United States Environmental Protection Agency
Office of Water
Office of Environmental Information
Washington, DC
EPA841-B-07-004

Survey of the Nation's Lakes

Field Operations Manual

NOTICE

The intention of the Survey of the Nation's Lakes project is to provide a comprehensive "State of the Lakes" assessment for lakes, ponds, and reservoirs across the United States. The complete documentation of overall project management, design, methods, and standards is contained in companion documents, including:

- *Survey of the Nation's Lakes: Quality Assurance Project Plan (EPA 841-B-07-003)*
- *Survey of the Nation's Lakes: Lake Evaluation Guidelines (EPA 841-B-06-003)*
- *Survey of the Nation's Lakes: Field Operations Manual (EPA 841-B-07-004)*
- *Survey of the Nation's Lakes: Laboratory Methods Manual (EPA841-B-07-005)*

This document (*Field Operations Manual*) contains a brief introduction and procedures to follow at the base location and on-site, including methods for sampling water chemistry (grabs and *in situ*), phytoplankton, zooplankton, sediment (diatoms and mercury), a fecal indicator, algal toxins, benthic macroinvertebrates, and physical habitat. These methods are based on both the guidelines developed and followed in the Western Environmental Monitoring and Assessment Program (Baker, et. al., 1997) and methods employed by several key states that were involved in the planning phase of this project. Methods described in this document are to be used specifically in work relating to the Survey of the Nation's Lakes. All Project Cooperators should follow these guidelines. Mention of trade names or commercial products in this document does not constitute endorsement or recommendation for use. Details on specific methods for site evaluation and sample processing can be found in the appropriate companion document.

The suggested citation for this document is:

USEPA. 2007. Survey of the Nation's Lakes. Field Operations Manual. EPA 841-B-07-004. U.S. Environmental Protection Agency, Washington, DC.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

ANC	acid neutralizing capacity
CO_2	carbon dioxide
CPR	cardiopulmonary resuscitation
DI	deionized
DO	dissolved oxygen
DOC	dissolved organic carbon
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
ETOH	ethyl alcohol
GIS	geographic information system
GPS	global positioning device
HDPE	high density polyethylene
H_2S	hydrogen sulfide
MPCA	Minnesota Pollution Control Agency
NALMS	North American Lakes Management Society
NH_4	ammonium
NIST	National Institute of Standards
NO_3	nitrate
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
P-Hab	physical habitat
QA	quality assurance
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QCCS	quality control check solution
SOPs	Standard Operating Procedures
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
TVS	total volatile solids
USGS	United States Geological Survey

1.0 BACKGROUND

This manual describes field protocols and daily operations for crews to use in the Survey of the Nation's Lakes. The Survey is a statistical assessment of the condition of our Nation's lakes, ponds, and reservoirs (subsequently referred to in this manual as "lakes") and is designed to:

- Assess the condition of the Nation's Lakes
- Establish a baseline to compare future surveys for trends assessment and evaluate trends since the 1970's National Eutrophication Survey Study
- Help build State and Tribal capacity for monitoring and assessment and promote collaboration across jurisdictional boundaries

This is one of a series of water surveys being conducted by states, tribes, the U.S. Environmental Protection Agency (EPA), and other partners. In addition to lakes, partners will also study coastal waters, wadeable streams, rivers, and wetlands in a revolving sequence. The purpose of these surveys is to generate statistically-valid reports on the condition of our Nation's water resources and identify key stressors to these systems.

The goal of the Survey is to address two key questions about the quality of the Nation's lakes, ponds, and reservoirs:

- What percent of the Nation's lakes are in good, fair, and poor condition for key indicators of trophic state, ecological health, and recreation?
- What is the relative importance of key stressors such as nutrients and pathogens?

The Survey is designed to be completed during the summer growing season before lake turnover (June through September). Field crews will collect a variety of measurements and indicators from an "index site" located at the deepest point of the lake (≤50 meters, and near the center if sampling a reservoir), and document conditions of the littoral zone and shoreline from stations around the lake.

1.1 Selection of Sampling Locations

EPA selected sampling locations using on a probability based survey design. Sample Surveys have been used in a variety of field (e.g. election polls, monthly labor estimates, forest inventory analysis) to determine the status of population or resources of interest using a representative sample of a relatively few members or sites. Using this survey design allows data from the subset of sampled lakes to be applied to the larger target population and assessments with known confidence bounds to be made. For more information on how EPA selected the sampling locations for the Survey see: http://www.epa.gov/owow/lakes/lakessurvey/siteselect_factsheet.html.

With input from the states and other partners, EPA used the following framework to guide the site selection process:

- The National Hydrography Dataset was used to derive a list of lakes for potential inclusion in the survey.
- For purposes of this survey "lakes" refers to natural and manmade freshwater lakes, ponds, and reservoirs greater than 10 acres (4 hectares) in the conterminous U.S., excluding the Great Lakes.
- Mine ponds, retention basins, cooling ponds, and saline lakes due to salt water intrusion were excluded from this study. For more information on the site exclusion criteria refer to EPA 841-B-06-003.
- The sample size was set to include 1,000 lake sampling events.
- The result was the inclusion of 909 discrete lakes, with 91 of the lakes to be scheduled for revisits. An "oversample" of additional lakes was also done so that any state wishing to conduct a state scale survey could be accommodated.
- The design was constructed to include a representative subset of the lakes that were included in the National Lake Eutrophication Study, conducted by EPA in 1972. This will allow for a trends assessment from the original 1972 NES study Lake selection for the survey provided for 5 size class categories, as well as spatial distribution across the lower 48 states and 9 aggregated Omernik Level 3 ecoregions.
- 10 acres (4 hectares) was set as the minimum size for inclusion in the Lakes Survey.

Related Survey documents include the following: *Survey of the Nation's Lakes: Quality Assurance Project Plan* (EPA 841-B-07-003), *Survey of the Nation's Lakes: Lake Evaluation Guidelines* (EPA 841-B-06-003), and *Survey of the Nation's Lakes: Laboratory Methods Manual* (EPA 841-B-07-005). These documents are available at: http://www.epa.gov/owow/lakes/lakessurvey.

1.2 Selection and Description of Survey Indicators

As part of the indicator selection process, EPA sought the advice of the scientific community at a conference co-sponsored by the Agency and the National Association of Lakes Managers, the National Conference Planning a Survey of the Nation's Lakes held April of 2006. The Agency formed a Survey of the Nation's Lakes Steering Committee with state and regional representatives to develop and refine methodologies. This section summarizes the Conference and Steering Committee recommendations to EPA for selecting Survey indicators.

The Agency developed screening and evaluation criteria and identified potential indicators based on recommendations from received at the Conference. Key screening and evaluation criteria included indicator applicability on a national scale, the ability of an indicator to reflect various aspects of ecological condition, and cost-effectiveness.

Conference participants included individuals with a technical background in water monitoring program design and execution, as well as those with knowledge of programmatic protocols relating to state water monitoring programs. Meeting participants provided feedback on indicators, field protocols, and analytical procedures for the Survey. EPA, states, tribes, members of the North American Lake Management Society, and others discussed approaches

and options on the chemical, physical, and biological parameters to be measured. Participants explored the technical and financial feasibility of sampling and analytical methods, and the use of specialized technologies (e.g., remote sensing), practical considerations for getting the assessment done (e.g., use of volunteers, availability of labs, timeframes, funding), and emerging pollutants and contaminant issues. Conference discussions examined both technical and programmatic aspects of the Survey's implementation.

The Agency sought the advice of its Steering Committee on a final list of Survey indicators. The Committee, comprised of state representatives from each of the EPA regions, provides advice and recommendations to the Agency on matters related to the Survey. EPA used the Committee's recommendations to refine methods and develop final documents. A summary of the National Conference and the Lake's Survey Steering Committee Report is available at http://www.epa.gov/owow/lakes/lakessurvey.

The remainder of this section briefly describes the indicators that the Survey will use to assess trophic status, ecological integrity, recreational value, and lake characteristics (also see Table 1-1). Some indicators provide a basis for evaluating more than one category. For example, an assessment of phytoplankton allows for an examination of ecological integrity and trophic status, and to a certain extent, recreational value.

1.2.1 Trophic Status Indicators

Lakes are classified according to their trophic state. "Trophic" means nutrition or growth. A eutrophic ("well-nourished") lake has high nutrients and high plant growth. An oligotrophic lake has low nutrient concentrations and low plant growth. Mesotrophic lakes fall somewhere in between eutrophic and oligotrophic lakes.

Three variables, chlorophyll, Secchi disk depth, and total phosphorus, are most often used to estimate biomass and define trophic state of a particular lake. Other variables are measured in conjunction with the trophic state variables to supplement and enhance understanding of lake processes that affect primary productivity.

Vertical Profile Measurements

Depth profiles for temperature, pH and dissolved oxygen (D.O.) will be taken with a calibrated water quality probe meter or multi-probe sonde from the index station in each lake. This information will be used to determine the extent of stratification and the availability of the appropriate temperature regime and level of dissolved oxygen necessary to support aquatic life.

Secchi Disk Transparency

A Secchi disk is a commonly used black and white patterned disk used to measure the clarity of water in visibility distance. The Secchi disk measurement is used to help make an estimate of the euphotic zone depth in the field.

Water Chemistry and Associated Measurements

Water chemistry measurements will be used to determine the acidic conditions, trophic state and nutrient enrichment, and classification of water chemistry type.

Chlorophyll-*a*

Chlorophyll a is the pigment that makes plants and algae green. Its measurement is used to determine algal biomass in the water and estimate trophic status.

1.2.2 Ecological Integrity Indicators

Ecological integrity describes the ecological condition of a lake based on different assemblages of the aquatic community and their physical habitat. The indicators include plankton (phytoplankton and zooplankton), benthic macroinvertebrates, diatoms, and the physical habitat of the shoreline and littoral zone.

Phytoplankton Assemblage

Phytoplankton are plant microorganisms that float in the water, such as certain algae, and are the primary source of energy in most lake systems(Schriver et al. 1995).Phytoplankton are highly sensitive to changes in ecosystems (e.g., turbidity and nutrient enrichment).

Zooplankton Assemblage

Zooplankton are animal microorganisms that float in water and consist of crustaceans (copepods and cladocerans), rotifers ("wheel-animals"), pelagic insect larvae (phantom midges), and aquatic mites. The zooplankton assemblage constitutes an important element of the food web, where zooplankton transfer energy from algae (primary producers) to larger invertebrate predators and fish. The zooplankton assemblage responds to environmental stressors such as nutrient enrichment and acidification. The effects of these environmental stressors on zooplankton can be detected through changes in species composition, abundance, and body size distribution.

Benthic Macroinvertebrate Assemblage

Benthic macroinvertebrates are bottom-dwelling animals without backbones ("invertebrates") that are large enough to be seen with the naked eye ("macro"). Examples of macroinvertebrates include: crayfish, snails, clams, aquatic worms, leeches, and the larval and nymph stages of many insects, including dragonflies, mosquitoes, and mayflies. Populations in the benthic assemblage respond to a wide array of stressors in different ways so that it is often possible to determine the type of stress that has affected a macroinvertebrate assemblage (e.g., Klemm et al., 1990). Because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, the structure and function of the macroinvertebrate assemblage is a response to exposure of present or past conditions.

Diatom Assemblage

Diatoms are a group of microscopic algae with a silicon dioxide cell wall and are commonly preserved in lake sediments. This indicator is unique in its ability to tell us about past conditions in the lake and its basin based on the species specific environmental requirements. In addition, environmental variables (e.g. alkalinity, total P, conductivity, etc.) have been inferred using diatom-based predictive models.

Mercury

Mercury is found in many rocks including coal. When coal is burned, mercury is released into the environment. Mercury in the air eventually settles into water or is washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that builds up in fish, shellfish, and animals that eat fish. Fish and shellfish are the main sources of methylmercury exposure to humans.

Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Birds and mammals that eat fish are more exposed to mercury than other animals in water ecosystems. Similarly, predators that eat fish-eating animals may be highly exposed. At high levels of exposure, methylmercury's harmful effects on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior. Mercury information collected from the Survey will allow scientists to better predict the impacts of mercury deposition on a watershed.

Physical Habitat Survey

The physical habitat shoreline and littoral surveys (the region lying along a shore) will serve three purposes. First, habitat information is essential to the interpretation of what lake ecological condition is expected to be like in the absence of many types of anthropogenic impacts. Second, the habitat evaluation is a reproducible, quantified estimate of habitat condition, serving as a benchmark against which to compare future habitat changes that might result from anthropogenic activities. Third, the specific selections of habitat information collected aid in the diagnosis of probable causes of ecological degradation in lakes.

In addition to information collected in the field by the shoreline and littoral surveys, the physical habitat description of each lake includes many map-derived variables such as lake surface area, shoreline length, and shoreline complexity. Furthermore, an array of information, including watershed topography and land use, supplements the physical habitat information. The shoreline and littoral surveys concentrate on information best derived "on the ground." As such, these survey results provide the linkage between large watershed-scale influences and those influences that directly affect aquatic organisms day to day. Together with water chemistry, the habitat measurements and observations describe the variety of physical and chemical conditions that are necessary to support biological diversity and foster long-term ecosystem stability. These characteristics of lakes and their shorelines are the very aspects that are often changed as a result of anthropogenic activities.

1.2.3 Recreational Indicators

Recreational indicators address the ability of the population to support recreational uses such as swimming, fishing and boating. The protection of these uses is one of the requirements in the Clean Water Act under 305b. Both the extent of a fecal indicator (*Enterococci*) and algal toxins (microcystins) will serve as the primary indicators of recreational value.

Fecal Indicator (*Enterococci*)

Enterococci are bacteria that are endemic to the guts of warm blooded creatures. These bacteria, by themselves, are not considered harmful to humans but often occur in the presence

of potential human pathogens (the definition of an indictor organism). Epidemiological studies of marine and fresh water bathing beaches have established a direct relationship between the density of *enterococci* in water and the occurrence of swimming-associated gastroenteritis. *Enterococci* samples will be taken from the last physical habitat transect in waist deep water.

Algal toxins (microcystins)

Microcystis is a microscopic organism that is found naturally at low concentrations in freshwater systems. Under optimal conditions (such as high light and calm weather, usually in summer), *Microcystis* occasionally forms a bloom, or dense aggregation of cells, that floats on the surface of the water forming a thick layer or "mat." At higher concentrations, *Microcystis* blooms are so dense that they resemble bright green paint that has been spilled in the water. These blooms potentially affect water quality as well as human health (*Microcystis* produces microcystin, a potent liver toxin) and natural resources. Decomposition of large blooms can lower the concentration of dissolved oxygen in the water, resulting in hypoxia (low oxygen) or anoxia (no oxygen). Sometimes, this results in fish kills. The blooms can also be unsightly, often floating at the surface in a layer of decaying, odiferous, gelatinous scum.

Although the likelihood of people being affected by a *Microcystis* bloom is low, minor skin irritation can occur with contact, and gastrointestinal discomfort can also occur if water from a bloom is ingested. People recreationally exposed (e.g., personal watercraft operators) to microcystins have also reported minor skin irritation. Health problems may occur in animals if they are chronically exposed to fresh water with *Microcystis* present. Just as livestock and domestic animals can be poisoned by drinking contaminated water, fish and bird mortalities have been reported in water bodies with persistent *Microcystis* blooms.

1.2.4 Other Indicators / Lake Characteristics

Observations and impressions about the lake and its surrounding catchment by field teams will be useful for ecological value assessment, development of associations and stressor indicators, and data verification and validation.

Table 1-1. Summary table of indicators.

Indicator Type	Indicator	Specs/Location in Lake
Trophic Indicators	*Vertical profile measurements* (D.O., Temperature, pH)	Vertical profile from deepest point (index station)
	Secchi Disk transparency	Index station
	Water chemistry (TP, TN [NH_4, NO_3), basic anions and cations, alkalinity [ANC], DOC, TOC, TSS, conductivity	Upper 2 m of water column at index station (depth-integrated)
	Chlorophyll-a	Index station
Ecological Integrity	Phytoplankton assemblage	Upper 2 m of water column at index station (depth-integrated)
	Zooplankton assemblage (composition and structure, size distribution)	Vertical tow through water column
	Benthic macroinvertebrate assemblage (Littoral)	Littoral margin of lake from 3 habitat types at physical habitat stations
	Diatom assemblage	Sediment cores
	Mercury	Sediment core
	Physical habitat survey	10 stations equidistant around lake margin
Recreational	Fecal indicator (*Enterccoccus*)	Water samples taken nearshore at final habitat station (last sampling activity)
	Algal toxins (microcystins)	From index station
Other Indicators (desktop, some field observations.)	Lake area	Done at desktop, and used in target lake population selection
	Basin morphometry	Done at desktop
	Characteristics of watershed	Done at desktop using GIS and verified by state agencies

1.3 Supplemental Material to the Field Operations Manual

The field operations manual describes field protocols and daily operations for crews to use in the Lakes Survey. Following these detailed guides will ensure consistency across regions and reproducibility for future surveys. Before beginning sampling on a lake, crews should prepare a packet for each lake containing pertinent information to successfully conduct sampling. This includes a road map and set of directions to the lake, topographic or bathymetric maps, land owner access forms, site evaluation forms and other information necessary to ensure an efficient sampling day.

Field crews will also receive a quick-reference handbook that contains tables and figures summarizing field activities and protocols from the Field Operations Manual for Lakes. This waterproof handbook will be the primary field reference used by field teams after a completing a

required field training session. The field teams are also required to keep the field operations manual available in the field for reference and for possible protocol clarification.

Large-scale and/or long-term monitoring programs such as those envisioned for national surveys and assessments require a rigorous QA program that can be implemented consistently by all participants throughout the duration of the monitoring period. Quality assurance is a required element of all EPA-sponsored studies that involve the collection of environmental data (USEPA 2000a, 2000b). Field teams will be provided a copy of the integrated Quality Assurance and Project Plan (QAPP). The QAPP contains more detailed information regarding QA/QC activities and procedures associated with general field operations, sample collection, measurement data collection for specific indicators, and data reporting activities. For more information on the Quality Assurance procedures, refer to the *Survey of the Nation's Lakes: Quality Assurance Project Plan (EPA 841-B-07-003*)

2.0 DAILY OPERATIONS SUMMARY

This section presents a general overview of the activities that a two person field team is to conduct during a typical 1-day sampling visit to a lake. General guidelines for recording data and using standardized field data forms and sample labels are also presented. Finally, safety and health considerations and guidelines related to field operations are described.

2.1 Sampling Scenario

Field methods for the Lakes Survey are designed to be completed in one field day for most lakes. Depending on the time needed for both the sampling and traveling for that day, an additional day may be needed for pre-departure and post-sampling activities (e.g., cleaning equipment, repairing gear, shipping samples, and traveling to the next lake). Remote lakes with lengthy or difficult approaches may require more time to gain access to the lake, and field teams will need to plan accordingly.

A field team typically will consist of two people. Two people are always required in the boat together to execute the sampling activities and to ensure safety. Any additional team members may either remain on shore to provide logistical support or are deployed in a second boat to assist in data collection. A daily field sampling scenario showing how the work load may be split between team members is presented in Figures 2-1 and 2-2. Each field team should define roles and responsibilities for each team member to organize field activities efficiently. Minor modifications to the sampling scenario may be made by teams; however the sequence of sampling events presented in Figure 2-1 cannot be changed and is based on the need to protect some types of samples from potential contamination and to minimize holding times once samples are collected. The following sections further define the sampling sequence and the protocols for sampling activities.

***NOTE**: When sampling Large Lakes (lakes >5000 hectares), field teams will omit the physical habitat and benthic macroinvertebrate sampling efforts altogether, and the fecal indicator sample will be collected at the launch site.*

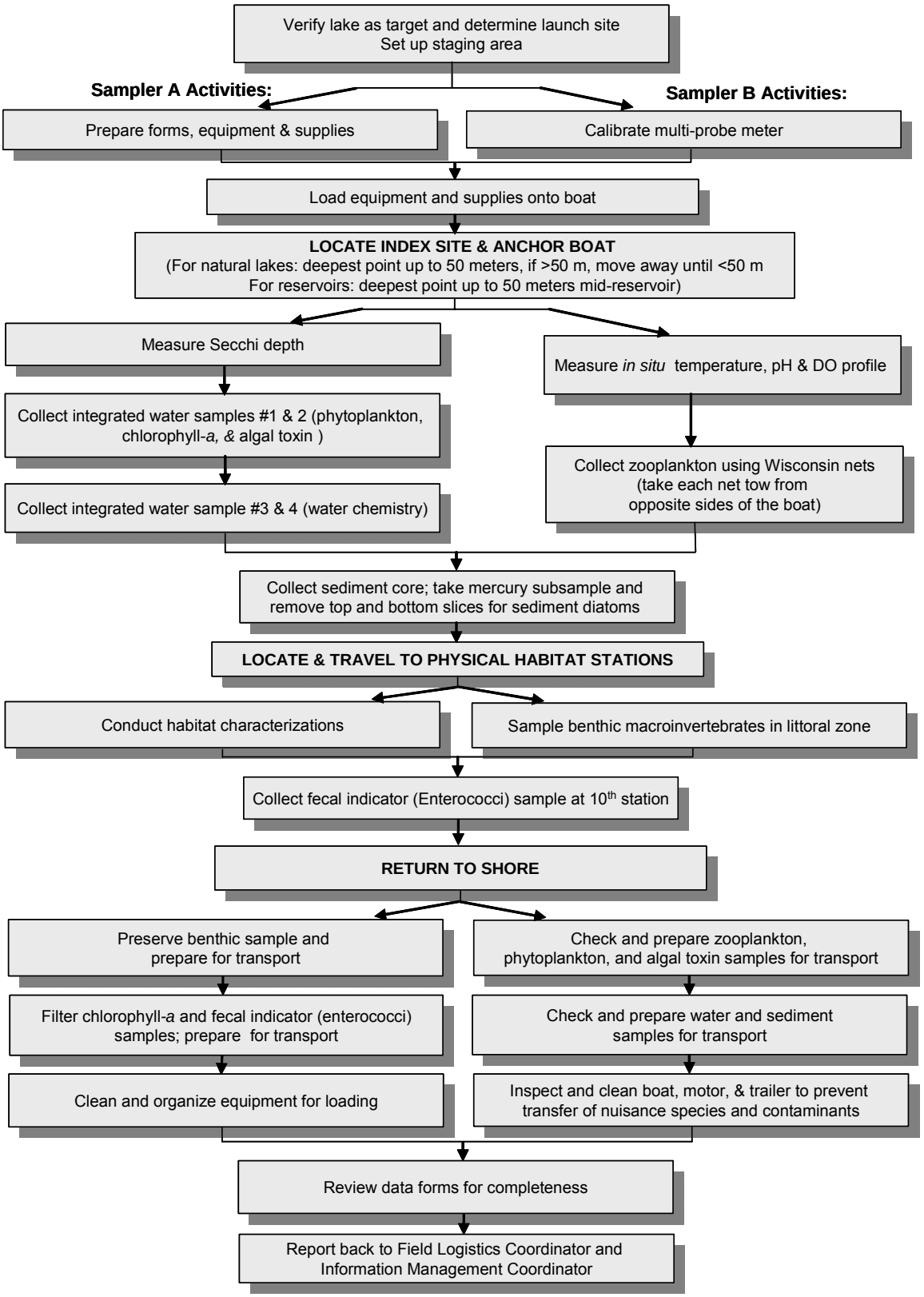


Figure 2-1. Field sampling scenario.

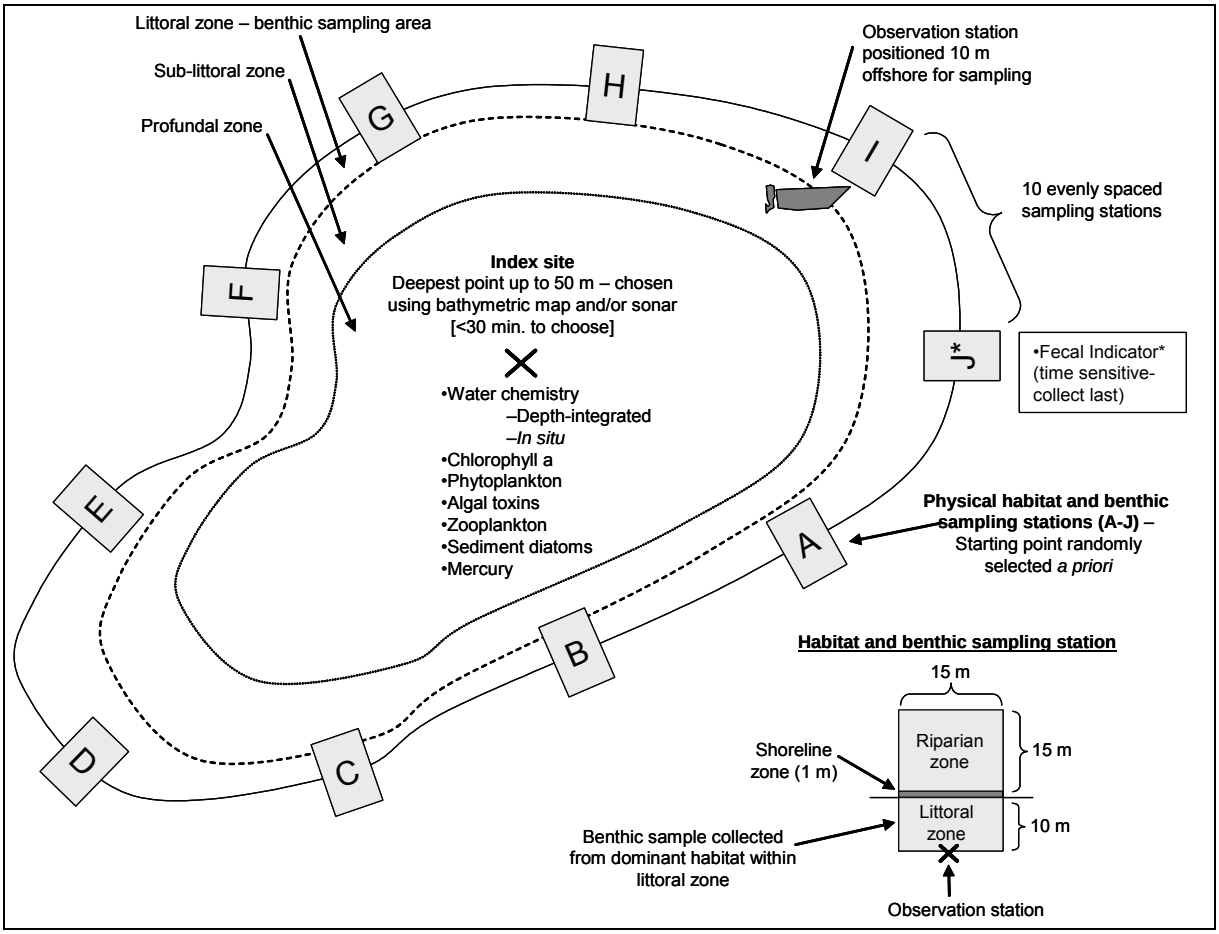


Figure 2-2. Location of sample collection points and physical habitat (P-Hab) stations.

The field team is to arrive at the lake in the early morning to complete the sampling in a single day. The sampling sequence is to:

- verify lake and locate index site,
- conduct depth profile measurements of dissolved oxygen and temperature,
- take Secchi disk transparency depth measurement,
- use the integrated sampler to collect water chemistry, chlorophyll-*a*, phytoplankton, and algal toxin samples,
- collect zooplankton samples,
- collect sediment core samples for diatoms and mercury,
- conduct physical habitat characterization,
- collect benthic samples,
- collect fecal indicator sample,
- filter chlorophyll-*a* and fecal indicator samples,
- preserve and prepare all samples for shipment,
- review field forms,
- report sampling event,
- ship time-sensitive samples.

2.2 Recording Data and Other Information

All samples need to be identified and tracked, and associated information for each sample must be recorded. To assist with sample identification and tracking, labels are preprinted with sample ID numbers (Figure 2-3).

It is imperative that field and sample information be recorded accurately, consistently, and legibly. The cost of a sampling visit coupled with the short index period severely limits the ability to resample a lake if the initial information recorded was inaccurate or illegible. Guidelines for recording field measurements are presented in Table 2-1.

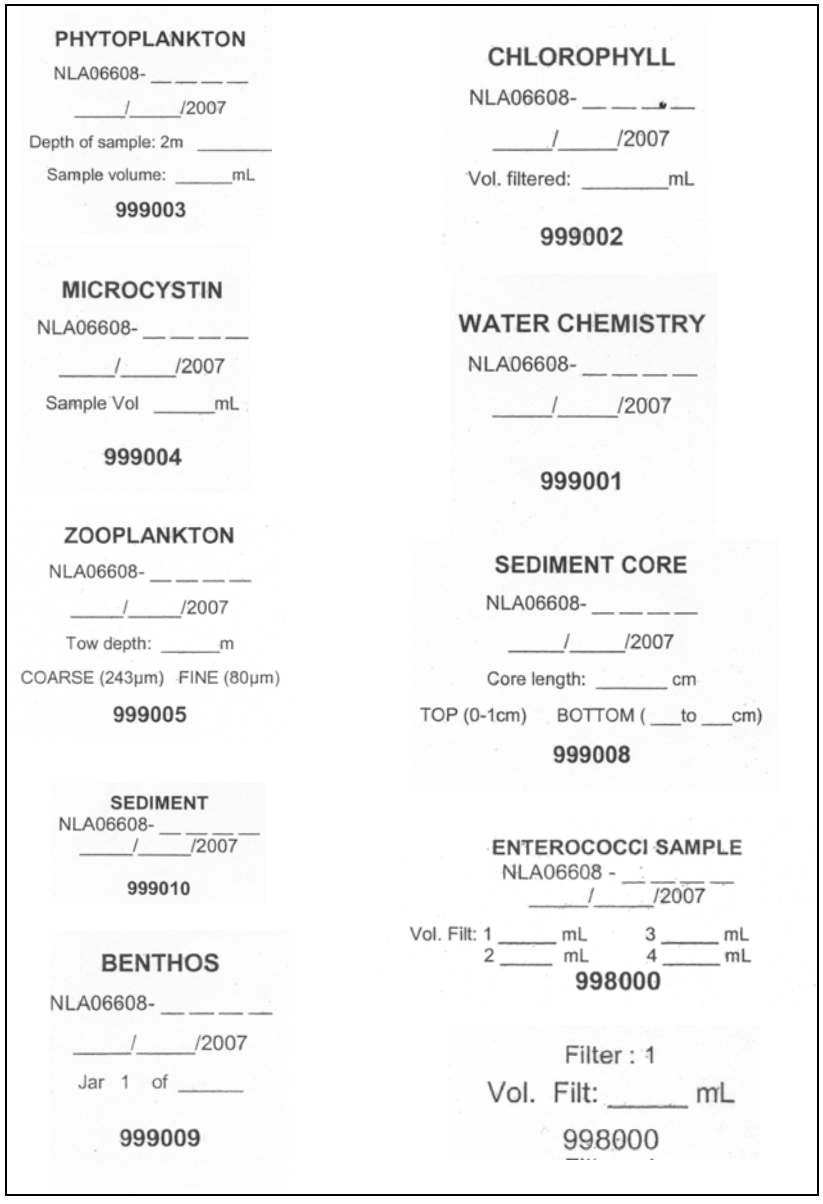


Figure 2-3. Sample labels for sample tracking and identification.

Table 2-1. Guidelines for recording field measurements and tracking information.

ACTIVITY	GUIDELINES
Field Measurements	
Data Recording	Record measurement values and observations on data forms preprinted on water-resistant paper. Use No. 2 pencil only (fine-point indelible markers can be used if necessary) to record information on forms. Record data and information using correct format as provided on data forms. Print legibly (and as large as possible). Clearly distinguish letters from numbers (e.g., 0 versus O, 2 versus Z, 7 versus T or F, etc.), but do not use slashes. In cases where information is to be recorded repeatedly on a series of lines (e.g., physical habitat characteristics), do not use "ditto marks" (") or a straight vertical line. Record the information that is repeated on the first and last lines, and then connect these using a wavy vertical line. When recording comments, print or write **legibly**. Make notations in comments field only; avoid marginal notes. Be concise, but avoid using abbreviations or "shorthand" notations. If you run out of space, attach a sheet of paper with the additional information, rather than trying to squeeze everything into the space provided on the form.
Data Qualifiers (Flags)	Use only defined flag codes and record on data form in appropriate field. K = Measurement not attempted or not recorded. Q = Failed quality control check; remeasurement not possible. U = Suspect measurement; remeasurement not possible. F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field team during a particular sampling visit (also used for qualifying samples). Explain reason for using each flag in comments section on data form.
Review of Data Forms	Review data forms for accuracy, completeness, and legibility before leaving lake. The Field Team Leader must review all data forms for consistency, correctness, and legibility before transfer to the Information Management Center.
Sample Labels	Use adhesive labels with preprinted ID numbers and follow the standard recording format for each type of sample. Use a pencil to record information on labels. Cover completed labels with clear tape.
Sample Collection Information	Record sample ID number from label and associated collection information on sample collection form preprinted on water-resistant paper. Use a No. 2 pencil only (fine-point indelible markers can be used if necessary to record information on forms). Record collection information using correct format as provided on the sample collection form.

(continued)

Table 2-1 (continued). Guidelines for recording field measurements and tracking information.

ACTIVITY	GUIDELINES
Sample Collection and Tracking	
Sample Qualifiers (Flags)	Use only defined flag codes and record on sample collection form in appropriate field. K = Sample not collected or lost before shipment; resampling not possible. U = Suspect sample (e.g., possible contamination, does not meet minimum acceptability requirements, or collected by non-standard procedure). F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field team during a particular sampling visit (also used for field measurements). Explain reason for using flags in "Comments" on sample collection form.
Review of Labels and Collection Forms	Compare information recorded on labels and sample collection form for accuracy before leaving lake. Review labels and sample collection form for accuracy, completeness, and legibility before leaving lake. The Field Team Leader must review sample collection forms for consistency, correctness, and legibility before transfer to the Information Management Center.

2.3 Safety and Health

Collection and analysis of samples can involve significant risks to personal safety and health. This section describes recommended training, communications, and safety considerations, safety equipment and facilities, and safety guidelines for field operations.

2.3.1 General Considerations

Important considerations related to field safety are presented in Table 2-2. It is the responsibility of the group safety officer or project leader to ensure that the necessary safety courses are taken by all field personnel and that all safety policies and procedures are followed. Sources of information regarding safety-related training include the American Red Cross (1979), the National Institute for Occupational Safety and Health (1981), U.S. Coast Guard (1987) and Ohio EPA (1990).

Table 2-2. General health and safety considerations.

Recommended Training:
● First aid
● Cardiopulmonary resuscitation (CPR)
● Vehicle safety (e.g., operation of 4-wheel drive vehicles)
● Boating and water safety (if boats are required to access sites)
● Field safety (weather, personal safety, orienteering, site reconnaissance of prior to sampling
● Equipment design, operation, and maintenance
● Handling of chemicals and other hazardous materials
Communications
● Check-in schedule
● Sampling itinerary (vehicle used & description, time of departure & return, travel route)
● Contacts for police, ambulance, hospitals, fire departments, search and rescue personnel
● Emergency services available near each sampling site and base location
● Cell (or satellite) phone, if possible
Personal Safety
● Field clothing and other protective gear including lifejackets for all team members
● Medical and personal information (allergies, personal health conditions)
● Personal contacts (family, telephone numbers, etc.)
● Physical exams and immunizations

Persons using sampling equipment should become familiar with the hazards involved and establish appropriate safety practices prior to using them. 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 U.S. Coast Guard rules and regulations for safe boating contained in a pamphlet, "*Federal Requirements for Recreational Boats*, " available from a local U.S. Coast Guard Director or Auxiliary or State Boating Official (U.S. Coast Guard, 1987). All boats with motors must have fire extinguishers, boat horns, life jackets or flotation cushions, and flares or communication devices.

A communications plan to address safety and emergency situations is essential. All field personnel need to be fully aware of all lines of communication. Field personnel should have a daily check-in procedure for safety. An emergency communications plan should include contacts for police, ambulance, fire departments, hospitals, and search and rescue personnel.

Proper field clothing should be worn to prevent hypothermia, heat exhaustion, sunstroke, drowning, or other dangers. Field personnel should be able to swim, and personal flotation devices must be used. Chest waders made of rubberized or neoprene material and suitable footwear must always be worn with a belt to prevent them from filling with water in case of a fall.

Many hazards lie out of sight in the bottoms of lakes, rivers and streams. Broken glass or sharp pieces of metal embedded in the substrate can cause serious injury if care is not exercised when walking or working with the hands in such environments. Infectious agents and toxic substances that can be absorbed through the skin or inhaled may also be present in the water or sediment. Personnel who may be exposed to water known or suspected to contain

human or animal wastes that carry causative agents or pathogens must be immunized against tetanus, hepatitis, typhoid fever, and polio. Biological wastes can also be a threat in the form of viruses, bacteria, rickettsia, fungi, or parasites.

2.3.2 Safety Equipment

Appropriate safety apparel such as waders, gloves, safety glasses, etc. must be available and used when necessary. First aid kits, fire extinguishers, and blankets must be readily available in the field. Cellular or satellite telephones and/or portable radios should be provided to field teams working in remote areas for use in case of an emergency. Supplies must be available for cleaning of exposed body parts that may have been contaminated by pollutants in the water such as anti-bacterial soap and an adequate supply of clean water or ethyl alcohol.

2.3.3 Safety Guidelines for Field Operations

General safety guidelines for field operations are presented in Table 2-3. Personnel participating in field activities on a regular or infrequent basis should be in sound physical condition and have a physical examination annually or in accordance with Regional, State, or organizational requirements. All surface waters and sediments should be considered potential health hazards due to potential toxic substances or pathogens. 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 (e.g., National Institute for Occupational Safety and Health [1981]; U.S. EPA [1986]).

During the course of field research activities, field teams may observe violations of environmental regulations, may discover improperly disposed hazardous materials, or may observe or be involved with an accidental spill or release of hazardous materials. In such cases it is important that the proper actions be taken and that field personnel do not expose themselves to something harmful. The following guidelines should be applied:

1. First and foremost, protect the health and safety of all personnel. Take any necessary steps to avoid injury or exposure to hazardous materials. If you have been trained to take action such as cleaning up a minor fuel spill during fueling of a boat, do it. However, you should always error on the side of personal safety.

2. Field personnel should never disturb or retrieve improperly disposed hazardous materials from the field to bring back to a facility for "disposal". To do so may worsen the impact, may incur personal liability or liability for the team members and their respective organizations, may cause personal injury, or may cause unbudgeted expenditure of time and money for proper treatment and disposal of the material. However, it is important not to ignore environmental incidents. Notify the proper authorities of any incident of this type so they may take the necessary actions to properly respond to the incident.

3. For most environmental incidents, the following emergency telephone numbers should be provided to all field teams: State or Tribal department of environmental quality or protection, U.S. Coast Guard, and the U.S. EPA regional office. In the event of a major environmental incident, the National Response Center may need to be notified at 1-800-424-8802.

Table 2-3. General safety guidelines for field operations.

- Two persons must be present during all sample collection activities, and no one should be left alone while in the field.
- Exposure to lake water and sediments should be minimized as much as possible. Use gloves if necessary, and clean exposed body parts as soon as possible after contact.
- All electrical equipment must bear the approval seal of Underwriters Laboratories and must be properly grounded to protect against electric shock.
- Use heavy gloves when hands are used to agitate the substrate during collection of benthic macroinvertebrate samples.
- Use appropriate protective equipment (e.g., gloves, safety glasses) when handling and using hazardous chemicals
- 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 handy.
- Field personnel should also protect themselves against the bite of deer or wood ticks because of the potential risk of acquiring pathogens that cause Rocky Mountain spotted fever and Lyme disease.
- All field personnel should be familiar with the symptoms of hypothermia and know what to do in case symptoms occur. Hypothermia can kill a person at temperatures much above freezing (up to 10^{o}C or 50^{o}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 move a suffering individual into cooler surroundings and hydrate immediately.
- Handle and dispose of chemical wastes properly. Do not dispose any chemicals in the field.

3.0 BASE SITE ACTIVITIES

Field teams are to conduct a number of activities at their base site (i.e., office or laboratory, camping site, or motel). These include tasks that must be completed both before departure to the lake site and after return from the field (Figure 3-1). Close attention to these activities is required to ensure that the field teams know (1) where they are going, (2) that access is permissible and possible, (3) that equipment and supplies are available and in good working order to complete the sampling effort, and (4) that samples are packed and shipped appropriately.

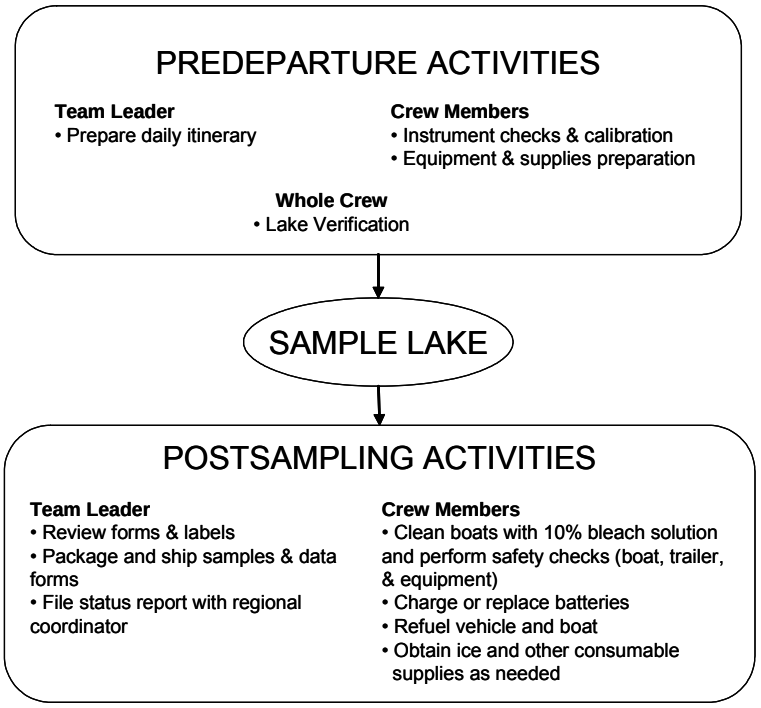


Figure 3-1. Overview of base site activities.

3.1 Predeparture Activities

Predeparture activities include the development of a daily itineraries, instrument checks and calibration, equipment and supply preparation, and lake verification. Procedures for these activities are described in the following sections.

3.1.1 Daily Itineraries

The Field Team Leaders are responsible for developing daily itineraries. This entails compiling maps, contact information, copies of permission letters, and access instructions (a "lake packet"). The Field Team Leader must be sure to transfer the Lake Outline Sketch to the Lake Verification Form and lay out the physical habitat (P-Hab) stations before the sampling day (see Section 5.1.3). Additional activities include confirming the best access routes, calling the landowners or local contacts, confirming lodging plans, and coordinating rendezvous locations

with individuals who must meet with field teams prior to accessing a site. Changes in the itinerary during the week, such as cancelling a sampling day, must be relayed by the Field Team Leader to the Field Logistics Coordinator as soon as possible.

3.1.2 Instrument Checks and Calibration

Each field team must test and calibrate instruments prior to sampling. Calibration can be conducted prior to departure for the lake site or at the lake, with the exception of dissolved oxygen calibration. Because of the potential influence of altitude, dissolved oxygen calibration is to be performed only at the lake site. Field instruments include a multiprobe unit for measuring temperature, dissolved oxygen, and pH and a Global Positioning System (GPS) receiver. Field teams should have access to backup instruments if any instruments fail the manufacturer performance tests or calibrations.

3.1.2.1 Multi-probe Meter Performance Test

Test and precalibrate the multi-probe meter prior to departure from the base. Each field team should have a copy of the manufacturer's calibration and maintenance procedures. All dissolved oxygen meters should be calibrated according to manufacturer specifications provided along with the meter.

Field teams should perform a QC check of the pH meter calibration (and conductivity meter calibration, if this optional measurement is taken). The following is a stock solution for preparing a QC sample for pH and conductivity:

- Dissolve 3.4022 g KH2PO4 and 3.5490 g Na2HPO4 (analytical grade; dried at 120 °C for 3 h and stored desiccated) in 1000.0 g (1.0018 L at 20 °C, 1.0029 L at 25 °C) reagent water.
- Prepare a 1:100 dilution of standard stock solution with reagent water for a QC sample that has a theoretical pH of 6.98 and a theoretical conductivity = 75.3 µS/cm at 25℃ (Metcalf et al. 1993).

3.1.2.2 Global Positioning System Battery Check

Turn on the GPS receiver and check the batteries prior to departure. (Replace batteries immediately if a battery warning is displayed.)

3.1.3 Equipment and Supply Preparation

Field teams must check the inventory of supplies and equipment prior to departure using the equipment and supplies checklists provided in Appendix A; use of the lists is mandatory. Pack meters, probes, and sampling gear in such a way as to minimize physical shock and vibration during transport. If necessary, prepare stock preservation solutions as described in Table 3-1. Follow the regulations of the Occupational Safety and Health Administration (OSHA).

Table 3-1. Stock solutions, uses, and methods for preparation.

Solution	Use	Preparation
Bleach (1%)	Clean nets, other gear, and inside of boat.	Add 400 mL bleach to 3,600 mL distilled water.
Calibration QC sample	QC sample for pH and conductivity calibration check	Dissolve 3.4022 g KH2PO4 and 3.5490 g Na2HPO4 (analytical grade; dried at 120 °C for 3 h and stored desiccated) in 1000.0 g (1.0018 L at 20 °C, 1.0029 L at 25 °C) reagent water. Prepare a 1:100 dilution of standard stock solution with reagent water for a QC sample that has a theoretical pH of 6.98 and a theoretical conductivity = 75.3 µS/cm at 25℃
Lugol's	Preservative for phytoplankton samples.	Dissolve 100 g KI in 1 L of distilled water. Dissolve 50 g iodine (crystalline) in 100 ml glacial acetic acid. Mix these two solutions. Remove any precipitates. Store in the dark.
95% Ethanol	Preservative for benthic invertebrate samples and zooplankton samples.	

In addition, field teams must inspect the vehicles, boats, and trailers every morning before departure, paying particular attention to the trailer hitch, electrical connections, tiedowns, air pressure in the tires, and the overall condition of the boats. Refuel vehicles and conduct maintenance activities the night before a sampling trip. Check trailer lights, turn signals, and brake lights before departure.

Teams must also label and package the sample containers into site kits prior to departure. Container labels should not be covered with clear tape until all information is completed during sampling at the lake. Store an extra kit of sampling supplies (cubitainers, bottles, chlorophyll-*a* filters, fecal indicator filters, foil, gloves, and labels) in the vehicles. Inventory these extra supply kits prior to each lake visit. Be sure to order field sampling site kits well in advance by contacting the Field Logistics Coordinator (Jennifer Pitt, 410-356-8993).

3.2 Lake Verification

3.2.1 Lake Verification at the Launch Site

The field team must verify that the lake is correctly identified and located. Lake verification is based on map coordinates, locational data from the GPS when possible, and any other evidence such as signs or conversations with local residents. Record locational coordinates for the lake on the Lake Verification Form, Side 1 (Figure 3-2a). If GPS coordinates are obtained, check the GPS box and record the latitude, longitude, and the type of satellite fix (2D or 3D) for the launch site. Compare the map coordinates given on the lake spreadsheet for the lake with the GPS coordinates displayed for the launch site, and check to see if the two sets of coordinates are within 0.004167 decimal degrees of latitude and longitude. This distance is approximately equal to the precision of the GPS receiver (±100 m) without differential correction of the position fix. This is the desired level of precision but is not required if it can be confirmed via other methods (e.g., map, landowner confirmation) that the correct sample lake has been located. If GPS coordinates are not available, do not record any information but try to obtain the

information at a later time during the visit. A fix may be taken at any time during a lake visit and recorded on the form. Mark the location of the launch site with an "L" on the Lake Outline Sketch (which must be transferred to the Lake Verification Form BEFORE the sampling day) on the Lake Verification Form, Side 1 (Figure 3-2a).

Record directions to the lake and a description of the launch site on the Lake Verification Form, Side 1 (Figure 3-2a), regardless of whether the site is sampled or not. This information is very important and will be used in the future if the lake is revisited by another sampling team. Provide information about signs, road numbers, gates, landmarks, and any additional information you feel will be useful to another sampling team in relocating this lake. It is also helpful to describe the distance traveled (miles) between turns. Also describe the launch site on the same form. For example: Can the boat be launched with a trailer? Are there fees? Is the launch paved or does it consist of soft sand? What landmarks are at the launch?

In addition to or in the absence of an accurate GPS reading, use as many of the following methods as possible to verify the site:

- Obtain confirmation from a local person familiar with the area.
- Identify confirming roads and signs.
- Compare lake shape to that shown on a topographic map (USGS 7.5 minute map or equivalent).
- Determine lake position relative to identifiable topographic features shown on the map.

If the lake shape on the USGS topographic map does not correspond with the actual lake shape (which should be sketched on the Lake Verification Form, Side 2 [Figure 3-2(b)]), and you cannot verify the lake by any other means, check "Not Verified" and provide comments on the Lake Verification Form. At each lake, evaluate whether or not the lake meets the study's operational definition of a "lake":

- $\geq$ 4 ha in total surface area
- $\geq$ 1000 square meters of open water
- $\geq$ 1 meter in depth
- Not saline (due to salt water intrusion or tidal influence)
- Not used for aquaculture, disposal-tailings, mine-tailings, sewage treatment, evaporation, or other unspecified disposal use

If the lake does not fit this definition, check "Non-target" in the lake sampled section on the middle of the Lake Verification Form, Side 1 (Figure 3-2a) and provide an explanation for not sampling the lake. Add any additional explanation as required. (For complete details on the Lake Evaluation process, refer to the companion document *Lake Evaluation Guidelines* [EPA 841-B-06-003]).

Field team personnel and duties performed at each particular lake are to be recorded. Record the names of each team member and check off the duties performed by each individual at the bottom of the Lake Verification Form, Side 2 (Figure 3-2b).

LAKE VERIFICATION FORM

Reviewed by (initial): JD

SITE ID: NLA06608- 9999 DATE: 05/01/2007 VISIT: (1) 2

SITE NAME: SUZANNE'S LAKE MODE OF ACCESS: ● Vehicle ○ Hike-In ○ Aircraft TEAM: XX-1

LAKE VERIFICATION INFORMATION

Lake shape compares with map? ● YES ○ NO | GPS Datum Used (e.g. NAD27): NAD27

Lake verified by (X all that apply): ● GPS ○ Local Contact ● Signs ○ Roads ● Topo. Map

○ Other (Describe Here): ○ Not Verified (Explain in Comments)

Coordinates		Latitude North	Longitude West	Type of GPS Fix
MAP	Degrees, Minutes, and Seconds OR Decimal Degrees	33.073900	096.925640	
LAUNCH SITE	Degrees, Minutes, and Seconds OR Decimal Degrees	33.074260	096.925380	○ 2D ● 3D
INDEX SITE	Degrees, Minutes, and Seconds OR Decimal Degrees	33.073580	096.936100	○ 2D ● 3D

DID YOU SAMPLE THIS SITE?

● YES ○ NO

If NO, mark one reason below and provide explanation:

○ Not Visited ○ Inaccessible ○ Non-target ○ Other

Explanation if lake not sampled:

GENERAL COMMENTS:

DIRECTIONS TO LAKE & LAUNCH SITE (from nearest main road or town):

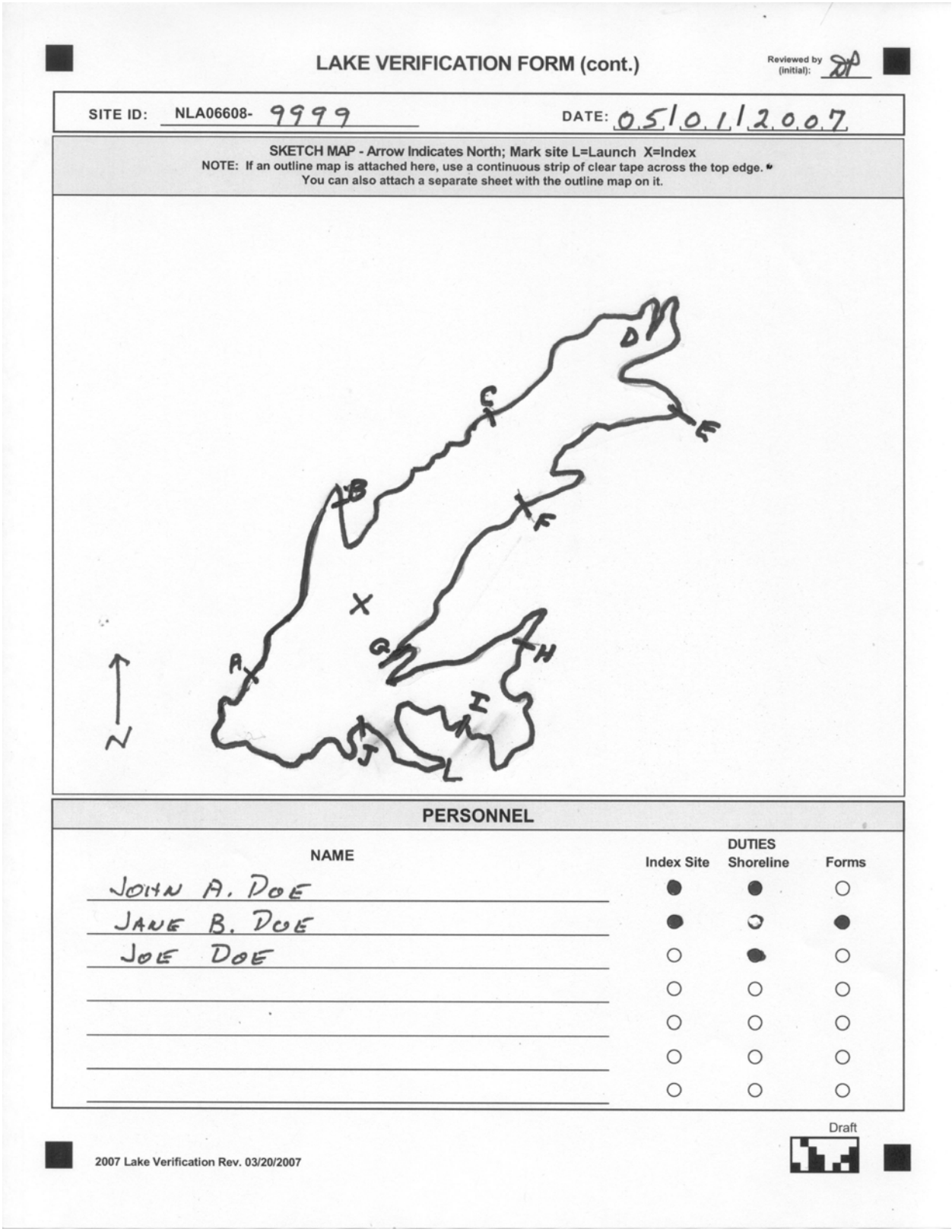
FROM SUZANNEVILLE, GO WEST ON SR121 TO EXIT 17 (LEONA RD.). GO NORTH ON LEONA RD. ~1 MI. TO LAKE VISTA DR. GO WEST ON LAKE VISTA DR. ~0.5 MI. TO COUNTY PARK. FOLLOW SIGNS TO LAUNCH AREA.

LAUNCH SITE DESCRIPTION: WELL-MAINTAINED PAVED LAUNCH AREA. EASY ACCESS, LOTS OF PARKING, AND PICNIC TABLES CAN BE USED AS WORK AREA TO PROCESS SAMPLES.

Draft

2007 Lake Verification Rev.03/20/2007

Figure 3-2(a). Lake Verification Form, Side 1.



LAKE VERIFICATION FORM (cont.)

Reviewed by (initial):

SITE ID: NLA06608- 9999 DATE: 05/01/2007

SKETCH MAP - Arrow Indicates North; Mark site L=Launch X=Index
NOTE: If an outline map is attached here, use a continuous strip of clear tape across the top edge.
You can also attach a separate sheet with the outline map on it.

PERSONNEL

NAME	DUTIES Index Site	Shoreline	Forms
JOHN A. DOE	●	●	○
JANE B. DOE	●	○	●
JOE DOE	○	●	○
	○	○	○
	○	○	○
	○	○	○
	○	○	○

Draft

2007 Lake Verification Rev. 03/20/2007

Figure 3-2(b). Lake Verification Form, Side 2.

3.2.2 Lake Verification at the Index Site Location

Use the following procedure to locate the index site for natural lakes and reservoirs:

For natural lakes*.* To find the location of the index site for natural lakes, find the deepest point in the lake ≤50 meters by using sonar and/or a bathymetric map and by observing the lake shape and surrounding topography. If the lake is >50 meter deep, move away from the deepest point until you reach a depth of 50 meters.

For reservoirs*.* To find the location of the index site for reservoirs, find the deepest point up to 50 meters that is near the center of the reservoir. Avoid sampling near the dam of the reservoir (even though this is often the deepest point) since it will not provide a representational sample.

When an acceptable site is located, anchor the boat. Lower the anchor slowly to minimize disturbance to the water column and sediment. Determine the coordinates of the index site by GPS (if satellite coverage is available) and record on the Lake Verification Form, Side 1 (Figure 3-2a). In addition, check the GPS fix box to indicate the type of satellite fix (2D or 3D) for the index site coordinates. If satellite coverage is not available at that time, try again before leaving the index site. Identify the index site on the sketch map with an "X" on the Lake Verification Form, Side 2 (Figure 3-2b).

Compare the spreadsheet coordinates with the GPS coordinates recorded for the index site. If coordinates at the launch site or the index site are not within 0.004167 decimal degrees of the map coordinates listed in the spreadsheet, question whether or not you are at the correct lake. Information collected through the other methods described in the previous subsection should always be considered before deciding whether or not the identity of a lake can be verified. If the lake is sampled and coordinates are not within criteria or the lake shape does not match, provide comments justifying your actions on the Lake Verification Form, Side 1 (Figure 3-2a).

3.2.3 Equipment and Supply List

Table 3-3 is the checklist for equipment and supplies required to conduct protocols described in this section. It is similar to but may be different somewhat from the checklist in Appendix A that is used at a base site to assure that all equipment and supplies are taken to and available at the lake. Field teams should use the checklist presented in this section to assure that the equipment and supplies are organized and available on the boat in order to conduct protocols correctly and efficiently.

Table 3-3. Lake Verification Checklist.

Equipment and Supplies	Number Needed per Lake
Clipboard / #2 pencils	1
Lake Verification Form	1
Field notebook	1
Field Operations Manual and Field Handbook	1
Survey of the Nation's Lakes Fact Sheets	20

Sampling permit (if required)	1
Hand-held Sonar	1
GPS unit with manual, reference card, extra battery pack	1
Anchor with 50 m line	1-2
Float to attach to anchor	1

3.3 Post Sampling Activities

Upon return to the launching location after sampling, the team must review all labels and completed data forms for accuracy, completeness, and legibility and make a final inspection of samples. If information is missing from the forms or labels, the Field Team Leader is to provide the missing information. The Field Team Leader is to initial all data forms after review. If obtainable samples are missing, the lake is to be rescheduled for complete sampling. Other post sampling activities include: inspection and cleaning of sampling equipment, inventory and sample preparation, sample shipment, and communications.

3.3.1 Equipment Cleanup and Check

Table 3-4 describes postsampling equipment care. Inspect all equipment, including nets, boat, and trailer, and clean off any plant and animal material. This effort ensures that introductions of nuisance species such as Eurasian watermilfoil (*Myriophyllum spicatum*) and zebra mussels (*Dreissena polymorpha*) do not occur between lakes. Prior to leaving a lake, drain all bilge water or live wells in the boat. Inspect, clean, and handpick plant and animal remains from vehicle, boat, motor, and trailer that contact lake water. Inspect and remove any remnants of vegetation or animal life. Before moving to the next lake, if a commercial car wash facility is available, wash vehicle, boat, and trailer and thoroughly clean (hot water pressurized rinse--no soap). Rinse equipment and boat with 1% bleach solution to prevent spread of exotics.

3.3.2 Shipment of Samples and Forms

The field team is to ship or deliver time-sensitive samples (i.e., water chemistry, chlorophyll-*a*, and mercury) to the appropriate analytical laboratories as soon as possible after collection. Other samples (i.e., phytoplankton, zooplankton, sediment diatoms, algal toxins, fecal indicator (enterococci), and benthic macroinvertebrates) may be shipped or delivered in batches provided they can be adequately preserved. For example, algal toxin samples need to remain completely frozen and cannot be allowed to thaw prior to shipping. Make sure to report all sample shipments to the Information Management Coordinator as soon as possible so that the analytical labs can be notified to receive samples and they can be tracked if they do not arrive when expected.

Table 3-4. Postsampling equipment care.

1. Clean for biological contaminants (e.g., Eurasian water milfoil, zebra mussels, and alewife).

-Prior to departing from a lake, drain all bilge water from the boat.

-At the lake, inspect motors, boat, and the trailer for evidence of plant fragments especially in or near the propeller and water intakes. Remove all plant fragments.

-At the lake or base site, dry out nets and buckets and inspect and remove any remnant vegetation or animal life. Disinfect gear with 1% bleach solution.

-If a commercial car wash facility is available, thoroughly clean vehicle and boat (hot water pressurized rinse--no soap).

2. Clean and dry other equipment prior to storage.

-Rinse chlorophyll-*a* and enterococci filtration chambers three times with distilled water after each use.

-Briefly soak zooplankton nets in a 1% bleach solution and dry after each use. Do not dry in sunlight because the mesh is photosensitive.

-Rinse core sampler, sectioning apparatus, and siphon with tap water at the base site.

-Rinse coolers with water to clean off any dirt or debris on the outside and inside.

3. Inventory equipment and supply needs and relay orders to the Field Logistics Coordinator.

4. Remove multi-probe meter and GPS from carrying cases and set up for predeparture checks and calibration. Examine the oxygen membranes for cracks, wrinkles, or bubbles. Replace if necessary.

5. Recharge/replace batteries as necessary.

6. Recheck field forms from the day's sampling activities. Make corrections and completions where possible, and initial each form after review.

7. Replenish fuel and oil.

Field teams are to fill out one sample tracking form for each sample shipment. As previously mentioned, some samples will be sent individually to analytical labs, while others will be sent in batches. On each sample tracking form (Figure 3-3) the following information must be recorded:

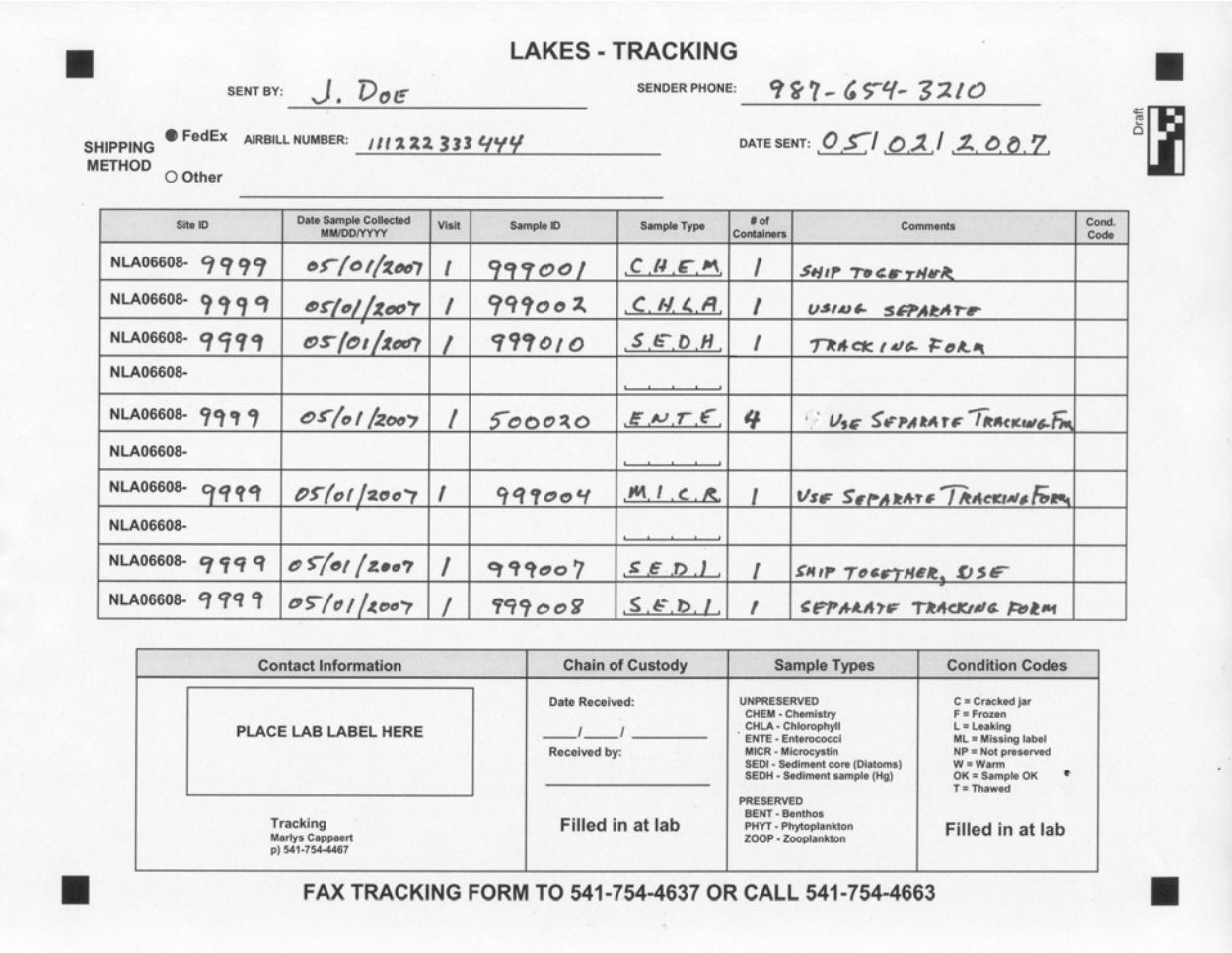
- Airbill or package tracking number
- Date sample(s) were sent
- Site ID where each sample was collected
- Sample type code:
  - MICR – Algal toxin (microcystins)
  - CHEM – Chemistry
  - CHLA – Chlorophyll-*a*
  - ENTE – Fecal indicator (Enterococci)
  - SEDI – Sediment core slices
  - SEDH – Sediment mercury

BENT – Benthos
PHYT– Phytoplankton
ZOOP – Zooplankton

- Date when the sample(s) was collected
- Site visit number (e.g., 1 for first visit, 2 for re-visit)
- Sample ID number encoded on label
- Number of containers for each sample
- Any additional comments

Packaging and shipping guidelines for each type of sample are summarized in Figure 3-4. More detailed sample shipping instructions are presented in Appendix C.

After checking the Field Forms for completeness and accuracy, the Field Crew Leader will make copies of all Field Forms and retain the copies. The original forms will be mailed to Marlys Cappaert in the FedEx envelope provided in the site kit. A pre-addressed airbill to will be provided.



LAKES - TRACKING

SENT BY: J. Doe SENDER PHONE: 987-654-3210

SHIPPING METHOD ● FedEx ○ Other AIRBILL NUMBER: 111222333444 DATE SENT: 05/02/2007

Draft

Site ID	Date Sample Collected MM/DD/YYYY	Visit	Sample ID	Sample Type	# of Containers	Comments	Cond. Code
NLA06608- 9999	05/01/2007	1	999001	CHEM	1	SHIP TOGETHER	
NLA06608- 9999	05/01/2007	1	999002	CHLA	1	USING SEPARATE	
NLA06608- 9999	05/01/2007	1	999010	SEDH	1	TRACKING FORM	
NLA06608-							
NLA06608- 9999	05/01/2007	1	500020	ENTE	4	USE SEPARATE TRACKING FM	
NLA06608-							
NLA06608- 9999	05/01/2007	1	999004	MICR	1	USE SEPARATE TRACKING FORM	
NLA06608-							
NLA06608- 9999	05/01/2007	1	999007	SEDI	1	SHIP TOGETHER, USE	
NLA06608- 9999	05/01/2007	1	999008	SEDI	1	SEPARATE TRACKING FORM	

Contact Information	Chain of Custody	Sample Types	Condition Codes
PLACE LAB LABEL HERE Tracking Marlys Cappaert p) 541-754-4467	Date Received: ___/___/___ Received by: Filled in at lab	UNPRESERVED CHEM - Chemistry CHLA - Chlorophyll ENTE - Enterococci MICR - Microcystin SEDI - Sediment core (Diatoms) SEDH - Sediment sample (Hg) PRESERVED BENT - Benthos PHYT - Phytoplankton ZOOP - Zooplankton	C = Cracked jar F = Frozen L = Leaking ML = Missing label NP = Not preserved W = Warm OK = Sample OK T = Thawed Filled in at lab

FAX TRACKING FORM TO 541-754-4637 OR CALL 541-754-4663

Figure 3-3. Lakes Sample Tracking Form.

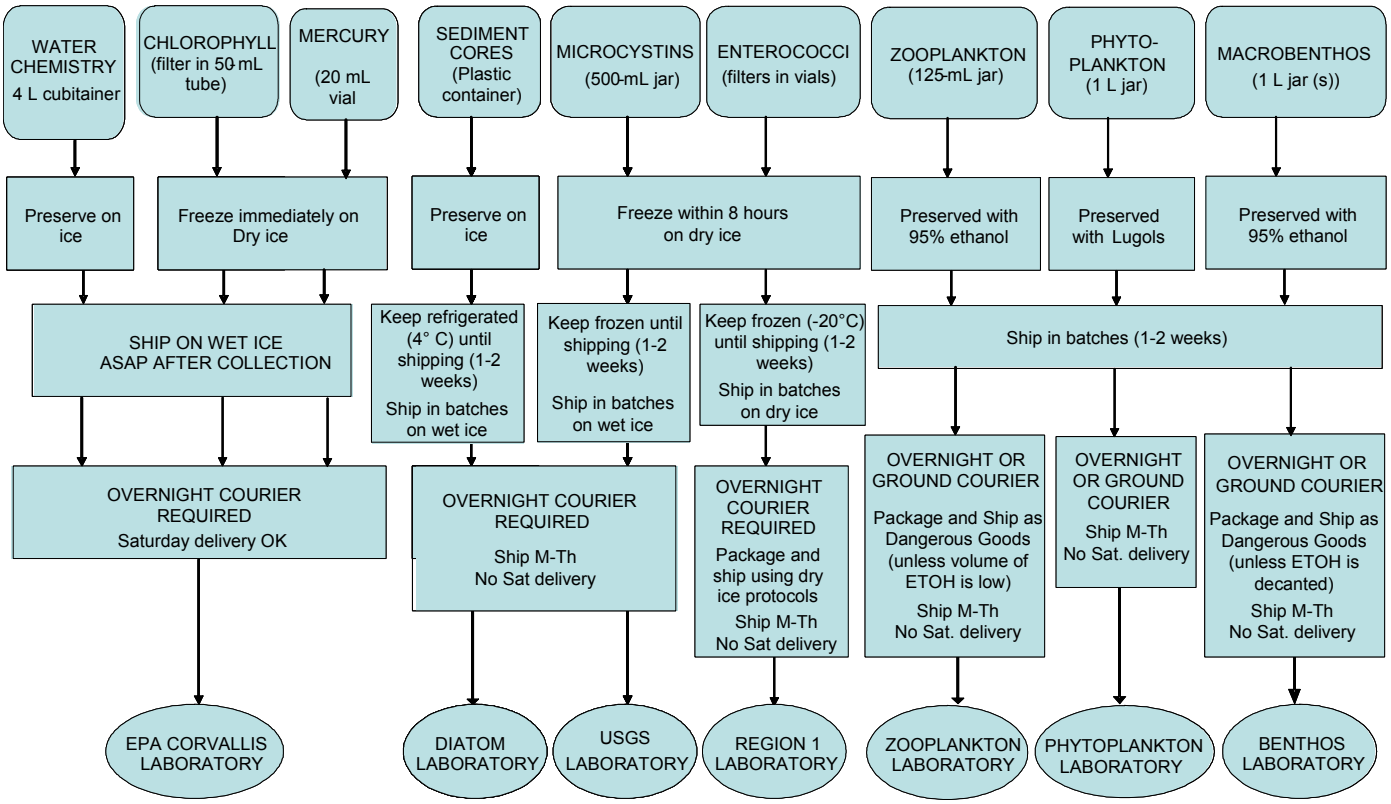


Figure 3-4. Sample packaging and shipping procedures.

3.3.3 Communications

Field Logistics Coordinator: Jennifer Pitt
Telephone number: 410-356-8993
Email address: Jennifer.Pitt@tetratech.com

The Field Logistics Coordinator serves as the central point of contact for information exchange among field teams, the management and QA staffs, the information management team, and the public (Figure 3-5). The Field Coordinator also monitors all aspects of field sampling activities and responds to supply replenishment requests. When possible, teams should inventory their supplies after each lake visit and submit requests well in advance of exhausting on-hand stocks.

Each Field Team Leader must call or email the Field Logistics Coordinator and provide a brief description of activities during the previous week including lakes visited and sampled, problems encountered, and requests for information. The Field Logistics Coordinator must contact the EPA Headquarters Coordinator to provide regional updates throughout the sampling period. The EPA Headquarters Coordinator will maintain a database of all sampling activities and reconnaissance information.

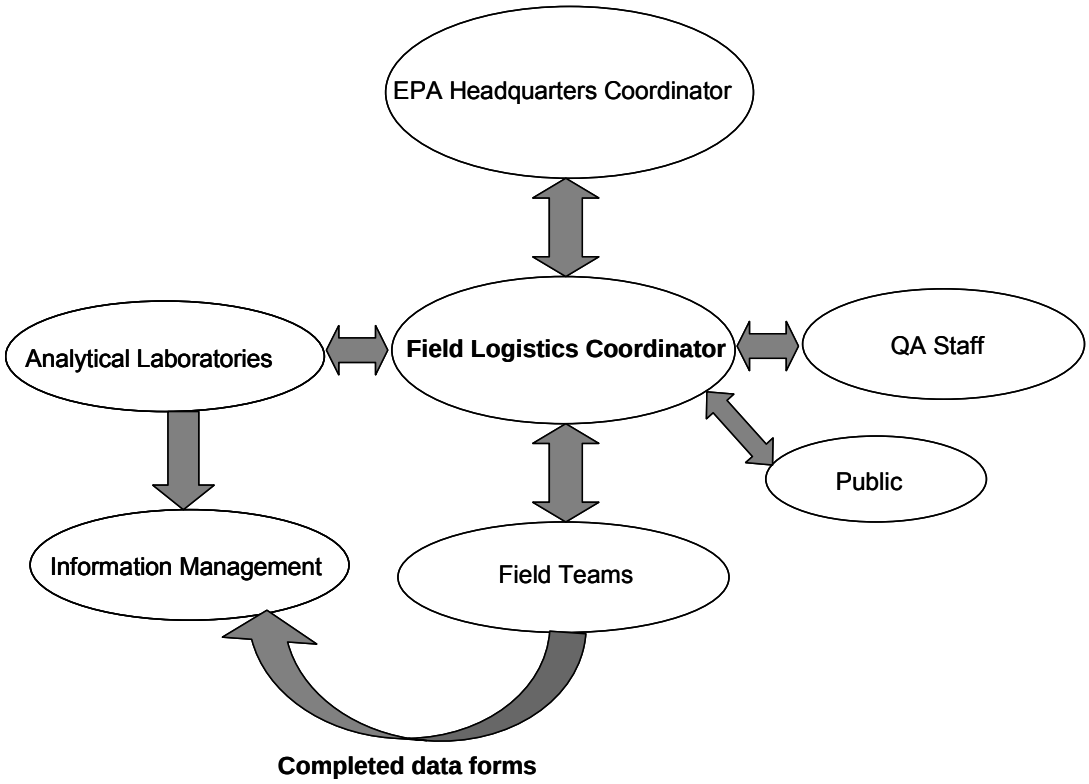


Figure 3-5. Communications flowchart for the Lakes Survey.

The Information Management Coordinator monitors all aspects of data form and shipping activities, including coordinating and tracking field sample shipments to the various analytical laboratories. The Field Team Leader must review all data forms for consistency, correctness, and legibility before transfer to the Information Management Center. The Field Team Leader must also provide sample tracking information as soon as possible following sample shipment to the analytical labs. The information can be relayed either by faxing a copy of the sample tracking form to the Information Management Center or by calling in the information recorded on the tracking form. Contact information for the Information Management Center is listed on the bottom of the Lakes Sample Tracking Form (Figure 3-3) and is as follows:

- Sample Tracking (Fax): 541-754-4637
- Sample Tracking (Phone): 541-754-4663
- Ms. Marlys Cappaert, EPA Lakes Survey Information Management Coordinator (541-754-4467)

4.0 INDEX SITE SAMPLING

Field teams are to collect measurements and indicators from the index site located at the deepest point of the lake (≤50 meters, and near the center if sampling a reservoir) for temperature, dissolved oxygen, pH, Secchi transparency, chlorophyll-a, phytoplankton, algal toxins, water chemistry, zooplankton, and a sediment core. A detailed description of the individual elements is provided below.

4.1 Temperature, Dissolved Oxygen, and pH

4.1.1 Summary of Method

The field team is to measure temperature, dissolved oxygen, and pH by using a multi-parameter water quality meter (or sonde) at predefined depth intervals. First, the team calibrates the sonde, records site conditions, determines the site depth, and determines measurement intervals. The sonde is then lowered in the water and the team measures the vertical profile of temperature, dissolved oxygen, and pH at the predetermined depth intervals. Once the profile is completed, another dissolved oxygen measurement is taken at the surface and compared to the initial reading. If the lake is stratified, the team is to note the top and bottom of the metalimnion.

The instruments are delicate and care should be taken to avoid the probe contacting bottom sediments. Therefore, the site depth must be accurately measured before taking the measurements. An accurate depth measurement is also needed to determine the number of measurements needed and entering the depth intervals on the Lake Profile Form.

4.1.2 Equipment and Supplies

Table 4-1 provides the equipment and supplies needed for field operations to measure temperature, pH, and dissolved oxygen profiles at the index site.

Table 4-1. Equipment and supplies – temperature, pH, and dissolved oxygen profiles.

For determining water column depth	• Hand-held sonar unit (or a calibrated sounding line, or a calibrated pole for very shallow lakes)
For taking profile measurements and calibrating the water quality meter	• Multi-parameter water quality meter with temperature, pH, and DO probes. • 50 m sonde communication cable with length marked in 0.5 m intervals • Extra batteries • Deionized and tap water • Calibration cups • Calibration standards • Barometer or elevation chart to use for calibration
For recording profile measurements	• Lake Profile Form • Pencils (for data forms) and permanent markers (for labels)

4.1.2.1 Multi-Probe Sonde

The multi-probe sonde must be heavy enough to minimize wobbling as it is lowered and raised in the water column. Also, the instrument must be stabilized prior to taking a reading. The field team must experiment with the sonde prior to sampling and add weight to the cable if needed. Some state or tribal agencies may want to attach additional probes to the sonde and collect profile data on other parameters (e.g., specific conductance). While not required for the Lakes Survey Program, including this data is not discouraged, and the Lake Profile form is designed to capture these additional data.

4.1.2.2 Temperature Meter

The Field team must check the accuracy of the sensor against a thermometer that is traceable to the National Institute of Standards (NIST) at least once per sampling season. The entire temperature range encountered in the Lakes Survey should be incorporated in the testing procedure and a record of test results kept on file.

4.1.2.3 Dissolved Oxygen Meter

The field team must calibrate the DO meter prior to each sampling event. It is recommended that the probe be calibrated in the field against an atmospheric standard (ambient air saturated with water) prior to launching the boat. In addition, manufacturers typically recommend periodic comparisons with a DO chemical analysis procedure (e.g., Winkler titration) to check accuracy and linearity.

4.1.2.4 pH Meter

The field team must calibrate the pH meter prior to each sampling event. Calibrate the meter in accordance with the manufacturer's instructions and with the team agency's existing SOP. The team must also conduct a quality control check with a different standard to verify the calibration and periodically evaluate instrument precision (see Section 3.1.2.1).

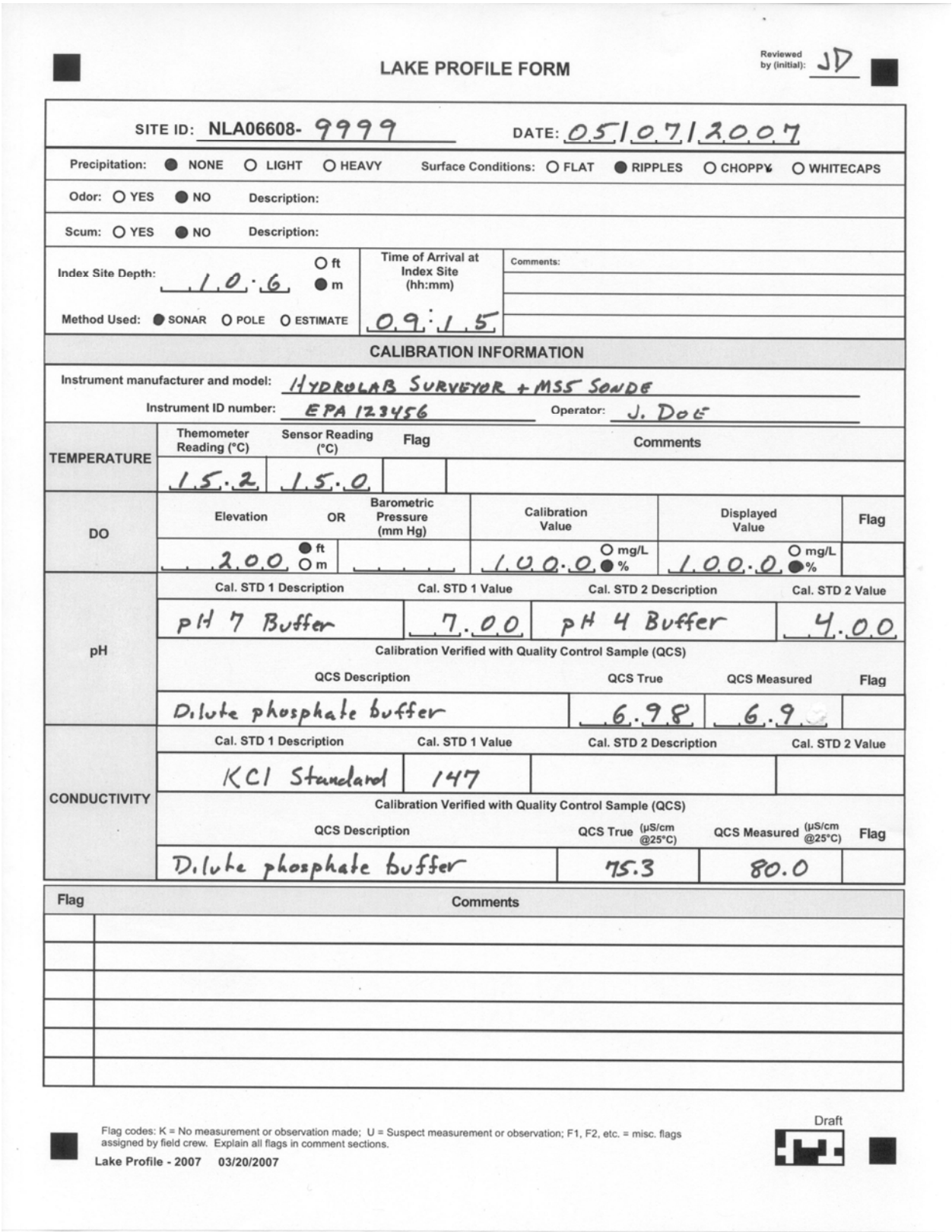
4.1.2.5 Conductivity

A field conductivity measurement is optional for the Lakes Survey. If the field team opts to take conductivity measurements, the conductivity meter must be calibrated prior to each sampling event. Calibrate the meter in accordance with the manufacturer's instructions.

4.1.2.6 Lake Profile Form

The 2-page Lake Profile Form is shown in Figures 4-1(a) and (b). Field team members use the Lake Profile Form to record the following:

- The top portion of page 1 of the Lake Profile Form is used to record environmental conditions observed at the site and overall depth.



LAKE PROFILE FORM

Reviewed by (initial): JD

SITE ID: NLA06608- 9999 DATE: 05/07/2007

Precipitation: ● NONE ○ LIGHT ○ HEAVY Surface Conditions: ○ FLAT ● RIPPLES ○ CHOPPY ○ WHITECAPS

Odor: ○ YES ● NO Description:

Scum: ○ YES ● NO Description:

Index Site Depth: 10.6 ○ ft ● m

Method Used: ● SONAR ○ POLE ○ ESTIMATE

Time of Arrival at Index Site (hh:mm): 09:15

Comments:

CALIBRATION INFORMATION

Instrument manufacturer and model: HYDROLAB SURVEYOR + MS5 SONDE

Instrument ID number: EPA 123456 Operator: J. DOE

TEMPERATURE	Themometer Reading (°C)	Sensor Reading (°C)	Flag	Comments
	15.2	15.0		

DO	Elevation	OR Barometric Pressure (mm Hg)	Calibration Value	Displayed Value	Flag
	200 ● ft ○ m		100.0 ○ mg/L ● %	100.0 ○ mg/L ● %	

pH	Cal. STD 1 Description	Cal. STD 1 Value	Cal. STD 2 Description	Cal. STD 2 Value
	pH 7 Buffer	7.00	pH 4 Buffer	4.00

Calibration Verified with Quality Control Sample (QCS)

QCS Description	QCS True	QCS Measured	Flag
Dilute phosphate buffer	6.98	6.9	

CONDUCTIVITY	Cal. STD 1 Description	Cal. STD 1 Value	Cal. STD 2 Description	Cal. STD 2 Value
	KCl Standard	147		

Calibration Verified with Quality Control Sample (QCS)

QCS Description	QCS True (µS/cm @25°C)	QCS Measured (µS/cm @25°C)	Flag
Dilute phosphate buffer	75.3	80.0	

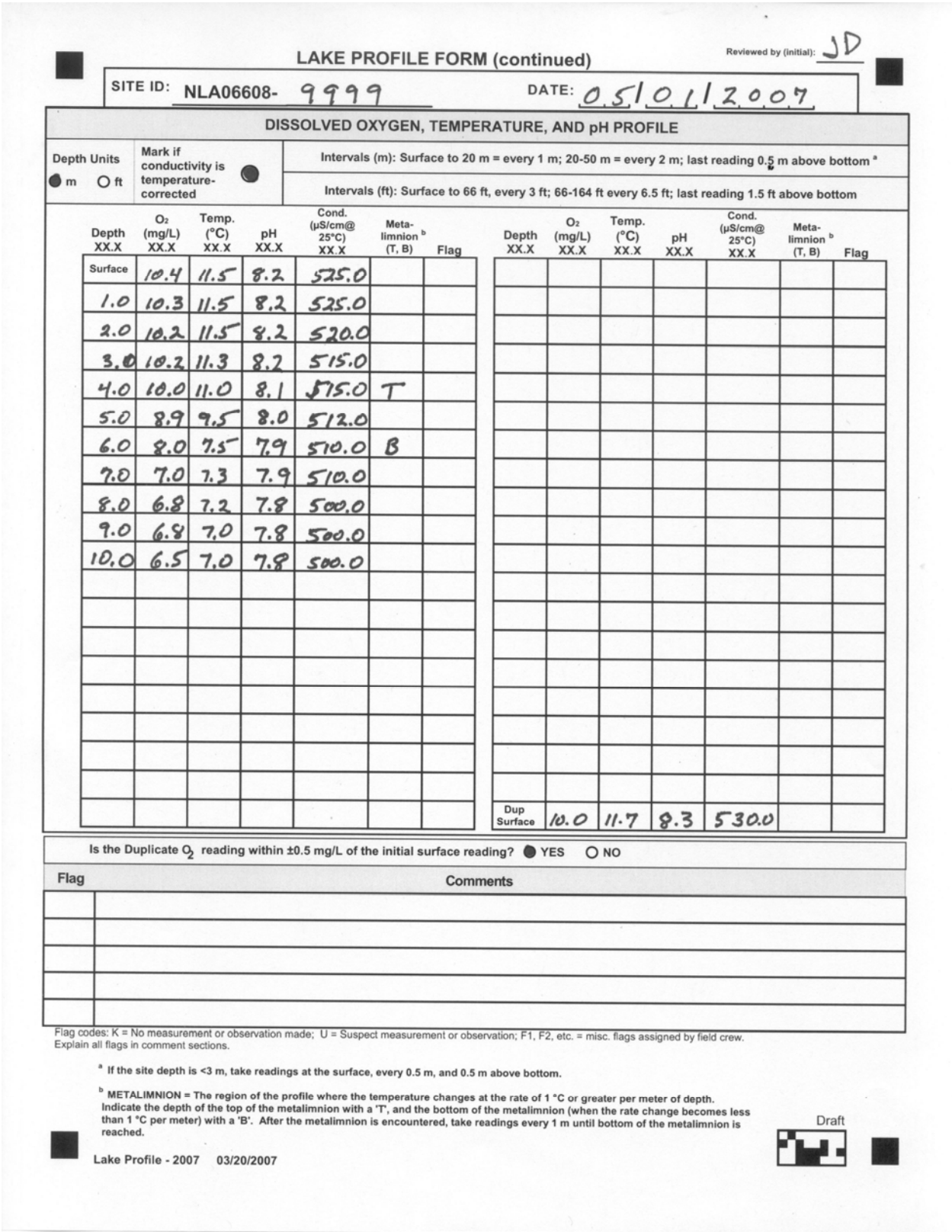
Flag	Comments

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

Lake Profile - 2007 03/20/2007

Draft

Figure 4-1(a). Lake Profile Form, Page 1.



LAKE PROFILE FORM (continued)

Reviewed by (initial): JD

SITE ID: NLA06608- 9999 DATE: 05/01/2007

DISSOLVED OXYGEN, TEMPERATURE, AND pH PROFILE

Depth Units: ● m ○ ft

Mark if conductivity is temperature-corrected ●

Intervals (m): Surface to 20 m = every 1 m; 20-50 m = every 2 m; last reading 0.5 m above bottom [a]

Intervals (ft): Surface to 66 ft, every 3 ft; 66-164 ft every 6.5 ft; last reading 1.5 ft above bottom

Depth XX.X	O_2 (mg/L) XX.X	Temp. (°C) XX.X	pH XX.X	Cond. (µS/cm@ 25°C) XX.X	Meta-limnion [b] (T, B)	Flag
Surface	10.4	11.5	8.2	525.0		
1.0	10.3	11.5	8.2	525.0		
2.0	10.2	11.5	8.2	520.0		
3.0	10.2	11.3	8.2	515.0		
4.0	10.0	11.0	8.1	515.0	T	
5.0	8.9	9.5	8.0	512.0		
6.0	8.0	7.5	7.9	510.0	B	
7.0	7.0	7.3	7.9	510.0		
8.0	6.8	7.2	7.8	500.0		
9.0	6.8	7.0	7.8	500.0		
10.0	6.5	7.0	7.8	500.0		

Depth XX.X	O_2 (mg/L) XX.X	Temp. (°C) XX.X	pH XX.X	Cond. (µS/cm@ 25°C) XX.X	Meta-limnion [b] (T, B)	Flag
Dup Surface	10.0	11.7	8.3	530.0		

Is the Duplicate O_2 reading within ±0.5 mg/L of the initial surface reading? ● YES ○ NO

Flag	Comments

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

[a] If the site depth is <3 m, take readings at the surface, every 0.5 m, and 0.5 m above bottom.

[b] METALIMNION = The region of the profile where the temperature changes at the rate of 1 °C or greater per meter of depth. Indicate the depth of the top of the metalimnion with a 'T', and the bottom of the metalimnion (when the rate change becomes less than 1 °C per meter) with a 'B'. After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached.

Draft

Lake Profile - 2007 03/20/2007

Figure 4-1(b). Lake Profile Form, Page 2.

- The remaining portion of page 1 is used to record calibration information. Documentation includes the instrument's manufacturer and model number (e.g., YSI 600XL with 650 display), identification number, QCCS values (for pH and conductivity), and the instrument readings. The purpose of the ID number is to track which instrument provided the data, in the event it is later discovered that the unit was operating in error; it will likely be an internal reference number or code supplied by the entity conducting the field sampling.

- The profile table is on page 2. It includes columns to record depth, DO, pH and temperature (as well as optional conductivity) and a column to indicate the location of the metalimnion. It also contains a "Flag" column to note a problem or other conditions of interest.

- The comment section is used to report on "Flagged" measurements or other conditions of note.

4.1.3 Sampling Procedure

Table 4-2 presents step-by-step procedures for measuring temperature, pH, and dissolved oxygen profiles at the index site.

Table 4-2. Sampling procedure – temperature, pH, and dissolved oxygen profiles.

Calibrate Instrument	Check meter and probes and calibrate according to manufacturers specifications. Enter calibration information on Page 1 of the Lake Profile Form.
Record Site Conditions	• Observe site conditions and fill out the "Site Conditions" portion of the Lake Profile Form. Conditions to be reported include: Precipitation ("None, "Light," or "Heavy.") • Surface conditions ("Flat," "Ripples," "Choppy," or "Whitecaps.") • Presence or absence of odor or scum. (Choice of "Yes" or "No" plus space to describe the odor or scum if present.)
Determination of Site Depth	Use sonar or other means to determine the depth of the site and record the depth on the Lake Profile Form. Indicate on the form if sonar was not used to determine depth.

Determination of Measurement Intervals	The number of readings and the depth intervals taken will depend on the depth at the index site. Below is a list of rules for determining the intervals. • The profile will always begin with a measurement just below the surface. • The deepest measurements will always be at 0.5 m above the bottom. • If the site is < 3.0 m deep, measurements should be recorded just below the surface and at 0.5 m intervals, until 0.5 m above the bottom. • If the depth is between 3.0-20 m, measurements should be recorded just below the surface, then at 1.0 m, intervals through 20 m (or until reaching 0.5 m above the bottom). • If the depth exceeds 20 m, record at 1.0 m, intervals through 20 m, then record measurements every 2 m starting at 22 m (until 0.5 m above the bottom or the maximum depth of 50 m is reached). Using the above rules, record the intervals for the profile in Depth column of the Lake Profile Form.
Measure Temperature, DO, and pH	• Lower the sonde in the water and measure the vertical profile of temperature, dissolved oxygen and pH at the predetermined depth intervals. • Record the measurements on the Lake Profile Form. • Flag any measurements that the team feels needs further comment or when a measurement cannot be made. • Use the flag codes on the form and the comment box found on the second page.
Repeat Surface DO Measurement	• When the profile is completed, take another measurement at the surface, record it, and compare it to the initial surface reading. • Mark Yes or No on the form if the second DO reading is within 0.5 mg/L of the initial surface reading. • This provides information regarding measurement precision and possible calibration drift during the profile.
Determine the Metalimnion	• If the lake is thermally stratified, note the top and bottom of the metalimnion in the Metalimnion column. • For standardization purposes the metalimnion has been defined in the protocol as an area where water temperature changes at least 1 degree per meter. • If you suspect that the metalimnion exists but does not change at the specified rate, flag the data form and explain.

4.2 Secchi Disk Transparency

4.2.1 Summary of Method

A Secchi disk is a black and white patterned disk used to measure a lake's clarity (See Figure 4-2). The reading is taken on the shady side of the boat, without sunglasses or view aids. Measurements are recorded at the depth that the disk disappears and again when it reappears.

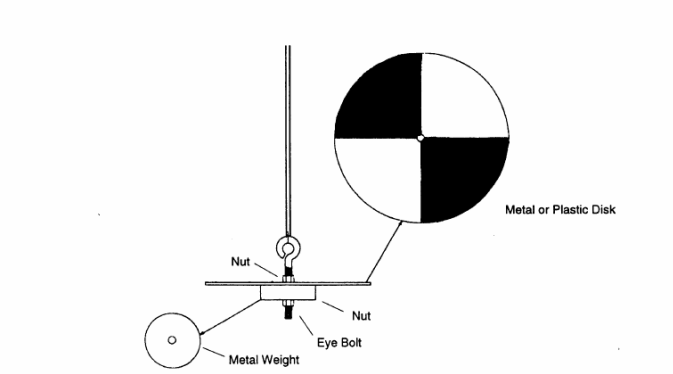


Figure 4-2. Secchi disk diagram (EPA, 1991).

4.2.2 Equipment and Supplies

- Secchi disk and calibrated sounding line (marked in half meter intervals)
- Tape measure (in centimeters)

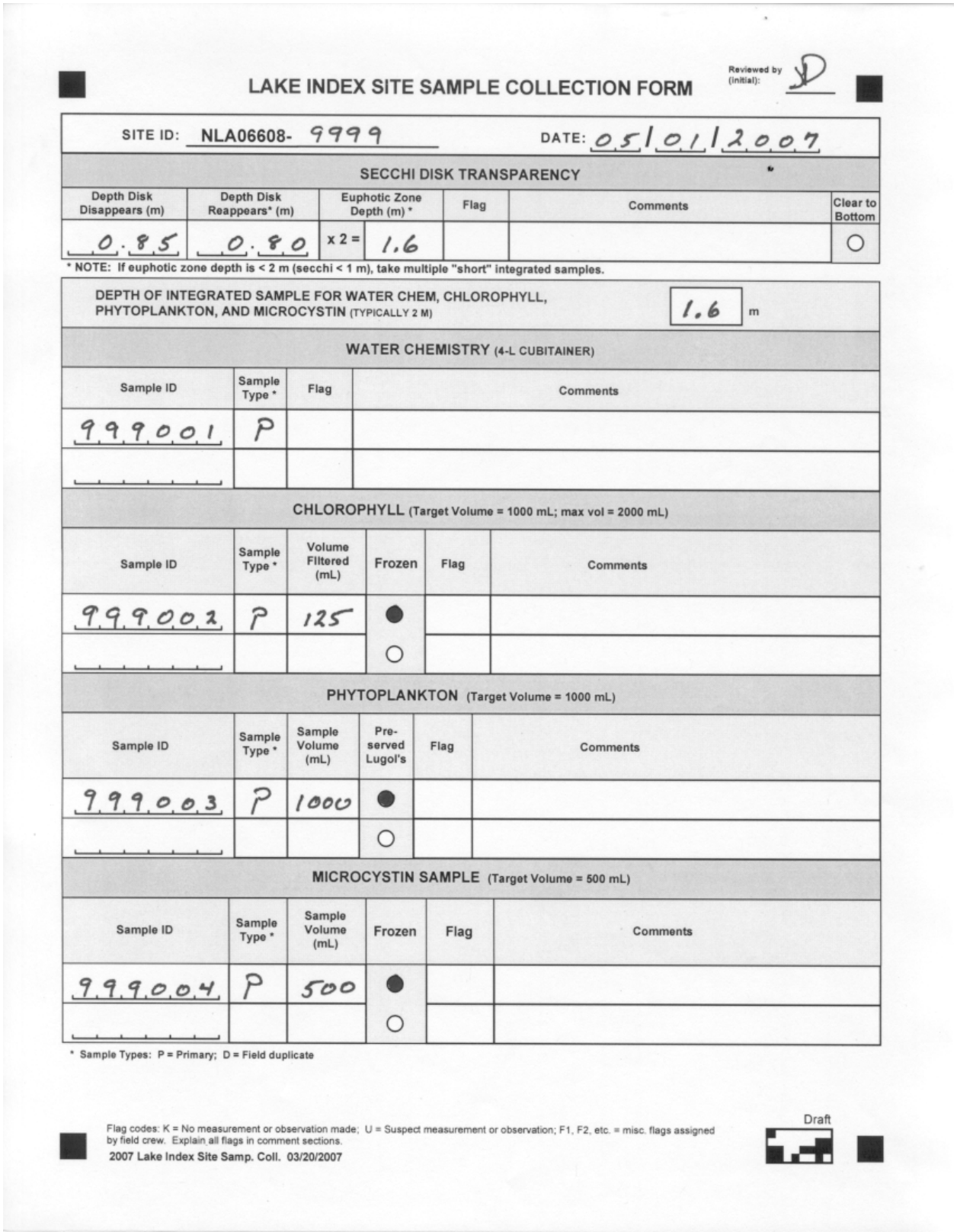
Field teams are to record the Secchi disk readings on p. 1 of the Lake Index Site Sample Collection Form, as seen in Figure 4-3(a).

4.2.3 Sampling Procedure

Because different people measuring Secchi transparency at the same site may obtain different results (due to differences in vision and interpreting disk disappearance and reappearance), it is recommended that one team member conduct Secchi disk measurements for all lakes (see Table 4-3).

If the lake is shallow and the water clear, the Secchi disk might reach the bottom and still be visible. If this is the case, it is important to not stir up the bottom sediments while anchoring the boat. Teams must be sure to move the boat away from the anchor before taking the reading. If the disk is visible at the bottom of the lake, indicate this on the form.

States that wish to take additional measurements for comparisons using a viewscope are encouraged to do so after completing the Secchi disk measurements following the previously described protocols.



LAKE INDEX SITE SAMPLE COLLECTION FORM

Reviewed by (initial):

SITE ID: NLA06608- 9999 DATE: 05/01/2007

SECCHI DISK TRANSPARENCY

Depth Disk Disappears (m)	Depth Disk Reappears* (m)	Euphotic Zone Depth (m) *		Flag	Comments	Clear to Bottom
0.85	0.80	x 2 =	1.6			○

* NOTE: If euphotic zone depth is < 2 m (secchi < 1 m), take multiple "short" integrated samples.

DEPTH OF INTEGRATED SAMPLE FOR WATER CHEM, CHLOROPHYLL, PHYTOPLANKTON, AND MICROCYSTIN (TYPICALLY 2 M): 1.6 m

WATER CHEMISTRY (4-L CUBITAINER)

Sample ID	Sample Type *	Flag	Comments
999001	P		

CHLOROPHYLL (Target Volume = 1000 mL; max vol = 2000 mL)

Sample ID	Sample Type *	Volume Filtered (mL)	Frozen	Flag	Comments
999002	P	125	●		
			○		

PHYTOPLANKTON (Target Volume = 1000 mL)

Sample ID	Sample Type *	Sample Volume (mL)	Pre-served Lugol's	Flag	Comments
999003	P	1000	●		
			○		

MICROCYSTIN SAMPLE (Target Volume = 500 mL)

Sample ID	Sample Type *	Sample Volume (mL)	Frozen	Flag	Comments
999004	P	500	●		
			○		

* Sample Types: P = Primary; D = Field duplicate

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

2007 Lake Index Site Samp. Coll. 03/20/2007

Draft

Figure 4-3(a). Lake Index Site Sample Collection Form, Page 1.

LAKE INDEX SITE SAMPLE COLLECTION FORM (cont.)

Reviewed by (initial): SD

SITE ID: NLA06608- 9999 DATE: 05/01/2007

ZOOPLANKTON (Fill to Mark on Bottle = 80 mL)
NOTE: Make sure to keep net and bucket of same mesh size together.

	Sample ID	Sample Type *	Depth of Tow (m)	No. of Jars	Narc-otized (CO_2)	Pre-served (ETOH)	Flag	Comments
Coarse 243 µm	9.9.9.0.0.5	P	10.0	1	●	●		
Fine 80 µm	9.9.9.0.0.6	P	10.0	1	●	●		
					○	○		
					○	○		

SEDIMENT CORE SAMPLES (Target Core Length = 35 to 45 cm)
NOTE: Field duplicate sample not required

Collected at:	● INDEX ○ OTHER	If OTHER, record GPS coordinates:	Latitude North	Longitude West
			____ ____ ____ ____ . ____	____ ____ ____ ____ . ____

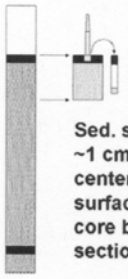
Sample Class	Sample ID	Sample Type *	Length of Core (cm)	INTERVAL (cm) From	INTERVAL (cm) To	Flag	Comments
SED	9.9.9.0.1.0	P	40	0	1		
TOP	9.9.9.0.0.7	P		0	1		
BOTTOM	9.9.9.0.0.8	P		37	38		

* Sample Types: P = Primary; D = Field duplicate

Sediment Core Subsamples

Top: 0 to 1 cm

Bottom: ~2 cm from bottom of core



Sed. sample: ~1 cm^3 from center of surface of core before sectioning

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

2007 Lake Index Site Samp. Coll. 03/20/2007

Draft

Figure 4-3(b). Lake Index Site Sample Collection Form, Page 2

Table 4-3. Sampling procedure – Secchi disk transparency.

1. Confirm that the lowering line is firmly attached to the Secchi disk.
2. Remove sunglasses. Also, **do not** use view scopes or other visual aids. If wearing prescription sunglasses, temporarily replace them with regular clear lens prescription glasses.
3. Lower the Secchi disk over the shaded side of the boat until it disappears.
4. Read the depth indicated on the lowering line. If the disappearance depth is <1.0 meter, determine the depth to the nearest 0.05 meter by marking the line at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 meter. Record the disappearance depth on the Sample Collection Form.
5. Lower the disk a bit farther and then slowly raise the disk until it reappears and record the reappearance depth on the Sample Collection Form.
6. Calculate the euphotic zone on the Sample Collection Form.
7. Note any conditions that might affect the accuracy of the measurement in the comments field.

4.3 Water Sample Collection and Preservation

4.3.1 Summary of Method

Field teams are to collect water samples using an "integrated sampler." The device is a PVC tube 6.6 feet (2 meters) long with an inside diameter of 1.24 inches (3.2 centimeters) fitted with a stopper plug on one end and a valve on the other (based on a design by the Minnesota Pollution Control Agency, see Figure 4-4). The device allows collection of water from the upper two meters of the water column (within the euphotic zone). If the euphotic zone is < 2.0m deep (as calculated in the Secchi Disk Transparency section of the Sample Collection Form), the integrated sampler will be lowered only to the depth of the euphotic zone, and additional draws will be taken to collect the volume needed for the samples.

The field team is to remove the rubber stopper and rinse the sampler by submerging three times in the lake. With the valve open and the stopper off, the sampler is slowly lowered into the water as vertically as possible until the upper end is just below the surface. Cap and slowly raise the sampler. Close the valve when the bottom is near the surface. Empty the sample into a 4 L cubitainer.

4.3.2 Equipment and Supplies

Table 4-4 provides the equipment and supplies needed for field operations to collect water samples at the index site. Field teams are to record the Water Sample Collection and Preservation data on p. 1 of the Lake Index Site Sample Collection Form, as seen in Figure 4-3(a).

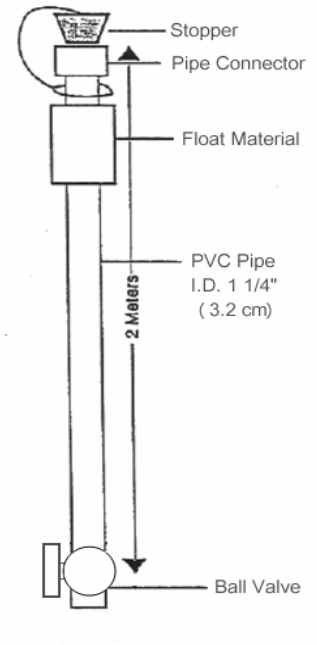


Figure 4-4. Integrated water sampler device (MPCA).

Table 4-4. Equipment and supplies – water samples.

For collecting water samples	• Integrated sampler (MPCA design) • Surgical gloves (non-powdered)
For storing and preserving water samples	• One 4 L cubitainer • HDPE sample bottles (one 1L, one 2 L, and one 500mL) • Wet ice • Dry ice • Lugol's solution • Coolers
For filtering chlorophyll-*a* sample	• Whatman GF/F or equivalent 0.7 µm glass fiber filter • Filtration apparatus with graduated filter holder • Hand pump • 50-mL steam-top centrifuge tube • DI water • Aluminum foil
For documenting the collection of water samples	• Sample Collection Form • Pencils and permanent markers

4.3.3 Sampling Procedure

The field team is to collect four integrated water samples (Figure 4-5 and Table 4-5). Samples #1 and #2 are to be transferred from the sampler to the 4 L cubitainer, mixed thoroughly, and poured off into one 2 L sample bottle for chlorophyll-*a* filtering, one 1 L sample bottle for phytoplankton processing, and one 500 mL bottle for the algal toxin sample. Samples #3 and #4 are to be transferred from the sampler to the 4 L cubitainer for the water chemistry sample.

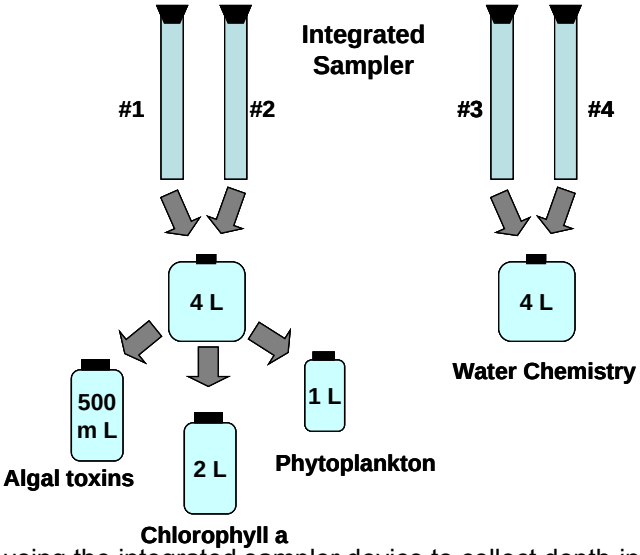


Figure 4-5. Procedure for using the integrated sampler device to collect depth-integrated samples.

Table 4-5. Sampling procedure –water samples.

1. Make sure all the water sample containers have the same bar code and the labels are completely covered with clear tape.
2. Put on surgical gloves (non-powdered). Do not handle any food, drink, sunscreen, or insect repellant until after the water chemistry sample has been collected.
3. Remove the rubber stopper cap and open the valve on the sampler and field rinse by submerging it three times in the lake and draining. Do this on the opposite side of the boat you plan to sample from. Do not take samples near the motor.
4. Slowly lower the sampler into the lake as vertically as possible. Stop when the upper end is just below the surface. If the euphotic zone is < 2.0 m deep (as calculated in the Secchi Disk Transparency section of the Sample Collection Form), the integrated sampler will be lowered only to the depth of the euphotic zone; additional draws will be taken to collect the volume needed for the samples (8 L total).
5. Cap the upper end with the rubber stopper firmly and slowly raise the sampler.
6. When the bottom of the sampler is near the surface, reach underneath and close the valve on the bottom end.
7. Lift the sampler in the boat, keeping it as vertical as possible.
8. Pour the contents of Pull #1 and Pull #2 into the 4 L cubitainer and mix well.
9. Fill the 2 L bottle from the 4 L cubitainer. This is the chlorophyll sample, which will be filtered on shore (see Section 6.2.1). Immediately after the sample is collected, wrap bottle in aluminum foil to minimize exposure to light and place on ice until filtration can be initiated.

Table 4-5. Sampling procedure –water samples.

10. Fill the 1 L bottle from the 4 L cubitainer, allowing enough headspace to add ~20-25 mL of preservative. This is the phytoplankton sample. Add a small amount of Lugol's solution (~10 mL) until the sample resembles the color of weak tea, shake well, and place the bottle in the cooler with sealed 1-gal plastic bags of ice. 11. Fill the 500 mL bottle from the 4 L cubitainer. This is the algal toxin sample. Place the bottle in the cooler with sealed 1-gal plastic bags of ice. The sample must be frozen on dry ice within 8 hours. 12. Pour the contents of Pull #3 and Pull #4 into the 4 L cubitainer. Seal the cap tightly and wrap electrical tape clockwise around the cap. Place the cubitainer in a cooler with sealed 1-gal plastic bags of ice.

4.4 Zooplankton Collection

4.4.1 Summary of Method

The field team is to collect two vertical samples using a fine mesh (80 μm) and course mesh (243 μm) Wisconsin net. The fine mesh tow net, with a collection bucket attached to the end, is slowly lowered over the side of the boat until it is 0.5 meters off of the bottom of the lake. The tow net is retrieved back to the surface at a steady constant rate. Once the net is lifted out of the water, it is rinsed from the outside to free organisms from the side of the net, and to concentrate them into the collection bucket. The sample is transferred to a sample container, and the organisms are narcotized and preserved. The tow is repeated with the course mesh net on the opposite side (or end) of the boat. (**Note**: If the depth of the index site is less than 2 m and the Secchi disk can be seen at the bottom, a second 1.5 m tow is made and the samples combined (total tow length=3 m).

4.4.2 Equipment and Supplies

Table 4-6 provides the equipment and supplies needed for field operations to collect a zooplankton sample. Figure 4-6 is an illustration of the Wisconsin nets and collection buckets. Field teams are to record the Water Sample Collection and Preservation data on p. 2 of the Lake Index Site Sample Collection Form, as seen in Figure 4-3(b).

Table 4-6. Equipment and supplies – zooplankton collection.

For collecting zooplankton sample	• Wisconsin net (80 μm mesh) and collection bucket • Wisconsin net (243 μm mesh) and collection bucket • calibrated line, marked in 0.5 m increments
For storing and preserving zooplankton sample	• 125 ml sample bottles • Squirt bottle with DI water • 95% ethanol • CO_2 tablets (or Alka-seltzer or club soda) • 500 mL container • Self-sealing plastic bag • Electrical tape
For documenting the collection of zooplankton sample	• Sample Collection Form • Pencils and permanent markers

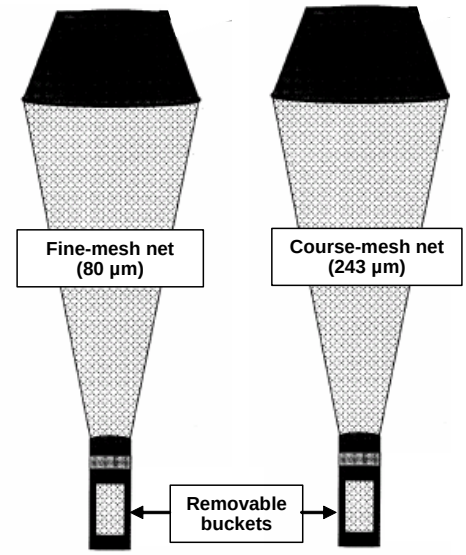


Figure 4-6. Wisconsin net and collection bucket diagram.

4.4.3 Sampling Procedure

The procedures for collecting and processing zooplankton samples are presented in Table 4-7.

Table 4-7. Sampling procedure – zooplankton collection.

Sample Collection

1. Record the lake ID on the sample label.
2. Prior to each use, carefully clean and thoroughly rinse the interior of the plankton nets and buckets with DI water.
3. Carefully inspect the nets and buckets for holes or tears.
4. Attach the collection buckets to the "cod" end of the nets and secure.
5. Attach the bridled end of the plankton net to a ¼" calibrated line with markings every 0.5 m (you could use the line for the Secchi disk if necessary).
6. Carefully and slowly lower the first net in a constant upright position over the side of the boat.
7. Continue lowering the net until the mouth of the net is 0.5 meters above the lake bottom. If the depth is < 2 m and the Secchi disk could be seen at the bottom, a second 1.5 m tow is made and the samples combined (total tow length=3 m).
8. Retrieve the net by pulling back to the surface at a steady constant rate without stopping (0.3 m or 1 ft per second).
9. Once at the surface, slowly dip the net up and down in the water without submersing the net mouth and help rinse contents into the collection bucket.
10. Complete the rinsing of the net contents by spraying water against the outside of the net with a squirt bottle or similar tool.
11. Holding the collection bucket in a vertical position, carefully remove the bucket from the net.
12. Concentrate the contents of the collection bucket by swirling the bucket without spilling the contents. Excess lake water will filter out of the bucket from the screened sides.
13. Repeat steps 6-12 with the second net on the opposite side (or end) of the boat.

Sample Processing

1. Carefully remove the mesh bucket from its net. Set the bucket in a 500-mL container filled three-fourths full with lake water to which a CO_2 tablet has been added. Alternatively, Alka-Seltzer or club soda may be used. The CO_2 narcotizes the zooplankton to relax their external structure prior to preservation in 95% ethanol. This facilitates taxonomic identification. Wait until zooplankton movement has stopped (usually about 1 minute).
2. Record the sample ID number and check on the Sample Collection Form that it is preserved.
3. Use small volumes of DI water from a squirt bottle to rinse the contents of the mesh net bucket into the polyethylene jar. Rinse bucket with DI water three to four times or until the majority of zooplankton have been removed. Drain the remaining filtrate into the sample container. Fill the jar of zooplankton to the mark (~80 mL or a little more than half full) with 95% ethanol.
4. In some cases, the volume of zooplankton collected in bucket may exceed 125 mL. Do not try to force all of the sample into a single bottle or the preservative will not function properly and the sample may be lost. In such cases, use a second bottle to preserve the additional amount of sample. Use an "extra jar" label (i.e., one with no sample number printed on it). Complete the label, and print in the sample number assigned to the first container on the label of the second container. On the Sample Collection Form, record a "2" in the "No. Jars" field.
5. Record the length of the tow on the Sample Collection Form and on the sample labels. Verify that all information on the labels and the form is complete and correctly recorded. Cover each label completely with a strip of clear tape.
6. Seal the lids of the jars by wrapping electrical tape in a clockwise direction so that the lid is pulled tight as the tape is stretched around it. Place jars in a self-sealing plastic bag.
7. Repeat steps 1-6 for the second sample collected.

4.5 Sediment Diatom & Mercury Sample Collection

4.5.1 Summary of Method

Lakes Survey team members will use a corer to extract a sediment sample at the index site, use clean technique to collect a small sediment sample from the surface of the core, and then slice off the top and bottom of the core for diatom analysis in the laboratory. The results will be used to assess sediment mercury concentrations across the nation, and to compare current conditions with past conditions based on the diatom frustule abundance and composition. The bottom core sample collected from natural lakes will not be dated (using radioisotopes or other means) so it will be impossible to pinpoint the age of the bottom of the core. Nonetheless, this investigation will provide a general indication of how the lake has changed over time.

4.5.2 Equipment and Supplies

Table 4-8 provides the equipment and supplies needed for field operations to collect a sediment core sample. Figure 4-7 is an illustration of the modified KB corer and sectioning apparatus. Core tubes will be marked at 45 cm. Field teams are to record the sediment sampling data on p. 2 of the Lake Index Site Sample Collection Form, as seen in Figure 4-3(b).

Table 4-8. Equipment and supplies - sediment core sample.

For collecting sediment core sample	• Modified KB corer • Plexiglas sectioning apparatus • Core tubes • Siphon tube with a bent plastic tip
For collecting sediment sample for mercury analysis	• Pre-washed 20-mL PET vial • Pre-washed 5-mL plastic pipette tip
For storing and preserving sediment core sample	• Natural Lakes: 2 small plastic containers with lids • Reservoirs: 1 small plastic container with lid
For documenting the collection of sediment core sample and mercury subsample	• Sample Collection Form • Pencils and permanent markers

4.5.3 Sampling Procedure

The field team is to collect a 45 cm long sediment core from undisturbed sediments, and section off 1 cm of sediment from the top and bottom (for natural lakes) of the core for analysis. Before sectioning off the top 1 cm, a small amount of sediment will be removed from the center of the core, to be used for measuring total and methyl mercury. In natural lakes, the composition and texture of the bottom will vary from lake to lake and, in some lakes, it will be impossible to get a 45 cm core because the bottom is too rocky, the sediments too dense, or, if it a shallow lake, there are macrophytes covering the bottom. It is essential that the GPS coordinates be recorded and the collection location be marked on the Lake Verification Form, Side 2 (Fig. 3-2b).

If the team collects a core less than 45 cm on the first try they should try moving to another location near the index site with the intent of finding an area with a softer bottom. In addition the team can experiment with getting improved penetration by releasing the corer further above the sediments. If a 45 cm core sample cannot be collected from these natural lakes waterbodies, the longest core that the team can obtain should be processed. The procedures for collecting and processing sediment cores are presented in Table 4-9.

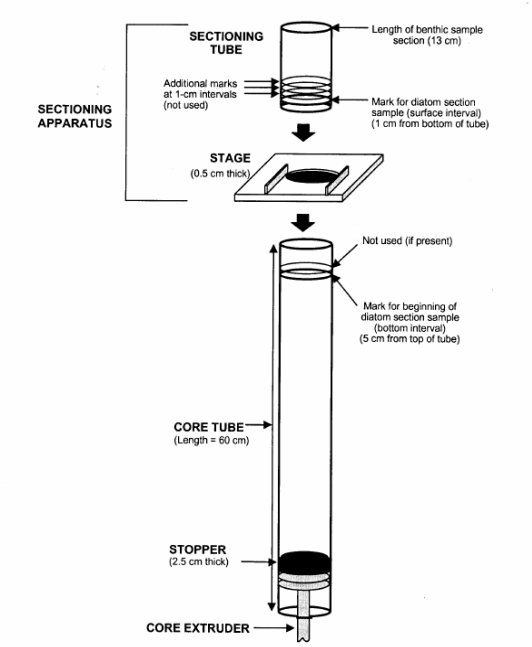


Figure 4-7. Illustration of the modified KB corer and sectioning apparatus (EMAP).

Table 4-9. Sampling procedure - sediment core.

Collect the Sediment Core from Natural Lake

1. Record the lake ID and the date on three sample labels. Mark one label for the top interval (TOP), one for the bottom interval (BOTTOM), and one smaller label (from a separate sheet) for the sediment sample (SED). Attach the labels to two small plastic containers (for diatoms) and one 20 mL plastic (PET) vial (for sediment). Record the bar code numbers on the collection form.
2. If the bottom has been disturbed during the initial depth determination or for any other reason, move at least 5 m to take the core. It is critical that the corer strikes undisturbed surface sediments.
3. Put on surgical gloves. They must be worn during sample collection because the sediments may contain contaminants.
4. Insert the core tube into the sampling housing apparatus and tighten the hose clamp steams to secure the tube.
5. Attach the messenger to the sampler line and slowly lower the corer through the water column until the bottom of the core tube is 0.5 m above the sediment surface. While maintaining a slight tension on the line, let the line slip through the hands and allow the corer to settle into the bottom sediments. Immediately after the corer drops into the sediments, maintain line tension to prevent the corer from tilting and disturbing the core sample. (Keep in mind that the goal is to obtain a core 45 cm in length. If this core length is not obtained the first time, the operation might need to be repeated at a new site using a greater release height in order to improve penetration and attain a longer core.)
6. Trip the corer by releasing the messenger weight so that it slides down the line.
7. Slowly raise the corer back to the surface, until the core tube and rubber seal are just under the water.
8. While keeping the seal under water, slowly tilt the corer until you can reach under the surface and plug the bottom of the corer with a rubber stopper. To do this without disturbing the water-sediment interface, you cannot tilt the corer more than 45 degrees. (This is a fairly difficult operation and stoppers are easily lost. Be sure to have spares available at all times.)
9. Keeping your hand under the stopper, raise the corer into the boat in a vertical position. Stand the corer in a large tub to prevent contaminating the boat with sediment material.

Process the Sediment Core

1. Detach the core tube from the corer. One team member should hold the sampler in a vertical position while the second person dismantles the unit.
2. Measure the length of the core to the nearest 0.1 cm and record the interval on the Sample Collection Form and on the two sample labels.
3. Slowly extrude the sample. To do this, position the extruder under the stopper at the base of the coring tube. Supporting both the core tube and the extruder in a vertical position, slowly lower the coring tube until the sediment is approximately 1 cm below the top of the tube.
4. Remove the water above the sediment core by using a siphon tube with a bent plastic tip (or a small disposable pipette) so that the surface sediments are not disturbed.
5. Continue extruding the core slowly and gently until the top of the core is just below the top of the core tube.

6. The pre-washed "sampling kit" for the sediment sample will be provided in a resealable plastic bag. Do not open the bag until you are ready to collect the sediment sample, and make sure the contents of the kit do not come into contact with anything other than the sediment sample.
7. Use the pre-washed 5-mL plastic pipette tip to collect a 1 cm3 sample from the center of the core. Use the wide end of the pipette tip like a corer and insert it into the core sample to the top of the collar on the tube (1 cm deep). place your finger over the other end of the pipette tip to remove the sediment sample
8. Transfer the removed sediment into the pre-labeled and pre-washed PET vial. Do not rinse the sample into the vial. Place the sediment sample on dry ice immediately to quick freeze the sample, and keep frozen until shipment. Pipette tips are not re-used, so they should be rinsed with lake water or DI water and disposed of properly.
9. Place the Plexiglas sectioning apparatus (marked with a line 1 cm from the bottom) on the stage directly over the coring tube. Slowly extrude the sediment core into the attached sectioning apparatus until the top of the sediment reaches the 1-cm line on the sectioning tube. Slide the top 1 cm section of sediment into the plastic container labeled for the top interval. Record this interval on the Index Site Sample Collection Form and on the sample label for the TOP interval.

IF YOU ARE SAMPLING A RESERVOIR. GO TO STEPS 12-13 BELOW. IF YOU ARE SAMPLING A NATURAL LAKE. CONTINUE WITH STEPS 10-13.

10. Before collecting the bottom section, remove the sectioning apparatus and rinse in lake water. This procedure prevents contamination of the bottom sediment layer with diatoms from the upper portion of the core. This step is critical as a small amount of sediment contains millions of diatoms which would destroy the population structure needed to compare environmental conditions depicted by top and bottom core samples.
11. Continue extruding the sample, discarding the central portion in the tube, until the bottom of the stopper is approximately 5 cm (3 inches) from the top of the coring tube. Affix the sectioning apparatus to the top of the tube. Extrude the sample until the bottom of the stopper reaches the lower black line at the top of the tube (approximately 3 cm from the top of the tube). Section the extruded sediment (2cm) and discard. Rinse the sectioning tube with lake water. Without removing the sectioning apparatus from the coring tube, slightly tilt the tube and wash the sectioning stage with a small amount of water from a squirt bottle. Make sure the rinse water runs off the stage and not into the coring tube with sediment. Lower the tube until the top of the sediment is at the 1-cm mark on the sectioning tube. Collect the 1-cm section of core material in the second plastic container labeled for the BOTTOM interval. Record this interval on the Sample Collection Form and on the sample label for the bottom core. Discard the remaining 2 cm.
12. Cover the labels on each container completely with clear tape. Place containers in a cooler with bags of ice.
13. Rinse the corer, collection apparatus, and sectioning apparatus thoroughly with lake water. Rinse with tap water at the next base site.

5.0 LITTORAL AND SHORELINE ACTIVITIES

To better understand the character of near-shore habitats and conditions, the Lakes Survey team will travel to 10 evenly spaced physical habitat ("P-Hab") stations around the lake and document conditions and characteristics observed within a defined plot area. The full array of measurements and sampling described in this chapter include:

- measures or observations of littoral and riparian physical habitat structure at 10 P-Hab stations;
- observations of invasive plants and macroinvertebrates;
- sampling of benthic macroinvertebrates at each of the 10 stations and composited as a single sample; and
- collection of water sample at the last P-Hab station for fecal indicator (Enterococci) analysis.

It should be noted that for lakes with a surface area of greater that 5,000 ha (defined as Large Lakes) the Lakes Survey team will not be required to travel to the P-Hab stations and perform physical habitat assessments or benthic macroinvertebrate sampling due to the increased level of effort required to complete such large areas. Additionally, such lakes will require modified procedures for collecting the fecal indicator (see Section 5.3).

5.1 Physical Habitat Assessment

5.1.1 Summary of Method

Figure 2-2 displays the placement and distribution of P-Hab stations around the lake. The plot at each station measures 25 m by 15 m and include portions of the riparian zone (shoreline and uplands) and the littoral zone. Figure 5-1 displays the plot dimensions of a P-Hab station used in the Lakes Survey.

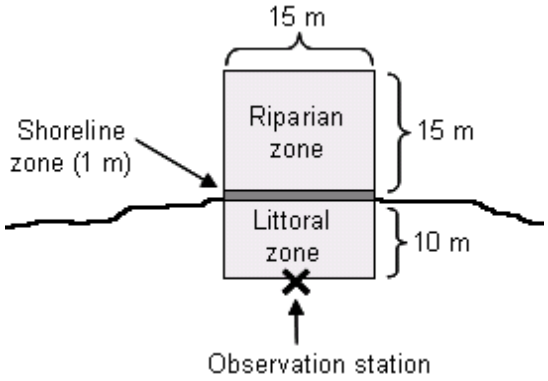


Figure 5-1. Dimensions and layout of a P-Hab station.

The approximate locations of the 10 stations are determined prior to the sampling visit and marked on the Lake Outline Sketch to be attached to the Lake Verification Form, Side 2 (Figure 3-2b). Once on the water, the Lakes Survey field team travels to a station and establishes the dimensions of the survey plot. The survey begins by estimating an observation

location 10 m (perpendicular) from the shoreline. This spot may be marked with a buoy and is the vantage point from which the team records riparian observations, and is also the point that separates the open water from the rectangular littoral plot. The remaining dimensions of the plot are visually estimated.

The riparian portion of the plot extends 15 m into the upland (beginning at the shoreline) and 15m along the lakeshore (15 m is about 3 standard canoe lengths). In this zone the team records information about the vegetation type and the height and areal coverage of trees, shrubs, and grasses. Observing the shoreline, they record information about shoreline substrate (e.g., gravel, sand), the high-water mark, and bank slope. Anthropogenic activities and other features (e.g., buildings, land use, docks) will also be noted.

The littoral region of the lake is that portion of the shoreward profile susceptible to the habitation of autotrophic plants, and includes the region of fluctuating water level between the high and low water marks (Ruttner 1969). The littoral portion of the plot measures 10 m distance from buoy to shoreline and 15 m across (7.5 m on either side of the boat). At the shore station 10 m offshore, the field team measures the water depth. They note any surface film or algae growth in the zone and probe the sediments to determine the type (e.g., gravel, sand) and areal cover of each bottom substrate type. In addition they estimate the areal cover of macrophytes and habitat/cover within the littoral plots using a simple coding system. All these observations are recorded on Side 1 of the Physical Habitat Characterization Form (Figure 5-2a). Physical habitat comments are recorded on the bottom half of Side 2 of the form (Figure 5-2b).

5.1.2 Equipment and Supplies

Table 5-1 provides the equipment and supplies needed for field operations to locate the P-Hab stations and conduct the physical habitat assessment. Field teams are to record the physical habitat observations on the Physical Habitat Characterization Form, as seen in Figure 5-2 (a) and (b).

Table 5-1. Equipment and supplies list for Physical Habitat Assessment.

Item	Quantity
Physical Habitat Assessment	
Sonar	1
GPS unit with manual, reference card, extra battery pack	1
Anchor with 50-m line	1
Float to attach to anchor	1
Surveyor's tape	1 roll
Lake Verification Form	1
Physical Habitat Characterization Forms	10
Field notebook	1
Quick reference field operations handbook	1
PVC sounding rod, 3-m length, marked in 0.1 m increments	1
Buoy for marking observation point	1

5.1.3 Locating the Physical Habitat Stations and Defining the Shoreline Boundary

A Lake Outline Sketch from a 1:100:000 topographic map should be recorded on Side 2 of the Lake Verification Form (Figure 3-2a). (Alternatively, a photocopy of the lake may be made and attached to the form, as long as the top of the copy has a continuous strip of tape going across it; if there are gaps it will catch in the scanner). A random starting point (i.e., Station A) on the lake outline should then be assigned prior to beginning sampling activities (e.g., in the office before beginning field work). Any reasonable method may be used to randomly select the starting point (e.g. tossing a coin on the map, place a compass on the map in the center of the lake and find due north). It is important that the remaining nine stations be located at equal distances around the lake going in a clockwise direction (see Figure 2-2). This can be done using a string to trace the perimeter of the lake, which can then be straightened and marked in equal intervals, or by using a planimeter wheel to measure the perimeter and dividing by 10. Coordinates entered as GPS waypoints greatly facilitate correctly locating P-Hab stations by boat in the field, especially on large lakes.

Starting at the nearest boat access point, proceed by boat around the lake near the shore, observing bank, shoreline, emergent, and subsurface characteristics. Using the Lake Outline Sketch and a topographic map or GPS unit, locate and stop at each of the 10 P-Hab stations. Position the boat at a distance of 10 m (~30 ft, offshore), anchor if necessary, and make the semi-quantitative measurements on the Physical Habitat Characterization Form, (Figure 5-2a and b). A separate Physical Habitat Characterization Form will be completed for each station. Make every reasonable attempt to record physical habitat observations and measurements for all 10 P-Hab stations. Where this is impossible, record a "K" flag in each field to clearly indicate on the form that no observations could be made at that particular station.

PHYSICAL HABITAT CHARACTERIZATION - LAKES

Draft

Reviewed by (initial): DD

SITE ID: NLA06608 - 9999 DATE: 05/01/2007

STATION: ● A ○ B ○ C ○ D ○ E ○ F ○ G ○ H ○ I ○ J

DEPTH AT STATION (10 m offshore) 2.0 ○ ft ● m

LAT 33.07900

IF STATION WAS RELOCATED, INDICATE HERE: ○ DROPPED: ○

NEW STATION (K, L, etc.) ___ IS IT AN ISLAND? ○ UNABLE TO SAMPLE: ○

LONG 096.94020

LITTORAL ZONE

Surface film type: ● None ○ Scum ○ Algal Mat ○ Oily ○ Other

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

BOTTOM SUBSTRATE		Flag
Bedrock (>4000mm; larger than a car)	(0) 1 2 3 4	
Boulders (250-4000mm; basketball-car)	(0) 1 2 3 4	
Cobble (64-250mm; tennis ball-basketball)	(0) 1 2 3 4	
Gravel (2-64mm; ladybug to tennis ball size)	0 1 2 (3) 4	
Sand (0.06 - 2mm; gritty between fingers)	0 (1) 2 3 4	
Silt, Clay, or Muck (<0.06mm; not gritty)	(0) 1 2 3 4	
Woody Debris	(0) 1 2 3 4	
Organic (Leaf Pack, Detritus)	(0) 1 2 3 4	
Color	○ Black ○ Gray ● Brown ○ Red ○ Other	
Odor	● None ○ H_2S ○ Anoxic ○ Oil ○ Chemical ○ Other	

AQUATIC MACROPHYTES		Flag
Submergent	0 (1) 2 3 4	
Emergent	0 (1) 2 3 4	
Floating	0 (1) 2 3 4	
Total Aquatic Macrophyte Cover	0 1 (2) 3 4	

Do macrophytes extend lakeward? ○ Yes ● No

FISH COVER		Flag
Aquatic and Innundated Herbaceous Veg.	0 1 (2) 3 4	
Woody Debris/Snags > 0.3 m Dia.	(0) 1 2 3 4	
Woody Brush/Woody Debris <0.3 m dia. (alive or dead)	0 (1) 2 3 4	
Inundated Live Trees >0.3 m dia	(0) 1 2 3 4	
Overhanging Veg. within 1 m of Surface	(0) 1 2 3 4	
Ledges or Sharp Dropoffs	(0) 1 2 3 4	
Boulders	(0) 1 2 3 4	
Human Structures- Docks, Landings, etc	(0) 1 2 3 4	

Human Influence Zones

RIPARIAN ZONE

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

CANOPY (>5 m high) Flag

○ Deciduous ○ Broadleaf Evergreen ○ Coniferous ○ Mixed ● None

Big Trees (Trunk >0.3 m dBH)	(0) 1 2 3 4	
Small Trees (Trunk <0.3 m dBH)	(0) 1 2 3 4	

UNDERSTORY (0.5 TO 5m high) Flag

● Deciduous ○ Broadleaf Evergreen ○ Coniferous ○ Mixed ○ None

Woody Shrubs & Saplings	0 (1) 2 3 4	
Tall Herbs, Grasses, & Forbs	0 1 (2) 3 4	

GROUND COVER (<0.5 high)		Flag
Woody Shrubs & Saplings	0 (1) 2 3 4	
Herbs, Grasses and Forbs	0 1 (2) 3 4	
Standing Water or Inundated Vegetation	0 (1) 2 3 4	
Barren, Bare Dirt or Buildings	0 (1) 2 3 4	

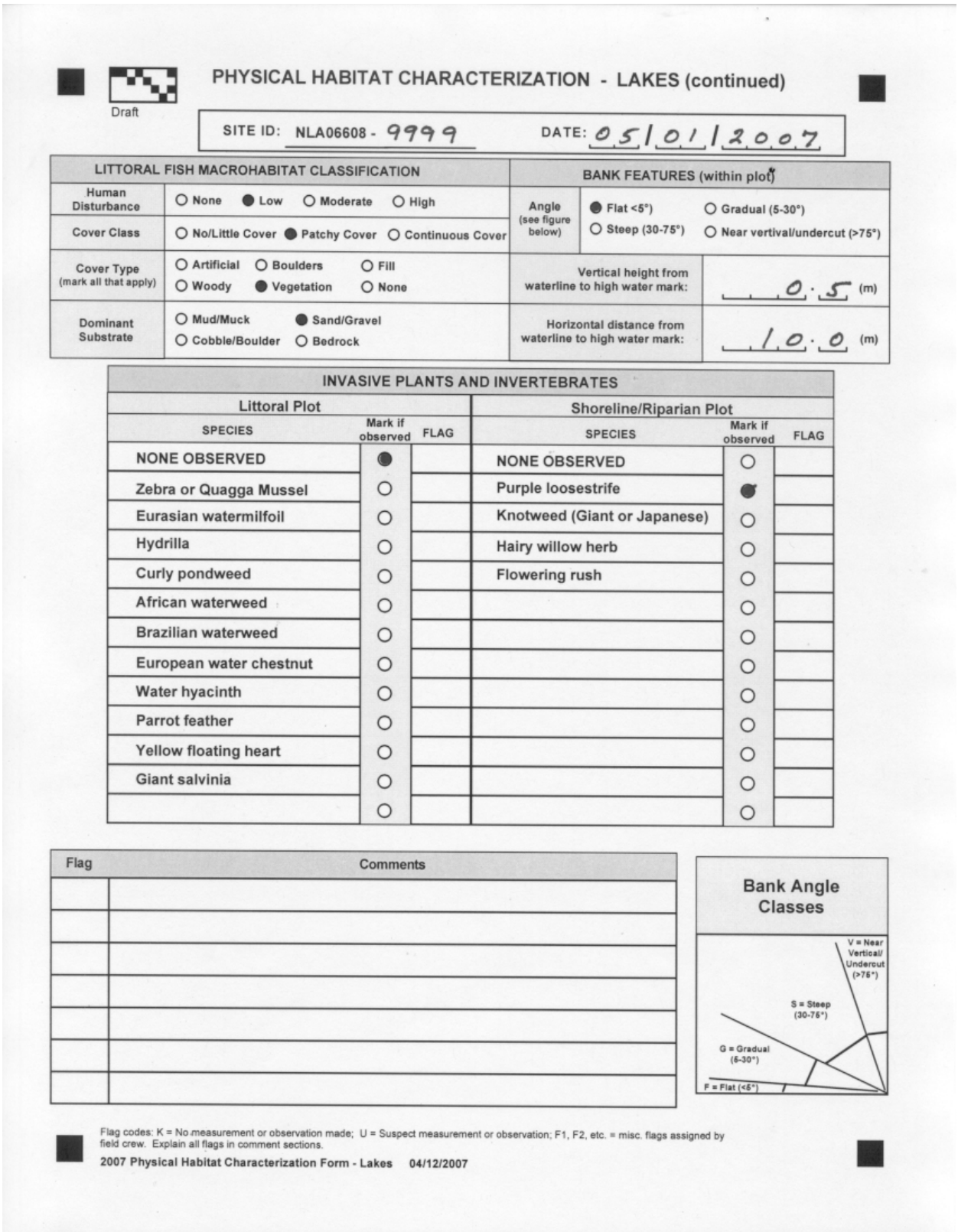
SHORELINE SUBSTRATE ZONE		Flag
Bedrock (>4000mm; larger than a car)	(0) 1 2 3 4	
Boulders (250-4000mm; basketball-car size)	(0) 1 2 3 4	
Cobble (64-250mm; tennis ball-basketball size)	(0) 1 2 3 4	
Gravel (2-64 mm; ladybug-tennis ball size)	(0) 1 2 3 4	
Sand (0.06 - 2mm; gritty between fingers)	0 1 2 (3) 4	
Silt, Clay, or Muck (<0.06mm; not gritty)	0 (1) 2 3 4	
Woody Debris	(0) 1 2 3 4	
Organic (Leaf Pack, Detritus)	0 (1) 2 3 4	
Vegetation or Other	0 (1) 2 3 4	

HUMAN INFLUENCE		Flag
0 = Not Present P = Present outside plot C = Present within plot		
Buildings	(0) P C	
Commercial	(0) P C	
Park Facilities/ Man-made beach	(0) P C	
Docks/Boats	(0) P C	
Walls, dikes or revetments	(0) P C	
Landfill/Trash	0 P (C)	
Roads or Railroad	(0) P C	
Power lines	(0) P C	
Row Crops	(0) P C	
Pasture/Range/Hay Field	0 (P) C	
Orchard	(0) P C	
Lawn	(0) P C	

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

2007 Physical Habitat Characterization Form - Lakes 04/12/2007

Figure 5-2(a). Physical Habitat Characterization Form, Side 1.



PHYSICAL HABITAT CHARACTERIZATION - LAKES (continued)

Draft

SITE ID: NLA06608 - 9999 DATE: 05/01/2007

LITTORAL FISH MACROHABITAT CLASSIFICATION		BANK FEATURES (within plot)		
Human Disturbance	○ None ● Low ○ Moderate ○ High	Angle (see figure below)	● Flat <5°) ○ Gradual (5-30°) ○ Steep (30-75°) ○ Near vertival/undercut (>75°)	
Cover Class	○ No/Little Cover ● Patchy Cover ○ Continuous Cover			
Cover Type (mark all that apply)	○ Artificial ○ Boulders ○ Fill ○ Woody ● Vegetation ○ None	Vertical height from waterline to high water mark:	0.5 (m)	
Dominant Substrate	○ Mud/Muck ● Sand/Gravel ○ Cobble/Boulder ○ Bedrock	Horizontal distance from waterline to high water mark:	10.0 (m)	

INVASIVE PLANTS AND INVERTEBRATES					
Littoral Plot			Shoreline/Riparian Plot		
SPECIES	Mark if observed	FLAG	SPECIES	Mark if observed	FLAG
NONE OBSERVED	●		NONE OBSERVED	○	
Zebra or Quagga Mussel	○		Purple loosestrife	●	
Eurasian watermilfoil	○		Knotweed (Giant or Japanese)	○	
Hydrilla	○		Hairy willow herb	○	
Curly pondweed	○		Flowering rush	○	
African waterweed	○			○	
Brazilian waterweed	○			○	
European water chestnut	○			○	
Water hyacinth	○			○	
Parrot feather	○			○	
Yellow floating heart	○			○	
Giant salvinia	○			○	
	○			○	

Flag	Comments

Bank Angle Classes

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

2007 Physical Habitat Characterization Form - Lakes 04/12/2007

Figure 5-2(b). Physical Habitat Characterization Form, Side 2.

5.1.3.1 Shoreline Adjustments

Once in the field, the field team might run into conditions or problems that will require modifications to the shoreline and/or station location(s) as drawn on the Lake Outline Sketch. If this occurs, the field team makes the corrections and adjustments on the Lake Verification Form and the Physical Habitat Characterization Form and notes reasons on the comments section of the form. The general guidelines for locating or modifying the location of the littoral and shoreline stations are summarized in Table 5-2.

Table 5-2. General guidelines for locating or modifying the location of littoral and shoreline stations.

At Each Physical Habitat (P-Hab) Sampling Station:

1. Locate station using maps, aerial photos, or GPS units.
2. Define shore as either the current waterline OR the boundary between open water and the edge of dense vegetation (terrestrial, wetland, or emergent vegetation) or extensive very shallow water. (Shoreline defined by limit for navigating sample boat.)
3. If the shoreline observed in the field differs from the mapped shoreline, enter a comment on the Physical Habitat Characterization Form (Side 2) stating the apparent reason (e.g., drought, flooding, dredging). Mark "Station Relocated" on side 1.
4. If a P-Hab station is lost because of shoreline changes, position one or more new stations at approximately equal intervals. Mark "Station Relocated" at the top of the Physical Habitat Characterization Form.
5. If a station is eliminated, enter "K" flags on the Physical Habitat Characterization Form to indicate no observations, mark the "Station Dropped" box.
7. If the shoreline observed in the field differs radically from the Lake Outline Sketch and you are sure you are at the correct lake, draw a new map on the same page as the original lake. Use a string to measure the new outline, divide it into 10 equal parts, and lay out the 10 station locations.
8. At each of the 10 P-Hab stations, position the boat at an observation point 10 m from shore. Drop buoy at observation point, or maintain position while anchored.
9. Limit shoreline and riparian observations to an area 15 m (50 ft) wide by 15 m (50 ft) inland from shore, and littoral observations to an area 15 m wide (50 ft) by 10 m (30 ft) from shore to the boat.
10. Record littoral and riparian characteristics on side 1 of the Physical Habitat Characterization Form. Record any observed invasive plants and invertebrates, as well as any additional comments on side 2 of the Physical Habitat Characterization Form.

The shoreline is defined as the interface between "lake-like" conditions and riparian or wetland conditions. 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.

- If there has been a big drop in lake level due to drought, dam repair, or other reasons, shallow areas may be exposed that are usually covered with water. 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 shoal-type areas, consider the shoreline to be the boundary between the shallow area and deeper open water, as defined by ease of access by small sampling boat.

- 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 sampling boat.

All adjustments to the shoreline based on field observations should be drawn directly on the Lake Outline Sketch and noted in the comments section of the Physical Habitat Characterization Form. If the Lake Outline Sketch does not in any way match the lake shoreline, the field team will need to draw a new sketch map approximating the shoreline, and establish the 10 P-Hab stations. A quick way to locate 10 evenly-spaced P-Hab 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 sites on the map.

5.1.3.2 Relocating, Adding, and Eliminating Stations

The goal of the physical habitat survey is to characterize the lakeshore based on observations of conditions at 10 evenly spaced P-Hab sites around the lake. Adjustments to station locations might be needed if the field team runs into unusual conditions or problems. Below are some rules concerning modifications to the station location(s).

Actual shoreline is different than appears on the map

- If only a small portion of the shoreline differs and it does not affect, or only slightly affects, a P-Hab site location, sketch the lake shoreline on the Lake Outline Sketch and reposition the station (if needed).
- If the difference causes a contraction of the shoreline and a P-Hab station location is lost, the field team should sketch the lake shoreline on the Lake Outline Sketch and make a decision to (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 the team should sketch the lake shoreline on the Lake Outline Sketch and make a decision to (a) add one or more stations, mark them on the revised shoreline map and adjust some or all other stations if needed so they are evenly spaced around the lake (i.e., designate more than 10 stations), or (b) adjust the stations so they are evenly spaced around the lake (i.e., keep 10 stations). On larger lakes the field team should try to maintain the goal of 10 stations.

P-Hab Station is inaccessible

- If a P-Hab station is inaccessible the field team must make a decision to (a) relocate the station and adjust some or all other stations so 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. On larger lakes the field team should try to maintain the goal of 10 stations.

5.1.3.3 Identifying Relocated and New Stations on the Form

The field team should use the following notations when recording station location modifications.

- If a station is relocated, note the new location on the Lake Outline Sketch and check the appropriate original station letter (e.g., "C") on that form. The team also must check the box for the station letter on the Physical Habitat Characterization Form and check the box for "Station Relocated".
- If a station is lost and cannot be replaced, cross out the original station location on the pre-printed Lake Outline Sketch and check the box for "Station Dropped" on the Physical Habitat Characterization form, fill in each of the data boxes with "K" to indicate that no observations were made at the designated station, and note the reason in the comments.
- If one or more stations are added, check the nearest station locations on the Lake Outline Sketch, and fill in the box for "New Station" on a blank Physical Habitat Characterization Form.

5.1.4 Physical Habitat Characterization Form and Instructions

At each P-Hab station, make observations and measurements of the shoreline from the boat which is 10 m offshore (estimated by eye). It is important to stay 10 m from shore and to limit bank and shoreline observations at each station to the area that is within the defined plot dimensions. The littoral and riparian observation plots have fixed dimensions (Figure 5-1) that are estimated by eye. Littoral measurements pertain to the water and lake bottom in the 10 m (30 ft) distance between the boat and the shoreline and extending 15 m (50 ft) along the shore. Riparian observations at each station pertain to the adjacent land or wetland area that is 15 m wide and extends 15 m back onto land. The bank angle and shoreline substrate observations refer to a narrower shoreline zone that extends 1 m landward from the present waterline.

The shoreline boundary is defined as the approximate interface between "lake-like" conditions and riparian or wetland conditions. In cases where the lake shoreline is not obvious (e.g., where there is evidence of large seasonal change in lake level) define the shoreline as the current waterline. In cases where the lake shoreline is not visible, define the lake shoreline as the approximate boundary between open water and swamp or marsh conditions into which your boat could not easily move.

Use the rating system based on areal coverage in evaluations of riparian vegetation, shoreline substrate, littoral bottom substrate, fish cover, and aquatic macrophytes. The five entry choices range from 0 (absent) to 4 (>75% cover) and are defined in Table 5-3, which lists steps required to complete the Physical Habitat Characterization Form (Figures 5-2a and b). The second page of the form has space for comments. When estimating cover or substrate type, mixtures of more than one class might all be given sparse (1), moderate (2), or heavy (3) rankings. One dominant class 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 with more than 40 percent cover can both be ranked 3.

Table 5-3. Completing the physical habitat characterization form.

General	1. **Fill in a Physical Habitat Characterization Form** at each of the 10 P-Hab stations, clearly indicating station from which the observations have been made. **2. Survey plot dimensions:** • Riparian Vegetation – 15 m along shoreline and 15 m back onto land. • Shoreline Substrate and Bank Angle – 15 m along shore and 1 m back. • Littoral (in lake) – 15 m along shoreline and 1 m out into lake 3. Use **semi-quantitative ranking** for vegetation, substrate, aquatic macrophytes & fish cover: • Very heavy (greater than 75% coverage) = 4 • Heavy (40 to 75% coverage) = 3 • Moderate (10 to 40% coverage) = 2 • Sparse (present, but less than 10% coverage) = 1 • Absent = 0
Littoral Habitat	1. **Measure lake depth** 10 m from shore at each P-Hab station, noting new location if the point has to be relocated for some reason. 2. **Note the presence or absence of water surface scums, algal mats, or oil slicks**. 3. **Determine the lake bottom substrate** visible from the boat. If the bottom is not visible, attempt to collect a sample or characterize by remote sensing with a sounding tube (e.g., PVC tubing). 4. **Rank the littoral substrate sediment particle size**, making multiple probes if the bottom is not visible. If the bottom is covered with leaves or other organic debris, choose "Organic substrates". If the substrate is concealed and remote sampling is not possible, use "Not observed" flag (K). 5. **Note sediment color and odor** if a sample can be seen or collected. 6. **Estimate the areal coverage of the three individual aquatic macrophyte types and the areal coverage of all three types combined**: submerged, emergent, and floating within the 10 x 15 m plot between the boat and shoreline. If you cannot see or probe the bottom, move closer to shore and note your new location with a Flag in the "Bottom Substrate" section. 7. **Record fish habitat cover** observed from the shore to the boat and 15 m along shore. 8. **Record fish habitat macrohabitat classification** for the general vicinity visible from the sampling station 10 m by 15 m littoral area. 9. **Record invasive plant or invertebrate species** observed.
Riparian Habitat	**1. Divide shoreline vegetation into 3 categories:** • Greater than 5 m high = canopy layer • 0.5 to 5 m high = understory layer • Less than 0.5 m high = ground cover layer *(Grasses or woody shrubs and tree branches can occur in >1 layer. The ground cover layer may be vegetation, water, barren ground, or duff.)* 2. **Record the type of vegetation** in the two tallest shoreline vegetation layers (canopy & understory) as none, deciduous, coniferous, broadleaf evergreen, or mixed. Define mixed as a segment where at least 10% of the areal coverage is made up of the alternate vegetation type. 3. **Estimate the areal cover of the shoreline vegetation**, recording the % of each coverage type within 3 vegetation classes (canopy, understory, and ground cover): 4. **Rate the shoreline substrate** 1 m into the riparian plot for areal coverage in particle size classes shown on the Physical Habitat Characterization Form. 5. **Describe the angle of the shoreline bank** back 1 m from the edge of the water **6.** Estimate the **vertical and horizontal distances between the present lake level and the high water line.** 7. Record presence of each **human influence** type 8. **Record invasive plant or invertebrate species** observed.

On the human influence entry fields, mark "C" if present within the shoreline or littoral plot. Record a "P" if visible but adjacent or behind (outside) the plot, or "0" for absence of listed features. "Adjacent" is defined as found within a hypothetical plot of equal size to the right or left of the sampling plot. If, for some reason, you cannot make measurements at a station, record a "K" flag in all data fields for that station. This entry is very important, as there is no other way of determining whether your intent is to record the absence of features or to denote a missed station.

For any particular measurement variable, if no effort is made to collect data, or if you make an effort but for some reason are unable to obtain data, enter a "K" flag in the flag field. Explain on the Physical Habitat Characterization Form, Side 2 (Figure 5-2b) in the section designed for comments why data could not be obtained. If you collect data for a variable but have reason to believe it is suspect (or it was collected using a nonstandard protocol), enter a "U" flag in the flag field. In the comments section, explain why you think it is suspect (or describe what nonstandard procedure was used and why). If there is unusual or otherwise relevant information critical to interpreting data entered on the form, enter sequential flags (F1, F2, F3, etc.), and explain these flags in the comments section. Numbered "F" flags pertain to the front and back side of each individual form.

5.1.5 Littoral Zone Habitat Characterization

Lake depth at the observation point 10 m (30 feet) offshore in each littoral station is taken using the sonar, calibrated Secchi disk line, or the marked PVC sounding rod. Record the presence or absence of water surface scums, algal mats, or oil slicks. All measurements or observations in the following categories are recorded on the Physical Habitat Characterization Form (Figure 5-2a).

5.1.5.1 Bottom Substrate

To characterize littoral bottom substrate, restrict observations to the substrate you can detect from the boat. If you can't see the bottom, examine sediment indirectly using a long tube (e.g., the 3-m PVC sounding rod). Probe the bottom beneath the boat with the sounding rod (you may have to move closer to shore if too deep to use rod). Soft sediment can be brought to the surface for examination. Hard sediments can be "felt" with the sounding rod. Sandy substrate can be "felt" or "heard" by twisting the sounding rod and detecting grittiness. If you had to move into shallow water to use sounding rod to observe sediment characteristics, flag the observation and record (on the Physical Habitat Characterization Form comments section) the depth where you observed the sediment. Rate the cover of substrate sediment particle sizes that have very heavy, heavy, moderate, sparse, and absent areal coverage. Base these ratings on visual observations and judgments using the size classes defined on the form. If the bottom is covered with leaves or other organic debris, choose "Organic substrates". If the substrate is obscured by vegetation and you cannot obtain a PVC sounding rod sample, enter a "K" flag to denote "no observation made", and explain reason in comment field on back of form. However, probing with the sediment tube usually makes it possible to determine if the sediment is soft (therefore either Sand or Silt/Clay/Muck).

Sediment color and odor are subjective observations to be noted on the form, whenever possible. Select "None" or "Other" if sediment color does not match one of the categories. For sediment odor, the choices are "H_2S" (sulfurous, rotten egg), "Anoxic" (sewage odor), "Chemical" (strong odor like turpentine, paint, etc.), "Oil", or "Other" (including musty, no odor,

organic, and fishy odors). If "Other" is indicated, explain the observation on the comment form.

5.1.5.2 Aquatic Macrophytes

To characterize aquatic macrophytes, separately estimate the areal coverage (as defined in Table 5-3) within the lake area between your boat and the shoreline for each of the three aquatic macrophyte types:

- submerged,
- emergent (has erect portions above the water surface), and
- floating (either rooted or non-rooted vegetation)

Count any plant as being in only one of these types. Then estimate the coverage of all combined types of aquatic macrophytes in the same area. You may have to probe the bottom with the PVC sounding tube or your anchor if the water is turbid. Indicate ("yes" or "no") if the aquatic macrophytes extend further out into the lake than the area included in your observation area (i.e., more than 10 m [or 30 ft] from shore).

5.1.5.3 Fish Habitat Cover

Evaluate the areal cover of the listed types of fish habitat and cover features that are in the water and shoreline within the 10 x 15 m littoral portion of the field of vision at each P-Hab station (Table 5-3). Select a rating of 0 (absent) to 4 (>75% cover) based on the abundance of the various fish cover types (Table 5-3). These features are within or partially within the water and conceal fish from aquatic and terrestrial predators such as larger fish, otters, kingfishers, and ospreys.

- 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 rootwads with diameter >0.3 m (1 ft)
- 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 from the water surface (do not include higher overhanging vegetation, which might provide perches for birds such as kingfishers)
- Ledges or Sharp Dropoffs -- overhanging banks, submerged rock shelves, and steep sloping rock walls
- Boulders -- >basketball size
- Human Structures -- docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts)

5.1.5.4 Littoral Fish General Macrohabitat Habitat Classification

At each physical habitat station, classify the general category of fish macrohabitat in the general vicinity of the sampling station. The hierarchical classification system defined in Table 5-4 consists of four levels. The first classification level refers to disturbance: is there major human influence in the littoral zone (not the shore) or is this area in a more or less natural state (including largely recovered areas)? The second level refers to the presence of cover: is there

cover for fish or open water or a mixture of the two? The third level defines the kind of cover: human influence includes "structures" (e.g., docks, boats, floating platforms) and "fill" (e.g., revetment boulders, trash); natural areas include in-lake vegetation, boulders, or woody materials or a mixture. The fourth level describes substrate. Check the appropriate box for each category on the Physical Habitat Characterization Form, Side 2 (Figure 5-2b).

Table 5-4. Littoral macrohabitat characteristics.

Littoral Fish Macrohabitat Classification	Classify the habitat for fish into the following categories for each respective level: **1st level (in-lake disturbance)** High, Med, or Low **2nd level (in-lake cover)** Cover (major fish cover), Open, or Mixed (patchy). **3rd level (cover type)** Artificial Structure (docks, boats), Fill (revetment, boulders, etc.), Vegetated, Woody, Boulders, Mixed (a combination), or None. **4th level (dominant substrate)** Mud/Muck, Sand/gravel, Cobble/Boulder, or Bedrock.

5.1.6 Riparian Zone Habitat Characterization

The riparian habitat characterization includes riparian vegetation cover, shoreline substrate, bank features, and human influences. Record all measures or observations for these categories on the Physical Habitat Characterization Form (Figures 5-2a with comments on 5-2b).

5.1.6.1 Riparian Vegetation Cover

To characterize riparian vegetation, observe the visible area from the shoreline back a distance of 15 m (50 ft) from the shore. If the high water mark is more than 15 m away from shore, the riparian plot includes parts of the shore that are sometimes inundated. On the other hand, if the "shoreline" boundary (defined as the approximate interface between "lake-like" conditions and riparian or wetland conditions) is an inundated wetland, then this area includes the wetland vegetation, or aquatic macrophytes. Conceptually divide the shoreline vegetation into three layers:

- Canopy (>5 m high)
- Understory Layer (0.5 to 5 m high)
- Ground Cover Layer (<0.5 m high)

Note that several vegetation types (e.g., grasses or woody shrubs) can potentially occur in more than one layer. Similarly note that some things other than vegetation are possible entries for the "Ground Cover" layer (e.g., water or barren ground), as indicated in Table 5-3. Before estimating the areal coverage of the vegetation layers, record the type of vegetation in each of the two taller layers (Canopy and Understory).

- deciduous,
- broadleaf evergreen,
- coniferous (needle-leafed, usually evergreen),

- mixed, or
- none

Consider the layer "Mixed" if >10% of the areal coverage is made up of the alternate vegetation type.

5.1.6.2 Shoreline Substrate

Rank, by areal coverage (very heavy, heavy, moderate, sparse, and absent) particle size classes of the substrate that are visible in the 1-m wide (terrestrial) strip nearest to the lake shoreline. These size estimates are made by eye from the boat, using the size classes and cover class ratings defined on Side 1 of the Physical Habitat Characterization Form (Figure 5-2a). If the inorganic substrate is obscured by vegetation, choose "Vegetation or Other"; if there is another type (e.g., organic flotsam), record its coverage rank in the "Vegetation or Other" category and then identify the category in the comments section.

5.1.6.3 Human Influences

Select "C" for any and all of the human activities and influences that you observe within the defined lake and riparian observation areas. If present (15 x 15 m areas to left and right) adjacent to the plot or within your field of vision behind (outside) the defined observation area, choose "P." Select "0" if human activity is not present in either lake or riparian areas.

5.1.6.4 Bank Type and Evidence of Lake Level Changes

Choose the bank angle description that best reflects the current shoreline that is dominant within your field of vision and 1 m into the riparian plot: Near vertical/undercut (>75 degrees, steep (>30 to 75 degrees; need hands to climb up), gradual, (5 to 30 degrees; can walk up), or flat (< 5 degrees). Estimate the vertical difference between the present level and the high water line (using survey pole and level or visual estimation); similarly, estimate the horizontal distance up the bank between current lake level and evidence of higher level (usually done using a laser range finder).

5.1.7 Invasive Plants and Invertebrates

Record if any invasive plant and invertebrate species listed in Table 5-5 have been observed within the habitat plot. Check the boxes on the side 2 of the Physical Habitat Characterization Form (Figure 5-2b) for any species observed within the littoral or shoreline/riparian plots.

Table 5-5. Invasive plants and invertebrates.

Littoral Species	• Zebra (or Quagga) mussel • Eurasian watermilfoil • Hydrilla • Curly pondweed • African waterweed • Brazilian waterweed	• European waterchestnut • Water hyacinth • Parrot feather • Yellow floating heart • Giant salvinia
Shoreline/Riparian Species	• Purple loosestrife • Knotweed (Giant or Japanese)	• Hairy willow herb • Flowering rush

5.2 Benthic Macroinvertebrate Sampling

5.2.1 Summary of Method

Benthos are collected using a semi-quantitative sampling of multiple habitats in the littoral zone of lakes using a D-frame dip net (Figure 5-3). Sample collection is stratified on the following three specific habitat types: rocky/cobble/large woody debris; macrophyte beds; and organic fine muds or sand.

Figure 5-3. D-frame net used for collecting benthic macroinvertebrates.

5.2.2 Equipment and Supplies

Table 5-6 provides the equipment and supplies needed for field operations to collect benthic macroinverbrates. Field teams are to record the benthic macroinvertebrate sampling data on the Lake Shoreline Sample Collection Form, Side 1 (Figure 5-5a).

Table 5-6. Equipment and supplies list for benthic macroinvertebrate collection.

Item	Quantity
Benthic Macroinvertebrate	
Modified kick net (D-frame with 500 µm mesh) and 4-ft handle	1
Spare net(s) and/or spare bucket assembly for end of net	
Buckets, plastic, 8- to 10-qt capacity	2
Sieve-bucket or soil sieve with 500 µm mesh openings (U.S. std No. 35)	1
Watchmakers' forceps	2 pr.
Wash bottle, 1-L capacity labeled "LAKE WATER"	1
Small spatula, spoon, or scoop to transfer sample	1
Funnel, with large bore spout (optional)	1
Sample jars, HDPE plastic with leakproof steam caps, 500-mL and 1-L capacity, suitable for use with ethanol	4 to 6 each sample
95% ethanol, in a properly labeled container	2 gal
Rubber gloves	2 pr.

Table 5-6. Equipment and supplies list for benthic macroinvertebrate collection.

Cooler (with suitable absorbent material) for transporting ethanol and samples	1
Benthic sample labels, with preprinted sample numbers	2
Benthic sample labels without preprinted sample numbers	4
Internal benthic sample labels on waterproof paper	6
Lake Shoreline Sample Collection Form	1
Soft (#2) lead pencils	
Fine-tip indelible markers	
Clear tape strips	1 pkg.
Plastic electrical tape	4 rolls
Scissors	1
Pocket-sized field notebook (optional)	1
Field operations and methods manual	1 copy

5.2.3 Sampling Procedure

5.2.3.1 Site Selection and Sample Collection

The process for selecting the p-Hab stations is described in the Physical Habitat Assessment Section 5.1. All benthic samples should be collected from the dominant habitat type within the 10 m x 15 m littoral zone component of each of the 10 P-Hab stations (Figure 5-4). The sampling process is described in Table 5-7.

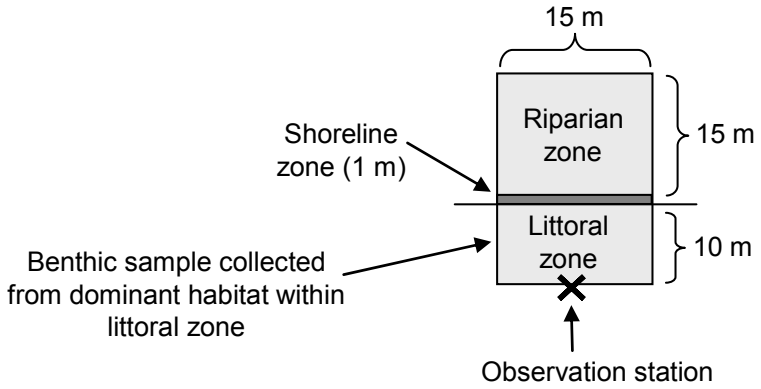


Figure 5-4. Benthic and habitat sampling station diagram.

5.2.3.2 Sample Processing in the Field

Use a 500 μm mesh sieve bucket placed inside a larger bucket full of lake water while sampling to carry the composite sample as you travel around the lake. Once the composite sample from the collections from the 10 stations is sieved and reduced in volume, store in a 1-liter jar and preserve with 95% ethanol. Multiple jars may be required if detritus is heavy (Table

5-8). If more than one jar is used for a composite sample, use the "extra jar" label provided; record the SAME sample ID number on this "extra jar" label. The sample ID number is also recorded with a lead pencil (No. 2) on a waterproof label that is placed inside each jar. If a sample requires more than one jar, make sure the correct number of jars for the sample is recorded on the Sample Collection Form. Record information for each composite sample on the Lake Shoreline Sample Collection Form as shown in Figure 5-5(a).

Check to be sure that the pre-numbered adhesive label is on the jar and covered with clear tape. Place the samples in a cooler or other secure container for transporting and/or shipping the laboratory (see Appendix C).

Table 5-7. Procedure for benthic macroinvertebrate sampling

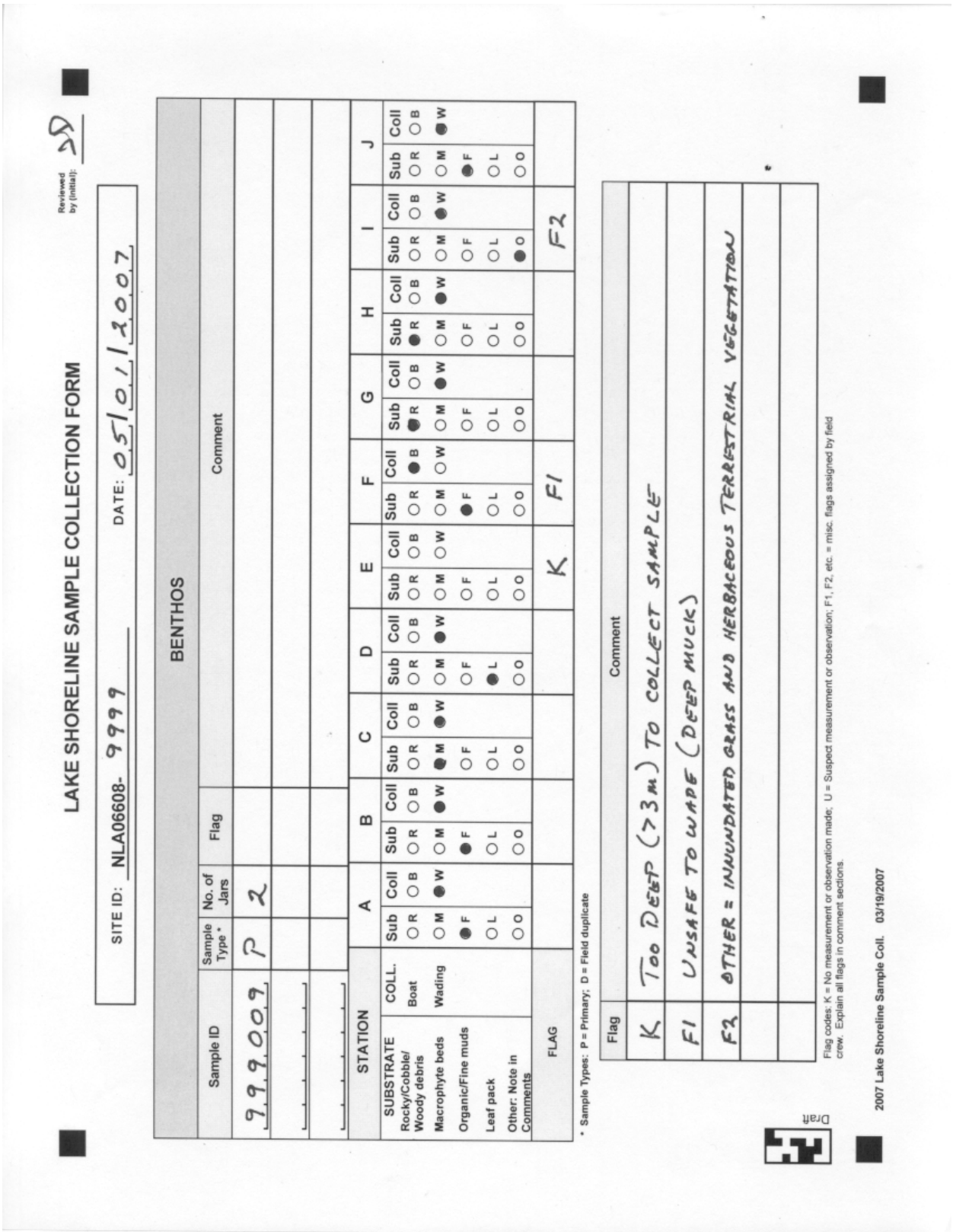
1. After locating the sample site according to procedures described in the physical habitat section, identify the dominant habitat type within the plot:
    - Rocky/cobble/large woody debris;
    - Macrophyte beds;
    - Organic fine muds or sand;
    - Leaf Pack

2. After identifying the dominant habitat type, use the D-frame dip net (equipped with 500 µm mesh) to sweep through 1 linear meter of the dominant habitat type at a single location within the 10m x 15m littoral zone sampling area, making sure to disturb the substrate enough to dislodge organisms.

    - If the dominant habitat is rocky/cobble/large woody debris it may be necessary to exit the boat and disturb the substrate (e.g., overturn rocks, logs) using your feet while sweeping the net through the disturbed area.
    - Because a dip-net is being used for sampling, the maximum depth for sampling will be approximately 0.5 m (the length of the dip-net staff); therefore, in cases in which the depth of the lake quickly drops off it may be necessary to sample in the nearest several meters to the shore.

3. After completing the 1-meter sweep, remove all organisms and debris from net and place them in a bucket following sample processing procedures described in the following section.

4. Proceed to the next sampling station and repeat steps 1-5. The organisms and detritus collected at each station on the lake should be combined in a single bucket to create a single composite sample for the lake. After sampling at all 10 stations is completed, process the composite sample in the bucket according to procedures described in the following section.



LAKE SHORELINE SAMPLE COLLECTION FORM

SITE ID: NLA06608- 9999 DATE: 05/01/2007

Reviewed by (initial): SD

BENTHOS

Sample ID	Sample Type *	No. of Jars	Flag	Comment
9999009	P	2		

STATION		A		B		C		D		E		F		G		H		I		J	
SUBSTRATE	COLL.	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll	Sub	Coll
Rocky/Cobble/ Woody debris	Boat	○ R	○ B	○ R	○ B	○ R	○ B	○ R	○ B	○ R	○ B	○ R	● B	● R	○ B	● R	○ B	○ R	○ B	○ R	○ B
Macrophyte beds	Wading	○ M	● W	○ M	● W	● M	● W	○ M	● W	○ M	○ W	○ M	○ W	○ M	● W	○ M	● W	○ M	● W	○ M	● W
Organic/Fine muds		● F		● F		○ F		○ F		○ F		● F		○ F		○ F		○ F		● F	
Leaf pack		○ L		○ L		○ L		● L		○ L		○ L		○ L		○ L		○ L		○ L	
Other: Note in Comments		○ O		○ O		○ O		○ O		○ O	K	○ O	F1	○ O		○ O		● O	F2	○ O	
FLAG																					

* Sample Types: P = Primary; D = Field duplicate

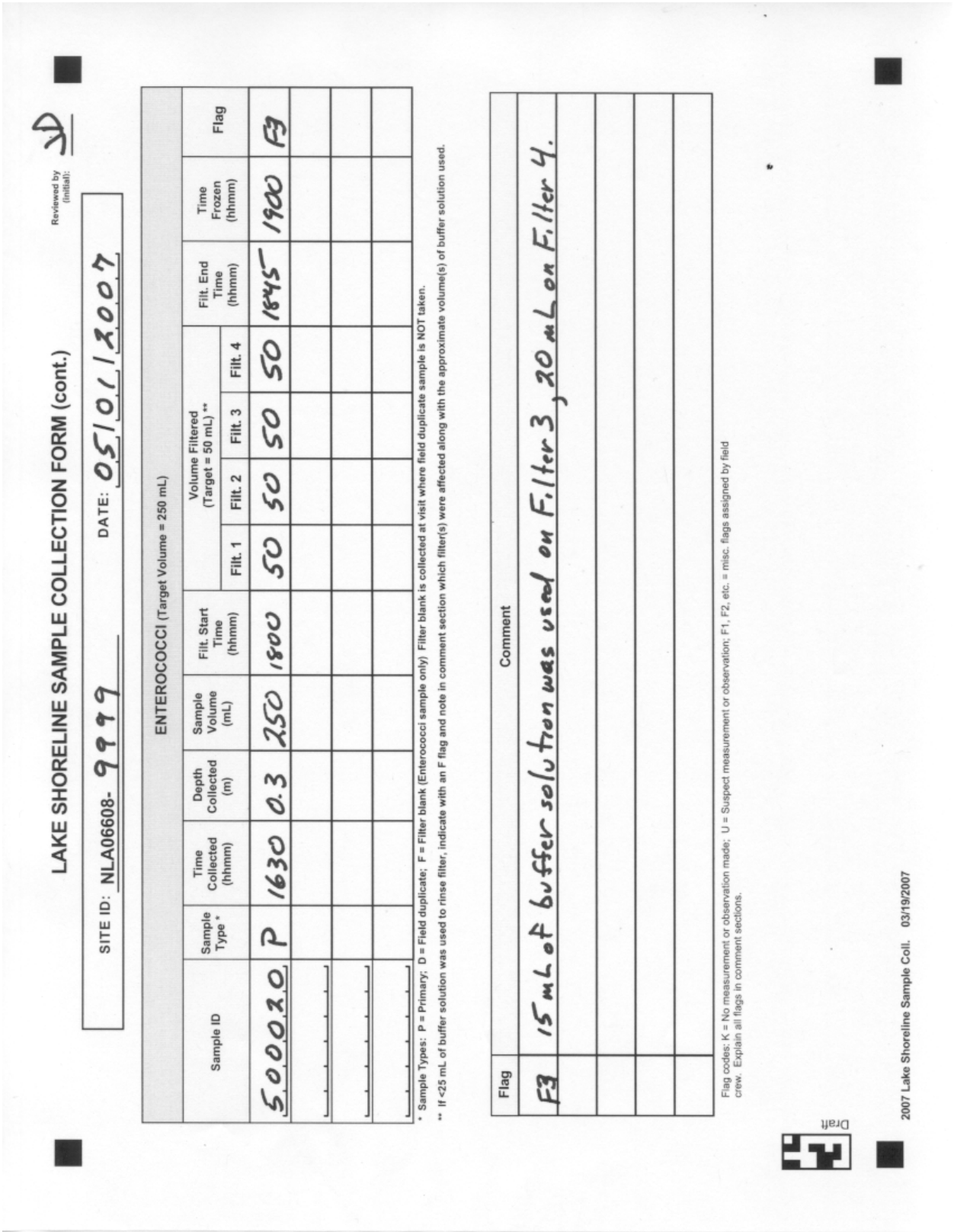
Flag	Comment
K	TOO DEEP (>3m) TO COLLECT SAMPLE
F1	UNSAFE TO WADE (DEEP MUCK)
F2	OTHER = INUNDATED GRASS AND HERBACEOUS TERRESTRIAL VEGETATION

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

Draft

2007 Lake Shoreline Sample Coll. 03/19/2007

Figure 5-5a. Lake Shoreline Sample Collection Form, Side 1.



LAKE SHORELINE SAMPLE COLLECTION FORM (cont.)

SITE ID: NLA06608- 9999 DATE: 05/01/2007

Reviewed by (initial): JD

ENTEROCOCCI (Target Volume = 250 mL)

Sample ID	Sample Type *	Time Collected (hhmm)	Depth Collected (m)	Sample Volume (mL)	Filt. Start Time (hhmm)	Volume Filtered (Target = 50 mL) **				Filt. End Time (hhmm)	Time Frozen (hhmm)	Flag
						Filt. 1	Filt. 2	Filt. 3	Filt. 4			
500020	P	1630	0.3	250	1800	50	50	50	50	1845	1900	F3

* Sample Types: P = Primary; D = Field duplicate; F = Filter blank (Enterococci sample only) Filter blank is collected at visit where field duplicate sample is NOT taken.

** If <25 mL of buffer solution was used to rinse filter, indicate with an F flag and note in comment section which filter(s) were affected along with the approximate volume(s) of buffer solution used.

Flag	Comment
F3	15 mL of buffer solution was used on Filter 3, 20 mL on Filter 4.

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

Draft

2007 Lake Shoreline Sample Coll. 03/19/2007

Figure 5-5b. Lake Shoreline Sample Collection Form, Side 2.

Table 5-8. Procedure for preparing composite samples for benthic macroinvertebrates

1. Pour the entire contents of the bucket through a sieve (or into a sieve bucket) with 500 µm mesh size. Remove any large objects and wash off any clinging organisms back into the sieve before discarding.

2. Using a wash bottle filled with lake water, rinse all the organisms from the bucket into the sieve. This is the composite sample for the lake.

3. Estimate the total volume of the sample in the sieve and determine how large a jar will be needed for the sample (500-mL or 1-L) and how many jars will be required.

4. Fill in a sample label with the Lake ID and date of collection. Attach the completed label to the jar and cover it with a strip of clear tape. Record the sample ID number for the composite sample on the Sample Collection Form. For each composite sample, make sure the number on the form matches the number on the label.

5. Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little water from the wash bottle as possible. Use a large-bore funnel if necessary. If the jar is too full pour off some water through the sieve until the jar is not more than ½ full, or use a second jar if a larger one is not available. Carefully examine the sieve for any remaining organisms and use watchmakers' forceps to place them into the sample jar.

   - If a second jar is needed, fill in a sample label that does not have a pre-printed ID number on it. Record the ID number from the pre-printed label prepared in Step 4 in the "SAMPLE ID" field of the label. Attach the label to the second jar and cover it with a strip of clear tape. Record the number of jars required for the sample on the Sample Collection Form. **Make sure the number you record matches the actual number of jars used.** Write "Jar *N* of *X*" on each sample label using a waterproof marker ("*N*" is the individual jar number, and "*X*" is the total number of jars for the sample).

6. Place a waterproof label inside each jar with the following information written with a number 2 lead pencil:

   - Lake ID
   - Type of sampler and mesh size used
   - Name of lake
   - Date of collection
   - Collectors initials
   - Number of stations sampled
   - Jar N of X

7. Completely fill the jar with 95% ethanol (no headspace). It is very important that sufficient ethanol be used, or the organisms will not be properly preserved. Existing water in the jar should not dilute the concentration of ethanol below 70%.

   - NOTE: Prepared composite samples can be transported back to the vehicle before adding ethanol if necessary. In this case, fill the jar with lake water, which is then drained using the net (or sieve) across the opening to prevent loss of organisms, and replaced with ethanol at the vehicle.

8. Replace the cap on each jar. Slowly tip the jar to a horizontal position, then gently rotate the jar to mix the preservative. Do not invert or shake the jar. After mixing, seal each jar with plastic tape.

Store labeled composite samples in a container with absorbent material that is suitable for use with 70% ethanol until transport or shipment to the laboratory.

5.3 Fecal Indicator (Enterococci)

5.3.1 Summary of Method

Field teams are to collect a water sample within the littoral zone of the final habitat station (station J) where the water is about waist deep (1 meter). Teams are to use a pre-sterilized, 250 ml bottle and collect the sample at about 0.3 meter (12 inches) below the water. Following collection, samples are placed in coolers and maintained on ice prior to filtration of four 50 mL volumes. Samples must be filtered within 8 hours of collection. For "large lakes" (greater than 5,000 ha) the sample is to be collected from the launch site at the end of the day.

5.3.2 Equipment and Supplies

Table 5-9 provides the equipment and supplies needed for field operations to collect the fecal indicator sample. The Lake Shoreline Sample Collection Form (Figure 5-5b) is used to record and document the fecal indicator sample.

Table 5-9. Equipment and supplies list for fecal indicator sampling

Item	Quantity
Fecal Indicator	
surgical gloves (non-powdered)	
pre-sterilized, 250 ml sample bottle	1
sodium thiosulfate tablet	1
Lake Shoreline Sample Collection Form	1
Fecal Indicator sample labels	4 vial labels and 1 bag label
Wet ice	
cooler	1

5.3.3 Sampling Procedure

Table 5-10. Procedure for Fecal Indicator (Enterococci) sample collection.

Collect the Enterococci Sample

1. Put on surgical gloves (non-powdered).
2. Approach 1 m deep sampling location slowly from downstream or downwind.
3. Lower the un-capped, inverted 250 ml sample bottle to a depth of 0.3 meter below the water surface, avoiding surface scum, vegetation, and substrates. Point the mouth of the container away from the body or boat. Right the bottle and raise it through the water column, allowing bottle to fill completely.
4. After removing the container from the water, discard a small portion of the sample to allow for proper mixing before analyses.
5. Add the sodium thiosulfate tablet, cap, and shake bottle 25 times.
6. Store the sample in a cooler on ice to chill (not freeze). Chill for at least 15 minutes and do not hold samples longer than 8 hours before filtration and freezing.

6.0 FINAL LAKE ACTIVITIES

Prior to leaving the lake, the field team makes a general visual assessment of the lake and its surrounding catchment and makes a final check of the data forms and samples. The objective of the lake assessment is to record field team observations of catchment and lake characteristics that are useful for future data interpretation, ecological value assessment, development of associations, and verification of stressor data. The observations and impressions of field teams are extremely valuable. The purpose of the second check of data forms and samples is to assure completeness of all sampling activities. Activities described in this section are summarized in Figure 6-1.

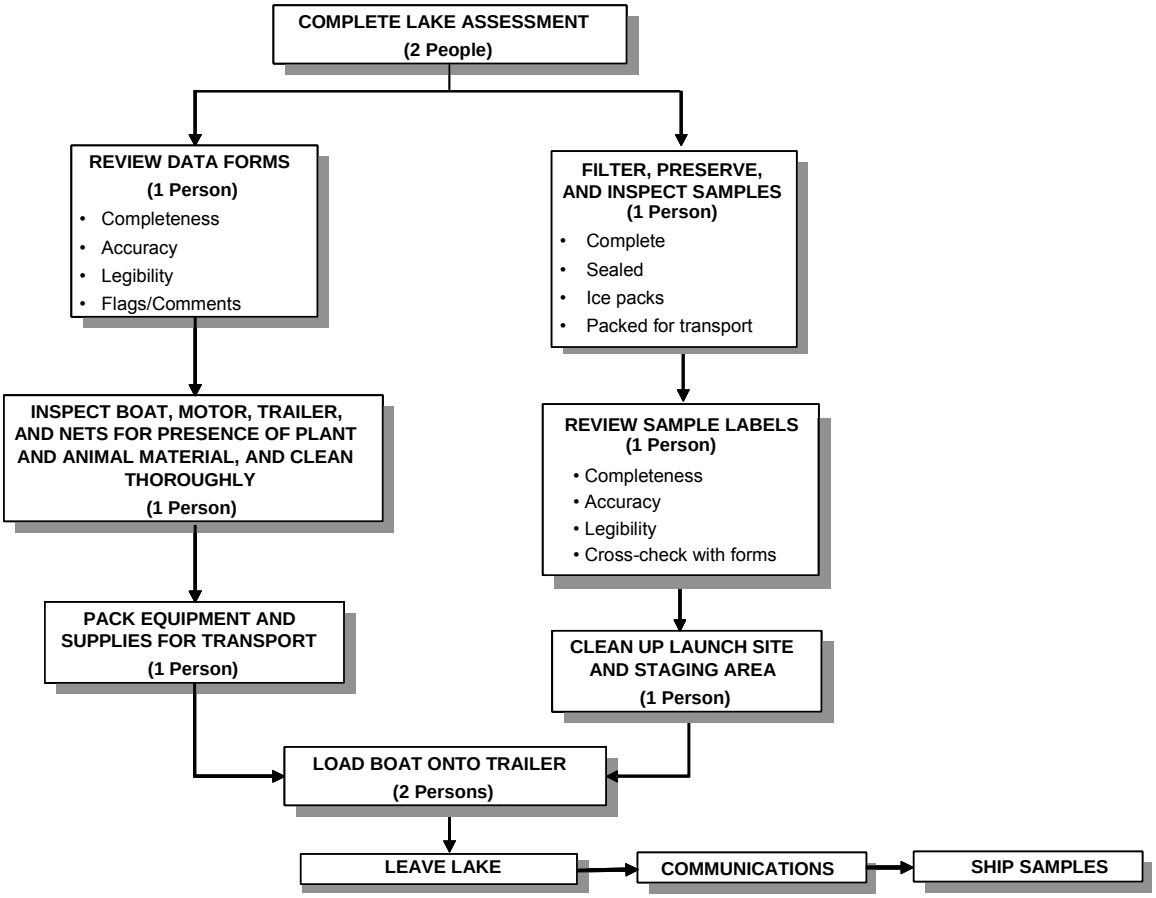


Figure 6-1. Final lake activities summary.

6.1 General Lake Assessment

The team members complete the Lake Assessment Form (Figures 6-2a and b) at the end of lake sampling, recording all observations from the lake that were noted during the course of the visit. This Lake Assessment Form is designed as a template for recording pertinent field observations. It is by no means comprehensive, and any additional observations should be recorded in the comments section. The form consists of five major sections: 1)

Lake/Catchment Site Activities and Disturbances Observed, 2) General Lake Information, 3) Shoreline Characteristics, 4) Qualitative Macrophyte Survey, and 5) Qualitative Assessment of Environmental Values.

6.1.1 Lake/Catchment Site Activities and Disturbances Observed

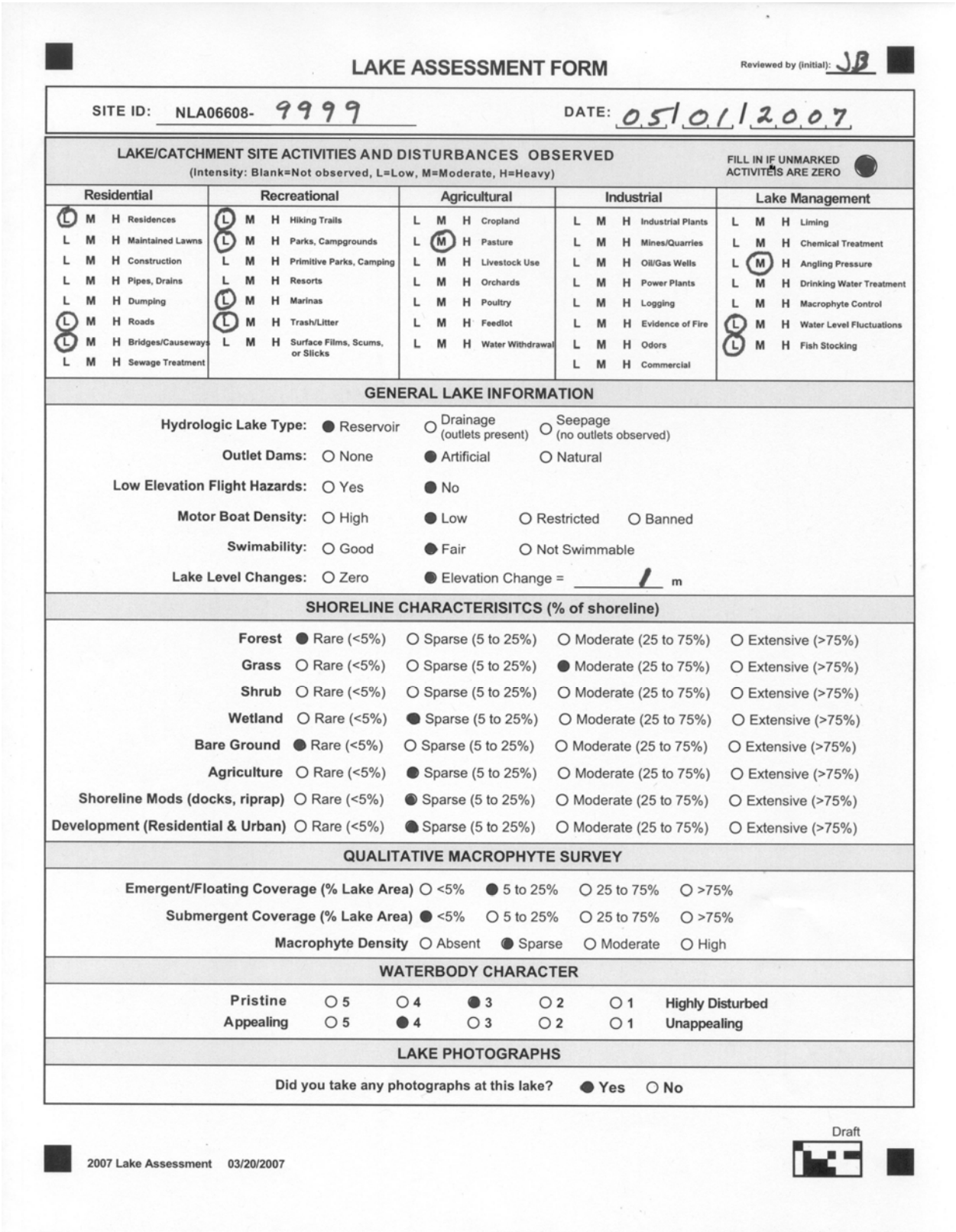
Record any of the sources of potential stressors listed in Table 6-1 on the Lake Assessment Form, Side 1 (Figure 6-2a), that were observed while on the lake, while driving or walking through the lake catchment, or while flying over the lake and catchment. For activities and stressors that you observe, 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.

6.1.2 General Lake Information

Observations regarding the general characteristics of the lake are described in Table 6-2, and are recorded on Side 1 of the Lake Assessment Form (Figure 6-2a). The hydrologic lake type is a very important variable for defining subpopulations for acidic deposition effects. Note any flight hazards that might interfere with either low-altitude fly-overs by aircraft (for future aerial photography or videography) or landing on the lake for sampling purposes (either by float plane or helicopter). When estimating the intensity of motor boat usage, in addition to the actual number of boats observed on the lake during the visit, use other observations such as the presence of boat houses, docks, and idle craft.

6.1.3 Shoreline Characteristics

Shoreline characteristics of interest during the final lake assessment are described in Table 6-3. Observations related to this portion of the assessment are recorded on the Lake Assessment Form, Side 1 (Figure 6-2a). To estimate the extent of major vegetation types, limit the assessment to the immediate lake shoreline (i.e., within 20 m of the water). Also estimate the percentage of the immediate shoreline that has been developed or modified by humans.



LAKE ASSESSMENT FORM

Reviewed by (initial): JB

SITE ID: NLA06608- 9999 DATE: 05/01/2007

LAKE/CATCHMENT SITE ACTIVITIES AND DISTURBANCES OBSERVED

(Intensity: Blank=Not observed, L=Low, M=Moderate, H=Heavy)

FILL IN IF UNMARKED ACTIVITIES ARE ZERO ●

Residential	Recreational	Agricultural	Industrial	Lake Management
(L) M H Residences	(L) M H Hiking Trails	L M H Cropland	L M H Industrial Plants	L M H Liming
L M H Maintained Lawns	(L) M H Parks, Campgrounds	L (M) H Pasture	L M H Mines/Quarries	L M H Chemical Treatment
L M H Construction	L M H Primitive Parks, Camping	L M H Livestock Use	L M H Oil/Gas Wells	L (M) H Angling Pressure
L M H Pipes, Drains	L M H Resorts	L M H Orchards	L M H Power Plants	L M H Drinking Water Treatment
L M H Dumping	(L) M H Marinas	L M H Poultry	L M H Logging	L M H Macrophyte Control
(L) M H Roads	(L) M H Trash/Litter	L M H Feedlot	L M H Evidence of Fire	(L) M H Water Level Fluctuations
(L) M H Bridges/Causeways	L M H Surface Films, Scums, or Slicks	L M H Water Withdrawal	L M H Odors	(L) M H Fish Stocking
L M H Sewage Treatment			L M H Commercial	

GENERAL LAKE INFORMATION

Hydrologic Lake Type: ● Reservoir ○ Drainage (outlets present) ○ Seepage (no outlets observed)

Outlet Dams: ○ None ● Artificial ○ Natural

Low Elevation Flight Hazards: ○ Yes ● No

Motor Boat Density: ○ High ● Low ○ Restricted ○ Banned

Swimability: ○ Good ● Fair ○ Not Swimmable

Lake Level Changes: ○ Zero ● Elevation Change = 1 m

SHORELINE CHARACTERISITCS (% of shoreline)

Forest	● Rare (<5%)	○ Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Grass	○ Rare (<5%)	○ Sparse (5 to 25%)	● Moderate (25 to 75%)	○ Extensive (>75%)
Shrub	○ Rare (<5%)	○ Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Wetland	○ Rare (<5%)	● Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Bare Ground	● Rare (<5%)	○ Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Agriculture	○ Rare (<5%)	● Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Shoreline Mods (docks, riprap)	○ Rare (<5%)	● Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)
Development (Residential & Urban)	○ Rare (<5%)	● Sparse (5 to 25%)	○ Moderate (25 to 75%)	○ Extensive (>75%)

QUALITATIVE MACROPHYTE SURVEY

Emergent/Floating Coverage (% Lake Area) ○ <5% ● 5 to 25% ○ 25 to 75% ○ >75%

Submergent Coverage (% Lake Area) ● <5% ○ 5 to 25% ○ 25 to 75% ○ >75%

Macrophyte Density ○ Absent ● Sparse ○ Moderate ○ High

WATERBODY CHARACTER

Pristine	○ 5	○ 4	● 3	○ 2	○ 1	**Highly Disturbed**
Appealing	○ 5	● 4	○ 3	○ 2	○ 1	**Unappealing**

LAKE PHOTOGRAPHS

Did you take any photographs at this lake? ● **Yes** ○ **No**

Draft

2007 Lake Assessment 03/20/2007

Figure 6-2(a). Lake Assessment Form, Side 1.

LAKE ASSESSMENT FORM (cont.)

Reviewed by (initial): JD

SITE ID: NLA06608- 9999 DATE: 05/01/2007

QUALITATIVE ASSESSMENT OF ENVIRONMENTAL VALUES

Ecological Integrity:	○ Excellent ○ Good ● Fair ○ Poor
General Assessment:	NOT MUCH WILDLIFE OBSERVED. FISH STOCKING OCCURS (INTRODUCED WARMWATER SPECIES) EVERY FEW YEARS. NUTRIENTS FROM RUNOFF COULD BE HIGH AT TIMES.
Wildlife Observed:	SMALL SONGBIRDS, GREAT BLUE HERON, CROWS, BOAT-TAILED GRACKLES
Trophic State:	○ Oligotrophic ○ Mesotrophic ● Eutrophic ○ Hypereutrophic
Visual Assessment:	MODERATE BIOMASS, PRIMARILY ALGAE / PHYTOPLANKTON
Algal Abundance & Type:	MODERATE ABUNDANCE BASED ON CHLOROPHYLL FILTER. GREEN ALGAE.
Nutrient Sources:	LAKESIDE RESIDENCES, PARKS, MARINAS, PASTURE LAND
Other:	
Recreational Value:	○ Excellent ● Good ○ Fair ○ Poor
Conditions and Local Contacts:	DID NOT TALK TO ANYONE DURING VISIT. LAKE OFFERS A VARIETY OF RECREATIONAL OPPORTUNITIES ACCORDING TO WEBSITE (WWW.SUZANNESLAKE.COM)
Observations (e.g. accessibility, boating, fishing, swimming, health concerns):	EASILY ACCESSIBLE, LOW TO MODERATE BOATING, FISHING, SEVERAL BEACH AREAS FOR SWIMMING. NO APPARENT HEALTH CONCERNS AT TIME OF VISIT.

Comments: SAMPLING VISIT WAS IN MID-SPRING. POTENTIAL EXISTS FOR DETERIORATING CONDITION LATER IN SUMMER IF PRECIPITATION IS LOW AND INTENSITY OF USE OF PARKS, CAMPGROUNDS, AND MARINAS INCREASES. FISHERY DOMINATED BY NON-NATIVE SPECIES.

Draft

2007 Lake Assessment 03/20/2007

Figure 6-2(b). Lake Assessment Form, Side 2.

Table 6-1. Lake site activities and disturbances.

Observe lake activities or disturbances listed and record as L (low), M (moderate), or H (heavy) intensity on Side 1 of the Lake 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. If known, write down what type of activity the pipe is associated with (e.g., storm sewer, plant intake) in the "Comments" section on Side 2.
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. If informal dumping areas exist, note that they are informal sites in the "Comments" section on Side 2.
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	Presence of any marinas.
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.
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. Describe the type of industry in the "Comments" section on Side 2.
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.

Table 6-1. Lake site activities and disturbances.

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.
Fish Stocking	Any evidence of fish stocking in the lake.
Record any other oddities observed or additional information for any specific activity in the "Comments" section on Side 2.	

Table 6-2. General lake information noted during lake assessment.

Hydrologic Lake Type	Note if there are any stream outlets from the lake, even if they are not flowing. If no lake outlets were observed, record the lake as a seepage lake. If the lake was created by a man-made dam (not that a dam is present just to raise the water level), record the lake as a reservoir. Otherwise record the lake as a drainage lake.
Outlet Dams	Note the presence of any dams (or other flow control structures) on the lake outlet(s). Differentiate between artificial (manmade) structures and natural structures (beaver dams).
Low Elevation Flight Hazards	If there are any hazards (above tree level) that would interfere with low elevation aircraft flights or landing on the lake, check "Yes"; otherwise check "No." Examples include radio towers or power lines.
Motor Boat Density	Record your impression of the density of motor boat usage on this lake (high or low). If there is a restriction on the size of motor boat engines, check "Restricted." If motor boats are banned, check "Banned." Consider the day of the week and weather in your assessment as well as the number of boathouses, idle craft. Count jet skis and any other motorized craft, which could stir up the lake, as motor boats.
Swimmability	Record a subjective impression about the aesthetics of swimming in this lake (swimmability) along the range of "good" to "not swimmable."
Lake Level Changes	Examine the lake shoreline for evidence of lake level changes (e.g., bathtub ring). If there are none, check "zero"; otherwise try to estimate the extent of vertical changes in lake level from the present conditions based on other shoreline signs.

Table 6-3. Shoreline characteristics observed during final lake assessment.

Check percent of shoreline characteristics:	
Forest	Deciduous, coniferous, or mixed forest, including sapling vegetation.
Grass	Meadows, lawns, or other open vegetation.
Shrub	Shrub vegetation
Wetland	Forested and non-forested wetlands (submerged terrestrial vegetation).
Bare Ground	Non-vegetated areas such as beaches, sandy areas, paved areas, and exposed rock.
Agriculture	Cropland, orchard, feedlot, pastureland, or other horticultural activity.
Shoreline Modifications	Actual shoreline that has been modified by the installation of riprap, revetments, piers, or other human modifications.
Development	Immediate shoreline area developed by human activity; include lawns, houses, stores, malls, marinas, golf courses, or any other human-built land use.

6.1.4 Qualitative Macrophyte Survey

Macrophytes (aquatic plants large enough to be seen without magnification) are important indicators of lake trophic status. The most important indicator for this survey is the percentage of the lake area covered with macrophytes, as perceived by observers. For both "emergent/floating" and "submergent" coverage, choose one of the four percentage groupings (0-25%, 25-50%, 50-75%, 75-100%), on Side 1 of the Lake Assessment Form (Figure 6-2a). In some cases, it will be fairly easy to estimate the percentage from observations made during sampling. In other cases, it will be an educated guess, especially if the water is turbid. After recording the areal percentage of macrophyte coverage, record the density of the plants in the observed macrophyte beds as absent, sparse, moderate, or high. All activities described in this subsection are recorded on Side 1 of the Lake Assessment Form (Figure 6-2a).

6.1.5 Waterbody Character

Rate the ***waterbody character*** which is the physical habitat integrity of the water body and is largely a function of riparian and littoral habitat structure, volume change, trash, turbidity, slicks, scums, color, and odor. The Lakes Survey attempts to define water body character through two attributes: **degree of human development** and **aesthetics**. Rate each of these attributes on a scale of 1 to 5. For development, give the lake a "5" if it is pristine, with no signs of any human development. A "1" would indicate a lake is totally developed; for example, the entire lake is ringed with houses, seawalls, docks, etc. For aesthetics (whether the lake is appealing or not) base the decision on any factors about the lake that disturb you (trash, algal growth, weed abundance, overcrowding). Circle the number that best describes your opinion about how suitable the lake water is for recreation and aesthetic enjoyment today:

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.

6.1.6 Qualitative Assessment of Environmental Values

The primary goal of this study is to assess three major ecological values with respect to lakes: trophic state, ecological integrity, and recreation. Based on your field experience, record your own assessment of these values on the Lake Assessment Form, Side 2 (Figure 6-2b). Write comments on these values in this section.

- ***Ecological integrity*** is the ability to support and maintain a balanced, integrated, adaptive community with a biological diversity, composition, and functional organization comparable to natural lakes of the region. Record your overall impression of the "health" of the biota in the lake. Note any possible causes of impairment. The presence of higher order consumers (fish-eating birds and mammals) is an indication of a healthy food web and should be noted here. Similarly, the absence of an organism that you might expect to see is an important observation.

- ***Trophic state*** is the rate or amount of phytoplankton and macrophytes produced or present in a lake. Give your visual impression of the trophic status as oligotrophic (little or no biomass in the lake water), mesotrophic (intermediate amounts of biomass in the lake water), eutrophic (large amounts of biomass in the lake water), or hypereutrophic (choked lake, with more biomass than water). Give your overall impression of algal abundance and general type (e.g., filamentous). List any observed potential nutrient sources to the lake (e.g., septic tanks and agricultural runoff).

- Suitability for ***Recreation*** is the ability to support recreational uses such as swimming, fishing, and boating. Record your overall impression of the lake as a site for recreation. Note any possible causes of impairment. Note the presence or absence of people using the lake for recreational activities.

Use the comments section on the Lake Assessment Form, Side 2 (Figure 6-2b) to note any other pertinent information about the lake or its catchment. Here the field team can record any observations that may be useful for future data interpretation.

6.2 Processing the Fecal Indicator and Chlorophyll-a Samples

6.2.1 Equipment and Supplies (Fecal Indicator)

Table 6-4 provides the equipment and supplies needed to process the Fecal Indicator sample.

Table 6-4. Equipment and supplies list for fecal indicator processing

Item	Quantity
Fecal Indicator	
surgical gloves (non-powdered)	
sterile screw-cap 50-mL PP tube	1
Sterile filter holder, Nalgene 145/147	1
Osmotics 47 mm polycarbonate sterile filters	1 package
Sterile disposable forceps	1
Sterile microcentrifuge tubes containing sterile glass beads	3

Table 6-4. Equipment and supplies list for fecal indicator processing

Fecal Indicator sample labels	4 vial labels and 1 bag label
Dry ice	
cooler	1

6.2.2 Procedures for Processing the Fecal Indicator Sample

The procedures for processing the Fecal Indicator Sample are presented in Table 6-5.

Table 6-5. Processing procedure – fecal indicator sample.

1. Put on surgical gloves (non-powdered).
2. Set up sample filtration apparatus on flat surface and attach hand pump. Set-out 50-mL sterile PP tube, sterile 60-mm Petri dish, 2 bottles of chilled phosphate buffered saline (PBS), Polycarbonate (PC) filter box and 2 filter forceps.
3. Chill Filter Extraction tubes with beads on dry ice.
4. Aseptically transfer 4 PC filters from filter box to base of opened Petri dish. Close filter box and set aside.
5. Remove cellulose nitrate (CN) filter from funnel and discard.
6. Load filtration funnel with sterile PC filter on support pad (shiny side up).
7. Shake sample bottle(s) 25 times to mix well.
8. Measure 25-mL of the mixed water sample in the sterile graduated PP tube and pour into filter funnel.
9. Replace cover on filter funnel and pump to generate a vacuum. Keep pumping until all liquid is in filtrate collection flask.
10. If the first 25 mL volume passes readily through the filter, add another 25 mL and continue filtration. If the filter clogs before completely filtering the first or second 25 mL volume, discard the filter and repeat the filtration using a lesser volume.
11. Pour a quarter (approx. 25-mL) of the chilled phosphate buffered saline (PBS) into the graduated PP tube used for the sample. Cap the tube and shake 5 times. Remove the cap and pour rinsate into filter funnel to rinse filter.
12. Filter the rinsate and repeat with another 25 mL of phosphate buffered saline (PBS).
13. Remove filter funnel from base without disturbing filter. Using sterile disposable forceps remove the filter (touching only the filter edges) and fold it in half, in quarters, in eighths, and then in sixteenths (filter will be folded 4 times).
14. Insert filter into chilled filter extraction tube (with beads). Replace and tighten the screw cap, insert tube(s) into ziplock bag on dry ice for preservation during transport and shipping.
15. Record the volume of water sample filtered through each filter and the volume of buffer rinsate each filter was rinsed with on the Enterococci Filtration / Sample Processing Form. Record the filtration start time and finish time for each sample.
16. Repeat steps 6 to 15 for the remaining three 50-mL sub-sample volumes to be filtered.

6.2.3 Equipment and Supplies (Chlorophyll-a)

Table 6-6 provides the equipment and supplies needed to process the Chlorophyll-a sample.

Table 6-6. Equipment and supplies list for Chlorophyll-a processing

For filtering chlorophyll-*a* sample	• Whatman GF/F or equivalent 0.7 µm glass fiber filter • Filtration apparatus with graduated filter holder • Hand pump • 50-mL steam-top centrifuge tube • DI water • Sample Collection Form • Sample labels • Pencils and permanent markers • Surgical gloves • Forceps

6.2.4 Procedures for Processing the Chlorophyll-*a* Sample

The procedures for processing chlorophyll-*a* samples are presented in Table 6-7. Whenever possible, sample processing should be done in subdued light, out of direct sunlight.

Table 6-7. Processing procedure - chlorophyll-a sample.

1. Put on surgical gloves.
2. Place a glass fiber filter (Whatman GF/F or equivalent 0.7 µm filter) in the graduated filter holder apparatus. Do not handle the filter with bare hands; use clean forceps.
3. Pour 250 mL of water into the filter holder, replace the cap, and pump the sample through the filter. If 250 mL of lake water will not pass through the filter, change the filter, rinse the apparatus with DI water, and repeat the procedures using 100-mL of lake water. *NOTE: IF the water is green or turbid, use a smaller volume to start with.*
4. Rinse the upper portion of the filtration apparatus thoroughly with DI water to include any remaining cells adhering to the sides and pump through the filter. Monitor the level of water in the lower chamber to ensure that it does not contact the filter or flow into the pump.
5. Observe the filter for visible color. If there is visible color, proceed; if not, repeat steps 3 & 4 until color is visible on the filter or until a maximum of 2,000 mL have been filtered. Record the actual sample volume filtered on the Sample Collection Form and on the sample label.
6. Remove the bottom portion of the apparatus and pour off the water from the bottom.
7. Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored side folded in on itself.
8. Place the folded filter into a 50-mL steam-top centrifuge tube and cap. Record the sample volume filtered on a chlorophyll label and attach it to the centrifuge tube (do not cover the volume markings on the tube). Ensure that all written information is complete and legible. Cover with a strip of clear tape. Double check that the "total volume of water filtered" on the Sample Collection Form matches the total volume recorded on the sample label. Wrap the tube in aluminum foil and place in a self-sealing plastic bag. Place this bag between two small bags of ice in a cooler.
9. Rinse filter chambers with de-ionized (DI) water.

6.3 Data Forms and Sample Inspection

After the Lake Assessment Form is completed, the Field Team Leader reviews all of the data forms and sample labels for accuracy, completeness, and legibility. The other team

member inspects all sample containers and packages them in preparation for transport, storage, or shipment.

Ensure that all required data forms for the lake have been completed. Confirm that the LAKE-ID and date of visit are correct on all forms. On each form, verify that all information has been recorded accurately, the recorded information is legible, and any flags are explained in the comments section. Ensure that written comments are legible, with no "shorthand" or abbreviations. After reviewing each form initial the lower right corner of each page of the form.

Ensure that all samples are labeled, all labels are completely filled in, and each label is covered with clear plastic tape. Make sure that all sample containers are properly sealed.

6.4 Launch Site Cleanup

Load the boat on the trailer and inspect the boat, motor, and trailer for evidence of weeds and other macrophytes. Clean the boat, motor, and trailer as completely as possible before leaving the launch site. Inspect all nets for pieces of macrophyte or other organisms and remove as much as possible before packing the nets for transport. Pack all equipment and supplies in the vehicle and trailer for transport; keep them organized as presented in the equipment checklists (Appendix A). Lastly, be sure to clean up all waste material at the launch site and dispose of or transport it out of the site if a trash can is not available.

7.0 FIELD QUALITY CONTROL

Standardized training and data forms provide the foundation to help assure that data quality standards for field sampling are met. These Standard Operating Procedures for field sampling and data collection are the primary guidelines for all cooperators and field teams. In addition, repeat sampling and field evaluation and assistance visits will address specific aspects of the data quality standards for the Survey of the Nation's Lakes.

7.1 Repeat Sampling

A total of 10% of the target sites visited will be revisited during the same field season by the same field team that initially sampled the lake. The repeat sample sites were selected by taking the first 91 lakes (10% of the lakes) from the entire draw of lakes for the survey. A list of repeat sites will be provided to each State by the EPA Regional Lakes Coordinator. Because of the selection process, some states may have a large number of repeat sample sites, while other states may not have any. If a site selected for repeat sampling is dropped, then the alternate assigned to replace it should be revisited. The primary purpose of this "revisit" set of sites is to provide variance estimates that can be used to evaluate the survey design for its potential to estimate status and detect trends in the target population of lakes. The revisit will include the full set of indicators and associated parameters. The time period between the initial and repeat visit to a lake should be as long as possible.

7.2 Field Evaluation and Assistance Visits

A rigorous program of field and laboratory evaluation and assistance visits has been developed to support the Survey of the Nation's Lakes Program. These evaluation and assistance visits are explained in detail in the Quality Assurance Project Plan (QAPP) for the Lakes Survey. The following sections will focus only on the field evaluation and assistance visits.

These visits provide a QA/QC check for the uniform evaluation of the data collection methods, and an opportunity to conduct procedural reviews as required to minimize data loss due to improper technique or interpretation of field procedures and guidance. Through uniform training of field teams and review cycles conducted early in the data collection process, sampling variability associated with specific implementation or interpretation of the protocols will be significantly reduced. The field evaluations will be based on the evaluation plan and checklists. This evaluation will be conducted for each unique team collecting and contributing data under this program (EPA will make a concerted effort to evaluate every team, but will rely on the data review and validation process to identify unacceptable data that will not be included in the final database).

7.2.1 Specifications for QC Assurance

Field evaluation and assistance personnel are trained in the specific data collection methods detailed in this Lakes Survey Field Operations Manual. A plan and checklist for field evaluation and assistance visits have been developed to detail the methods and procedures. The plan and checklist are included in the QAPP. Table 7-1 summarizes the plan, the checklist, and corrective action procedures.

Table 7-1. General lake information noted during field evaluation.

Field Evaluation Plan	• Regional Lake Coordinators will arrange the field evaluation visit with each Field Team, ideally within the first two weeks of sampling. • The Evaluator will observe the performance of a team through one complete set of sampling activities. • If the Team misses or incorrectly performs a procedure, the Evaluator will note this on the checklist and immediately point this out so the mistake can be corrected on the spot. • The Evaluator will review the results of the evaluation with the Field Team before leaving the site, noting positive practices and problems.
Field Evaluation Checklist	• The Evaluator observes all pre-sampling activities and verifies that equipment is properly calibrated and in good working order, and Lakes Survey protocols are followed. • The Evaluator checks the sample containers to verify that they are the correct type and size, and checks the labels to be sure they are correctly and completely filled out. • The Evaluator confirms that the Field Team has followed Lakes Survey protocols for locating the lake and determining the index site on the lake. • The Evaluator observes the index site sampling, confirming that all protocols are followed. • The Evaluator observes the littoral sampling and habitat characterization, confirming that all protocols are followed. • The Evaluator will record responses or concerns, if any, on the Field Evaluation and Assistance Check List.
Corrective Action Procedures	• If the Evaluator's findings indicate that the Field Team is not performing the procedures correctly, safely, or thoroughly, the Evaluator must continue working with this Field Team until certain of the Team's ability to conduct the sampling properly so that data quality is not adversely affected. • If the Evaluator finds major deficiencies in the Field Team operations the Evaluator must contact a Lakes Survey QA official.

It is anticipated that evaluation and assistance visits will be conducted with each Field Team early in the sampling and data collection process, and that corrective actions will be conducted in real time. If the Field Team misses or incorrectly performs a procedure, the Evaluator will note this on the checklist and immediately point this out so the mistake can be corrected on the spot. The role of the Evaluator is to provide additional training and guidance so that the procedures are being performed consistent with the Field Operations Manual, all data are recorded correctly, and paperwork is properly completed at the site.

7.2.2 Reporting

When the sampling operation has been completed, the Evaluator will review the results of the evaluation with the Field Team before leaving the site (if practicable), noting positive practices and problems (i.e., weaknesses [might affect data quality] or deficiencies [would adversely affect data quality]). The Evaluator will ensure that the Team understands the findings and will be able to perform the procedures properly in the future. The Evaluator will record responses or concerns, if any, on the Field Evaluation and Assistance Check List. After

the Evaluator completes the Field Evaluation and Assistance Check List, including a brief summary of findings, all Field Team members must read and sign off on the evaluation.

If the Evaluator's findings indicate that the Field Team is not performing the procedures correctly, safely, or thoroughly, the Evaluator must continue working with this Field Team until certain of the Team's ability to conduct the sampling properly so that data quality is not adversely affected. If the Evaluator finds major deficiencies in the Field Team operations (e.g., less than three members, equipment or performance problems) the Evaluator must contact the following QA official:

- Mr. Otto Gutenson, EPA Lakes Survey Project QA Officer (202-566-1183)

The QA official will contact the Project Manager or Project Technical Advisor to determine the appropriate course of action. Data records from sampling sites previously visited by this Field Team will be checked to determine whether any sampling sites must be redone.

8.0 LITERATURE CITED

American Red Cross. 1979. *Standard First Aid and Personal Safety*. American National Red Cross. 269 pp.

Baker, J.R., D.V. Peck, and D.W. Sutton (Eds.) 1997. Environmental Monitoring and Assessment Program -Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington, D.C.

Carmichael, W. W. 1997. The cyanotoxins. Advances in Botanical Research 27:211-240.

Jones, G.J., and W. Korth. 1995. In situ production of volatile odour compounds by river and reservoir phytoplankton populations in Australia. *Water Science and Technology* 31:145-151.

Kamman, N. 2005 [Draft]. Development of Biocriteria for Vermont and New Hampshire Lakes Criteria Development for Phytoplankton and Macroinvertebrate Assemblages for Three Lake Classes. Vermont Department of Environmental Conservation. Waterbury, VT.

Klemm, D. J., P. A. Lewis, F. Fulk, and J. M. Lazorchak. 1990. *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*. EPA 600/4-90/030. U.S. Environmental Protection Agency, Cincinnati, Ohio.

Larsen, D. P., and S. J. Christie (editors). 1993. EMAP Surface Waters 1991 Pilot Report. EPA/620/R-93/003. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon.

Metcalf, R. C., and D. V. Peck. 1993. A dilute standard for pH, conductivity, and acid neutralizing capacity measurement. Journal of Freshwater Ecology 8:67-72.

National Institute for Occupational Safety and Health. 1981. *Occupational Health Guidelines for Chemical Hazards* (Two Volumes). NIOSH/OSHA Publication No. 81-123. U.S. Government Printing Office, Washington, D.C.

Ohio EPA. 1990. *Ohio EPA Fish Evaluation Group Safety Manual.* Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio.

Persson, P.E. 1980. On the odor of 2-methylisobornol. Water Research 32(7):2140-2146.

Ruttner, F. 1969. Fundamentals of Limnology. University of Toronto Press, Toronto, Ontario, Canada. 295 pp.

Schindler D.W. 1987. Detecting ecosystem responses to anthropogenic stress. Canadian Journal of Fisheries and Aquatic Sciences, 44, 6-25.

Schriver et al. 1995. Impact of Submerged Macrophytes on Fish-Zooplankton- Phytoplankton Interactions - Large-Scale Enclosure Experiments in a Shallow Eutrophic Lake. Freshwater Biology 33, no. 2: 255-70.

Stanley, T. W., and S. S. Verner. 1986. The U.S. Environmental Protections Agency's quality assurance program. Pp. 12-19 IN: J.K. Taylor and T.W. Stanley (eds.). Quality Assurance for Environmental Measurements. ASTM STP 867, American Society for Testing and Materials, Philadelphia, Pennsylvania.

U.S. Coast Guard. 1987. *Federal Requirements for Recreational Boats.* U.S. Department of Transportation, United States Coast Guard, Washington, D.C.

USEPA. 2000a. EPA Quality Manual for Environmental Programs 5360A1. May 2000. http://www.epa.gov/quality/qs-docs/5360.pdf

USEPA. 2000b. EPA Order 5360.1 A2 CHG2, Policy and Program Requirements for Mandatory Agency-wide Quality System, May 5, 2000. http://www.epa.gov/quality/qs-docs/5360-1.pdf

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

USEPA. 1986. *Occupational Health and Safety Manual.* Office of Planning and Management, U.S. Environmental Protection Agency, Washington, D.C.

APPENDIX A

LIST OF EQUIPMENT AND SUPPLIES

Equipment & Supply Lists

General Equipment
50 m sonde cable with length marked in 0.5 m intervals
Anchor with 50 m line
Barometer or elevation chart to use for calibration
Batteries
Bleach
Access instructions
1-L wash bottle with deionized water
Buoy for marking observation point
Calibration cups
Calibration standards
Calibration QC check solution
Clear tape strips
Clipboards
Contact info
Electrical tape
Extra batteries
Field forms
Field notebook
Field operations and methods manual
Filtration apparatus with graduated filter holder
Fine-tip indelible markers
Float to attach to anchor
GPS unit with manual and reference card
Maps
Hand-held sonar unit
Pencils (#2) and permanent markers
Permission letters
Plastic storage tub
Pocket-sized field notebook (optional)
PVC sounding rod, 3-m length, marked in 0.1 m increments
Quick reference field operations handbook
Rubber gloves
Sampling permit (if required)
Scissors
Screwdriver
Spare water quality meter (optional)
Surgical gloves (non-powdered)
Survey of the Nation's Lakes Fact Sheets
Surveyor's tape
Tape measure (cm)
Watchmakers' forceps
1-L wash bottle labeled "LAKE WATER"
Sample labels

Boat Equipment List
Motor
Gas Can
Lifejackets (1/person)
Type IV PFD (Throwable Life Saving device)
Bow/Stern lights
Anchor with 75m line or sufficient to anchor in 50m depth
Second anchor for windy conditions and Littoral sampling (w/50m line)
Sonar Unit
Oars or Paddles
First Aid Kit
Extra Boat Plug
Spare Prop Shear Pin
Emergency Tool kit
Hand Bilge pump
Fire Extinguisher
Boat horn

Sample/Data Collection
Modified KB corer
Modified kick net (D-frame with 500 µm mesh) and 4-ft handle
Core tubes
Screwdriver
rubber stoppers
Multi-parameter water quality meter with pH, temperature, and DO probes
Secchi disk and calibrated sounding line, marked in 0.5 m intervals
Integrated sampler device (MPCA design)
Spare net(s) and/or spare bucket assembly for end of net
Wisconsin net (243 µm mesh) and collection bucket
Wisconsin net (80 µm mesh) and collection bucket
Pre-washed 5-mL pipette tip
20 mL plastic (PET) scintillation vial in a Ziploc bag

Sample Processing/Preservation
95% ethanol
CO_2 tablets (or Alka-seltzer or club soda)
Narcotization chamber
Lugol's solution
Hand pump
Osmonics 47 mm polycarbonate sterile filters
Plexiglas sectioning apparatus
Siphon tube with a bent plastic tip
Sterile disposable forceps
Sterile filter holder, Nalgene 145/147
Funnel, with large bore spout (optional)
Buckets, plastic, 8- to 10-qt capacity
Sieve-bucket or soil sieve with 500 µm mesh openings (U.S. std No. 35)
Small spatula, spoon, or scoop to transfer sample
Whatman GF/F or equivalent 0.7 µm glass fiber filter

Sample Storage
125 mL sample bottles for zooplankton
50-mL steam-top centrifuge tube
500 mL sample bottle for algal toxins
1-L polypropylene bottles for phytoplankton
2-L polypropylene bottles for chlorophyll-*a*
4 L cubitainer
Plastic containers for sediment core slices
Sterile microcentrifuge tubes containing sterile glass beads
Aluminum foil
Electrical tape

Packaging/Shipping
Coolers
Cooler liners (30-gal garbage bags)
Dry ice
Wet ice
Self-sealing plastic bags
1-gallon self-sealing bags
Shipping tape
FedEx airbills
Class 9 Dangerous Goods label

A Site Kit will be provided to the field crews for each sampling site. Please call the Field Logistics Coordinator well in advance of field sampling to request the Site Kits.

Supplies provided in each Site Kit:

- Field Data Forms
- Sample Labels
- Pre-washed 5-mL pipette tip (Mercury sampling)
- 20 mL plastic (PET) scintillation vial in a Ziploc bag for mercury sample
- Osmonics 47 mm polycarbonate sterile filters
- 60 mL petri dish
- Sterile phosphate buffered saline (PBS) (2)
- Sterile 250 mL fecal indicator bottle
- Sterile disposable forceps (2)
- Sterile vacuum filter holder, Nalgene 145/147
- Whatman GF/F 0.7 µm glass fiber filter
- 125 mL sample bottles for zooplankton (2)
- 50 mL screw top centrifuge tube
- 500 mL sample bottle for algal toxins
- 1-L polypropylene bottle for phytoplankton
- 1-L benthos jars (2)
- 4-L cubitainer for water chemistry
- Plastic containers for sediment core slices (2)
- Sterile microcentrifuge tubes containing sterile glass beads (4)
- Foam envelope
- FedEx airbills for EPA Corvallis lab
- FedEx airbills for other labs

APPENDIX B

SAMPLE FORMS

APPENDIX C

SHIPPING GUIDELINES

SHIPPING GUIDELINES

Before shipping, it is very important to preserve each sample as directed in the sample collection portion of this Field Operations Manual.

- Preserve the samples as specified for each indicator before shipping (Fig. C-1).
- Be aware of the holding times for each type of sample (Table C-1):
  - **Water chemistry samples must be shipped the same day as collection.**
  - Chlorophyll-*a* and mercury samples have a longer holding time, but will be sent with the water chemistry samples since they are going to the same laboratory.
  - The **remaining samples must be preserved immediately** upon collection; they may then be sent in batches to the appropriate laboratory.

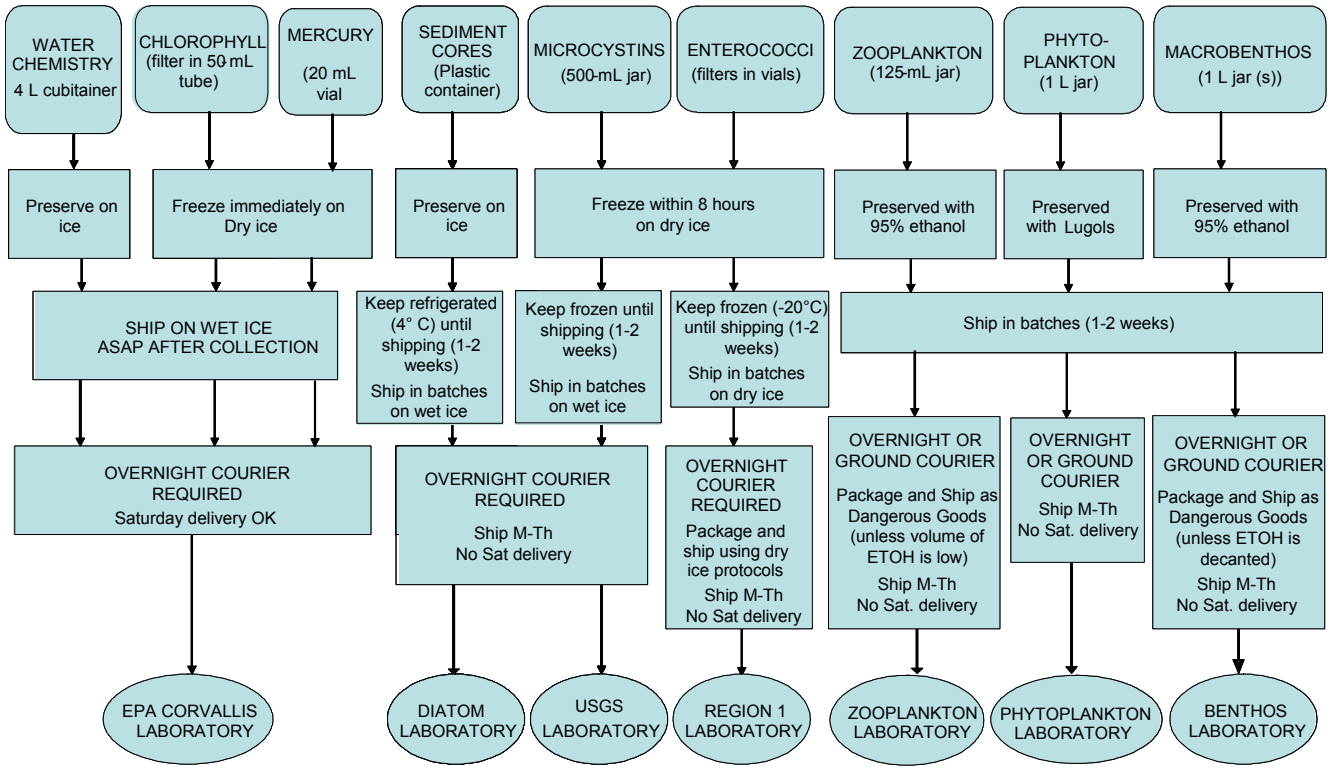


Figure C-1. Sample packaging and shipping summary.

Table C-1. Sample preservation, packaging, and holding times.

SAMPLE	PRESERVATIVE	PACKAGING FOR SHIPMENT	HOLDING TIME
Water Chemistry	Wet ice	Ship in cooler with wet ice	24 hours; these 3 samples shipped together
Chlorophyll-*a*	Dry ice		
Mercury	Dry ice		
Sediment Core	Wet ice	Ship in cooler with wet ice	Batch
Algal Toxin	Dry ice; must be frozen within 8 hours of collection	Ship in cooler with wet ice	Batch
Fecal Indicator	Dry ice; MUST be filtered & frozen within 8 hours of collection	Ship in cooler with DRY ICE	Batch
Zooplankton	95% Ethanol	Ship in cooler or sturdy container; ship with courier's Dangerous Goods protocols; no additional preservative needed for shipping.	Batch
Macrobenthos	95% Ethanol		Batch
Phytoplankton	Lugol's		Batch

When ice is used for shipment (water chemistry, chlorophyll-a, mercury, sediment cores, and algal toxins):

- Ensure that the ice is fresh before shipment.
- Line the cooler with a large, 30-gallon plastic bag.
- Contain the ice separately within numerous 1-gallon self-sealing plastic bags.
- White or clear bags will allow for labeling with a dark indelible marker. Label all bags of ice as "ICE" with an indelible marker to prevent misidentification by couriers of any leakage of water as a possible hazardous material spill.
- Place samples and bags of ice inside the cooler liner and seal the cooler liner.
- Secure the cooler with strapping tape.

When dry ice is used for shipping (fecal indicator samples):

- Indicate dry ice on shipping airbill.
- Label cooler with a Class 9 Dangerous Goods label.
- Securely tape the cooler drainage open to prevent pressure build-up in the cooler.
- Secure the cooler with strapping tape
- See "Dry Ice Shipping Protocols" at the end of this Appendix.

WATER CHEMISTRY, CHLOROPHYLL-*a*, and MERCURY SAMPLES

- **Water Chemistry**
  Stored in a 4-L cubitainer
  - Confirm that the cubitainer is labeled and covered with clear tape.
  - Place the cubitainer in a second bag inside the cooler liner.
- **Chlorophyll-*a***
  Stored in a 50-mL steam-top centrifuge tube
  - Confirm that the label with bar code is completed and covered with clear tape.
  - Place the centrifuge tube in a 1-qt self-sealing plastic bag.
  - Place the bag in a1-gal self-sealing plastic bag and place inside second bag with water chemistry sample.

- **Mercury**
  Stored in a 20-mL scintillation vial
  - Confirm that the label with bar code is completed and covered with clear tape.
  - Place the vial in self-sealing Ziploc bag.
  - Place the bag inside second bag with water chemistry and chlorophyll sample.

- Close the second bag containing all samples.
- Surround the bag with bags of fresh ice. It is important to keep the samples as cold as possible.
- Ship the water chemistry, chlorophyll-*a*, and mercury samples on the day of collection whenever possible. If shipping on the day of collection is not possible, the samples must be shipped the next day with fresh ice.

SEDIMENT CORE SAMPLES
Stored in plastic containers

- Confirm that the labels with bar codes attached to each of the containers containing sediment (top and bottom) are complete and covered with clear plastic tape.
- Place the containers in a second bag inside the cooler liner.
- Close the bag containing all samples.
- Surround the bag with bags of fresh ice. It is important to keep the samples as cold as possible.
- Samples can be held and shipped in batches to the laboratory for analysis.

ALGAL TOXIN SAMPLES
The sample needs to be frozen on dry ice as soon as possible after collection (within 8 hours).

- Confirm that the 500ml sample container is labeled and properly sealed.
- Place the sample container in a second bag inside the cooler liner.
- Pack the cooler with wet ice.
- Samples can be held frozen and shipped in batches to the laboratory for analysis.

FECAL INDICATOR
The sample needs to be filtered and frozen as soon as possible after collection (within 6 hours).

- Confirm that the container is labeled and properly sealed.
- Place the container in the cooler and close.
- Pack the cooler with 5-10 lbs of dry ice.
- Refer to the DRY ICE SHIPPING PROTOCOLS at the end of this Appendix.
- Samples can be held frozen and shipped in batches to the laboratory for analysis.

ZOOPLANKTON SAMPLES
Preserved in 95% ethanol and sealed at the lake.

- Confirm that each jar is labeled with the appropriate bar code and covered with clear plastic tape. If a sample requires an additional jar, confirm that the bar code number of the corresponding labeled sample is recorded on the supplemental label.
- Verify that each jar is sealed with electrical tape and sealed in a quart-size self-sealing plastic bag.
- Place the bags in the appropriate shipping container.

- Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
- Samples can be held and shipped in batches to the laboratory for analysis.

NOTE: If shipped, these samples must be shipped as "DANGEROUS GOODS" and should be packaged and labeled in accordance with the requirements of the chosen courier. For shipping 95% ethanol via UPS, label as a flammable liquid; no more than 5 L total can be included per shipment.

PHYTOPLANKTON SAMPLES
Preserved with Lugol's solution and sealed at the lake.

- Confirm that the bottle is labeled with the appropriate bar code and covered with clear plastic tape.
- Verify that the bottle is sealed with electrical tape.
- Place the sealed bottles in a gallon-size self-sealing plastic bag.
- Place the bagged samples in the appropriate shipping container.
- Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
- Samples can be held and shipped in batches to the laboratory for analysis.

BENTHIC INVERTEBRATE SAMPLES
Preserved in 95% ethanol and sealed at the lake.

- Confirm that the bottle is labeled with the appropriate bar code and covered with clear plastic tape.
- Check to make sure jars are sealed with electrical tape.
- Place up to twenty 500-mL or ten 1-L jars in each cooler.
- Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
- Samples can be held and shipped in batches to the laboratory for analysis.

NOTE: If shipped, these samples must be shipped as "DANGEROUS GOODS" and should be packaged and labeled in accordance with the requirements of the chosen courier. For shipping 95% ethanol via UPS, label as a flammable liquid; no more than 5 L total can be included per shipment. *Alternatively, the ethanol may be decanted from the benthic invertebrate samples so that they may be shipped using standard overnight shipping:*

- Allow the samples to sit for at least 1 week to adequately preserve the organisms.
- Immediately before shipping, decant the ethanol from the samples jars, leaving enough liquid to keep the samples moist.
- Make sure to use an overnight delivery so that the lab can immediately restore the ethanol to the sample jars.
- Alert the laboratory so that they are aware they will need to refill the jars immediately upon receipt.

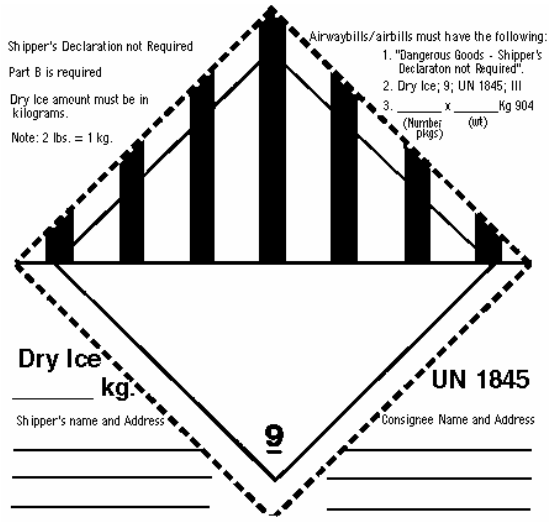
DRY ICE SHIPPING PROTOCOLS

1. Indicate dry ice on shipping airbill

    - Fill out Section 1 and Section 3 of the Fed Ex airbill with your Sender and Recipient address and phone number.

- In Section 4, check "FedEx Priority Overnight."
- In Section 5, check "Other."
- In Section 6, under "Does this shipment contain dangerous goods?":
  - Check "Yes/Shipper's Declaration not required."
  - Check "Dry Ice," and fill out "_1_ x _(*amt. of dry ice in kg*)_ kg"
- In Section 7, fill out weight and declared value of package.

2. Label cooler with a Class 9 Dangerous Goods label (available from FedEx) (Fig. C-2).



- Place the label on the front side of the cooler, not the top of the cooler.
- Fill out #3 in the top right hand corner of the label with the same information as in Section 6 of the FedEx airbill.
- Declare the weight of the dry ice again in the lower left hand corner.
- Fill out the Sender ("Shipper") and Recipient ("Consignee") address on the bottom of the label.

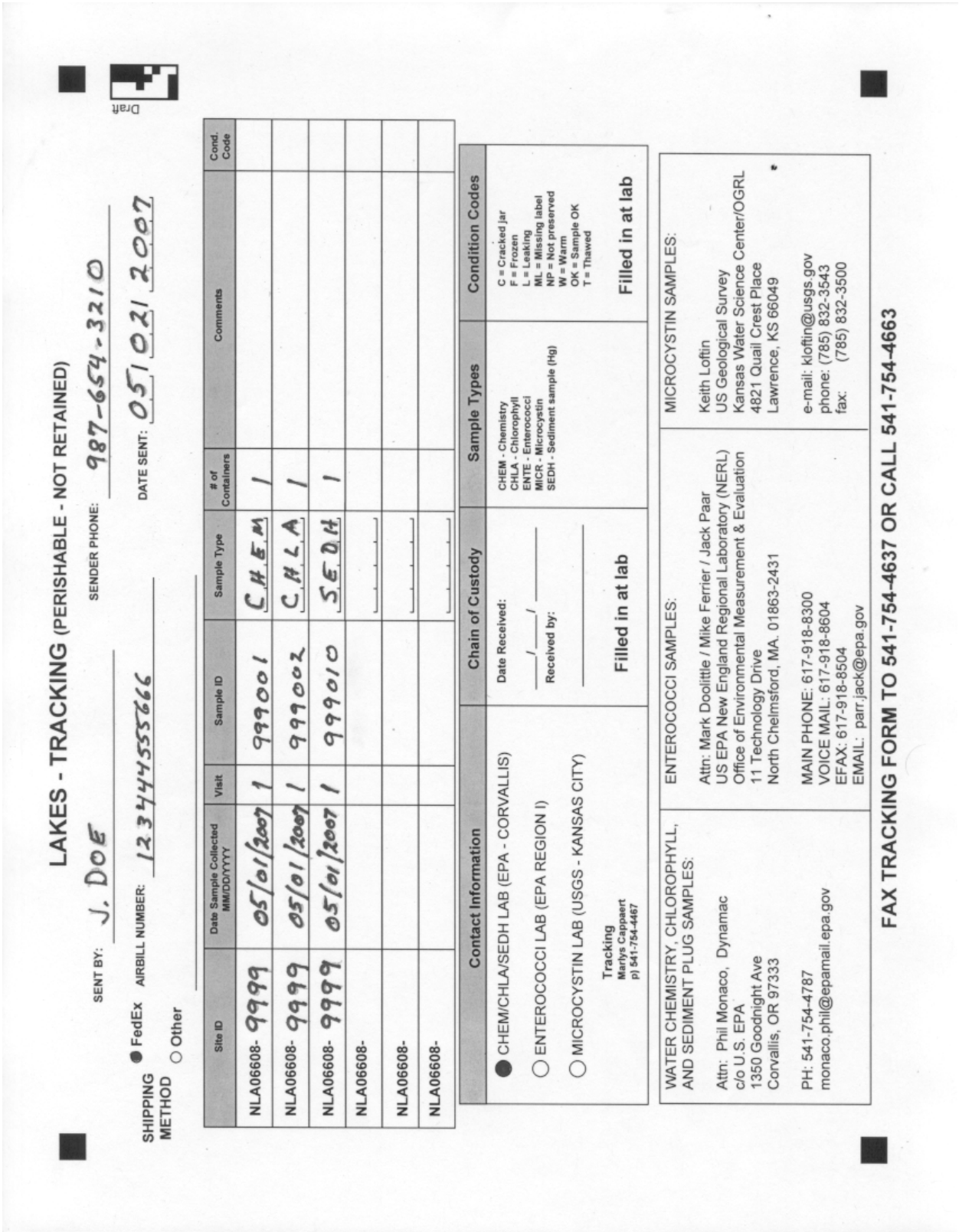
Figure C-2. Class 9 Dangerous Goods label.

3. Securely tape the cooler drainage open to prevent pressure build-up in the cooler. This is critical to ensure proper venting of the dry ice.
4. Secure the cooler with strapping tape.
5. Place the completed airbill on the top of the cooler.

NOTE: Not all FedEx locations will accept shipments containing dry ice. Please be sure to call in advance to ensure your location will accept the package for shipment.

TRACKING FORMS

A Tracking Form must be filled out to accompany each sample shipment. Please refer to Figures C-3 and C-4 for examples of Tracking Forms completed for both unpreserved and preserved samples. Be very careful to fill in the information correctly and legibly, especially the airbill number, Site ID, and Sample ID numbers. Use the codes on the bottom of the form to indicate sample type. The Tracking Form is to be placed in a self-sealing plastic bag and included inside the shipping container. Before sealing the container, remember to contact the Information Management Center (via fax or phone) using the contact information at the bottom of the tracking form. For preserved samples, the Information Management Center must be alerted both when the samples are brought to the holding facility AND when they are shipped to the appropriate laboratory.



LAKES - TRACKING (PERISHABLE - NOT RETAINED)

SENT BY: J. DOE SENDER PHONE: 987-654-3210

SHIPPING METHOD ● FedEx ○ Other AIRBILL NUMBER: 123445555666 DATE SENT: 05 01 21 2007

Draft

Site ID	Date Sample Collected MM/DD/YYYY	Visit	Sample ID	Sample Type	# of Containers	Comments	Cond. Code
NLA06608- 9999	05/01/2007	1	999001	CHEM	1		
NLA06608- 9999	05/01/2007	1	999002	CHLA	1		
NLA06608- 9999	05/01/2007	1	999010	SEDH	1		
NLA06608-							
NLA06608-							
NLA06608-							

Contact Information

● CHEM/CHLA/SEDH LAB (EPA - CORVALLIS)
○ ENTEROCOCCI LAB (EPA REGION I)
○ MICROCYSTIN LAB (USGS - KANSAS CITY)

Tracking
Marlys Cappaert
p| 541-754-4467

Chain of Custody

Date Received: ___/___/___
Received by: _____

Filled in at lab

Sample Types

CHEM - Chemistry
CHLA - Chlorophyll
ENTE - Enterococci
MICR - Microcystin
SEDH - Sediment sample (Hg)

Filled in at lab

Condition Codes

C = Cracked jar
F = Frozen
L = Leaking
ML = Missing label
NP = Not preserved
W = Warm
OK = Sample OK
T = Thawed

WATER CHEMISTRY, CHLOROPHYLL, AND SEDIMENT PLUG SAMPLES:

Attn: Phil Monaco, Dynamac
c/o U.S. EPA
1350 Goodnight Ave
Corvallis, OR 97333

PH: 541-754-4787
monaco.phil@epamail.epa.gov

ENTEROCOCCI SAMPLES:

Attn: Mark Doolittle / Mike Ferrier / Jack Paar
US EPA New England Regional Laboratory (NERL)
Office of Environmental Measurement & Evaluation
11 Technology Drive
North Chelmsford, MA. 01863-2431

MAIN PHONE: 617-918-8300
VOICE MAIL: 617-918-8604
EFAX: 617-918-8504
EMAIL: parr.jack@epa.gov

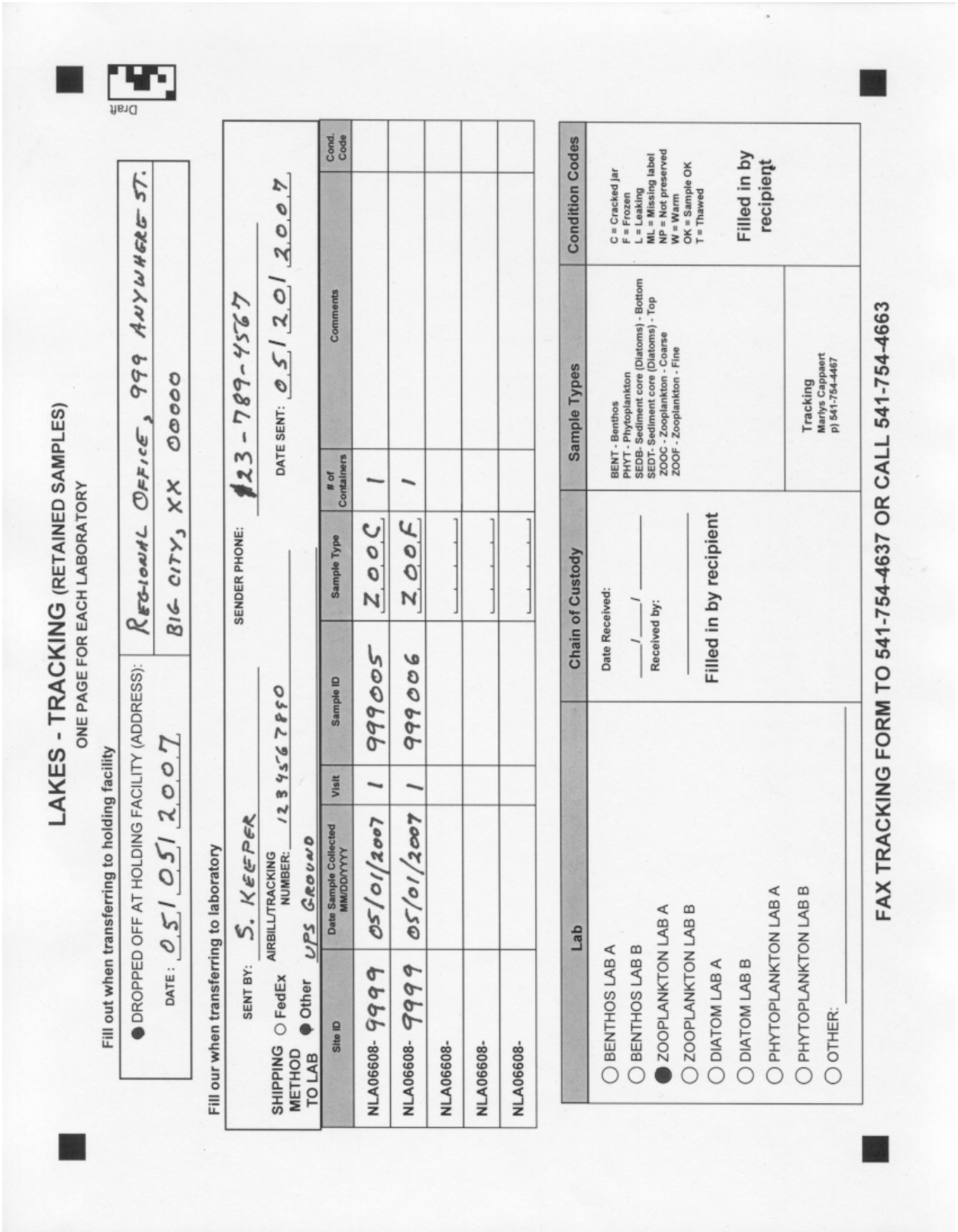
MICROCYSTIN SAMPLES:

Keith Loftin
US Geological Survey
Kansas Water Science Center/OGRL
4821 Quail Crest Place
Lawrence, KS 66049

e-mail: kloftin@usgs.gov
phone: (785) 832-3543
fax: (785) 832-3500

FAX TRACKING FORM TO 541-754-4637 OR CALL 541-754-4663

Figure C-3. Example Tracking Form for Unpreserved Samples



LAKES - TRACKING (RETAINED SAMPLES)

ONE PAGE FOR EACH LABORATORY

Draft

Fill out when transferring to holding facility

● DROPPED OFF AT HOLDING FACILITY (ADDRESS): Regional Office, 999 Anywhere St.

DATE: 05/05/2007 Big City, XX 00000

Fill our when transferring to laboratory

SENT BY: S. Keeper SENDER PHONE: 123-789-4567

SHIPPING METHOD TO LAB: ○ FedEx AIRBILL/TRACKING NUMBER: 123456789 DATE SENT: 05/20/2007 ● Other UPS Ground

Site ID	Date Sample Collected MM/DD/YYYY	Visit	Sample ID	Sample Type	# of Containers	Comments	Cond. Code
NLA06608-9999	05/01/2007	1	999005	Z00C	1		
NLA06608-9999	05/01/2007	1	999006	Z00F	1		
NLA06608-							
NLA06608-							
NLA06608-							

Lab	Chain of Custody	Sample Types	Condition Codes
○ BENTHOS LAB A ○ BENTHOS LAB B ● ZOOPLANKTON LAB A ○ ZOOPLANKTON LAB B ○ DIATOM LAB A ○ DIATOM LAB B ○ PHYTOPLANKTON LAB A ○ PHYTOPLANKTON LAB B ○ OTHER:	Date Received: ___/___/___ Received by: Filled in by recipient	BENT - Benthos PHYT - Phytoplankton SEDB - Sediment core (Diatoms) - Bottom SEDT - Sediment core (Diatoms) - Top ZOOC - Zooplankton - Coarse ZOOF - Zooplankton - Fine Tracking Marlys Cappaert p) 541-754-4467	C = Cracked jar F = Frozen L = Leaking ML = Missing label NP = Not preserved W = Warm OK = Sample OK T = Thawed Filled in by recipient

FAX TRACKING FORM TO 541-754-4637 OR CALL 541-754-4663

Figure C-4. Example Tracking Form for Preserved Samples