2011 ADDENDUM

to update the

Quality Assurance Project Plan for Rhode Island Ambient River Monitoring Program

State of Rhode Island and Providence Plantations

Rhode Island Department of Environmental Management (DEM)

Office of Water Resources

December 1, 2011

RIDEM Project Manager: Katie DeGoosh

Signature/Date: _____ _____

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2011 ARM QAPP ADDENDUM

This document and attachments serve as an update to the RI Ambient River Monitoring Program QAPP to reflect any changes to the document for the 2011 sampling season. The following bullets summarize all changes or updates:

- Addition of new personnel allowed Mark Nimiroski to replace Katie DeGoosh as Field Data Collection Team Leader. Terrence (Terry Gray) also replaced Thomas Getz as the RIDEM QA Manager. These changes are reflected in both the updated distribution list (pages 2-3) and updated **Figure 1. Organizational Chart for RIDEM Ambient River Monitoring Program** (attached).

- RIDEM has initiated a project to develop nutrient criteria under the management of Jane Sawyers. Fieldwork for this project will be done in conjunction with the Ambient River Monitoring Program and will be coordinated with staff as noted in Figure 1 (the updated Organizational Chart). To help develop and refine nutrient criteria, all ARM water samples tested for conventional parameters were also tested for True Color at HEALTH. Addition of this constituent did not change any field sampling procedures, as the ½ gallon container (with no preservative) used to collect water to test Cl, pH, turbidity, TSS, dissolved orthophosphate, Na and hardness held enough sample volume to also test color. This parameter was added to **Figure 2. Sample Submission Form/Chain of Custody;** and details of all laboratory analysis can be found in new attachments:

  Table 12. 2011 Parameters analyzed by HEALTH (updated Table 6)
  Table 13. 2011 Holding Times and Measurement Performance Criteria (updated Table 10)
  Appendix G Addendum. HEALTH Analytical Measurement Performance Criteria.

- **Figure 4. Materials for Ambient River Monitoring** was revised to serve multiple purposes: a checklist of materials, an inventory sheet, a to-do list for the morning and end of the day (to check weather, send email to alert HEALTH, post float/sample plan), to document weather conditions, and record history of precipitation (non-direct measurements listed in Section 9). The title was also changed to: **Figure 4. RIDEM Ambient River Monitoring Program Sampling Event Documentation**.

- A new map (**Figure 5**) and new list of 2011 sampling stations (**Table 11**) reflects the stations targeted for the 2011 basin rotation to the Wood and Pawcatuck River watershed basins.

- **Figure 6. Training Documentation Form** was added to improve consistency of fieldwork training documentation (Section 8).

- To address Comment #4 from EPA (RFA# 11017) from the draft QAPP, RIDEM devised a Teflon basket sampler to use instead of a Teflon bucket for collecting water samples from a bridge. Using this basket to put clean sample bottles into addressed any concerns for collecting samples for bacteria analysis, which

required sterile equipment. Pictures of the basket sampler are attached in **Figure 7**, and it was used starting with the June sampling event.
(The use of the sampling bucket was discontinued on 06-09-2011).

Further, one field equipment blank (FEB) was collected on every other sampling day. FEBs tested if ARM collection techniques or equipment contaminated samples by filling sample bottles in the field with deionized water from the RIDOH lab. The water was transported to the exact sampling location on the bridge or on the stream bank at the station, and sample bottles were filled on site using the same type of sampling equipment used to collect the sample at that station. FEBs tested all possible sampling techniques and equipment (bucket sampler, basket sampler, wading, and sampling wand) under varying sampling conditions, which may also effect sampling results (e.g. at sites with high traffic, rusty bridges or stations near construction).

- To avoid contaminating field gear (such as waders which are difficult to decontaminate in the field between sites) and prevent the spread of invasive species such as didymo or Asian clam larvae, beginning with the June sampling event, a sampling pole (**Figure 8**) was used to collect samples from streams without wading into them. This new sampling technique also avoids exacerbating streambank erosion, disturbing stream bottom sediments, or disrupting riparian buffers. Additional benefits include shorter time required to collect samples and increased safety to personnel (reduced contact with harmful vegetation such as poison ivy or stinging nettle, less likely to slip and fall due to slippery rocks, uneven stream beds, and/or high flow situations).

- To aid in nutrient criteria development, at some sites, additional fieldwork was performed and supplemental data was collected in accordance with **Appendix H**. Table 11 lists the sites where this additional fieldwork was performed. This additional sampling included collecting periphyton by scraping substrates (both natural and artificial) in accordance with DEM SOP-WR-W-37 (Appendix H). Samples were analyzed by HEALTH for Chlorophyll *a* using EPA Method 446.0 Rev. 1.2: Spectrophotometry in accordance with RIDOH SOP TO32 (see **Appendix G** Addendum for Measurement Performance Criteria). Additionally, these samples will be analyzed to measure and identify diatoms by a contract agency (currently Rhithron) as noted in Figure 1. To help characterize the periphyton growth an estimate of canopy cover was also taken using a densiometer in accordance with RIDEM SOP-WR-W-35 (Appendix H) as well as an observed measurement of benthic algae cover using a viewing bucket in accordance with RIDEM SOP-WR-36 (Appendix H).

- In order to ensure that a stream is well mixed, multiple YSI field measurements were taken across a stream to make sure that there was consistency in the field parameters. Stream width is the deciding factor in how many measurements should be taken. For streams less than 5 feet, 3 measurements are sufficient (one in the center, and one measurement close to each of the right and left banks). For streams greater than 5 feet, 10 measurements evenly spaced along the width of the stream should be taken. Measurements for each parameter should be written on the data sheets. In the case where measurements are different across the cross section, a median of the parameter will be calculated, and this value will be reported and stored in the database. This procedure should be done at a minimum of one time per year at each site to characterize if the water is well mixed at the sampling site. A variety of conditions (storm runoff, spill events, snowmelt) would make it advantageous to do multiple measurements for each sampling site.

Figure 1: Organizational Chart for RIDEM Ambient River Monitoring Program

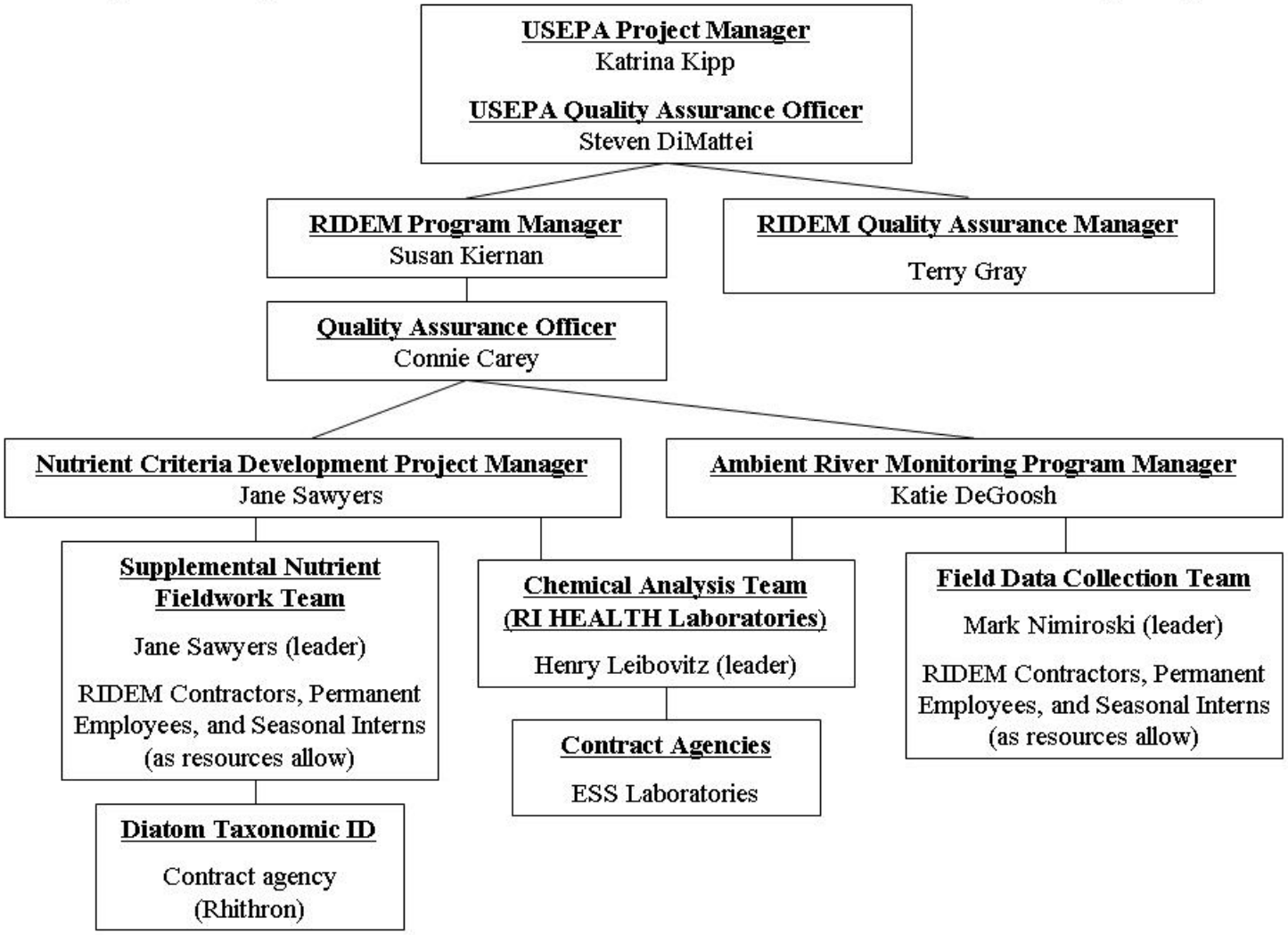

Figure 2

Sample Submission Form/Chain of Custody

ICED **ICED FOR TRANSPORT** Rhode Island Department of Health Laboratories
50 Orms Street, Providence, RI 02904

Legal Sample | |

Client: DEM - WRE Ambient River Monitoring

A. Client ID#: WRE-AMBIENT MONITORING Run #:	Mail Report To: RIDEM –OWR Room 200
B. Client Name: **DEM-OWR**	Street: 235 Promenade Street
	City: Providence, RI
	Report To (Agency/Person) : Mark Nimiroski 222-4700 x 7545

Collected By: _____ Collected Date: _____ Time: _____ Matrix: Water **X** Other

Source# _____ **C.** Facility ID#: _____ **D.** _____ **E.** Sample Point ID#: «Station_»

Collection Point **(tap/well):** _____«RiverName»_____

Collection Point Address: ___«StationLocation»_____
Name **Street** **City**

Class:_____ Origin#: _____ pH: _____ (adj.pH): _____ CL Residual: _____

Inorganics Lab	DUP
Non-metals Tests	
_X_WL1 Turbidity	
_X_WL4 Color **TRUE**	
_X_WL7 Total Suspended Solids	
___WL10 BOD	
_X_WL12 Total Phosphorous	
_X_WL13 pH	
_X_WL17 ortho-phosphate	
ESS WL ammonia - N	
ESS WL Total Kjeldahl - N	
_X_WL Total Nitrogen	
___WL11 Cyanide (335.4)	
_X_WL16 Nitrate (353.2)	
___WL18 Alkalinity (2320B)	
_X_WL20 Chloride (300.0)	
___WL21 Fluoride (300.0)	
_X_WL22 Hardness (2340B)	
___WL56 Nitrite (353.2)	
___WL_____	
Metals DEM Ambient River Monitor	
_X_WL62 (200.8) Diss. Cd, Cu, Pb, Zn	
_X_WL62Fe (200.8) Total Fe	
___WL67 Full Set (200.8)	
___WL69 Magnesium	
___WL70 Potassium	
_X_WL71 Sodium	
___WL72 Calcium	
___WL73 Sodium Composite(200.8)	

Metals	DUP
___WL36 Mercury (245.1)	
___WL65 Lead & Copper(200.8)	
Metals for New Systems	
___WL66 Full Set (200.8)	
___WL75 Antimony	
___WL76 Arsenic	
___WL77 Barium	
___WL78 Beryllium	
___WL79 Cadmium	
___WL81 Chromium	
___WL64 Copper	
___WL82 Iron	
___WL63 Lead	
___WL83 Manganese	
___WL84 Nickel	
___WL85 Selenium	
___WL86 Silver	
___WL87 Thallium	
___WL88 Zinc	
Metals Routine Set	
___WL68 Full Set (200.8)	
___WL78 Berylljum	
___WL81 Chromium	
___WL84 Nickel	
___WL76 Arsenic	
___WL85 Selenium	
___WL79 Cadmium	
___WL75 Antimony	
___WL77 Barium	
___WL87 Thallium	

Organics Lab	FB
___PE4–CARB (531.1)	
___PE12–Pest/PCB (608)	
___PE14–EBD/DBCP (504)	
___PE18–Pest/PCB (508)	
___PE21–HERB/ (515.3)	
___PE22–Pest/PCB+ (508)	
___PE_____	
___TO2–THM (524.2)	
___TO3–PWVOC (524.2)	
___TO4–PET HCS & TO3	
___TO11–UFVOC (624/603)	
___TO12–WQVOC (524.2)	
___TO14–USR Fee B/N Ext	
___TO17–PET HC & TO12	
___TO19–Total EXTR (625)	
___TO25–WQ SEMI (525.2)	
___TO27–AGR SVOC (525.2)	
___TO32_Chlorophyll a (446)	
___TO_____	

Sanitary Microbiology
___SM2 – MF Total Coliform
___SM3 – SPC
___SM34 – Colilert
___SM36 – Pres./Abs.
___SM1 – MPN
of Tubes ____ Dil._____ Thru___ Fecal Coliform____
_X_SM37 Enterolert
___SM38 A1 Fecal Coliform

Must Be Completed For Legal Sample	**Container**		**Preservative Added**		
Test Code	Number	Type	By Lab	By Collector	Special Instructions
Ammonia-N					To be analyzed by ESS
TKN					To be analyzed by ESS

Chain of Custody

Relinquished By	Date	Time	Received By	Date	Time	Comments

SAMPLE SUBMISSION FORM (rev. DEM 04/28/2011)

Figure 4. RIDEM Ambient River Monitoring Program Sampling Event Form

1 Sampling Event Information General Area: Date:

- ☐ Sent email notification to DOH?
- ☐ Label Blank bottles and put in cooler
- ☐ Posted Float Plan at Project Manager's cube (note: Who / Where / Why / Which vehicle)

2 Weather

Current Conditions *Temp:* *Barometric Pressure:* *(online or measured?)*

% Chance of Rain forecasted today: Circle one: Overcast Clear Scattered Clouds

_____ % @ Providence Airport -- Warwick (NOAA): Time of Departure from Foundry: _____

_____ % @ Smithfield (NOAA):

_____ % @ Westerly (NOAA): Time of Arrival at HEALTH: _____

_____ % @ Weather.com zipcode:

_____ % @ weatherunderground.com zipcode: Time of Arrival at Foundry: _____

2-day Weather History (amount of precipitation in the last 48 hours must be ≤ 0.10 inches)

_____ in. @ Providence Airport (Warwick) between (days/times) _____

_____ in. @ Smithfield between (day/times)_____

_____ in. @ Westerly between (days/times)_____

3 Required Sample Bottle Sets:

_____ =Total Number of Stations Sampling Today (****note number of DUPS and BLANKS)

_____ = Number of Sets of "*Suite 1*" (5 bottles: conventionals, nutrients, entero)

_____ = Number of Sets of "*Suite 1 + metals*" (6 bottles: conventionals, nutrients, entero)

_____ = Number of Sets of "*Suite 1 + Metals + Fe(or Cu)*" (6 bottles: conventionals, nutrients, metals)

_____ = Number entero only bottles:

Other data to collect today: (circle) **habitat data** **shade** **flow** **periphyton**

measured or USGS gage?

4 Field Gear Inventory (check box when packed and write a note if we need to order more or resolve any problems)

☐ Coolers with Ice	☐ YSI meter # _____	☐ Orange Vests
☐ Sample Bottles	☐ Extra YSI batteries	☐ POWDER FREE gloves
☐ Sampling basket/bucket & rope	☐ Camera w/ charged battery	☐ First Aid Kit
☐ Waders or Hip boots	☐ Sprayer for waders	☐ Safety Hats
☐ Safety Cones	☐ meter measuring tape	☐ Hand sanitizer/wipes
☐ Sampling Wand	☐ bottled DI water for FEB	☐ flow meter/staff

5 Paperwork to bring (in metal clipboard)

☐ Chain of Custody Forms	☐ Directions (list of station order)	☐ YSI data Collection Sheets
☐ Labels for Sample Bottles	☐ site specific plans	☐ ICE emergency sheets
☐ List of carwashes/gas stations	☐ Pens/Pencil/sharpies	☐ Map/atlas

6 Helpful things to bring (but not required)

☐ Sunscreen	☐ Lunch	☐ cell phone
☐ Bugspray	☐ Sunglasses/hat	☐ Towel/dry clothes
☐ Technu	☐ Garbage bag/sample bags	☐ Clippers

END OF THE DAY REMINDERS (please initial who will do this and check off when completed, cross out if NA)

___ Re-fuel Vehicle	___ Return Car Keys	___ Restock Ice in Freezer
___ Pick up bottles at HEALTH	___ Charge Camera Battery	___ Email New Bottle Order
___ Refill Blue Distilled Water at HEALTH		___ Enter YSI 85 Data
___ Download Pictures from Camera		___ Download ProPlus Data

Figure 5. Map of 2011 Ambient River Monitoring Stations in the Wood-Pawcatuck River Basin

Figure 6. TRAINING DOCUMENTATION FORM (Front)

Signatures below indicate _____ has received a copy of the *RIDEM Quality Assurance Project Plan (QAPP) for Rhode Island Ambient River Monitoring Program* from the RIDEM/OWR Project Manager. _____ has read and understands the document, and has been given the opportunity to ask any questions pertaining to policies and procedures described herein. The undersigned has received appropriate training in these QAPP procedures and has also read the associated Standard Operating Procedures. This original training documentation form will be kept on file with the QA Manager and personnel may be provided with a copy if requested. Subsequent field assessments will be recorded below to document that the Project Manager periodically evaluates said personnel in the field to insure conformance with this QAPP.

_____	_____	_____
Printed Name	Signature	Date
_____	_____	_____
Project Manager	Signature	Date

Field Crew Data Collection Training Documentation

To ensure field operations are in compliance with the project data quality objectives indicated in this QAPP, the Project Manager will periodically conduct a Field Assessment to evaluate personnel conformance with the QAPP and associated SOPs.

Results of the Field Assessments will be documented below to indicate conformance or non-conformance (or if not evaluated, indicate N/A). Should the undersigned fail to comply with procedures outlined herein the RIDEM/OWR Project Manager will consult with the RIDEM/OWR Quality Assurance Manager and take corrective action to retrain personnel in proper procedures.

Trained Field Personnel: Project Manager Initials:

Trianing Date:	**Task Evaluated**	**Performance Assessment Result: -Conforms to QAPP -Non-conformance -Not evaluated (N/A)**	**Corrective Actions Taken or other comments**
	Calibration Procedures and Documentation		
	Field Data Recording		
	Sampling Methodology		
	Sample handling, storage and labeling		
	Chain of Custody Procedures and Documentation		

TRAINING DOCUMENTATION FORM (back)

Evaluated Field Personnel: Project Manager Initials:

Field Assessment Date:	**Task Evaluated**	**Performance Assessment Result:** **-Conforms to QAPP** **-Non-conformance** **-Not evaluated (N/A)**	**Corrective Actions Taken or other comments**
	Calibration Procedures and Documentation		
	Field Data Recording		
	Sampling Methodology		
	Sample handling, storage and labeling		
	Chain of Custody Procedures and Documentation		

Evaluated Field Personnel: Project Manager Initials:

Field Assessment Date:	**Task Evaluated**	**Performance Assessment Result:** **-Conforms to QAPP** **-Non-conformance** **-Not evaluated (N/A)**	**Corrective Actions Taken or other comments**
	Calibration Procedures and Documentation		
	Field Data Recording		
	Sampling Methodology		
	Sample handling, storage and labeling		
	Chain of Custody Procedures and Documentation		

Figure 7. Teflon Basket Sampler to use to collect samples from bridges where wading is not possible.

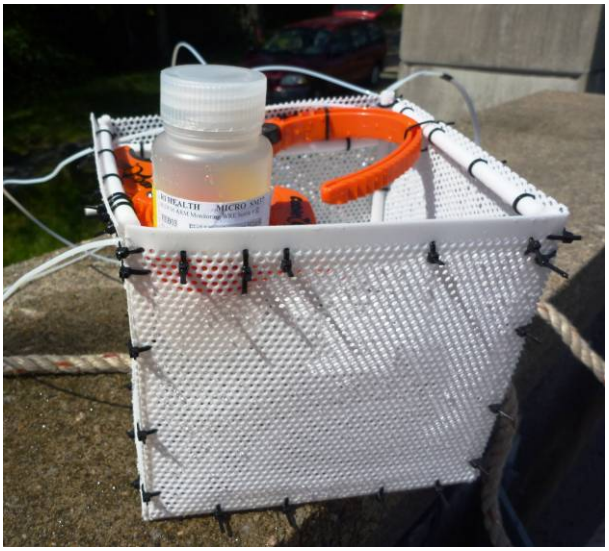

Figure 8. To avoid contaminating field gear (such as waders which are difficult to decontaminate in the field between sites) and to prevent the spread of invasive species such as didymo or Asian clam larvae, a sampling pole is used to collect samples from streams without wading into them. This new sampling technique also avoids exacerbating streambank erosion, disturbing stream bottom sediments, or disrupting riparian buffers.

Table 11. Ambient River Monitoring Stations 2011

Station location and schedule of water chemistry samples collected for RIDEM – Ambient River Monitoring Program May 2011 – Fall 2011. See Table 12 for explanation of analytical methods for conventionals, nutrients, metals, enterococci and Chl a.

				Water Chemistry Suites[A] analyzed by HEALTH				
Station ID	**River Name**	**Latitude**	**Longitude**	**May-11**	**Jun-11**	**Jul-11**	**Aug-11**	**Sep-11**
LPK01	Pawcatuck River & Tribs	41.40251	-71.83067	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
LPK02	Mastuxet Brook & Tribs	41.35839	-71.81504	P1	P1	P1	P1	P1
LPK03	Mastuxet Brook & Tribs	41.34676	-71.81543	S1	P1	P1	S1	S1
PAW01	Pawcatuck River & Tribs	41.3975	-71.84158	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW05	Chipuxet River & Tribs	41.50616	-71.53112	S1 + metals + Fe	P1	P1	S1 + metals + Fe + Chl *a*	S1 + metals + Fe
PAW09	Chickasheen Brook & Tribs	41.49001	-71.55848	--	--	--	Chl *a*	--
PAW11	Mile Brook	41.41645	-71.79055	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW12	Ashaway River & Tribs	41.42495	-71.78970	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW13	Parmenter Brook & Tribs	41.44738	-71.79005	S1	P1	P1	S1 + Chl *a*	S1
PAW15	Tomaquag Brook & Tribs	41.44299	-71.76027	S1	P1	P1	S1 + Chl *a*	S1
PAW17	Perry Healy Brook & Tribs	41.37473	-71.71612	S1 + metals	P1	P1	S1 + metals + Chl *a*	S1 + metals
PAW20	Meadow Brook	41.46639	-71.69004	S1	P1	P1	S1 + Chl *a*	S1
PAW22	Meadow Brook	41.48738	-71.67657	S1	P1	P1	S1	S1
PAW25	Taney Brook	41.46058	-71.64782	S1	P1	P1	S1 + Chl *a*	S1
PAW26	Pasquiset Brook	41.44373	-71.62683	S1	P1	P1	S1	S1
PAW28	Beaver River	41.46409	-71.62784	S1 (no P1)	--	--	S1 (no P1)	S1 (no P1)
PAW29	Beaver River & Tribs	41.49253	-71.62800	S1	P1	P1	S1 + Chl *a*	S1
PAW34	Alewife Brook	41.42923	-71.56845	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW35	Chipuxet River	41.48253	-71.55113	S1	P1	P1	S1 + Chl *a*	S1
PAW36	Chipuxet River	41.51791	-71.52558	hardness + metals + Fe	--	--	hardness + metals + Fe	hardness + metals + Fe
PAW37	Chipuxet River	41.53025	-71.51733	P1	P1	P1	P1	P1
PAW38	Pawcatuck River & Tribs	41.40733	-71.74820	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW39	Pawcatuck River & Tribs	41.39923	-71.79993	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW40	Pawcatuck River	41.44521	-71.62693	P1	P1	P1	P1	P1

Table 11 (continued). Station location and schedule of water chemistry samples collected for RIDEM – Ambient River Monitoring Program May 2011– Fall 2011. See Table 6 for explanation of analytical methods for conventionals, nutrients, metals, enterococci and Chl a.

				Water Chemistry Suites[A] analyzed by HEALTH				
Station ID	**River Name**	**Latitude**	**Longitude**	**May-11**	**Jun-11**	**Jul-11**	**Aug-11**	**Sep-11**
PAW41	Pawcatuck River & Tribs	41.44765	-71.63665	S1	P1	P1	S1	S1
PAW43	Pawcatuck River & Tribs	41.43281	-71.69412	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
PAW45	White Brook	41.47043	-71.66920	S1 (no P1)	--	--	S1 (no P1)	S1 (no P1)
PAW49	Pawcatuck River & Tribs	41.41744	-71.82342	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
QN01	Usquepaug River	41.47599	-71.60713	S1	P1	P1	S1	S1
QN03	Glen Rock Brook & Tribs	41.52221	-71.61242	S1	P1	P1	S1	S1
QN04	Sherman Brook	41.51821	-71.60405	S1	P1	P1	S1 + Chl *a*	S1
QN06	Locke Brook & Tribs	41.53761	-71.58581	S1	P1	P1	S1 + Chl *a*	S1
QN08	Sodom Brook	41.56499	-71.56408	S1	P1	P1	S1 + Chl *a*	S1
QN09	Queens River & Tribs	41.56256	-71.54817	S1	P1	P1	S1 + Chl *a*	S1
QN10	Queens Fort Brook & Tribs	41.54903	-71.54474	S1 + metals + Fe	P1	P1	S1 + metals + Fe + Chl *a*	S1 + metals + Fe
QN13	Dutemple Brook	41.57234	-71.57206	P1	P1	P1	P1	P1
QN11	Queens River & Tribs	41.57871	-71.54313	S1	P1	P1	S1	S1
QN20	Queens Fort Brook	41.57560	-71.52508	S1	P1	P1	S1	S1
QN21	Queens River & Tribs	41.51711	-71.60041	S1	P1	P1	S1	S1
QNAB	Queens River & Tribs	41.53899	-71.56862	S1	P1	P1	S1 + Chl *a*	S1
WRB02	Wood River & Tribs	41.4371	-71.72240	S1 + metals	P1	P1	S1 + metals	S1 + metals
WRB03	Wood River & Tribs	41.46016	-71.71858	S1	P1	P1	S1	S1
WRB04	Canonchet Brook & Tribs	41.47764	-71.72935	P1	P1	P1	P1	P1
WRB05	Canonchet Brook & Tribs	41.47799	-71.73450	S1 + metals	P1	P1	S1 + metals	S1 + metals
WRB06	Canonchet Brook & Tribs	41.48253	-71.74629	S1 + metals + Fe	P1	P1	S1 + metals + Fe	S1 + metals + Fe
WRB07	Canonchet Brook & Tribs	41.49446	-71.75049	S1 + metals + Fe	P1	P1	S1 + metals + Fe + Chl *a*	S1 + metals + Fe
WRB08	Wood River & Tribs	41.49841	-71.71628	S1	P1	P1	S1	S1
WRB09	Brushy Brook & Tribs	41.50783	-71.71590	S1	P1	P1	S1	S1

Table 11 (continued). Station location and schedule of water chemistry samples collected for RIDEM – Ambient River Monitoring Program May 2011 – Fall 2011. See Table 6 for explanation of analytical methods for conventionals, nutrients, metals, enterococci and Chl a.

				Water Chemistry Suites[A] analyzed by HEALTH				
Station ID	**River Name**	**Latitude**	**Longitude**	**May-11**	**Jun-11**	**Jul-11**	**Aug-11**	**Sep-11**
WRB11	Moscow Brook & Tribs	41.52355	-71.75106	S1	P1	P1	S1 + Chl *a*	S1
WRB12	Brushy Brook & Tribs	41.53231	-71.74354	P1	P1	P1	P1	P1
WRB13	Canob Brook	41.52123	-71.69150	Fe only	--	--	Fe only	Fe only
WRB14	Wood River	41.52225	-71.69152	S1	P1	P1	S1	S1
WRB15	Wood River	41.54041	-71.69612	S1	P1	P1	S1	S1
WRB16	Baker Brook	41.54225	-71.69322	P1	P1	P1	P1	P1
WRB17	Wood River & Tribs	41.57410	-71.72054	S1	P1	P1	S1	S1
WRB18	Parris Brook & Tribs	41.56487	-71.72587	S1	P1	P1	S1 + Chl *a*	S1
WRB22	Falls River & Tribs	41.58018	-71.72120	S1	P1	P1	S1 + Chl *a*	S1
WRB23	Breakheart Brook & Tribs	41.58789	-71.70923	S1	P1	P1	S1 + Chl *a*	S1
WRB27	Phillips Brook & Tribs	41.62132	-71.73102	P1	P1	P1	P1	P1
WRB28	Acid Factory Brook & Tribs	41.63400	-71.72187	P1	P1	P1	P1	P1
WRB31	Coney Brook & Tribs	41.63347	-71.77196	S1 + Cu	P1	P1	S1 + Cu	S1 + Cu

[A] S1 = Conventionals, nutrients, enterococci

P1 = enterococci
Metals include Cd, Cu, Pb, Zn;
(Total Fe will be analyzed as needed)
For complete list of parameters, see Table 12

Table 12. 2011 Parameters analyzed by HEALTH
Chemical parameters, analytical methods and Standard Operating Procedure Documents followed by RI State Health Laboratories to analyze water samples for the RIDEM Ambient River Monitoring Program.

Parameter	Abbreviation	Units	Method	Standard Operating Procedure Document
Conventionals				
Chloride	Cl	mg/L	EPA 300.0 Rev. 2.1 Ion Chromatography Lachet	RIDOH SOP WL20 rev. 3 Chloride
Hardness	--	mg/L	SM2340 C Titration	RIDOH SOP WL22 rev. 4 Hardness
pH	pH	pH units	SM 4500-H+ B Electrode Orion Instrument model 720 A	RIDOH SOP WL13 rev. 6 PH
Sodium	Na	mg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1
Total Suspended Solids	TSS	mg/L	SM2540 D Gravimetric	RIDOH SOP WL 7 SOLIDS rev. 3 TSS
True Color	--	CU	Observation relative to standard	RIDOH SOP WL04 rev. 7
Turbidity	--	NTU	EPA 180.1 Nephelometric Turbidimeter	RIDOH SOP WL1 Turbidity
Nutrients				
Total ammonia [A]	NH_3-N (total)	mg/L	EPA 350.1 Rev. 2.0 Semi-automated Colorimetry	ESS Laboratory SOP 40_0024L
Total Kjeldahl Nitrogen [A]	TKN	mg/L	EPA 351.2 Semi-automated Colorimetry	ESS Laboratory SOP 40_0019B Total Kjeldahl Nitrogen
Nitrate-Nitrite as Nitrogen, Dissolved	NO_2 + NO_3-N	mg/L	EPA 353.2 Rev. 2.0 Autoanalyzer – Lachet	RIDOH SOP WL16 rev. 4 nitrate & RIDOH SOP WL56 rev. 5 nitrite
Ortho-phosphate	PO4-P	mg/L	EPA 300.0 Rev. 2.1 Ion Chromatography	RIDOH SOP WL17 Ortho-phosphate
Total Phosphorus	TP	mg/L	SM 4500 P B.5 & E Persulfate Digestion and Ascorbic Acid Method	RIDOH SOP WL12 rev. 3 Total Phosphorus
Chlorophyll *a*	Chl *a*	mg/L	EPA 446.0 Rev. 1.2 Spectrophotometry	RIDOH SOP TO32
Pathogens				
Enterococci	Entero	Entercocci/ 100 mL	Enterolert	RIDOH SOP SM 37 Enterolert
Metals				
Cadmium	Cd (dissolved)	µg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1
Copper	Cu (dissolved)	µg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1
Lead	Pb (dissolved)	µg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1
Zinc	Zn (dissolved)	µg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1
Total Iron	Fe (total)	µg/L	EPA 200.8 ICP-MS	RIDOH SOP WL ICPMS rev. 1

[A] Samples are analyzed by a laboratory certified in RI to test these parameters in non-potable water.

Note: Dissolved Oxygen, water temperature, conductivity, specific conductance, and salinity are measured in the field using YSI instrumentation. Total Nitrogen is reported as the addition of the following fractions: (NO_3-N) + (TKN)

Table 13. 2011 Holding Times and Measurement Performance Criteria

Sample holding times, lab quantitation limits, and method detection limits of each parameter analyzed by RI State Health Laboratories for the RIDEM Ambient River Monitoring Program.

Parameter*	Abbreviation	Units	Max holding time	Quantitation Limit (QL)	Method Detection Limit (MDL)
Conventionals					
Chloride	Cl	mg/L	28 days	0.2	0.02
Hardness	--	mg/L	6 months	–	–
pH	pH	pH units	immediately	–	–
Sodium	Na	mg/L	6 months	1	0.05
Total Suspended Solids	TSS	mg/L	3 days	1.0	–
True Color	–	CU	48 hours	–	–
Turbidity	–	NTU	24 hours	0.2	–
Nutrients					
Total ammonia [A]	NH3-N (total)	mg/L	7 days	0.05	0.02
Total Kjehldahl Nitrogen [A]	TKN	mg/L	28 days	0.2	–
Nitrate-Nitrite as Nitrogen, Dissolved	NO3-N	mg/L	28 days	0.05	0.01
Ortho-phosphate	PO4-P	mg/L	28 days	0.02	0.01
Total Phosphorus	TP	mg/L	28 days	0.02	0.01
Chlorophyll *a*	Chl *a*	mg/l	24 hours (unfiltered) 21 days (filtered)	0.1	0.046
Pathogens					
Enterococci	Entero	Entercocci per 100 mL	6 hours	< 1	–
Metals					
Cadmium	Cd	µg/L	6 months	1.0	0.05
Copper	Cu	µg/L	6 months	1.0	0.13
Lead	Pb	µg/L	6 months	1.0	0.08
Zinc	Zn	µg/L	6 months	20	1.13
Total Iron	Fe (total)	µg/L	6 months	20	8.42

[A] Samples are analyzed by a laboratory certified in RI to test these parameters in non-potable water.

Note: Dissolved Oxygen, water temperature, conductivity, specific conductance, and salinity are measured in the field using YSI instrumentation. Total Nitrogen is reported as the addition of the following fractions: (NO_3-N) + (TKN)

Appendix G Addendum. HEALTH Analytical Measurement Performance Criteria.

Sampling SOP	RIDOH SOP TO32
Medium/Matrix	Surface Water
Analytical Parameter	Chlorophyll *a*
Concentration Level	mg/L

Data Quality Indicator	Analytical Method/ SOP Reference/ Laboratory	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S/A)
Method Blank/ Trip or Field Blank	Spectrophotometry / SOP TO32 / RIDOH	<0.10 mg/L (RL)	Accuracy/bias Contamination	A
Quality Control Sample - QCS	Spectrophotometry / SOP TO32 / RIDOH	70 – 130% recovery	Accuracy/bias Contamination	A
Lab Duplicates	Spectrophotometry / SOP TO32 / RIDOH	<30% RPD	Precision	A
Field Duplicates	Spectrophotometry / SOP TO32 / RIDOH	<50% RPD	Accuracy	S/A
Data Review 100%	Spectrophotometry / SOP TO32 / RIDOH	Data collected are determined to be useable	Data - Completeness	A

Sampling SOP	RIDOH SOP WL04 rev. 7
Medium/Matrix	Surface Water
Analytical Parameter	True Color
Concentration Level	None (CU)

Data Quality Indicator	Analytical Method/ SOP Reference/ Laboratory	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S/A)
Laboratory Field /Trip Reagent Blank	Observation relative to standard / SOP WL04 rev. 7 / RIDOH	No MDL's	Accuracy/bias contamination	S/A
QCS-Quality Control Sample	Observation relative to standard / SOP WL04 rev. 7 / RIDOH	Within Manufacturer's limit	Accuracy/bias contamination	A
Lab Duplicates	Observation relative to standard / SOP WL04 rev. 7 / RIDOH	<10%RPD	Precision	A
Field Duplicates	Observation relative to standard / SOP WL04 rev. 7 / RIDOH	<20% RPD	Accuracy	S/A
Data Review	Observation relative to standard / SOP WL04 rev. 7 / RIDOH	Data collected determined to be useable	Data Completeness	A

APPENDIX H

NUMERIC NUTRIENT CRITERIA DEVELOPMENT FIELDWORK TO BE CONDUCTED IN COORDINATION WITH THE AMBIENT RIVER MONITORING PROGRAM

Task Description

This new Appendix in the ARM QAPP Addendum is intended to describe supplemental fieldwork being conducted in conjunction with the current Ambient River Monitoring (ARM) program for the purpose of numeric nutrient criteria development. This fieldwork initiative will be incorporated into the ARM program for the current rotation cycle 2011-2014.

Project Organization

The fieldwork to be conducted for numeric nutrient criteria will be undertaken by RIDEM/OWR permanent, contractual, and seasonal personnel. Jane Sawyers, Project Manager for numeric nutrient criteria development, will serve as the Supplemental Nutrient Fieldwork Team Leader and will be in charge of organizing sample and field data collection for the supplemental fieldwork only.

Background

The U.S. Environmental Protection Agency (EPA) has directed all states and territories to strengthen narrative criteria for nutrients by development of specific numeric nutrient criteria. EPA guidance further recommends that acceptable levels of total phosphorus (TP), total nitrogen (TN), chlorophyll *a* (chl *a*), and turbidity in rivers and streams be established (USEPA 2000). The preferred approach is to develop criteria that reflect local conditions and protect specific uses of surface waters. A review of data available to support nutrient criteria development for Rhode Island rivers and streams revealed an information gap on the primary production response to nutrients, especially benthic algae and some of the important associated habitat parameters. Recognizing that numeric nutrient criteria development requires appropriate biological response and habitat data, RIDEM has planned a data collection effort in coordination with the rotating basin schedule of the ARM program. The collection of benthic algae and associated habitat data will occur in a select number of the wadeable ARM sites each year of the entire rotation 2011-2014.

It has been the experience of some states that the relationship between elevated nutrient concentrations and biological response does not produce a threshold that allows for identification of numeric nutrient criteria. Furthermore, several New England states have been challenged with how to appropriately address water bodies that exhibit elevated nutrient concentration without reaching nuisance or adverse levels of conventional biological response parameters (NEIWPCC 2011). Therefore, Rhode Island plans to collect a number of benthic algal response variables and habitat measurements to address the potential biological and management issues in stream nutrient criteria development.

RIDEM/OWR plans to measure taxonomic identification of diatoms, chlorophyll *a* abundance of benthic algae, coverage of benthic algae, and percent coverage of aquatic macrophytes including duckweed (*Lemna minor*) and watermeal (*Wolffia sp.*) in wadeable streams.

Methods

Site Selection

Sites for numeric nutrient criteria development will be selected from the list annually generated by the ARM Project Team as described in Section II.1 of the ARM QAPP. From this list, only wadeable sites will be reviewed for numeric nutrient criteria development fieldwork. Approximately 20 sites will be selected per year, depending on funding and staff availability. Based on geographic analysis of the streams by RIDEM, an equal division of high and low gradient sites will be selected. Since the statistical analysis of the nutrient and response data necessitates a range of nutrient conditions, the historical data available from RIDEM's water quality database, WQUAL, will be consulted for sites historically high and low in both TP and TN. From this information, sites encompassing the range of possible conditions will be selected prior to the field season.

Sampling Methods

The procedures to be performed at the numeric nutrient criteria sites are documented in SOPs and the EPA Habitat Assessment Field Data Sheet-Low Gradient Streams, which are included in this addendum. The included SOPs are listed in the table below:

SOP #	Title
SOP-WR-W-35	Standard Operating Procedure for Stream Canopy Measurements by Densiometer
SOP-WR-W-36	Standard Operating Procedure for Measurement of Benthic Algae Cover by Viewing Bucket
SOP-WR-W-37	Standard Operating Procedure for Collection of Benthic Algae from Natural and Artificial Substrates

Two site visits will be required in late July through August to the selected sites. Unlike the water quality sampling described in the ARM QAPP, the supplementary sampling does not require dry weather prior to sampling. It does require low flow conditions typical of late summer in Rhode Island for maximum potential of benthic algae growth. The Supplemental Nutrient Fieldwork Team Leader, Jane Sawyers, will consult with ARM Project Manager, Katie DeGoosh and Field Data Collection Team Leader, Mark Nimiroski, and any field staff that have recently visited the selected sites regarding flow conditions.

The first sampling event for the supplemental fieldwork will include the procedures described in SOP-WR-W-35 and SOP-WR-W-36. The first sampling event will also include the implementation of Sections 5.2.1 through 5.2.6 of SOP-WR-W-37, placement of the artificial substrates. The second sampling event will complete Sections 5.2.7 through 5.2.9 of SOP-WR-W-37, retrieval of the artificial substrates and sampling the natural substrates. Additionally, at low gradient sites, the second sampling event will include completion of the EPA Habitat Assessment Field Data Sheet-Low Gradient Streams.

Data Quality Objectives and Measurement Performance Criteria

Data Quality Objectives

The supplemental fieldwork will operate under the data quality objectives stated in the ARM QAPP. The relevant quality assurance procedures of the ARM QAPP will be used to verify the use of proper, consistent field procedures, handling measures, laboratory analyses, and database management activities:

- Standard Operating Procedures (SOPs) will be implemented during sampling and field data collection (see Appendix H).
- EPA-approved, standardized methods will be adhered to for all chemical analysis procedures;
- Qualified, trained scientists will perform the sample collection and laboratory analyses;
- Chain of Custody forms will be completed when handling samples and transferring custody from field crew to both the RIDOH Laboratories as well as the authorized state vendor for analytical laboratory services. (ARM Figure 2);
- One trip blank (sample bottles filled with DI water in the lab) for each day of sampling will be transported by each field crew ensure there is no contamination of sampling containers in the field during transportation;
- Trip blanks will only be collected on the second sampling event when chlorophyll *a* samples will be collected.

Data Quality Indicators

The same data quality indicators (DQI) as stated in the ARM QAPP will be used for the chlorophyll *a* laboratory samples, except for Data Comparability and Precision of artificial substrate collection. The precision of the artificial substrate chlorophyll *a* will take place at 10% duplicate sites. The samples sent to a contractor for diatom taxonomy will use the same Data Representativeness and Sampling Completeness DQI as stated in the ARM QAPP. The Precision of the supplementary diatom taxonomy fieldwork will be assessed by collection of 10% duplicate stations. A relative percent difference (RPD) on the percent or raw abundance data is not an appropriate measure of precision for duplicate taxonomy samples. The species abundance duplicate samples will be assessed by cluster confidence intervals. The duplicate samples must fall within the equivalent of a 95% confidence interval. The contracted laboratory will be required to prepare as part of a final report the internal QAQC checks included a measure between analysts, which will indicate the major source of potential Bias. Because all of the supplementary fieldwork is data that has never been collected in Rhode Island, the Data Comparability will be assessed by reviewing relevant literature studies and relationships and communicating with other states about the results from similar studies.

Instrument/Equipment Testing, Inspection, Maintenance, and Calibration

The methods that will be employed do not require calibration. The methods also do not require electronic instruments. All field equipment will be inspected as required in the respective SOPs. At a minimum, equipment will be inspected by the field analyst prior to a sampling event and annually by the Numeric Nutrient Criteria Development Project Manager, Jane Sawyers.

Inspection for Supplies and Consumables

The inspection of supplies will occur as stated in the ARM QAPP, except that Jane Sawyers will perform the duties of the Project Manager and Supplemental Nutrient Fieldwork Team Leader for the supplemental fieldwork only. The samples sent to the contracted laboratory for diatom taxonomy will require a preservative. The Numeric Nutrient Criteria Development Project Manager, Jane Sawyers, will ensure that the preservative is received by RIDEM and was not damaged in shipment (i.e. no leaking contents; lid securely attached).

Non-direct Measurements

The supplemental fieldwork will not require dry conditions as described in the ARM QAPP. However, high flows are a concern for the artificial substrate deployment. As described earlier, Jane Sawyers will consult with the ARM Project Manager, Katie DeGoosh, and other staff who have been to the sites recently regarding high flows. The USGS website for real-time stream data may also be consulted: http://waterdata.usgs.gov/nwis/rt

Data Validation and Usability

As Project Manager of the numeric nutrient criteria project, Jane Sawyers will complete all requirements stated in the ARM QAPP Sections III.1 through Sections III.3 for data generated from the supplementary fieldwork only.

Assessment and Oversight

As Project Manager of the numeric nutrient criteria project, Jane Sawyers will complete all requirements stated in the ARM QAPP Sections IV.1 through Sections IV.2 for data generated from the supplementary fieldwork only.

Standard Operating Procedure for Stream Canopy Measurements by Densiometer

SOP-WR-W-35

APPROVALS:

Deputy Chief of Water Resources:

Sue Kiernan	Sue Kiernan	8/12/11
Printed Name	Signature	Date

Quality Assurance Manager:

Connie Carey	Connie Carey	8/1/2011
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DISTRIBUTION

(x) Surface Water Monitoring & Assessment (Connie Carey) ..... By: cgc Date : 8/1/11

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

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

Title: Standard Operating Procedure for Densiometer Canopy Measurements
Originator Name: Jane Sawyers

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Standard Operating Procedure for Stream Canopy Measurements by Densiometer

1. APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in collecting canopy cover measurements in streams using a densiometer. 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 measurements of canopy cover in streams using a densiometer. 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 Densiometer – A convex or concave mirror with twenty-four ¼" square engraved on the surface.

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 canopy cover measurements for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance 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 it does not require any additional special training or certification.

To properly employ the densiometer, 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 use of the densiometer should be assisted by OWR staff who are accustomed to using the equipment.

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 densiometer is in proper operating condition prior to use (i.e. no cracks in the mirror or level; taped areas covered) and communicating to the project manager when equipment is in need of repair or replacement. The field analyst is also responsible for ensuring that all supplementary equipment (hand-held tally counter, waders, hip boots, etc.) is present and in working condition. 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 measurement 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 operates the densiometer 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 densiometer is maintained in proper operating condition annually. This includes ensuring the densiometer mirror and level are not cracked and the taped areas are covered. The project manager is also responsible for repairing the densiometer 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 review 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 USE OF DENSIOMETER

5.1.1 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Densiometer – convex, modified as described in Strickler (1959) (Figure 1, similar to Forestry Suppliers Item Number 43887)
- Datasheet or field notebook printed on waterproof paper (Figure 2; paper similar to Grainger Item Number 3XFR7)
- Hand-held tally counter (Similar to Grainger Item #2PAU4)
- Clipboard
- Pencil or Rite in the Rain Pen (similar to Forestry Suppliers Item Number 49237)
- Waders or hip boots

5.1.2 USING THE DENSIOMETER IN THE FIELD

For most purposes, the densiometer is used specifically for in situ canopy cover measurements taken directly in the field in streams. This method does not require sample containers or preservation.

5.1.3 RECORDING PARAMETER UNITS

The following units should be used when recording measurements taken with the densiometer:

Canopy cover.....# of dots

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 densiometer measurement is taken in the correct order. This procedure may disrupt fish and microscopic organisms, such as benthic macroinvertebrates, fish, and algae, which can interfere with other field procedures and sample collections in streams. Furthermore, this procedure can dislodge sediment, which can interfere with water quality

sample collections. Densiometer measurements should be measured after these samples have been collected.

5.2.2 DETERMINE THE LOCATION OF TRANSECTS AND SAMPLING POINTS

This procedure will typically occur in conjunction with SOP-WR-W-36 Standard Operating Procedure for Measurement of Benthic Algae Cover by Viewing Bucket. The procedure for determining the location of transects and sampling points are described in Sections 5.2.2 and 5.2.3 of SOP WR-W-36. Densiometer measurements should be taken at the same time as viewing bucket measurements.

5.2.3 TAKING THE CANOPY COVER MEASUREMENT

Each transect will have a left bank, middle, and right bank sampling point. At each of three transects, the field analyst will take measurements at all sampling points along each transect. At each transect, the field analyst will take one canopy measurement at the left bank sampling point, four canopy measurements at the middle sampling point, and one canopy measurement at the right bank sampling point (Figure 3). A total of 18 canopy cover measurements will be taken at each stream segment.

- The field analyst will enter the stream at the most downstream transect at the left bank sampling point (1A). Standing at the left bank sampling station, the field analyst will face the left bank. It is important to begin at the left bank, because it is the most downstream station. By starting at the most downstream station, the possibility for disruption of sediment will be minimized for other analyses.

- The field analyst will hold the densiometer 12”-18” in front of them with the mirrored surface closest to their body.

- The field analyst should raise or lower the densiometer’s height until it is 0.3m (a little less than 1ft) above the surface of the water.

- The field analyst should note the position of the bubble level in the lower right-hand corner of the densiometer face. The field analyst should rotate the densiometer until the air bubble is in the middle of the gray circle to indicate the densiometer is level. The field analyst should ensure that the densiometer stays level by observing the air bubble is in the middle of the gray circle throughout the procedure.

- The field analyst will move their head until it is just outside the field of view at the bottom of the triangle area of visible mirrored surface.

- The field analyst will observe and count the number of dots on the mirror obscured by canopy vegetation. The field analyst will use the hand-held tally counter to keep track of the number of dots obscured. The field analyst will read aloud the number of dots obscured by canopy vegetation. The recording field analyst will record the number of dots on the datasheet or in the appropriate field notebook.

  - Note: The dots are not marked on the face of the mirrored surface. The field analyst must observe the etched lines on the mirrored surface. The corners of the squares formed by the etched lines are the location of dots imagined by the field analyst (Figure 4).

  - Note: There are 17 available points. The field analyst will observe and report to the recording field analyst a number between 0 (no points covered) to 17 (all points covered).

- The field analyst move to the middle sampling station (1B). The field analyst will face upstream and repeat the above procedure to determine the number of dots obscured by canopy vegetation.

  - The field analyst will turn to face the left bank. The field analyst will repeat the above procedure to determine the number of dots obscured by canopy vegetation.

  - The field analyst will turn to face downstream. The field analyst will repeat the above procedure to determine the number of dots obscured by canopy vegetation.

  - The field analyst will turn to face the right bank. The field analyst will repeat the above procedure to determine the number of dots obscured by canopy vegetation.

- The field analyst move to the right bank sampling station (1C). The field analyst will face the right bank and repeat the above procedure to determine the number of dots obscured by vegetation.

- The field analyst will move to the next transect upstream. The field analyst will locate and move to the left bank sampling station (2A). The field analyst will repeat the above procedure for all sampling points located on transect 2.

- The field analyst will then move upstream to transect 3 and locate the left bank sampling station (3A). The field analyst will repeat the above procedure for all sampling stations located on transect 3.

- Sampling is complete when 18 canopy measurements have been recorded by the recording field analyst.

6. QUALITY CONTROL

6.1 QUALITY CONTROL

Quality control will be assessed by the recording field analyst repeating the measurements at 10% of stream segments. This will give a measure of bias for 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

Kaufmann, P.R., P. Levine, E.G. Robinson, C. Seeliger, and D.V. Peck. 1999. *Quantifying Physical Habitat in Wadeable Streams*. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, D.C.

OWEB. 1999. “Chapter 14: Stream Shade and Canopy Cover Monitoring Methods.” *Water Quality Monitoring: Technical Guide Book*. Oregon Watershed Enhancement Board. http://www.oregon.gov/ODF/privateforests/docs/ShadeProt.pdf?ga=t

Strickler, G.S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. Forest Service, U.S. Department of Agriculture, Research Note No. 180.

Figure 1. <u>Densiometer Modification from Strickler (1959)</u>

J. Sawyers

Figure 2. Densiometer Datasheet for Monitoring Section Sampling Events

Densiometer Canopy Measurements

Stream Segment : _____ Town: _____

Site Number: _____

Date: _____ Military Time: _____ Collectors _____

Sampling Point	Upstream	Left bank	Downstream	Right bank
1A				
1B				
1C				
2A				
2B				
2C				
3A				
3B				
3C				

Figure 3. Canopy Measurements Taken at Each Sampling Station

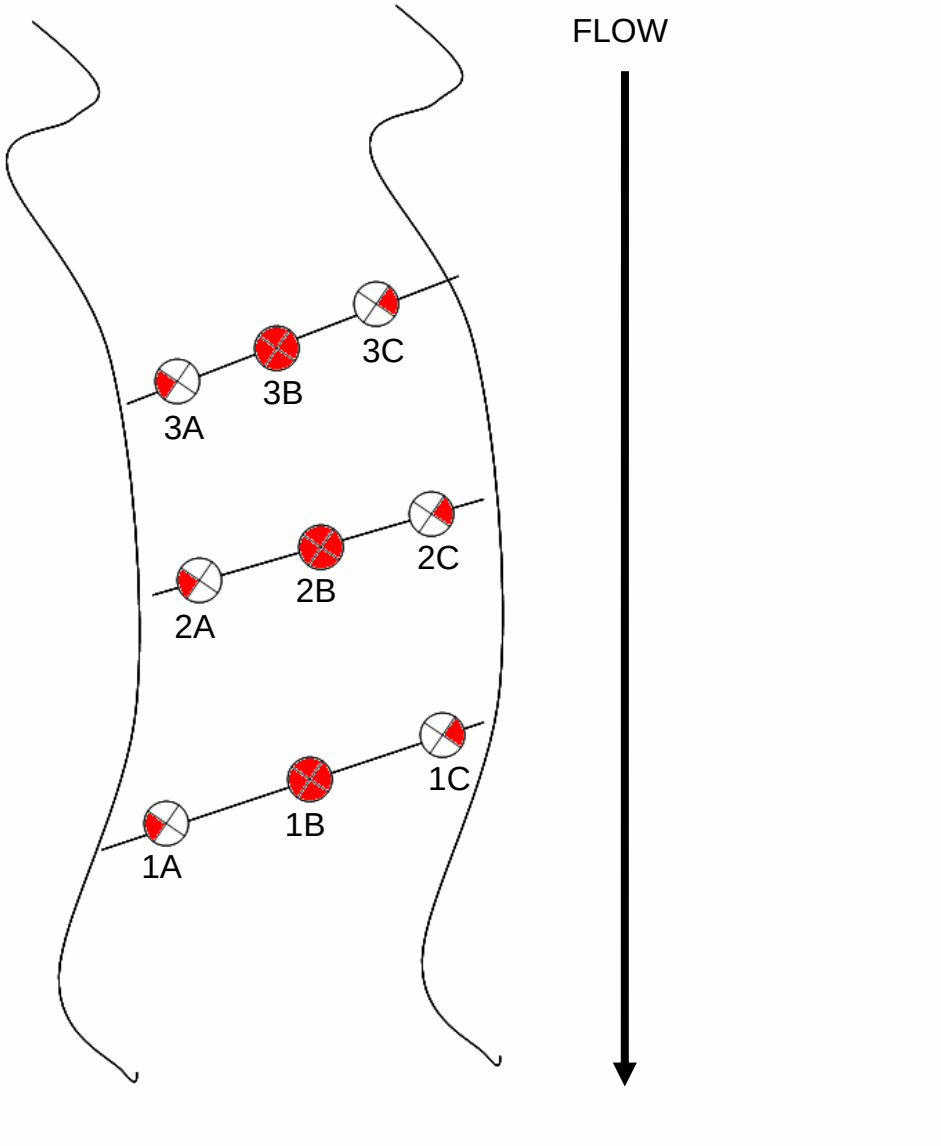

Figure 4. Location of Coverage Points on Densiometer

J. Sawyers

Standard Operating Procedure for Measurement of Benthic Algae Cover by Viewing Bucket

SOP-WR-W-36

APPROVALS:

Deputy Chief of Water Resources:

Sue Kiernan	Sue Kiernan	8/12/11
Printed Name	Signature	Date

Quality Assurance Manager:

Connie Carey	Connie Carey	8/1/2011
Printed Name	Signature	Date

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

Title: Standard Operating Procedure for Measurement of Benthic Algae Cover by Viewing Bucket
Originator Name: Jane Sawyers

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Standard Operating Procedure for Measurement of Benthic Algae Cover by Viewing Bucket

1. APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in collecting benthic algae cover measurements in shallow, wadeable stream reaches using a viewing bucket. 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 measurements of benthic algae coverage in wadeable streams using a viewing bucket. 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 Benthic algae – Micro- and macroalgae growing on the bottom of a stream or lake

3.4.1 Macroalgae – Algae that have either a large colonial structure or a plant like structure visible to the naked eye

3.4.2 Microalgae – Algae that are either unicellular or colonial without structure visible to the naked eye

3.5 Wadeable stream – Perennial streams 1st through 3rd order draining a watershed area of at least 0.5mi^2 and with a maximum depth less than or equal to 1.0m.

3.5.1 Perennial stream – A stream with continuous flow year-round under typical conditions

3.6 Riffle – A section of stream characterized by shallow, fast-flowing water with the water surface broken by the presence of rocky substrate

3.7 Pool – A section of stream characterized by deep, slow-moving water with the surface not broken by the presence of rocky substrate

3.8 Run – A section of stream that is characterized by fast-flowing water with the surface not broken by the presence of rocky substrate

3.9 Riparian area – The area of land immediately adjacent to the stream

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 benthic algae cover measurements with a viewing bucket for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance 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 additional special training or certification is not required.

To properly employ the viewing bucket, 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 use of the viewing bucket should be assisted by OWR staff who are accustomed to using the equipment.

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 viewing bucket is in proper operating condition prior to use (i.e. no cracks in the acrylic sheet; white dot pattern apparent; silicon seal water-tight) and communicating to the project manager when equipment is in need of repair or replacement. The field analyst is also responsible for ensuring that all supplementary equipment (waders/hip boots, etc.) is present and in working condition. 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 measurement 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 operates the viewing bucket 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 viewing bucket is maintained in proper operating condition annually. This includes ensuring the acrylic sheet is not cracked, the dot pattern is apparent, and the silicon seal is water-tight. The project manager is also responsible for repairing the viewing bucket 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. If the measurement is being done on a stream that is not accessible by foot, the project manager will determine if the measurement can be done from another location on the stream. Further, the project manager shall ensure annual review 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

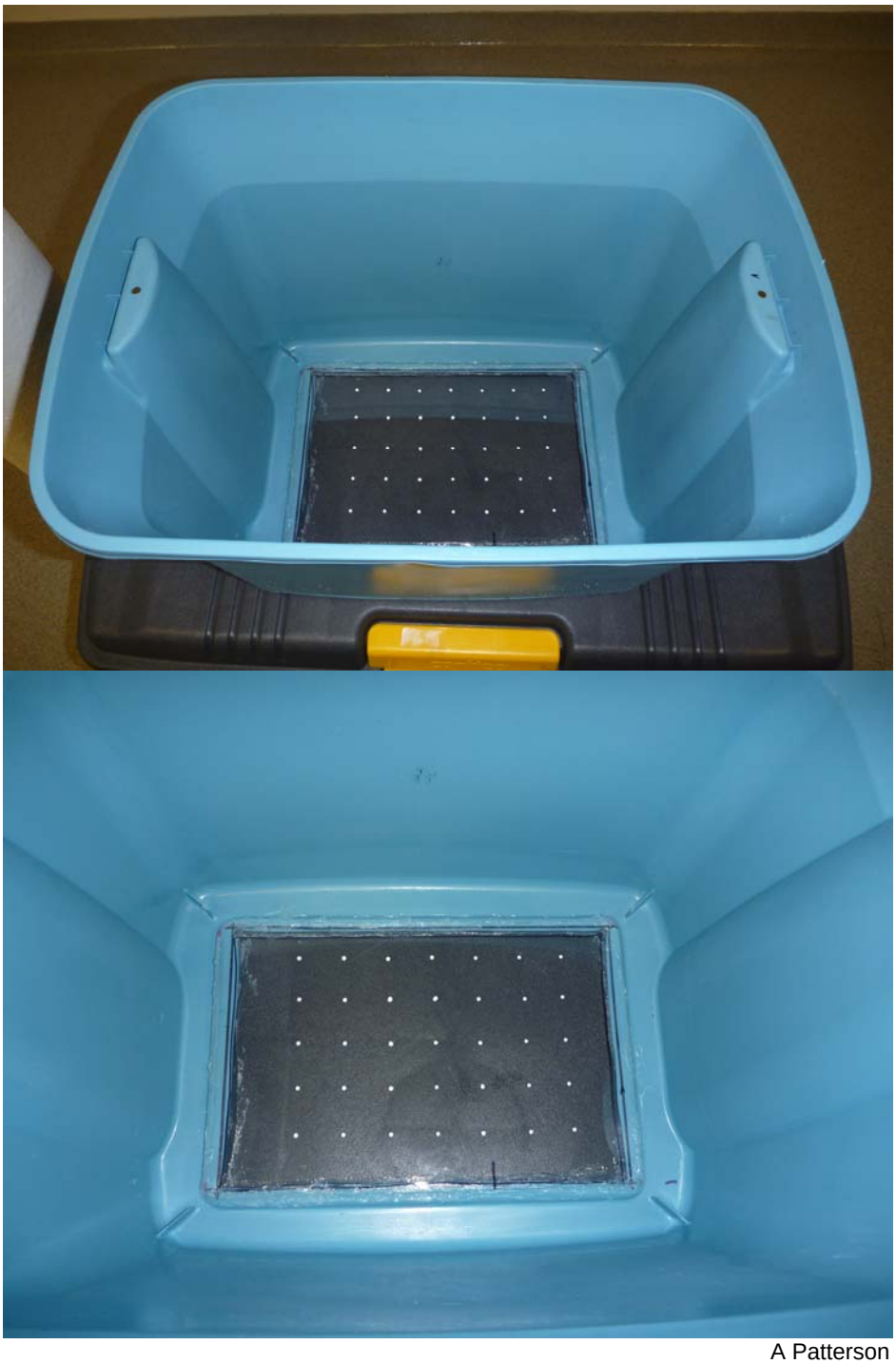
5.1 PROPER USE OF VIEWING BUCKET

5.1.1 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Viewing Bucket (Figure 1)
- Metric Ruler (Similar to Fisher Scientific Item S40641P)
- Datasheet (Figure 2)
- Clipboard
- Pencil or Rite in the Rain Pen (Similar to Forestry Suppliers Item 49237)
- Waders, hip or knee boots
- Handheld Tally Counter (Similar to Grainger Item #2PAU4)

Figure 1. Viewing Bucket



A Patterson

Figure 2. Viewing Bucket Datasheet for Monitoring Section Sampling Events

Viewing Bucket Sampling Datasheet

Stream Segment :	_____			**Town:**	_____
Site Number:	_____				
		Military			
Date:	_____	**Time:**	_____	**Collectors:**	_____
Meter #	_____			**Pictures:**	_____
Max Depth:	_____	ft	**UTMs:**	_____	
Weather: (Circle)	**Clear**		**Partly Cloudy**		**Overcast**
	Raining		**Windy**		**Sunny**
Comments/Notes:					
	# of dots				
Woody Substrate			**Macroalgae Length**		
Rocky Substrate					
Total					

Rank	Description	Tally
0	No visual evidence	
1	Thin layer visually evident	
2	0.5 - 1mm thick	
3	1.01 - 5mm thick	
4	5.01mm - 2cm thick	
5	Greater than 2.01cm thick	

5.1.2 USING THE VIEWING BUCKET IN THE FIELD

For most purposes, the viewing bucket is used specifically for in situ benthic algae cover measurements taken directly in the field, in wadeable streams. This method does not require sample containers or preservation.

5.1.3 RECORDING PARAMETER UNITS

The following units should be used when recording measurements taken with the viewing bucket:

Macroalgae length.....millimeter

Microalgae mat depth……rank tally

Suitable substrate……...count of dots

Micro- and macroalgal coverage……..count of dots

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 viewing bucket measurement is taken in the correct order. This procedure may disrupt sediment, fish and benthic organisms, which can interfere with other field procedures and sample collections in streams. Viewing bucket measurements should be measured after these samples have been collected. However, viewing bucket measurements should be taken before any sampling procedure or activity that may disturb bottom sediments to avoid increasing turbidity at the location. The field analyst should note any disturbance to the bottom sediment in the Comment/Notes section of the field datasheet (Figure 2) or appropriate field notebook.

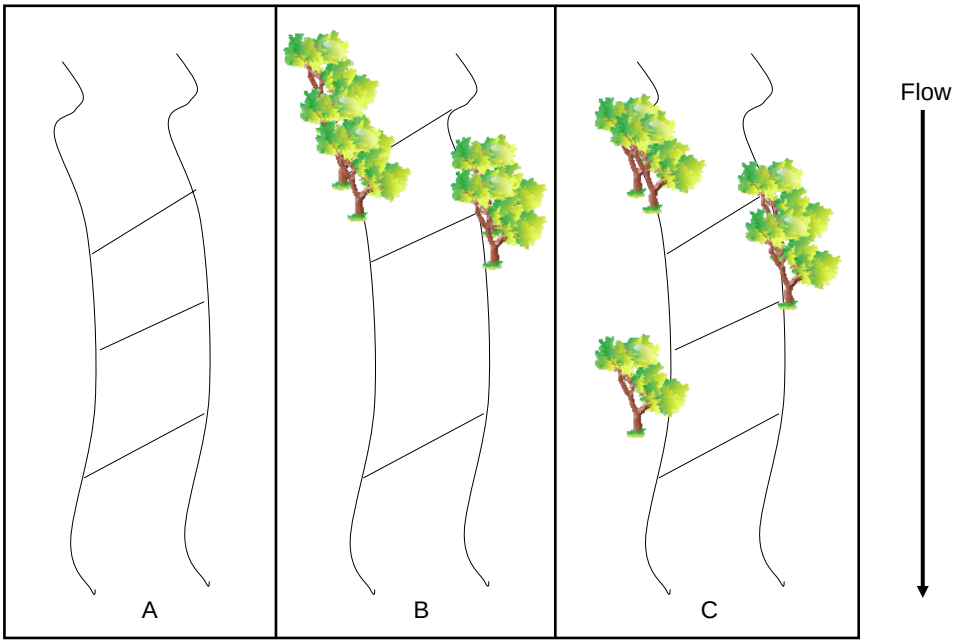
5.2.2 ESTABLISH TRANSECTS

The field analyst will establish three (3) transects running diagonal across the stream. The field analyst should observe the location of riffles, runs, and pools along the stream segment. The field analyst should locate transects in areas with runs and riffle, if present, and avoid locations with large pools.

The transects should be approximately at a 45º angle to the left bank (Figure 3A). The field analyst should observe the amount of shade and, using best professional judgment, locate the transects to capture the

range of shade conditions available (Figure 3B,3C). The location of the transects should not overlap another transect on any part of the transect.

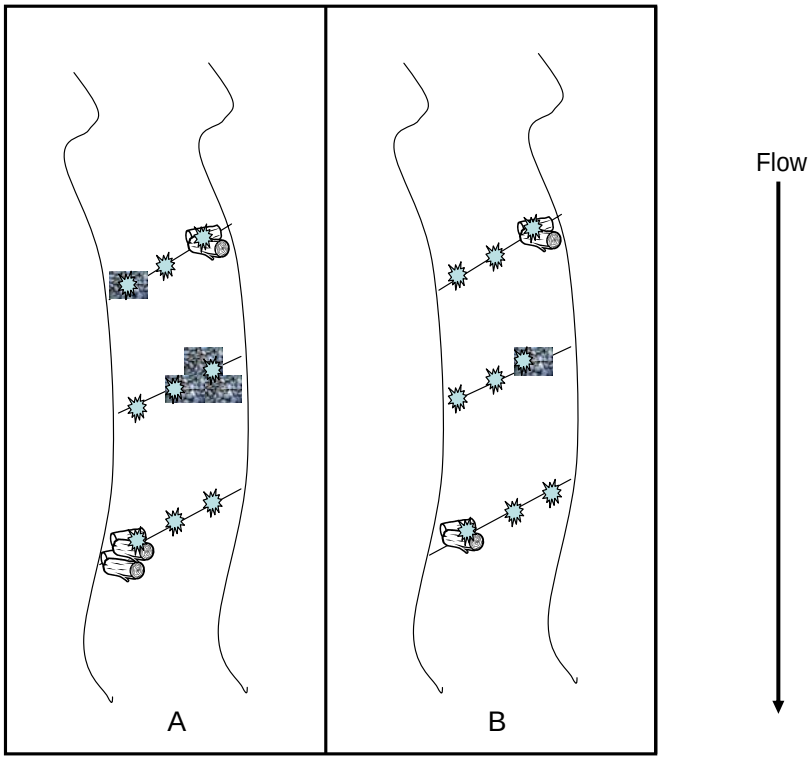
Figure 3. Appropriate establishment of transects



5.2.3 ESTABLISH SAMPLING POINTS

The field analyst will establish three (3) sampling points along each transect for a total of nine (9) sampling points. The field analyst should observe the different available habitat and stream conditions and, using best professional judgment, locate the sampling stations to capture the range of available habitats and stream conditions (Figure 4A, 4B).

Figure 4. Appropriate establishment of sampling points



5.2.4 TAKING SUBSTRATE AND BENTHIC ALGAE MEASUREMENTS WITH THE VIEWING BUCKET

The field analyst will take measurements of available rocky substrate, available woody substrate, amount of macroalgae cover, maximum length of macroalgae, and amount and rank of microalgae cover.

- Record the stream segment station name and number, date, time, and collectors at the top of the datasheet or field notebook. Note any observations about stream condition, riparian area, benthic algae growth, or sampling trip.

- Carefully enter the stream at the most downstream transect at the left bank. Locate the left bank sampling point. It is important to begin at the left bank, because it is the most downstream station. By starting at the most downstream sampling point, the possibility for disruption of sediment and obscuring the bottom of the stream will be minimized.

- Immerse the viewing bucket into the stream so that approximately 4 inches of the bottom of the bucket is underwater. The viewing bucket should be oriented with the longest length perpendicular to flow, and the field analyst should be downstream of the viewing bucket to

minimize sediment disruption obscuring visibility of the bottom. The field analyst should bend over or squat in the water to view the bottom of the stream without interference. If glare or floating is a problem, add a little water to the viewing bucket.

- The field analyst will observe a grid of white dots painted on the clear acrylic sheet in the bottom of the viewing bucket. The dots will be used as locations to estimate and measure the amount of benthic algae growth at the nine sampling stations as described in the following sections.

5.2.5 MEASUREMENT OF AVAILABLE WOODY AND ROCKY SUBSTRATE

- Using the handheld tally-counter, count the number of dots under which suitable rocky substrate is present. Read aloud the number of dots to the recording field analyst. Reset the handheld tally-counter.
    - Suitable rocky substrate is >2cm in length
- Using the handheld tally-counter, count the number of dots under which suitable woody substrate is present. Read aloud the number of dots to the recording field analyst. Reset the handheld tally-counter.
    - Suitable woody substrate is woody branches or logs that are stationary.

5.2.6 MEASUREMENT OF MACROALGAE COVER AND MAXIMUM LENGTH

- Using the handheld tally-counter, count the number of dots that occur over macroalgae growth. Read aloud the number of dots to the recording field analyst. Reset the handheld tally-counter.
- Using the metric ruler, measure the length of the longest macroalgae growth. Read aloud the measurement to the recording field analyst.

5.2.7 MEASUREMENT OF MICROALGAE COVER AND RANK OF GROWTH

- For microalgae, the field analyst should locate the lower left-hand corner of the viewing bucket. Beginning in the lower left-hand corner should allow the field analyst to minimize movement of viewing bucket for measurement, which will help to keep the viewing bucket over the sampling station.
- At each white dot, using the metric ruler, the field analyst will measure the depth of the microalgae layer, if one is present, on the available woody or rocky substrates. The field analyst should read aloud the measurement to the recording field analyst. If no algae layer is present, the field analyst will say zero to the recording field analyst.

- Note: The recording field analyst should review the chart on the datasheet to rank the amount of growth (0-5) on the substrate based on the measurement taken by the field analyst, and make a tally mark in appropriate row on the chart (Figure 2).

- The recording field analyst will add up the number of tally marks. The recording field analyst will ensure that the number of recorded data for tally marks equal the total number of white dots.

5.2.8 COMPLETING THE MEASUREMENTS AT ALL SAMPLING POINTS AND UPSTREAM TRANSECTS

- The field analyst will move to the sampling point in the middle of the stream on the transect and repeat the counts and measurements of substrate, macroalgae growth, and microalgae growth described in Sections 5.2.5, 5.2.6, and 5.2.7.

- The field analyst will move to the sampling point at the right bank of the stream on the transect and repeat the counts and measurements of substrate, macroalgae growth, and microalgae growth described in Sections 5.2.5, 5.2.6, and 5.2.7.

- After completing all sampling points on the downstream transect, the field analyst will move to the next transect upstream. The field analyst will repeat the counts and measurements for all transect sampling points beginning at the left bank as described in Sections 5.2.5, 5.2.6, and 5.2.7. The field analyst will then move upstream to the next transect and repeat all counts and measurements at all transect sampling points beginning at the left bank as described in Sections 5.2.5, 5.2.6, and 5.2.7.

- After completing measurements on all transects, the recording field analyst will check that nine (9) sampling points have been assessed.

- The field analyst will exit the stream, if possible, at the final sampling station or another location that is accessible.

6. QUALITY CONTROL

6.1 QUALITY CONTROL

Quality control will be assessed by the recording field analyst repeating the measurements of the entire procedure at 10% of stream segments. This will give a measure of bias for 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

Charles, D., D. Winter, and M. Hoffman. 2000. Field sampling procedures for the New Jersey Algae Indicators Project. Patrick Center for Environmental Research, Academy of Natural Sciences. Procedure No. P-13-64.

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Standard Operating Procedure for Collection of Benthic Algae from Natural and Artificial Substrates

SOP-WR-W-37

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Title: Standard Operating Procedure for Collection of Benthic Algae from Natural and Artificial Substrates
Originator Name: Jane Sawyers

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Standard Operating Procedure for Collection of Benthic Algae from Natural and Artificial Substrates

1. APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in collecting benthic algae in wadeable streams from natural and artificial substrates. 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 quantitative field collection of benthic algae in wadeable streams from natural and artificial substrates. 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 Benthic algae – Micro- and macroalgae growing on the bottom of a stream or lake.

3.5 Periphytometer – A piece of equipment designed to hold glass slides for colonization of benthic algae

3.6 Artificial substrate – Any substrate not naturally occurring in streams, such as clay tiles, glass slides, trash, or human-made structures.

3.7 Natural substrate – Natural substrate – Any substrate that naturally occurs in streams, such as logs, rocks, or aquatic vegetation

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 benthic algae for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance 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 it does not require any additional special training or certification.

4.2 RESPONSIBILITIES OF FIELD ANALYST

To properly collect benthic algae, 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 collection of benthic algae should be assisted by OWR staff who are accustomed to collecting benthic algae.

The field analyst is responsible for checking the required equipment in the Sampling Center at the beginning of deployment and retrieval of artificial substrates and collection from natural substrates. The field analyst is responsible for verifying that the periphytometers are in proper operating condition prior to use (i.e. floats are properly attached; glass slides not cracked and locked into place) and communicating to the project manager when equipment is in need of repair or replacement. The field analyst is also responsible for ensuring that all supplementary equipment (trays, brushes, waders, hip boots, etc.) is present and in working condition. The field analyst is responsible for cleaning and storing the field equipment before and after deployment and before winter storage.

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 measurement 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 collects benthic algae 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 periphytometers are maintained in proper operating condition annually. This includes ensuring the floats are properly attached to the periphytometers, glass slides are cleaned and

not cracked, and the supplementary equipment is present. The project manager is also responsible for repairing the periphytometers or reordering equipment when necessary.

The project manager will determine and communicate with field analysts what procedures and the order of procedures during deployment and retrieval of artificial substrates and collection from natural substrates. The project manager will determine the dates of deployment and retrieval and communicate the schedule to the field staff. The project manager will also monitor stream gages in the area during deployment to determine the schedule for retrieval of the periphytometers. The project manager will communicate with other OWR field staff sampling the stream segment about the potential for high flows. The project manager will communicate with other OWR staff, contractors, and departments the location of deployed substrates. Further, the project manager shall ensure annual review and periodic updates to this SOP as necessary to reflect current needs and standards as well as revise this SOP every five years.

5. GUIDELINES AND PROCEDURES

5.1 PROPER COLLECTION OF BENTHIC ALGAE

5.1.1 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Datasheet or field notebook printed on waterproof paper (Figure 1; paper similar to Grainger Item Number 3XFR7)
- Clipboard
- Pencil or Rite in the Rain Pen (similar to Forestry Suppliers Item Number 49237)
- Waders or hip boots
- Periphytometers (Figure 2, similar to Wildco model # 156-D30)
- 10% buffered formalin (similar to Fisher item 23245684)
- Disposable dropper (similar to Grainger item 3TRD2)
- Backpack containing (Figure 3):
    - Periphyton brush (similar to Wildco model # 156-F40)
    - Sample sorting tray (similar to Wildco model # 182-F20)
    - 2 - 250ml amber HDPE Nalgene® bottles per site (similar to Fisher item 02 923 103), pre-labeled with each the site name, date, collectors, and time.

  - Algae sampling frame (made from LDPE plastic similar to Grainger item 1YZU4, with circle cut out measuring 2.5 inches in diameter)
  - 8 Whirl-Pak® bags per site; labeled with the site name/ID, location(s) and a letter A-H
  - Rope (similar to Grainger item 2ELD3)
  - Multi-tool with knife (similar to Grainger item 3FRA8)
  - Black electrical tape
  - Tape measure
  - GPS or ArcPad
  - Infrared thermometer (similar to Forestry Suppliers item 89642)
- Secchi disk attached to tape measure
- Bricks or concrete blocks
- Bleach
- Acetone (90%)
- Pressure sprayer filled with tap water
- 2.5 L jug filled with distilled water

5.1.2 COLLECTION OF BENTHIC ALGAE IN THE FIELD

For most purposes, benthic algae collection will be completed in the field with samples taken from artificial or natural substrates in streams. This method does require sample containers and preservation.

5.1.3 RECORDING PARAMETER UNITS

The following units should be used when recording measurements taken with the artificial samplers and plastic algae frame:

Area sampled.....m^2

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

event to the sampling location and the order in which the field procedures should be completed. Prior to performing these analyses, the field analyst should ensure the benthic algae collection is completed in the correct order. This procedure may disrupt fish and microscopic organisms, such as benthic macroinvertebrates, fish, and algae. This disruption can interfere with other field procedures and sample collections in streams. Furthermore, this procedure can dislodge sediment, which can interfere with water quality sample collections. Benthic algae collection should preferably be completed on days when these samples are not being collected. If other sampling activities must occur on the same day, benthic algae collection should be undertaken after other water quality sampling has been completed. This procedure will typically take place late July through September to capture low flow conditions and maximum algal growth. This will also highlight a time period in Rhode Island when streams may go dry. It is important that this procedure take place in streams that have continuous flow throughout the deployment of the artificial substrates.

5.2.3 BENTHIC ALGAE COLLECTION

Depending on the individual project goals, benthic algae collection can be taken from natural and/or artificial substrates. This method describes the procedure for collecting from both types of substrates. After collection of the artificial substrates and natural substrates in the field, all samples should be kept on ice and out of the light to prevent degradation of the samples. After compositing of samples, the samples will be stored in amber bottles that prevent light penetration. Any further preparation of the samples for preservation, shipping, or analysis should prevent exposure to light.

5.2.4 ARTIFICIAL SUBSTRATE PREPARATION

Prior to departure from the sampling center, the field analyst will prepare the appropriate number of periphytometers for placement in the stream, as communicated by the project manager. If the periphytometers and concrete blocks have been deployed in previous years, the field analyst will need to scrub the artificial substrate equipment with warm, soapy water prior to the field season. Artificial substrates are sprayed with bleach prior to winter storage, so this wash will remove any bleach residue.

A scrubbing pad or toothbrush can be gently used on the periphytometers and deployment equipment to dislodge any remaining debris or biological growth. The artificial substrate equipment will then need to be rinsed free of soap and allowed to dry. New rope should be used every year.

Once dry, the periphytometers are prepared by sliding open the locking pieces on the top of the sampling tray (Figure 2). Using gloves, the field analyst will handle the edges of the slides and place a single slide in each of eight (8) slots (Figure 4A). It is important to wear gloves because skin contact with the glass slides can inhibit the growth of the algae due to oils

that naturally occur on the skin. The field analyst will slide the locking piece closed to prevent the slides from slipping out.

Prior to the sampling event, the field analyst will prepare the periphytometers for deployment in the sampling center. The field analyst will then attach a rope on both sides of the periphytometer to the cement blocks, which will act as anchors. The field analyst will then tie a rope around a concrete block or brick. The block should be tied so that the rope is looped around the block twice, with one end extending a little more than 1.5 feet to allow for manipulation of the concrete block placement to ensure the periphytometer is below the surface of the water (Figure 4B, 5). The field analyst will repeat this with a second concrete block or brick. The field analyst will securely tie the rope from one block to one ring on the periphytometer (Figure 4C). The field analyst will then use black electrical tape to secure the loose end of rope (Figure 4C). The field analyst will tie the other block to the ring on the other side of the periphytometer, securing the end with black electrical tape (Figure 4D). The field analyst will place the required number of periphytometers in separate boxes to keep the slides from breaking and to prevent any contamination from other field equipment in the vehicle.

5.2.5 ARTIFICIAL SUBSTRATE PLACEMENT CONSIDERATIONS

Artificial substrates should be placed in the stream at least 3 weeks prior to collection to allow for maximum colonization and growth of benthic algae. The periphytometer will be left at the location for at least 3 weeks, preferably 4 weeks. Previous research has shown that maximum accrual in enriched and unenriched streams is reached at 4 weeks (Biggs 1988), but the potential for sloughing of materials from high flows and maximum growth could become an issue near the end of the deployment.

The field analyst will observe the stream and canopy conditions at the sampling location. Several factors should be considered when determining the location of the periphytometer placement:

- The artificial substrate should be placed in an area with continuous flow. The field analyst should make sure that the flow is not back flow (upstream flow) or from backwaters of the main channel. To maintain similar flow conditions across the periphytometer, it should not be placed in bends of the stream where flow will be directed in an arc across the side of the periphytometer.

- The periphytometer should be placed in an area where light is penetrating to the bottom of the stream.

    - The field analyst will ensure that light is penetrating to the bottom by lowering a Secchi disk to the bottom of the stream. The field analyst will say aloud whether the Secchi disk is visible on the stream bottom, and this data will be recorded on the field data sheet (Figure 1) by the recording field analyst.

- The periphytometer should not be placed in areas with excessively turbulent flow conditions (i.e. areas with large amounts of spray-off from flow striking rocks or other substrate).

- The periphytometer should be placed in an area that receives some sunlight at some point through the day.

    - NOTE: Some sites may have extremely dense canopy cover. Every effort should be made to locate the periphytometer in a place with some sunlight to keep light from becoming the limiting factor to growth. If a lighted area is not available at the sampling location, the field analyst should alert the recording field analyst to make a note on the datasheet or appropriate field notebook.

- To minimize disturbance and vandalism, the periphytometer should be placed in areas that are inconspicuous (away from public roadways, bridges, or walking paths).

    - NOTE: The periphytometer will be submerged just under the surface of the water to mimic light conditions of natural substrate, which should assist in minimizing disturbance and vandalism.

5.2.6 ARTIFICIAL SUBSTRATE PLACEMENT

Both analysts should wear gloves throughout the entire procedure to minimize the possibility of contact with the glass slides. Contact with the glass slides can inhibit algal colonization and growth. The artificial substrate slides will be used to composite one sample for chlorophyll *a* analysis and one sample for diatom identification for each stream site.

- Once the placement location has been selected, the recording field analyst will record the sampling station name and number, date, time, and collectors at the top of the datasheet or field notebook (Figure 1). The recording field analyst will note any observations about stream condition, riparian area, benthic algae growth, or sampling trip and record this information on the datasheet. (Figure 1).

- To minimize disruption of the sediment, both analysts will enter the stream at a point downstream of the selected placement location. Sediment can obscure the view and coat the slides with a source of nutrients other than the flowing water. The recording field analyst will assist with carrying and handing materials to the field analyst. The recording field analyst will carry the backpack containing the supplies. The field analyst will carry the concrete blocks or bricks and the attached periphytometer.

- Both analysts will travel upstream to the selected location of the artificial substrate placement.

- The field analyst will hand one concrete block or brick connected to the periphytometer to the recording field analyst.

- The field analyst will observe the direction of flow and orient the flow guard of the periphytometer to face into the direction of flow.
    - The flow guard is the clear, curved plastic piece in between one of the floats and the plastic case containing the glass slides on the periphytometer (Figure 2).
- The field analyst will hold the periphytometer in one hand and the brick or concrete block in the other hand. Using the rope tied to the brick or concrete block, the field analyst will gently lower the brick or concrete block to the bottom of the stream. The field analyst will continue to hold onto the periphytometer with the other hand.
- The field analyst will then slowly lower the periphytometer to a depth 0.2 feet below the surface of the water. The recording field analyst will take their concrete block and stretch the length of rope until it is gently taut. The recording field analyst will slowly lower the concrete block to the bottom of the stream bed using the rope. The periphytometer should remain at least 0.2 feet below the surface of the water. If the periphytometer is less than 0.2 feet below the surface of the water, the recording field analyst should grasp the rope of the concrete block and bring it upstream. The recording field analyst will then move the concrete block downstream until the 0.2 feet depth is achieved.
- Using the tape measure attached to the Secchi disk, the field analyst will measure the depth of periphytometer from the stream substrate to the top of the plastic tray (Figure 6) and read the measurement aloud to the recording field analyst, who will record the value on the datasheet or field notebook.
    - NOTE: The field analyst should make sure the depth is measured from the stream substrate and not the top of the brick or concrete block.
- The field analyst will measure the depth of periphytometer from the water surface to the top of the plastic tray (Figure 6). The field analyst will read the measurement aloud to the recording field analyst, who will record the value on the datasheet or field notebook.
- The recording field analyst will hand a GPS unit or ArcPad to the field analyst. The field analyst will take a waypoint at the location of the periphytometer. The recording field analyst will retrieve the GPS unit or ArcPad and record the location of the waypoint. The recording field analyst will also note any major landmarks or features on the datasheet or field notebook to identify the location of the periphytometer.
- The recording field analyst will hand the infrared thermometer to the field analyst. The field analyst will point the thermometer at the water surface and press and release the gray button on the front. The field

analyst will read the measurement aloud to the recording field analyst, who will record the value on the datasheet or appropriate notebook.

- Both analysts will exit the stream at the periphytometer location or another location that is safe for them to exit.

- The field analyst should communicate the location of the periphytometer with project manager. These personnel can avoid disturbing the equipment and also provide notification if the equipment is damaged or missing. This will also ensure that field staff are not injured by becoming entangled in the ropes attached to the concrete blocks or bricks.

- The project manager will check any available stream gages (http://ri.water.usgs.gov/) in the area and communicate with other field staff sampling area regarding the potential for high flows. The project manager will communicate with the field analyst and recording field analyst when the periphytometers should be retrieved from the sampling location.

5.2.7 RETRIEVING THE ARTIFICIAL SUBSTRATE

- Using the GPS location and the major landmarks or features, the analysts will return to the location of the periphytometer. Both analysts should wear gloves to retrieve the periphytometers to avoid contamination of the samples.

    - NOTE: If the periphytometer is not located, the recording field analyst should note this on the datasheet. Section 5.2.7 will not be completed, and the analysts should continue with Section 5.2.8 Sampling the Natural Substrate. The field analyst will notify the project manager if any periphytometers were not recovered.

    - NOTE: If site conditions have deteriorated (i.e. high flows, bank erosion) significantly since placement of the periphytometer, the field analysts should not retrieve the periphytometer or sample the natural substrate. Photographs of the site conditions should be taken to document the issue for the project manager. The field analyst will communicate with the project manager any lost equipment or inaccessible sites. The project manager will determine any follow-up action to retrieve the artificial substrates or sample the natural substrates.

- To minimize sediment disruption, the analysts will enter the stream at a location downstream of the periphytometer and travel upstream to the location of the periphytometer. The recording field analyst will assist with carrying and handing materials to the field analyst. The recording field analyst will carry the backpack containing the supplies.

- At the stream bank, the recording field analyst will remove 8 Whirl-Pak® bags from the backpack, each labeled with the site location and a letter A-H.

- The field analyst will observe the location and condition of the periphytometer. The field analyst should relay to the recording field analyst any unusual circumstances of the periphytometer (plants caught on the periphytometer, periphytometer is out of the water, etc.). The recording field analyst should record this information on the datasheet or appropriate field notebook (Figure 1).

- Using the tape measure attached to the Secchi disk, the field analyst will then measure the depth of periphytometer from the stream substrate to the top of the plastic tray (Figure 6) and read the measurements aloud to the recording field analyst, who will record the value on the datasheet or field notebook. The field analyst will then measure from the water surface to the top of the plastic tray (Figure 6) and read aloud the recording field analyst, who will record the value on the datasheet or appropriate field notebook.

    - NOTE: The field analyst should make sure the depth is measured from the stream substrate and not the top of the brick or concrete block.

- The field analyst will carefully grasp the rope of the upstream cement block or brick just under the periphytometer. The field analyst will gently hold the periphytometer by a float or plastic sides in the other hand. The field analyst will then gently pull on the rope attached to the brick or concrete block. The field analyst should pull the rope until the brick or concrete block is exposed from the water. The recording field analyst will repeat this with the downstream concrete block or brick.

    - NOTE: Do not use the periphytometer to pull up the brick or concrete block. This risks ripping off the floats or cracking the plastic tray holding the glass slides.

    - NOTE: Depending on the site conditions, the field analysts may cut the ropes to retrieve the periphytometer. The field analysts will then need to retrieve the concrete blocks or bricks by pulling on the floating rope.

- Both analysts will move to the stream bank. The field analyst will place the upstream concrete block or brick on the stream bank near the recording field analyst. The recording field analyst will then place the downstream concrete block or brick on the stream bank. The field analyst will then hand the periphytometer to the recording field analyst.

- The recording field analyst will slide open the locking mechanism to remove the glass slides from the periphytometers (Figure 2). Carefully avoiding touching the face of each slide, the recording field analyst will remove a single slide from each slot and place one slide in each of the 8 Whirl-Pak® bags. The recording field analyst will add some distilled water to each of the Whirl-Pak® bags. The recording

field analyst will roll the top of the bag and close with the imbedded twist-tie.

- The field analyst will observe the amount of aquatic macrophyte and duckweed (*Lemna* sp) and/or watermeal (*Wolffia* sp) growth in the visible 25m reach of stream upstream and 25m downstream of the periphytometer location. If necessary, the field analyst can hike or wade around overhanging vegetation or bends in the stream. If this cannot be accomplished (due to deep water or impassable vegetation), the recording field analyst will estimate how far they can see, and record that visible distance on the field sheet (Figure 1).

- The field analyst will estimate and say aloud the percent cover of all macrophyte growth and duckweed and/or watermeal. The recording field analyst will circle the percent cover of macrophytes and duckweed and/or watermeal growth on the datasheet or appropriate field notebook.

5.2.8 SAMPLING THE NATURAL SUBSTRATE

The field analyst will collect two composite samples. One sample will be analyzed for chlorophyll *a*, and the second sample will be sent to a contractor for diatom identification. During the collection of the natural substrates, the field analyst will need to keep 2 amber Nalgene® HDPE bottles in their wader pocket.

- Following retrieval of the artificial substrates, the field analyst will observe the location of natural substrates in the stream. Natural substrate will need to be completely submerged in the water. The natural substrate should be fixed at the location but easy to remove for sampling. Natural substrate will be collected with the following decreasing preference:

    1. Rocky substrate (>2cm – 25cm in diameter)

    2. Woody substrate (branches or sticks greater than 2cm in diameter or surface area)

    3. Aquatic vegetation (such as wild celery (Figure 7)) or other broad leafed vegetation with some portion under the water)

    o NOTE: Do not sample any vegetation that is skin irritant, such as poison ivy or stinging nettle (Figure 7).

    o NOTE: Aquatic vegetation should only be used when rocky or woody substrate is not available. Broad-leafed vegetation can be sampled in the process described below, but the field analyst will need to scrub gently to avoid rupturing the cells of the vegetation.

    o NOTE: It is important to sample the same species of vegetation or a species of the same growth type. The recording field analyst should record on the datasheet or field notebook when a growth form other than broad-leafed vegetation is used.

- The field analyst should observe the amount of growth in the stream. The field analyst will use best professional judgment to select substrates that are representative of the benthic algal growth conditions.
    - For example, in a stream with a single green rock or branch the field analyst should not sample the only rock or branch with growth, or in the case of a stream with large amounts of growth, the field analyst should not sample the only clean rock and woody substrate.
- The field analyst will randomly collect six pieces of natural substrate representative of algal growth and bring them to a relatively flat surface. The field analyst will attempt to get a mix of different types of substrate. The field analyst will need to get a number of substrates that is divisible by two, because the same number and kinds of substrates should be sampled for each composited natural substrate sample collected.
    - For example, the field analyst should collect 4 rocks and 2 branches or sticks. Each sample, one for chlorophyll *a* analysis and one for diatom taxonomy, would use 2 rocks and 1 branch.
- The field analyst will retrieve the backpack of sampling materials from the recording field analyst. The field analyst will remove the periphyton brush, sample sorting tray, algae sampling plastic, and wash bottle filled with distilled water.
- The field analyst will sit on the stream bank; their feet directly in front of them; and knees slightly bent to make a 45º angle. The field analyst will place the sampling tray on their thighs with the pour spout closest to their body. All rinse water should be collected in the sampling tray. The field analyst should also take care to minimize the amount of rinse water to avoid overfilling the bottles for processing and shipment.
    - NOTE: Do not sit with knees bent in more than a 45º angle. This can promote spilling of the rinse water.
- The field analyst will place the plastic algae sampling frame on the surface of the natural substrate. If the circle cut into the plastic is not filled by the surface of the natural substrate, the field analyst will need to observe and estimate the amount of the circle filled.
- Using the periphyton brush, the field analyst will scrub the surface of the natural substrate over the sorting tray. The field analyst will remove the plastic algae sampling frame and place it next to the natural substrate. The field analyst will use a small amount of water to rinse the scrubbed circle on the substrate, and if necessary, any debris on the frame. The field analyst will repeat the scrubbing and rinsing until a clear circle is apparent on the surface of the natural substrate.

- NOTE: If the circle was not filled by the surface being scrubbed, the field analyst will select another location on the surface and scrub the appropriate area to complete the surface area encompassed by the circle.

- After the circle is scrubbed and rinsed clean, the field analyst will rinse any debris remaining on the plastic algae sampling frame into the tray. The field analyst will select two other substrates and repeat the scrubbing and rinsing of the surface until a clear circle is apparent on the surface of the natural substrates.

    - NOTE: Again, at least one of the 3 selected natural substrates should be different than the other selected natural substrates (i.e. 1 rocks, 2 sticks or 2 rocks, 1 stick). If this is not possible at a site, the field analyst will sample 3 of the same natural substrates.

- When the field analyst has scrubbed 3 natural substrates, the field analyst will rinse the periphyton brush until a clear rinse has been achieved. If spray from scrubbing the samples has gotten on the field analyst's hands, the field analyst will then rinse their hands into the sorting tray.

- The field analyst will then take and open 1 of the amber Nalgene® HDPE bottles and place it at the bottom of the pour spot. The field analyst will then pour the rinse water into the Nalgene® bottle and rinse the entire sampling tray into the bottle. The field analyst will then tightly replace the lid.

- The field analyst will announce to the recording field analyst the types of substrate sampled for the first sample. The recording field analyst will record this information on the appropriate datasheet or field notebook.

- The field analyst will then rinse the sampling tray, periphyton brush, and plastic algae sampling frame with distilled water. This is to ensure that all debris from scraping has been rinsed clean.

- The field analyst will then select the fourth substrate. The field analyst will again place the sampling tray on their thighs at a 45º angle with the pour spout closest to their body. Using the periphyton brush, the field analyst will scrub the surface of the natural substrate over the sorting tray. The field analyst will remove the plastic algae sampling frame and place it next to the natural substrate. The field analyst will use a small amount of water to rinse the scrubbed circle on the substrate, and if necessary, any debris on the frame. The field analyst will repeat the scrubbing and rinsing until a clear circle is apparent on the surface of the natural substrate.

    - NOTE: If the circle was not filled by the surface being scrubbed, the field analyst will select another location on the surface and scrub the appropriate area to complete the surface area encompassed by the circle.

- After the circle is scrubbed and rinsed clean, the field analyst will rinse any debris remaining on the plastic algae sampling frame into the tray. The field analyst will select two other substrates and repeat the scrubbing and rinsing of the surface until a clear circle is apparent on the surface of the natural substrates.

    - NOTE: At least one of the 3 selected natural substrates, should be different than the other selected natural substrates (i.e. 1 rocks, 2 sticks or 2 rocks, 1 stick). If this is not possible at a site, the field analyst will sample 3 of the same natural substrates.

- When the field analyst has scrubbed 3 natural substrates, the field analyst will rinse the periphyton brush until a clear rinse has been achieved. If spray from scrubbing the substrates has gotten on the field analyst's hands, the field analyst should rinse their hands into the tray.

- The field analyst will then take and open 1 of the amber Nalgene® HDPE bottles and place it at the bottom of the pour spot. The field analyst will then pour the rinse water into the Nalgene® bottle and rinse the entire sampling tray into the bottle. The field analyst will then tightly replace the lid.

- The field analyst will announce to the recording field analyst the types of substrate sampled for the first sample. The recording field analyst will record this information on the appropriate datasheet or field notebook.

- The field analyst will then rinse the sampling tray, periphyton brush, and plastic with distilled water. This is to ensure that all debris from scraping has been rinsed clean.

- The analysts will exit the stream at the periphytometer location or another location that is safe to exit.

- The benthic algae samples collected will be placed in a cooler on ice.

- Upon return to the vehicle, the field analyst will spray the sampling equipment with pressurized water to minimize potential transfer of contaminants and invasive species. It will also ensure that sampling equipment is clean between sites to minimize cross-contamination of samples.

- Samples for diatom taxonomy will need to be preserved upon return to the Sampling Center. See Section 5.2.10. All chlorophyll *a* will need to remain in a cooler or refrigerator until filtering.

5.2.9 PROCESSING THE ARTIFICIAL SUBSTRATES IN THE SAMPLING CENTER

The compositing of samples should be done within 24 hours of collection, preferably immediately upon return to the sampling center after retrieval

or the artificial substrates. Four slides will be composited for analysis of chlorophyll *a*. The other 4 slides will be composited for diatom taxonomic identification and analysis.

- Once back in the sampling center, the field analyst will remove one set of artificial substrate samples from one site for a total of 8 Whirl-Pak® bags. The field analyst will then place two amber Nalgene® bottles on the counter. The field analyst should attempt to minimize light in the sampling center, but the field analyst should not dim the lights to a point where safety will be a concern.

- Using a book or other equipment, the field analyst will set the sampling tray at a 45º angle on the counter.

- The field analyst will put on gloves and unwhirl Whirl-Pak® bag A from the site. The field analyst will carefully remove the glass slide, handling only the sides of each slide.

- Using a periphyton brush or razor blade, the field analyst will carefully scrub or scrape only the surface of each side of the glass slide over the sampling tray. The field analyst will not scrub the edges of the slide. The field analyst will rinse the scrubbed area into the tray and repeat the scrubbing and rinsing until the slide surface is clean. The field analyst will then place slide A in a wash tub filled with warm, soapy water.

- The Whirl-Pak® bag A should then be rinsed with distilled water into the sampling tray. The Whirl-Pak® bag A should then be discarded in the trash.

- The field analyst will then unwhirl Whirl-Pak® bag B, C and D and repeat the above procedure.

- The field analyst will then rinse the periphyton brush or razor blade into the sorting tray until the rinse is clean. The field analyst will then rinse their hands if spray is apparent on the gloves. The field analyst will then place one of the empty, labeled amber Nalgene® bottles under the pour spout. The field analyst will then rinse the sorting tray into the amber Nalgene® bottle. The field analyst will then recap the bottle and place it back in the refrigerator.

- The field analyst will set the sampling tray at a 45º angle on the counter.

- The field analyst will then unwhirl Whirl-Pak® bag E for the site. The field analyst will carefully remove the glass slide, handling only the sides of the slides.

- The field analyst will carefully scrub only the surface of each side of the glass slide over the sampling tray using a periphyton brush or razor blade. The field analyst will not scrub the edges of the slide. The field analyst will rinse the scrubbed area and repeat the scrubbing

and rinsing until the slide surface is clean. The field analyst will then place slide E in a wash tub filled with warm, soapy water.

- The field analyst will then then unwhirl Whirl-Pak® bags F, G, and H for the site. The field analyst will then rinse the periphyton brush until the rinse is clean. The field analyst will then rinse their hands if spray is apparent on the gloves. The field analyst will then place the second empty amber Nalgene® bottles for the site under the pour spout. The field analyst will then rinse the sorting tray into the amber Nalgene® bottle.

5.2.10 DIATOM TAXONOMY SAMPLE PRESERVATION

- The field analyst will add 3 mL of 10% buffered formalin to each bottle being sent for diatom analysis. The bottle will then be placed in the refrigerator until shipping to the contractor.
    - NOTE: Most algal preservatives contains acid, which will interfere with the analysis of chlorophyll *a*. To ensure that chlorophyll *a* samples are not exposed to acid, preservative should only be added at the end of compositing all sample sites processed at the end of the day.

5.2.11 EQUIPMENT MAINTENANCE

Periphytometers are designed to be reused over many years and sampling sites. In order to minimize cross-contamination of sites and years, the periphytometers and all equipment deployed in the stream must be cleaned and decontaminated after deployment. This process will use bleach, so the field analyst will need to wear clothes or a lab coat that can be bleached. The field analyst should also consult the MSDS and safety sticker on the bottle of bleach to determine whether safety glasses or other protective equipment is required. The field analyst should wear gloves when cleaning the glass slides.

- After deployment, the field analyst will need to prepare a bucket of warm, soapy water. The field analyst will use scrubbing pads and toothbrushes to gently scrub and clean any debris or growth from the periphytometers and deployment equipment.

- The field analyst will need to prepare a dilute solution of bleach (10%). The field analyst will spray the periphytometers with the bleach solution. The bleach should not be washed off to allow for all current growth to be killed and to discourage any growth over the winter. The periphytometer should be allowed to air dry then placed in the sampling center for winter storage.

- Discard any broken slides in the appropriate glass disposal container in the sampling center. It is preferable to use new slides, but slides that are going to be reused should be scrubbed in warm, soapy water. The slides should then be soaked in 90% acetone overnight. The

slides will then be rinsed with distilled water and allowed to dry. The slides can then be stored in the Sampling Center for the winter.

6. QUALITY CONTROL

6.1 QUALITY CONTROL

Quality control of the artificial substrate procedure will be assessed by placing a second periphytometer at 10% of stream segments. Quality control of natural substrate procedure will be assessed by collection of a second set of bottles by the field analyst at 10% of stream segments. This will give a measure of precision for both procedures.

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

Biggs, B.J.F. 1988. Artificial substrate exposure times for periphyton biomass estimates in rivers. New Zealand J. Marine Freshw. Res. 22:507-515.

Danielson, T. 2006. Protocols for Sampling Benthic Algae in Streams, Wetlands, and Freshwater Wetlands. Maine Department of Environmental Protection. DEPLW-0634

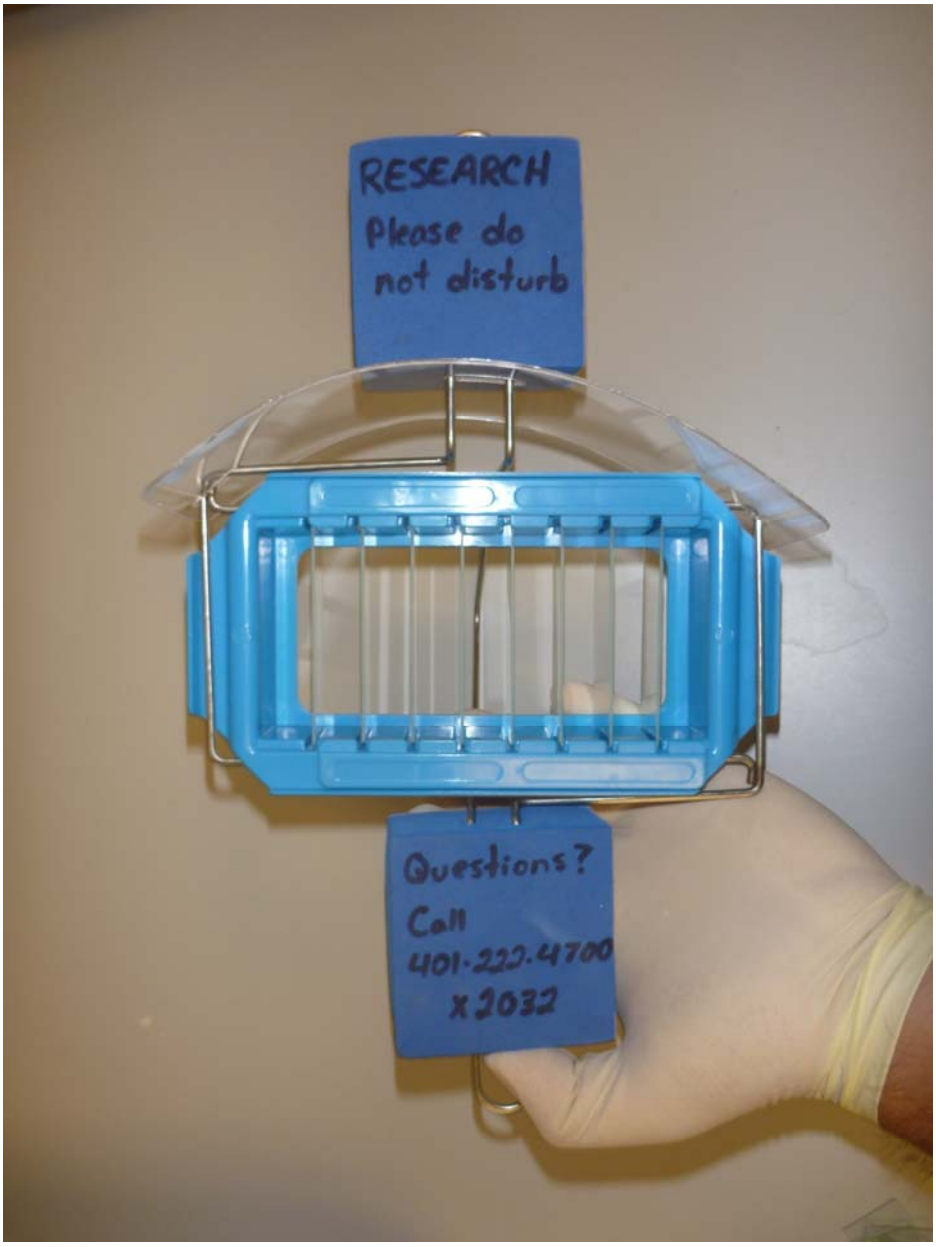
Danielson, T. 2009. Description of Nutrient Criteria for Fresh Surface Waters (Chapter 583). Maine Department of Environmental Protection. DEPLW-0974A.

Potapova, M. and D.F. Charles. 2005. Choice of substrate in algae-based water-quality assessment. J. N. Am. Benthol. Soc. 24:415-427.

Figure 1. Benthic Algae Collection Datasheet for Monitoring Section Sampling Events

	Benthic Algae Collection Datasheet						
Stream Segment :	_____				**Town:**	_____	
Site Number:	_____		**Depth:**	_____ft	**Periphytometer #**		_____
			Depth:	_____ft			
Deployment Date:	_____	**Time:**	_____	**Pictures:**	_____	**Collectors:**	_____
Retrieval Date:	_____	**Time:**	_____	**Pictures:**	_____	**Collectors:**	_____
UTMs of Art Sub:	_____				**QA Site?**	**Yes**	**No**
UTMs of Art Sub Dup:	_____						
Major Landmarks of Art Sub:	_____				**Secchi?**	**Yes**	**No**
Major Landmarks of Art Sub Dup:	_____				**Secchi?**	**Yes**	**No**
Comments/Notes:							
Percent Macrophyte Cover (Circle 1)	0	10 - 20	21 - 30	31 - 40	41 - 50	51 - 60	
	61 - 70	71 - 80	81 - 90	91 - 100			
Percent Duckweed and/or Watermeal (Circle 1)	0	10 - 20	21 - 30	31 - 40	41 - 50	51 - 60	
	61 - 70	71 - 80	81 - 90	91 - 100			
	Deploy	**Pickup**			**Deploy**	**Pickup**	
Art Sub Depth Below Surface	_____	_____	in	**Depth to Bottom**	_____	_____	in
Art Sub Depth Below Surface Dup	_____	_____	in	**Depth to Bottom**	_____	_____	in
Art Sub Retrieved?	**Yes**	**No**		**Intact Glass Slides**		_____	
Art Sub Retrieved Dup?	**Yes**	**No**		**Intact Glass Slides Dup**		_____	
# of Nat Sub Sampled (Chl)	**Rocks**	_____	**Wood**	_____	**Vegetation Type:**	_____	
Total Area (Circles*31.6531)	_____	cm^2					
# of Nat Sub Sampled (Tax)	**Rocks**	_____	**Wood**	_____	**Vegetation Type:**	_____	
Total Area (Circles*31.6531)	_____	cm^2					

Figure 2. Periphytometer



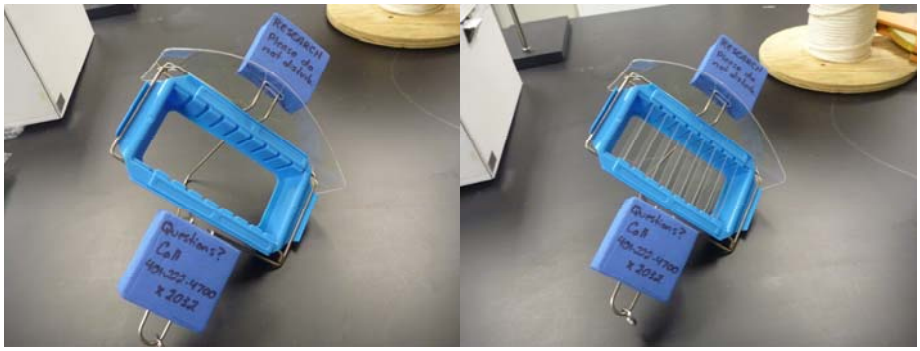
A Patterson

Figure 3. <u>Supplementary Equipment</u>

A Patterson

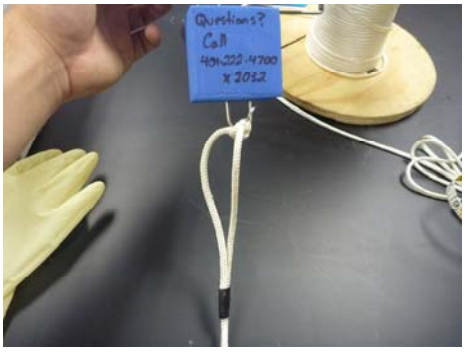
Figure 4. Preparation of the Artificial Substrates

A



B

C



D

A Patterson

Figure 5. Deployed Artificial Substrate

Figure 6. Measurements of Periphytometer Depths

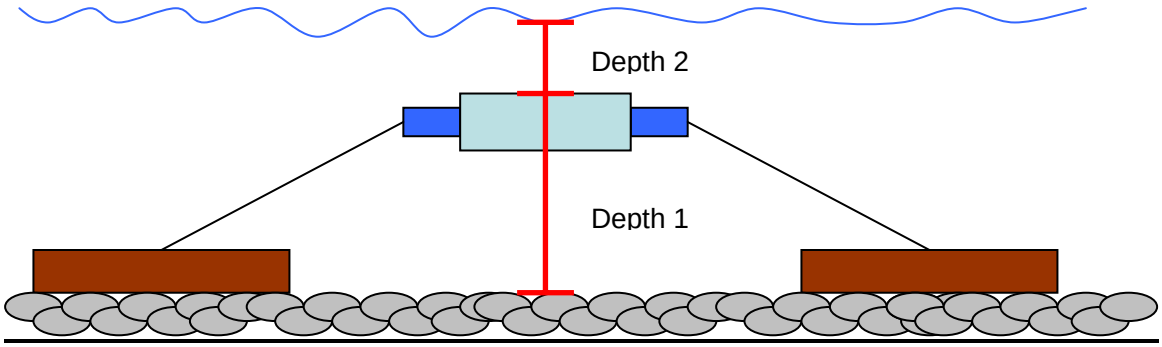


Figure 7. Vegetation Pictures

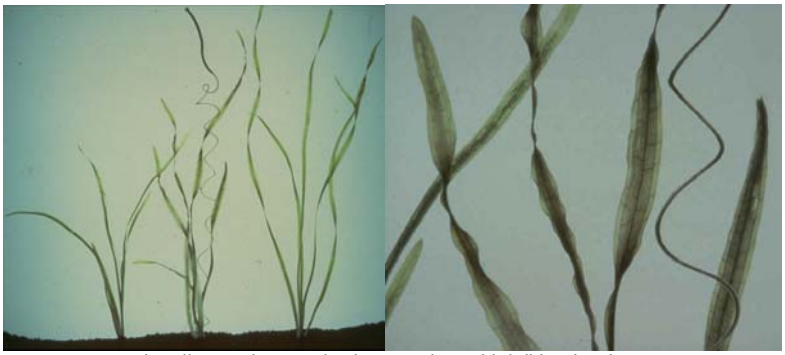
Poison Ivy
(*Toxicodendron radicans* (L.) Kuntze)

http://greatermd.bbb.org/watch-out-for-poison-ivy-/

Stinging Nettle
(*Urtica dioica* L.)

http://www.wildmanstevebrill.com/Plants.Folder/Nettle.html

Wild Celery
(*Apium graveolens* L.)



http://www.mlswa.org/underwaterplantguide/wild_celery.htm