Standard Operating Procedure for Macrophyte Cover Lakes, Ponds, and Reservoirs

SOP-WR-W-31

APPROVALS:

Deputy Chief of Water Resources:

Sue Kiernan (Printed Name) | Susan Kiernan (Signature) | 9/2/11 (Date)

Quality Assurance Manager:

Connie Carey (Printed Name) | Connie Carey (Signature) | 9/2/11 (Date)

DISTRIBUTION

(x) Surface Water Monitoring & Assessment (Connie Carey) ..... By: cgc Date : 9/2/11

(x) TMDL Program (Elizabeth Scott) ..... By:_____ Date :_____

(x) Quality Assurance Manager (Tom Getz) ..... By:_____ Date :_____

Title: Standard Operating Procedure for Macrophyte Cover – Lakes, Ponds, and Reservoirs
Originator Name: Jane Sawyers

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Standard Operating Procedure for Macrophyte Cover in Lakes

1. APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in collecting macrophyte cover estimates in lakes, ponds, and reservoirs. Exemption from the use of this SOP for project work shall be allowed for reasons of inapplicability determined by management discretion.

2. PURPOSE

This SOP establishes a standardized method for performing semi-quantitative field estimates of macrophyte cover in lakes, ponds, and reservoirs. It sets a consistent protocol to ensure the quality of OWR's data collection—resulting in improved uniformity, reproducibility, verifiability, and defensibility of the data, as well as increased program credibility.

3. DEFINITIONS

3.1 RIDEM – Rhode Island Department of Environmental Management

3.2 OWR – RIDEM Office of Water Resources

3.3 SOP – Standard Operating Procedures

3.4 Macrophyte – Forms of aquatic vegetation that are visible without magnification

3.4.1 Emergent macrophyte – Macrophytes that are rooted in the substratum, but leaves and stems extend out of the water (cattail, arrowhead, pickerel weeds, sedges, and rushes)

3.4.2 Floating-leaved macrophyte – Macrophytes that are rooted in the substratum, but possess leaves that float on the water surface (water lilies, watershield, water chestnut)

3.4.3 Submersed macrophyte – Macrophytes that are rooted in the substratum, but possess stems and leaves that grow entirely under water (coontail, bladderworts, water-milfoils)

3.4.4 Freely floating macrophyte – Macrophytes typically not rooted to the substratum, but live unattached within or upon the water (duckweed, *Wolffia*, *Azolla*, *Eichhornia*)

3.5 QA – Quality Assurance refers to a systematic process to ensure production of valuable, accurate, reliable, reproducible and defensible environmental data.

3.6 QC – Quality Control refers to the activities performed to affirm production of valuable, accurate, reliable, reproducible and defensible environmental data.

3.7 QI – Quality Improvement refers to any act or process performed to enhance the value, accuracy, reliability, reproducibility or defensibility of environmental data collected by RIDEM OWR.

4. RESPONSIBILITIES

4.1 TRAINING

Any RIDEM/OWR personnel collecting macrophyte cover estimates for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance (QA) Manager. This training ensures the field analyst recognizes the importance of proper data collection and management and he/she comprehends the significance of the environmental decisions that may be made with the data. It is suggested that field analysts have also completed the USEPA Water Quality Standards Academy Basic Course and Supplemental Topic Modules online, but does not require any additional special training or certification.

To properly estimate macrophyte cover, the field analyst must be familiar with and comply with the data collection techniques stated in this SOP. The field analyst is required to read and understand this SOP. The field analyst should complete and submit any required training forms and/or field assessments for project and/or program QAPPs to document proficiency with this procedure. Any field analyst not familiar with the estimation of macrophyte cover should be assisted by OWR staff who are accustomed to performing the procedure.

4.2 RESPONSIBILITIES OF FIELD ANALYST

The field analyst is responsible for checking the required equipment in the Sampling Center at the beginning of the sampling event before taking measurements in the field. The field analyst is responsible for verifying that the canoe or kayak is in proper operating condition prior to use and communicating to the project manager when equipment is in need of repair or replacement. The field analyst is also responsible for using best professional judgment to determine if site conditions are safe for performing the procedure. The field analyst is accountable for employing proper estimation procedures and data recording in accordance with this SOP.

4.3 RESPONSIBILITIES OF PROJECT OR PROGRAM MANAGER

The project or program manager is responsible for providing the materials, resources, and/or guidance necessary to perform the measurements in accordance with this SOP. The project manager is responsible for ensuring that the field analyst estimates macrophyte coverage correctly in accordance with this SOP and that any additional, project-specific requirements are communicated to the project team. The project manager is responsible for ensuring the canoe or kayak is maintained in proper operating condition annually. This includes repairing it or reordering equipment when necessary. The project manager will

determine and communicate with field analysts what procedures and order of procedures are to be accomplished during each sampling event to a sampling location. Further, the project manager shall ensure annual renewal and periodic revisions to this SOP as necessary to reflect current needs and standards as well as renew this SOP every five years.

5. GUIDELINES AND PROCEDURES

5.1 PROPER MAPPING OF MACROPHYTE COVER

5.1.1 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Bathymetric map, lake outline or field notebook printed on waterproof paper (paper similar to Grainger Item Number 3XFR7)
    - Bathymetric map (if available: S:\COMMON\Jane\Bathymetric Maps) or Lake outline (if available: S:\COMMON\Jane\Lake Outlines)
- Clipboard
- Pencil or Rite in the Rain Pen (similar to Forestry Suppliers Item Number 49237)
- Boat, canoe or kayak
- Paddles and motor
- Anchors
- Lifejackets
- Depth finder

5.1.2 ESTIMATING MACROPHYTE COVER IN THE FIELD

For most purposes, estimation of macrophyte cover will be taken directly in the field, in lake, ponds, and reservoirs. This method does not require sample containers or preservation.

5.1.3 RECORDING PARAMETER UNITS

The following units should be used when calculating recorded measurements taken while estimating macrophyte cover:

Macrophyte cover.....%

Available substrate.....rank

5.2 FIELD MEASUREMENT PROCEDURES

5.2.1 DETERMINE FIELD PROCEDURE SCHEDULE

Prior to departure, the project manager will communicate with the field analysts what procedures should be accomplished for each sampling trip to the sampling location and the order the field procedures should be completed. Prior to performing this analysis, the field analyst should ensure the macrophyte cover estimate is taken at an appropriate time of year and in the correct order. This procedure may disrupt fish and microscopic organisms, such as phytoplankton and zooplankton, which can interfere with other field procedures and sample collections in lakes, ponds, and reservoirs. Macrophyte cover estimates should be measured after these samples have been collected. Macrophyte cover estimates should be made later in the growing season, after July 1, and can continue as late as October. This will capture full annual growth and coverage of macrophytes in the lake, pond, or reservoir.

5.2.2 POSITION THE BOAT AT THE DEEPEST POINT OR DESIRED DEPTH

If a bathymetric map is available, the field analyst should use the map and distinguishing land characteristics (i.e. outfall structures, points, inlets, boat launch) to find the general location of the deepest spot or desired depth in the lake or river. The field analyst should verify the location by confirming several depth locations with the depth finder around the general location of the deepest spot or desired depth. Once the deepest location or desired depth is established, the field analyst should carefully lower the anchor so that bottom sediment is not disturbed into the water column. The field analyst should record the depth of the deepest location or desired depth to the nearest tenth of a meter on the bathymetric map, lake outline, or appropriate field notebook. For monitoring section projects, the field analyst should note the date, time, and field analysts performing the procedure at the top of the bathymetric map or lake outline.

5.2.3 ESTIMATING MACROPHYTE COVER IN THE FIELD

The field analyst recording the data should position themselves to be able to see major landmarks throughout as much of the basin as possible.

- On the bathymetric map or lake outline, the field analyst should note any major landmarks that can be seen from the boat. See key for major landmark symbols (Figure 1).
    - Any landmarks the field analyst determines are important to the map but do not have a symbol denoted, should be clearly labeled with a written description.
- The field analysts will slowly canoe or use a trolling motor to survey the lake.

- The recording field analyst will continue to observe and record macrophyte observations during the survey, assisting with paddling or navigation as needed.
- The non-recording field analyst will paddle and navigate the survey route during the survey, assisting with macrophyte observations as needed.
    - At 5% of lakes, the non-recording field analyst will also complete the mapping procedures on a separate bathymetric map or lake outline for QC measurement of bias.

- The survey route is determined by the shape the lake and best professional judgment.
    - In nearly round or oblong lakes with the deepest spot in the middle, the survey route will cover two transects (Figure 2).
        - Each transect will be established running parallel to the longest shore length.
    - In round or oblong lakes with the deepest spot at one end, the survey route will cover one transect (Figure 3).
        - The transect will be established running parallel to the longest shore length.
    - In lakes with the deepest spot at one end with two inlet arms, the survey route will cover two transects (Figure 4).
        - The transects will be established running parallel to the shore of each arm.
    - The survey route will deviate from this transect establishment guidelines when the field analysts determine that the macrophyte cover present is not visible from the survey route.
        - The field analysts, based on best professional judgment, may navigate away from the survey route to detail observations in coves, boat ramps or inlets that are not clearly observable from the survey route.
        - The field analysts, based on best professional judgment, may navigate away from the survey route to detail observations in dense patches of macrophyte growth to differentiate between the different macrophyte growth forms.

- The recording field analyst will observe patches of macrophyte growth and sketch on the bathymetric map or lake outline the geographic extent of the growth.

- The previously drawn shore landmarks and lake shoreline should be used by the recording field analyst as points of reference to draw on the bathymetric map or lake outline.

- The recording field analyst will then rank the macrophyte patches using the following scale:
  - Sparse = 0 – 25% plant density
  - Moderate = >25 – 50% plant density
  - Dense = >50 – 75% plant density
  - Very dense = >75 – 100% plant density
- The recording field analyst will then indicate the rank on the bathymetric map or lake outline using the following markings in the sketched macrophyte patches (Figure 4):
  - Sparse = no markings (only outline of the patch)
  - Moderate = dotting (::::::::)
  - Dense = hatched lines (////////)
  - Very dense = cross-hatched lines (XXXXX)
- The recording field analyst will then clearly write the dominant macrophyte growth form on top of each sketched and ranked macrophyte patch using the following markings:
  - Emergent macrophyte = Emergent
  - Floating-leaved macrophyte = Floating
  - Submersed macrophyte = Submersed
  - Freely-floating macrophyte = Free

5.2.4 ESTIMATING THE AVAILABLE SUBSTRATE

At four random locations during the macrophyte survey, the field analyst will estimate the percent rank of the available substrate. The four random locations should be chosen in areas where the bottom of the lake is visible or the total depth is less than 12 feet, as checked by a depth finder.

Any available rocky substrate will be ranked using a general geomorphic classification of bedrock; boulders; cobbles; gravel; sand; silt, clay, or muck. Organic debris substrate will be ranked using intact large woody debris (branches, sticks, etc.) or decaying organic matter (leaf pack, general detritus) designations.

The field analyst will observe the area on the bottom of the lake equaling the length of the watercraft until approximately one meter out from the watercraft. The field analyst will rank the percent availability of the different types of substrate. The following ranking will be used to estimate the percent cover of available substrate:

- 0 = 0%
- 1 = <10%
- 2 = 10 – 30%
- 3 = 31 – 50%
- 4 = 51 – 70%
- 5 = 71 – 90%
- 6 = 100%

The field analyst will say out loud the ranking of each type of available substrate. The recording field analyst will circle the appropriate ranking of each type of substrate for each of the four sites observed (Figure 5) or record the information in the appropriate field notebook. The recording field analyst will also observe and record the GPS location of the substrate sites.

If the bottom is not visible due to high biological growth, turbidity, or suspended solids, the field analyst will use an oar to touch the nearby bottom. The field analyst should investigate the substrate by probing the bottom for the rocky or organic debris. The field analyst will use best professional judgment to rank the available substrate. The recording field analyst should note that the bottom was not visible at the site on the datasheet or appropriate field notebook.

5.2.5 CALCULATING TOTAL MACROPHYTE COVER

The project manager will calculate the total macrophyte cover using the bathymetric map or lake outline observations collected by the field analysts in the field.

- The project manager will overlay a see-through square grid pattern (¼") on top of the scale located on the bathymetric map or lake outline.
- The project manager will determine the conversion of boxes:distance on the scale and calculate the area equal to 1 box.
  - For example, ¼" (1 box) = 300 ft (scale)

$$(¼")^2 = (300\ ft)^2$$

$$1\ box = 900\ ft^2$$

- The project manager will overlay the see-through square grid pattern (¼") on top of each sketched macrophyte patch.
- The project manager will count the number of squares covered by each macrophyte patch for each macrophyte growth form.
- The project manager will calculate the area covered by each macrophyte patch and calculate the total coverage for each macrophyte growth form, converting to the correct units as necessary.
- To determine the percent (%) cover of each macrophyte growth form, the project manager will divide the total area coverage for each macrophyte growth form by the known total lake area.

6. QUALITY CONTROL

6.1 QUALITY CONTROL

At 5% of mapped lakes, the non-recording field analyst will also follow the mapping procedure during the survey route to produce two (2) macrophyte maps of the same lake, pond, or reservoir. This quality control procedure will give a measure of bias. The project manager will calculate the total macrophyte cover from each map and compare the percent (%) cover of each macrophyte growth form between the maps. A percent difference of greater than 10% in any macrophyte growth form will indicate that bias is being introduced into the procedure.

At 10% of lakes surveyed, the recording field analyst will also observe and rank the available substrate. A weighted average of the available substrates at the four sites will be calculated. A different greater than 20% relative percent different between the weighted average of the analysts will indicate that bias is being introduced into the procedure.

6.2 QUALITY ASSURANCE PLANNING CONSIDERATIONS

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. Unless specified otherwise in a site or project-specific work plan, Quality Assurance Project Plan (QAPP), Quality Assurance Program Plan (QAPP) or laboratory Quality Assurance Manual (QAM), all data collected following the protocols set forth in this document will be collected in accordance with the minimum QAQC requirements of Section 6.1. Further quality assurance requirements will be defined in project specific work plans and may include duplicate or replicate measurements or confirmatory analyses.

7. REFERENCES

PADEP. 2009. *Aquatic Macrophyte Procedures for Lake Assessments*. Pennsylvania Department of Environmental Protection. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Methodology/AquaticMacrophyteCover_2009AM.pdf

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

Wetzel, R.G. and Likens, G.E. 2001. *Limnological Analyses*, 3rd ed. New York: Spring Science and Business Media, Inc., 429 pp.

Figure 1. Topographic Symbols for Designating Landmarks

Figure 2. Middle Deep Spot Survey Route

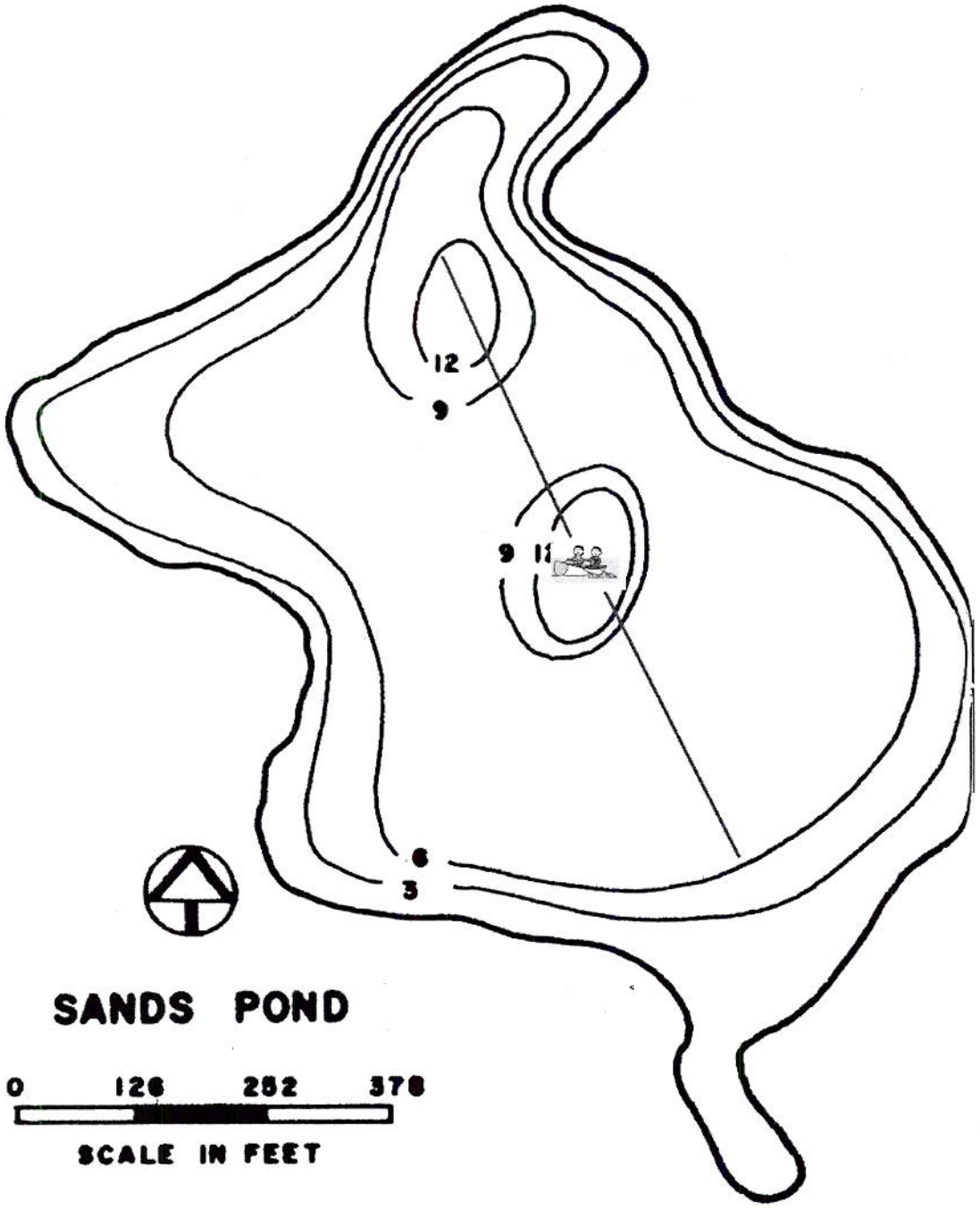

Figure 3. <u>One End Deep Spot Survey Route</u>

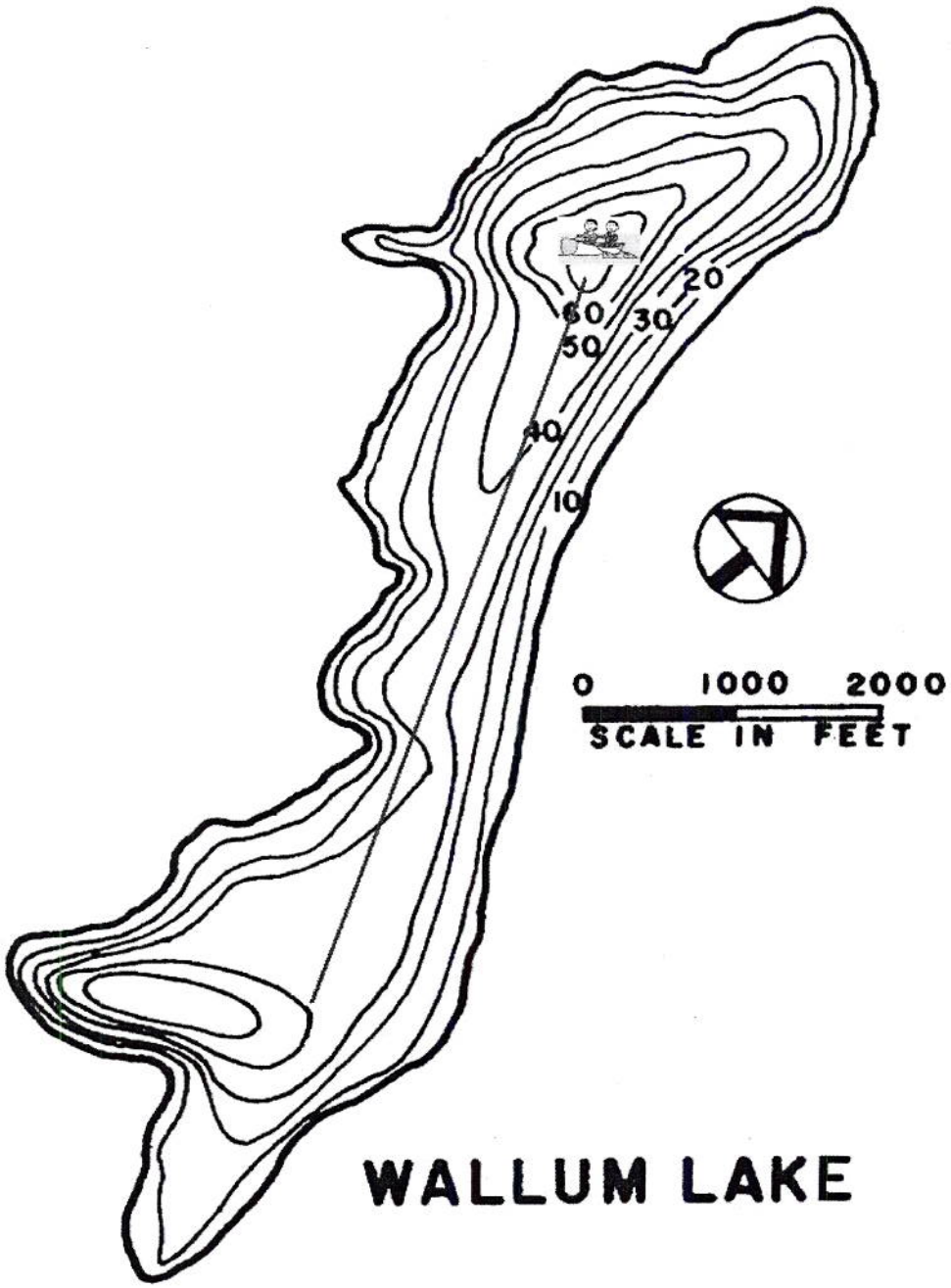

Figure 4. Two Inlet Arms Survey Route

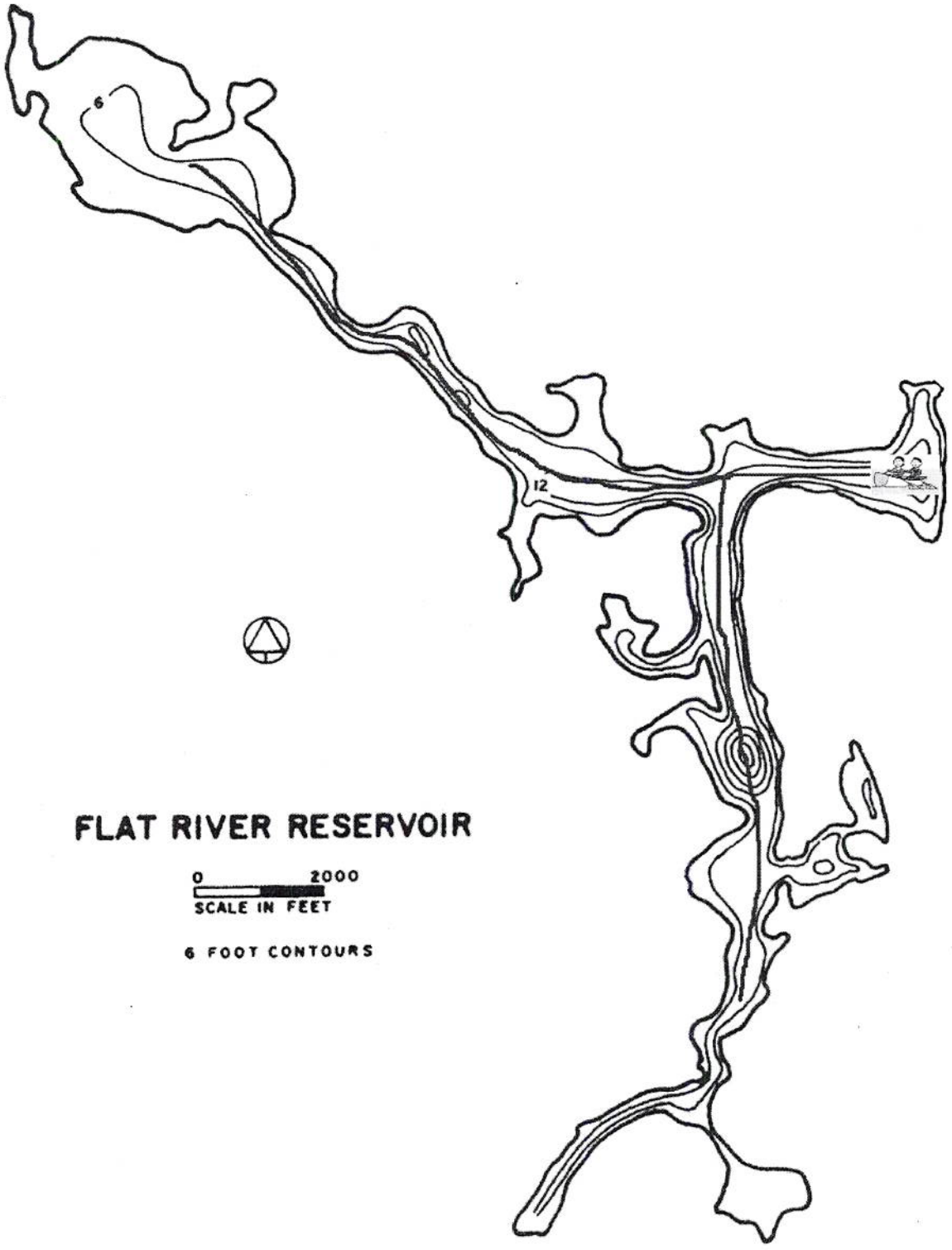

Figure 5. Available Substrate Datasheet for Monitoring Section Sampling Events

Substrate Sampling Datasheet

Lake Name: _____ Town: _____

Date: _____ Time: _____ Collectors: _____

Site 1 Type	GPS: Size	Lat Comparable Size	_____ Rank					Long _____ Bottom Visible?	Yes	No
			0%	<10%	10 – 30%	31 – 50%	51 – 70%	71 – 90%	100%	
Bedrock	>4000mm	Bigger than a car	0	1	2	3	4	5	6	
Boulders	250 - 4000mm	basketball - car	0	1	2	3	4	5	6	
Cobble	64-250mm	tennis ball - basketball	0	1	2	3	4	5	6	
Gravel	2 - 64mm	ladybug - tennis ball	0	1	2	3	4	5	6	
Sand	0.6 - 2mm	gritty btwn fingers	0	1	2	3	4	5	6	
Silt, clay, muck	<0.6mm	not gritty btwn fingers	0	1	2	3	4	5	6	
Woody debris		branches, logs	0	1	2	3	4	5	6	
Organic		leaves, detritus	0	1	2	3	4	5	6	

Site 2 Type	GPS: Size	Lat Comparable Size	_____ Rank					Long _____ Bottom Visible?	Yes	No
			0%	<10%	10 – 30%	31 – 50%	51 – 70%	71 – 90%	100%	
Bedrock	>4000mm	Bigger than a car	0	1	2	3	4	5	6	
Boulders	250 - 4000mm	basketball - car	0	1	2	3	4	5	6	
Cobble	64-250mm	tennis ball - basketball	0	1	2	3	4	5	6	
Gravel	2 - 64mm	ladybug - tennis ball	0	1	2	3	4	5	6	
Sand	0.6 - 2mm	gritty btwn fingers	0	1	2	3	4	5	6	
Silt, clay, muck	<0.6mm	not gritty btwn fingers	0	1	2	3	4	5	6	
Woody debris		branches, logs	0	1	2	3	4	5	6	
Organic		leaves, detritus	0	1	2	3	4	5	6	

Substrate Sampling Datasheet

Lake Name: _____

Site 3 Type	GPS: Size	Lat Comparable Size	_____ Rank					Long _____ Bottom Visible?	Yes	No
			0%	<10%	10 – 30%	31 – 50%	51 – 70%	71 – 90%	100%	
Bedrock	>4000mm	Bigger than a car	0	1	2	3	4	5	6	
Boulders	250 - 4000mm	basketball - car	0	1	2	3	4	5	6	
Cobble	64-250mm	tennis ball - basketball	0	1	2	3	4	5	6	
Gravel	2 - 64mm	ladybug - tennis ball	0	1	2	3	4	5	6	
Sand	0.6 - 2mm	gritty btwn fingers	0	1	2	3	4	5	6	
Silt, clay, muck	<0.6mm	not gritty btwn fingers	0	1	2	3	4	5	6	
Woody debris		branches, logs	0	1	2	3	4	5	6	
Organic		leaves, detritus	0	1	2	3	4	5	6	

Site 4 Type	GPS: Size	Lat Comparable Size	_____ Rank					Long _____ Bottom Visible?	Yes	No
			0%	<10%	10 – 30%	31 – 50%	51 – 70%	71 – 90%	100%	
Bedrock	>4000mm	Bigger than a car	0	1	2	3	4	5	6	
Boulders	250 - 4000mm	basketball - car	0	1	2	3	4	5	6	
Cobble	64-250mm	tennis ball - basketball	0	1	2	3	4	5	6	
Gravel	2 - 64mm	ladybug - tennis ball	0	1	2	3	4	5	6	
Sand	0.6 - 2mm	gritty btwn fingers	0	1	2	3	4	5	6	
Silt, clay, muck	<0.6mm	not gritty btwn fingers	0	1	2	3	4	5	6	
Woody debris		branches, logs	0	1	2	3	4	5	6	
Organic		leaves, detritus	0	1	2	3	4	5	6	