Lower Delaware Water Quality Monitoring Program

Quality Assurance Project Plan

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Delaware River Basin Commission

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

Project Officer:	____________________ Geoffrey Smith	________ Date
Quality Assurance Officer:	____________________ Edward Santoro	________ Date
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EPA Project Officer:	____________________ Peter Bentley	________ Date

July 10, 2003

Table of Contents

List of Tables

List of Figures

1. Project Management

1.1 Distribution

Table 1 is list of key individuals associated with the Lower Delaware Water Quality Monitoring Program. Each of the listed individuals will participate, in some capacity, in the Lower Delaware Water Quality Monitoring Program. To ensure the quality of this program, each of these individuals listed will receive a copy of the Quality Assurance Project Plan (QAPP) prior to initiation of the 2003 sampling season. 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 Lower Delaware Water Quality Monitoring Program

Individual	Organization
Peter Bentley	U.S. Environmental Protection Agency
Thomas Fikslin, PhD	Delaware River Basin Commission
Kenneth Najjar, PhD, P.E.	Delaware River Basin Commission
Todd Kratzer, P.E.	Delaware River Basin Commission
Robert Limbeck	Delaware River Basin Commission
Edward Santoro	Delaware River Basin Commission
Geoffrey Smith	Delaware River Basin Commission
Jonathan Zangwill	Delaware River Basin Commission
George Latham	New Jersey Analytical Laboratories
James Amon	Delaware River Greenways Lower Delaware Management Committee
Jeffrey Fischer	United States Geological Survey
Richard Kropp	United States Geological Survey
William Sharp	National Park Service
Donald Gephart	PA Department of Conservation of Natural Resources
Deborah Hammond	NJ Department of Environmental Protection
Richard Shertzer	PA Department of Environmental Protection

1.2 Project/ Task Organization

Figure 1 is an organizational chart describing the lines of communication for the Lower Delaware Water Quality Monitoring Program. Table 2 lists the individuals that will participate in at least part of the Lower Delaware Water Quality Monitoring Program and the role that each of the participants will have in the program.

Figure 1. Organizational Chart of the Lower Delaware Water Quality Monitoring Program

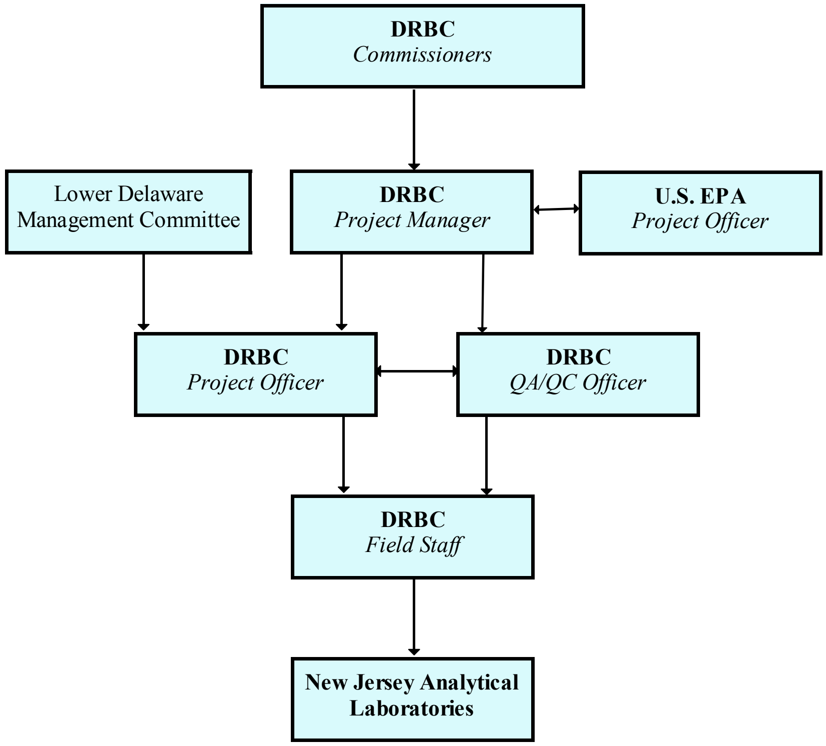

Table 2. Roles and Responsibilities of Individuals associated with the Lower Delaware Water Quality Monitoring Program

Name	Title	Organization	Role	Responsibility
Geoffrey Smith	Field Technician	DRBC	Principle Investigator	*Coordination of Monitoring Efforts *Supervision of Sample Collection *QAPP revision *Data Management
Edward Santoro	Monitoring Coordinator	DRBC	QA/ QC Officer	*Ensure the quality of all aspect of this project
Thomas Fikslin, Ph.D.	Branch Head, Modeling and Monitoring Branch	DRBC	Project Officer (Monitoring)	*General oversight of monitoring program *Review of QAPP *Technical Support *Contract Officer
George Latham	Co-President	NJAL	Analytical Services	*Direct analytical services of Laboratory

1.3 Problem Definition/ Background

In 1999, DRBC began monitoring to characterize the existing water quality of the Lower Non-tidal Delaware River; the reach extending from Trenton, NJ (River Mile 134) to the Delaware Water Gap (River Mile 210). This monitoring network was established because little data existed to characterize water quality in this reach, which has been included in the National Wild and Scenic Rivers System.

In 1999 a pilot study was conducted, leading to development of a 42-site fixed network that was monitored in 2000. Water quality samples were collected bi-weekly through the May-October index period for the purpose of defining existing water quality over a five year period. The 2003 monitoring season will be the fourth in the five-year effort to define existing water quality and develop water quality management strategies that protect and possibly improve water quality of the Lower Non-tidal Delaware River by maintaining existing water quality and improving it where practical.

From May to October 2003, DRBC will monitor water quality of the Lower Non-tidal Delaware River and its tributaries. The mission of the Lower Delaware Water Quality Monitoring Program is to obtain environmental data that:

- Defines the existing water quality of the Lower Non-tidal Delaware River within five years
- Establish targets for development of an anti-degradation protection strategy that supports Special Protection Waters management strategies.
- Reports current water quality status and identifies key factors controlling maintenance and improvement of the ecological integrity of the river
- Augments the water quality, physical, and biological data collection efforts of various federal, state, local, and citizen monitoring agencies
- Provides support for the determination of abatement priorities for point and non-point sources of pollution
- Provides a prioritization scheme for tributaries for monitoring and watershed planning purposes
- Expands ecological knowledge of the Lower Non-tidal Delaware River
- Helps to safeguard the health and safety of the river-using public

1.4 Project/ Task Description

The Lower Delaware River Water Quality Monitoring Program consists of routine baseline monitoring of water chemical and physical parameters. Sampling is conducted bi-weekly at 9 Delaware River sites and 15 tributary sites beginning May 6, 2003 and ending September 26, 2003. A total of 10 samples per site will be collected from 24 sites during the 2003 season.

Samples will be collected using 500mL bottles lowered by rope from bridges crossing the Delaware River or tributary to be sampled. Samples are then poured from the sampling bottle to prepared bottles provided by the contract laboratory. Tributary samples are taken from the thalweg. River samples are collected from 3 points (1/3 channel, center channel, and 2/3 channel width) across the river transect and then composited into prepackaged laboratory bottles. New Jersey Analytical Laboratory, Pennington, NJ, will measure various nutrient, bacteria, and physical parameters.

Field measurements will also be conducted on site by DRBC staff with each sample collection. These measurements will be done using a Hydrolab Quanta™ Multi-parameter sonde. A water surface elevation (Gage Height) will be collected with each sample using a surveyor's tape. This measurement will then be used to calculate discharge and estimate pollutant-loading rates associated with each tributary sample.

All data will be managed using Microsoft Excel. Data will also be uploaded into the STORET national database using the STORET Interface Module (SIM) created by Gold Systems, Inc.

All participants in this project are required to read and become familiar with this QAPP prior to the initiation of sampling. All participants are, or will be, trained in the methodologies for each of the measurements required for this project prior to sample collection. The QA Officer will audit field sample collection and laboratory performance during the 2003 sampling season.

1.5 Quality Objectives and Criteria for Measurement Data

The purpose of this project is to gather sufficient data to determine existing water quality of the Lower Non-tidal Delaware River for development of numerical criteria for water quality regulations consistent with the goals of the Lower Delaware Management Plan and the National Wild and Scenic designation.

Field Measurement and Observations

In order to collect data of the highest quality, extensive preventative maintenance and calibration are essential. Table 3 shows the parameters to be measured, meters to be used, expected range of measurements, range of meter, accuracy of meter, and resolution of meter, as they pertain to the Lower Delaware Water Quality Monitoring Program. Table 4 shows the calibration procedures and frequency for Lower Delaware Water Quality Monitoring. Records will be kept of all calibrations and routine maintenance. This data will be analyzed to ensure that all data collected by meters used will be of the highest quality. Example of sheets used for the calibration logbook and equipment service logbook can be found in Appendix A, Figures 1 and 2, respectively.

Table 3. Parameters and Meters to be used during Lower Delaware Water Quality Monitoring Program

Parameter	Expected Values	Meter	Meter Range	Accuracy	Resolution
Air Temperature	0-35 °C	Enviro-safe Thermometer	-5-50 °C	±0.5 °C	0.5 °C
Water Temperature	0-30 °C	Hydrolab Quanta	-5-50 °C	±0.2 °C	0.01°C
Dissolved Oxygen	0-20 mg/L	Hydrolab Quanta	0-50 mg/L	±0.2 mg/L	0.01 mg/L
Conductivity	0-10 mS/cm	Hydrolab Quanta	0-100 mS/cm	±1% of reading ±1mS/cm	4 digits
pH	4-10 units	Hydrolab Quanta	2-12 units	±0.2 units	0.01 units
Turbidity	0-75 NTU	Hydrolab Quanta	0-1000 NTU	±5% of reading ±1 NTU	0.1 NTU
Air Temperature	0-35 °C	YSI 52	-5-45 °C	±0.1 °C	0.1 °C
Water Temperature	0-30 °C	YSI 52	-5-45 °C	±0.1 °C	0.1 °C
Dissolved Oxygen	0-20 mg/L	YSI 52	0-19.99 mg/L	±0.1 mg/L	0.01 mg/L
Conductivity	0-10 mS/cm	YSI 30	0-4999 µS/cm	±5% of reading	1.0 µS/cm
pH	4-10 units	Isfet	2-12 units	±0.1 units	0.1 units

Table 4. Calibration Requirements for Lower Delaware Water Quality Monitoring Program

Parameter	Unit	Laboratory Preparation	Frequency	Field Prep.	Frequency
Air Temperature	°C	Factory Calibration	*NA*	*NA*	*NA*
Water Temperature	°C	Factory Calibration	Annual	*NA*	*NA*
Dissolved Oxygen (DO)	mg/L	Winkler Titration	Daily	Air Calibration	Per Site
Conductivity	mS/cm	2 point; 0 & 84µS standards	Daily	DI Rinse	Per Site
PH	Standard Units	2 point: 7 & 10 standards	Daily	DI Rinse	Per Site
Turbidity	NTU	2 point: 0.2 & 40 NTU standards	Daily	DI Rinse	Per Site

Physical/Chemical Analytical Samples

Like the field measurements and observations, analytical data must be of the highest quality as the intended use is legal definition of existing water quality and development of water quality criteria. To ensure that this occurs, sampling, preservation, and transport methods must be followed exactly. Table 5 lists parameters, analytical methods, and sample preservation, transport, and storage techniques that must be followed to ensure that the resulting data is adequate for its intended uses; definition of water quality and development of water quality criteria for the non-tidal Lower Delaware River.

Table 5. Sampling, Transport, and Storage requirements for Lower Delaware Water Quality Monitoring Program

Parameter	Sample Container	Preservative	Transport/Storage	Holding Time
Hardness, total as $CaCO_3$	120 mL plastic bottle	Nitric Acid (pH<2)	Ice (Temp.<4°C)	7 days
Chloride	1 L plastic bottle	None	Ice (Temp.<4°C)	7 days
Alkalinity as $CaCO_3$	1 L plastic bottle	None	Ice (Temp.<4°C)	24 hours
Turbidity	1 L plastic bottle	None	Ice (Temp.<4°C)	24 hours
Fecal Coliform	120 mL plastic bottle	None	Ice (Temp.<4°C)	6 hours
E. Coli	120 mL plastic bottle	None	Ice (Temp.<4°C)	6 hours
Enterococcus	120 mL plastic bottle	None	Ice (Temp.<4°C)	6 hours
Total Coliform	120 mL plastic bottle	None	Ice (Temp.<4°C)	6 hours
Nitrate as N	1 L plastic bottle	None	Ice (Temp.<4°C)	7days
Nitrite as N	1 L plastic bottle	None	Ice (Temp.<4°C)	7 days
Ammonia as NH_3	500 mL plastic bottle	Sulfuric Acid (pH<2)	Ice (Temp.<4°C)	7 days
Phosphorus, total as P	500 mL plastic bottle	Sulfuric Acid (pH<2)	Ice (Temp.<4°C)	7 days
Orthophosphate (dissolved)	1 L plastic bottle	None	Ice (Temp.<4°C)	24 hours
Chlorophyll a	1 L amber glass bottle	None	Ice (Temp.<4°C)	24 hours
Total Kjeldahl Nitrogen	500 mL plastic bottle	Sulfuric Acid (pH<2)	Ice (Temp.<4°C)	7 days
Total Suspended Solids	1 L plastic bottle	None	Ice (Temp.<4°C)	24 hours
Total Dissolved Solids	1 L plastic bottle	None	Ice (Temp.<4°C)	24 hours

Data Quality Indicators

In order to effectively determine the quality of the data that is generated as part of this project, a series of standard quality indicator tests (precision, accuracy, representativeness and completeness) will be run on the data following completion of the sampling season. These tests will not be run to determine which data to reject or discard, rather, identify data that is of insufficient quality. Once identified, the data will be flagged and its use will be discretionary based upon its application.

Precision

The precision of selected chemical analyses will be examined by using standard solutions and comparison of duplicate analysis. Relative percent difference (RPD) will be calculated for field duplicate analysis to assess precision of field collection procedure. Laboratory precision will be determined by calculating RPD of results of "unknown" analysis and laboratory duplicate analysis. The following is the formula used for calculation of RPD:

$$RPD = \{(C_1 - C_2)/[(C_1 + C_2)/2]\} \times 100$$

RPD= Relative Percent Difference
C_1= Larger of two observed values
C_2= Smaller of two observe values

Accuracy

The accuracy of resulting data will be calculated for both field and laboratory techniques. Field accuracy testing will be done by assessing field blanks that are collected. These samples should be free of all constituents and collected, preserved, transported, and stored in the same manner as all other samples. The goal of these blank samples is to have no detectable concentration of any of the parameters that are being analyzed. Laboratory accuracy is assessed by calculating percent recovery of matrix spikes, "unknown" solutions, and laboratory duplicates, with the exception of total dissolved solid and bacteria analysis. The accuracy of these parameters will be analyzed using comparison against field and laboratory duplicates only. The following is the formula used for calculation of percent recovery.

$$\%R = 100 \times (C_m / C_{rm})$$

%R = Percent recovery
C_m = Measured concentration of standard reference material
C_{rm} = actual concentration of standard reference material

Representativeness

The representativeness of the resulting data is dependent upon the sampling design and satisfied by the ability to follow the sampling and analytical procedures. Field representativeness will be achieved by having all samples collected and field measurements taken as prescribed in this Quality Assurance Project Plan (QAPP). Laboratory representativeness will be achieved by following analytical procedure and standard operating procedures, meeting holding times, and assessment and comparison of field duplicate samples.

Completeness

Completeness will be measured on both field and laboratory data. Field completeness will be determined by analyzing the number of actual data points generated against the number of expected data points. Laboratory completeness will be determined by analyzing the number of actual data points generated against the number of expected data points. The actual data points will be those points that have passed the other quality indicator tests. The following is the formula used for calculation of completeness:

$$\%C = 100 \times (V / n)$$

%C = Percent completeness
V = number of data points determined valid
n = number of expected data points

1.6 Special Training and Certification

Sample collection will be conducted by individuals who are trained in the various sampling protocols that are necessary for this study and have read and become familiar with this QAPP. Any other individual who collects samples under this program will do so under supervision of the program manager until they have proven their familiarity with sampling and scientific methods. All individuals affiliated with this project will have read and become familiar with DRBC's "Field Safety Manual" prior to sample collection.

Chemical and Physical analysis will be performed by individuals familiar with the analytical techniques described by this plan. These analyses will be conducted by New Jersey Analytical Laboratory (NJAL), a state certified lab in Pennington, NJ.

1.7 Documentation and Records

The project manager will be responsible for managing and archiving all data pertaining to this project. Hardcopies of all files will be kept on file at the DRBC office. Electronic data specific to this program will be kept in-house as well as a back-up copy stored off-site. A report will be compiled at the end of the sampling season to document all proceeding of this monitoring season.

Standard Data Reporting Format
Data will be reported to DRBC from NJAL in hardcopy form. An example of this format can be found in Appendix A, Figure 3.

2 Measurement/ Data Acquisition

2.1 Sampling Process Design

Field measurements and ambient water samples will be taken at 24 stations on both tributaries and mainstem non-tidal Lower Delaware River. Of the 24 stations to be monitored, 9 will be mainstem, Delaware River stations and 15 will be tributary stations. The 9 mainstem Delaware River sites were selected based on their equidistance from each other, covering the entire length of the 73 mile non-tidal Lower Delaware River. All of the samples taken will be taken from bridges spanning the river. Tributaries chosen for inclusion into the program were either major contributors to the Delaware River or under Wild and Scenic designation. All samples will be collected either from bridges or by wading. Samples will be collected bi-weekly during the May – October index period, resulting in 10 samples per site, per season, or 240 total samples. A table of sampling locations and a map showing their relative locations can be found in Table 6 and Figure 2, respectively. A schedule of events associated with the Lower Delaware Water Quality Monitoring Program can be found in Table 7.

Table 6. List of Sites monitored during the Lower Delaware Water Quality Monitoring Program

Site Name	River Mile	Drainage Area (mi^2)	Latitude	Longitude
Delaware River at Calhoun St.	134.34	6780.0	40.219722	-74.778333
Delaware River at Washintons Crossing	141.80	6735.0	40.295278	-74.868889
Pidcock Creek	146.30	12.7	40.345278	-74.945833
Delaware River at Lambertville-New Hope	148.70	6680.0	40.365833	-74.949167
Wickecheoke Creek	152.50	26.6	40.411667	-74.986944
Lockatong Creek	154.00	23.2	40.415833	-75.018056
Delaware River at Bulls Island	155.40	6598.0	40.407500	-75.037778
Paunacussing Creek	155.60	7.9	40.407500	-75.041667
Tohickon Creek	157.00	112.0	40.423056	-75.066667
Tinicum Creek	159.90	24.0	40.485278	-75.072500
Nishisakawick Creek	164.10	11.1	40.526389	-75.060278
Delaware River at Milford	167.70	6381.0	40.566389	-75.098889
Cooks Creek	173.73	29.5	40.586667	-75.211944
Musconetcong River	174.60	156.0	40.592500	-75.186667
Delaware River at Riegelsville	174.80	6328.0	40.593889	-75.191111
Pohatcong Creek	177.40	57.1	40.624722	-75.186111
Lehigh River	183.66	1364.0	40.691111	-75.204722
Delaware River at Northampton St. (Easton)	183.82	4717.0	40.691111	-75.204167
Bushkill Creek	184.10	80.0	40.695278	-75.206111
Martins Creek	190.80	45.5	40.784722	-75.184722
Pequest River	197.80	157.0	40.834167	-75.061111
Delaware River at Belividere	197.84	4378.0	40.828889	-75.085000
Paulins Kill	207.00	177.0	40.920833	-75.088333
Delaware River at Portland	207.40	4165.0	40.784722	-75.184722

Figure 2. Locations of Sites monitored during the Lower Delaware Water Quality Monitoring Program

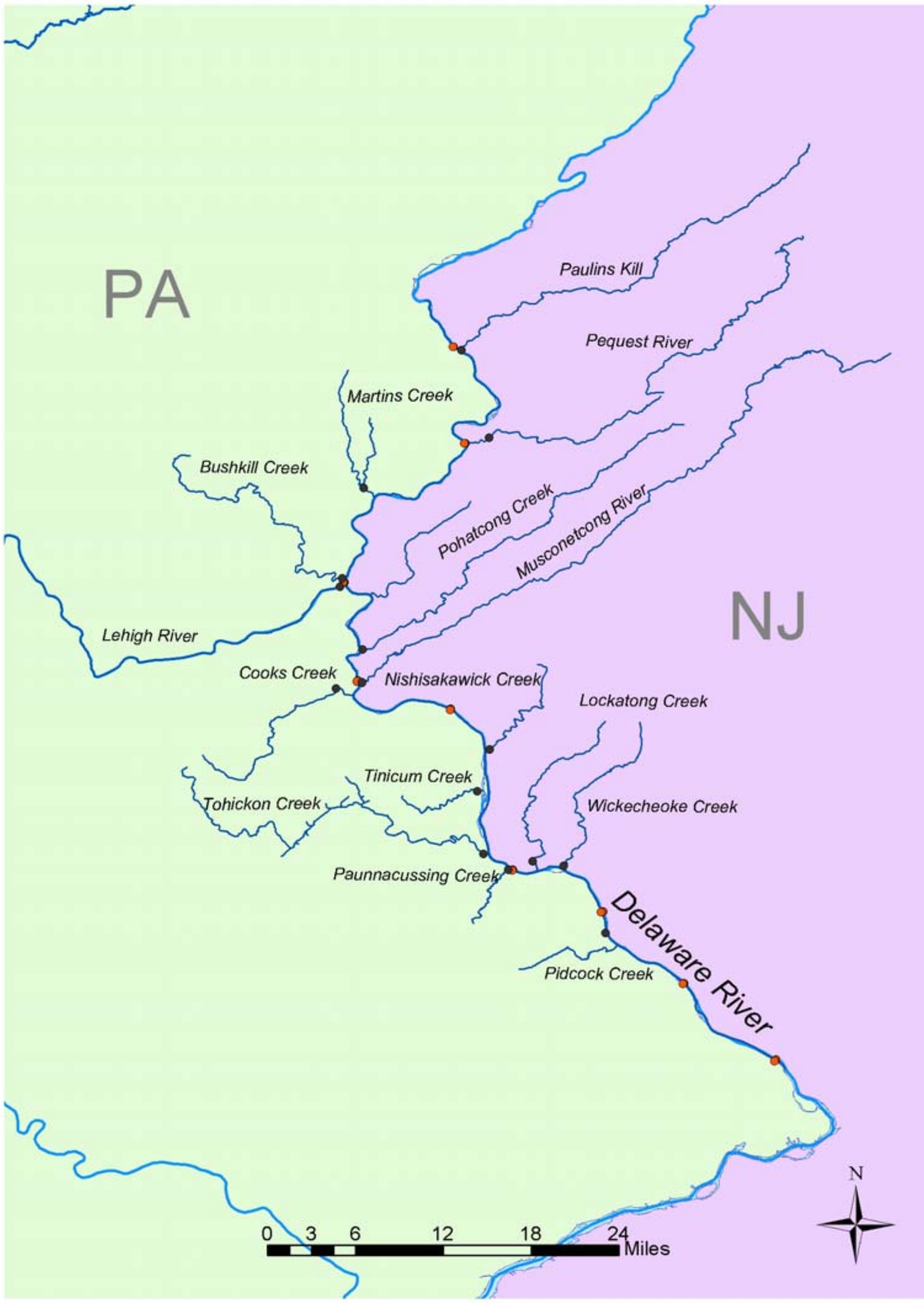

Table 7. Schedule of events associated with the 2003 Lower Delaware Monitoring Program

Activity	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
QAPP Development		■	■	■	■							
Field Collection Preparation			■	■	■							
Sample Collection					■	■	■	■	■			
Data Management					■	■	■	■	■	■		
Data QA/ QC					■	■	■	■	■	■	■	
Laboratory QA/ QC					■	■	■	■	■	■	■	
STORET Data Entry											■	■
Report Generation											■	■

2.2 Sampling Methods

Field Measurements / Observations
All field measurements will be collected using a Hydrolab Quanta mulitparameter sonde. Measurements will be taken by lowering sonde directly into water body and allowing it to stabilize prior to recording of data. Tributary field measurements will be taken at point where sample is collected. At sites where a composite sample is taken, field measurements will be taken at center channel. Between sites, meter will be rinsed and stored in deionized water as recommended by manufacturer. Table 8 lists methods used for field measurement analysis by each of the instruments used for collection. While onsite, weather and site observations will also be recorded. Appendix A, Figure 5 is an example of field collection sheet.

Table 8. Methods used for collection of field measurement data for the Lower Delaware Water Quality Monitoring Program

Meter	Parameter	Unit	Method
Hydrolab Quanta	Water Temp.	^{o}C	Standard Method 2550 Thermometric
Hydrolab Quanta	Dissolved Oxygen	mg/L	Standard Method 500 O Membrane electrode
Hydrolab Quanta	pH	Units	Standard Method 4500 H+ Electometric
Hydrolab Quanta	Conductivity	mS/cm	International Organization of Standardization 7888-1985
Hydrolab Quanta	Turbidity	NTU	Great Lakes Initiative Method 2
Thermometer	Air Temp.	^{o}C	Standard Method 2550 Thermometric
YSI 52	Air Temp.	^{o}C	Standard Method 2550 Thermometric
YSI 52	Water Temp.	^{o}C	Standard Method 2550 Thermometric
YSI 52	Dissolved Oxygen	mg/L	Standard Method 4500 O Membrane electrode
Isfet	pH	Units	Standard Method 4500 H+ Electometric
YSI 30	Conductivity	μS/cm	SM 2510 Platinum electrode cond. cell

Discharge Measurement

A discharge value will be associated with each of the field measurements and samples collected during the Lower Delaware Water Quality Monitoring Program. A gage height measurement will be taken at all sites where there is no USGS continuous monitor present. This measurement will be taken from a marked point using a fiberglass surveyor's tape. A weighted tape will be lowered until weight just breaks water's surface. The measurement will then be recorded at the point marked. This point was determined prior to sampling and surveyed so that its location is known incase a change occurs. These gage heights will then be associated with a flow rating curve that is specific to each water body. This rating curve will be developed using the incremental velocity-area method (Wahl et al. 1995). A series of discharge measurements ($n \geq 5$) will be taken over the expected range of flows using a Gurley digital pygmy meter and wading rod for use in development of the rating curve. With each of the discharge measurements, a gage height will be recorded so that the measurement can be related to a point on the curve. Table 9 lists sites and methods of discharge determination.

A pair of Design Analysis Associates, Inc. DH-21 Waterloggers will also be used for discharge measurement. These monitors are continuous, pressure gages that monitor gage height on a set increment. These monitors will be placed in Cooks and Tinicum Creeks for the entire monitoring season. The monitors will be set to take reading at 30 minute intervals until the water level raises 0.04 ft. and then the frequency of measure increases to every 10 minutes until the level no longer fluctuating more than 0.04 ft in the 30 minute time period. Data will be downloaded from data logger monthly to conserve usage of memory on the unit and minimize possibility of breaks in data set as a result of expended memory or failure of equipment.

The discharge values generated by the United States Department of the Interior, United States Geological Survey (USGS) will be used for the Delaware River and gaged tributaries. For sites where gage is not located at sampling point but does exist in the watershed, a discharge value will be calculated based on drainage area weighting. The formulas used are as follows;

Using 2 known discharge values

$$Q_x = Q_d - [((Q_d - Q_u)/(DA_d - DA_u)) \times (DA_d - DA_x)]$$

Where:

Q_x = Discharge of Unknown
Q_d = Discharge of Downstream Point
Q_u = Discharge of Upstream Point
DA_x = Drainage Area of Unknown Point
DA_d = Drainage Area of Downstream Point
DA_u = Drainage Area of Upstream Point

Using 1 known discharge value

$$Q_x = Q_d - [(Q_d / DA_d) \times (DA_x - DA_d)]$$

Where:
Q_x = Discharge of Unknown
Q_d = Discharge of Downstream
DA_x = Discharge of Unknown
DA_d = Discharge of Downstream

The calculations will be computed using 15-minute measurement data. Values selected will be those closest to actual sampling time.

Table 9. Methods used for determination of discharge values for the Lower Delaware Water Quality Monitoring Program

Site Number	Site Name	Gage Type	USGS Gage No.	Reason for Inclusion
NJPAC01	Delaware River at Calhoun St.	USGS	01463500	
NJPAC02	Delaware River at Washintons Crossing	USGS*	NA	
PA0008	Pidcock Creek	Instantaneous	NA	Wild and Scenic
NJPAC11	Delaware River at Lambertville-New Hope	USGS*	NA	
NJ0012	Wickecheoke Creek	Instantaneous	NA	NJ C1 Classification
NJ0013	Lockatong Creek	Instantaneous	NA	NJ C1 Classification
NJPAC04	Delaware River at Bulls Island	USGS*	NA	Major Contributor
PA0016	Paunacussing Creek	Instantaneous	NA	Wild and Scenic
PA0015	Tohickon Creek	USGS*	01459500	
PA0017	Tinicum Creek	DH-21	NA	Wild and Scenic
NJ0020	Nishisakawick Creek	Instantaneous	NA	NJ C1 Classification
NJPAC06	Delaware River at Milford	USGS*	NA	
PA0021	Cooks Creek	DH-21	NA	Wild and Scenic
NJ0027	Musconetcong River	Instantaneous	NA	Major Contributor
NJPAC07	Delaware River at Riegelsville	USGS	01457500	
NJ0027	Pohatcong Creek	Instantaneous	NA	NJ C1 Classification
PA0026	Lehigh River	USGS*	01454700	Major Contributor
NJPAC08	Delaware River at Northampton St. (Easton)	USGS*	NA	
PA0028	Bushkill Creek	Instantaneous	NA	Major Contributor
PA0031	Martins Creek	Instantaneous	NA	Major Contributor
NJ0032	Pequest River	USGS*	01445500	Major Contributor
NJPAC09	Delaware River at Belividere	USGS	01446500	
NJ0036	Paulins Kill	USGS*	01443500, 01443900	Major Contributor
NJPAC11	Delaware River at Portland	USGS*	NA	

** Gage not located at sampling site, values generated by extrapolation*

Sample Collection Procedures
All chemical/ physical samples will be collected using a rope and bottle apparatus lowered from predetermined points on bridges crossing each of the water bodies to be sampled. NJAL provides a packaged, labeled set of bottles for each of the samples to be collected. This package contains all the bottles necessary for collection of the correct volume for analysis. These bottles contain any preservatives required for proper analysis as described in the analytical methods for each of the parameters to be measured. This ensures proper fixation of appropriate samples and limits improper preservation and possible accidents associated with such chemical preservation methods (e.g. acid burns)

Mainstem Samples
All Delaware River samples will be composited, width-integrated samples. Aliquots will be collected at 3 marked points across the transect; left, center, and right. These marking are at equal intervals across the channel. Like the tributary samples the first deployment and retrieval of the sample bottle will serve as the field decontamination procedure. With the following deployment and retrievals, the contents of the sampler will be poured into each of the bottles until it is approximately one-third full. Once each of the bottles is filled to this level, they are capped and taken to the next position on the bridge and this process is repeated, filling this time until each of the bottles is two-thirds full. Again, once all bottles are filled to this level, they are capped and the collector(s) proceed to the third station and the process is repeated again. The bottles are filled the remainder of the way and then capped, returned to labeled bag, and placed in the iced cooler for transport.

Tributary Samples
Samples will be collected at predetermined point near the thalweg of the waterbody to be sampled. The sample bottle will be lowered into the water, bottle retrieved, and contents poured out. This will be considered the “rinse” or decontamination of sampler prior to sample collection. The bottle will then be lowered back into the water and the subsequent retrievals will be poured into sample bottles prepared by laboratory prior to sampling. Once all bottles are filled, they will be returned to the labeled bag from which they were removed and placed in an iced cooler for transportation to the laboratory.

2.3 Sample Handling and Custody Requirements

All samples will be transferred to an ice filled cooler immediately following completion of sampling at a site. Samples will be transported to the laboratory while on ice as prescribed by analytical methodology. At no time during the sample transport will the samples be removed from the cooler. In order to meet holding times, samples will be delivered by to laboratory immediately following completion of daily sampling. Due to time constraints, the samples from the third day of sampling (WQ 3) are picked up by a courier and delivered to the laboratory for analysis, allowing holding times to be more easily met. Details about preservation techniques and holding times can be found in Table 5.

As samples are collected, the sample number, date, and time are recorded on the chain of custody record. This chain of custody will follow these samples as they progress through collection and analysis procedures. The properly completed chain of custody record will help ensure quality of samples and resulting data. Upon arrival at laboratory, the samples are relinquished to laboratory staff by a member of the sample collection team. As part of relinquishment process, the recipient of the samples signs the chain of custody record and presents the collection team with a duplicate chain of custody record prior to release of the samples into laboratory custody. The original chain of custody is then returned to the project manager with the hard-copies of the analytical results. If any discrepancies arise in the chain of custody, the results associated with that chain will be examined thoroughly prior to their inclusion in any analysis. An example of the chain of custody record can be found in Appendix A, Figure 4.

2.4 Analytical Methods

All DRBC analysis and measurement methodologies used under this program will be EPA approved methods. Methods for field measurements can be found in Table 7. Laboratory analysis methods conducted by NJAL and number of samples to be analyzed under this program can be found in Table 10.

Table 10. Analytical procedures conducted as part of the Lower Delaware Water Quality Monitoring Program

Parameter	Method	MDL	Samples Collected	Rinsate Blanks	Bottle Blanks	Field Duplicates	Total Samples Collected
Hardness, total as $CaCO_3$	EPA 130.2	2.0 mg/L	240	30	10	24	304
Chloride	EPA 300.0	0.1 mg/L	240	30	10	24	304
Alkalinity as $CaCO_3$	EPA 310.1	2.0 mg/L	240	30	10	24	304
Turbidity	EPA 180.1	0.5 NTU	240	30	10	24	304
Fecal Coliform	SM 9222 D	1 col./100mL	240	30	10	24	304
E. Coli	SM 9222 B	1 col./100mL	240	30	10	24	304
Enterococcus	SM 9230 C	1 col./100mL	240	30	10	24	304
Total Coliform	SM 9222 B	1 col./100mL	240	30	10	24	304
Nitrate as N	EPA 300.0	0.02 mg/L	240	30	10	24	304
Nitrite as N	EPA 300.0	0.06 mg/L	240	30	10	24	304
Ammonia as NH_3	EPA 350.2	0.05 mg/L	240	30	10	24	304
Phosphorus, total as P	EPA 365.2	0.02 mg/L	240	30	10	24	304
Orthophosphate (dissolved)	EPA 365.2	0.01 mg/L	240	30	10	24	304
Chlorophyll a	SM 10200 H	1.0 mg/m^3	140	30	10	14	194
Total Kjeldahl Nitrogen	EPA 351.3	0.05 mg/L	240	30	10	24	304
Total Suspended Solids	EPA 160.2	2.0 mg/L	240	30	10	24	304
Total Dissolved Solids	EPA 160.1	6.0 mg/L	240	30	10	24	304

2.5 Quality Control

To ensure that all data used is of the highest quality, quality assurance procedures will be conducted on all aspects of this project before the resulting data is finalized.

Field Measurement and Sample Collection
Field QA/QC will be obtained by using trained staff for all field measurement and sample collection. All measurements and sample collection will be conducted by only those individuals who have read this Quality Assurance Project Plan prior to sample collection. All parties will have been trained in each of the measurements or collections procedures that they will participate in. All equipment used for measurements and collection of samples will be properly maintained and decontaminated as previously described in plan. Logbooks of calibration and maintenance of equipment will be kept, documenting all procedures conducted on equipment throughout the sampling season. Frequency and methods of calibration can be found in Table 4. Decontamination of sample collection apparatus will be conducted by placing bottle in a detergent bath (>4% Alconox solutions) for a minimum of 2 hours. Once this time period is met, the bottle will be removed and rinsed 3 times with distilled water and 3 times with deionized water to ensure all detergent residues have been removed and will not contaminate the sample. Field collections and sample handling, preservation, and transport procedures are subject to audit by the DRBC QA Officer and anytime during this project.

QA/ QC Samples
Rinsate blanks will be taken once per sampling event (n=30) over the course of the sampling season. These will be collected using the same method as normal sample collection. The sampling apparatus will be filled with deionized water and decanted into the prepackaged bottles provided by the laboratory. The first filling of the sampling apparatus will be the decontamination procedure and will be discarded, all subsequent fillings will be poured into the sample bottles for analysis. Bottle blanks will be taken once per the three day sampling trip (n=10). For this sample, deionized water will be poured directly into prepackaged sampling bottles to ensure bottles that are received from lab have not been contaminated. Field duplicates will be collected once per site per year (n=24). All duplicates will be collected in the same manner and analyzed for the same parameters as regular samples from that waterbody.

Laboratory Analysis
As specified by the contract, NJAL supplied the laboratory standard operating procedures and quality assurance plan to DRBC staff for review and inclusion in this quality assurance project plan. All samples received by laboratory will be preserved as described by method and holding times met to ensure accurate results. NJAL will submit all Method Detection Limit (MDL) test results, unknown test results, and calibration curves for review by DRBC staff as part of this project. The NJAL Standard Operating Procedures, MDL study (2002), and Quality Assurance and Control Plan can be found in Attachment A. Quality control samples will also be analyzed to ensure data received is valid. Field duplicates will be taken at each site over the course of the sampling season. The date of collection for these samples will be randomly generated. Laboratory duplicates (Split samples) will be analyzed by the laboratory at a frequency greater than one duplicate per twenty samples analyzed.

Data Management
All of the results that come from the laboratory will be checked for outliers as they are being entered into the database. Any values that appear to be incorrect will be investigated prior to entry into the database. Upon completion of data entry, the entire data base is checked against the reports provided by the lab to ensure that no typographical errors exist in the dataset. After all values are verified against the lab reports, calibration curves are reviewed to validate the data provided by laboratory. At this time, all calibration logs are checked to verify field measurements.

2.6 Instrument / Equipment Testing, Inspection, and Maintenance

To ensure that all data collected under this project is of sufficient quality, all instruments and equipment used will be maintained on a regular basis. Records of all maintenance activities will be documented in an Equipment Service Logbook that will be stored in the DRBC laboratory, near the equipment preparatory area. An example of a page of the Equipment Service Logbook can be found in Appendix A, Figure 2. A kit, which includes replacement parts for each of the pieces of equipment to be used as well as tools to conduct this maintenance, will be present at time of sampling.

Hydrolab Quanta
The Hydrolab Quanta will be subject to daily, routine maintenance as well as a annual maintenance. The daily maintenance includes both lab and field procedures to ensure that all measurements taken are both accurate and precise. Between sites, the sonde will be rinsed with deionized water to prevent fouling by accumulation of contaminants found in the waters samples. The storage cup, used to store sonde in while transporting from site to site, will be filled with fresh, deionized water after each site, according to manufacturer's recommendations. After daily sampling is complete, sonde will be disinfected with an Alconox Soap Solution (4%) to prevent accumulation of bacteria or other biological contaminants. The soap will be applied to all parts of the sonde, excluding the Dissolved Oxygen membrane, using a cotton swab and then rinsed with deionized water to remove soap residues. For long-term storage, storage cup will be filled with tap water to further prevent colonization of bacteria and other biological contaminants on sonde. Upon completion of sampling season, the entire Quanta unit will be sent to manufacturer for annual maintenance as prescribed by the manufacturer. All service performed on the Hydrolab Quanta unit will be documented in the Equipment Service Logbook.

Gurley Pygmy Meters
The Gurley pygmy meters will also be subjected to extensive maintenance throughout the sampling season. Due to the fragile nature of this piece of equipment, all storage, transport, and usage instructions described by manufacturer will be followed explicitly. Before each usage of the pygmy meters, all moving parts will be well oiled to allow them to move freely. After usage, the cup apparatus will be rinsed thoroughly to flush out all particles that may have adhered to the oil. Once rinse is complete, the apparatus will be allowed to dry and then oiled prior to storage. During storage and transport, the "measurement" pin will be removed "transport" pin will be placed in the unit as recommended by the manufacturer. All wiring and other electrical

equipment associated with the pygmy will be inspected frequently. All services conducted on the Gurley pygmy meters will be documented in the Equipment Service Logbook.

Design Analysis Associates, Inc. DH-21 Waterloggers
Both DH-21 Waterlogger units will be frequently inspected following their deployment to ensure that the resulting data is of the highest quality. When data is downloaded from unit, the person conducting the download will inspect the cable, logger, and transmitter for damage prior to reinitializing data collection mode. In addition to visual inspection of equipment, the resulting data is analyzed, looking for erroneous data that may indicate a malfunction in the equipment. If the need arises, maintenance will be conducted by manufacturer. An annual maintenance and recalibration procedure will be conducted by manufacturer following the completion of the sampling season. All services conducted on DH-21 Waterloggers will be documented in the Equipment Service Logbook.

2.7 Instrument / Equipment Calibration and Frequency

Hydrolab Quanta
All calibrations will be conducted as recommended by manufacturer. Hydrolab calibration procedures and frequency of calibration can be found in Table 4. If during the time of collection any values seem to fall outside of the expected range, these values will be noted and a calibration will occur upon completion of sampling to verify measurements taken. An annual factory calibration will be done prior to the 2003 sampling season. All calibrations will be documented in the Calibration Logbook.

Gurley Pygmy Meters
Preparation procedure for the pygmy meters will be a 60-second spin test prior to sampling. This will ensure that cups are moving freely and results will be precise and accurate.

Design Analysis Associates, Inc. DH-21 Waterlogger
Each of the DH-21 Waterloggers will be subject to an annual factory calibration prior to sampling. When calibration is conducted, a pre- and postcalibration measurement is taken to ensure the accuracy of the equipment. These values will then be used to adjust measurements if difference is found to be significant.

2.8 Data Management

All data generated by this program will be managed by the Delaware River Basin Commission. All laboratory analytical results will be presented to DRBC in hard-copy format. In-house staff will then enter data into a STORET-ready spreadsheet created by DRBC staff. An example of database format can be found in Appendix A, Figure 7. Data will be managed and maintained using Microsoft Excel. Data generated by this program will also reside in the STORET national database shortly after completion of sampling season.

3. Assessment and Oversight

3.1 Assessment and Response Actions

Assessment of and responses to problems involving data elements will be conducted routinely. The QA/QC officer and Project Manager will be 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 as a result of any aspect of this project will be noted and the respective data handled at their discretion. These measures will ensure data of the highest quality for data reporting, assessment, and criteria development.

3.2 Reporting

Reporting of the QA/QC assessment will be conducted on an "as required" basis. A report of findings will be submitted to management only if the quality of the data produced by this project is in question. This report will identify the respective data set, the basis for its identification as invalid, and measures taken as a result of the findings. This report will also be included in the preliminary and final reports for the project to validate the findings of the project.

4. Data Validation and Usability

4.1 Data Review, Verification, and Validation

All data elements that are generated by this project will undergo a review process prior to their analysis and subsequent release in report form. There will be various levels of review scheduled to ensure that the data generated are valid for analysis. Table 11 lists data validation methods and procedures.

Table 11. Data Review and Validation Procedures

Development Process

Aspect Under Review	Person(s)	Reason
Collection Methodolgy	Project Officer Program Manager	To guarantee that the protocol picked best fit the intent of data
Analysis Packages	Planning & Implementation Program Officer	To guarantee that sample analysis methods will serve the perscribed function of the program

Collection Process

Aspect Under Review	Person(s)	Reason
Sample Collection	QA/ QC Officer Program Officer	Sample collection is consistent with protocol as well as with each other
Calibration Log	QA/ QC Officer Program Officer	To ensure that physical measurements collected are valid

Sample Analysis Process

Aspect Under Review	Person(s)	Reason
Laboratory Analysis	QA/ QC Officer Program Manager	To guarantee that methods used and results given are valid

Data Analysis Process

Aspect Under Review	Person(s)	Reason
Data Entry	Program Officer	To ensure that data was correctly input into analysis package
Data Analysis	Planning & Implementation	To ensure that methods used for analysis are valid prior to reporting
Data Storage/ Reporting	Program Manager Program 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

The data gathered by this project will be used for the definition of the Existing Water Quality of the non-tidal Lower Delaware River as well as criteria development for adoption into The Delaware River Basin Water Quality Regulations. With this criteria in place, it will allow the Commission to maintain and possibly improve the quality of the waters found in the non-tidal Lower Delaware River Basin.

5. References

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Appendix A

Figure 1. Example of Calibration Logbook Field Sheet

Hydrolab Quanta Calibration Sheet

Date: ________ Time: __________

DO Percentage
**Air Calibration*

	Initial Value	Calibration	Final Value	Initials
Air Temperature:	________	Y or N	________	________

DO Concentration (mg/L)

	Initial Value	Calibration	Final Value	Initials
Water Temperature:	________			
DO (mg/L):	________	Y or N	________	________

Winkler Titrations
1. ____________________
2. ____________________
3. ____________________ ________

Comments: ____________________

pH Calibration (2pt)

	Initial Value	Calibration	Final Value	Initials
7.0 Buffer:	________	Y or N	________	
4.0 Buffer:	________	Y or N	________	________

*anticipated values less than 7.0

7.0 Buffer:	________	Y or N	________	
10.0 Buffer:	________	Y or N	________	________

*anticipated values greater than 7.0

Comments: ____________________

Specific Conductance (84 µS/cm Standard)

	Initial Value	Calibration	Final Value	Initials
Specific Conductivity:	________	Y or N	________	
Temperature:	________			________

Comments: ____________________

Tubidity (2pt, 4000 NTU Stock)
**dilution created using 1mL stock and 99mL water*

	Intial Value	Calibration	Final Value	Initials
Zero (DI water):	________	Y or N	________	
40 NTU Standard:	________	Y or N	________	________

Comments: ____________________

Figure 2. Example of Equipment Logbook Sheet

Equipment Service Log

Date	Initials	Service	Comments

Figure 3. Example of New Jersey Analytical Laboratory Result Reporting Format

New Jersey Analytical Laboratories

Sample Information

Lab ID:	**Date Sampled:**
Site No.	**Time Sampled:**
Location:	**Date Received:**
	Collection Method:

Parameter	Result	Detection Limit	Units	Dilution	Method Code
Total Coliform		4	Colonies/100 ml	4	SM 9222 B
E. Coli		4	Colonies/100 ml	4	SM 9222 B
Fecal Coliform		4	Colonies/100 ml	4	SM 9222 D
Enterococcus		4	Colonies/100 ml	4	SM 9230 C
Chlorophyll		1.0	mg/m^3	NA	SM 10200 H
Ammonia as NH3-N		0.05	mg/L	1	EPA 350.3
Total Kjeldahl Nitrogen		0.05	mg/L	1	EPA 351.3
Nitrite as N		0.02	mg/L	1	EPA 300.0
Nitrate as N		0.02	mg/L	1	EPA 300.0
Chloride		0.10	mg/L	1	EPA 300.0
Ortho-Phosphate		0.01	mg/L	1	EPA 365.2
Phosphorus, total as P		0.02	mg/L	1	EPA 365.2
Turbidity		0.5	NTU	1	EPA 180.1
Alkalinity as CaCO3		1.0	mg/L	1	EPA 310.1
Hardness, total as CaCO3		1.0	mg/L	1	EPA 130.2
Total Suspended Solids		0.5	mg/L	1	EPA 160.2
Total Dissolved Solids		6.0	mg/L	1	EPA 160.1

ND:Not Detected above Detection Limit
NA:Not Applicable

George Latham — Date
Laboratory Director

Laboratory ID # 11005

Precision testing for a cleaner environment.

Figure 4. Example of Chain of Custody Record

LOWER DELAWARE MONITORING PROGRAM
CHAIN-OF-CUSTODY RECORD

Page: 1 of 1

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: Lower Delaware Cooperative Monitoring			
Date Collected (YYYYMMDD)	Time Collected (Mil. HHMM)	Site No. Location	# jars	Sample Type (see below)	Preserv-ation (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	
Received by (signature):				Date		Time	
Received by (signature):				Date		Time	

Instructions/Notes: Each Sample Bag Contains:

1 L Unpreserved = N/N; Alk; Ortho; TDS; TSS
500 ml pH<2 H_2SO4 = TP; NH_3; TKN
120 ml sterilized = Fecal Coliform
120 ml sterilized = Enterococci
120 ml sterilized = E. coli & Total Coliform
120 ml pH<2 HNO_3 = Hardness
1 L Amber unpreserved glass = Chlorophyll a (selected sites)

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.

Figure 5. Example of Field Measurement/ Observation Data Sheet

Lower Delaware Water Quality Monitoring Program
Field Measurement / Observation Reporting Form

1.) River Mile (RM/ Trib 1/ Trib 2/ State) ____________

Station Name: ____________

Station Number: ____________

2.) Date (YYYY/MM/DD) and **Time** (Military) ____________ ____:____

3.) Dissolved Oxygen Method: ____________ ________ mg/l

4.) Air Temperature Method: ____________ ________ °C

5.) Water Temperature Method: ____________ ________ °C

6.) Specific Conductance Method: ____________ ________ μmhos/cm

7.) pH Method: ____________ ________ pH units

8.) Turbidity (*in situ*) Method: ____________ ________ NTU

9.) Gage Height ________ + ________ = ________ ft.
measurement leader

10.) Weather Conditions: ____________

Dates of Last Rain: ____________ and ____________

11.) Water and Site Conditions: ____________

12.) Personnel

Name	Role

Figure 6. Example of Tributary Discharge Measurement Sheet

Lower Delaware Water QualityMonitoring Program
Discharge Measurement Data Sheet **Tributary**

Station Name ______
River Mile
Station Number DRBC
Date (MM/DD/YYYY) ______ Time (HHMM) ______
Party ______ Agency DRBC
Location of Test Site From Gage Station ______
Weather Conditions ______
Dates Last Rain __/__/__ ______ inches
__/__/__ ______ inches

Gage Read-ings		Time	Tape Reading		Leader Length		Total Gage
	Before			+		=	
	After			+		=	

Gage Height at Substrate
Meter Type
Spin Test (sec)
Interval Width Chosen
Total Number of Intervals

Tape Reading @ Near Bank
Tape Reading @ Far Bank
Total Width of Stream

Flow Width = (total width)-(zero flow intervals)
Flow Area = Sum(incremental width **X** incremental depth)
Average Depth = flow area / flow width
Average Velocity = total discharge / total flow area

Intervals	Tape Reading[1]	Dist. From stream edge[2]	Interval Width (tenths)	Interval Depth (tenths)	Observ Depth[3] (tenths)	Revolutions[4]	Time (sec)	rev/sec	Velocity @ point	Interval Area (W X D)	Interval Discharge (A X V)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
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25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
		Totals							Totals		

Modified from ***Kratzer, 1996***

Figure 7. Data Management Format for the Lower Delaware Water Quality Monitoring Program

Station ID	Station Visit Start Date	Visit Comments	Activity ID	Activity Type	Medium	Activity Category	Field Replicate Number	Activity Start Date	Activity Start Time	Sample Collection Procedure	Gear ID

Figure 7. Data Management Format for the Lower Delaware Water Quality Monitoring Program (continued)

Gear Configuration ID	Sample Preservation, Transport and Storage	Characteristic Group ID	Characteristic Row ID	Result Value	Result Comment	Lab ID	Quantification Low	Quantification High	Detection Limit Value	Detection Limit Unit	Station Visit

Figure 8. Matrix of Monitoring Activities associated with the Lower Delaware Water Quality Monitoring Program

Lower Delaware Monitoring Matrix, May-September 2003

F = grab sample, analyze in field
G = grab sample, preserve for lab
C = composite sample from PA-Center-NJ channels
S = get ADAPS streamflow data for time of sample

LGR = Water Level Logger installed for all or part of season
BLACKOUT = No Samples
T= Surveyor's Tape

				DRBC Field						Contract Lab Parameters															
Site No	River Mile	Sites	DATE/2003	DO (SM 4500 O)	pH (SM 4500 H+)	Air temp (SM 2550)	Water temp (SM 2550)	Gage Ht (ft.01)	Conductivity (ISO 7888:1985)	Hardness (EPA 130.2)	Turbidity (EPA 180.1)	Alkalinity (EPA 310.1)	Chlorophyll a (SM 10200H)	Total P (EPA 365.2)	Orthophosphate (EPA 365.2)	Ammonia N (EPA 350.2)	Nitrate (EPA 300.0)	Nitrate (EPA 300.0)	TKN (EPA 351.3)	Fecal Coliform (SM 9222D)	E. coli & TC (SM 9222B+coliblue)	Enterococcus (SM 9230C)	TSS (EPA 160.2)	TDS (EPA 160.1)	Chloride (EPA 300.0)
		RUNS 1 THROUGH 10																							
DRBCNJPAC01	134.34	Delaware River @ Calhoun St Bridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCNJPAC02	141.80	Delaware River @ Washington Crossing Br, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCPA0008	146.30	Pidcock Creek, PA	DAY1 WQ1	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC11	148.70	Delaware River @ Lambertville-New Hope Bridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCNJ0012	152.50	Wickecheoke Creek, NJ	DAY1 WQ1	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJ0013	154.00	Lockatong Creek, NJ	DAY1 WQ1	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC04	155.40	Delaware River @ Bulls Island Footbridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCPA0016	155.60	Paunacussing Creek, PA	DAY2 WQ2	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCPA0015	157.00	Tohickon Creek, PA	DAY2 WQ2	F	F	F	F	T	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DRBCPA0017	159.90	Tinicum Creek, PA	DAY2 WQ2	F	F	F	F	LGR	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJ0020	164.10	Nishisakawick Creek, NJ	DAY2 WQ2	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC06	167.70	Delaware River @ Milford, NJ-PA	DAY2 WQ2	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCPA0021	173.70	Cooks Creek, PA	DAY2 WQ2	F	F	F	F	LGR	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC07	174.80	Delaware River @ Riegelsville Br, PA-NJ	DAY2 WQ2	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCNJ0025	174.60	Musconetcong River, NJ	DAY2 WQ2	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJ0027	177.40	Pohatcong Creek, NJ	DAY2 WQ2	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC08	183.82	Delaware River @ Northampton St Br, PA-NJ	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCPA0026	183.66	Lehigh River, PA	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DRBCPA0028	184.10	Bushkill Creek, PA	DAY3 WQ3	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCPA0031	190.80	Martins Creek, PA	DAY3 WQ3	F	F	F	F	T	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJ0032	197.80	Pequest River, NJ	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC09	197.84	Delaware River @ Belvidere-Riverton Bridge, NJ-PA	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
DRBCNJ0036	207.00	Paulins Kill, NJ	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DRBCNJPAC10	207.40	Delaware River @ Columbia-Portland Footbr, NJ-PA	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
		10X/Summer Summary	n / week =	24	24	24	24	24	24	24	24	24	14	24	24	24	24	24	24	24	24	24	24	24	24
			n/year	240	240	240	240	240	240	240	240	240	140	240	240	240	240	240	240	240	240	240	240	240	240

Run	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
WQ1	5/6	5/20	6/4	6/17	7/8	7/22	8/5	8/19	9/9	9/23
WQ2	5/7	5/21	6/4	6/20	7/9	7/23	8/6	8/20	9/10	9/24
WQ3	5/8	5/22	6/5	6/19	7/10	7/24	8/7	8/21	9/11	9/25