deployed at equal depth intervals on the instrument line between the two Onset DO/T sondes. The depth intervals for the temperature probes are based on the site depth and availability of probes. Figure 5.1 provides a basic diagram of an example vertical profile deployment.

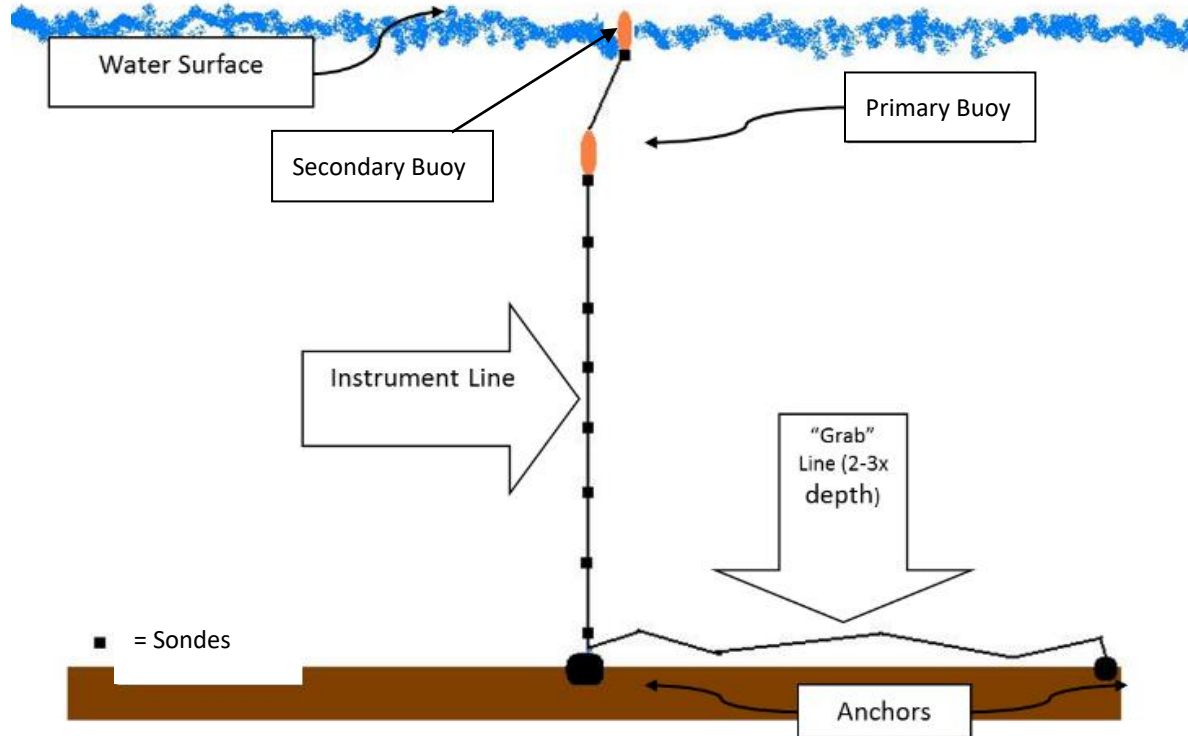


Figure 5.1 Diagram of a vertical profile deployment (Stamp 2020)

5.2.2. Equipment and Supplies

Table 5.1 provides the equipment and supplies needed for a continuous temperature and DO vertical profile deployment.

Table 5.1 Equipment and supplies – continuous temperature and DO vertical profiles

Type	Item	Quantity
Field Sheet	Vertical Profile Deployment	1 per lake
Collection: Continuous Temperature Dissolved Oxygen	Sonar unit	1 per lake
	Onset HOBO DO and temperature data logger (DO/T)	2 per lake
	Onset HOBO Tidbits MX data logger (Temp)	As needed
	Instrument rope line – length based on lake depth (e.g., ¼" solid braided polyester rope, ½" braided poly rope, 3/8" Potwarp)	1 per lake
	Floating line (grab line)	As needed
	Primary buoy (sub-surface)	1 per lake
	Secondary buoy (surface)	1 per lake
	Primary anchor (instrument line)	1 per lake
	Secondary anchor (grab line)	1 per lake
	Supplemental floats for grab line	2 per lake
	Multiprobe - YSI EXO Sonde and Logger (temperature, DO, pH, conductivity)	1



Table 5.1 Equipment and supplies – continuous temperature and DO vertical profiles

Type	Item	Quantity
	1 m metallic ruler	1 per lake
	Sounding line w/weighted grappler	1 per lake
	Deploy toolkit (adjustable wrench, screwdriver, work gloves)	1

5.2.2.1. Deployment Sondes

The sondes used for the continuous temperature and DO vertical profiles are the Onset HOBO dissolved oxygen and temperature data logger and HOBO Tidbit MX temperature data logger. The **TAM Coordinator** is responsible for requesting calibrated deployment sondes from the **Field and Laboratory Operations Coordinator** for all surveys that require them. The request must be made no later than one week before the survey. The **Field and Laboratory Operations Coordinator** or designee calibrates the deployment sondes the day before or the morning of the survey. A YSI EXO multi-probe sonde and logger is included in the deployment sonde calibration request to collect discrete vertical profile measurements for QA/QC purposes.

5.2.3. Vertical Profile Deployment Procedure

1. Deployment Preparations (*Completed at the base station*)
 - a. Determine the depth of the lake at the **Index Site** (point of maximum depth) using existing bathymetric maps or depth data collected on previous surveys.
 - b. Construct the vertical instrument line (primary subsurface buoy – instrument line – primary anchor). The bottom of the primary subsurface buoy should be approximately 0.75 to 1.0 m below the water surface. Include attachment points (e.g., rope loops, stainless steel links) for the secondary surface buoy line at the top and the grab line at the bottom. The purpose of the primary subsurface buoy is to keep the instrument line taut and vertical.
 - c. Construct the grab line (approximately 2-3x the depth) with floating line (place supplemental floats on the float line if necessary), and the secondary anchor. The grab line is attached to the instrument line at the primary anchor using stainless steel links. The grab line can be attached just before deployment.
 - d. Construct the secondary surface buoy line with regular (non-floating) line and the surface buoy. Leave approximately 1.5 – 2.0 m of line between the subsurface buoy and surface buoy. The secondary surface buoy line can be attached just before deployment. The surface buoy should have signage that clearly conveys the project and contact information so everyone may know the purpose of the deployment and who to contact for questions or issues.
 - e. Attach the calibrated deployment sondes (Onset DO/T and Onset Tidbits) to the instrument line. The Onset DO/T sondes are attached just below the bottom of the subsurface buoy (approx. 0.75 to 1.0 m below the surface) and 0.75 - 1.0 m from the



mid-point of the primary anchor on the instrument line. The Onset Tidbit temperature sondes are attached on the instrument line between the Onset DO/T sondes.

- i. If the lake is less than 5 m in depth, Onset Tidbit temperature sondes are attached approximately every 0.5 m between the Onset DO/T sondes on the instrument line.
 - ii. If the lake is more than 5 m in depth, Onset Tidbit temperature sondes are attached approximately every 1.0 m between the Onset DO/T sondes on the instrument line.
 - f. Use the **Vertical Profile Deployment** field sheet to record the sonde identification number (Sonde ID#), OWMID, and sonde type (DO/T, Temp, Other). Record information in the order (top to bottom) that the sondes are attached on the instrument line. Measure the distance from the top of the primary subsurface buoy to each attached sonde and record in the Measured Sensor Stringer Depth column on **Vertical Profile Deployment** field sheet. Record the basic site information (Unique ID, Station Name, Project, crew) if not already completed.
2. Sonde Deployment
 - a. Navigate to the **Index Site** and anchor the boat. In windy conditions, it may be advisable to anchor the boat on both the bow and stern. **(NOTE: IF WATER QUALITY SAMPLE COLLECTION IS OCCURRING ON THE SAME SITE VISIT, COLLECT WATER SAMPLES FIRST)**
 - b. Measure the lake depth at the **Index Site** using a sonar unit. If there is any uncertainty on the accuracy of the sonar unit, check the depth with a weighted sounding line. If this depth measurement is significantly different ($> \pm 0.5$ m) from the selected depth used to construct the instrument line, reposition the boat to a more appropriate depth OR adjust the instrument line and/or the location of the sondes on the line as appropriate.
 - c. Record the Sonar Max Depth on the **Vertical Profile Deployment** field sheet.
 - d. Deploy the vertical instrument line.
 - i. Attach the grab line with the secondary anchor and secondary surface buoy line to the instrument line.
 - ii. Lower the primary anchor and instrument line slowly and in a controlled manner into the water while keeping the secondary surface buoy and secondary anchor in the boat. The grab line (attached to the secondary anchor) can be used in combination with the instrument line to lower the primary anchor to the bottom. **Use caution to avoid hitting the sondes on the side of the boat when lowering the instrument line.**
 - iii. If needed, use the AquaView camera to assess the success of the deployment (e.g., is the instrument line tangled? did the primary anchor hit something on the bottom and rollover?). If the deployment is satisfactory, the secondary buoy and line can be placed in the water.



- iv. Pull up the boat anchor(s) and motor or row due north from the deployment while running out the grab line. Once all the grab line is out, drop the secondary anchor attached to the grab line into the water.
 - e. Record the Start Date and Immersion Time on the **Lake Vertical Profile Deployment** field sheet.
 - f. Return to the deployed vertical instrument line.
 - i. Measure the distance from the surface of the water to the top of the sub-surface buoy using a meter stick and record it on the **Vertical Profile Deployment** field sheet in the Sub-Surface Buoy Depth field.
 - ii. Add the Sub-Surface Buoy Depth to each of the Measured Sensor Stringer Depths and record the results in the Calculated Sensor Water Depth column on the **Vertical Profile Deployment** field sheet.
 - iii. Using a field GPS unit, record the coordinates of the sub-surface buoy in the **Field Latitude and Field Longitude** fields on the **Vertical Profile Deployment** field sheet.
 3. QA/QC Checks using a multiprobe and logger.
 - a. See Section 5.3 generally and 5.3.4 specifically for guidance.

5.3. Discrete Temperature, DO, pH and Conductivity Vertical Profiles

5.3.1. Summary of Method

Use a multi-parameter water quality sonde (multiprobe) to measure temperature, DO, conductivity and pH at predefined depth intervals. The predefined intervals are based on the index site depth and the location of any sondes deployed on a vertical instrument line. Lower the multi-probe sonde into the water and record the vertical profile of temperature, DO, conductivity and pH at the predetermined depth intervals. Avoid putting the sonde into contact with the bottom sediments as this will likely result in inaccurate measurements. An accurate measure of the current index site depth using a sonar unit will help prevent this from occurring.

5.3.2. Equipment and Supplies

Table 5.2 provides the equipment and supplies needed to measure the temperature, DO, pH and conductivity profiles.

Table 5.2 Equipment and supplies – discrete temperature, DO, pH and conductivity vertical profiles

	Type	Item	Quantity
No Sondes Deployed	Field sheet	Lakes Field Sheet (Index Site)	1
		EDGE tablet (pre-loaded with survey information)	1
	Collection: Water column depth	Sonar unit	1 per lake
	Collection:	Multiprobe - YSI EXO Sonde and Logger	1



Table 5.2 Equipment and supplies – discrete temperature, DO, pH and conductivity vertical profiles

	Type	Item	Quantity
	Profile measurements	(temperature, DO, pH, conductivity)	
Sondes Deployed	Field sheet	Vertical Profile Deployment	1
	Collection: Water column depth	Sonar unit	1 per lake
	Collection: Profile measurements	Multiprobe - YSI EXO Sonde and Logger (temperature, DO, pH, conductivity)	1
		1 m metallic ruler	1 per lake
		Sounding line w/weighted grappler	1 per lake
		Deploy toolkit (adjustable wrench, screwdriver, work gloves)	1

5.3.2.1. Multiprobe Sonde

Vertical profile data will be collected with a multi-probe sonde (YSI EXO sonde and logger). The **TAM Coordinator** is responsible for requesting calibrated multi-probes from the **Field and Laboratory Operations Coordinator** for all surveys that require them. The request must be made no later than one week before the survey. If sondes are deployed on an instrument line at the site, the request for the calibrated multi-probes is done in conjunction with the request for the deployed sondes. The **Field and Laboratory Operations Coordinator** will calibrate the multi-probe the day before or the morning of the survey. More detailed information regarding the operation of the multiprobe sondes and logger can be found in Appendix F.

5.3.3. Discrete Vertical Profile (No Sondes Deployed)

5.3.3.1. Index Site and Index Site Profile Field Sheets

If sondes are not deployed in the lake, use the Multiprobe Information section in the **Lakes Field Sheet (Index Site)** to record the discrete vertical profile data, not the **Vertical Profile Deployment** field sheet.

Use the Observation section of the **Lakes Field Sheet (Index Site)** to record the following:

- The depth at the index site and the method used to measure the depth in the Sample Data section on page 2.

Use the Multiprobe Information section of the **Lakes Field Sheet (Index Site)** to record the following:

- The sonde and logger identification numbers and calibration information on the top of the page.
- The OWMID assigned to all the discrete vertical profile measurements is located in the Multi-Probe Information section. OWMIDs are assigned by the **TAM Coordinator** prior to each survey.
- The profile table is located in the Multi-Probe Data section. It includes columns to record time, depth, temperature, DO, percent saturation, conductivity, and pH (as well as optional total dissolved solids and phycocyanin). Each row includes measurements collected at a single depth. If the number of rows in the profile table is insufficient to record the entire profile use an additional page to complete the profile.



5.3.3.2. Vertical Profile Procedure

These are the step-by-step procedures for using a multiprobe to measure temperature, pH, conductivity, and DO vertical profiles at the index site.

1. Multiprobe Preparation:
 - a. Remove storage cup (YSI EXO – storage cup is over the sonde guard). **CHECK TO ENSURE THE SONDE IS SECURELY ATTACHED TO THE DATA CABLE.** If necessary, attach the sonde weight to the end of the sonde guard (e.g., windy conditions).
 - b. Record the sonde and logger identification numbers on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section.
 - c. Calibrate the depth with the sonde out of the water and indicate on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section that this step was completed.
 - d. Select the OWMID identified on the **Lakes Field Sheet (Index Site)** in the Multiprobe Information section from the pre-loaded list in the logger. Manually enter the OWMID if it is not listed.
2. Determine Site Depth:
 - a. Accurately measure the depth using a sonar unit or other means and record on the **Lakes Field Sheet (Index Site)**.
 - b. Record the method used to determine the depth on the **Lakes Field Sheet (Index Site)**.
3. Determine Measurement Intervals:
 - a. The number of measurements and the depth intervals between measurements depends on the site depth. Below is a list of rules for determining the intervals between measurements:
 - i. The vertical profile will always begin with a measurement just below the surface (0.5 m).
 - ii. If the site is less than 5.0 m deep, record measurements beginning just below the surface (0.5 m) and then at 0.5 m intervals, until approximately 0.5 m above the lake bottom.
 - iii. If the depth is greater than 5.0 m, record measurements beginning just below the surface (0.5 m) and then at 1.0 m intervals until reaching approximately 0.5 m above the lake bottom.
 - iv. The depth of the last measurement (just above the lake bottom) should be determined conservatively and take in account max depth and bottom substrate uncertainty to avoid lowering the sonde into the bottom sediment or sediment/water interface (e.g., soft bottom).
Example: the sonar indicates the maximum depth is 4.1 m; the depth of the last measurement should be 3.5 m.
4. Measure Temperature, DO, pH and conductivity:
 - a. Lower the sonde in the water column and measure the vertical profile of temperature, DO, pH and conductivity at the predetermined depth intervals as described above (top



- to bottom direction). Use caution to avoid lowering the sonde into the bottom sediment or sediment/water interface.
- Let readings stabilize (using the Auto Stable function in the YSI logger or manually) at each measurement depth before starting to log readings.
 - Log measurements in the logger for 3 minutes (logger automatically stores measurements every 15 seconds) at each predetermined depth. Record the last set of logged measurements from each depth on the **Lakes Field Sheet (Index Site)** in the Multiprobe Data section.
 - Note any measurements that need additional comments (e.g., parameter instability, last measurement may have been in the sediment/water interface) or when a measurement cannot be made in the Probe Notes section.

5.3.4. Discrete Vertical Profile (*Sondes Deployed QA/QC Check*)

Discrete vertical profiles conducted when sondes are deployed on a vertical instrument line in the lake serve two purposes. The discrete vertical profile serves both as a QA/QC check on the deployed sondes and as additional information regarding physicochemical (e.g., pH and conductivity) conditions in the lake. The vertical profile can also serve as backup DO and temperature data if the deployed sondes fail to meet QA/QC criteria.

5.3.4.1. Lake Vertical Deployment Field Sheet

If sondes are deployed in the lake, use the **Vertical Profile Deployment** field sheet and the QC Multiprobe – Vertical Profile Deployment section to record the discrete vertical profile data and not the Multiprobe Information section in the **Lakes Field Sheet (Index Site)**.

Use the **Vertical Profile Deployment** field sheet to record the following:

- The multiprobe sonde and logger identification numbers and calibration information near the top of the QC Probe – Vertical Profile Deployment section. Three QC Probe – Vertical Profile Deployment pages are provided in the field sheet for three QA/QC events. If there are additional QA/QC events add additional QC Probe – Vertical Profile Deployment pages.
- The OWMID assigned to all the discrete vertical profile measurements is located in the QC Probe – Vertical Profile Deployment section. OWMIDs are assigned by the **TAM Coordinator** prior to the deployment survey.
- The profile table is located in the QC Probe – Vertical Profile Deployment section. It includes columns to record time, depth, temperature, DO, percent saturation, conductivity, and pH (as well as optional total dissolved solids), and which deployed sonde is located at that depth. Each row includes measurements collected at a single depth. If the number of rows in the profile table is insufficient to record the entire profile use an additional page to complete the profile.



5.3.4.2. Vertical Profile Procedure

These are the step-by-step procedures for using a multiprobe to measure temperature, pH, conductivity, and DO vertical profiles at the index site.

1. Examine the vertical line deployment (buoys and lines). Note any issues in the Vertical Profile Deployment Notes section of the **Vertical Profile Deployment** field sheet. Also indicate in the QC Probe – Vertical Profile Deployment section if the deployment has moved. Examples of issues or evidence of movement that could be noted: instrument line is not taut, grab line is floating at the surface, surface buoy is missing, etc.
2. Determine the depths of the deployed sondes:
 - a. Measure the distance from the surface of the water to the top of the sub-surface buoy and record it on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
 - b. Add the Sub-Surface Buoy Depth measured on the QC date to each of the Measured Sensor Stringer Depths in the Vertical Profile Deployment information section and note the current water depth of each sonde deployed on the vertical instrument line.
Measurements should be collected at all depths with deployed sondes.
3. Multiprobe Preparation:
 - a. Remove storage cup (YSI EXO – storage cup is over the sonde guard). **CHECK TO ENSURE THE SONDE IS SECURELY ATTACHED TO THE DATA CABLE.** If necessary, attach the sonde weight to the end of the sonde guard.
 - b. Record the sonde and logger identification number on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
 - c. Calibrate the depth and indicate on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section that it was completed.
 - d. Select the correct OWMID identified on the **Vertical Profile Deployment** field sheet in the Multiprobe – Vertical Profile Deployment section from the pre-loaded list in the logger. Manually enter the OWMID if it is not listed.
4. Determine Site Depth:
 - a. Accurately measure the depth using a sonar unit or other means and record on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
5. Determine Measurement Intervals:
 - a. The number of measurements and the depth intervals between measurements depends on the site depth and deployed sonde depths. Below is a list of rules for determining the intervals:
 - i. The vertical profile will always begin with a measurement just below the surface (0.5 m).
 - ii. Record measurements at each depth corresponding to a deployed sonde (See Step 1). Record the probe number from Vertical Profile Deployment Information section that corresponds to the probe deployed at the measurement depth.



- iii. The vertical profile will always end with a measurement just above the lake bottom (approximately 0.5 m). The depth of the last measurement should be determined conservatively and take in account max depth and bottom substrate uncertainty to avoid lowering the sonde into the bottom sediment or sediment/water interface (e.g., soft bottom).
 - iv. Add additional measurements at depths without deployed sondes as needed to complete the profile. It may be necessary to add measurements at depths between deployed sondes to complete the profile (i.e., insufficient probes to deploy at planned depths). Use the general convention described in section 5.3.3 (3a) for guidance.
6. Measure Temperature, DO, pH and conductivity:
- a. Lower the sonde in the water column and measure the vertical profile of temperature, DO, pH and conductivity at the predetermined depth intervals (top to bottom direction). Use caution to avoid lowering the sonde into the bottom sediment or sediment/water interface.
 - b. Let readings stabilize (using the Auto Stable function in the YSI logger or manually) at each measurement depth before starting to log readings.
 - c. Log measurements in the logger for 3 minutes (logger automatically stores measurements every 15 seconds) at each predetermined depth. Record the last set of logged measurements from each depth on the **Vertical Profile Deployment** field sheet in the QC Probe – Vertical Profile Deployment section.
 - d. Note any measurements that need additional comments (e.g., instability, last measurement may have been in the sediment/water interface) or when a measurement cannot be made in the Multiprobe QC Notes section.

5.4. Secchi Disk Transparency

5.4.1. Summary of Method

A Secchi disk is a round opaque 20 cm disk with alternating black and white quadrants that is lowered into the water column to measure the lake's transparency or clarity (see Figure 5.2). Take the reading on the sunny side of the boat using a Viewscope without sunglasses or a hat. Record the depths where the disk disappears when descending and reappears when retrieving.

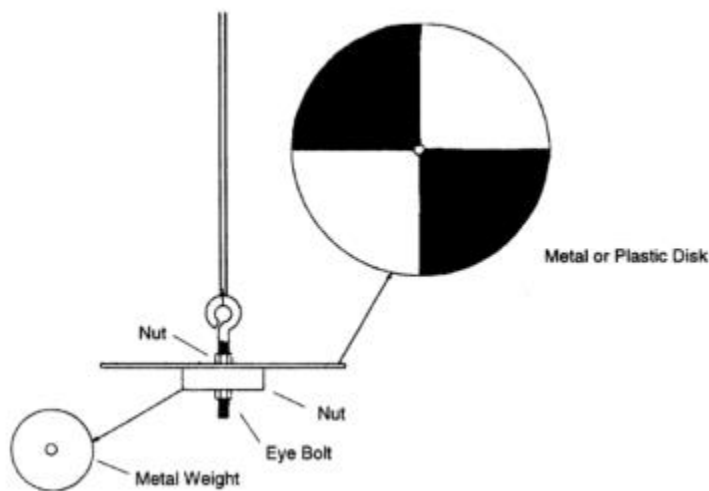


Figure 5.2 Secchi disk diagram (USEPA 1991).

5.4.2. Equipment and Supplies

Table 5.3 provides the equipment and supplies needed to measure the Secchi Disk transparency.

Table 5.3 Equipment and supplies – Secchi disk transparency

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
	EDGE tablet (pre-loaded with survey information)	1
Collection: Secchi Disk transparency	Secchi Disk (20 centimeters)	1 per lake
	Sounding line (20 m, calibrated, marked in 0.1 m intervals)	1 per lake
	Viewscope	1 per lake

5.4.3. Procedure for Determining Secchi Disk Transparency

Note that the optimal time to measure Secchi disk transparency is within 3 hours of solar noon so take measurements approximately between the hours of 10 am and 4 pm, if practicable. Solar noon is approximately 1 PM Daylight Saving Time, which applies to the typical summer sampling period.

Measure Secchi disk transparency:

1. Verify that the Secchi disk line has been calibrated and accurately marked in 0.1 m increments.
2. Without the use of sunglasses, vertically insert one end of the Viewscope a few inches into the water on the sunny side of the boat to eliminate the effects of ripples and glare on the observation.



3. Lower Secchi disk so it is not in the boat's shadow. If no Viewscope is available, lower the Secchi disk from the shaded side of the boat and note on the **Lakes Field Sheet (Index Site)** that the Viewscope was not used.
4. While observing through the Viewscope tube, record Secchi disk depth as the average of the observed depth to complete disappearance and the slightest hint of reappearance. Record the Secchi disk depth (nearest 0.1 m), measurement conditions, and the time of the measurement on the **Lakes Field Sheet (Index Site)**.
5. If Secchi disk is visible on the bottom of the lake, record the depth (nearest 0.1 m) as the Secchi disk depth and indicate it was on the bottom on the **Lakes Field Sheet (Index Site)**.
6. For situations with complete lake surface cover (e.g., algal scum, complete duckweed or macrophyte cover at the surface), clear an area at the surface temporarily in order to observe the disk and get an accurate measurement (if possible, noting conditions). Where it is not possible to create a temporary clear vertical column to take a measurement, do not take a measurement (and note conditions).
7. Repeat the procedure with a different crew member and record the measurement (Dup) on the **Lakes Field Sheet (Index Site)** next to the first measurement.

5.5. Water Sample Collection and Preservation

5.5.1. Summary of Method

Collect ALL water samples using a Van Dorn sampler. This sampler allows samples to be collected at discrete depths in the water column. The Van Dorn sampler is an open tube with spring loaded seals and valves on both ends of the tube and is suspended on a line calibrated and accurately marked at 0.1 m intervals (Figure 5.3). The sampler is lowered to the desired depth in the water column and a weight or messenger is sent down the line holding the sampler to trigger the spring mechanism that shuts the end seals. The sampler is retrieved, and its contents are dispensed to the appropriate sample containers.

Pre-rinse the Van Dorn sampler once with lake water from the selected collection depth prior to collecting samples. Set the spring-loaded end seals on the Van Dorn sampler and lower it to 0.5 m (surface), trigger the end seals, and retrieve the sampler. Dispense the contents into the appropriate sample containers for storage. Complete additional sampler drops as necessary to collect the needed volume of water. Repeat this process to collect samples at 0.5 – 1.0 m above the lake bottom (near bottom). Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and cause inaccurate results. Preserve the samples using the appropriate method for each sample analyte.

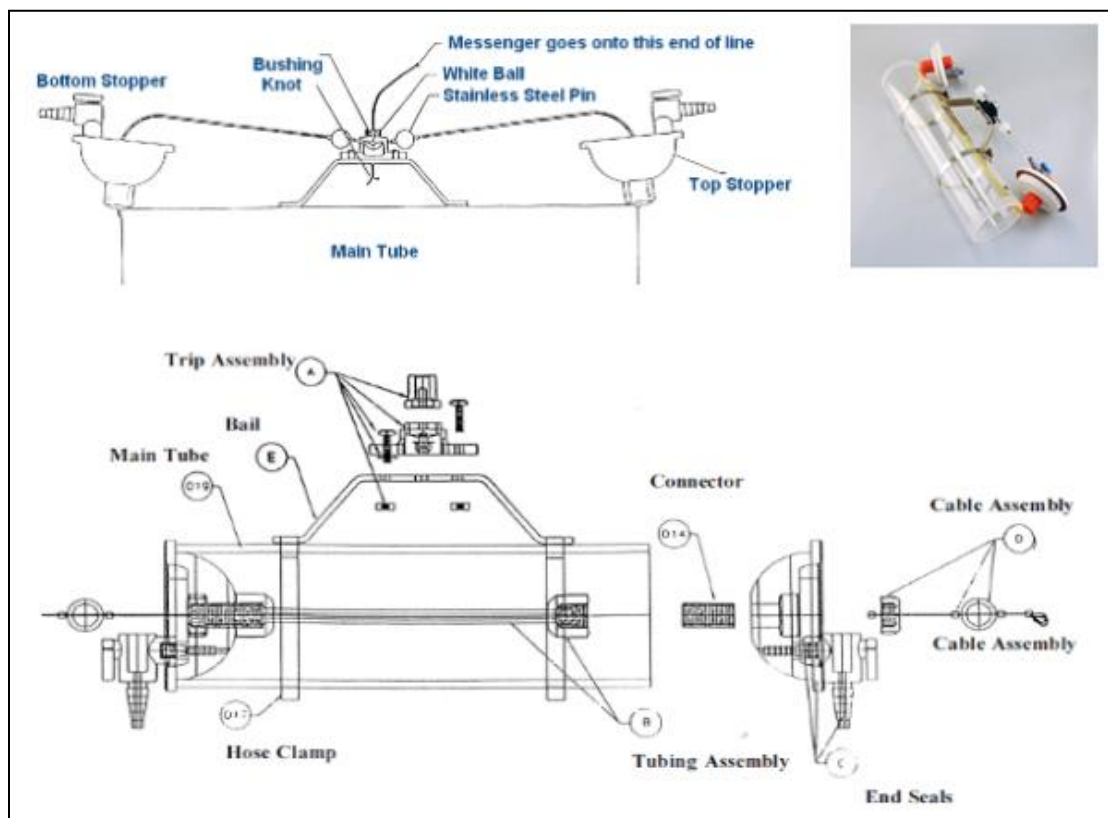


Figure 5.3 Van Dorn samplers

5.5.2. Equipment and Supplies

Table 5.4 provides the equipment and supplies needed to collect water samples at the index site.

Table 5.4 Equipment and supplies – water sample collection

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
	EDGE tablet (pre-loaded with survey information)	1
Collection: Water Sample	Van Dorn sampler 2.2 L (Beta)	1 per lake
	Disposable syringe (60 mL)	1 per lake
	Syringe filter (0.45 um)	1 per lake
	Deionized (DI) water (3L – QC lakes)	1
Storing & Preservation	HDPE bottle (500 mL, natural, narrow mouth) Total Alkalinity	1 per lake
	HDPE bottle (500 mL, natural, narrow mouth) Total Hardness	1 per lake
	HDPE bottles (120 mL, natural, wide mouth) Color/turbidity	1 per lake
	Amber glass vials (40 mL, glass vial pre-preserved with H ₃ PO ₄) Dissolved organic carbon	2 per lake



Table 5.4 Equipment and supplies – water sample collection

Type	Item	Quantity
	HDPE bottles (250 mL, natural, wide mouth) Nutrients (surface), nutrients (near bottom)	2 per lake
	HDPE bottles (60 mL, natural, wide mouth) Chloride	1 per lake
	1 mL 9N H ₂ SO ₄ vials	2 per lake
	2 mL 1:1 HNO ₃ vial – total hardness (Added post-survey in WPP lab)	1 per lake
	Wet ice	As need
	Cooler	1

5.5.3. Sampling Procedure

Collect and preserve water samples:

1. Check the OWMIDs on the bottle labels to confirm the bottles are correct for the site and depth, then organize the bottles for sampling. (e.g., filtered samples, near bottom)
2. Rinse the Van Dorn sampler with lake water at 0.5 m (near surface) by collecting an initial sample.
 - a. Set the spring-loaded end seals on the sampler to the open position and lower it to the near surface depth (0.5 m) using the marked line (0.1 m intervals).
 - b. Wait a few seconds, send the messenger to trigger closing the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
 - c. Open both drain valves to rinse the stoppers on the end seals. Dispose of rinse water (i.e., initial sample) on opposite side of the boat from the sample collection side.
3. Collect samples at 0.5 m (near surface) using the Van Dorn sampler.
 - a. Set the spring-loaded end seals on the sampler to the open position and lower it to the near surface depth (0.5 m) using the marked line (0.1 m intervals). **Check that the drain valves are closed prior to setting the spring-loaded end-seals.**
 - b. Wait a few seconds, send the messenger to trigger closing the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
 - c. Rinse the listed sample bottles three times (cap/shake/discard) using the water from the sampler. Use the drains on the end seals to dispense the water the bottles.
 - i. 500 mL total alkalinity bottle
 - ii. 500 mL total hardness bottle
 - iii. 250 mL nutrients (near surface) bottle
 - iv. 60 mL chloride bottle
 - v. 120 ml color/turbidity bottle



- d. Fill each of the rinsed sample bottles (excluding the total alkalinity bottle) to the shoulder (approx. ½" head space) with the water from the sampler. **Fill the total alkalinity sample bottle completely with the water from the sampler leaving NO head space.**
- e. Rinse the 60 mL syringe three times with water from the sampler and attach the 0.45 um filter to the syringe.
- f. Fill the syringe with water from the sampler and flush the 0.45 um filter with approximately 20 - 30 mL of sample water.
- g. Repetitively fill the syringe and filter the water from the sampler to sample bottles. Fill the two 40 mL DOC vials (**w/ no rinse**). The DOC bottle is pre-preserved with H₃PO₄, so use caution to avoid losing the preservative (e.g., overfilling, tipping) when collecting the sample. Remove the filter prior to pulling the plunger out to refill the syringe then reattach before filling the syringe again.
4. Rinse the Van Dorn sampler with lake water from approximately 0.5 – 1.0 m above the lake bottom (near bottom) by collecting an initial sample.
 - a. Set the spring-loaded end seals on the sampler to the open position and lower it to the near bottom depth using the marked line (0.1 m intervals). **Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and lead to inaccurate results.**
 - b. Wait a few seconds, send the messenger to trigger closing the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
 - c. Open both drain valves to rinse the stoppers on the end seals. Dispose of rinse water (i.e., initial sample) on opposite side of the boat from the sample collection side.
5. Collect samples at approximately 0.5 – 1.0 m up from the lake bottom (near bottom) using the Van Dorn sampler.
 - a. Set the spring-loaded end seals on the sampler to the open position and lower it to the near bottom depth using the marked line (0.1 m intervals). Check that the drain valves are closed prior to setting the spring-loaded end-seals. **Use caution to avoid lowering the sampler into the bottom sediments or sediment/water interface which could contaminate the sample and lead to inaccurate results.**
 - b. Wait a few seconds, send the messenger to trigger closing the end seals, and retrieve the sampler slowly. Make sure that there is a good seal at both ends before pulling the sampler into boat.
 - c. Rinse the 250 mL nutrient (near bottom) bottle three times using the water from the sampler.
 - d. Fill the rinsed sample bottle to the shoulder (approx. ½" head space) with the water from the sampler.
6. Preserve the samples bottles as indicated on the COC forms.
 - a. 500 mL total alkalinity bottle - Cool to 4°C



- b. 500 mL total hardness bottle - Cool to 4°C, 2 mL 1:1 HNO₃ (**added at WPP lab**)
- c. 250 mL nutrients (surface) bottle - Cool to 4°C, 1 mL 9N H₂SO₄
(Larger sample volumes will require more H₂SO₄.)
- d. 250 mL nutrients (near bottom) bottle - Cool to 4°C, 1 mL 9N H₂SO₄
(Larger sample volumes will require more H₂SO₄.)
- e. 60 mL chloride bottle - Cool to 4°C
- f. 120 mL color/turbidity bottle - Cool to 4°C
- g. 40 mL dissolved organic carbon amber glass vials (2) - Cool to 4°C, pre-preserved with H₃PO₄
7. Place all samples in the cooler with ice.
8. Record the sample times, depths, analyses, and types on the **Lakes Field Sheet (Index Site)**.

5.6. Chlorophyll-a and Phytoplankton Assemblage

5.6.1. Summary of Method

Collect the chlorophyll-a and phytoplankton depth integrated samples from the top 2 m of the water column using a depth integrated sampler. There are two exceptions for the 2 m sample integration depth. If the euphotic zone (estimated as 2 times the Secchi disk transparency) is less than 2 m deep, the integration depth is the depth of the euphotic zone. If the lake depth is less than 2.5 m and the estimated euphotic zone is greater than or equal to the lake depth, the integration depth is the lake depth minus 0.5 m. There are two options for the depth integrated sampler: a 3 m flexible metered PVC tube with an inner diameter of 1.3 cm and a weight attached to the end (tube depth integrated sample) and a 2 m solid metered PVC pipe with an inner diameter of 3.5 cm with ball valves on both ends (pipe depth integrated sampler) (Figure 5.4).

Lower the depth integrated sampler down to the correct integration depth, clamp the tube or close the pipe ball valve above the water surface and pull the depth integrated sampler up through the water column, plugging the end of the tube or closing the bottom pipe ball valve prior to breaking the water surface. Hold the end of the depth integrated sampler near the mouth of a sample compositing container and release the tube clamp or open pipe ball valves to allow the water to drain out into the sample compositing container. Repeat the sampling procedure until a minimum of 750 mL is collected in the sample compositing container. Mix the sample in the compositing container and dispense to the appropriate sample containers. Preserve the samples as needed using the appropriate methods.

5.6.2. Equipment and Supplies

Table 5.5 provides the equipment and supplies needed to collect chlorophyll-a and phytoplankton samples at the index site.



Table 5.5 Equipment and supplies – chlorophyll-a and phytoplankton sample collection

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
	EDGE tablet (pre-loaded with survey information)	1
Collection: Depth Integrated Sample	Depth integrated sampler	1 per lake
	Sample composite container (2L)	1 per lake
	Secchi disk w/sounding line (0.1 m increments)	1 per lake
	Funnel	1
	Deionized (DI) water (2L – QC lakes)	1
Storing & Preservation	HDPE bottle (250 mL, amber, rectangle) Phytoplankton	1 per lake
	HDPE bottles (250 mL, amber, round) Chlorophyll-a	1 per lake
	Disposable graduated pipettes	2
	Lugol's solution (6 mL) (<i>Added post-survey in WPP lab</i>)	6 mL
	Wet ice	As need
	Cooler	1

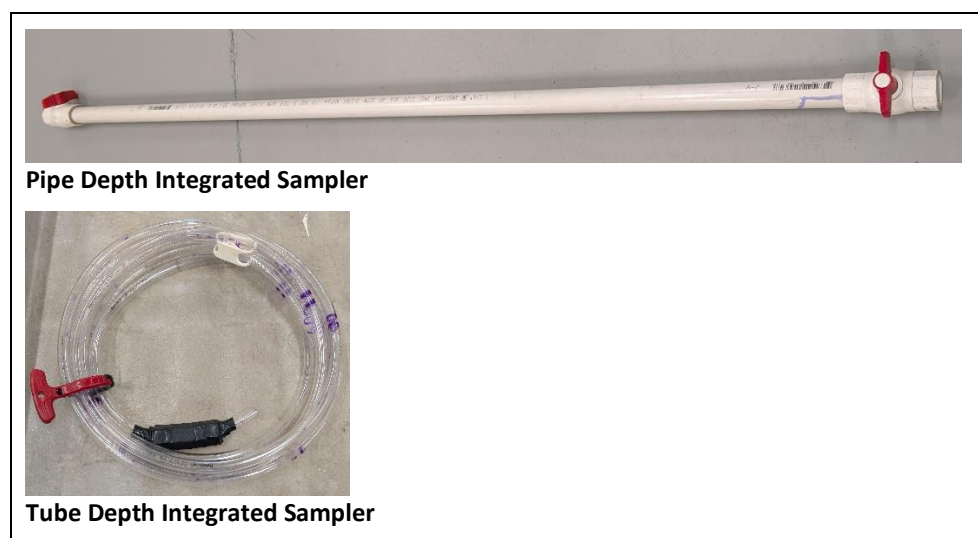


Figure 5.4 Depth integrated samplers

5.6.3. Sampling Procedures

Collect and preserve water samples:

1. Check OWMIDs to confirm the selected bottles are correct and to organize the bottles for sampling.
2. Measure Secchi disk transparency depth (Section 5.2) and multiply the measurement by two to estimate the euphotic zone.
3. Determine the appropriate sample integration depth.



- a. If the estimated euphotic zone is greater than 2 m and the lake depth is greater than 2.5 m, the integration depth is 2 m.
 - b. If the estimated euphotic zone is less than 2 m deep and the lake depth is greater than 2.5 m, the integration depth is the depth of the estimated euphotic zone.
 - c. If the lake depth is less than 2.5 m and the estimated euphotic zone is greater than or equal to the lake depth, the integration depth is the lake depth minus 0.5 m.
4. Pre-rinse the depth integrated sampler with lake water by collecting an initial sample.
 - a. Lower the depth integrated sampler down to the integration depth, clamp the tube or close the top ball valve above the water surface and pull the depth integrated sampler up and out of the water. Place your thumb over the end of the tube or close the bottom ball valve before it breaks the water surface to prevent the sample from leaking out of the tube.
 - b. Hold the end of the depth integrated sampler on opposite side of the boat from the sample collection side and release the tube clamp or open the ball valves to allow the water to drain into the lake.
5. Collect samples using the depth integrated sampler.
 - a. Lower the depth integrated sampler down to the integration depth, clamp the tube or close the top ball valve above the water surface and pull the depth integrated sampler up and out of the water. Place your thumb over the end of the tube or close the bottom ball valve just before it breaks the water surface to prevent the sample from leaking out of the tube.
 - b. Hold the end of the depth integrated sampler near the mouth of a sample compositing container and release tube clamp or open the ball valves to allow the water to drain out into the sample compositing container.
 - c. Repeat this process until a minimum of 750 mL is collected in the sample compositing container. Approximately, 125 mL is collected for every meter that the tube depth integrated sampler is lowered into the water column and 900 mL is collected for every meter the pipe depth integrated sampler is lowered into the water column.
 - d. Rinse the 250 mL phytoplankton bottle and 250 mL chlorophyll-a bottle one time with water from the sample compositing container. Fill the sample bottles to the shoulder with water from the sample compositing container. DO NOT fill the phytoplankton bottle beyond the shoulder to allow appropriate preservation. **Mix the sample in the compositing container prior to filling each bottle.**
6. Preserve the samples bottles as indicated on the COC forms.
 - a. 250 mL phytoplankton bottle - Cool to 4°C, 5 mL Lugol's solution. **On single day surveys, the Lugol's solution is added to the phytoplankton samples at the base station (WPP lab).**
 - b. 250 mL chlorophyll-a bottle - Cool to 4°C
7. Place all samples in the cooler with ice.



8. Record the sample times, integration depths, analyses, and types on the **Lakes Field Sheet (Index Site)**.

5.7. Condition Observations

5.7.1. Summary of Method

Collect semi-quantitative data on weather conditions, aesthetic conditions, potential pollution sources and macrophyte composition and density. This data will provide a general description of the lake conditions at the time of sample collection. Visually observe conditions on the lake while in transit to the index site and following the collection of samples at the index site. Record the semi-quantitative observations in the appropriate sections on the **Lakes Field Sheet (Index Site)**.

5.7.2. Equipment and Supplies

Table 5.6 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the lake.

Table 5.6 Equipment and supplies – visual semi-quantitative observations (Index site)

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Index Site)	1
	EDGE tablet (pre-loaded with survey information)	1
	Macrophyte Identification/Voucher	1
Collection: Visual Observations	Macrophyte key (non-natives)	1
	Viewscope	1
	Compass (GPS unit)	1

5.7.3. Sampling Procedures

Observe and record lake conditions at the Index Site:

1. Observe weather conditions including air temperature, wind and wave conditions, and lake level. Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the observations.
 - a. If available, use a current air temperature from a smartphone weather application or a display in a vehicle versus estimating.
 - b. If uncertain about the wind direction, use a compass to determine the direction.
 - c. If the lake level is not normal, estimate the difference from normal (ft) and record on the field sheet.
2. Observe the lake aesthetic conditions (odor, turbidity, color, objectionable deposits, and floating scum). Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the observations.
 - a. If “other” is selected for any observation description, make notes describing the observation.



- b. Describe the details, extent and severity of any significant objectionable deposits or floating scum in the space provided or General Notes. Especially note if the deposits or scum are minor or natural.
3. Based on the observations of aesthetic conditions, indicate on the **Lakes Field Sheet (Index Site)** whether the field crew considers the lake aesthetic use to be impaired by those conditions.
 - a. Aesthetics are by nature subjective so there should be robust discussion between field crew members on the question of impairment.
4. Examine the lake and shoreline for existing beneficial uses and pollution sources. Check the categories on the **Lakes Field Sheet (Index Site)** that best describes the observations.
 - a. Describe the details, extent and severity of any observed beneficial uses or pollution sources in the space provided or the General Notes.
5. Observe macrophyte densities at the Index Site. Check the appropriate density description (none, sparse, moderate, dense, or very dense) for each macrophyte category in the Station Specific Plant Density section and record the species, if known, on the **Lakes Field Sheet (Index Site)**.
6. Observe algal density and water column characteristics (e.g., color, transparency, pH, DO saturation) to determine if a bloom is occurring. If a bloom is occurring, check the categories on the **Lakes Field Sheet (Index Site)** that best describes the evidence, type, and extent/severity of the bloom.
 - a. Physicochemical water characteristics (e.g., DO saturation and pH) could provide evidence of a bloom so complete this section after the vertical profile measurements.
7. If any non-natives macrophyte species are observed while in transit to or at the Index Site, note them on a **Macrophyte Identification/Voucher** field sheet. Record the species observed, observation location (e.g., near access point) and the purpose for the observation (i.e., “non-native”).
 - a. If a **Macrophyte Identification/Voucher** field sheet is required, be sure to complete the site information section of the field sheet including the field sheet log ID from the corresponding **Lakes Field Sheet (Index Site)** or the survey.
 - b. If a suspected non-native macrophyte is observed, collect a voucher in a reclosable plastic bag, label the bag with site ID, voucher ID, and the date. Record the voucher ID, observation location and the observation purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.
 - c. If more than one macrophyte voucher sample is collected, place all the vouchers in a larger reclosable plastic bag and label it with site ID and the date. Keep all macrophyte vouchers in a cooler in the field and during transport to the base station for species identification confirmation.
8. In the Site Specific Periphyton and Whole Lake Plants sections of the field sheet, the densities are typically marked as unobservable. During the typical activities of an Index Site survey, the field crew cannot observe these conditions over the entire lake.



6. LITTORAL SURVEYS

To better understand littoral habitats, document conditions and characteristics observed within a defined plot area at 10 evenly spaced littoral habitat stations located around the lake. The full array of measurements and sampling described in this chapter include:

- measures or observations of littoral habitat cover and structure at the 10 littoral stations.
- observations of aesthetic conditions within and adjacent to the littoral station.
- observations of non-native macrophytes.
- collection of benthic macroinvertebrates at each of the 10 littoral stations and composited as a single sample to represent the lake wide community.

6.1. Locating and Establishing the Littoral Zone Plots

The approximate locations (latitude, longitude) of the 10 evenly spaced littoral zone stations are determined prior to the sampling visit, uploaded to a field GPS unit, and marked on a site map by the TAM Coordinator. GIS is used to select the 10 littoral zone stations on the lake outline. While the first littoral zone station which is the basis for the location of the other stations was not randomly selected, it was selected by GIS based on the numbering and positioning of the digitized vertices which will not create a systematic bias in the data and is essentially random.

Using the site maps and GPS, proceed by boat around the lake, locate, and stop at each of the pre-determined 10 littoral zone stations. At each littoral zone station, visually establish a plot that measures 15 m wide and extends 10 m out from the shoreline. **The shoreline is defined as the interface between “lake-like” conditions and riparian or wetland conditions.** Note any significant changes to the original littoral zone station location on the site map. The littoral habitat, human disturbance and aesthetic condition characterizations, and benthic macroinvertebrate sample collection will occur in and around this littoral zone plot.

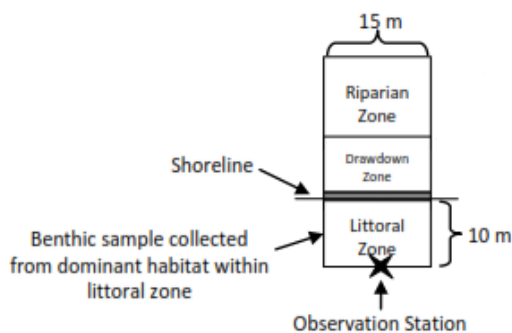


Figure 6.1 Location of the littoral plot in relation to the shoreline, drawdown zone and riparian zone.



6.1.1. Ambiguous Shorelines

In most cases, the shoreline will be easily identified as the current waterline. In some instances, however, the shoreline might not be obvious. Listed below are some general situations and rules that should be applied to the latter. Make field notations for all circumstances.

- If there has been a significant drop in lake level due to drought, dam repair, or other reasons, shallow areas that are usually covered with water may be exposed. In this case, consider the current waterline as shoreline for the purposes of this survey, not the normal waterline.
- If there are extensive very shallow areas or shoals, consider the shoreline to be the boundary between the shallow area and deeper open water, as defined by ease of access by a small boat with little draft.
- If access to the true shoreline is prevented by an area of dense aquatic or terrestrial vegetation, consider the shoreline to be the boundary between the vegetation and deeper open water. Again, define the operational shoreline by ease of access by small boat.
- If a river or stream enters a lake, the shoreline begins where no flow is visible.

6.1.2. Altered Shoreline

Adjustments to the littoral zone habitat station locations may be needed if the field crew runs into unusual conditions or problems (i.e., differences between the site map and current on the ground conditions). Below are some rules concerning modifications to the station location(s).

- If only a small portion of the shoreline differs and it does not or only slightly affect a littoral zone station location, sketch the lake shoreline on the site map and relocate the station (if needed).
- If the difference causes a contraction of the shoreline and a littoral zone station location is lost, sketch the lake shoreline on the site map and decide to either (a) keep the station, relocate it on the revised shoreline map and adjust some or all other stations in order to keep stations evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations).
- If the difference causes an expansion of the shoreline, sketch the lake shoreline on the site map and either decide to (a) add one or more stations, mark them on the revised shoreline map and adjust some or all other stations locations (if needed) so stations are evenly spaced around the lake (i.e., designate more than 10 stations), or (b) adjust the stations so that they are evenly spaced around the lake (i.e., keep 10 stations).
- If the Site Map does not in any way match the actual lake shoreline, draw a new sketch map approximating the shoreline, and re-establish the 10 littoral stations. A quick way to locate 10 evenly spaced littoral zone stations is to: (a) lay a piece of string on the lake perimeter, (b) pick up the string, measure it, and mark out 10 equal parts, and (c) lay the string back on the perimeter and use the marks to locate the 10 stations on the map.



6.1.3. Littoral Zone Station Inaccessible

- If a littoral zone station is inaccessible, either decide to (a) relocate the station and adjust some or all other stations so that they are evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations). The size of the lake will help drive this decision.
- Draw and explain all adjustments to the shoreline based on field observations directly on the site map.

6.2. Physical Littoral Habitat Characterization

6.2.1. Summary of Method

The littoral habitat, human disturbances, and aesthetic conditions are characterized based on semi-quantitative visual observations at 10 evenly spaced littoral zone plots. Locate and establish the littoral zone plots as described in Section 6.1. Position the boat within the littoral zone plot and complete the semi quantitative observations to characterize the habitat (substrate, aquatic macrophyte, fish) and aesthetics condition within each littoral zone plot, and human disturbances present within and around each littoral zone plot on the **Macroinvertebrate Littoral Habitat** field sheet.

6.2.2. Equipment and Supplies

Table 6.1 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the lake.

Table 6.1 Equipment and supplies – visual semi-quantitative observations

Type	Item	Quantity
Field sheet	Macroinvertebrate Littoral Habitat	1
	Macrophyte Identification/Voucher	1
	Site Map	1
Collection: Visual Observations	Macrophyte key (non-natives)	1
	Viewscope	1 per lake
	Field GPS unit	1
	Sonar Unit	1 per lake
	Medium reclosable plastic bags	As needed
	Large reclosable plastic bags	As needed

6.2.3. General Observations

Begin the littoral habitat characterization with general observations.

1. Visually establish the littoral zone plot.
2. Measure and record the lake depth 10 m from the shore at each littoral station. Note the new location on the site map if the point has to be significantly relocated for some reason.



3. Look for evidence of any shoreline flooding. If present, visually estimate and record the vertical depth and the horizontal distance of flooding on the **Macroinvertebrate Littoral Habitat** field sheet. A lake at normal high-water level at the time of sampling will have zero values for both flooding height and horizontal distance.
4. Look for evidence of any lake drawdown. If present, visually estimate and record the vertical height and the horizontal distance between the present lake level and the normal high-water line on the **Macroinvertebrate Littoral Habitat** field sheet. A lake at normal high-water level at the time of sampling will have zero values for both drawdown height and horizontal distance.
5. Record the presence or absence of lake surface scums, algal mats, or oily sheens within the littoral zone on the **Macroinvertebrate Littoral Habitat** field sheet.

6.2.4. Substrate Characteristics

Semi-quantitative categories are used to estimate the cover for substrate types (e.g., cobble and leaf pack), fish habitat cover (e.g., woody debris and overhanging vegetation) and aquatic macrophytes (e.g., floating, emergent) visible within the littoral zone plot. The cover categories are as follows:

- 0 = absent (0% cover)
- 1 = sparse (<10% cover)
- 2 = moderate (10 – 40% cover)
- 3 = heavy (40 – 75% cover)
- 4 = very heavy (>75% cover)

When estimating the cover mixture of more than one class visible in the littoral zone plot, all present classes might be given a moderate (2) or heavy (3) rating. One dominant class present with no clear subdominant class might be ranked very heavy (4) with all the remaining classes either sparse (1) or absent (0). Two dominant classes visible in the littoral plot with more than 40 percent cover each can both be ranked heavy (3).

1. Estimate the areal cover of bottom substrate types and particle size classes visible within the littoral zone plot. Cover categories range from absent to very heavy (0 – 4), as described in above. Record all observations by filling in the appropriate number on the **Macroinvertebrate Littoral Habitat** field sheet. The estimates of bottom substrate cover (i.e., first substrate encountered on the surface of the littoral bottom) are based on observations made from the boat, while wading or sampling macroinvertebrates. If the bottom is covered with materials other than mineral substrates, choose "Organic (leaf pack, detritus, wood)". Note: The purpose of this measure is to characterize the littoral substrate bottom generally and qualitatively.
2. Record sediment color within the littoral zone. Select "None" or "Other" if the sediment does not match one of the color categories options on the Physical Habitat form.
3. Record sediment odor within the littoral zone. For sediment odor, the choices are "HS" (sulfurous, rotten egg), "Anoxic" (sewage odor), "Chemical" (strong unnatural odor like turpentine, paint, etc.), "Oil" (petroleum), or "Other" (including musty, organic, and fishy odors). If "Other" is indicated, explain the observation in the comment section of the form.



6.2.5. Macrophyte Cover

1. Estimate the areal cover of submerged, emergent (has erect portions above the water surface), floating (either rooted or non-rooted vegetation), and total macrophytes visible within the littoral zone plot. Cover categories range from absent to very heavy (0-4), as described in Section 6.2.4. Record all observations by filling in the appropriate numbers on the **Macroinvertebrate Littoral Habitat** field sheet. These estimates can be made from the boat or while wading.
2. Record if any non-native macrophytes are observed within the littoral plots on the **Macrophyte Identification/Voucher** field sheet. Record the observed species, observation location (e.g., Plot D) and the purpose for the observation (i.e., “non-native”).
 - If there is a macrophyte suspected to be non-native, collect a voucher in a reclosable plastic bag and label the bag with site ID, voucher ID, and the date. Record the voucher ID, observation location and purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.
 - a. If more than one macrophyte voucher is collected, place all the vouchers in a larger reclosable plastic bag and label it with site ID and the date. Keep all macrophyte vouchers in a cooler in the field and during transport to the base station for species identification confirmation.

6.2.6. Fish Cover

Estimate the areal cover of potential fish habitat visible within the littoral zone. These features are within or partially within the water and conceal fish from aquatic and terrestrial predators such as large fish, otters, kingfishers, and osprey. Cover categories range from absent to very heavy (0-4), as described in Section 6.2.4. Record all observations by filling in the appropriate numbers on the **Macroinvertebrate Littoral Habitat** field sheet. In most cases these estimates can be made from the boat.

1. Estimate and record cover for the following fish habitat types:
 - Aquatic and Inundated Herbaceous Vegetation: Submerged, floating, or emergent live aquatic or non-woody herbaceous plants
 - Woody Debris/Snags: Inundated or partially inundated dead trees, branches, or root wads with diameter >0.3 m (1 foot)
 - Woody brush/woody debris: Inundated dead or living woody vegetation <0.3 m diameter.
 - Inundated Live Trees: Inundated portions of trees >0.3 m in diameter
 - Overhanging Vegetation: <1 m above the water surface (do not include higher overhanging vegetation, which may provide perches for birds such as kingfishers)
 - Ledges or Sharp Drop-offs: Overhanging banks, submerged rock shelves, and steep sloping rock walls
 - Boulders: Larger than basketball size



- Human Structures: Docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts)

6.2.7. Human Influences

Record observations of human influences within or adjacent to the littoral zone plot. Adjacent is defined as found within a hypothetical plot of equal size (10 m deep by 15 m wide) on each side of the littoral zone plot. Observations are recorded as not present (0), present adjacent to littoral zone plot (A), or present within (W) the littoral zone plot. Record all observations by filling in the appropriate observation on the **Macroinvertebrate Littoral Habitat** field sheet. Do not mark "A" if it is already marked "W" in the littoral zone (only mark the more influential).

1. Note the presence or absence of the following human influences:

- Buildings
- Commercial
- Park Facilities/Man-made Beach
- Docks/Boats
- Walks, dikes, or revetments
- Trash/Landfill
- Roads or Railroads
- Power Lines
- Row Crops
- Pasture/Hay fields
- Orchard
- Lawns
- Other (if present)

6.3. Benthic Macroinvertebrate Assemblage

6.3.1. Summary of Methods

Benthic macroinvertebrates are collected using a semi-quantitative sampling of multiple habitats in the littoral zone of a lake with a 500 μ m mesh kick net (Figure 6.2). Sample collection is stratified on the following specific habitat types: rocky/cobble/large woody debris, macrophyte beds, fines (including mud, sand, or silt), and leaf packs.



Figure 6.2 Standard kick net (500 μ m) used for collecting benthic macroinvertebrates.

6.3.2. Equipment and Supplies

Table 6.2 provides the equipment and supplies needed to collect benthic macroinvertebrate samples.

Table 6.2 Equipment and supplies – benthic macroinvertebrate collection

Type	Item	Quantity
Field sheet	Macroinvertebrate Littoral Habitat	1
	Macrophyte Identification/Voucher	1
Documentation	Labels: Benthic macroinvertebrate samples	1
	Scissors	1
Collection: Benthic macroinvertebrate	Standard Kick net (500 μ m) with 4-foot handle	1 per lake
	Spare net(s)	As needed
	Bucket (5-gallon capacity, plastic)	1 per lake
	Tote (14-gallon, plastic, white)	1 per lake
	Sieve bucket (500 μ m)	1 per lake
	Forceps	1
	Squirt bottle (1 L Nalgene) – lake water	1
	Chest waders	1 per person
Storing and preserving	HDPE bottle (2 L, white, wide mouth)	1-5 per lake
	Reagent alcohol (100%)	2 gal
	Grease pen	1
	Cooler	1

6.3.3. Sampling Procedure

6.3.3.1. Site Selection and Sample Collection

The process for selecting the littoral zone plots is described in Section 6.1 Locating and Establishing the Littoral Zone Plots. All macroinvertebrate samples should be collected from the **dominant habitat type** within the sampleable area (< 1 m deep) of the 10 m x 15 m littoral plot. Because a rectangular-frame kick-net is being used for sampling, the maximum depth for sampling will be approximately 1 m (the approximate length of the dip-net handle). The sampling process is described below.



6.3.3.2. Sample Processing in the Field

Use a tote/bucket while sampling to transport the composite sample to each littoral zone plot for sample collection. Once the composite sample from the collections at all of the 10 littoral zone plots is sieved and reduced in volume, store in a 2 L bottle and preserve with 100% reagent alcohol. Multiple bottles will likely be required if the sample contains a large volume of detritus. Sample bottles should not be filled more than about halfway with collected materials before starting a new bottle.

Place paper labels (Figure 6.3) indicating the TAM site identification (e.g., TAM-015), date, name of the lake, town, sample bottle count (e.g., 3 of 4) and the collector inside each sample bottle. Use a lead pencil (No. 2) to write the labels. The date, site identification, sample bottle count (e.g., 3 of 4) and preservation solution (100% reagent alcohol) if used, are marked on each sample bottle side and lid using a grease pen.

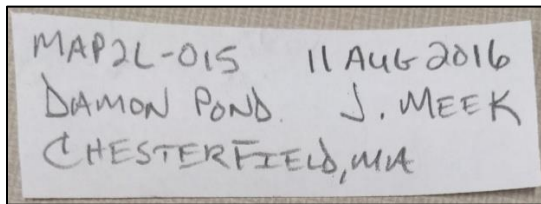


Figure 6.3 Example of label to be placed in containers with benthos samples

6.3.3.3. Benthic Macroinvertebrate Sampling

1. After locating and establishing the littoral zone plots according to the procedures described in Section 6.1, identify the dominant habitat type within the sampleable area of the plot from the classifiers below:
 - Rocky/cobble/large woody debris
 - Macrophyte beds
 - Fines (including mud, sand, or silt)
 - Leaf pack
2. After identifying the dominant habitat type, use the rectangular-frame kick-net (equipped with 500- μ m mesh) to sweep through 1 linear meter of the dominant habitat type at a single location within the sampleable area of the 10 m x 15 m littoral plot, making sure to disturb the substrate enough to dislodge organisms.
 - When safe to do so, it is preferable that you exit the boat and disturb the substrate (e.g., overturn rocks, logs) using your feet, brush (i.e., wood debris), or net frame (i.e., macrophyte beds) while sweeping the net through the disturbed area.
 - Because a rectangular-frame kick-net is being used for sampling, the **maximum depth for sampling will be approximately 1 m** (the length of the dip-net handle); therefore, in



areas where lake depth drops off quickly, it may be necessary to sample in the nearest few meters to the shore.

3. After completing the 1-meter sweep, remove all organisms and debris/detritus from the net and place them in a tote/bucket.
4. Record the dominant habitat type sampled and the collection method on the **Macroinvertebrate Littoral Habitat** field sheet. Note: Often multiple habitat types will be sampled inadvertently when targeting the dominant habitat type (e.g., sampling fines or muck when targeting macrophytes or leaf packs). If this is significant, note both habitat types on the field sheet.
5. Proceed to the next littoral zone plot and repeat steps 1-4. The organisms and debris/detritus collected at each littoral zone plot on the lake should be combined in a single tote/bucket to create a single composite sample for the lake. After sampling all 10 littoral zone plots, process the composite sample in the tote/bucket according to procedures described in the following section. One to five bottles should be sufficient to hold the composited sample from each lake.
 - If there are large amounts of debris (e.g., sticks, plants, leaves) accumulating in the composite sample, remove debris between sampling stations, after the debris is inspected, picked, and/or washed to ensure no organisms are lost.
 - If your first collection includes in too much debris, discard it, move location within the same littoral plot and dominant habitat type, and take another sample.

6.3.3.4. *Preparing Composite Samples*

1. Remove large washable portions of debris (e.g., sticks, plants, leaves) from the tote/bucket and place them into a sieve bucket with 500 μ m mesh size. Wash off any clinging organisms back into the sieve before discarding the debris.
2. Wash the remaining contents of the sieve bucket to one side by gently agitating the sieve in the water. Wash the remaining contents back into the tote/bucket using as little water from the wash bottle as possible. This is the composite sample for the lake.
3. Estimate the total volume of the sample in the tote/bucket and determine how many sample bottles will be needed. Using your hands, place any remaining smaller debris (e.g., leaves, woody debris, pine needles etc.) in the sample evenly into the selected sample jars. Rinse your hands in the sieve bucket following transfer to the sample bottles. If the volume of sample would fill more than three sample bottles (e.g., large amounts of detritus), consider homogenizing the sample (i.e., mixing well) and collecting only a portion of the sample contents.
4. If the sample bottle is too full, pour off some water through the sieve until the sample bottle is not more than half full, or use a second bottle or more if necessary. Carefully examine the sieve for any remaining organisms and use forceps to place them into the sample jar.
5. Place a paper label (Figure 6.2) inside each sample bottle with the following information written with a number 2 lead pencil:
 - TAM site identification (e.g., TAM-015)
 - Date of collection



- Name of lake
 - Town
 - Sample bottle count (e.g., 3 of 4)
 - Collector
6. Using a grease pen, write the date, site identification, sample bottle count (e.g., 3 of 4) and preservation solution (100% reagent alcohol) on each sample bottles side and lid.
 7. Fill each sample bottle to the neck with 100% reagent alcohol. NOTE: Prepared composite samples can be transported back to the vehicle before adding alcohol.
 8. Clean the cap and sample bottle threads with a toothbrush and place the cap securely on each sample bottle. Slowly tip the sample bottle to a horizontal position, and then gently rotate the sample bottle to mix the preservative. Do not invert or shake the jar.

7. SHORELINE SITE SURVEYS

The shoreline site is located at an area of the lake with known public recreation (e.g., a beach, canoe launch) or easy public access (e.g., abutting road) where recreation in the lake is most likely to occur. The following indicators are collected at the shoreline site (as described in Table 1.1): *E. coli* (pathogen surrogate). In addition, several semi-quantitative visual observations of weather, aesthetics, pollution sources and algal bloom characteristics (if one exists) are recorded to provide a general description of the conditions at the shoreline site at the time samples were collected by the field crews. These data will support the evaluation of the recreation use condition or status. A detailed description of the individual elements is provided below.

7.1. Selecting and Locating the Shoreline Site

The approximate locations (latitude, longitude) of the shoreline sites for each lake are determined prior to the first sampling visit, uploaded to an auto GPS unit, and marked on a site map by the **TAM Coordinator**. The shoreline site locations are determined by evaluating locations of public access on each lake and determining which of the available options would best reflect an area of known or potential public recreation and contact with the water. In cases where access to the lake is restricted (e.g., restricted water supplies), a shoreline site will be selected based on the locations that the public would likely utilize if access to the lake were not restricted. This selection process could involve site reconnaissance to determine the best location for the site. Generally, the order of preference for the location of the shoreline site is as follows:

- Beach or other swimming area
- Cartop launch
- Boat ramp area
- Fishing area
- Abutting road



Using the site maps and an auto GPS unit, locate and stop at the shoreline site on each lake within the survey group. At the shoreline site use a field GPS to identify the exact location if it is unclear from the auto GPS and site maps. In general, do not alter the pre-determined stations, unless necessary.

7.2. Water Sample Collection and Preservation

7.2.1. Summary of Method

Collect the *E. coli* samples using a pole sampler (Figure 7.1). Wade approximately knee to waist deep into the lake at a location that reflects the water quality within the recreational zone (e.g., designated swimming area). Extend the sampling pole away from the shore to collect the *E. coli* samples. Preserve the samples as needed using the appropriate methods.



Figure 7.1 Sampling pole

7.2.2. Equipment and Supplies

Table 7.1 provides the equipment and supplies needed to collect *E. coli* samples.

Table 7.1 Equipment and supplies – *E. coli* samples

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Shoreline Site)	1
	EDGE tablet (pre-loaded with survey information)	1
Collection: <i>E. coli</i>	Gloves (latex/nitrile, non-powdered)	As needed
	Sampling pole	1
Storing and preserving	IDEXX bottle (120 mL, clear, round, sterile) <i>E. coli</i>	1 per lake
	Wet ice	As need
	Cooler	1
	Hip boots or chest waders	1 per person

7.2.3. Sampling Procedures

Collect and preserve *E. coli* samples:



1. Check OWMIDs to confirm the selected bottles are correct then organize the bottles for sampling.
2. Wade approximately knee to waist deep into the lake at a location that reflects the water quality within the recreational zone (e.g., designated swimming area). Minimize the suspension of bottom sediments to the extent possible when wading into the lake.
3. Rinse the cable cuffs and the collection end of the sampling pole in the lake.
4. Collect *E. coli* samples using a sampling pole.
 - a. Place the listed sample bottles in the appropriate cable cuff and squeeze close.
 - i. 120 mL IDEXX bottle – *E. coli*
 - b. Remove the cap from the bottle and extend the pole to the desired, undisturbed sampling location.
 - c. Rotate the pole until the bottle is upside down just prior to breaking the water surface. Immerse the bottle to the desired depth (**approx. 6 - 9 inches below the surface**) and then rotate the pole to fill the bottle. **DO NOT RINSE SAMPLE BOTTLE.**
 - d. Remove the sample bottle from the water, cap it and then remove it from the cable cuff.
 - e. Shake sample bottle gently to mix the contents, uncap the sample bottle, pour off water until the level is approximately at the shoulder of the bottle and recap.
5. Preserve the samples bottles as indicated on the COC forms.
 - a. 120 mL IDEXX bottle - Cool to 4°C, bottle pre-preserved
6. Place all samples in the cooler with ice.
7. Record the sample times, integration depths, analyses, and types on the **Lakes Field Sheet (Shoreline Site)**.

7.3. Condition Observations

7.3.1. Summary of Method

Collect semi-quantitative data on weather conditions, aesthetic conditions, and algal bloom characteristics (if one exists). These data will provide a general description of the shoreline site conditions at the time of sample collection. Visually observe conditions at the shoreline site before and after sample collection. Record the observations in the appropriate sections of the **Lakes Field Sheet (Shoreline Site)**.

7.3.2. Equipment and Supplies

Table 7.2 provides the equipment and supplies needed to make visual semi-quantitative observations of condition at the shoreline site.

Table 7.2 Equipment and supplies – visual semi-quantitative observations (shoreline site)

Type	Item	Quantity
Field sheet	Lakes Field Sheet (Shoreline Site)	1



	EDGE tablet (pre-loaded with survey information)	1
	Macrophyte Identification/Voucher	1
Collection: Visual Observations	Macrophyte key (non-natives)	1

7.3.3. Sampling Procedures

Observe and record conditions at the shoreline site:

1. Observe the weather conditions including water surface characteristics at the shoreline site. Check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the observations.
 - a. If available, use a current air temperature from a smartphone weather application or a display in a vehicle versus estimating.
 - b. If uncertain about wind direction, use a compass to determine the direction (e.g., smartphone app).
 - c. If the lake level is not normal, estimate the level difference from normal (ft) and record on the field sheet.
2. Observe the aesthetic conditions (odor, turbidity, color, objectionable deposits, and floating scum) at the shoreline site. Check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the observations.
 - a. If “other” is selected for any observation description, make notes describing the observation.
 - b. Describe the details, extent and severity of any significant objectionable deposits or floating scum in the space provided or General Notes. Especially note if the deposits or scum are minor or natural.
3. Based on the observations of aesthetic conditions, indicate on the **Lakes Field Sheet (Shoreline Site)** whether the field crew considers the aesthetic use at the shoreline to be impaired by those conditions.
 - a. Aesthetics are by nature subjective so there should be robust discussion between field crew members on the question of impairment.
4. Observe algal density and water column characteristics (e.g., color, transparency, pH, DO saturation) to determine if a bloom is occurring. If a bloom is occurring, check the categories on the **Lakes Field Sheet (Shoreline Site)** that best describes the evidence, type, and extent/severity of the bloom.
5. If any non-native macrophyte species are observed during sampling at the shoreline site, note them on a **Macrophyte Identification/Voucher** field sheet. Record the observed species, observation location (e.g., near access point) and the purpose for the observation (i.e., “non-native”).
 - a. If a **Macrophyte Identification/Voucher** field sheet is required, be sure to complete site information section of the field sheet including the field sheet log ID from the corresponding **Lakes Field Sheet (Shoreline Site)** or the survey.



- b. If there is a macrophyte suspected to be non-native, collect a voucher in a reclosable plastic bag, label the bag with site ID, voucher ID, and the date. Record the voucher ID, observation location and the observation purpose as “suspected non-native” on the **Macrophyte Identification/Voucher** field sheet.
- c. If more than one macrophyte voucher is collected, place all the vouchers in a larger reclosable plastic bag and label it with site ID and the date. Keep all macrophyte vouchers in a cooler in the field and during transport to the base station for species identification confirmation.

8. WHOLE LAKE SURVEYS

Some indicators require that data be collected throughout the lake (as described in Table 1.1). Fish tissue, macrophyte (cover, biovolume and non-native) and lake wide activity/disturbance data are collected throughout the lake to provide a comprehensive assessment of these indicators at the time data were collected by the field crews. Detailed descriptions of the individual indicators are provided in the following sections.

8.1. Macrophyte Survey

8.1.1. Summary of Method

Quantitative measurements of lake depth and submerged aquatic macrophyte cover and biovolume are collected along a series of parallel transects in the lake using both down scanning and side scanning transducers (sonar unit). The data collected by the sonar unit is uploaded to BioBase, a cloud-based platform that automates the processing of sonar data to produce digital maps and reports regarding bathymetry and submerged aquatic macrophyte cover and biovolume. Macrophyte collections will be conducted via rake throws (manual extraction) at 10 grid locations with the goals of identifying the dominant macrophyte species in the lake and the presence of non-native macrophyte species. In addition, a paper map indicating semi-quantitative estimates of biovolume throughout the lake will be completed as a backup to the BioBase generated maps.

There are two lower levels of effort for the macrophyte survey that can be used in certain situations.

- Visual biovolume estimates using only the paper maps (i.e., no biovolume mapping with the sonar unit) and a full macrophyte survey (i.e., identification of dominant and non-native species). This level of effort is appropriate in lakes where the macrophyte biovolume is very high or very low over a significant portion of the lakes surface area.
- Visual biovolume estimates using only the paper maps (i.e., no biovolume mapping with the sonar unit) and a non-native macrophyte species search (i.e., identification of non-native species only). This level of effort is appropriate in lakes where the macrophyte biovolume is very high or very low over a significant portion of the lakes surface area and resources are constrained.



8.1.2. Equipment and Supplies

Table 8.1 provides the equipment and supplies needed for aquatic macrophyte surveys.

Table 8.1 Equipment and supplies - aquatic macrophyte survey

Type	Item	Quantity
Field sheet	Macrophyte Survey	1
	Macrophyte Identification/Voucher	1
	Site Maps (<i>included in field sheets</i>)	1
Collection: Aquatic macrophyte survey	Sonar unit (with microSD loaded with transects/sites)	1
	Underwater camera (AquaView)	1
	Viewscope	1 per lake
	Macrophyte rake	1 per lake
	Macrophyte key	1
	Field GPS unit	1
Storage and Preservation	Medium reclosable plastic bags	As needed
	Large reclosable plastic bags	As needed
	Small cooler	1
	Wet ice	As needed

8.1.3. Depth, Biovolume and Percent Cover Measurement Procedure

These are the step-by-step procedures for measuring depth, biovolume and percent cover within the lake using a sonar unit.

1. Set relevant sonar settings to the recommended values from BioBase and the sonar manufacturer manual. Refer to the BioBase Quick Reference in Appendix G for guidance on the settings.
2. Mount the sonar transducers (down scanning and side scanning) to the boat transom using the clamps (Figure 8.1).
 - Mount transducer and side scan sonar to starboard (right side facing the front of the boat) of propeller. Avoid mounting transducers within 3" of the propeller.
 - Ensure transducer and side scan sonar are 12 inches apart.
 - Ensure transducer is level and at least 1/8 inch below hull.
 - If there is interference, adjusting the transducer angle may help.
 - See Appendix H for other general mounting and adjustment guidance (Navico 2014).

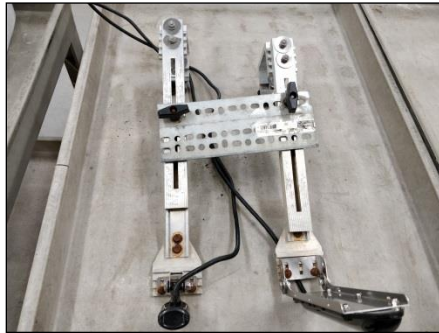


Figure 8.1 Sonar transducer mounting clamps

3. Load the general sampling transects (created in GIS and pre-loaded from a gpx file) onto the sonar from the SD card in the sonar (*Optional*).
 - On the main Lowrance HDS sonar screen go to Files in the menu, select the desired transect (.gpx) file, and Import the file. The lake site ID and transect type will be indicated in the file name.
 - The pre-loaded transect spacing for each lake will vary based on lake size and resource constraints. Transect space should be set so that mapping can be completed in 1 day.
 - Two types of transect can be preloaded: straight line transects parallel to the longest shoreline and concentric circle transects following the shoreline. The use of pre-loaded transects and the selection of the type of transects to use will be at the discretion of the **Field Crew Lead**. Generally, concentric circles are more appropriate for smaller ponds and coves in larger lakes.
 - Pre-loaded transects are for general guidance and set at a minimum spacing. If time allows, reduce the transect spacing or consider adding additional transects based on field conditions or in directions perpendicular to their original transects.
4. Record the offset of transducer to the water surface on **Macrophyte Survey** field sheet when boat is filled with passengers and gear.
5. Complete the general information sections (e.g., date, time, field crew, sampling activity) in the **Macrophyte Survey** field sheet.
6. Start logging sonar measurements.
 - On the main Lowrance HDS sonar screen go to Settings, select Sonar then select Log Sonar
 - Name the sonar logging file and select Record. Record the file name on **Macrophyte Survey** field sheet.
 - Make sure you select sl3 file type to capture both transducer and side scan sonar.
 - In the case of low battery, stop sonar logging prior to changing the battery and restart sonar logging with a different file name when battery change is complete.
7. Travel the designated transect with the boat while logging measurements with the sonar unit.
 - Maintain a speed between 3-5 mph which will minimize disturbance from the motor and increase the transducers' ability to obtain an adequate signal.



- Adjusts the designated transect as necessary based on field conditions. Considerable individual judgment may be required to successfully complete the mapping.
- 8. Complete the Macrophyte Survey Details and Data File Tracking sections in the **Macrophyte Survey** field sheet. Indicate areas of the lake not surveyed both in the Macrophyte Survey Details section and on the Macrophyte Percent Biovolume map.
- 9. Record the visual semi-quantitative biovolume estimates for the backup biovolume map on the **Macrophyte Survey** field sheet.
 - Estimate biovolume visually while traveling the designated transects and record the locations and extent of each biovolume percentage category on the lake outline map using the provided shading key.

Priority should be given to recording areas on the lake outline map where biovolume is estimated to be dense (50% - 75%) or very dense (75% - 100%). Estimates of lower biovolume percentages will be difficult to visually estimate, especially the specific extent or boundaries.

8.1.4. Dominant Macrophyte Species Identification Procedures

The goal of this procedure is to identify the dominant macrophyte species (>10% cover) in the lake and the presence of any non-native macrophyte species. A full quantitative assessment of all aquatic macrophytes present is not possible due to resource constraints and not required to achieve the TAM lake assessment objectives.

These are the step-by-step procedure for using rake throws to identify the dominant macrophyte species and the presence of non-native species.

1. Complete the General Information sections (e.g., date, time, field crew, sampling activity) in the **Macrophyte Identification/Voucher** field sheet.
2. Use a handheld GPS unit to navigate to the rake throw locations. The **TAM Coordinator** is responsible for preloading rake throw locations for all TAM lakes into the handheld GPS unit.
 - In the handheld GPS unit, select Custom POIs in the Where To screen (Extra in older models), select the correct folder of POIs (e.g., Rake Throws TAM B2-5), select desired rake throw location, and select Go. The POI file will contain 10 rake throw locations identified with lake site ID and numbers 1 -10 (e.g., TAM-019_4).
 - Completing the 10 rake throws is the minimum level of effort. If resources allow, select additional rake throw sites based on field conditions to achieve the monitoring objectives.
3. At each lake throw location complete the following activities. The rake throws can be conducted either concurrently or consecutively with the macrophyte mapping depending on field conditions and general efficiency determinations.
 - a. Confirm throwing line is securely attached to weighted rake at one end. Throw the rake approximately 5 – 10 m toward the rake throw location and the highest density of macrophytes. Allow the rake to settle to the lake bottom and slowly pull the rake back to the boat and remove representative macrophytes from the rake for identification.



- b. Record all identified macrophyte species from the rake throw on the **Macrophyte Identification/Voucher** field sheet and the observed location (e.g., rake throw #4). If any species appears at multiple locations, add newer locations to the first record of the species on the field sheet (e.g., rake throw #4, 7, 10). See Appendix D for an example
 - c. Retain a voucher sample of any macrophyte species not positively identified and any non-native species (requires confirmation from additional staff). Write a voucher ID (Site ID – Voucher#) and the date on a medium reclosable bag and place the voucher sample into the bag with some lake water to prevent the plant from drying out then place in a cooler. Record the voucher ID and observed location on the **Macrophyte Identification/Voucher** field sheet.
 - d. If there is insufficient time, it is permissible to retain a single voucher sample bag containing multiple species from a single rake throw versus retaining a voucher sample bag for each individual species. Indicate on the reclosable bag and **Macrophyte Identification/Voucher** field sheet how many species are suspected in each bag. See Appendix D for an example.
 - e. Visually estimate the biovolume and percent cover in an approximately 10 m x 10 m area around the lake throw location. If necessary, use the AquaView underwater camera or view scope to make the visual estimate. If no plants are collected in the rake throw, assume biovolume is 0% (No Plants).
 - f. Record the estimate on the Macrophyte Species Map next to the corresponding rake throw in the **Macrophyte Survey** field sheet. Sparse (S) = 5%-25%, Moderate (M) = 25%-50%, Dense (D) = 50% - 75%, Very Dense (VD) = 75% - 100%, No Plants (NP) = 0%.
 - g. If an area of significant macrophyte densities is excluded from the 10 rake throws and time allows, conduct additional rack throws in those areas following the above procedures. Indicate the location of any additional rake throws on the Macrophyte Species Map in the **Macrophyte Identification/Voucher** field sheet.
4. Complete post-survey base station activities.
 - a. Identify macrophyte species in all voucher samples and record the identifications on the **Macrophyte Identification/Voucher** field sheet. If it is necessary or advantageous to print out a new **Macrophyte Identification/Voucher** field sheet to complete this activity due to the number of voucher samples, write “Draft” in the header of the original field sheet and “Final” in the header of new field sheet. Discard the “Draft” version once the “Final” version is complete.
 - b. Record on the **Macrophyte Identification/Voucher** field sheet the overall percent cover for each species in the lake. This is a qualitative estimate based on the number of observed locations for each species and a general estimate of the percent cover at each location for the given species.



8.2. General Lake Assessment

8.2.1. Lake/Catchment Site Activities and Disturbances

Record any of the sources of potential stressors listed in Table 8.2 on the **Macrophyte Survey** field sheet, that were observed while on the lake conducting the macrophyte survey, or while driving or walking through the lake catchment. For activities and stressors that you observe, rate their abundance, or influence as low (L), moderate (M), or heavy (H) on the line next to the listed disturbance. Leave the line blank for any disturbance not observed. The distinction between low, moderate, and heavy will be subjective. For example, if there are two to three houses on a lake, circle "L" for low next to "Houses." If the lake is ringed with houses, rate it as heavy (H). Similarly, a small patch of clear-cut logging on a hill overlooking the lake would rate a low ranking. Logging activity right on the lake shore, however, would get a heavy disturbance ranking. The section for "Lake Site Activities and Disturbances Observed" includes residential, recreational, agricultural, industrial, and lake management categories.

Table 8.2 Site activities and disturbances observed during macrophyte survey

Observe lake activities or disturbances listed and record as L (low), M (moderate), or H (heavy) intensity on the Assessment form (except as noted below):	
Residences	Presence of any houses and residential buildings around the lake.
Maintained Lawns	Presence of any maintained lawns around the lake.
Construction	Presence of any recent construction in the immediate area around the lake or signs of recent sedimentation events (depositional fans).
Pipes/Drain	Presence of any pipes or drains feeding into or out of the lake.
Dumping	Any evidence of landfill or dumping around the lake, including garbage pits and informal dumping of large amounts of trash or cars and appliances along roads or lakeshore. This does not include small amounts of litter.
Roads	Presence of any maintained roads in the immediate area around the lake.
Bridges/Causeways	Presence of any bridges or causeways across or in the immediate vicinity of the lake.
Sewage Treatment	Presence of sewage treatment facility.
Hiking Trails	Presence of formal hiking trails around the lake.
Parks, Campgrounds	Presence of organized public or private parks, campgrounds, beaches, or other recreational areas around the lake.
Primitive Parks, Camping	Presence of informal or primitive parks, camping areas, beaches, or other recreational areas (e.g., swimming holes) around the lake.
Resorts	Level of resort activity; this could include motels, resorts, golf courses, and stores.
Marinas/Docks	Presence of any marinas or boat docks.
Trash/Litter	Relative abundance of trash or litter around the lake.
Surface Films, Scum or Slicks	Relative abundance of surface films, scum, or slicks on the lake.
Cropland	Presence of cropland.



Table 8.2 Site activities and disturbances observed during macrophyte survey

Observe lake activities or disturbances listed and record as L (low), M (moderate), or H (heavy) intensity on the Assessment form (except as noted below):	
Pasture	Presence of pastures.
Livestock Use	Presence of livestock use.
Orchards	Presence of orchards.
Poultry	Presence of poultry operations.
Feedlot	Presence of feedlot or concentrated animal feeding operations.
Water Withdrawal	Any evidence of water withdrawal from the lake.
Industrial Plants	Any industrial activity (e.g., canning, chemical, pulp) around the lake or in the catchment.
Mines/Quarries	Any evidence of mining or quarrying activity in the catchment or around the lake.
Oil/Gas Wells	Any evidence of oil or gas wells in the catchment or around the lake.
Power Plants	Presence of any power plants.
Logging	Any evidence of logging or fire removal of trees in the lake area.
Evidence of Fire	Any evidence of forest fires in the lake area.
Odors	Presence of any strong odors.
Commercial	Any commercial activity (e.g., convenient stores, shopping centers, restaurants) around the lake or in the catchment.
Liming	Any evidence of liming activities.
Chemical Treatment	Presence of any chemical treatment facilities.
Angling Pressure	Estimate of the intensity of fishing activity in the lake.
Drinking Water Treatment	Presence of any drinking water treatment facilities.
Macrophyte Control	Any evidence of dredging or other activities to control macrophyte growth; describe these in the "Comments" section on Side 2.
Water Level Fluctuations	Any evidence of water level fluctuations due to lake management.

8.2.2. Overall Waterbody Character

The waterbody character is the physical habitat integrity of the waterbody and is largely a function of riparian and littoral habitat structure, lake drawdown, trash, turbidity, sheens, scums, color, and odor. TAM attempts to define water body character through two attributes: degree of human disturbance and aesthetic conditions. Rate each of these attributes on a scale of 1 to 5.

In the human disturbance evaluation, a "1" indicates that a lake is highly disturbed (e.g., surrounded by houses, seawalls, docks, etc.) and a "5" indicates the lake is pristine with no signs of any human disturbance. On the **Macrophyte Survey** field sheet, fill in the number that best describes your opinion about human disturbance.

In the aesthetics evaluation (whether the lake is appealing or not), the decision is based on any factors about the lake that may impact human enjoyment of the lake (e.g., trash, algal growth, weed



abundance, overcrowding). On the **Macrophyte Survey** field sheet, fill in the number using the descriptions in Table 8.3 that best describes how suitable the lake is for recreation and aesthetic enjoyment today (i.e., Aesthetic Appeal). If the aesthetic appeal score is less than 3, indicate the cause(s) in the Aesthetics Impairment Cause section and describe the extent and severity.

Table 8.3 Aesthetic score descriptions

Score	Description
1	Enjoyment is nearly impossible.
2	Level of enjoyment is substantially reduced.
3	Enjoyment is slightly impaired.
4	There are very minor aesthetic problems; it is otherwise excellent for swimming, boating, and enjoyment.
5	It is beautiful and could not be any nicer.

8.3. Fish Tissue

8.3.1. Summary of Method

Fish (live or freshly killed) may be collected using several different sampling methods or fish collection gears including electroshocking, gill netting, trotline, traps, and angling. Three individuals of edible and legal size are collected for each target species with the goal of collecting fish in five different species. These numbers are the goal but can vary depending on the sampling efficiency and species present in the lake. The samples are iced immediately and transported to the WPP fish laboratory for preparation. Fish sample preparation consists of dissecting a skinless fillet from one side of the whole fish. The tissue samples are wrapped, tagged, bagged, and frozen until they can be delivered to the lab for analysis. The tissue samples from the individuals in each species will be composited into one sample at WES before analysis.

8.3.2. Equipment and Supplies

Table 8.4 provides the equipment and supplies needed to collect and process fish tissue samples. The table contains only information for the two most used collection methods, electroshocking boat, and gillnets.

Table 8.4 Equipment and supplies – fish tissue collection and processing

Type	Item	Quantity
Collection: Electrofishing Boat	Coffelt 18-foot electrofishing boat	1 per lake
	40-inch Wisconsin ring and droppers	1 per lake
	Honda EG 5000™ Generator	1
	Dip nets	3 per lake
	Rubber gloves	3
	Novelty bat	1



Table 8.4 Equipment and supplies – fish tissue collection and processing

Type	Item	Quantity
	Depth sounder	1
Collection: Gillnets	Gillnets (various size and configurations)	As needed
	Floats	As needed
	Novelty bat	1
	Depth sounder	1 per lake
Storing and preserving	Cooler	1
	Wet ice	As needed

8.3.3. Sampling Procedures

All collections are made in accordance with a Scientific Collection Permit issued to WPP staff by the Massachusetts Department of Fisheries and Wildlife (MDFW). The goal at each lake is to collect three individuals of edible and legal size in five of the target species. In order to assess the level of contamination present in fish of different trophic guilds and habitat types, fish species targeted should include, at a minimum: predators - largemouth bass (*Micropterus salmoides*) and/or chain pickerel (*Esox niger*); water column invertivores/omnivores - yellow perch (*Perca flavescens*) and/or white perch (*Morone americana*); and benthic feeding omnivores – bullhead (*Ameiurus sp.*) and/or common carp (*Cyprinus carpio*). Other potential target species are listed in Table 8.5.

Table 8.5 Target species list

Common Name	Scientific Name	Trophic Guild Habitat
largemouth bass	<i>Micropterus salmoides</i>	predator
smallmouth bass	<i>Micropterus dolomieu</i>	predator
chain pickerel	<i>Esox niger</i>	predator
black crappie	<i>Pomoxis nigromaculatus</i>	predator/piscivore
white perch	<i>Morone americana</i>	water column invertivore
yellow perch	<i>Perca flavescens</i>	water column invertivore
Bluegill	<i>Lepomis macrochirus</i>	littoral invertivore
Pumpkinseed	<i>Lepomis gibbosus</i>	littoral invertivore/omnivore
white sucker	<i>Catostomus commersoni</i>	bottom feeding omnivore
brown bullhead	<i>Ameiurus nebulosus</i>	bottom feeding omnivore
yellow bullhead	<i>Ameiurus natalis</i>	bottom feeding omnivore
carp	<i>Cyprinus carpio</i>	bottom feeding omnivore

The preferred method of fish collection is boat electroshocking and will be use wherever possible but depending on the situation, lakes can also be sampled using one or more of the other collection methods described below.



8.3.3.1. Electroshocking Boat

Boat electrofishing is performed by maneuvering an electrofishing boat along known fish habitats: shorelines and littoral areas; submerged, floating, and emergent macrophyte beds; rockpiles, logs, and stumps; and other habitat "structure". Fish stunned by the electroshocking are collected by one or two netters stationed on the platform located in the bow of the boat. Fish are held in a live well filled with site water until collection is completed. The sample is chosen from the collected fishes. Fish, which are selected as part of the sample, are dispatched by a blow to the head (using a small novelty baseball bat or piece of hardwood). They are then immediately placed on ice in coolers. All remaining fish are released alive.

8.3.3.2. Gill Net

Gill netting entails the deployment of gill nets (vertical panels of monofilament netting). The nets are anchored by weights at each end and attached to the bottom weighted edge of the net (lead line). The upper edge of the net is composed of a polyethylene line, which floats and thereby keeps the net "open" or spread. Surface floats are attached with rope to both ends of this "float line". Nets are usually 50-100 m in length and 2 m in height. The size of fish caught is dependent on the size of mesh that is incorporated in the construction of a particular mesh. Mesh sizes usually range from 1.5 – 7.5 cm. Most gill net sets are made on the bottom. Orientation is usually perpendicular to shore or along weed beds or other structure. Sets are between 2 to 24 hours in length. Fish that are caught in gill nets frequently die. Fish chosen for inclusion as part of a sample are those which are still alive or appear fresh. Live fish are dispatched by a blow to the head. They are immediately placed on ice in coolers. All remaining live fish are released. Dead fish are disposed of either on or offsite.

8.3.3.3. Trotlines

Trot lines are essentially long lines of baited hooks. They either rest on the bottom or in the case of polyethylene lines float slightly above the bottom. They are anchored by a weight at one or both ends and are buoyed by a float at the other. Trotlines are usually baited with worms or small fishes, set late in the afternoon, and left overnight. Lines are retrieved on the following morning and fish are removed. Fish that are chosen for inclusion as part of a sample, are either alive, or appear fresh. If alive they are dispatched with a blow to the head and immediately placed in ice filled coolers following collection. All remaining fish are either released alive or if dead are disposed of either on or offsite.

8.3.3.4. Traps

Fish traps are wooden or metal/plastic gear (e.g., lobster traps) employed on rare occasions in an attempt to catch bullhead or catfish. Wooden traps require soaking in water for few days prior to deployment. Traps are baited with dog food, fish food pellets, or other bait and allowed to set overnight. Traps are checked the following day and fish are removed. Fish chosen for inclusion as part of a sample are dispatched by a blow to the head then immediately placed in coolers on ice. All remaining fish are released alive.



8.3.3.5. Angling

Angling usually pertains to rod and reel fishing. Rod and reel angling is performed by casting or placing lures or bait into areas which are likely to be holding fish. Fish that take the bait or lure are hooked and reeled in. Fish meeting species and size requirements are dispatched by a blow to the head and then immediately placed on ice. All remaining fish are released alive.

8.3.4. Sample Processing

8.3.4.1. Sample Login

Fish packed in ice are brought to the WPP fish laboratory in Worcester. Each fish is assigned a Sample Lab ID that is comprised of the WES Sample Login Batch Number (the calendar year followed by a three-integer identifier determined by the WES laboratory) followed by a three-place integer identifier and in the case of composites followed by a small letter. For example, the first fish from a survey conducted in the Year 2015 would be assigned a code of 2015233-001. If it is part of a composite, the letter "a" is added (2015233-001a). The next fish in that composite would be numbered 2015233-001b. If the next fish were to be analyzed individually or as part of a different composite sample the number would change to 2015233-002 or 2015233-002a. Each fish is measured and weighed, and notes are recorded, when appropriate, as to an individual fish's general condition (i.e., the occurrence of lesions, tumors, or other anomalies). All information is recorded on a Fish Collection and Inventory form and a WES Sample Batch Number Form (see Attachment G).

8.3.4.2. Filleting

An individual fish is placed on its side on a pre-cleaned glass cutting board (washed and rinsed in hot tap water and rinsed twice more in de-ionized water). The fish is filleted, and the fillet is laid skin side down on the cutting board. All fish to be included in a composite sample are processed in the same manner providing there is room on the glass cutting board. Each fillet is then skinned, by running a fillet knife between the skin and the flesh. An appropriate amount of the dorsal muscle tissue is excised from the full fillet. All equipment used in the filleting process is then rinsed in hot tap water to remove slime, scales, and blood, then rinsed twice in de-ionized water before the next sample is prepared. This procedure is followed until all samples have been prepared.

8.3.4.3. Partitioning, Packaging, and Labeling

The boneless fish flesh sample is then picked up with the knife and placed in a HDPE container. The cover and the container itself are marked in permanent ink with the sample lab ID. Pre-numbered paper labels are also used when provided by the laboratory. Composite samples range from two to five fish (depending on the success of the catch) from like-sized individuals (within approx. 25% for each total length) of the same species. Any deviations from this definition are noted. Samples from a specific waterbody are put into one- or two-gallon Ziplock™ freezer bags with the Sample Tracking Chain of



Custody Record (COC) and the WES Sample Batch Number Form. The freezer bags are then placed in the freezer. Fish are delivered to the WES within 14 days.

9. DECONTAMINATION FOR INVASIVE SPECIES

9.1. Overview

The primary mechanisms to be employed to prevent the spread of invasive plant and animal species (non-native and native) are as follows:

- Sampling one lake per day and cleaning/drying in-between uses
- Using duplicate equipment when sampling > 1 lake per day to avoid using the same equipment on multiple lakes
- Decontaminating equipment back at the office using high pressure washing or freezing
- Managing sampling schedule to allow for sufficient drying time for equipment
- Cleaning and inspection as standard protocol
- Using portable sprayers with salt solution or other approved decontamination solution (e.g., white vinegar) in the field when visiting multiple lakes during shoreline surveys
- Using self-serve car washes, if necessary
- Generally limiting the number of lakes sampled in one day to two (to minimize logistical complications)

All lakes shall be treated using the same procedures, regardless of the presence/absence of invasive organisms. The primary cleaning fluids are pressurized water (i.e., no chemical additives for normal cleaning), white vinegar, and 5% salt (NaCl) solution. As necessary, procedures shall also comply with annual statewide decontamination protocols.

9.2. Watercraft (boats, motors, and trailers)

9.2.1. Summary of Method

Boats, motors, and trailers will be used at only one lake per crew trip. If sampling two or more lakes in one day, multiple boats, motors and trailers will be used in combinations to prevent introduction of the trailer/boat/motor that was used at the first lake into the next lake. Clean all boats and trailers using high pressure washing upon returning to the office. Clean outside and inside of motors (i.e., remove propeller to clean drive shaft if appropriate) thoroughly with wash water using earmuff device. Clean, inspect, let dry for 48 hours prior to next use. **Trailers that are not submerged into a lake can be used at multiple lakes (e.g., trailers for Jon boats that are carried into the lake).**

9.2.2. Equipment and Supplies

- Min. 1000 PSI pressure washer
- Earmuff
- NaCl



9.2.3. Decontamination Procedures

One lake/day surveys:

Check the boat, trailer, and motor and do a thorough inspection and clean off any visible plants (or segments), animals and mud by hand after exiting the water body. Use small dip net to trap remnants in live well, and then pour salt granules in live well. Pressure wash the boats, trailers, and motors upon return to the office (use a minimal of 1000 PSI). Let equipment dry for 48 hours prior to next use.

>One Lake/day Surveys:

If sampling two lakes or more in one day, multiple boats, motors and trailers will be used in combinations to prevent introduction of the trailer/boat/motor that was used at the first lake into the second lake. Before leaving each waterbody, check the boat, do a thorough inspection, and clean off any visible plants (or segments), animals and mud by hand. Clean the boats, trailers, and motors using high pressure washing upon return to the office (as described above). Let dry for 48 hours prior to next use.

Trailers that are not submerged into a lake can be used at multiple lakes (e.g., trailers for Jon boats that are carried into the lake).

9.3. Other Equipment

9.3.1. Summary of Method

Where possible, use the same concept as for watercraft. If sampling two or more lakes in one day, use multiple sets of equipment to prevent introduction of equipment used at the first lake into the next lake. If this is not possible, use a 5% salt solution or other approved decontamination solution (e.g., white vinegar) sprayer to wash/soak equipment in-between lakes. For larger equipment items, pressure wash thoroughly upon return to the office (as described above) and let dry for 48 hours prior to next use. For smaller more sensitive items, wash with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. For smaller non-sensitive items, freeze equipment for a minimum of 12 hours prior to next use.

9.3.2. Equipment and Supplies

- Min. 1000 PSI pressure washer
- NaCl salt solution
- Sprayer

9.3.3. Decontamination Procedures

One lake/day surveys:

Check the equipment, do a thorough inspection, and clean off any visible plants (or segments), animals and mud by hand after exiting the water body. Pressure wash the large equipment (e.g., fish gill nets) upon return to the office (use a minimal of 1000 PSI and use fabric cloth for the catch basin opening at 8 New Bond St. loading dock drain). Let equipment dry for 48 hours prior to next use. Wash other smaller



sensitive equipment (e.g., Van Dorn samplers) with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. Freeze smaller non-sensitive equipment (e.g., anchor ropes, Secchi disk, dip nets, kick nets) for a minimum of 12 hours prior to next use.

>One Lake/day Surveys:

If sampling two or more lakes in one day, use multiple sets of equipment where possible (i.e., one set per lake). Before leaving each waterbody, check all equipment, do a thorough inspection, and clean off any visible plants (or segments), animals and mud by hand. On shoreline surveys, it is necessary to use some equipment at multiple lakes. Use 5% salt solution sprayer to decontaminate waders, sampling pole, etc. between sites. Clean large equipment (e.g., fish gill nets) using high pressure washing upon return to the office (as described above). Let dry for 48 hours prior to next use. Wash smaller more sensitive equipment (e.g., Van Dorn samplers) with soap, tap water (and DI water rinse for equipment contacting sample water) and let dry for 48 hours prior to next use. Freeze smaller non-sensitive equipment (e.g., anchor ropes, Secchi disk, dip nets, kick nets) for a minimum of 12 hours prior to next use.



10. LITERATURE CITED

MassDEP. 2021. Massachusetts Surface Water Quality Standards (Revision of 314 CMR 4.00, effective November 11, 2021). Massachusetts Department of Environmental Protection, Boston, MA.

MassDEP. 2022. CN 564.0 Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual for the 2022 Reporting Cycle. October 2022. Massachusetts Department of Environmental Protection, Worcester, MA.

MassDEP. 2025. MassDEP Mercury Information. [Online]. [MassDEP Mercury Information | Mass.gov](#). Massachusetts Department of Environmental Protection, Boston, MA.

Navico. 2014. [Lowrance HDS Gen3 Installation Manual](#). Navico Group, Mettawa, IL.

Stamp, Jen. 2020. *Lake RMN Protocol Document Vertical Profile (11/7/2020) Version 1.2*. Prepared for United States Environmental Protection Agency by Tetra Tech, Montpelier, VT.

USCG. 2023. [A Boater's Guide to the Federal Requirements for Recreational Boats](#). United States Coast Guard, Washington, DC.

USEPA. 1991. Volunteer lake monitoring: A methods manual. Office of Water, U.S. Environmental Protection Agency, Washington, DC. USEPA 440/4-91-002.

USEPA. 2011. 2012 National Lakes Assessment. Field Operations Manual. USEPA 841-B-11-003. United States Environmental Protection Agency, Washington, DC.

USEPA (Environmental Protection Agency). 2020. Regional Monitoring Networks (RMN) for Inland Lakes in the Northeast and Midwest: Assessment of Data Needs and Sampling Methods. (EPA/600/R-18/370). Washington, DC: National Center for Environmental Assessment, Washington. Available online at <http://www.epa.gov/ncea>.



APPENDIX A: SEVEN-YEAR FLEXIBLE WATERSHED MONITORING SCHEDULE



Seven-year Flexible Watershed Monitoring Schedule

Introduction

Most elements of the MassDEP's existing surface water monitoring programs are administered by personnel of the Division of Watershed Management's Watershed Planning Program (DWM-WPP). Current and proposed surface water monitoring program elements are presented in A Strategy for Monitoring and Assessing the Quality of Massachusetts' Waters to Support Multiple Water Resource Management Objectives 2016 - 2025 (the Monitoring Strategy). The goal embodied in the Monitoring Strategy is to implement a comprehensive monitoring program that serves all water quality management needs and addresses all water body types. As such, the monitoring program is designed to provide data and information from streams, rivers, lakes, reservoirs, estuaries, coastal areas, and wetlands to support the five major objectives listed below.

- 1) Assess the status or condition of Massachusetts' waters
- 2) Develop, implement, and evaluate pollution control strategies
- 3) Develop policies and standards and identify emerging issues
- 4) Measure the effectiveness of water quality management programs
- 5) Maintain reserve monitoring capacity to respond to unforeseen data needs

Major themes inherent in both the MassDEP's water management programs and the monitoring elements that support them are 1) the focus on the watershed as the fundamental planning unit for water quality management, 2) the assessment of biological communities, such as aquatic macroinvertebrates and fish, as the most reliable indicators of water quality conditions and ecosystem health, 3) the application of new technology and streamlined systems for data processing and analysis to support monitoring and assessment activities, and 4) the formation and reliance on partnerships and collaboration to meet water quality goals. Massachusetts' existing and proposed water monitoring programs include both deterministic (targeted) and probabilistic (random) sampling networks and encompass both rotating watershed monitoring cycles as well as non-rotating, priority-driven schedules.

Probabilistic sampling designs provide statistically valid estimates of the use support status of 100% of the waters in a target population (e.g., shallow streams, deep rivers, lakes, etc.) with data and information collected from a random sample of those waters. Beginning in 2011 MassDEP carried out a five-year probabilistic survey of shallow streams and applied a similar sampling design to lakes and ponds from 2016 – 2018. A random sampling design for Massachusetts' coastal waters is currently in development.

While probabilistically derived sampling networks determine, at larger scales (e.g., statewide), the percentage of stream miles or lake acres that are meeting water quality standards, they are not as useful for assessing the use-support status of individual water bodies or assessment units (AU) or for identifying individual impaired waters for listing pursuant to § 303(d) of the Clean Water Act (CWA). The Monitoring Strategy calls for the use of targeted monitoring designs to confirm causes and identify sources of impairment or to demonstrate that previously impaired waters are now supporting their beneficial uses and can be removed from the 303(d) list of impaired waters. Furthermore, monitoring data from targeted waters are needed to develop, implement, and measure the effectiveness of control strategies, such as



TMDLs, watershed-based plans, National Pollutant Discharge Elimination System (NPDES) wastewater discharge permits and best management practices (BMP). These program elements and the monitoring networks needed to support them are depicted in Figure 1.

Rotating Watershed Water Quality Management

Watershed protection is the dominant theme of many state water quality management programs, and the EPA has endorsed this approach by providing financial and technical support for watershed-based water quality management activities. In 1993 the MassDEP placed the 27 major watersheds and coastal drainage areas (loosely termed “basins”) in Massachusetts on a rotating five-year schedule to synchronize monitoring, assessment, and other components of its watershed management program. The goal was to allocate one year to each of five water management steps or phases (i.e., Year 1 – planning; Year 2 – monitoring; Year 3 – assessment; Year 4 – implementation of control strategies; and Year 5 – effectiveness evaluation), after which the process would begin again.

The completion of all the steps in the watershed management process within a five-year timeframe proved to be impracticable. The practice of watershed management is inherently complex, resource-intensive, and time-consuming and project demand often outpaces available funding and other resources. Therefore, while MassDEP’s water management program continues to progress in a stepwise fashion to restore impaired waters and protect waters that meet water quality standards, in practice these steps are typically not completed within a five-year timeframe as originally conceived. Furthermore, the watersheds were originally grouped to balance workloads associated with permitting and other related administrative tasks rather than equalizing the number of river miles or lake acres among the five groups for monitoring and assessment purposes. To facilitate monitoring, the “basins” were regrouped in 2010 on a regional basis to take advantage of potential benefits to monitoring survey logistics of more closely aligned watersheds, and to more equitably distribute Massachusetts’ total river miles among the five groups. To date, despite this new arrangement, targeted assessment monitoring in these watershed groups has been precluded by priority-driven monitoring schedules and a general lack of resources.

Flexible Seven-Year Basin Rotation for Monitoring

The use of the watershed, or river basin, as a fundamental planning unit for water quality management was a guiding principle in the development of the Monitoring Strategy, and it remains a goal of the DWM-WPP to resume monitoring and assessment activities on a rotating watershed schedule. However, the need exists to maintain enough flexibility within that schedule to perform additional monitoring to meet other water management program needs. To that end, the DWM-WPP is establishing a sequential schedule that provides the opportunity for monitoring to be carried out in each watershed at least once every seven years yet allows for monitoring resources to be disproportionately applied in each watershed to fulfill specific water resource management objectives. Massachusetts’ 27 major watersheds and coastal drainage areas have been arranged by geography (and hydrology) into four major groups, or cohorts (A-D), each consisting of three to ten “basins”. In turn, each major cohort is subdivided into one or two minor cohorts, each of which represents one year of the seven-year monitoring schedule (Figures 2 and 3).

Basic assessment monitoring will be performed in each minor cohort for one year and will be consecutive within major cohorts (e.g., A2 will always follow A1). However, the extended time allotted to the major cohorts (two years for all but three basins) allows for the basic schedule to be adapted to fulfill specific



data needs. As such, the level of effort applied to monitoring within each major cohort, will not necessarily be evenly distributed through the minor cohorts or among individual basins, but will vary depending on priorities and objectives. Therefore, targeted monitoring may be focused anywhere within the major cohort and, if necessary, extend through all or a portion of the time allotted to that cohort. A few examples are presented below to illustrate how the above design provides the flexibility to meet several monitoring objectives while maintaining an overall rotating watershed structure.

Absent the need for site- or project-specific data, the overall monitoring goal will default to basic assessment and monitoring each year will be designed in accordance with the prioritization scheme presented in the following section. In Cohort A, the Concord, Merrimack, Nashua and Shawsheen watersheds (A1) would be monitored in Year 1 followed by the Ipswich, Parker, and Charles watersheds, and North Coastal and Boston Harbor coastal drainage systems (A2) in Year 2. WPP monitoring resources could be applied disproportionately, if, for example, the Merrimack and Charles watersheds received higher priority for whatever reason, in which case they might be monitored for both years in Cohort A.

Alternatively, sampling at selected locations could be performed for up to two years in larger-order rivers if pollutant loading information is needed to support TMDL development or NPDES permit development, while rotating through smaller-order rivers in the corresponding minor cohorts. If intensive surveys were needed to support model development in a particular watershed, they could also be carried out in multiple years within the major cohort. Finally, depending upon circumstances, monitoring resources might be more efficiently applied by performing stream sampling in both minor cohorts (A1 and A2) in the first year followed by lake sampling in the second year.

The proposed rotating basin structure not only provides flexibility to prioritize and apportion monitoring resources, but also presents multiple options for managing various monitoring program elements. For example, the delegation of monitoring projects to WPP monitoring personnel can be place-based (e.g., monitoring coordinator is assigned a basin for managing any monitoring activities in that basin), expertise-driven (e.g., one coordinator manages all fish sampling to be carried out in a given year, or resource-driven (e.g., one coordinator manages lake monitoring, while others coordinate stream sampling, etc.). In any case, projects will be assigned in accordance with the monitoring priorities established for the major cohort and may extend up to two years in most cohorts.



Prioritizing Waters for Targeted Assessment Monitoring

Priority	Priority Order	General Category	Category Descriptions ¹
High	1	Delisting	Assessment units currently listed in Categories 4c or 5 where there are indications it <u>should not</u> be listed for at least one impairment cause (indications can be environmental improvement or listing/assessment methodology changes or errors).
High	2	Listing	Assessment units NOT listed in Categories 4c or 5 where there are indications it <u>should be</u> listed for at least one impairment cause (indications can be environmental degradation or listing/assessment methodology changes or errors).
Medium	3	Unassessed (suspect impairment)	Assessment units listed in Category 3 or waters without an assessment unit where there are indications it could listed in Categories 4c or 5 for at least one impairment cause (i.e., unassessed waters suspected to be impaired).
Medium	4	Stressor Identification	Assessment units listed in Category 5 for a non-pollutant (i.e., Fishes Bioassessment, Aquatic Macroinvertebrate Bioassessment) with no stressor impairment causes.
Medium	5	CWF Determination	Assessment units or waters without an assessment unit thought to be an undesignated or under documented coldwater fishery (CWF).
Low	6	Unassessed (suspect support)	Assessment units listed in Category 3 or waters without an assessment where there are indications it could listed in Category 1 or 2 (i.e., unassessed waters likely to support uses).
Low	7	Priority NPDES	Assessment units or most sensitive receiving waters with a prioritized NPDES permit development (i.e., situations where a <u>reassessment</u> of the targeted assessment unit would be of value).
Low	8	TMDL Effectiveness	Assessment units currently listed in Category 4a where the TMDL was potentially successful in removing the use impairment or the original listing of the impairment cause was potentially <u>in error</u> .
Low	9	Priority TMDL	Assessment units in Category 5 prioritized for TMDL development (i.e., situations where a <u>reassessment</u> of the listed assessment unit would be of value).

1 – Assessment units placed in prioritization categories based on available information (indications) from multiple sources (monitoring data, landscape data, assessment methodology, pollution control, assessment methodologies, etc.). Annual basin selection will be consistent with rotating basin schedule. Monitoring parameters will generally include all typical default analytes (e.g., bacteria, nutrients, chloride, probes) unless an indicator specific project is identified.

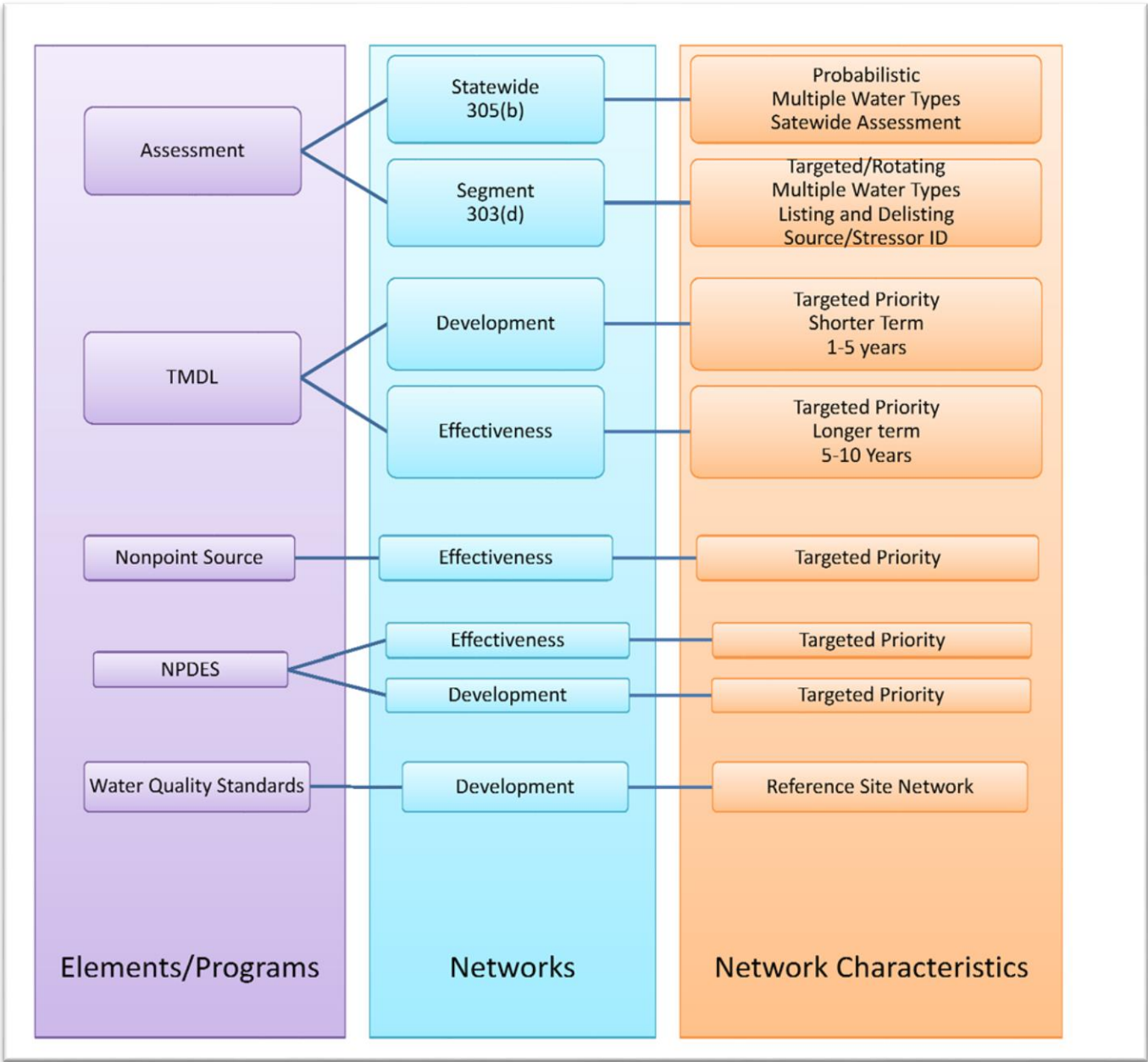


Figure 1. Monitoring Networks for Multiple Water Management Objectives



Table 2. DWM-WPP Seven-Year Basin Rotation for Water Resource Monitoring

				NHD Water Resource Estimations					Assessment Units	
NAME	Major Cohort	Total Years in Cohort	Minor Cohort	Perennial River Miles	River Miles per Year	Lakes > 5 Acres	Lake Acreage	Lakes per Year	River Segments (Total Length Miles)	Lake Segments (Total Area Acres)
Concord (SuAsCo)	A	2 (2021-2022)	A1	529	1324	134	7186	367	53 (187)	61 (6572)
Merrimack			A1	344		93	5071		39 (140)	29 (3515)
Nashua			A1	664		126	10344		79 (273)	69 (9524)
Shawsheen			A1	98		12	408		21 (65)	14 (406)
Ipswich			A2	157		68	2992		22 (97)	39 (1922)
North Coastal			A2	116		64	2698		22 (41)	42 (2006)
Parker			A2	81		24	588		7 (28)	12 (290)
Charles			A2	384		113	3726		45 (178)	50 (2824)
Boston Harbor			A2	274		100	4352		60 (166)	50 (2982)
Connecticut			B	2 (2023-2024)		B1	999		1722	96
Chicopee	B1	907			168	31113	51 (259)	74 (29797)		
Millers	B2	435			97	4762	30 (134)	64 (3846)		
Westfield	B2	630			85	4295	63 (320)	33 (3648)		
Deerfield	B2	474			21	788	130 (366)	22 (561)		
Ten Mile	C	2 (2025-2026)	C1	92	1322	21	937	611	10 (35)	12 (595)
Taunton			C1	746		223	13697		49 (222)	87 (10901)
Narragansett Bay			C1	178		29	4552		20 (65)	6 (3769)
Blackstone			C1	334		148	6509		48 (168)	100 (5177)
Quinebaug			C1	210		56	2451		28 (86)	25 (1980)
French			C1	97		56	3603		18 (39)	43 (3420)
Buzzards Bay			C2	479		210	6546		25 (79)	72 (4983)
South Coastal			C2	244		131	4925		22 (58)	75 (4214)
Cape Cod			C2	177		280	11567		16 (33)	68 (5706)
Islands			C2	86		69	5738		6 (12)	5 (106)
Housatonic	D	1 (2027)	D1	547	952	117	5982	194	35 (219)	33 (4284)
Hudson			D1	229		13	759		26 (109)	8 (716)
Farmington			D1	175		64	3907		40 (108)	18 (2135)
			Totals	9687		2618	152852		1028 (3830)	1157 (118338)



7-Year Basin Rotation Major and Minor Cohorts

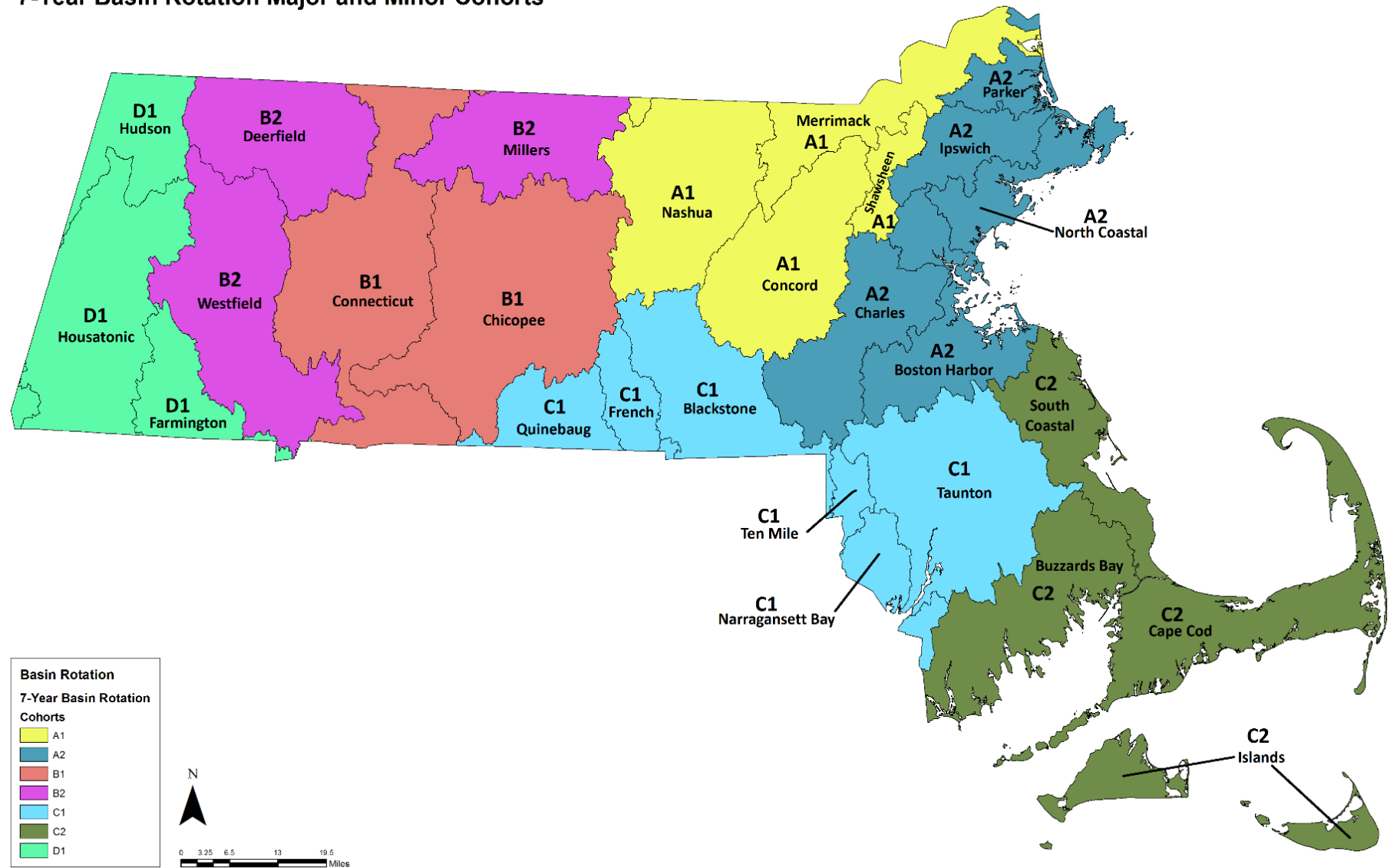




Figure 3. DWM-WPP Seven-Year Basin Rotation for Water Resource Monitoring

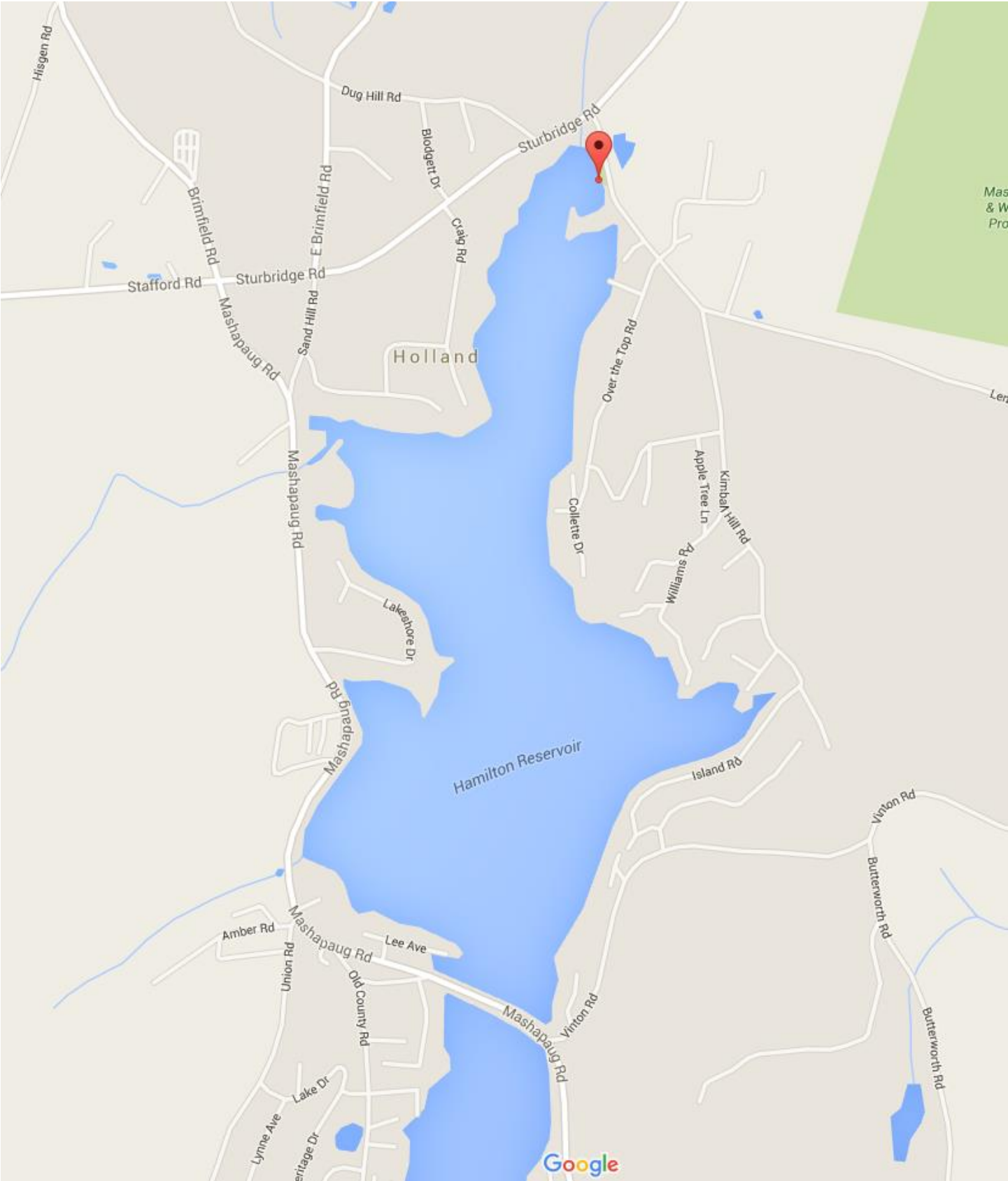


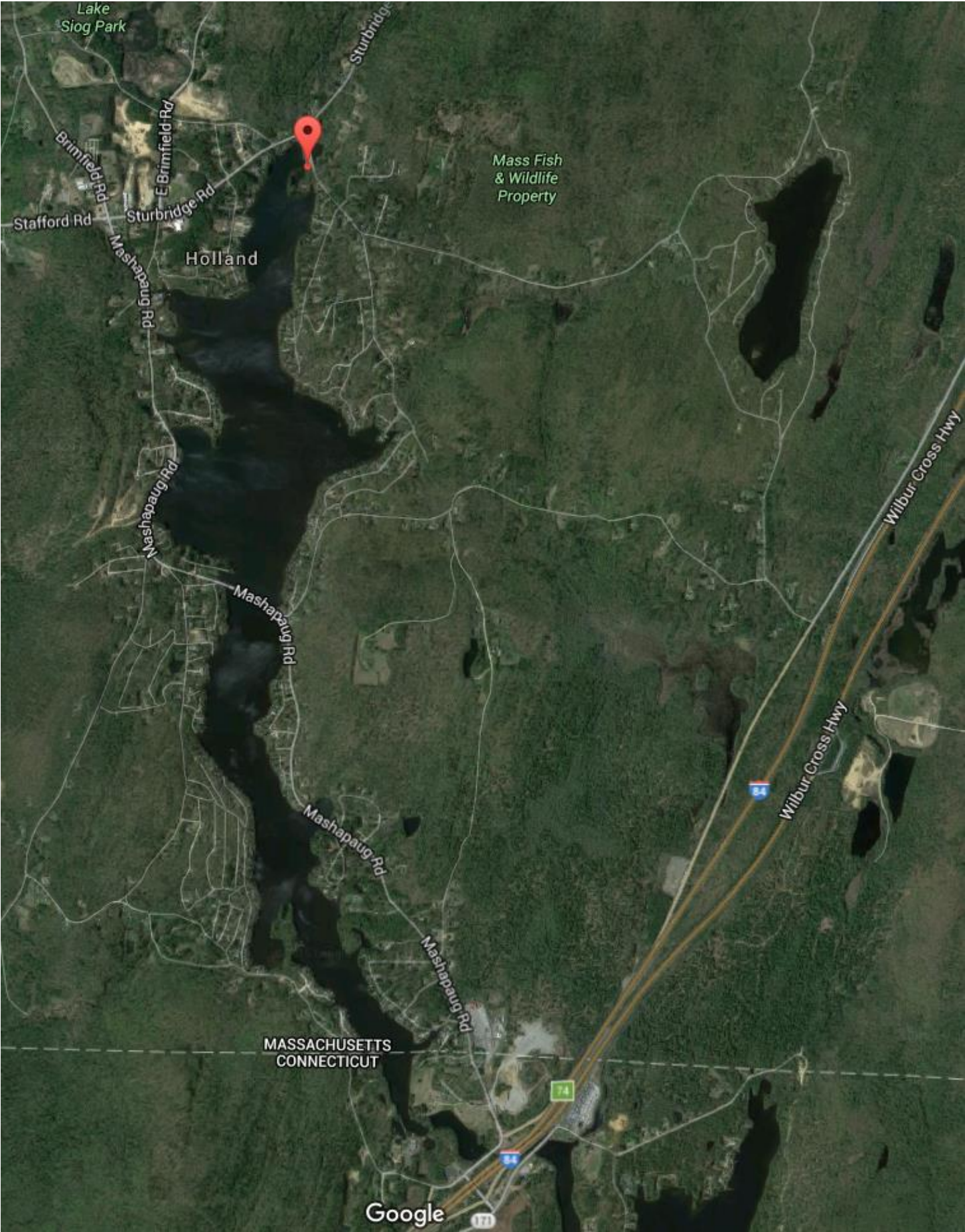
APPENDIX B: EXAMPLE LAKE DOSSIER



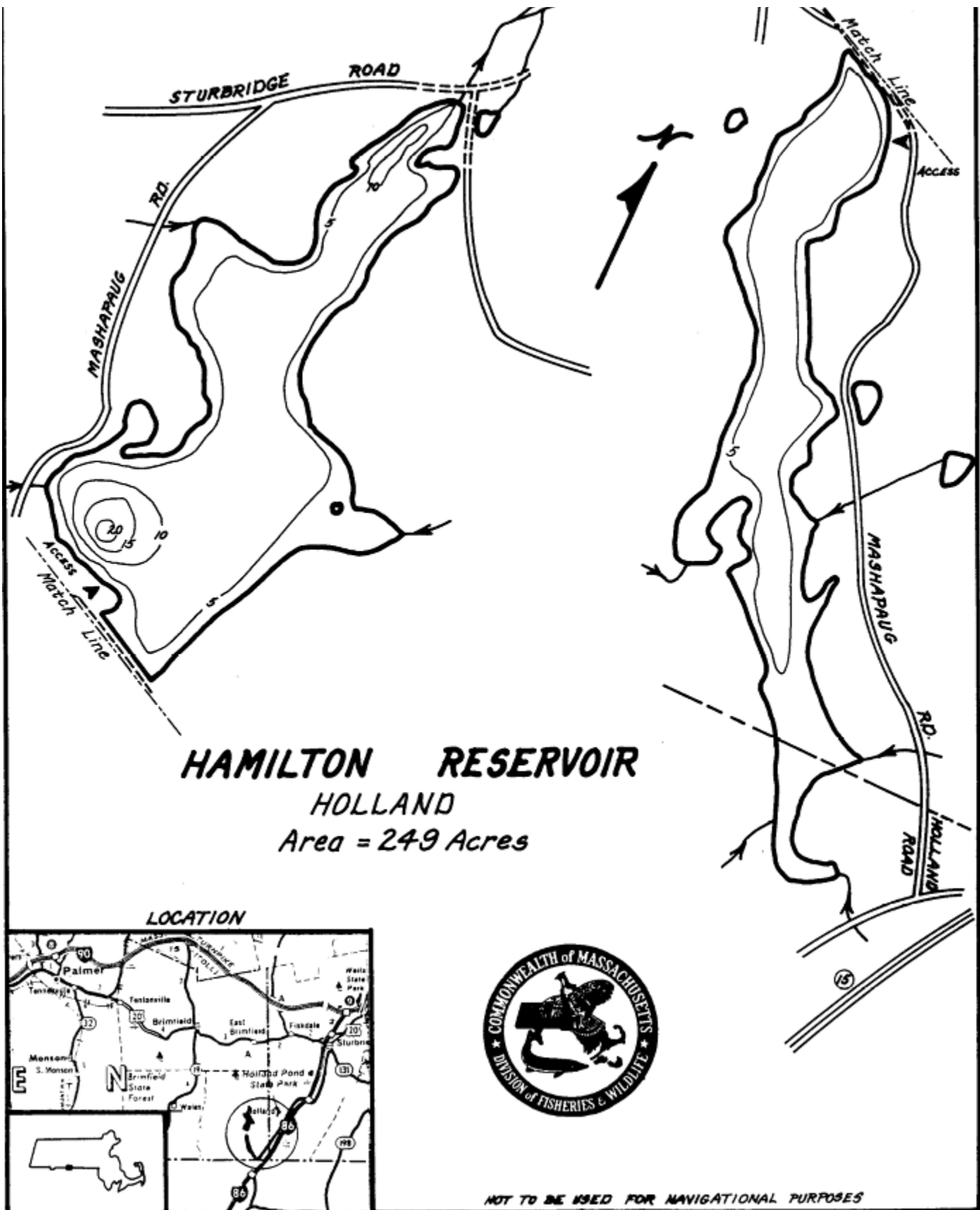
TAML-002		Hamilton Reservoir			
Town	Holland	Watershed	Quinebaug	Impoundment	Yes
Size (ha)	97.0	Max Depth (m)	6.4	Herbicide 2015	Yes
Known Non-natives	Variable Milfoil				
303(d) List Causes	(Non-Native Aquatic Plants*)				
Access Type	Public Boat Ramp	Ownership	Town of Holland		
Access (Lat, Long)	42.06784, -72.15245	Access Contact Info	None		
Trailer Accessible	Yes	WQ Motor Minimum Distance to Index (m)	Gas (2600)		
Index Site ID	W2619	Index Site (Lat, Long)	42.05275, -72.15819 (Estimate)		
Confirmed Index Site (Lat, Long)					
Notes					













APPENDIX C: EXAMPLE WEEKLY SCHEDULE



WPP 2016 Environmental Monitoring Program – Weekly Monitoring Assignments

Week 3: May 16 – 20, 2016

Monday	Tuesday	Wednesday	Thursday	Friday
May-16	May-17	May-18	May-19	May-20
MAPL - Fish TT	MAPL - Fish TT	RSN 2 - DO\WQ	MAPL - Fish TT	MAPL - Fish TT
Davis	Maietta	Meek	Mitchell	Maietta
Reardon	Rousseau	Bangoret	Davis	Rousseau
Diebboll	Dewani		Bangoret	Dieboll
		MAPL 3 - Shoreline (BacT Only)		
	Instr Lab - RSN QC Probe Cal	Mitchell	Color/Turbidity Lab	Delivery (WES)
	Nuzzo	Dewani	Diebboll	Bangoret
			Rousseau	Dewani
		Colilert Lab Process	Colilert Lab Read	
		Diebboll	Diebboll	
		Rousseau	Rousseau	

Key (Format: *Project-Site Group or Lakes Task1\Task2\etc.*)

T = Temperature Probe Deploy

DO = Multiprobe Deploy (Onset or Hydrolab)

Index = Index Site (deep hole) Sampling

Shoreline = Shoreline Site Sampling

LT = Long-term probe

M&M = Macrophytes and macroinvertebrate

Fish TT = Fish Toxics Tissue

QC = QC check on long-term deploy

PU = Long-term probe pickup

RSN = Reference Site Network

MAPL = Probabilistic Lake Monitoring

Profile = Lake DO/T Profile

WQ = Water Quality Sampling

Delivery = Sample delivery



APPENDIX D: FIELD SHEET



MassDEP/Division of Watershed Management/Watershed Planning Program
LAKES FIELD SHEET (2022)

Crew Lead (initial) _____

STATION INFORMATION (fill out prior to departure)	
Field Sheet Login #: 22-M017-01	Unique ID: W3159
Project: TAM A2-4 (2022)	Site Name (STAID): TAM-008
Waterbody Name: Keyes Pond (93009)	Town: Westford
GENERAL SITE INFORMATION	
Alternate Station Description (Does site match description?) <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If not, describe below:	
Field Lat/Long	Lat/Long Method <input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Handheld GPS <input type="checkbox"/> Other
Survey Crew Lead: Meek	Other Crew: <u>Galligan</u>
Date: 9/27/2022	Time: <u>845</u> <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT
Weather Conditions <input type="checkbox"/> Clear <input type="checkbox"/> Mostly sun <input type="checkbox"/> Mostly cloud <input checked="" type="checkbox"/> Overcast <input type="checkbox"/> Fog <input type="checkbox"/> Drizzle <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Snow	
Air Temperature <input type="checkbox"/> < 20 °F <input type="checkbox"/> 21-30 °F <input type="checkbox"/> 31-40 °F <input type="checkbox"/> 41-50 °F <input type="checkbox"/> 51-60 °F <input checked="" type="checkbox"/> 61-70 °F <input type="checkbox"/> 71-80 °F <input type="checkbox"/> 81-90 °F <input type="checkbox"/> 91-100 °F	
Water Odor <input checked="" type="checkbox"/> None <input type="checkbox"/> Musty <input type="checkbox"/> Petrol <input type="checkbox"/> Sewage <input type="checkbox"/> Effluent <input type="checkbox"/> Sulfide <input type="checkbox"/> Fishy <input type="checkbox"/> Chlorine <input type="checkbox"/> Rotten Veg. <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Turbidity <input type="checkbox"/> None <input checked="" type="checkbox"/> Slightly Turbid <input checked="" type="checkbox"/> Moderately Turbid <input type="checkbox"/> Highly Turbid <input type="checkbox"/> Unobservable	
Water Color <input type="checkbox"/> None <input type="checkbox"/> Brownish <input type="checkbox"/> Blackish <input checked="" type="checkbox"/> Greenish <input type="checkbox"/> Greyish <input type="checkbox"/> Reddish <input type="checkbox"/> Yellowish <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Floating Scum <input checked="" type="checkbox"/> None <input type="checkbox"/> Algal mat <input type="checkbox"/> Foam <input type="checkbox"/> Oily sheens <input type="checkbox"/> Pollen blankets <input type="checkbox"/> Sewage <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
General Notes:	
OBSERVATIONS (RIVER AND LAKE)	
Objectionable Deposits <input checked="" type="checkbox"/> None <input type="checkbox"/> Trash <input type="checkbox"/> Flocculent mass <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
Shoreline Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Unobservable Description:	
Wildlife <input type="checkbox"/> None <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input checked="" type="checkbox"/> Birds <input type="checkbox"/> Amphibians <input type="checkbox"/> Other Description:	
Beneficial Uses <input type="checkbox"/> None <input type="checkbox"/> Swimming <input checked="" type="checkbox"/> Boating <input type="checkbox"/> Water intake <input checked="" type="checkbox"/> Fishing <input type="checkbox"/> Other Description:	
Pollution Sources <input type="checkbox"/> None <input type="checkbox"/> Outfalls <input type="checkbox"/> Garbage <input checked="" type="checkbox"/> Road runoff <input type="checkbox"/> Waterfowl <input type="checkbox"/> Land clearing <input checked="" type="checkbox"/> Lawns	
Aesthetics Impaired? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO Based on water odor, clarity, unnatural color, growths, scum and/or deposits, is the site impaired?	
Water Level (relative to annual high-water level) <input type="checkbox"/> Low <input type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below _____ ft	
STATION SPECIFIC PLANT DENSITY <input checked="" type="checkbox"/> None 0% <input type="checkbox"/> Sparse 1-25% <input type="checkbox"/> Moderate 25-50% <input type="checkbox"/> Dense 50-75% <input type="checkbox"/> Very Dense 75-100% <input type="checkbox"/> Unobservable	
Overall Aquatic Plants <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Floating Aquatic Plants <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:	
Emergent Aquatic Plants <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:	
Submerged Aquatic Plants <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U Species:	
Duckweed <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Free-floating algae <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
ALGAL BLOOM	
Algal Bloom Present <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	
Bloom Type <input type="checkbox"/> Cyanobacteria <input type="checkbox"/> Green Algae <input type="checkbox"/> Other <input type="checkbox"/> Unknown	
Evidence of Bloom (check all that apply) <input type="checkbox"/> Scum <input type="checkbox"/> Color <input type="checkbox"/> Turbidity <input type="checkbox"/> Odor <input type="checkbox"/> Other	
Lakeward Width (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Shoreline Length (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Bloom specific notes:	



SITE SPECIFIC PERIPHYTON		None: 0%	Sparse: 1-25%	Moderate: 25-50%	Dense: 50-75%	Very Dense: 75-100%	Unobservable
Filamentous	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other					
	<input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Film	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other					
	<input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Loose Floe	<input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Orange <input type="checkbox"/> White <input type="checkbox"/> Other					
	<input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U	Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
OBSERVATIONS (LAKE)							
Wind Conditions <input checked="" type="checkbox"/> Calm <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Gusty <input type="checkbox"/> Strong							
Wind Direction <input checked="" type="checkbox"/> Calm <input type="checkbox"/> North <input type="checkbox"/> Northeast <input type="checkbox"/> East <input type="checkbox"/> Southeast <input type="checkbox"/> South <input type="checkbox"/> Southwest <input type="checkbox"/> West <input type="checkbox"/> Northwest							
Water Surface <input checked="" type="checkbox"/> Calm <input type="checkbox"/> Ripples <input type="checkbox"/> Choppy <input type="checkbox"/> White caps							
Dom. Habitat <input type="checkbox"/> Bedrock <input type="checkbox"/> Boulder <input type="checkbox"/> Cobble <input type="checkbox"/> Gravel <input type="checkbox"/> Sand <input type="checkbox"/> Silt <input type="checkbox"/> Woody debris <input type="checkbox"/> Organic <input type="checkbox"/> Vegetation <input type="checkbox"/> Other <input checked="" type="checkbox"/> Unobservable							
Max Depth Site <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Station Max. Depth <u>5.5</u> meters		Depth Method <input type="checkbox"/> Secchi <input type="checkbox"/> Lead line <input checked="" type="checkbox"/> Sonar <input type="checkbox"/> Survey Rod <input type="checkbox"/> Other			
WHOLE LAKE PLANTS None 0% Sparse 1-25% Moderate 25-50% Dense 50-75% Very Dense 75-100% Unobservable							
Overall Aquatic Plants <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U							
Dominant Aquatic Plants (in order of dominance, include any NON-NATIVE)							
(E/S/F)							
(E/S/F)							
(E/S/F)							
Duckweed specific <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input checked="" type="checkbox"/> U							
Duckweed Band Width (m) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m							
Duckweed % Cover <u> </u>							
SECCHI MEASUREMENT							
Secchi Measured <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Time: <u>9:15</u> <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT		Secchi Method <input checked="" type="checkbox"/> Secchi disk <input type="checkbox"/> Secchi tube <input type="checkbox"/> Other			
Secchi depth <u>1.70</u> meters		Dup. Secchi depth <u>1.64</u> m		On bottom <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Secchi reading condition <input checked="" type="checkbox"/> Viewfinder used <input type="checkbox"/> In weeds <input type="checkbox"/> In sunlight		Secchi Comments:					
SAMPLE - GENERAL							
Samples taken from <input type="checkbox"/> From shore/left bank <input type="checkbox"/> From shore/center stream <input type="checkbox"/> From shore/right bank							
<input type="checkbox"/> Wade in/left bank <input type="checkbox"/> Wade in/center stream <input type="checkbox"/> Wade in/right bank							
<input type="checkbox"/> Bridge upstream <input type="checkbox"/> Bridge downstream							
<input checked="" type="checkbox"/> Boat <input type="checkbox"/> Shore (Lake) <input type="checkbox"/> Wading (Lake) <input type="checkbox"/> Dock							
<input type="checkbox"/> Pipe							
<input type="checkbox"/> Other (describe): <u> </u>							
Samples taken from description:							



Sample-Lab	25-0653	25-0654	25-0655
Sample Type	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input checked="" type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:
OWMID Parent			
Medium	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other
Medium (Subdivision)	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown
Relative Depth	<input checked="" type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom	<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input checked="" type="checkbox"/> Near Bottom	<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom
Start/End Depth (m)	0.5 /	4.7 /	0 / 4.5
Start Time (Date/Time)	09/27/22 1845 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST	09/27/22 1900 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST	09/27/22 1915 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST
End Time (Date/Time)	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST
Gear Type	<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input checked="" type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A	<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input checked="" type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A	<input type="checkbox"/> Water Bottle <input checked="" type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A
Gear Serial #	1317111A	1317111A	
Composite (Type)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input checked="" type="checkbox"/> Depth
Field Lat/Long	/	/	/
Field Lat/Long Method	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS
Sample Notes	SURFACE	NEAR BOTTOM	INTEGRATED
Bottle Group	Planned Collected Preserved In Field Filtered In Field	Planned Collected Preserved In Field Filtered In Field	Planned Collected Preserved In Field Filtered In Field
Bacteria (B)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Na ₂ S ₂ O ₃ <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Na ₂ S ₂ O ₃ <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Na ₂ S ₂ O ₃ <input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N)	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> H ₂ SO ₄ <input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> H ₂ SO ₄ <input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> H ₂ SO ₄ <input type="checkbox"/> Y <input type="checkbox"/> N
Metals (M)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
OrgCarb (OC)	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> H ₃ PO ₄ <input checked="" type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> H ₃ PO ₄ <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> H ₃ PO ₄ <input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N3)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
Solids (S)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
Chl a (I)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input checked="" type="checkbox"/> N
Color/Turb (R)	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
Alkalinity (C)	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
Hardness (H)	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> HNO ₃ <input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N
Phytoplank (A)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y <input type="checkbox"/> N	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Lugols <input type="checkbox"/> Y <input checked="" type="checkbox"/> N

[illegible]



MassDEP/Division of Watershed Management/Watershed Planning Program
LAKES FIELD SHEET (2022)

Crew Lead (initial) DS

STATION INFORMATION (fill out prior to departure)	
Field Sheet Login #: 22-M002-01	Unique ID: W3154
Project: TAM A2-4 (2022)	Site Name (STAID): TAM-0055
Waterbody Name: Learned Pond (82069)	Town: Framingham
GENERAL SITE INFORMATION	
Alternate Station Description (Does site match description?) <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If not, describe below:	
Field Lat/Long /	Lat/Long Method <input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Handheld GPS <input type="checkbox"/> Other
Survey Crew Lead: Davis	Other Crew: Malmquist
Date: 6/27/2022	Time: 8:00 <input type="checkbox"/> EST <input checked="" type="checkbox"/> EDT
Weather Conditions <input type="checkbox"/> Clear <input type="checkbox"/> Mostly sun <input type="checkbox"/> Mostly cloud <input checked="" type="checkbox"/> Overcast <input type="checkbox"/> Fog <input type="checkbox"/> Drizzle <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Snow	
Air Temperature <input type="checkbox"/> <20 °F <input type="checkbox"/> 21-30 °F <input type="checkbox"/> 31-40 °F <input type="checkbox"/> 41-50 °F <input type="checkbox"/> 51-60 °F <input type="checkbox"/> 61-70 °F <input checked="" type="checkbox"/> 71-80 °F <input type="checkbox"/> 81-90 °F <input type="checkbox"/> 91-100 °F	
Water Odor <input checked="" type="checkbox"/> None <input type="checkbox"/> Musty <input type="checkbox"/> Petrol <input type="checkbox"/> Sewage <input type="checkbox"/> Effluent <input type="checkbox"/> Sulfide <input type="checkbox"/> Fishy <input type="checkbox"/> Chlorine <input type="checkbox"/> Rotten Veg. <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Turbidity <input checked="" type="checkbox"/> None <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Moderately Turbid <input type="checkbox"/> Highly Turbid <input type="checkbox"/> Unobservable	
Water Color <input checked="" type="checkbox"/> None <input type="checkbox"/> Brownish <input type="checkbox"/> Blackish <input type="checkbox"/> Greenish <input type="checkbox"/> Greyish <input type="checkbox"/> Reddish <input type="checkbox"/> Yellowish <input type="checkbox"/> Other <input type="checkbox"/> Unobservable	
Floating Scum <input checked="" type="checkbox"/> None <input type="checkbox"/> Algal mat <input type="checkbox"/> Foam <input type="checkbox"/> Oily sheens <input type="checkbox"/> Pollen blankets <input type="checkbox"/> Sewage <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
General Notes:	
OBSERVATIONS (RIVER AND LAKE)	
Objectionable Deposits <input checked="" type="checkbox"/> None <input type="checkbox"/> Trash <input type="checkbox"/> Flocculent mass <input type="checkbox"/> Other <input type="checkbox"/> Unobservable Description:	
Shoreline Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Unobservable Description:	
Wildlife <input type="checkbox"/> None <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input checked="" type="checkbox"/> Birds <input type="checkbox"/> Amphibians <input type="checkbox"/> Other Description:	
Beneficial Uses <input type="checkbox"/> None <input checked="" type="checkbox"/> Swimming <input type="checkbox"/> Boating <input type="checkbox"/> Water intake <input type="checkbox"/> Fishing <input type="checkbox"/> Other Description:	
Pollution Sources <input type="checkbox"/> None <input type="checkbox"/> Outfalls <input type="checkbox"/> Garbage <input checked="" type="checkbox"/> Road runoff <input type="checkbox"/> Waterfowl <input type="checkbox"/> Land clearing <input checked="" type="checkbox"/> Lawns	
Aesthetics Impaired? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO Based-on water odor, clarity, unnatural color, growths, scum and/or deposits, is the site impaired?	
Water Level (relative to annual high-water level) <input type="checkbox"/> Low <input checked="" type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below _____ ft	
STATION SPECIFIC PLANT DENSITY None 0% <input type="checkbox"/> Sparse 1-25% <input type="checkbox"/> Moderate 25-50% <input type="checkbox"/> Dense 50-75% <input type="checkbox"/> Very Dense 75-100% <input type="checkbox"/> Unobservable	
Overall Aquatic Plants <input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Floating Aquatic Plants <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Species:
Emergent Aquatic Plants <input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Species:
Submerged Aquatic Plants <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Species:
Duckweed <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
Free-floating algae <input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	
ALGAL BLOOM	
Algal Bloom Present <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	
Bloom Type <input type="checkbox"/> Cyanobacteria <input type="checkbox"/> Green Algae <input type="checkbox"/> Other <input type="checkbox"/> Unknown	
Evidence of Bloom (check all that apply) <input type="checkbox"/> Scum <input type="checkbox"/> Color <input type="checkbox"/> Turbidity <input type="checkbox"/> Odor <input type="checkbox"/> Other	
Lakeward Width (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Shoreline Length (in meters) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m	
Bloom specific notes:	



SITE SPECIFIC PERIPHYTON		None: 0%	Sparse: 1-25%	Moderate: 25-50%	Dense: 50-75%	Very Dense: 75-100%	Unobservable
Filamentous	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Film	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
Loose Floc	<input checked="" type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U	Color: <input type="checkbox"/> Black <input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Grey <input type="checkbox"/> Orange <input type="checkbox"/> White <input type="checkbox"/> Other Location: <input type="checkbox"/> On plants <input type="checkbox"/> On rocks <input type="checkbox"/> On bottom Location Type: <input type="checkbox"/> Riffle <input type="checkbox"/> Run <input type="checkbox"/> Pool					
OBSERVATIONS (LAKE)							
Wind Conditions <input type="checkbox"/> Calm <input type="checkbox"/> Slight <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Gusty <input type="checkbox"/> Strong							
Wind Direction <input type="checkbox"/> Calm <input type="checkbox"/> North <input type="checkbox"/> Northeast <input type="checkbox"/> East <input type="checkbox"/> Southeast <input checked="" type="checkbox"/> South <input type="checkbox"/> Southwest <input type="checkbox"/> West <input type="checkbox"/> Northwest							
Water Surface <input checked="" type="checkbox"/> Smooth <input checked="" type="checkbox"/> Ripples <input type="checkbox"/> Choppy <input type="checkbox"/> White caps							
Dom. Habitat: <input type="checkbox"/> Bedrock <input type="checkbox"/> Boulder <input type="checkbox"/> Cobble <input type="checkbox"/> Gravel <input checked="" type="checkbox"/> Sand <input type="checkbox"/> Silt <input type="checkbox"/> Woody debris <input type="checkbox"/> Organic <input type="checkbox"/> Vegetation <input type="checkbox"/> Other <input type="checkbox"/> Unobservable							
Max Depth Site <input type="checkbox"/> Yes <input type="checkbox"/> No		Station Max. Depth _____ meters		Depth Method <input type="checkbox"/> Secchi <input type="checkbox"/> Lead line <input type="checkbox"/> Sonar <input type="checkbox"/> Survey Rod <input type="checkbox"/> Other			
WHOLE LAKE PLANTS None: 0% Sparse: 1-25% Moderate: 25-50% Dense: 50-75% Very Dense: 75-100% Unobservable							
Overall Aquatic Plants <input type="checkbox"/> N <input checked="" type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U							
Dominant Aquatic Plants (in order of dominance, include any NON-NATIVE)							
Cattails						(E/S/F)	
						(E/S/F)	
						(E/S/F)	
Duckweed specific <input type="checkbox"/> N <input type="checkbox"/> S <input type="checkbox"/> M <input type="checkbox"/> D <input type="checkbox"/> VD <input type="checkbox"/> U							
Duckweed Band Width (m) <input type="checkbox"/> <1 m <input type="checkbox"/> 1-5 m <input type="checkbox"/> 5-10 m <input type="checkbox"/> 10-15 m <input type="checkbox"/> >15 m							
Duckweed % Cover _____							
SECCHI MEASUREMENT							
Secchi Measured <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Time: _____ <input type="checkbox"/> EST <input type="checkbox"/> EDT		Secchi Method <input type="checkbox"/> Secchi disk <input type="checkbox"/> Secchi tube <input type="checkbox"/> Other			
Secchi depth _____ meters		Dup. Secchi depth _____ m		On bottom <input type="checkbox"/> Yes <input type="checkbox"/> No			
Secchi reading condition <input type="checkbox"/> Viewfinder used <input type="checkbox"/> In weeds <input type="checkbox"/> In sunlight				Secchi Comments:			
SAMPLE - GENERAL							
Samples taken from <input type="checkbox"/> From shore/left bank <input type="checkbox"/> From shore/center stream <input type="checkbox"/> From shore/right bank <input type="checkbox"/> Wade in/left bank <input type="checkbox"/> Wade in/center stream <input type="checkbox"/> Wade in/right bank <input type="checkbox"/> Bridge upstream <input type="checkbox"/> Bridge downstream <input type="checkbox"/> Boat <input type="checkbox"/> Shore (Lake) <input checked="" type="checkbox"/> Wading (Lake) <input type="checkbox"/> Dock <input type="checkbox"/> Pipe <input type="checkbox"/> Other (describe): _____							
Samples taken from description:							



Sample-Lab	25-0505				<Place OWMID Label here>				<Place OWMID Label here>			
Sample Type	<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input checked="" type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:				<input type="checkbox"/> FQC_BLANK (Blank) <input type="checkbox"/> FQC_BLANKRINS (Equipment Blank) <input type="checkbox"/> FQC_REP (Field Duplicate) <input type="checkbox"/> FS_IVP (Integrated Vertical Profile) <input type="checkbox"/> FS_ROUTINE (Routine Sample) <input type="checkbox"/> Other:			
OWMID Parent												
Medium	<input checked="" type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other				<input type="checkbox"/> Water <input type="checkbox"/> Sediment <input type="checkbox"/> Other			
Medium (Subdivision)	<input checked="" type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown				<input type="checkbox"/> SW (Surface Water) <input type="checkbox"/> IndEff (Industrial Effluent) <input type="checkbox"/> MunSewEff (Muni. Sewage Effluent) <input type="checkbox"/> StmW (Stormwater) <input type="checkbox"/> Unknown			
Relative Depth	<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom				<input type="checkbox"/> Surface <input type="checkbox"/> Mid-Water <input type="checkbox"/> Near Bottom			
Start/End Depth (m)	/				/				/			
Start Time (Date/Time)	06/27/22 18:00 <input checked="" type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST			
End Time (Date/Time)	/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST				/ <input type="checkbox"/> EDT <input type="checkbox"/> EST			
Gear Type	<input checked="" type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A				<input type="checkbox"/> Water Bottle <input type="checkbox"/> Tygon Tube <input type="checkbox"/> Sampling Pole <input type="checkbox"/> Auto Sampler <input type="checkbox"/> Van Dorn <input type="checkbox"/> Other <input type="checkbox"/> Basket <input type="checkbox"/> N/A			
Gear Serial #												
Composite (Type)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input type="checkbox"/> Depth				<input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> Flow <input type="checkbox"/> Time <input checked="" type="checkbox"/> Depth			
Field Lat/Long	/				/				/			
Field Lat/Long Method	<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS				<input type="checkbox"/> GETAC F110 Tablet <input type="checkbox"/> Other: <input type="checkbox"/> Handheld GPS			
Sample Notes												
Bottle Group	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field	Planned	Collected	Preserved In Field	Filtered In Field
Bacteria (B)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Na ₂ S ₂ O ₃	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na ₂ S ₂ O ₃	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Na ₂ S ₂ O ₃	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₂ SO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₂ SO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₂ SO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N
Metals (M)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
OrgCarb (OC)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₃ PO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₃ PO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> H ₃ PO ₄	<input type="checkbox"/> Y <input type="checkbox"/> N
Nutrient (N3)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Solids (S)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Chl a (I)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Color/Turb (R)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Alkalinity (C)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Hardness (H)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N
Phytoplank (A)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> Y <input type="checkbox"/> N

[illegible]



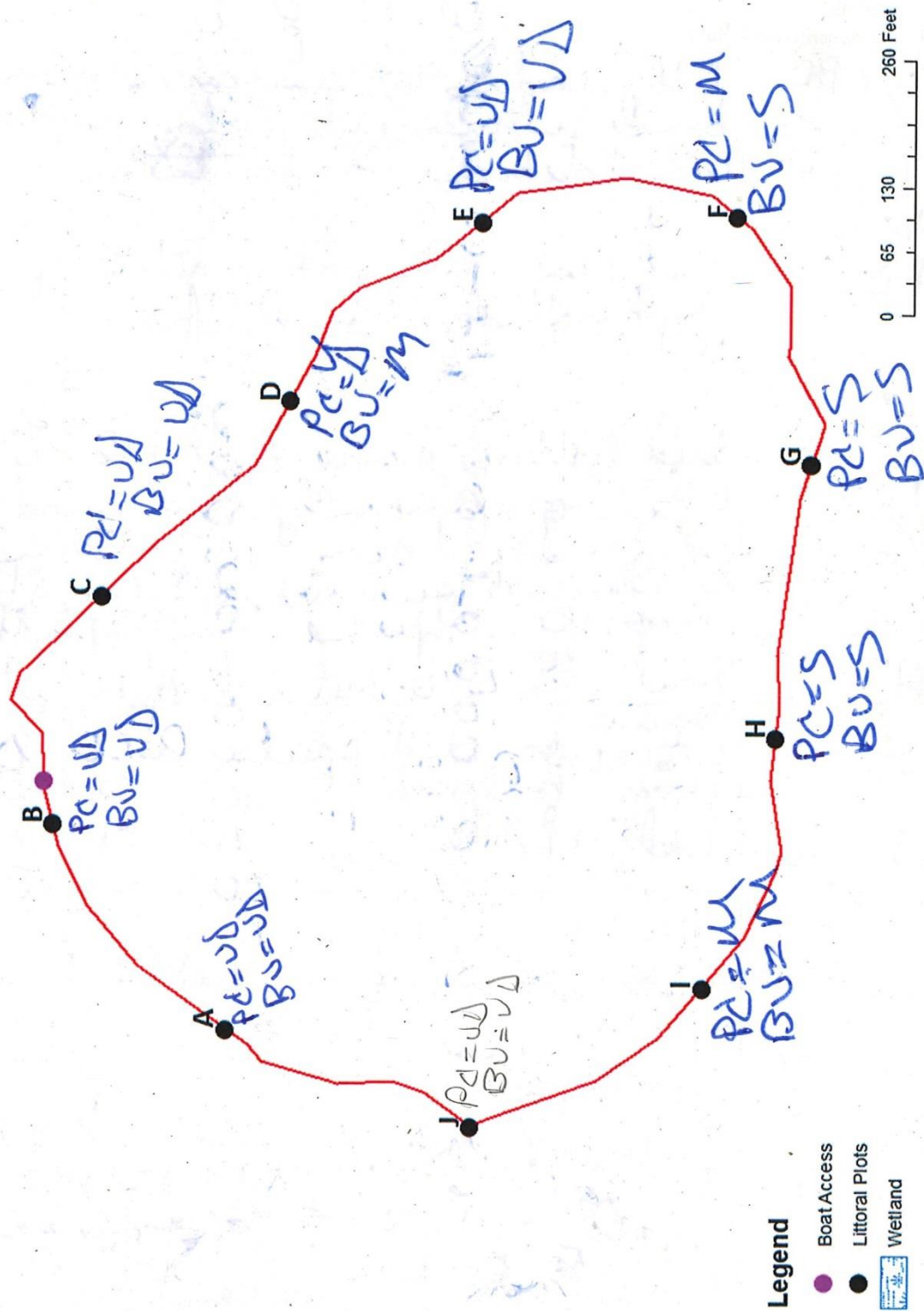
Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macroinvertebrate Littoral Habitat Field Sheet (2017)

General Information										
Project: MAP2 Lakes (2017)					Survey Crew Lead: <u>Muck</u>					
Lake (PALIS): Robbins Pond (81111)					Survey Crew Assist: <u>Tony</u>					
Site Name: MAP2L-145					Station Description (If new, describe below and record latitude and longitude) Composite sample – 10 littoral plots					
Date: <u>8/15/17</u>										
Time (24 hr): <u>830</u>					Plot A Lat: 42.53823			Plot A Long: -71.60602		
Littoral Plot	A	B	C	D	E	F	G	H	I	J
Plot Characteristics										
All estimates should be in metric.										
Depth (10 m offshore)	<u>0.5</u>	<u>0.5</u>	<u>0.9</u>	<u>1.0</u>	<u>2.0</u>	<u>1.5</u>	<u>2.0</u>	<u>1.0</u>	<u>0.7</u>	<u>0.5</u>
Shoreline Flooding (Depth/Distance)	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Drawdown (Height/Distance)	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Surface Film	N = None S = Scum A = Algal Mat O = Oily F# = Other									
	<u>N</u>	<u>N</u>	<u>N</u>	<u>O</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>
Substrate Odor	N = None S = H ₂ S A = Anoxic O = Oil F# = Other									
	<u>A</u>	<u>A</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Substrate Color	Bl = Black G = Gray Br = Brown R = Red F# = Other									
	<u>Bl</u>	<u>Bl</u>	<u>Bl</u>	<u>Br</u>	<u>Br</u>	<u>Bl</u>	<u>Br</u>	<u>Br</u>	<u>Br</u>	<u>Bl</u>
Macroinvertebrate Sample	R = Rocky/Cobble/Woody M = Macrophyte F = Fines (mud, silt, sand) L = Leaf Pack, Detritus F# = Other									
Habitat Sampled	<u>M</u>	<u>L</u>	<u>M</u>	<u>L</u>	<u>M</u>	<u>F</u>	<u>M</u>	<u>F</u>	<u>L</u>	<u>F</u>
Collection Method	B = Boat W = Wading									
	<u>B</u>	<u>B</u>	<u>B</u>	<u>B</u>	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>	<u>W</u>
Human Influences	O = Not Present P = Present adjacent to littoral plot C = Present within littoral plot									
Buildings	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Commercial	<u>O</u>	<u>O</u>	<u>P</u>	<u>P</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Park Facilities/Man-made Beach	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Docks/Boats	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Walks, dikes or revetments	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Trash/Landfill	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Roads or Railroads	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Power Lines	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Row Crops	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Pasture/Hay fields	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Orchard	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>
Lawn	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>	<u>O</u>



Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macroinvertebrate Littoral Habitat Field Sheet (2017)

MAP2L-145



Revision Date 10/2015

UniqueID#

Field Sheet Login#

For Office Use Only



Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Mark</i>		
Lake (PALIS): Robbins Pond (81111)		Survey Crew Assist: <i>Torres</i>		
Site Name: MAP2L-145		Station Description (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)		
Date: <i>8/15/17</i>				
Time (24 hr): <i>830</i>				
Sampling Activity <input type="checkbox"/> Macroinvertebrate <input type="checkbox"/> Macrophyte Mapping <input type="checkbox"/> Deep Site WQ <input type="checkbox"/> Shoreline WQ <input type="checkbox"/> Fish Tissue <input type="checkbox"/> Other				
Macrophyte Identification		VD = Very Dense (75 – 100%) D = Dense (50 – 75%) M = Moderate (25-50%) S = Sparse (1-25%)		
Species ID (If uncertain, leave blank and collect voucher)	Overall Percent Cover	Voucher ID (Site ID – Species ID) (Example: 002-01)	Observation Location - Purpose (Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID	ID Analyst
01 <i>Nymphaea odorata</i>	<i>D</i>		<i>RTA, B, C, D, E, J</i>	<i>JM</i>
02 <i>Nuphar variagata</i>	<i>S</i>		<i>Mixed in but at lower densities</i>	<i>JM</i>
03 <i>Cabomba caroliniana</i>	<i>S</i>		<i>RT J, mixed in</i>	<i>JM</i>
04				
05				
06				
07				
08				
09				
10				
11				
12				
13				
14				
15				
Voucher Labeling Place each plant voucher in a separate plastic bag labeled with the Voucher ID and Date. Place all individually bagged plant vouchers into a large bag labeled with the Site ID and Date.				
Voucher Plant Identification After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.				



Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macrophyte Survey Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Muk</i>		
Lake (PALIS): Stiles Pond (92063)		Survey Crew Assist: <i>Tomer</i>		
Site Name: MAP2L-169		Station Description (If new, describe below and record latitude and longitude)		
Lake Area (ha): 23.9				
Macrophyte Survey Details				
Start Date: <i>7/7/17</i>	End Date: <i>7/7/17</i>	Cover and Biovolume Method <input type="checkbox"/> Visual Estimates <input checked="" type="checkbox"/> Sonar Estimates		
Start Time: <i>9:30</i>	End Time: <i>1:30</i>	Sonar ID (if applicable):		
Approximate Transect Spacing: <i>~25m</i> Indicate the approximate orientation and location of the transects on the blank lake figure (reverse side).				
Entire Lake Surveyed? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		If no, reason(s)? <input type="checkbox"/> Equipment Failure <input type="checkbox"/> Macrophyte Density <input type="checkbox"/> Resources <input type="checkbox"/> Other		
Survey Notes:				
Data File Tracking				
Saved File Name: <i>169 20170707A B</i>		Saved Location:		
Data Upload Date:		Uploader:	Upload Destination:	
Data File Notes:				
Lake/Catchment Site Activities and Disturbances Observed in Field (Intensity: Blank = Not Observed, L = Low, M = Moderate, H = High)				
Residential	Recreational	Agricultural	Industrial	Lake Management
<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Residences	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Hiking Trails	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Cropland	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Industrial Plants	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Liming
<input checked="" type="radio"/> L <input type="radio"/> M <input type="radio"/> H Maintained Lawns	<input type="radio"/> L <input checked="" type="radio"/> M <input type="radio"/> H Parks, Campgrounds	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Pasture	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Mines/Quarries	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Chemical Treatment
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Construction	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Other Parks/Camping	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Livestock Use	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Oil/Gas Wells	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Angling Pressure
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Pipes, Drains	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Resorts	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Orchards	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Power Plants	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Drinking Water
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Dumping	<input checked="" type="radio"/> L <input type="radio"/> M <input type="radio"/> H Marinas <i>(Docks)</i>	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Poultry	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Logging	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Treatment
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Roads	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Trash/Liter	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Feedlot	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Evidence of Fire	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Macrophyte Control
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Bridges/Causeways	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Surface Films/Scum	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Water Withdrawal	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Odors	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Water Level Altered
<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Sewage Treatment	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Macrophytes	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Cranberry Bog	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Commercial	<input type="radio"/> L <input type="radio"/> M <input type="radio"/> H Fish Stocking
Overall Waterbody Character				
Human Disturbance		Aesthetic Appeal		
Pristine (5) (4) (3) (2) (1)		Highly Disturbed (1) (2) (3) (4) (5) Appealing (5) (4) (3) (2) (1) Unappealing		
Aesthetic Impairment Cause (Check all that apply)		Description (details, extent and severity):		
<input type="checkbox"/> Debris/Floatables/Trash <input type="checkbox"/> Excessive Algal Growth <input type="checkbox"/> Taste and Odor <input type="checkbox"/> Oil and Grease <input type="checkbox"/> Other				
<input type="checkbox"/> Foam/Flocs/Scum/Oil Slicks <input type="checkbox"/> Aquatic Plants (Macrophytes) <input type="checkbox"/> Turbidity <input type="checkbox"/> Sedimentation/Siltation				
Description (details, extent and severity):		<i>AESTHETICS SUPPORT</i>		



Visual Macrophyte Percent Biovolume Map

Site Name: MAP2L-169

Date: 7/7/17

Observer(s): M.K. Torres



Very Dense (75-100%)



Dense (51-74%)



Moderate (26-50%)



Sparse (0-25%)

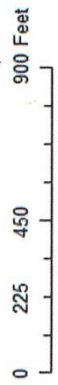
NOTE: BIOVOLUME
DOES NOT IMPAIR
REA USES

MAP2L-169



Legend

● Boat Access





Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Muh</i>		
Lake (PALIS): Stiles Pond (92063)		Survey Crew Assist: <i>Tones</i>		
Site Name: MAP2L-169		Station Description (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)		
Date: <i>7/2/17</i>				
Time (24 hr): <i>9/30</i>				
Sampling Activity <input type="checkbox"/> Macroinvertebrate <input checked="" type="checkbox"/> Macrophyte Mapping <input type="checkbox"/> Deep Site WQ <input type="checkbox"/> Shoreline WQ <input type="checkbox"/> Fish Tissue <input type="checkbox"/> Other				
Macrophyte Identification		VD = Very Dense (75 – 100%) D = Dense (50 – 75%) M = Moderate (25-50%) S = Sparse (1-25%)		
Species ID (If uncertain, leave blank and collect voucher)	Overall Percent Cover	Voucher ID (Site ID – Species ID) (Example: 002-01)	Observation Location - Purpose (Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID	ID Analyst
01		<i>169-01</i>	<i>RT 1 (1sp)</i>	
02		<i>169-02</i>	<i>RT 2 (1sp)</i>	
03		<i>169-03</i>	<i>RT 8 (4sp)</i>	
04		<i>169-04</i>	<i>RT 9 (1sp)</i>	
05		<i>169-05</i>	<i>RT 11 (2sp)</i>	
06		<i>169-06</i>	<i>COVE 1 (4sp)</i>	
07		<i>169-07</i>	<i>COVE 2 (1sp-UNIQUE)</i>	
08				
09				
10				
11				
12				
13				
14				
15				

Voucher Labeling

Place each plant voucher in a separate plastic bag labeled with the **Voucher ID** and **Date**. Place all individually bagged plant vouchers into a large bag labeled with the **Site ID** and **Date**.

Voucher Plant Identification

After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.



Indicate species locations using the species ID from the identification table.

Visual Macrophyte Species Map

Site Name: MAP2L-169

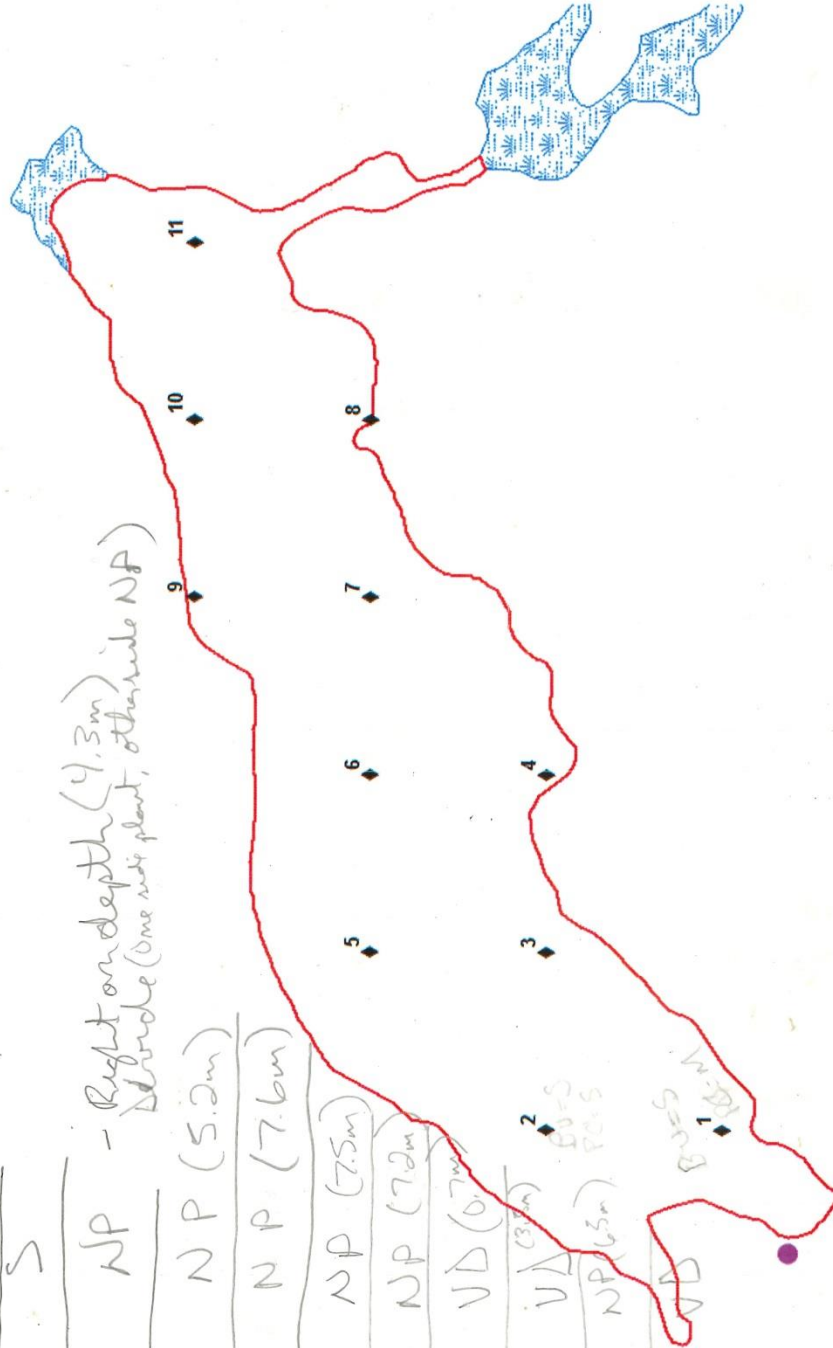
Date: 2/2/17

Observer(s): Mark, Tonia

RT1	BU	PC
RT2	S	M
RT3	S	S
RT4	NP	NP
RT5	NP	NP
RT6	NP	NP
RT7	NP	NP
RT8	D	VD
RT9	S	VD
RT10	NP	NP
RT11	M	VD

Handwritten notes:
- Right on depth (4.3m)
- Divide (one side plant, other side NP)
- 1 NP, 2 NP, 3 NP, 4 NP, 5 NP, 6 NP, 7 NP, 8 NP, 9 NP, 10 NP, 11 NP

MAP2L-169



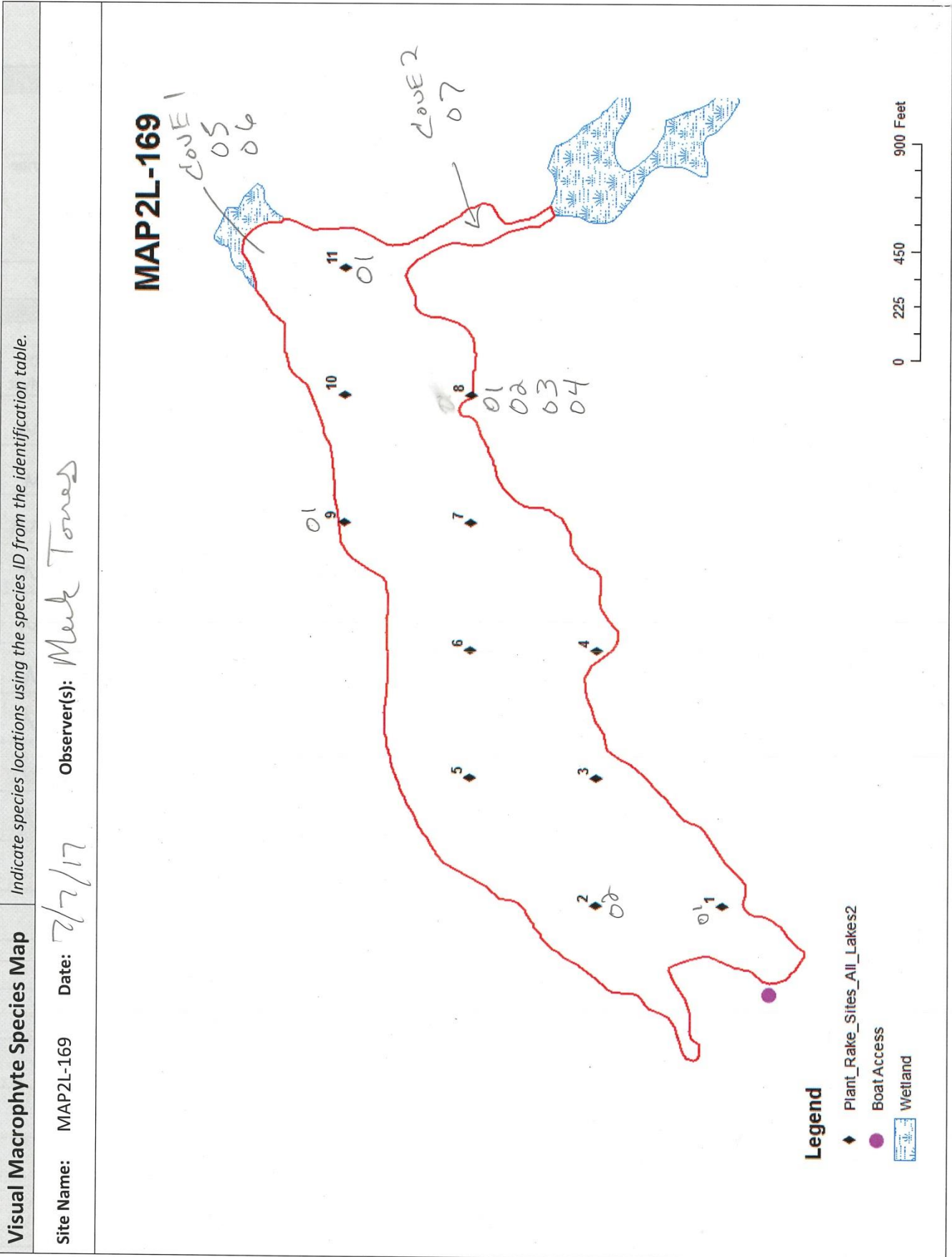
Legend

- Plant_Rake_Sites_All_Lakes2
- Boat Access
- Wetland



Massachusetts Department of Environmental Protection/Watershed Planning Program
MAP2 Macrophyte Identification/Voucher Field Sheet (2017)

General Information				
Project: MAP2 Lakes (2017)		Survey Crew Lead: <i>Muk</i>		
Lake (PALIS): Stiles Pond (92063)		Survey Crew Assist: <i>Tones</i>		
Site Name: MAP2L-169		Station Description (Does site match description? <input type="checkbox"/> YES <input type="checkbox"/> NO If NO, describe below)		
Date: <i>7/2/17</i>				
Time (24 hr): <i>930</i>				
Sampling Activity <input type="checkbox"/> Macroinvertebrate <input checked="" type="checkbox"/> Macrophyte Mapping <input type="checkbox"/> Deep Site WQ <input type="checkbox"/> Shoreline WQ <input type="checkbox"/> Fish Tissue <input type="checkbox"/> Other				
Macrophyte Identification				
VD = Very Dense (75 – 100%) D = Dense (50 – 75%) M = Moderate (25-50%) S = Sparse (1-25%)				
Species ID (If uncertain, leave blank and collect voucher)	Overall Percent Cover	Voucher ID (Site ID – Species ID) (Example: 002-01)	Observation Location - Purpose (Indicate location and/or purpose of collection) Ex. LPC (Littoral Plot C) – sampled substrate Ex. RT1 (Rake Throw 1) – plant ID	ID Analyst
01 <i>Potamogeton robbinsii</i>	<i>M</i>		<i>COVE 1</i> <i>RT1, RT8, RT9, RT11</i>	<i>JM</i>
02 <i>Aquatic moss</i>	<i>S</i>		<i>RT2, RT8</i>	<i>JM</i>
03 <i>Brasenia schreberi</i>	<i>S</i>		<i>RT8</i>	<i>JM</i>
04 <i>Nuphar variegata</i>	<i>S</i>		<i>RT8</i>	<i>JM</i>
05 <i>Nymphaea odorata</i>	<i>S</i>		<i>COVE 1</i>	<i>JM</i>
06 <i>Pontederia cordata</i>	<i>S</i>		<i>COVE 1</i>	<i>JM</i>
07 <i>Utricularia vulgaris</i>	<i>S</i>		<i>COVE 2</i>	<i>JM</i>
08				<i>JM</i>
09				<i>JM</i>
10				
11				
12				
13				
14				
15				
Voucher Labeling Place each plant voucher in a separate plastic bag labeled with the Voucher ID and Date . Place all individually bagged plant vouchers into a large bag labeled with the Site ID and Date .				
Voucher Plant Identification After the plant has been identified in the lab, record the species and the analyst that identified the plant on the field sheet.				





Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) JM

Lake Vertical Profile Probe Deployment (2022)

Site and Survey Information					
Field Sheet Login#: 22-M502-01		Unique ID: W3149		Site Name (STAID): TAM-003	
Project: TAM A2-4 (2022)			Lake (PALIS): Morses Pond (72079)		
Crew Lead: Meek			Other Crew: <u>Davis</u>		
Field Latitude (DD): <u>42.29716</u>			Field Longitude (DD): <u>-71.319743</u>		
General Comments:					
Water Level (relative to annual high-water level): <input type="checkbox"/> Low <input checked="" type="checkbox"/> Normal <input type="checkbox"/> High Water level, ft above/below:					
Start Date: 6/28/2022			Immersion Time (24hr): <u>910</u>		
End Date: <u>10/4/22</u>			Taken-out-of-water Time (24hr): <u>1220</u>		
Weighted Line Max Depth (m) @ Deploy: <u>6.9</u>			Sub-Surface Buoy Depth ¹ (m): <u>0.35</u>		
Vertical Profile Deployment Information					
Sonde No.	Measured Sonde Line Depth ² (m)	Calculated Sonde Water Depth ³ (m)	OWMID	Sonde ID#	Sonde Type
1	0.7	1.05	25-0423	20781156	<input checked="" type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
2	1.5	1.85	25-0424	20583767	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
3	2.5	2.85	25-0425	20583768	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
4	3.5	3.85	25-0426	20583769	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
5	4.5	4.85	25-0427	20583770	<input type="checkbox"/> DO/T <input checked="" type="checkbox"/> Temp <input type="checkbox"/> Other:
6	5.5	5.85	25-0428	20781151	<input checked="" type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
7			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:

If deploying more than 7 sondes, continue on the back

- 1 – Sub-surface buoy depth is distance from the water surface to the top of the sub-surface buoy.
- 2 – Sonde line depth is distance from the top of the sub-surface buoy to the sonde.
- 3 – Sonde water depth is distance from water surface to the top of the sub-surface buoy (1) PLUS distance from top of the sub-surface buoy to the sonde (2). Enter 3 into WQD for deploy sonde depth.



Vertical Profile Deployment Information (Continued)					
Sonde No.	Measured Sonde Line Depth ¹ (m)	Calculated Sonde Water Depth ³ (m)	OWMID	Sonde ID#	Sonde Type
8			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
9			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
10			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
11			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
12			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
13			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
14			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
15			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
16			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
17			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
18			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
19			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:
20			Affix OWMID # Label here		<input type="checkbox"/> DO/T <input type="checkbox"/> Temp <input type="checkbox"/> Other:

1 – Sub-surface buoy depth is distance from the water surface to the top of the sub-surface buoy.

2 – Sonde line depth is distance from the top of the sub-surface buoy to the sonde.

3 – Sonde water depth is distance from water surface to the top of the sub-surface buoy (1) PLUS distance from top of the sub-surface buoy to the sonde (2). Enter 3 into WQD for deploy sonde depth.

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) JM

Lake Vertical Profile Probe Deployment (2022)

Marses

[illegible]

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) _____ Lake Vertical Profile Probe Deployment (2022)

[illegible]

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial)

Lake Vertical Profile Probe Deployment (2022)

Morse

[illegible]

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) _____ Lake Vertical Profile Probe Deployment (2022)

[illegible]

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial)

Lake Vertical Profile Probe Deployment (2022)

240525

[illegible]

Massachusetts Department of Environmental Protection/Division of Watershed Management

Crew Lead (initial) _____

Lake Vertical Profile Probe Deployment (2022)

[illegible]





APPENDIX E: CHAIN OF CUSTODY FORMS



Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection
Senator William X. Wall Experiment Station

Sample Tracking & Chain-of-Custody Record

Cooler Temperature at Receipt _____ °C

WES Sample Log-In Batch # _____

Agency-Bureau-Division-Region

Bureau: BWR
Division/Unit: DWM - WPP
☐ DEP WES ☐ DEP Boston
☐ DEP NERO ☐ DEP SERO
☐ DEP CERO ☐ DEP WERO
☐ Other Agency: _____

Project Description

Name: MAP2 Lakes (2017)
Coordinator: James Meek
Phone #: 508-767-2863
Fax #: _____
RTN: _____
Case #: _____

Analytical Laboratory (for samples sent to a laboratory other than WES)

Name: Worcester
Address: 8 New Bond Street
Worcester, MA 01606
Contact: R. Chase
MA Cert#: _____
Phone #: 508.767.2859

Sample Lab ID (Batch # above plus # below)	Sample Field ID	Site Name	Field Locator (Within Site)	Sample Matrix Code*	Collector (last name, first initial)	Collection		Sample Preserv. Code #**	G/C***	Chlorine Residual (yes/no)	Analysis Requested
						Date	Time				
	10-5315	MAP2L-128		SRW	Reardon	9/28/2017	1108		G	Y	Color/Turbidity
	10-5316	MAP2L-128		SRW		9/28/2017	1112		G		Color/Turbidity
	10-5317	MAP2L-128		SRW		9/28/2017	1040		G		Color/Turbidity
	10-5321	MAP2L-128		SRW		9/28/2017	1140		C		Chlorophyll a
	10-5322	MAP2L-128		SRW		9/28/2017	1145		C		Chlorophyll a
	10-5323	MAP2L-128		SRW		9/28/2017	1055		C		Chlorophyll a
	10-5324	MAP2L-161		SRW		9/28/2017	1320		G		Color/Turbidity
	10-5326	MAP2L-161		SRW		9/28/2017	1345		C	Y	Chlorophyll a

Remarks: Week 39

Chain of Custody: (Required, including signatures, for all samples submitted to WES Laboratories)

Relinquished by:				Received by:			
Printed name	Signature	Org.	Date	Printed name	Signature	Org.	Date
Matthew Reardon		DEPDWM	9/28/17	Friede		DEPDWM	9/28/17
Friede		DEPDWM	9/29/17	DEPDWM		DEPDWM	9/29/17

* Matrix Codes

AC = Air Canister
ACT = Air Cartridge Tube
AF = Air Filter
CPL = Commercial Product Liquid
CPS = Commercial Product Solid
DW = Drinking Water
(Treatment and Distrib)
FBT = Fish/Biological Tissue
FEC = Feces/Fecal Matter
GRWV = Gray Water
GW = Ground Water
IWW = Industrial Wastewater
LL = Landfill Leachate
LW = Liquid Waste
ME = Marine/Estuarine Water
SED = Sediment
SOIL = Soil
SRW = Surface Water
STW = Storm water/CSO
SW = Solid Waste
TB = Trip Blank (Type I Reagent Water)
UN = Unspecified Water/Wastewater
WO = Waste Oil
WW = Domestic Wastewater
WWS = Wastewater Sludge

** Sample Preserv Codes

1 = Cool < 4° C
2 = pH < 2 with H₂SO₄
3 = pH < 2 with HNO₃
4 = pH < 2 with HCl
5 = pH > 12 with NaOH
6 = Ascorbic acid
7 = Filtered (0.45-µm pore size)
8 = Sodium thiosulfate (Na₂S₂O₃)
9 = Mercuric chloride (HgCl₂)
10 = Sodium sulfite (Na₂S)
11 = Ammonium chloride (NH₄Cl)
12 = Ethylenediamine
13 = EDTA
14 = Methanol
15 = Reagent Water (Type I)

*** G/C = Grab/Composite

N:\MONITORING\Probabilistic\MAP2 Lakes\Northeast_2017\Sampling\COG_Labels_Field sheets\COG\Color_Turb_Chlor_A_WPP_COG_Index.doc



APPENDIX F: QUICKGUIDE FOR FIELD USE OF YSI EXO SONDE AND LOGGER



YSI EXO User Quick Guide

Initial

- Hold blue storage cup and loosen (not separate) black tension ring by turning COUNTERCLOCKWISE to remove storage cup from probe.
- Press power button to turn on Exo

Calibrate Depth

- Calibrate depth BEFORE placing in water
- Press **"Calibrate"** button, select depth and press **Enter**
- Select calibrate and press **Enter**
- Check to make sure calibration value is 0.000 wait to make sure reading is stable (green checkmark appears at the right-hand corner of the graph)
- Press **Enter** to accept calibration.
- Press **"Handheld"** icon to return to **Setup** Screen

Select User ID

- Place probe in water at sampling location (for probe equilibration)
- Scroll down to **"User ID"** (selected user will be in brackets, E.G.: "UserID [Medeiros]")
- Select **"User ID [last name]"** and press **Enter**
- Select desired ID and press **Enter**
- Select **"Select [last name]"** and press **Enter**

Turn on Auto Stable

- On **Setup** Screen scroll to Auto Stable" (should read "Auto Stable [On]), press **Enter**
- Screen should read **"Auto Stable"** at top
- Scroll down to **"Start Auto Stable"**, press **Enter**

Blinking "AS" should be displayed next to parameters.

- Blinking red parameters are not yet stable. Blinking green parameters are stable. (Parameters must be consistent with auto stable settings for five consecutive samples ten seconds apart before they will be considered stable.)
- Once ALL parameters are stable the "AS" will be solid green for auto stable parameters. Wait at least 5 minutes before logging samples EVEN if "AS" has turned solid green. If it has been greater than 5 minutes and "AS" has not turned green indicating stability, use your best professional judgement and begin logging when you feel the parameters are stable.

Begin Logging

- To begin logging select **"Start Logging"** and press **Enter**
- Do **NOT** hit **"Start Now!"** yet!
- Scroll down to **"Site"** (current selected site will be in brackets E.G.: "Site ID [52-0756]")
- Select **Site [site ID]** and press **Enter**
- Select desired Site and press **Enter**
- Select **"Start Now!"** and press enter to start logging
 - If a site needs to be added that is not in the list, select **"add new"** and press **Enter**
 - Enter new site ID using virtual keyboard, scroll down to "enter" bar on keyboard and press **Enter**
 - **IMPORTANT** Scroll down and select **"Save"**, press **Enter**



- You can now select this as the site ID and press **Enter**
- Scroll back up and select "**Start Now!**", press **Enter**
- The logger will start logging at 30 second intervals (note the start time and log for 2 minutes)

Stop Logging

- To stop logging select "**Stop logging**" and press **Enter**

Review Data

- To review data Hit "**Data**" button
- Select "**View Data**" and press **Enter**
- Scroll to "**Site [site]**" and press **Enter**
- Select desired site ID, press **Enter**
- Scroll to "**Begin Date**", press **Enter**
- Enter desired date, press **Enter**
- Scroll to "**Show Data**", press **Enter**
- Data will be displayed on screen
- Write last line of data to appropriate spaces on field sheet

Move to Next Site

- Turn off handheld unit
- Place blue cup back on sonde and tighten ring to secure to bulkhead



APPENDIX G: BIOBASE QUICK REFERENCE



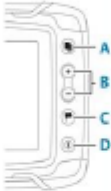
Quick Reference Guide (Updated 07/06/2022)

Installation

- We recommend following the Lowrance® HDS and Elite Ti²/FS unit installation instructions that accompany the unit. Failing to install the transducer correctly may interfere with the sonar signal and prevent the gathering of accurate data.
- Please ensure your unit has the latest firmware – see <https://downloads.lowrance.com/>
- Always ensure a clear signal (both Sonar and GPS) prior and during logging. Periodic disruptions due to various causes are ok; sustained disruptions of signal will result in inaccurate or no data. Always monitor the SONAR page.

Elite Ti²/FS Controls


Keys



A Pages	<ul style="list-style-type: none">• Press to activate the home page• Press to zoom the image• Simultaneous press both keys to save a Man Overboard (MOB) waypoint at the current vessel position
B Zoom in/out	
C Waypoint	<ul style="list-style-type: none">• Press to open the new waypoint dialog• Press twice to save a waypoint• Press and hold to access the find dialog
D Power	<ul style="list-style-type: none">• Press to turn the unit ON• Press and hold to turn the unit OFF• When ON press once to display the system controls dialog<ul style="list-style-type: none">- repeat short presses to cycle the backlight brightness

HDS LIVE Controls

Keys



A Pages	<ul style="list-style-type: none">• Press to activate the home page• Repeat short presses to cycle the favorite buttons
B Waypoint	<ul style="list-style-type: none">• Press to open the new waypoint dialog• Press twice to save a waypoint• Press and hold to access the find dialog
C Arrows	<ul style="list-style-type: none">• Press to position the cursor on the image• Press to pan the image in any direction• Press to navigate menus
D Exit	<ul style="list-style-type: none">• Press to clear the cursor or restore the cursor on the chart panel In menus and dialogs: <ul style="list-style-type: none">• press to return to previous menu level and to exit a dialog
E Enter	In menus and dialogs: <ul style="list-style-type: none">• press to confirm a selection
F Zoom in/out	<ul style="list-style-type: none">• Press to zoom the image• Simultaneous press both keys to save a Man Overboard (MOB) waypoint at the current vessel position
G Menu	<ul style="list-style-type: none">• Press to display the menu• Press twice to access the settings menu• Press and hold to hide the panel menu• Press to turn the unit ON• Press and hold to turn the unit OFF
H Power	<ul style="list-style-type: none">• When ON press once to display the system controls dialog<ul style="list-style-type: none">- Repeat short presses to cycle the backlight brightness
I Quick access*	<ul style="list-style-type: none">• Use the configurable keys option in the system settings dialog to configure the keys
J Card reader door	

*Not available for 7" and 9" units

Lowrance® HDS and Elite Unit Settings (Recommended)*

- On HDS, Channel 2 is the black 9pin plug and transmits Sonar, Down- and Side-Scan if present. Channel 1 is the blue plug and transmits Sonar only. With only one transducer installed, use the black CH2 port. If you find HDS is not reading the proper Channel source, either reboot or remove invalid sources in the Network - Data Sources area of the device's settings
- Transducer "Installation"
 - Press Pages button, select Gear Wheel (Settings), select SONAR; Select INSTALLATION; Select Transducer (check the silver tag on your transducer cable for the model). Depending on your unit, this may automatically be detected.
- Mode = Shallow Water (for vegetation detection or depths < 60ft, if deeper, use Fresh Water setting)
 - Press Pages button, select SONAR
- Sonar Range = Auto (Default): For optimal bottom and vegetation detection in lakes deeper than 15 ft (4.6 m). Fixing the range to twice the max bottom depth might aid bottom tracking in very shallow ponds.
 - Press Pages button, select SONAR
- Frequency of Broadband Sonar = SONAR Page. Select 200KHz



Quick Reference Guide (Updated 07/06/2022)

- WAAS Differential Correction Enabled on GPS
 - Press the Pages button select Gear Wheel (Settings), select SYSTEM, select SATELLITES, select CONFIGURE, enable WAAS
- Recommended Speed = ≤ 5.5 mph. Faster is ok for slowly changing bottom; go slower during rapid depth changes or through vegetation.
- Monitor your SONAR page; if signal becomes interrupted at faster speeds, slow down. Signal loss at speed is an indication the transducer is not installed correctly.
- Maximum Speed = 20 mph (Bathymetry), 10 mph (Vegetation), 10 mph (Bottom Composition).
- Bytes per sounding = Default 3200

Recording Sonar

- We recommend carrying two 8-32 (not ≥ 64) GB microSD cards. We recommend logging no longer than one hour per file. Ensure SD card compatibility/function prior to recording sonar by ensuring the card is recognized in the Log Sonar menu dialog.
- Logging sonar: Quick press the power button, select LOG SONAR.
- File Format = .slg (Sonar only, smallest file, min. needed for EcoSound maps), .sl2 (Sonar + Structure med. sized file - RECOMMENDED), .or .sl3 (Sonar + 3D Structure largest file). Select RECORD.
- Stop recording:
 - Quick press POWER and select STOP LOGGING
 - DO NOT select STOP/START SONAR during recording – this will only stop/start pinging, not recording.
- Do not adjust SONAR file/frequency/logging settings while recording is underway. If adjustments need to be made, stop the file, make the adjustment, and then resume logging a new file. Changing displays and zoom levels is ok.

Transects

- Transects can be any spacing and depends on the user coverage needs. Users can adjust the buffer in BioBase Reprocessing Tools. 40-m spacing is enough for most needs.
- Use a design (perpendicular to shore, parallel, concentric) that results in the most efficient coverage of water and maps features to your acceptable level of detail.
- Monitor your Lowrance Chart and record a trail to monitor coverage. For pre-planning purposes, transects can be created in GIS, saved to a .gpx file, and then imported into your HDS or Elite unit.

Data Upload

- Once recorded, files can be saved to the user's local computer or uploaded directly from the SD card using the BioBase upload client or web upload tool available in a user's dashboard at <https://www.BioBaseMaps.com/>.
- Time required to upload and process the files will depend on several factors including the size of the file, size of the area surveyed, and internet connection speed. Over weak upload connections (1 Mbps or less), uploading through a web browser may not work. The desktop client tool is more stable over slow internet connections. After successful upload, sonar logs go to a queue for processing. They are not available immediately upon upload
- An e-mail will be sent to you once processing is complete if you have elected to receive processing emails.
- Prior to merging trips, we recommend users review and verify individual trips with the sonar log. Sonar logs are not generated with merged trips.

**Refer to the Lowrance® HDS and Elite manuals or full EcoSound Operator's Guide for additional details. ©Navico Inc.*



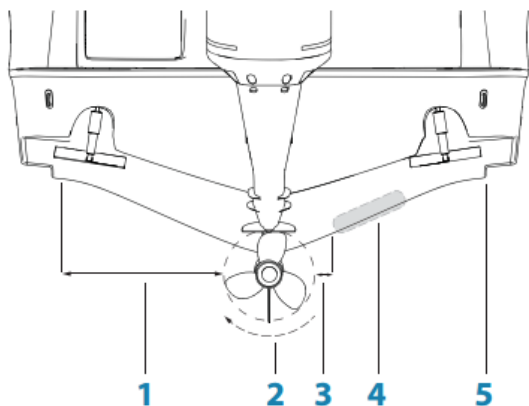


APPENDIX H: SONAR TRANSDUCER MOUNTING GUIDANCE



Select a transducer location

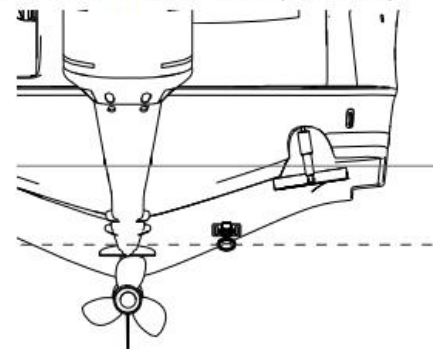
The primary aim is to stay clear of propeller and hull generated turbulence, while mounting the transducer as close to the center of the vessel as possible.



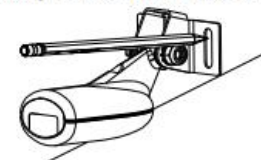
- 1 Avoid mounting within 1 m (3.3') to port (left) of propeller**
- 2 Conventional clockwise propeller rotation**
- 3 Avoid mounting within 7.5 cm (3") to starboard of propeller**
- 4 Best mounting location - undisturbed water flow**
- 5 Planing strake - avoid mounting behind here**

Attaching the transducer

The transducer should be installed parallel with the transom's waterline, not the bottom of the boat (deadrise).



- **Note:** Ensure the entire bottom surface of the transducer hangs at least 3 mm (1/8th of an inch) lower than the bottom of the hull.



Hold the transducer with bracket up to the transom of the boat and trace the slotted screw hole locations (two on the 83/200 KHz transducer, and four on the 50/200 KHz transducer). Mark drilling points in the middle of each outline, to allow for transducer height adjustment. Drill pilot holes to suit fasteners.

- **Note:** Check that there is nothing on the other side of the mounting surface that may be damaged by drilling.

Attach transducer to transom, using supplied stainless steel fasteners. Drill a 25 mm (1") hole above the waterline, large enough to pass the plug through.

