DELAWARE RIVER BASIN COMMISSION
DELAWARE RIVER BIOMONITORING PROGRAM

2014 QUALITY ASSURANCE PROJECT PLAN

DRAFT FOR DRBC AND EPA REVIEW

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

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DRBC Quality Assurance Officer:	Thomas J. Fikslin	Date
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1. Project Management

1.1 Distribution List

Table 1 is a list of all individuals associated with the Delaware River Biomonitoring program. Each of the following individuals will participate in some aspect of the Delaware River Biomonitoring Program. To ensure the quality of the Delaware River Biomonitoring Program, each of these listed individuals will receive a copy of the signed Quality Assurance Program Plan (QAPP) prior to initiation of annual sampling seasons. In the case of a revision, each of the participants will receive the revised version electronically in *.pdf* format.

Table 1: Distribution list for the Delaware River Biomonitoring Program

Individual	Organization
Office of Quality Assurance	U.S. Environmental Protection Agency Region 3
Thomas Fikslin, PhD.	Delaware River Basin Commission
Robert Limbeck	Delaware River Basin Commission
Erik Silldorff, PhD.	Delaware River Basin Commission
John Yagecic	Delaware River Basin Commission
Ronald MacGillivray	Delaware River Basin Commission
Intern(s)	Delaware River Basin Commission
Kimberly Scharl	U.S. Environmental Protection Agency
Greg Pond	U.S. Environmental Protection Agency
Lou Reynolds	U.S. Environmental Protection Agency
James Kurtenbach	U.S. Environmental Protection Agency
Don Hamilton	National Park Service (UPDE)
Jamie Myers	National Park Service (UPDE)
Allan Ambler	National Park Service (DEWA)
Donald Charles, PhD.	Academy of Natural Sciences of Drexel University
Contractor(s)	As Needed
Biological Monitoring Rep.	Pennsylvania DEP
Biological Monitoring Rep.	New York State DEC
Biological Monitoring Rep.	New Jersey DEP
Biological Monitoring Rep.	Delaware DNREC

1.2 Project/ Task Organization

Figure 1 is a chart describing the organization of the Delaware River Biomonitoring Program. Table 2 lists the individuals that will participate in at least part of the Delaware River Biomonitoring Program and the role that each of the participants will have in the program.

Figure 1: Organizational Chart of the Delaware River Biomonitoring Program

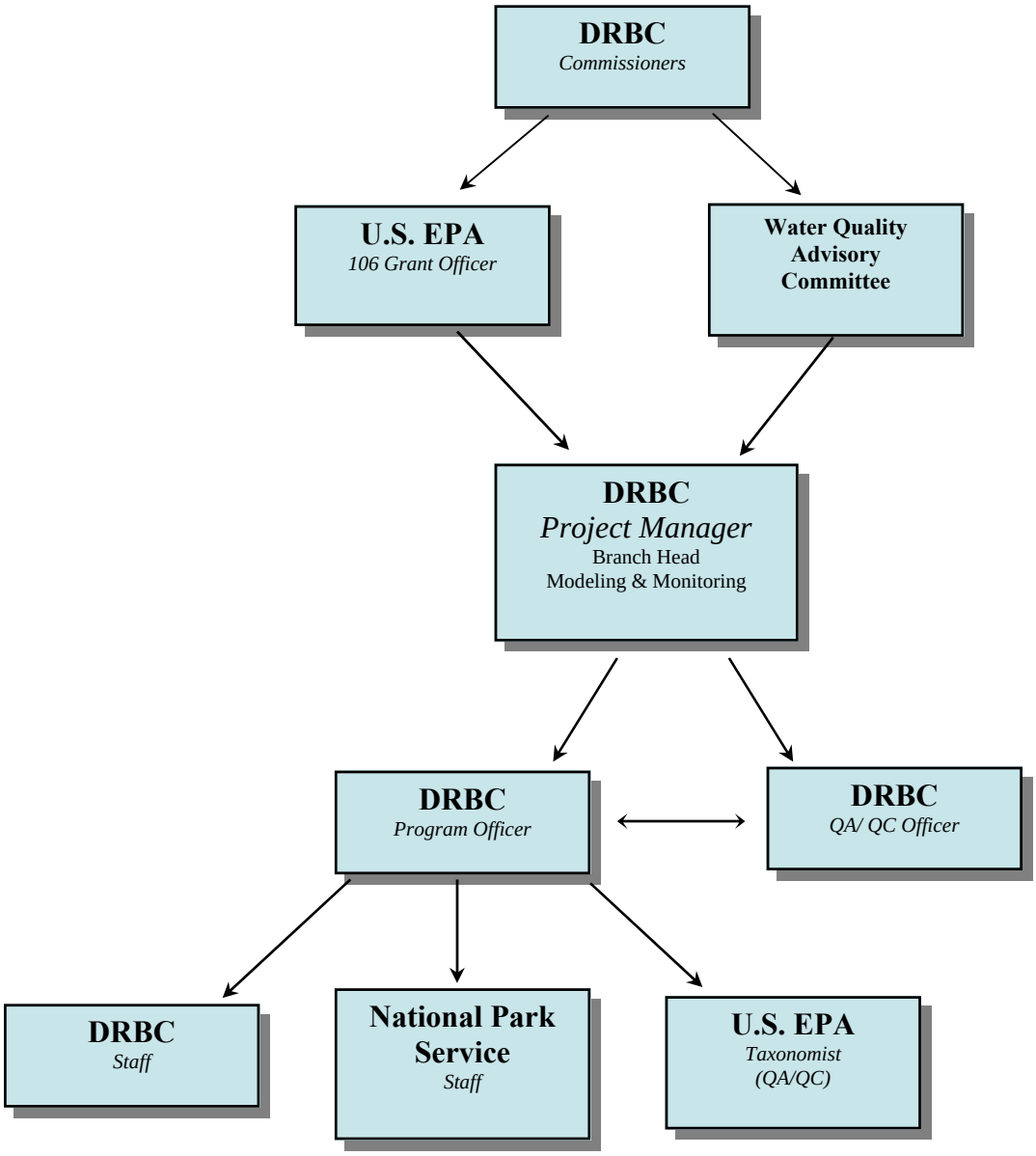

Table 2: Roles and responsibilities of individuals associated with Delaware River Biomonitoring Program

Name	Title	Organization	Role	Responsibility
		U.S. EPA	Project Officer	*106 Grant Officer (funding source)
Thomas Fikslin, PhD.	Branch Head, Modeling & Monitoring Branch	DRBC	Project Manager (Monitoring)	*Oversee Monitoring Programs *Review QAPP *Technical Support *Contract Officer
John Yagecic	Supervisor, Monitoring Section	DRBC	Supervisor (Monitoring)	*Oversee Monitoring Programs *Review QAPP *Technical Support
Robert Limbeck	Watershed Scientist	DRBC	Project Officer	*Site Selection *Coordinate Monitoring *QAPP creation *Supervise Personnel *Sample Collection *Criteria development *Data Analyst
Erik Silldorff, PhD.	Aquatic Biologist	DRBC	Project Officer	*Coordinate Monitoring *Site Selection *Macroinvertebrate Taxonomy *Sample Collection *Data Manager *Data Analyst
	Benthic Taxonomist		Taxonomy Lab	*Macroinvertebrate Taxonomy
David Velinsky	Environmental Geochemist	Academy of Natural Sciences	Chemistry Lab	*Benthic Algal Chemistry Analyses
Donald Charles	Algal Taxonomist	Academy of Natural Sciences	Taxonomy Lab	*Algal Taxonomy
Ronald MacGillivray, PhD.	Aquatic Toxicologist	DRBC	QA/QC Officer	*Ensure project quality
Greg Pond	Biologist	U.S. EPA	Taxonomist	*QC of Invertebrate Samples *Technical Support
Karen Reavy	GIS Coordinator	DRBC	GIS Coordinator	*GIS Technical Support
Don Hamilton	Natural Resources Specialist	NPS-UPDE	Sample Collection	*Technical Support (UPDE) *Aid in sample collection
Jamie Myers	Natural Resources Specialist	NPS-UPDE	Sample Collection	*Technical Support (UPDE) *Aid in sample collection
Allan Ambler	Biologist	NPS-DEWA	Sample Collection	*Technical Support (DEWA) *Aid in sample collection

1.3 Problem Definition/ Background

The Delaware River Biomonitoring Program (DRBP) is responsible for biomonitoring and biocriteria development for the non-tidal portion of the Delaware River. Along with selected chemistry data, aquatic assemblages are monitored in order to assess aquatic life use attainment in the Delaware River.

This project plan defines the habitat, benthic macroinvertebrate and periphyton components of DRBC's biological monitoring program. Additional types of biological monitoring are occasionally monitored as resources allow, including fish, Unionid mussels, plankton, submerged aquatic vegetation, and riparian condition. These activities, in addition to physical and chemical data gathering, provide a well-rounded view of water quality conditions in the Delaware River, and provide sufficient data for management decisions.

DRBC gathers sufficient physical, chemical, and biological information to implement biocriteria as part of Aquatic Life Use and Special Protection Waters (SPW) regulations for the non-tidal portion of the Delaware River. This project targets the main stem non-tidal Delaware River and selected large tributaries for biocriteria development and aquatic life use assessment.

Annual or biennial macroinvertebrate, periphyton, and habitat surveys of accessible river sites, targeting the richest habitats (riffles, runs, island margins), have been used to create a reference baseline of the existing biological community to quantify ecological integrity for the entire 200-mile non-tidal river. Biological criteria were drafted in 2009 (Silldorff and Limbeck, 2009). Since then, a benthic index of biotic integrity (B-IBI) has been used to assess aquatic life use attainment for the non-tidal portion of the Delaware River. In 2010, additional samples were collected from known reference and stressed locations on large tributaries to define the ability of the B-IBI to detect impairment and to establish a biological condition gradient.

A DRBC pilot study in 2005 for a periphyton monitoring network (DRBC 2006), found that eutrophication due to high nutrient concentrations may be problematic in the lower non-tidal portion of the Delaware River (between the Lehigh River confluence and Trenton). DRBC conducts annual or biennial periphyton community monitoring in richest targeted habitat for the purpose of biocriteria development related to general ecological health of the river, and specifically to detection of impacts due to excessive nutrients and eutrophication. After sufficient data has been collected, algal biological criteria for the non-tidal portion of the Delaware River will be proposed for use in 305B assessments. DRBC is following recent guidance and publications relating nutrients, eutrophication, urbanization, sedimentation and rapid flow regime changes to algal community indicators (Hill et. al 2000; Kelly et. al 2001; Kentucky DEP 2002; Ponader and Charles 2003; Potapova et. al 2004; Ponader et. al 2005; Potapova and Charles 2005).

1.4 Project Task/ Description

This program requires a biennial or an annual survey of benthic macroinvertebrates, periphyton and habitat at selected locations along the 200-mile length of the non-tidal Delaware River. After a sufficient multi-year collection period, the data are used to create or improve biological criteria for use with the Delaware River Basin Commission Water Quality Regulations; and 5 to 7-year sets of data are used to assess aquatic life use attainment.

Macroinvertebrates are collected from Richest Targeted Habitat (RTH) using the Big River Frame Net (BFN) at each of 25 Delaware River sites and occasionally from large tributary sites. Pebble counts, velocity measurements, qualitative RBP habitat assessments and instantaneous water quality samples are collected to characterize habitat and water quality at the time of sampling. Collection occurs during the August to September index period unless conditions are unsafe. All data collection is done by DRBC and partner agency

staff trained in these protocols. Macroinvertebrate taxonomy is completed by trained DRBC, U.S. EPA, or contract laboratory staff.

Periphyton samples are collected using the top-rock scrape method from 9 cobbles selected within RTH parallel to transects where macroinvertebrates are collected. Ancillary measurements include canopy cover, ambient nutrient concentrations, Chlorophyll *a* and Ash-Free Dry Mass, area scraped from each cobble; depth/velocity profiles of the sampling areas; and surface/bottom PAR measurements.

Habitat methods are being investigated relative to applicability in free-flowing large rivers. For Delaware River assessment, DRBC has primarily used the RBP habitat method for wadeable streams. Many RBP habitat parameters seem unsuitable for rivers as large as the Delaware, and there seem to be few relationships between habitat parameters and biological metrics. For this reason, DRBC may assess habitat conditions using and comparing a variety of methods: the RBP high gradient habitat protocol (Barbour et. al 1999); the EMAP Great Rivers field protocol (Angradi et. al 2004); EMAP habitat protocols for non-wadeable rivers and streams (Lazorchak et. al 2000); and the Qualitative Habitat Evaluation Index (Ohio EPA, Rankin 1989). The RBP presently remains DRBC's primary habitat evaluation method, but eventually DRBC expects to adopt other methods more suitable to rivers similar to the Delaware.

Data produced during this survey are compiled in standardized Access or Excel data bases and structured for import to the R statistical program. Metrics are calculated using R, Excel formulae, SQL scripts, or web applications. Statistics are analyzed using Analyse-It, a Microsoft Excel add-on program, or the R open-source statistical language. Data are stored at DRBC for organizational use, and are planned for upload onto EPA's STORET national data base for public usage.

All study participants must read this QAPP prior to sampling. All participants are trained in the study methods as appropriate to their role. The QA officer must be present for at least 10% (n=3) of samples collected during this survey and will produce a memo of program assessment findings. To ensure that samples are similar, quantitative measurements are taken to numerically characterize substrate (must be near gravel/cobble median particle size, about 40 to 90 mm); depth (0.5 to 2.5 feet); and flow (1 to 3 ft/sec) at sampling points to validate samples and rule out the subjectivity of site selection. Samples proven to be dissimilar must undergo further validation prior to their inclusion into the criteria data set.

1.5 Quality Objectives and Criteria for Measurement Data

The purpose of this program is to assess the biological quality of the Delaware River as part of DRBC water quality regulations consistent with the goals of the Wild and Scenic designation as directed by Congress. Few longitudinal surveys of this nature have previously been conducted on the non-tidal Delaware River, leaving few historical and comparable data. Due to the lack of existing data, the data quality standards discussed in this QAPP applies to validate each season's collected data. Investigators using data from this program are required to determine limitations of data outside of DRBC's desired usage for development of water quality criteria and a B-IBI for the Delaware River. Because of the assessment methods used, within a narrow range of site conditions mandated by monitoring a water body of this size, it is questionable whether or not it is possible to develop a true multi-metric index, as only the best-performing sites within the river are used to define the reference condition for comparison. USEPA-ORD continues to assist DRBC to determine the most useful model for future assessment of aquatic life conditions in the Delaware River, and especially in determining what conditions constitute "reference" or "impaired" conditions.

1.5.1 Bias

The aim of this study is to limit natural variability such that differences observed in biotic conditions are attributable mainly to changes only in local water quality. For this reason, we strive to collect samples within a limited seasonal, flow and physical instream habitat window, so that sites can be compared with one another

and from year to year. In the field, samples are taken from richest targeted habitat, such as riffles, island margins or shore margins defined by minimal canopy cover, substrate size D50 between 40 and 90 mm, velocity 1-3 ft./sec, and depth 0.5-2.5 ft. This allows for comparability between sites along a longitudinal river mile gradient. Samples are taken within an index period of August 1 to September 30, the low-flow season in the Delaware River. River flow must be less than 10,000 cfs at Trenton, and stable low flow must occur in the weeks leading up to sampling. In the case of flood events large enough to mobilize gravel and cobble sediments, no sampling can be done during a re-colonization time of 4 to 6 weeks after the flood. It is notable that this circumstance can reduce the index period and in some seasons (such as 2003 and 2004) entirely prevent sample collections. All samples are sorted in the laboratory. Laboratory sorting allows for comfortable and controlled lighting and temperature, preventing sorting that may be rushed and biased toward the larger, more easily seen organisms.

1.5.2 Precision

Precision of samples is determined by calculating the relative percent difference (RPD) between duplicate samples at 5 sites per year. Any samples that have a RPD greater than 10% are analyzed further and data disregarded at the discretion of the Project Officer. Best Professional Judgment is used to determine whether variability of this subset of data is due to the natural variability of the system or is truly erroneous data.

1.5.3 Completeness

The completeness of gathered data is dependent on the ability to physically collect samples as well the ability to taxonomically identify samples. Conditions may not allow for collection of samples at all sites during the prescribed sampling year, resulting in an incomplete sample set. In this case, additional samples are collected during the following year's index period. For establishing existing biological condition, an increased number of samples at any one site would not affect results, assuming all samples are collected in the same index period. Of course, such data may not be used to evaluate year-to-year trends, but the increase in N should limit variability of the data set and improve overall performance of metrics. Also, the taxonomist will note if the condition of macroinvertebrates may not allow for taxonomic identification, rendering the sample incomplete if a substantial number of individuals are in poor condition.

1.5.4 Comparability

Comparability of samples is ensured by analyzing substrate and habitat condition by numerical data collected on-site as well as maintaining the same methods and sampling locations throughout the study. Correlation of the physical habitat data between sites and year-to-year proves the comparability of collected samples. All samples should be taken from similar instream habitat (e.g. particle size and distribution, current velocity, and depth) so that data generated are comparable. The sampling protocol calls for sampling in the Richest Targeted Habitat (Moulton et. al 2002) which is here defined as perennially wetted cobble riffles, island margins or shore margins of the Delaware River with depth 0.5 to 2.5 feet, velocity between 1 and 3 ft/sec, and substrate median particle size between 40 and 90 mm. Stations remain the same for each annual survey unless substantial change to conditions arises or opportunities to access suitable habitat improve. Maintenance of the same protocols and habitat conditions for each sample should strengthen site to site, year to year, and within-site comparability for comparable results.

1.6 Special Training / Certification

Sampling is performed by personnel trained in the various sample elements of this study. Only those individuals trained in EPA's Rapid Bioassessment (Barbour et al. 1999) sampling and habitat assessment techniques, and familiar with the BFN will collect macroinvertebrate samples. Other personnel who are trained in gathering periphyton samples, flow measurements, conducting Wolman Pebble Counts, and making habitat assessments will perform those duties. Any participants unfamiliar with methods are instructed prior to sample collection.

All participants are trained in canoe/ small vessel safety if they do not already possess such knowledge. Participants also have read and understood the DRBC "Field Safety Manual".

Macroinvertebrate and periphyton taxonomy is conducted by trained taxonomists on the DRBC staff or contract laboratories. Macroinvertebrates are identified and catalogued using ITIS and other taxonomic standards. A sub-set of samples (10%) is sent to an outside contractor as part of the Quality Control requirements for the project. All QA/QC analyses are conducted by staff trained in taxonomy and sorting.

1.7 Documents and Records

The Project Manager is responsible for maintaining and archiving all documents that pertain to this survey. Hard copies of all files are kept by the Program Manager on file at the Delaware River Basin Commission office. Electronic data specific to this program are stored on digital media both on-site and off-site.

1.7.1 Standard Data Reporting Format

The standard data reporting format is the bench sheet found in Appendix B. Both the DRBC staff and Contract lab record data on these sheets prior to entry by DRBC staff in Ecological Data Application System (EDAS).

2 Measurement/ Data Acquisition

2.1 Sampling Process Design

Macroinvertebrate and periphyton samples are collected at twenty-five stations along the main stem, non-tidal Delaware River, its East and West Branches, and occasionally at sites located on large tributaries to the Delaware. The stations are distributed longitudinally over the entire 200 miles of non-tidal Delaware River with segmentation (approximately every 8 miles) as evenly as the geology and hydrology allow. All samples are collected during the August–September critical low flow index period. Table 3 shows the schedule of all tasks that are part of the biomonitoring program. See Appendix A for a list of sampling locations for the Delaware River Biomonitoring Program.

Table 3: Standard schedule for the Delaware River Biomonitoring Program

Tasks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
QAPP Update	■	■	■	■								
EPA QAPP Approval			■	■	■	■						
Sample Collection								■	■			
Taxonomy	■	■							■	■	■	■
Data Analysis	■	■	■									
Reporting		■	■	■								

2.2 Sampling Methods

2.2.1 DRBC Standard Operating Procedure - Macroinvertebrates

Macroinvertebrate sample collection is a modified RBP format. Samples are collected using a Big River Frame Net (BFN) with a substrate frame. The net was designed in 2001 by DRBC and Wildco, Inc. The net is 3 feet

wide by 2 feet high with tapered 595μm mesh top and canvas bottom, closely resembling a Slack sampler. A 2 foot wide by 2 foot long frame is used to delineate a 4 ft^2 sampling area to provide for semi-quantitative analysis and a large and representative total sample area of 12 ft^2 from a 3-kick composite sample. This design limits the amount of sample lost due to escape around net caused by the effects of the flow on the organisms suspended as part of the collection procedure. The large sample area frame was based on recommendations by the National Park Service and Academy of Natural Sciences citing low sample densities and inconsistent patchy distribution of macroinvertebrates in cobble substrate (National Park Service, Report Nos. 01-5F, 01-7F).

Site selection focuses upon the richest targeted habitat of the Delaware River, which has been specified as the midstream or margin gravel-cobble riffle microhabitat. The exact location of the sample is chosen after a visual inspection by the principal investigators. The selection of the site is based on the targeted depth, substrate and flow characteristics required for macroinvertebrate colonization as well as representative of the entire riffle to be sampled. Specific limitations of flow, depth, and substrate are also observed: flow velocity between 1.0 and 3.0 ft/sec; water depth between 0.5 and 2.5 ft; and median substrate particle size between 40 and 90 mm. The 25 fixed sample locations were chosen in 2001 for accessibility and are representative of similar habitat throughout the non-tidal Delaware River. It is important to determine that the sampling transect has been continuously wet for at least 6 weeks leading up to the sample time. Rapidly rising and falling river stages can ruin the ability of macroinvertebrates to colonize and build a stable community in the 0.5-2.5 foot target depth range, and sampling this previously dry substrate can severely bias results. In such cases, the investigator should attempt to safely sample deeper water or return to the site later under more stable flow conditions.

Once the sampling location is identified, samples are collected using a modification of the Traveling Kick Method (Barbour et al, 1999). A sampling transect line or arc is chosen, and sampling begins at the downstream end of 3 stations along transect. A person stands downstream of the sampling area and secures the net with one leg and both hands while kicking up substrate with the other leg within the frame. The frame is placed directly upstream of the net and is held in place by a second individual while the area inside the frame is agitated by foot by the individual holding the net. Prior to kicking the delineated sample area, large stones are hand-washed into the net by placing them in the net mouth and dislodging attached macroinvertebrates directly into the net (improves representativeness of heavy shells and stone-cased caddis). Once the coarse agitation of the substrate has been completed, a final check using a dive mask and snorkel is completed to ensure adequate sampling and to sample and/or record uncollected organisms (e.g., *Corbicula* clams added to net; Unionidae mussels tallied but not collected). An estimate of embeddedness is made by visual observation and difficulty of particle disturbance (easy-medium-hard). Last, a survey flag is placed at the upstream part of where the kick was completed, to mark the location for quantitative velocity, depth and substrate particle size profiling. This process is repeated at 2 more locations along the chosen transect.

The bulk of the 3-kick sample is composited and rinsed into a large, water-filled container to simplify the cleaning of the net. The macroinvertebrates that were not dislodged by the rinse are picked from the net using forceps and placed in a labeled sample container for preservation. Once the net has been picked, the contents of the larger container are condensed by pouring it through a 500μm sieve then transferred to the labeled sample container that contains the macroinvertebrates that were picked from the net. After careful inspection of both the net and container for remaining macroinvertebrates, both are rinsed and prepared for the next sample. The macroinvertebrate samples are then preserved in Ethyl Alcohol (>75%) for later identification. No container should be more than half-full of sample material, so multiple jars may be used (n), with labels numbered 1 of n, 2 of n, etc. Each jar should contain labels both inside and taped outside of the container. The sample label accompanies the sample through the entire sort-identify process. Sample information should be recorded on the chain-of-custody form. A sample label and sample log form can be found in Appendix B.

2.2.2 DRBC Standard Operating Procedure – Periphyton

The periphyton sample collection method gathers periphyton from Richest Targeted Habitat, just like the macroinvertebrate method used by DRBC. Periphyton are sampled just after macroinvertebrates, at the same locations (just upstream and parallel to the macroinvertebrate sampling transect). Collection methods were adapted from Field Sampling Procedures for the New Jersey Algae Indicators Project (ANSP Procedure No. P-13-64, Charles et. al. 2000).

After taking macroinvertebrate samples, a periphyton sampling transect is established in RTH upstream and parallel to the macroinvertebrate sampling transect. From this transect (approximately 30 to 50 m long), three (3) representative cobbles are taken and placed into a white plastic pan for Chlorophyll A and AFDM sampling. Locations where each cobble was taken are flagged. These rocks are photographed with a measurement scale. Using the top-rock scrape method described in the RBP (Barbour et. al 1999), a composite sample is scraped, rinsed and transferred into a pre-weighed and numbered 250 ml plastic bottle. The area of each cobble that was scraped is covered by aluminum foil and cut to shape for later area measurement in the office. The 3 foil cutouts are placed in a Ziploc bag and labeled. The AFDM/CHLA sample is iced, with no preservative, and shipped within 24 hours to the environmental geochemistry laboratory at the Academy of Natural Sciences of Drexel University in Philadelphia, PA. Once received by ANSP, the samples are analyzed under the following standard procedures, and results reported to DRBC:

1. Benthic Algae and Sediment Chlorophyll A Preparation and Analysis (ANSP Procedure No. P-16-117, Velinsky and DeAlteris, 2002)

2. Determination of Dry Weight and Percent Organic Matter for Sediments, Tissues and Benthic Algae (ANSP Procedure No. P-16-113, Kiry et. al. 2000).

An additional six (6) cobbles, preferably without large growths of filamentous algae or *Podostemum*, yet representative of cobbles found throughout RTH, are collected along the transect line and placed in a white plastic pan. Place flags to indicate locations where cobbles were taken. Cobbles are photographed, scraped, and rinsed with river water into a 500 ml plastic bottle and preserved with buffered formalin (constituting >5% of total sample volume). Samples are labeled and stored for later analysis of diatom taxonomy (by trained DRBC personnel or a contract diatom taxonomy lab). Diatom taxonomy follows the ANSP Standard Procedure:

1. Procedure for Semi-Quantitative Analysis of Soft Algae and Diatoms (ANSP Procedure No. P-13-65, Ponader and Winter, 2002).

Once the samples are taken, additional site measurements are taken and recorded on the Quantitative Targeted Habitat Periphyton Sample Field Data Sheet (Appendix B). Measurements include:

- 100-particle size class of substrate along the sample transect line/arc (using gravelometer template)
- At each flag, record depth, velocity, shading, percent canopy (densiometer), and macroalgae color/type.
- At upstream end, middle, and downstream end of transect, measure PAR 400-700 nm light intensity at 3 depths: above water surface, top of water and at bottom depth.
- Also transfer weather, precipitation, water quality, clarity and color characteristics from other sheets.

Upon return to the office, trace the outline of each piece of foil to an 8.5x11" gridded sheet (10 squares per inch) and record label information on each sheet. Count the squares within each outline and record the total measured area of each rock sampled. Copy and create a pdf document of these 25-75 sheets and save the document to the DRBC Biomonitoring folder on the general drive. Enter the measurements in the algal site file so that Chlorophyll a, AFDM, and algal densities can be expressed in the data set.

2.2.3 Quantitative Instream Habitat

Pebble counts, depth profiles and flow measurements are conducted to quantitatively characterize the microhabitat of the samples taken to eliminate the subjectivity of the site selection process).

Pebble Count: A 100-particle pebble count is conducted at the each of the sampling sites to numerically characterize the particle size of each of the sampled areas (Wolman, 1954). 100 particles are gathered along the sampled transect and measured using an AL-SCI Field Sieve from Albert Scientific. Particles are placed in the sieve to determine the size class of each particle and the data recorded using a #2 pencil on the brushed aluminum surface of the sieve until data can be transferred to a field sheet. Measurements are analyzed in the field for completeness, and to determine the median particle size (D50) and class of substrate present. These measurements are used to validate the comparability of the benthic community collected with each sample. The median particle size (D_{50}) should fall in the range between 40 and 90 mm. Outliers are noted in statistical analysis of results. Example of field sheet can be found in Appendix B.

Velocity Measurement: Velocity and depth are measured using a high-quality digital flow meter (e.g., Marsh-McBirney, Swoffer) and wading rod at the left, center, and right edge of each of the 2x2 ft kicks sampled for macroinvertebrates (total N=9), and once at each location where a cobble was taken for periphyton (total N=9). At each of these position, flow is measured at 0.6 depth to represent the average water column velocity (i.e., flow measurement are not taken near-bed). The average velocity and depth validates the comparability of samples. The average velocity at each site should fall in the range of 1.0 and 3.0 feet per second. Any samples falling outside this range will be noted in statistical analysis. Outliers are noted in statistical analysis. Sample field sheet is in Appendix B.

2.2.4 Water Quality: Physical

Instantaneous water quality measurements are taken once at each sampling site. The RBP Physical Characterization / Water Quality Field Sheet is completed once per site (see Appendix B). Eureka Manta2 multi-parameter meters (or other suitable, properly calibrate multi-parameter meters) are used to collect data for the following parameters:

- Dissolved Oxygen (mg/L)
- Temperature (^{o}C)
- Conductivity (mS/cm)
- pH
- Turbidity (NTU)

A sample field sheet for water quality parameters is in Appendix B.

Instrumentation is calibrated according to DRBC Standard Operating Procedures under NJ laboratory certification requirements. Meter calibration is verified prior to measurements at each site. Just after field measurements are taken, an additional check is made using pH 7 standard to ensure calibration. A sample calibration sheet from the calibration logbook can be found in Appendix B.

2.2.5 Qualitative Habitat Assessment: Rapid Bioassessment Protocol

Habitat conditions are qualitatively assessed using the high-gradient RBP (Barbour et. al 1999) habitat assessment once at each site. This habitat assessment system uses the following parameters to approximate the instream health of the system:

- Epifaunal Substrate/ Available Cover
- Embeddedness
- Velocity Depth Regime
- Sediment Deposition
- Channel Flow Status
- Channel Alterations
- Frequency of Riffles (or Meanders)
- Bank Stability
- Vegetative Protection
- Riparian Vegetative Zone Width

These measurements, once analyzed, are used to describe habitat conditions and identify factors attributing to biological changes. Field sheets are in Appendix B.

2.2.6 Location Information

Location information is collected at each site using a hand-held GPS unit set to decimal degrees at NAD83 datum. The positioning information is used for Geographic Information System (GIS) presentation and analysis of data. Location information and notes are reported on a set of DRBC "River Recreational Maps" and kept on hand for navigation during future studies.

Field notes are combined with field sheets for later data entry. Digital photographs are taken in the following order at each site:

- Directly upstream (1)
- Upstream toward right shore (2) and left shore (3)
- Directly toward right shore (4) and left shore (5)
- Downstream toward right shore (6) and left shore (7)
- Directly downstream (8)
- Substrate photo of macroinvertebrate station A (downstream end of transect) (9)
- Substrate photo of macroinvertebrate station B (mid-transect) (10)
- Substrate photo of macroinvertebrate station C (upstream end of transect) (11)
- Photos of white pan containing mussels from A (12), B (13), and C (14)
- Photo of white pan, with measurement scale, containing 3 Chlorophyll a / AFDM cobbles (15)
- Photo of white pan, with measurement scale, containing 6 Diatom Taxonomy cobbles (16)
- Other photos as needed (NOTE in field notes, starting with #17 per site no.)

2.3 Sample Handling and Custody Requirements

Samples are checked immediately upon return to DRBC and split if material fills any jar more than halfway. Samples reside at the DRBC office until identified taxonomically by DRBC Staff or transported to a contract taxonomy lab. While samples are in-house, they are periodically checked to ensure that preservative is fresh and at an adequate concentration to prevent decaying of the sample.

All samples are recorded on a sample log as they are collected by DRBC staff. This helps locate each of the samples and ensure that all samples are properly handled and identified. An example of a sheet from the sample log can be found in Appendix B. Also, a log is completed documenting the sorting and taxonomy of all samples (see Appendix B). This information is used for time allocation and budgeting for future studies.

Ten percent (n=3) of samples are sent to U.S. EPA Region 3 Laboratory (or other suitable independent laboratory) for Quality Control analysis following DRBC or contractor taxonomic identification. At this time, the randomly selected samples are analyzed for sorting efficiency and taxonomic accuracy. The samples are delivered to the laboratory staff in person or by mail, where custody will be relinquished at that time. The U.S. EPA or other independent taxonomist is given 120 days for sample analysis and data return to DRBC on bench sheets (Appendix B) following the DRBC format. Appendix B contains a sample chain of custody record for macroinvertebrate samples. No similar process is yet complete for periphyton taxonomy QAQC, but the Academy of Natural Sciences maintains rigid taxonomic standards as part of their phycology herbarium collections.

All identified samples are stored at the DRBC headquarters until completion of the project and criteria are finalized. This allows samples to be pulled and reanalyzed if any questions regarding taxonomy arise. A reference collection is stored onsite to aid in verification of identifications and training aids for taxonomists.

2.4 Analytical Methods

Macroinvertebrate taxonomy is conducted on a 500 organism (minimum) sub-sample for use in multi-metric or multivariate analyses. The sub-sample is collected by spreading the sample in a gridded pan and randomly selecting a grid to begin the sort. From this point, a series of randomly selected grids are sorted until a total of 500 organisms have been reached. Once a 500 count is met (minimum 500) the remainder of that grid is sorted, and all organisms are taxonomically identified. Completely sorting and identifying all organisms from the last randomly selected grid cell prevents the bias introduced by stopping at exactly 500 organisms, and allows quantitative estimates of sample density. Identification of organisms is to genus or lowest achievable taxon. Only those organisms with a complete head and thorax, or complete thorax and abdomen, are identified. All taxonomy is consistent with Integrated Taxonomic Identification System (ITIS) or other taxonomic standard.

Table 4 shows the current operational taxonomic units (OTU) used for calculation of DRBC macroinvertebrate metrics.

Table 4: Levels of benthic macroinvertebrate identification specified for this study.

Taxon	Level of Identification		Taxon	Level of Identification
Nematoda	Phylum		Megaloptera	Genus
Nemertea	Genus		Neuroptera	Genus
Turbellaria	Class		Trichoptera	Genus
Nematomorpha	Phylum		Lepidoptera	Genus
Mollusca	Genus		Coleoptera	Genus
Oligochaeta	Genus		Diptera	
Hirudinea	Genus		Chironomidae	Genus
Hydrachnida	Genus		Ceratopogonidae	Genus
Amphipoda	Genus		Tipulidae	Genus
Isopoda	Genus		Culicidae	Genus
Decapoda	Genus		Chaoboridae	Genus
Ephemeroptera	Genus		Simuliidae	Genus
Odonata	Genus		Other dipterans	Family/Genus
Plecoptera	Genus			
Hemiptera	Genus			

Details about DRBC's current bioassessment methods can be found in the following document:

Silldorff, E.and Limbeck, R. 2009. Interim Methodology for Bioassessment of the Delaware River for the DRBC 2010 Integrated Assessment. DRAFT 24-July-2009, Delaware River Basin Commission, West Trenton, NJ. DRBC's biological monitoring program is overseen by a committee of regional experts known as the Biological Advisory Subcommittee.

At present, DRBC has no periphyton taxonomy expertise, relying heavily upon the Academy of Natural Sciences of Philadelphia, Phycology Section. Diatoms are prepared and analyzed using ANSP Procedure for Semi-Quantitative Analysis of Soft Algae and Diatoms (Ponader and Winter, 2002) and the methods are also described in USGS NAWQA protocols for analysis of algal samples (Charles et. al 2002). Taxonomic identification is conducted at the species level for diatoms and genus or species for soft algae (lowest taxonomic unit possible).

Instantaneous ambient water quality measurements are collected using Eureka multi-parameter meters (or comparable multi-parameter meters). Methods used can be found in Table 5:

Table 5: Methods for water quality monitoring using multi-parameter meters

Measurement	Units	Method	Calibration
Dissolved Oxygen (DO mg/L)	mg/L	SM 4500-O.G.	Winkler Titration Method, SM 4500-O.C.
Dissolved Oxygen (DO %)	%	SM 4500-O.G.	Air Calibration (On-Site)
Specific Conductance (SpC)	mS/cm	ISO 7888-1985	Standard Solution (84mS/cm Standard)
Water Temperature	^{o}C	SM 2550	Factory Calibration
pH	pH units	SM 4500-H+	pH Buffer Solution (2 Point)
Turbidity (Turb)	NTU	GLI Method 2 ISO 7027:1999	4000 NTU Formazin Stock Solution (Dilution to 40 NTU) and a "Zero" (DIUF)

2.5 Quality Control

Field QA/QC is obtained by using trained staff for all sampling and field measurements. All are trained in each procedure. Site selection and macroinvertebrate collection is completed by the same personnel at all sites (R. Limbeck and E. Silldorff) to limit subjective errors. The QA officer oversees 10% of sampling (n=3) to assure that sampling is consistent with the methods described in this QAPP.

Visual inspection of net performance is conducted during collection of each sample. Prior to sampling, the net is visually inspected to ensure that no tears in the mesh are present. During sample collection, the sediment plume created by the sample collection is observed to make certain that the entire plume passes through the net. By doing this, it is safe to assume that no organisms are escaping around or over the net during collection and ensuring that sample collected is complete. Also, during this time, the passage of the water through the net is visually monitored to ensure that no portion of the sample is lost due to back wash caused by the net becoming clogged by detritus. In addition, the collectors observe and capture large and mobile species that attempt to escape capture, though this rarely occurs.

Laboratory QA/QC is achieved by having all taxonomy completed by trained staff using current taxonomic standards. All taxa will be verified using ITIS, ARGIS, or another taxonomic standard. Upon completion of taxonomy, 10% of samples will be sent to the United States Environmental Protection Agency, Region 3 Field Laboratory (or other suitable independent laboratory) for sorting efficiency measurement and taxonomic verification. Sorting efficiency is conducted on only the debris that is actually used for generation of the subsample (sort residue). If more than 50 organisms, or 10% of the subsample, are found in the sort residue, the sample is reconstituted and subsampling is conducted again.

2.6 Instrument / Equipment Testing, Inspection, and Maintenance

Macroinvertebrates are collected using a Big River Frame Net (BFN) developed by DRBC and Wildco. The net is rinsed and inspected for tears prior to each sample collected to prevent sample contamination and sample loss, respectively. If a tear is found, sample collection will be postponed until the net has been repaired.

Flow velocity meters undergo careful inspection before each usage and manufacturer specifications are followed. Connections are checked and instruments are cleaned before and after each use, and spare batteries are always available.

Eureka multi-parameter meters (or other suitable multi-parameter meters) are inspected each day prior to usage. All probes are maintained in compliance with manufacturer's recommendations and are calibrated daily.

2.7 Instrument / Equipment Calibration and Frequency

The multi-parameter meter is calibrated daily for all parameters to be measured. If any values fall outside of expected values, measurement is noted and a calibration is conducted after sampling to validate the measurement. Using standards, calibrations are verified prior to and after measurements at each site and are logged on the field sheet for that site. Calibration procedures can be found in Table 5. All calibrations are logged and used to validate measurements during the data analysis period. DRBC maintains NJ laboratory certifications and standard operating procedures for all multi-parameter instruments.

2.8 Data Management

All data generated by this program are managed by the Delaware River Basin Commission. Incoming data is delivered as specified by the Commission prior to collection of data. Data are managed and maintained using an ACCESS biological database located in-house by trained staff members familiar with the monitoring program. Data are available on DRBC's website (www.drbc.net), and are being prepared for entry to the STORET national database.

3 Assessment and Oversight

3.1 Assessment and Response Actions

Assessment and response to problems involving quality of data elements are conducted routinely. The QA/ QC officer and Program Manager are responsible for continuous assessment of sample collection procedures and the resulting data elements to ensure validity of the data reported. Any data that may be in question are noted and the respective data handled in an appropriate manner. These measures ensure data of the highest quality for data reporting, assessment, and criteria development.

3.2 Reporting

Reporting of the QA/ QC assessment is conducted on an "as required" basis, usually during the reporting period after field collections are completed. Findings are submitted to the program manager only if the quality of the data is in question. This memo identifies the respective data set, the basis for its identification as invalid, and measures taken as a result of the findings. Findings are noted in preliminary and final reports for projects.

4 Data Validation and Usability

4.1 Data Review, Verification, and Validation

All data that are generated by this project undergo a review process prior to their analysis and subsequent release in report form. There are various levels of review scheduled to ensure that the data are valid for analysis. See Table 6 for list of data validation methods.

Table 6: Data Review and Validation Procedures

Development Process

Aspect Under Review	Person(s)	Reason
Collection Methodology	QA/ QC Officer Project Officer	To guarantee that the protocol picked best fit the intent of data
Analysis Packages	QA/ QC Officer Project Officer	To guarantee that sample analysis methods will serve the prescribed function of the program

Collection Process

Aspect Under Review	Person(s)	Reason
Sample Collection	Project Officer	Sample collection is consistent with protocol as well as with each other
Calibration Log	QA/ QC Officer Project Officer	To ensure that physical measurements used to validate macroinvertebrate samples are in fact valid themselves

Sample Analysis Process

Aspect Under Review	Person(s)	Reason
Macroinvertebrate Sample	Taxonomist	Determine whether organisms are capable of being identified with confidence to desired taxon
Habitat Data	QA/ QC Officer Project Officer	To both validate the actual habitat data itself as well as the reproducibility of macroinvertebrate samples collected
Macroinvertebrate Taxonomy	Head Taxonomist QA/QC Officer Project Officer	To ensure that macroinvertebrate data reported is valid prior to analysis

Data Analysis Process

Aspect Under Review	Person(s)	Reason
Data Entry	Project Officer	To ensure that data was correctly input into analysis package
Data Analysis	Project Officer	To ensure that methods used for analysis are valid prior to reporting
Data Storage/ Reporting	Project Officer	To ensure that data that is being received has not been altered during any step of the entry or analysis process, rendering it invalid

4.2 Reconciliation with Data Quality Objectives

Data gathered by this project are used for the development of biological criteria for inclusion into The Delaware River Basin Water Quality Regulations as well as biological index development for the non-tidal Delaware River. Biological criteria are typically developed and used in two ways:

1. Effect level criteria for protection of designated Aquatic Life Use in the Delaware River Basin.

2. Anti-Degradation of high quality water resources of the Delaware River Basin.

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Appendix A

Map of sampling locations for Delaware River Biomonitoring Program

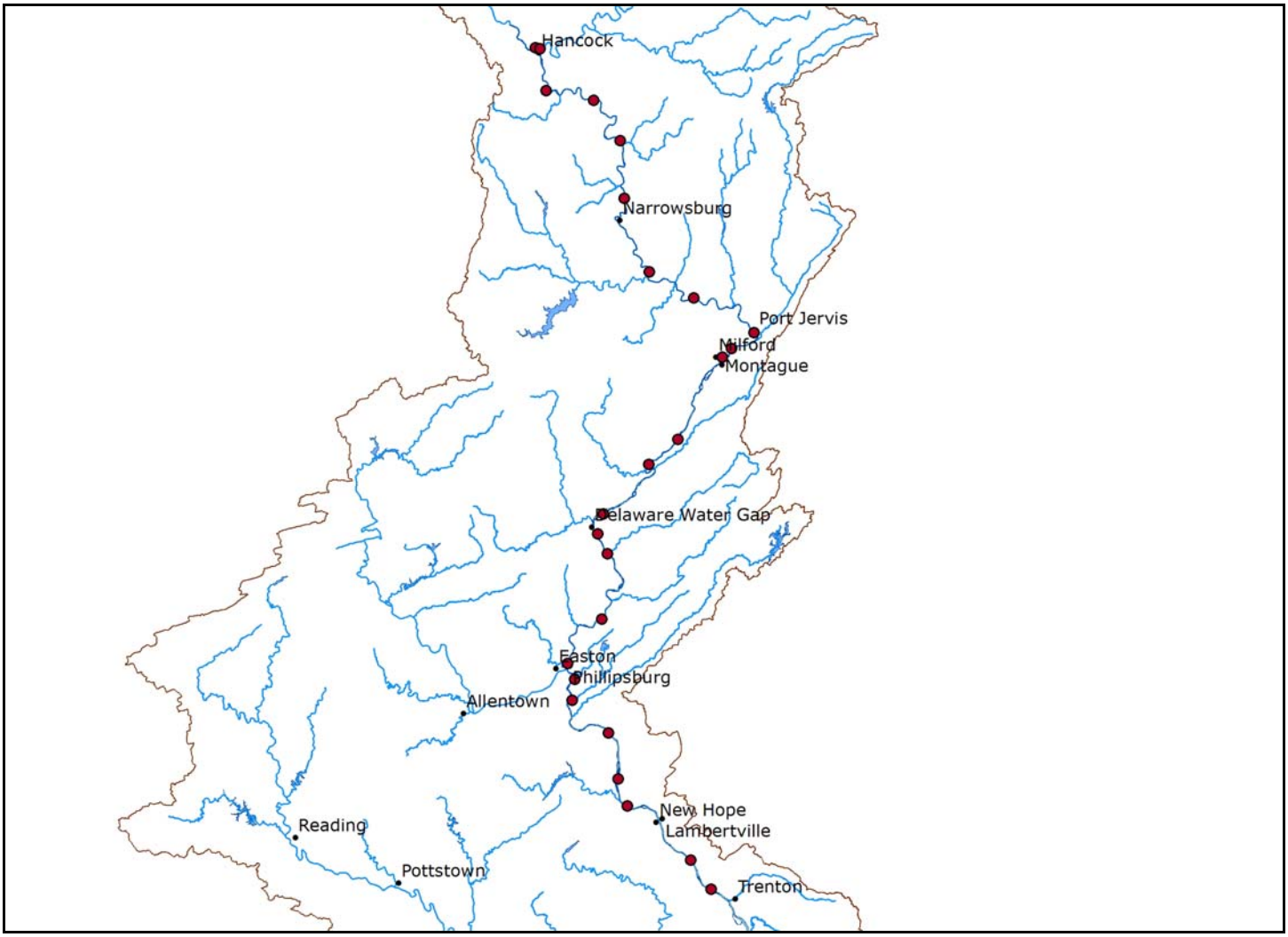


Table 1: Sampling sites and locations

Site Name	Site Number	River Mile	Latitude	Longitude
West Branch Delaware River	DRBC3310W	331.0	41.95341	-75.29195
East Branch Delaware River	DRBC3310E	331.0	41.95199	-75.28016
Buckingham Access	DRBC3250	325.0	41.86627	-75.26293
Long Eddy	DRBC3150	315.0	41.84669	-75.13317
Callicoon Bridge	DRBC3040	304.0	41.76508	-75.06120
Castillo del Rio	DRBC2935	293.5	41.64772	-75.04939
Ascalona Campground	DRBC2790	279.0	41.49817	-74.98205
Pond Eddy (Landers Base)	DRBC2690	269.0	41.44466	-74.86242
Port Jervis	DRBC 2550	255.0	41.37328	-74.69852
Kittatinny Access	DRBC 2499	249.9	41.34134	-74.75964
Cadoo Rd. (NPS Property)	DRBC 2475	247.5	41.32364	-74.78502
Spackmans Island	DRBC 2336	233.6	41.15630	-74.90523
Bushkill Access	DRBC 2285	228.5	41.10542	-74.98403
Worthington	DRBC 2150	215.0	41.00448	-75.10609
Arrow Island	DRBC 2108	210.8	40.96422	-75.12087
Portland	DRBC 2073	207.3	40.92398	-75.09402
Capush Island	DRBC 1949	194.9	40.79066	-75.10908
Getter's Island	DRBC 1843	184.3	40.69973	-75.20121
Wy-Hit-Tuk Park	DRBC 1810	181.0	40.66744	-75.18211
Raubs Island	DRBC 1776	177.6	40.62537	-75.18888
Upper Black Eddy	DRBC 1666	166.6	40.55870	-75.09096
Treasure Island	DRBC 1608	160.8	40.46501	-75.06567
Paunnacussing Bar	DRBC 1556	155.6	40.40936	-75.04072
Washington Crossing	DRBC 1418	141.8	40.29945	-74.87177
Rotary Island	DRBC 1369	136.9	40.23963	-74.81852

Appendix B

Macroinvertebrate Sample Label

Site Number: _____

Site Name: _____

Date: _____

Time: _____

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Type of Sample: _____

Preservative: _____

Method: _____

Collectors: _____

Container _____ of _____

Delaware River Biomonitoring Program

Instantaneous Water Quality and Flow Velocity Measurements

Station Name:

Station Number:

Date (YYYYMMDD) and **Time** (Military)**:**

Personnel:

Air Temperature (estimated or measured)**:**

Water Quality Meter:

Time at which water quality meter depolyed:

		Time of reading:					***Notes***
	Water Temperature (^{o}C)						
Specific Conductance (uS/cm)							
	Dissolved Oxygen (mg/L)						
Dissolved Oxygen (% Saturation)							
		pH					
Turbidity (NTU)							

	Flow Meter:		Spin Test:	seconds
Sample A	Depth	Velocity	Time	Revolutions
Left				
Center				
Right				
Sample B	Depth	Velocity	Time	Revolutions
Left				
Center				
Right				
Sample C	Depth	Velocity	Time	Revolutions
Left				
Center				
Right				

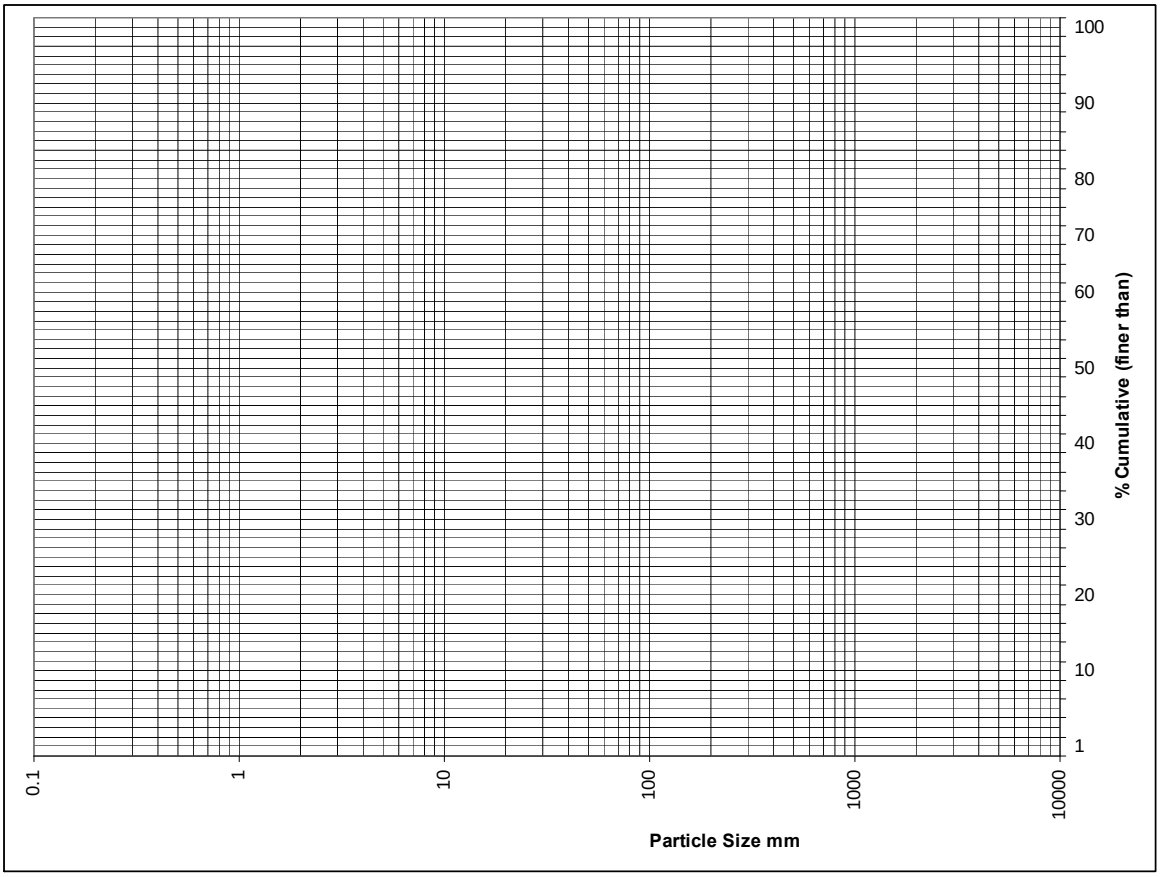
Comments:

Bioassessment Observations:

Sample	**Kick Difficulty**	**Unionids**	***Podostemum***	**Other**
A				
B				
C				

100-Particle Pebble Count from Benthic Sampling Transect

Class Name	Particle Size Class (mm)	Tally	Count	Cumulative Count
Sand	<2			
VF Gravel	2 - 4			
Fine Gravel	4 - 5.7			
Fine Gravel	5.7 - 8			
Med. Gravel	8 - 11.3			
Med. Gravel	11.3 - 16			
Coarse Gravel	16 - 22.6			
Coarse Gravel	22.6 - 32			
VC Gravel	32 – 45			
VC Gravel	45 - 64			
Sm. Cobble	64 – 90			
Sm. Cobble	90 - 128			
Lg. Cobble	128 – 180			
Lg. Cobble	180 - 256			
Sm. Boulder	256 - 362			
Sm. Boulder	362 - 512			
Med. Boulder	512 - 1024			
Lg. Boulder	1024 - 2048			
Bedrock	>4096			
	Totals			



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME_____ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
	1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
	6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	9. Vegetative Protection (score each bank)	More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score_____

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
❑	storm (heavy rain)	❑
❑	rain (steady rain)	❑
❑	showers (intermittent)	❑
____%❑	%cloud cover	❑____%
❑	clear/sunny	❑

Has there been a heavy rain in the last 7 days? ❑ Yes ❑ No

Air Temperature_____ ^{0} C

Other_____

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

STREAM CHARACTERIZATION

Stream Subsystem
❑ Perennial ❑ Intermittent ❑ Tidal

Stream Type
❑ Coldwater ❑ Warmwater

Stream Origin
❑ Glacial ❑ Spring-fed
❑ Non-glacial montane ❑ Mixture of origins
❑ Swamp and bog ❑ Other_____

Catchment Area_____km^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA (BACK)

WATERSHED FEATURES	**Predominant Surrounding Land use** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Other _____ ❑ Residential **Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources **Local Watershed Erosion** ❑ None ❑ Moderate ❑ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ❑ Trees ❑ Shrubs ❑ Grasses ❑ Herbaceous **dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** _____m **Estimated Stream Width** _____m **Sampling Reach Area** _____m^2 **Area in km^2 (m^2x1000)** _____km^2 **Estimated Stream Depth** _____m **Surface Velocity (at thalweg)** _____m/sec **Canopy Cover** ❑ Partly open ❑ Partly shaded ❑ Shaded **High Water Mark** _____m **Proportion of Reach Represented by Stream Morphology Types** ❑ Riffle_____% ❑ Run_____% ❑ Pool_____% **Channelized** ❑ Yes ❑ No **Dam Present** ❑ Yes ❑ No
LARGE WOODY DEBRIS	**LWD** _____m^2 **Density of LWD** _____m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ❑ Rooted emergent ❑ Rooted submergent ❑ Rooted floating ❑ Free floating ❑ Floating Algae ❑ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature**_____^{0} C **Specific Conductance**_____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ❑ Normal/None ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Fishy ❑ Other_____ **Water Surface Oils** ❑ Slick ❑ Sheen ❑ Globs ❑ Flecks ❑ None ❑ Other_____ **Turbidity (if not measured)** ❑ Clear ❑ Slightly turbid ❑ Turbid ❑ Opaque ❑ Stained ❑ Other_____
SEDIMENT/ SUBSTRATE	**Odors** ❑ Normal ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Anaerobic ❑ None ❑ Other_____ **Oils** ❑ Absent ❑ Slight ❑ Moderate ❑ Profuse **Deposits** ❑ Sludge ❑ Sawdust ❑ Paper fiber ❑ Sand ❑ Relict shells ❑ Other_____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ❑ Yes ❑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			**ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)**		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**%Composition n Sampling Area**
Bedrock			Detritus	Sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	Black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	Grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

Delaware River Biological Monitoring

Chlorophyll α / AFDM Sample Log

Site Number	Date	Time	Collector	Site Description	# of Jars	Analysis	Sample Type
Collectors:							
Sent to Lab:							

Delaware River Biological Monitoring

Benthic Invertebrate Sample Log

Site Number	Date	Time	Collector	Site Description	# of Jars	Analysis	Sample Type	Latitude	Longitude
						Genus ID			
						Genus ID			
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						Genus ID			
						Genus ID			
Collectors:			ES=	Erik Silldorff					
			RL=	Robert Limbeck					

Delaware River Biological Monitoring

Periphyton Taxonomy Sample Log

Site Number	Date	Time	Collector	Site Description	# of Jars	Analysis	Sample Type	Latitude	Longitude
						Diatom/Soft Algae ID			
						Diatom/Soft Algae ID			
						Diatom/Soft Algae ID			
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						Diatom/Soft Algae ID			
						Diatom/Soft Algae ID			
Collectors:			ES=	Erik Silldorff					
			RL=	Robert Limbeck					

Delaware River Biological Monitoring

Benthic Invertebrate Lab Matrix

Return To:	Robert Limbeck, DRBC, PO Box 7360, 25 State Police Drive, West Trenton, NJ 08628 (Robert.Limbeck@drbc.state.nj.us)						
Site Number	**Date Collected**	**Site Description**	**# of Jars**	**Date Floated**	**Date Identified**	**Squares Picked**	**No. Counted**
				jars			

DELAWARE RIVER BIOMONITORING PROGRAM

WATER QUALITY SAMPLE CHAIN-OF-CUSTODY RECORD

Page: of

Project Manager:		Robert L. Limbeck		Agency: Delaware River Basin Commission			
Address & Phone:		PO Box 7360, W. Trenton NJ 08628 609-883-9500 x 230		Project: Delaware River Biomonitoring			
Date Collected (YYYYMMDD)	Time Collected (Mil. HHMM)	Site No. Location	# jars	Sample Type (see below)	Preservation (see below)	Collect. Method (Grab / Composite)	Log Number (Seq.+)

Sampled by (signature):					
Received by (signature):		Date		Time	
Received by (signature):		Date		Time	
Received by (signature):		Date		Time	

Instructions/Notes:

Instructions:

Record all information concerning samples.

Check log numbers against containers to assure all samples are present, then sign in appropriate spaces.

Keep original Chain-of-Custody Record with samples.

Person relinquishing samples should receive a photocopy of this form.

Notify Project Manager immediately of any damaged or missing samples.

Delaware River Biomonitoring Program
Bench Tally Sheet

Site Name: _____ **Date:** _____

Site Number: _____ **Time:** _____

Collectors: _____ **Method:** _____

Taxonomist: _____ **Grids:** ___ of _____

Taxa	No.		Taxa	No.
1.			26.	
2.			27.	
3.			28.	
4.			29.	
5.			30.	
6.			31.	
7.			32.	
8.			33.	
9.			34.	
10.			35.	
11.			36.	
12.			37.	
13.			38.	
14.			39.	
15.			40.	
16.			41.	
17.			42.	
18.			43.	
19.			44.	
20.			45.	
21.			46.	
22.			47.	
23.			48.	
24.			49.	
25.			50.	

* Resized to fit page

Delaware River Biomonitoring Program

Quantitative Richest Targeted Habitat Periphyton Sample Field Data Sheet

Sample Number:	DRBC - _____ - _____ - _____ River Mile Date Time					
Station Name:						
River Mile:			**Reach Length (M):**			
Date YYYYMMDD			**Military Time:**			
GPS Coordinates (NAD83 dd)						
Collectors/Roles:						
Related Sampling:	WQUAL DISCH HABITAT INVERT FISH					
Clouds %	**Wind:** CALM LIGHT MODERATE GUSTY					
Precipitation	NONE RAIN SLEET SNOW					
Precipitation Intensity	N/A LIGHT MODERATE HEAVY					
Water Quality	**Water Temperature (C)**		**Air Temperature (C)**		**pH**	
	Dissolved Oxygen (mg/l)		**Specific Conductance (µmho/cm)**		**Turbidity (NTU)**	
Discharge (cfs)		**USGS Gage/Time**				
Riparian Shading	SHADED PARTIAL FULL SUN					
Water Clarity	CLEAR SLIGHTLY TURBID TURBID VERY TURBID					
Water Color	BLACK BROWN CLEAR DK GREEN LT GREEN YELLOW					
Photographs:						
Comments:						

Delaware River Biomonitoring Program

Periphyton Sample Field Data Sheet

Sample Number:	DRBC - _____ - _____ - _____ River Mile Date Time
Bottles:	Chlorophyll A + AFDM (250 ml, iced, no preservative) No._____ Algal Taxonomy (500 ml, buffered formalin preservative) No. _____
Sampling Information:	PRIMARY SAMPLE_____ REPLICATE SAMPLE_____
Sample Type:	RICHEST TARGETED HABITAT DEPOSITIONAL HABITAT
Periphyton Habitat Sampled:	EPILITHIC EPIDENDRIC EPIPHYTIC EPISAMMIC EPIPELIC
Periphyton Method:	TOP-ROCK SCRAPE CYLINDER GRAVEL SAMPLER PETRI DISH
CHLA/AFDM ROCKS (3)	DIAM1: cm2 DIAM2: cm2 DIAM3: cm2

Sample Location No.	**Depth (ft)**	**Velocity (ft/sec)**	**Shading** **S=Shaded** **P=Partial** **F=Full Sun**	**Densiometer (face S, % open)**	**Type and Color of Macroalgae**
CHLA 1					
CHLA 2					
CHLA 3					
TAXONOMY 1					
TAXONOMY 2					
TAXONOMY 3					
TAXONOMY 4					
TAXONOMY 5					
TAXONOMY 6					

Light Measurements in Transect		**Light Intensity Reading (PAR 400-700nm)**		
Reading No.	**From Surface**	**Location 1 (end)**	**Location 2 (mid)**	**Location 3 (end)**
		depth:	depth:	depth:
1	Top			
2	1/5			
6	bottom			

DRBC ALGAE SAMPLE			
Sample Number:	DRBC - _____ - _____ - _____ RMi Date Time		
Station Name			
Date		Time (Mil)	
Collectors			
Sample Type	RTH	Component	Microalgae
Subsample	DIATOM ID CHLA AFDM SOFT ALGAE		
Sample Volume		Subsample Volume	
Preservative	Buffered Formaldehyde	Preservative Volume	
Bottle_____of _____			