QUALITY ASSURANCE PROJECT PLAN

for

FRIENDS OF CASCO BAY

CITIZEN STEWARDS WATER QUALITY MONITORING PROGRAM

Revision 3

September 15, 2006

QUALITY ASSURANCE PROJECT PLAN

for

FRIENDS OF CASCO BAY
CITIZEN STEWARDS WATER QUALITY MONITORING PROGRAM

prepared by
Peter Milholland

FRIENDS OF CASCO BAY
43 SLOCUM DRIVE
SOUTH PORTLAND, ME 04106

prepared for

CASCO BAY ESTUARY PARTNERSHIP

and

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 1

REVISION 3

September 15, 2006   *RFA 06309*

(This document is valid for five years from the date of approval)

APPROVALS:
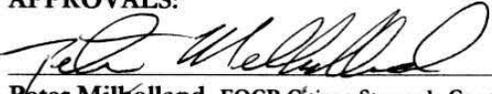
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Peter Milholland, FOCB Citizen Stewards Coordinator   Date
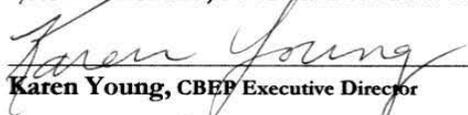
_____   9/28/2006
Karen Young, CBEP Executive Director   Date
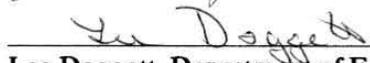
_____   10/2/06
Lee Doggett, Department of Environmental Protection   Date

_____   10/19/06
Arthur Clark, EPA QA Officer   Date
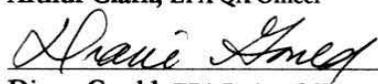
_____   10/11/06
Diane Gould, EPA Project Officer   Date

ACKNOWLEDGMENTS

A.2. Table of Contents

A.3. Distribution List

Karen Young
Casco Bay Estuary Partnership
University of Southern Maine
Muskie School of Public Service
P.O. Box 9300
49 Exeter St.
Portland, ME 04104-9300
p. (207)780-4820
f. (207)780-4317
kyoung@usm.maine.edu

Diane Switzer
New England Regional Laboratory
11 Technology Drive
North Chelmsford, MA 01863-2431
p. (617) 918-8377
Switzer.diane@epa.gov

Arthur Clark
New England Regional Laboratory
11 Technology Drive
North Chelmsford, MA 01863-2431
p. (617) 918-8374
f. (617) 918-8274
clark.arthur@epa.gov

Peter Milholland
Friends of Casco Bay
43 Slocum Drive
South Portland, ME 04106
p. (207) 799-8574
f. (207) 799-7224
pmilholland@cascobay.org

Diane Myrick Gould, Ph.D.
USEPA
1 Congress Street, Suite 1100 COP
Boston, MA 02114
p. (617) 918-1569
f. (617) 918-0569
gould.diane@epa.gov

Lee Doggett
Division of Environmental Assessment
Land and Water Bureau
Department of Environmental Protection
Station #17
Augusta, ME 04333
p. (207) 287-7666
f. (207) 287-7191
Lee.doggett@maine.gov

Laura Livingston
Department of Marine Resources
P.O. Box 8
West Boothbay Harbor, ME 04575
p. (207) 633-9501
f. (207) 633-9579
Livingston.laura@maine.gov

Official copies of the plan and any subsequent revisions will be sent to Lee Doggett, Diane Switzer, Arthur Clark, and Diane Gould. Notification of any revisions will be sent to all members of the Water Quality Advisory Committee as listed in Appendix I. Copies of the revised plan will be available to Committee members and other interested parties on request.

A.4. Project / Task Organization

The Citizen Stewards Water Quality Monitoring program for Casco Bay is being coordinated by Friends of Casco Bay. The program is approximately 40% funded by the Casco Bay Estuary Partnership.

The organization of the CSWQM program is shown in Figure 1.

Peter Milholland, FOCB's Citizen Steward Coordinator, is the Program Coordinator. He will be directly responsible to the Casco Bay Estuary Partnership. Responsibilities of the Program Coordinator will include working with the committees, conducting volunteer training and QA sessions, conducting sampling from the BayKeeper boat, reviewing collected data, and overseeing the selection and maintenance of equipment for the CSWQM program. The Program Coordinator will also network with other water quality monitoring programs and work to raise awareness of water quality issues within the community.

Volunteers and student interns will work directly with the Program Coordinator. In particular, volunteers acting as "regional coordinators" will be trained and overseen by the Program Coordinator. The regional coordinators will be familiar with the sites and monitors in their assigned regions and will work with the monitors to assure good site coverage. They will act as local depots for equipment and reagents, and will assist the Program Coordinator in doing site characterization visits (measuring latitude and longitude, taking reference photos, etc.) They may, depending on their experience, assist in the third, on-site phase of new monitor training and in QA reviews of other monitors.

Robert Michael Doan is FOCB's Research Associate. Responsibilities of the Program Research Associate include assisting in the design and execution of volunteer training and QA sessions, assisting in the selection and maintenance of equipment for the CSWQM program, assist in revisions of the QAPP and Training Manual as necessary, writing data analysis reports as required for submission to CBEP and the DEP and serving as first mate on the BayKeeper boat.

Joseph Payne, the Casco BayKeeper, will be available as Technical Advisor. Other FOCB staff will participate in the CSWQM program as necessary.

The Water Quality Advisory Committee is composed of representatives of academic institutions, state and federal agencies, and independent scientists and water quality experts. This committee will provide technical advice on volunteer training, QA/QC, data analysis, and additional testing protocols.

All status reports and final reports will be directed to the Director of the Casco Bay Estuary Partnership.

FIGURE 1. CWQM PROGRAM ORGANIZATION

EPA Project
Officer

Diane Gould
(617) 918-1569

Water
Quality
Advisory
Committee

EPA Project
Monitor

Diane Switzer
(617) 918-8377

FOCB
Executive
Director
Cathy Ramsdell
(207) 799-8574

EPA Quality
Assurance Officer

Arthur Clark
(617) 918-8374

Friends of Casco Bay
Citizen Stewards Coordinator

Peter Milholland
(207) 799-8574

Technical
Advisor

Joseph Payne
(207) 799-8574

Casco Bay
Estuary Project

Karen Young
(207) 780-4820

Research Associate

Robert M. Doan
(207) 799-8574

U Maine
Director, School of
Marine Sciences

David W. Townsend
(207) 581-4367

U Maine
Research Associate

Maura Thomas
(207) 581-4314

Volunteers
& Interns

Other
FOCB
Staff

A.5. Project Identification / Background

A. Objective and Scope Statement

Casco Bay became part of the U. S. Environmental Protection Agency's National Estuary Program in April, 1990. Casco Bay was nominated because of public concern about environmental degradation in the Bay. Casco Bay provides a major link between open ocean, fresh water, and the land. It has over 700 islands and exposed ledges and over 500 miles of coast. The Bay is extremely productive and provides essential food, cover, migratory corridors, and breeding and nursery areas for a wide variety of animals. Its rocky ledges, deep waters, mudflats, and wetlands provide habitats for birds, seals, whales, harbor porpoises, and many other species which contribute to a rich fishery. Portland is the second largest fishing port in New England. Casco Bay is an excellent area for both sail and power boating, for sea kayaking and wind surfing, and for bird watching, recreational fishing, and hunting.

Over the years, Casco Bay has been adversely impacted by human activities. Although many sources of pollution are now treated, questions remain about the ecological integrity of the Bay and about whether enough effort is being undertaken to protect that integrity. With the help of local governments and the public, the Casco Bay Estuary Partnership (CBEP) intends to explore and recommend management strategies designed to ensure protection of the Bay. The Project is also working to develop a sense of stewardship among the citizens of the Casco Bay watershed that will extend beyond the life of the project, now in its four-year implementation phase.

As a part of this effort, the Casco Bay Estuary Partnership has funded a Citizen Stewards Water Quality Monitoring (CSWQM) program. This program has been organized and implemented by Friends of Casco Bay (FOCB) with technical and facilities support from Southern Maine Community College (SMCC). The planning and design of the program is done in conjunction with a Water Quality Advisory Committee (WQAC) made up of representatives of academic institutions, state and federal agencies, and independent scientists and water quality experts (Appendix I). Volunteers form a large network of "bay watchers" who, by taking samples and making observations, can provide an ongoing assessment of water quality.

Friends of Casco Bay has organized a program that involves sampling around the Bay, in coastal waters. The parameters measured are five standard field data items: dissolved oxygen, pH, temperature, specific gravity (to determine salinity), and water clarity (limit of visibility). In addition, fecal coliforms are monitored at stations selected by the Maine Department of Marine Resources (DMR) from their existing stations. Sampling of river mouth stations has been coordinated with existing river and stream groups. The Maine Department of Environmental Protection (DEP) continues to work with the existing river and lake groups and is the repository of data from all groups. The ultimate goal of the Casco Bay Estuary Partnership, the DEP, and Friends of Casco Bay is to have a coordinated and comprehensive citizen monitoring program for the Bay and watershed. Through this program, accurate data of known quality can be collected at a scope and frequency attainable only with volunteers.

B. Data Usage

The data collected in the CSWQM program can aid environmental managers in:

• Establishing baseline water quality conditions.
• Determining long-term water quality trends.
• Documenting some effects of water quality improvement programs, e.g. CSO abatement, overboard discharge elimination, implementation of storm water Best Management Practices.
• Screening for sources of pollution by identifying current problems.
• Making decisions on shoreland planning and zoning.

The data gathered by the program is supplied to the Department of Environmental Protection and the Casco Bay Estuary Partnership in digital form to help with the assessment and management of water quality.

A.6. PROJECT/TASK DESCRIPTION

A. TASKS

Since its inception, the Friends of Casco Bays' Citizen Stewards Water Quality Monitoring Program has been collecting data under the guidance of it's first QAPP approved March 3, 1993 and subsequent revisions (Revision 1, approved May 1, 1997 & Revision 2, approved July 12, 2001). Tasks outlined in this revision generally correlate with previously approved QAPP's and are designed to maintain the program. A schedule of tasks and products (Table 1) will be revised as necessary and submitted for approval as outlined in annual Scope of Work contracts between Friends of Casco Bay and the Casco Bay Estuary Partnership. This document is valid for five years from the date of approval.

B. DESCRIPTION

The Friends of Casco Bay CSWQM program maintains approximately 100 citizen volunteers to monitor water quality at roughly 80 selected sites, and 10 "profile" sites monitored by FOCB staff. Volunteers and staff monitor water quality for basic oceanographic parameters: dissolved oxygen, temperature, salinity, pH, water clarity, and dissolved inorganic nutrients. Samples are collected once a month, April, May, June, and October, as well as twice a month in July, August, and September. Samples are collected at 07:00 AM (± ½ hour) & 15:00 PM (± ½ hour) with the exception of special projects.

Specifics of sampling procedures are described in more detail in section B, Element #10 & 11, pp: 20 - 35.

TABLE 1. SCHEDULE OF TASKS AND PRODUCTS

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Program Planning	<-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	----->
Conduct Annual QA Checks on Veteran Monitors		*---	group ------- ---*		*---	------- indivi	------ dual	---*					
Train New Monitors					*---	-------	-------	-----*					
Conduct Year-Round Sampling by FOCB Staff	<-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	----->
Conduct Sampling by Volunteer Monitors					*---	-------	-------	-------	-------	-------	--*		
Maintain Database	<-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	----->
Submit Data on Disk to CBEP & MEDEP								*					
Submit Reports to CBEP as Outlined in Work Scope	*	*	*	*	*	*	*	*	*	*	*	*	*
Deployment of ADCP							*_____	-------	-------	-------	-----*		
YSI 6600 Deployment for EPA/CBEP Targeted Watershed Initiative					*_____	-------	-------	-------	-------	-------	-----*		

A.7. DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

Table 2 summarizes the data quality objectives (DQO) defined by FOCB for data collected in the CSWQM program. These data quality objectives are subject to change if deemed necessary by the Water Quality Advisory Committee and upon approval by the EPA.

Guidelines for monitoring precision, accuracy, representativeness, comparability, and completeness will be as follows:

A. Precision

Monitors will be asked to collect and titrate duplicate dissolved oxygen samples at QA sessions and during each sampling event. On the basis of statistical analyses and a control sheet described in the Chesapeake Bay QAPP, monitors will be instructed to do a third titration if the difference between the first two is greater than 0.6 mg/l (upper warning limit). The average of the two closer values is recorded. If the difference between the two titrations is greater than 0.9 mg/l (upper control limit) and no third titration is done, the results will not be entered into the CSWQM program data file. If a volunteer reports values differing by greater than 0.6 mg/l two weeks in a row, the volunteer will be called to determine the cause of the problem. A site visit may be deemed necessary.

Duplicate samples for DO by YSI probe have been part of FOCB's SOP for "winter profile procedures", usually conducted when the water temp, salinity and DO are homogenous throughout the profile. Samples are collected at the surface, one meter, two meters and then at the bottom. If temperature is within one degree C, the salinity within one part per thousand or DO within one milligram per liter then the sample is considered homogenous. As the meter is pulled up to the surface a second sample will be collected at a randomly selected depth for comparison to the first one sampled.

In the case of fecal coliforms, when samples are analyzed by volunteers, replicate sample analyses will be performed monthly by splitting samples and having analyses performed by CSWQM program personnel, by an outside laboratory, and by the Department of Marine Resources.

Duplicate samples for DIN will be conducted once per "profile trip" by FOCB staff at a randomly selected station and depth. Random selection will be determined by means of drawing a coin (poker chip) with a station number written on it, and a separate coin with either *surface, bottom, above thermocline or below thermocline"* written. The duplicate sample will be identified to only FOCB staff and not the analytical lab performing the analysis. The duplicate will be performed to provide a measure of precision between field collection and lab analysis.

For Citizen Stewards collecting DIN a randomly selected date will be determined for them to collect a duplicate sample. The duplicate sample will be identified to FOCB staff and the volunteer collecting the sample but not the analytical lab performing the analysis.

TABLE 2. DATA QUALITY OBJECTIVES

Parameter	Method/Range	Units	Sensitivity (a)	Precision	Accuracy	Calibration Method
Temperature	Thermometer -5.0 to +45.0°C	degrees Celsius (°C)	0.5°C	±1.0°C (b)	±0.5°C (b)	NIST Certified Thermometer
	YSI DO Meter -5.0 to +45.0°C	degrees Celsius (°C)	0.1°C	±0.23°C (g)	±0.5°C (d)	NIST Certified Thermometer
	YSI 6600 Sonde -5.0 to +45.0°C	degrees Celsius (°C)	0.01°C	±0.25 (h)	±0.5°C (h)	NIST Certified Thermometer
	Nortek Aquadopp 0.6 MHz -4.0° to + 30°	degrees Celsius (°C)	0.01°C	±0.25°C	±0.1 °	NIST Certified Thermometer
pH	pH Octet Comparator (Wide-Range) 3.0 to 10.0 units	standard pH units	0.5 units	±0.6 units (b)	{±0.4 units} (b)	pH Meter
	pH Octet Comparator (Narrow-Range) 7.2 to 8.6 units	standard pH units	0.1 units	±0.3 units (c)	±0.2 units (b)	pH Meter
	Oakton Waterproof pHTestr 2 -1.0 to 15.0 units	standard pH units	0.1 units	±0.1 units (g)	±0.2 units (g)	pH Buffer Reference Standards
	YSI 6600 Sonde 0.0 to 14.0 units	standard pH units	0.01 units	±0.1 units (h)	±0.2 units (h)	pH Buffer Reference Standards
Dissolved Oxygen	Micro Winkler Titration 0 to 20 mg/l	milligrams per liter (mg/l)	0.1 mg/l	±0.9 mg/l (b)	±0.3 mg/l (b)	Standard Winkler
	YSI DO Meter 0 to 20 mg/l	milligrams per liter (mg/l)	0.1 mg/l	±0.4 mg/l (g & h)	±0.3 mg/l of rdg at 0°C; ±0.25 mg/l of rdg at 25°C (d)	Standard Winkler
	YSI 6600 Sonde 0 to 50 mg/l	milligrams per liter (mg/l)	0.01 mg/l	±0.4 mg/l (g & h)	±0.2mg/l of rdg up to 20mg/l	Standard Winkler
Dissolved Oxygen (pre- & post-measurement checks)	YSI DO Meter 0% to 200% saturation	percent air saturation (% sat)	0.1% sat	±0.4 mg/l (g & h)	±5% sat (d)	Barometric Pressure
	YSI 6600 Sonde 0% to 500% saturation	percent air saturation (% sat)	0.1% sat	10% RPD {±3% sat} (g)	±2% or 0.2% of rdg(whichever is greater)up to 200%; ±6% of rdg from 200-500%	Barometric Pressure

Parameter	Method/Range	Units	Sensitivity (a)	Precision	Accuracy	Calibration Method
Salinity	Hydrometer 0 to 42 ppt (1.0000 to 1.0700 specific gravity)	parts per thousand (ppt)	0.1 ppt (0.0005 specific gravity)	±1.0 ppt (b)	±0.82 ppt (b)	Orion 140 S-C-T Meter (ck'd vs. NIST Certified Conductivity Standards)
	YSI S-C-T Meter 0 to 40 ppt	parts per thousand (ppt)	0.1 ppt	±0.5 ppt (g)	±1.6 ppt at 33 ppt; ±0.7 ppt at 10 ppt (e)	NIST Certified Conductivity Standards
	YSI 6600 Sonde 0 to 70 ppt	parts per thousand (ppt)	0.01 ppt	±0.5 ppt (h)	±1.0% of reading or 0.1 ppt, whichever is greater	Orion 140 S-C-T Meter (ck'd vs. NIST Certified Conductivity Standards)
Conductivity (pre- & post-measurement checks)	YSI S-C-T Meter 0 to 50,000 µmhos/cm	micromhos per centimeter (µmhos/cm)	100 µmhos/cm	±112 µmhos/cm (g)	Pre-meas: ±250 µmhos/cm; Post-meas: ±600 µmhos/cm (f)	NIST Certified Conductivity Standards
	YSI 6600 Sonde 0 to 100 mS/cm	milliSiemens per centimeter (mS/cm)	0.001 mS/cm to 0.1 mS/cm (range dependent)	±100 µmhos/cm (h)	±0.5% of reading +0.001 mS/cm	NIST Certified Conductivity Standards
Limit of Visibility	Secchi Disk Depth 0 to 20 m	meters (m)	0.1 m	NA	NA	NA
Sample Depth	Marked Line 0 to 36 m	meters (m)	1 m	10% RPD	NA	NA
	YSI 6600 Sonde 0 to 200 m	meters (m)	0.001 m	NA	NA	barometric pressure
	Nortek (i) Aquadopp 0.6 MHz 0-100m	meters (m)		NA	NA	barometric pressure
Fecal Coliforms	Membrane Filtration 20 to 60 CFU	number of colony forming units (CFU) per 100 ml	1 CFU	10% RPD	NA	NA
Chlorophyll Fluorescence (j)	YSI 6600 Sonde 0-400 µg/L Chl (k)	micrograms per liter (µg/L)	0.1 µg/L	±0.3 µg/L (l)	NA	NIST Certified Rhodamine B
Turbidity	YSI 6600 Sonde 0 to 1000 NTU	nephalometric turbidity units (NTU)	0.1 NTU	NA	+ 2 % of reading or 0.3 NTU, whichever is greater	NIST Certified Turbidity Standards

Parameter	Method/Range	Units	Sensitivity	Precision	Accuracy	Calibration Method
Dissolved Inorganic Nutrients	NO_3+NO_2, NH_4, SiO_4, PO_4 Membrane Filtration	micromoles (μM)	0.01μM	< 20 μM, < 25 μM, < 30 μM,< 4 μM (m)	NA	NA

NA = Not Available

Note: Precision values shown within { } are values obtained from calibration records and/or annual QA sessions.

(a) Determined by the increments measurable with the stated method reflecting estimation where allowed.

(b) Data taken from EPA Volunteer Water Monitoring: A Guide for State Managers, 1990, EPA 440/4-90-010, p. 39; based on data provided by the Chesapeake Bay Citizen Monitoring Program.

(c) Data taken from the Quality Assurance Project Plan for the Chesapeake Bay Citizen Monitoring Program, Section 5, p. 2.

(d) Data taken from FOCB1995 Water Column Profile Data Report, 1996, Friends of Casco Bay Citizen Stewards Water Quality Monitoring Program, Volume I, pp. 28-29.

(e) Data taken from FOCB 1995 Water Column Profile Data Report, 1996, FOCB CSWQM Program, Volume I, pp. 28-29. The salinity accuracy figures are for +4° to +45°C. For -2 to +4°C, the meter should be accurate to ±1.9 ppt at 33 ppt and ±0.7 ppt at 10 ppt.

(f) Data taken from FOCB 1995 Water Column Profile Data Report, 1996, FOCB CSWQM Program, Volume I, pp. 28-29. The post-calibration errors actually errors actually observed in 1995 ranged from -296 to +320 μmhos/cm (after correction to 25°C).

(g) Data taken from 1995 Water Column Profile Data Report, 1996, FOCB CSWQM Program, Volume I, pp. 28-29.

(h) Data estimated from 1999 - 2000 calibration records.

(i) methods approved for QAPP by Steve DiMattei

(j) Determination of chlorophyll with YSI 6025 probe can <u>only</u> be considered qualitative and are an estimate of chlorophyll concentrations *in situ*.

(k) YSI Chlorophyll sensor range: 0-400 ug/L Chl; 0-100 Percent Full Scale (%FS) Fluorescence Units

(l) Precision calculated from 2001 – 2005 pre & post calibration records

(m) Data taken from FOCB/CBEP *Twelve-Year Water Quality Data Analysis: 1993 – 2004,* section 2.2 p.6

B. Accuracy

Accuracy of procedures and equipment used in the CSWQM program will be verified using standard reference materials. A detailed description of calibration procedures is given in Section B15 & B16.

C. Representativeness

Representativeness of the data collected in monitoring projects is considered and discussed in the project design and field plan, especially in sampling site selection. It will not be routinely monitored throughout the project, but will need to be considered when interpreting the data.

It is obvious that water flowing past a given location on land is constantly changing in response to inflow, tidal cycle, weather, etc. Periodic collection of data can help develop a better understanding of the variance associated with time series measurements of selected environmental variables. Such data collection can also provide increased resolution and sensitivity to localized and short term effects of events along tributary margins and in embayments.

During the first four years of the project, from 1993 to 1996, a dense network of sampling stations was established across Casco Bay. Samples were taken at Citizens Monitoring stations biweekly April through October. Stations monitored from the BayKeeper boat were sampled biweekly March through November (as allowed by weather conditions) and monthly December through February. The four years' worth of data demonstrated that conditions across the Bay were generally healthy, were relatively homogenous geographically, and changed fairly smoothly throughout the monitoring season.

On the basis of the previous data and after consultation with the Water Quality Advisory Committee, in February, 1997 the sampling frequency was changed to monthly for all stations. Monthly sampling allowed us to keep a close watch on what's going on in the Bay while making efficient use of our resources, especially staff and volunteer time.

In the spring of 2001 through 2005, FOCB staff began a series of internal program meetings to discuss data results and the future of the Citizen Stewards Monitoring Program. These meetings also coincided with two peer reviewed analytical reports *Friends of Casco Bay and Casco Bay Estuary Project ~ Six – Year Water Quality Data Analysis; 1993 – 1998 and Friends of Casco Bay ~ Twelve – Year Water Quality Data Analysis: 1993 – 2004,* both authored by P. Scott Libby from Battelle - Applied Coastal and Environmental Services. Based on recommendations from these peer reviewed reports, FOCB has implemented the following recommendations:

- Collect samples early in the morning to document worst case water quality
- Increase sampling during months of concern – July – September
- Add nutrients and biomass measurements to quantify loading and ambient conditions – suite of nitrogen parameters and chlorophyll concentration

D. Comparability

Efforts will be made to use methods that are EPA-approved and comparable to those employed by other water quality monitoring programs. Where the methods are necessarily different, either method comparison tests will be performed using EPA-approved methods and the degree of comparability will be determined and reported, or comparison tests in the literature will be referenced. Comparisons will be necessary for the parameters of pH, specific gravity and DIN when these parameters are not measured using EPA-approved methods.

pH will be measured using narrow-range and wide-range pH octet comparators. To determine the comparability of pH values measured using this method, comparison measurements will be made during QA sessions with a pH meter using EPA method 150.1. The narrow-range comparator uses a cresol red indicator. Interferences with cresol red at medium to high salinities are well documented in the literature. At 14 ppt salinity, cresol red gives an apparent pH reading which is too high by 0.21 units. At 32 ppt salinity, the error increases to 0.27 units. To compensate for these known errors, the pH data submitted by the monitors will be adjusted by the CSWQM database program MURPHY version 2.12, as described in Section B19.

Salinity will be measured using a hydrometer (Standard Methods, 16th Edition, Method 210B). From the actual specific gravity and temperature measurements of the water sample, a table will be used to calculate the water density and the corresponding salinity. To determine the comparability of salinity values measured by this method, comparison measurements will be made during QA sessions with an Orion Model 140 Salinity-Conductivity-Temperature meter or YSI model 6600 data Sonde using EPA method 120.1. The meter will be calibrated according to manufacturer's specifications using NIST certified conductivity standards.

E. Completeness

Completeness will be measured as the percentage of total samples collected that were analyzed as a whole and for individual parameters and sites. Volunteer monitors in the CSWQM program will be requested to collect data monthly April through October. Potentially, observations will be made seven times per site per year at all sites monitored by volunteers. However, it is assumed that some weeks may be missed due to vacations, illness, and severe weather. A complete data set has been initially set as 17 sampling events during the seven-month sampling period with a maximum 39 day interval between events and a minimum 24 day interval.

Fecal coliform samples will be collected monthly April through November for analysis by the DMR. Because samples are collected by boat and must be submitted for analysis on a specific day each month, there is the possibility that a collection day may be missed due to inclement weather. The DMR requires that six out of eight samples be taken per year at each site for random sampling. However, every effort will be made to take all eight samples.

Stations monitored from the BayKeeper boat will be sampled monthly year-round except in July, August, and September when samples will be collected bi-weekly. Potentially, observations will be made 15 times per site per year. However, due to the possibility of severe weather, a complete data set has been initially set as 12 complete sampling events per year. During the period from April through October, the maximum interval between events will be 49 days and the minimum will be 14 days. During the period from November through March, a monthly schedule will be followed as closely as weather allows, with a minimum interval between sampling events of 14 days. When weather conditions do not allow us to sample all the BayKeeper boat stations within the maximum sampling interval, we will sample at a subset of sites which can be reached in almost any weather. This subset has been selected to represent both deep-water and shallow-water sites.

Dissolved inorganic nutrient (DIN) samples will be collected during all profile trips and therefore follow the same criteria for completeness.

A.8. TRAINING REQUIREMENTS/CERTIFICATION

The most important step in ensuring that volunteer monitors are successful in collecting reliable data is the provision of a well-planned monitor training program. Training for the CSWQM program will be conducted by FOCB. If necessary, SMCC faculty or DEP staff will be asked for assistance. Training will involve three phases. During phase I, volunteers will be given extensive instructions on the protocols for measuring temperature, specific gravity, pH, dissolved oxygen and dissolved inorganic nutrients. In phase II, volunteers will practice all sampling, testing, and safety procedures. Phase III of the training will be conducted for each volunteer at his/her monitoring site, allowing the volunteers to further practice the testing procedures. Additional on-site training sessions may be necessary before monitors are allowed to proceed alone. Only trained volunteers will participate in monitoring activities.

Volunteers involved in the sampling of fecal coliforms at DMR stations will be certified by the DMR. Training will be conducted in the field. Phase I will allow the volunteers to practice sampling procedures. In phase II, the volunteers will demonstrate their ability to perform these procedures to a representative of the DMR. If sampling is initiated at non-DMR stations, volunteers will go through a similar two-phase training program but need not be certified by the DMR.

If FOCB implements its own fecal coliform analyses, training of volunteers involved in the analyses will be conducted in the laboratory. The analytical procedures for fecal coliform analyses are more complicated than for the other parameters being monitored in the CSWQM program. During phase I of training, volunteers involved in fecal coliform analyses will observe a demonstration of these procedures, have a chance to ask questions, and get hands-on practice in laboratory techniques. During phase II, each volunteer will perform a fecal coliform analysis under the observation of a trainer and will be able to practice specific techniques.

In addition to the training program, monitors will be provided with a copy of the <u>FOCB Citizen Stewards Water Quality Monitoring Training Manual</u>. This manual describes in detail the test procedures, proper care and handling of equipment, safety precautions, and data reporting procedures.

A.9. DOCUMENTATION AND RECORDS

Both volunteer monitors and FOCB staff will collect and report data on the Data Collection Forms supplied by the CSWQM program. All field measurements and observational data except profile data will be recorded on Side 1 of this form (Figure 2). Data requiring more notation and validation/verification by FOCB staff will be recorded on Side 2 (Figure 4). All observational data and DIN scintillation vial number & depth, collected during profile trips, are recorded on Side 1 (Figure 3) of the Profile Data Collection Forms. Actual profile data and validation/verification records are recorded on Side 2 (Figure 4).

Each monitor will be asked to make a copy of the data form and to send the original to the Program Coordinator of the CSWQM program monthly for review and data entry. The Program Coordinator will file the original in the program data file.

The copy of the data form will be retained by the volunteer in an accordion file provided by FOCB for the storage of water quality data and other program information. The purpose of these volunteer data files is to guard against loss and to facilitate discussion of any questions later about data reported. Volunteer data files will be reviewed for completeness during site visits.

FIGURE 2. CSWQM DATA COLLECTION FORM, SIDE 1

THE FRIENDS OF CASCO BAY CITIZENS' MONITORING PROGRAM
WATER QUALITY DATA SHEET (SIDE 1 OF 2)   ☐

**1
I.D.**

Site name: _____ Collection date (mo/dy/yr): ___/___/___

Monitor name(s): _____ Time (24-hour time): _____ hours

_____

**2
WEATHER
CONDITIONS**

Air temperature: ⌴⌴.⌴ °C   Wind direction: _____ (N,NE,E,SE,S,SW,W,NW)

Wind speed: _____ mph

Weather (check one)   ☐ clear   ☐ snow   ☐ overcast ☐ fog/haze
                         ☐ drizzle   ☐ downpour   ☐ partly cloudy

Rainfall in previous 24 hours (check one):   ☐ none
                                                ☐ light (___ inches)
                                                ☐ heavy (___ inches)

Number of days with similar weather (including today): _____ days (must be >0)

**3
SITE
OBSERVATIONS**

Tidal stage (check one):   ☐ high   ☐ low
                              ☐ high ebb   ☐ low flood
High tide: _____ hours ☐ ebb   ☐ flood
Low tide: _____ hours   ☐ low ebb   ☐ high flood

Water surface (check one):   ☐ calm   ☐ ripple   ☐ waves   ☐ whitecaps

Indicators (check all that apply):
☐ fishkills   ☐ dead crabs   ☐ oil on surface   ☐ debris
☐ erosion   ☐ foam   ☐ bubbles   ☐ odors
☐ abnormal color   ☐ birds   ☐ animals   ☐ other

Please elaborate on the above: _____
_____
_____
_____   DIN Vial #: ⌴ ⌴ ■ ⌴ ⌴ ⌴
_____   Time in freezer: _____
_____   (24-hour time)

**4
FIELD
MEASUREMENTS**

Secchi depth: ⌴⌴.⌴ meters   Water depth: ⌴⌴.⌴ meters

Water temperature: ⌴⌴.⌴ °C   pH: ⌴.⌴ N, W, O, mtr (circle one)

Specific gravity: ⌴.⌴⌴⌴⌴ read at temp of ⌴⌴.⌴ °C

Salinity: ⌴⌴.⌴ ppt

Dissolved oxygen: Test 1: ⌴⌴.⌴ mg/1   Test 2: ⌴⌴.⌴ mg/1

Test 3: ⌴⌴.⌴ mg/1   Avg: ⌴⌴.⌴ mg/1

Monitor signature(s): _____

_____

FIGURE 3. CSWQM PROFILE DATA COLLECTION FORM, SIDE 1

THE FRIENDS OF CASCO BAY CITIZENS' MONITORING PROGRAM
WATER QUALITY DATA SHEET (SIDE 1 OF 2) □

**1
I.D.**

Site name: _____ Collection date (mo/dy/yr): ___/___/___

Monitor name(s): _____ Time (24-hour time): _____ hours

_____

**2
WEATHER
CONDITIONS**

Air temperature: ⎵⎵.⎵ °C   Wind direction: _____ (N,NE,E,SE,S,SW,W,NW)

Wind speed: _____ mph

Weather (check one)   □ clear   □ snow   □ overcast   □ fog/haze
                         □ drizzle □ downpour □ partly cloudy

Rainfall in previous 24 hours (check one):   □ none
                                                □ light (___ inches)
                                                □ heavy (___ inches)

Number of days with similar weather (including today): _____ days   (must be >0)

**3
SITE
OBSERVATIONS**

Tidal stage (check one):   □ high   □ low
                             □ high ebb   □ low flood
High tide: _____ hours □ ebb   □ flood
Low tide: _____ hours   □ low ebb   □ high flood

Water surface (check one):   □ calm   □ ripple □ waves □ whitecaps

Indicators (check all that apply):

□ fishkills   □ dead crabs   □ oil on surface   □ debris
□ erosion   □ foam   □ bubbles   □ odors
□ abnormal color   □ birds   □ animals   □ other

Please elaborate on the above: _____
_____
_____

**4
FIELD
MEASUREMENTS**

Secchi depth: ⎵⎵.⎵ meters   Water depth: ⎵⎵.⎵ meters

GoMOOS Nutrient Sampling

Bottle #	1	2	3	4	5	6
Depth (m)						
DIN Vial #						

Monitor signature(s): _____

_____

FIGURE 4. CSWQM & PROFILE DATA COLLECTION FORM, SIDE 2

THE FRIENDS OF CASCO BAY CITIZENS' MONITORING PROGRAM
WATER QUALITY DATA SHEET (SIDE 2 OF 2)

WATER COLUMN PROFILE DATA	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (mg/l)
Model number of meter			
Serial number of meter			
Depth (m): 0	.	.	.
1	.	.	.
2	.	.	.
4	.	.	.
6	.	.	.
8	.	.	.
10	.	.	.
12	.	.	.
14	.	.	.
16	.	.	.
18	.	.	.
20	.	.	.
22	.	.	.
24	.	.	.
26	.	.	.
28	.	.	.
30	.	.	.
32	.	.	.
34	.	.	.
36	.	.	.
38	.	.	.

REMARKS:

Staff use ONLY	Date	Initials
Sheet rec'd		
Data ck'd		
Data entered into database		
Entry ck'd vs sheet		

F:\Data\PMilhollandCommon\WPDOCS\WQ\DTSHT01pr2.wpd

B.10. SAMPLING PROCESS DESIGN

The goal of the FOCB Citizen Stewards Water Quality Monitoring program is to coordinate a baywide citizen monitoring program which provides quality data to assist in the monitoring and protection of the waters of Casco Bay and its watershed. To meet this goal, quality assurance and quality control must be paramount in the program. These concepts are emphasized in volunteer training and in the development of sampling and analytical procedures.

1.   General Procedures for Sampling by Citizen Monitors

All regular sampling in the CSWQM program will involve ambient measurements collected and processed in the field. A few stations will be sampled from volunteers' boats, but most monitors will sample nearshore stations referenced to nearby fixed structures (e.g. end of pier). Preferably they will sample from bridges, piers, bulkheads, floats, jetties, docks, etc. where there is at least ten feet of water at low tide. This minimum water depth requirement would allow a Secchi disk reading to be taken at almost any tide stage. Unfortunately, requiring a strict minimum depth is not feasible. Because of the limited number of ideal spots and because consistency is related to convenience, a number of stations will be sampled by wading-in from shore. The disadvantage is that Secchi disk readings won't be taken, and that intertidal areas can be more dynamic than sub-littoral areas and thus harder to characterize. The advantage is that nearshore stations both intertidal and sub-littoral can be close to important nursery areas as well as providing habitat and a food source for adult marine organisms. These areas are also more likely to show the effects or presence of pollution from shoreline point and non-point sources.

Citizen monitors in the CSWQM program currently sample about forty stations, and this number is expected to remain fairly stable. All stations are visited by FOCB staff or volunteer regional coordinators to measure latitude and longitude using a GPS unit, to take a reference photo, and to establish a point at the station from which sampling can be done both safely and consistently. A list of all FOCB sites are noted in table 3.

All samples will be of surface water and will be collected by 5-gallon bucket. Monitors will be instructed to rinse the buckets three times before filling them for sampling. Sampling will be monthly from April through October except in July, August, and September when samples will be collected bi-weekly. Sampling will be conducted on a designated Saturday at 07:00 (7:00 AM) and 15:00 (3:00 PM) plus or minus ½ hour.

2.   Procedures for Sampling from the BayKeeper Boat

In addition to the stations sampled by citizen monitors, approximately ten stations will be sampled from the BayKeeper boat by the Program Coordinator and other FOCB staff. (Volunteers are invited and encouraged to participate in boat sampling.) These ten stations will be either deep water, mid-channel, off a submerged discharge, or some other area only accessible by boat. At these stations, water column profiles will be taken for dissolved oxygen, temperature, salinity, pH, chlorophyll fluorescence, and dissolved inorganic nutrients. Limit of visibility will also be measured. Sampling from the BayKeeper boat will be conducted monthly year-round except in July, August, and September when samples will be collected bi-weekly.

3.   Procedures for Fecal Coliform Sampling

Fecal coliforms will be sampled at selected stations with one or two boat crews sampling all stations and transporting samples to one or two sites where labs have been set up. The fecal stations will be at or near closed clam flats and will be selected in conjunction with the Maine Department of Marine Resources. Approximately fifteen to twenty stations will be sampled monthly April through November.

Fecal coliform samples will be collected in sterile plastic bags with the aid of sampling tongs. The sampling procedure is as follows:

1.   The prelabeled bag is held with one hand and the alligator clips of the tongs are placed on the tabs of the bag with the other. The top of the bag is torn off at the perforation; care is taken that the opening of the bag is not touched.

2.   With the tongs squeezed together, the bag is plunged 6 to 8 inches below the water surface. The bag is pointed into any apparent current and opened.

3.   The bag is brought to the surface, and the opening is closed by bringing the tongs together. To facilitate shaking the sample in the lab, excess water is squeezed out so that the bag is only 2/3 full.

4.   The bag is held by the paper-covered wire closures at the top and twirled around them. The closures are then twisted together over the top of the bag.

5.   The bag is placed upright in a cooler kept between +4 and +10°C.

4.   Procedures for collecting dissolved inorganic nutrients (DIN)

DIN samples will be collected with a 60 ml syringe (from the sampling bucket), filtered through a 0.45 μm Acrodisc* Premium syringe filter, into a high-density polyethylene liquid scintillation vial. Samples will then be kept insulated and out of direct sunlight, and frozen ASAP (no more than two (2) hours from collection. The sampling procedure are as follows:

Dissolved Inorganic Nutrients Step-By-Step Field Procedures for CSWQM Volunteers

NOTE: On page 45 of the field manual, the following procedure will occur between steps 4 and 5.
DIN SAMPLES ARE TO BE COLLECTED BEFORE FILLING DO BOTTLES.

1) Rinse the outside of the 60 ml syringe with the sample water.
2) Draw up a small amount of the sample water (10 ml ±) into the syringe, remove from bucket, pull plunger back, and shake to rinse
3) Expel the rinse water away from bucket
4) Repeat this three times
5) Fill the syringe with sample water (from the bucket), attach the filter, and rinse the (DIN) scintillation vial (and cap) three times.
6) Fill the DIN vial 2/3 full, leaving plenty of room for expansion upon freezing
7) Cap and place in foam (out of direct sunlight) in your kit.
8) Record DIN vial # on datasheet. When you return home, place vial in freezer bag, and in freezer ASAP. Be sure to record the time on your data sheet that the vial was put in the freezer.

After completing steps 1-7 continue collecting samples for Temp, salinity, DO etc.

Dissolved Inorganic Nutrients Step-By-Step Field Procedures for sampling from the Baykeeper Boat

NOTE   All DIN samples obtained by staff from the Baykeeper boat will be collected by pumping water through a 150' hose attached to YSI 6600 Sonde. In the event the pump system fails a 2.2 Liter Kemmerer water sampler will be deployed at the proper depth to collect DIN samples.

1) Set Sonde at surface of water (6" below surface is considered surface) to equilibrate with local conditions.
2) Switch on DIN pump to allow water to flush hose for 1 minute
3) After 1 minute rinse 500 ml amber Nalgene bottle three times with water from hose
4) Collect a full 500 ml amber Nalgene bottle, cap and set in cooler
5) Continue profile until a thermocline or halocline are observed
6) Hold Sonde above identified thermocline or halocline, and repeat steps 2-4
7) Continue profile until Sonde is below thermocline or halocline, repeat steps 2-4
8) Continue profile until Sonde reaches bottom, repeat steps 2-4
9) Once profile is complete, remove amber Nalgene bottles from cooler and process samples following steps 1-8 of CSWQM Volunteer field procedures
10) During the months of June – September, two drops of chloroform will be added to scintillation vials to preserve samples.
11) Place scintillation vials on ice in cooler
12) Immediately place vials in freezer at FOCB lab upon return

B.11. SAMPLING METHODS REQUIREMENTS

A.   Monitoring Parameters and Collection Frequency

Table 3 summarizes the water quality parameters monitored in the CSWQM program. Samples will be taken at all Citizens' Monitoring stations monthly April through October except in July, August, and September when samples will be collected bi-weekly. All measurements will be made by the monitors on-site, with the possible exception of dissolved oxygen (DO) and dissolved inorganic nutrients (DIN). When necessary, DO samples may be collected and fixed on-site, then titrated within eight hours after collection. DIN samples are to be collected and filtered on site and stored in kit (out of direct sunlight) until placed in freezer (no longer than 2 hrs from collection).

Stations monitored from the BayKeeper boat will be sampled monthly year-round except in July, August, and September when samples will be collected bi-weekly. Measurements for Secchi depth, DIN and water column profiles of water temperature, salinity, pH, dissolved oxygen, and chlorophyll fluorescence will be taken at these stations.

Fecal coliforms will be sampled at stations selected by the Maine Department of Marine Resources (DMR) from their existing stations monthly April through November. The samples will be delivered to the DMR laboratory in Boothbay for analysis.

Table 3. Site Locations for Friends of Casco Bay Water Quality Monitoring

Site Name	Site Number	Water Body Name	Water Body Code	Town	DIN Site[4]	Water Class
Anthoine Creek	ANT01	Portland Harbor	PH	South Portland		SC
B&M Railroad Trestle	BMR02	Portland Coast	PC	Portland	*	SC
Bartol Island Causeway	BAR48	Harraseeket River	HR	Freeport		SB
Bear Island1	P4BRI	Eastern Coast	EC	Phippsburg	*	SB
Ben Island	BEN03	Quahog Bay	QB	Harpswell		SB
Bethel Point	BTH04	Quahog Bay	QB	Harpswell	*	SB
Birch Point (East of)	BIR05	New Meadows River	NMR	West Bath		SB
Boat Cove, Cliff Island	CLF71	Western Bay	WB	Portland		SB
Broad Cove, Cumberland	BCC06	Foresides	FS	Cumberland		SB
Broad Sound1	P5BSD	Eastern Bay	EB	Cumberland	*	SB
Cape Small Harbor2	CSH07	Eastern Coast	EC	Phippsburg	*	SB
Cat Cove, West Point	CAT69	Eastern Coast	EC	Phippsburg		SB
Channel Crossing	CHX09	Portland Harbor	PH	South Portland		SC
Chebeague Island, Johnson Cove	CIJ72	Western Bay	WB	Cumberland		SB
Chebeague Island, Stone Pier	CHB10	Western Bay	WB	Cumberland	*	SB
Clapboard Island	CLP11	Western Bay	WB	Falmouth		SB
Clapboard Island1	P7CBI	Western Bay	WB	Falmouth	*	SB
Clark Cove	CLK12	Harpswell Sound	HS	Harpswell		SB
Cliff Island Public Landing	CLF13	Western Bay	WB	Portland		SB
CMP Dock	CMP61	Western Bay	WB	Yarmouth		SB
Cousins River, Muddy Rudder	CRV63	Royal River	RR	Yarmouth	*	SB
Cushing Island	CUS14	Western Bay	WB	Portland		SB
Custom House Wharf	CST15	Portland Harbor	PH	Portland	*	SC
Diamond Cove, Great Diamond Island	GRD21	Western Bay	WB	Portland		SB
Dyer Cove, Cape Elizabeth	DYR16	Cape Elizabeth	CE	Cape Elizabeth		SB
Dyers Cove, Quahog Bay	DYQ17	Quahog Bay	QB	Harpswell	*	SB
East End Beach	EEB18	Portland Coast	PC	Portland	*	SC
Ewin Narrows	EWN77	Harpswell Sound	HS	N. Harpswell		SB
Fort Gorges1	P6FGG	Portland Coast	PC	Portland	*	SC
Googins Ledge	GGL20	Eastern Bay	EB	Freeport		SB
Goslings	GOS19	Eastern Bay	EB	Harpswell		SB
Gun Point	GUN65	Quahog Bay	QB	Harpswell	*	SB
Halfway Rock1	P2HWR	Offshore	OFF	Harpswell	*	SA
High Head Yacht Club2	HHY22	Harpswell Sound	HS	Harpswell		SB
Indian Rest	IND66	New Meadows River	NMR	Harpswell		SB
International Ferry Terminal2	INT23	Portland Harbor	PH	Portland		SC

Site Name	Site Number	Water Body Name	Water Body Code	Town	DIN Site[4]	Water Class
Jordan Point, Harpswell	JOR24	Middle Bay	MB	Harpswell		SB
Little Bustins Island1	P8LBI	Eastern Bay	EB	Freeport		SB
Little Chebeague	LCH25	Western Bay	WB	Portland		SB
Little Diamond Island	LTD60	Western Bay	WB	Portland		SB3
Little Flying Point	LFP26	Maquoit Bay	MQ	Freeport		SB
Little Flying Point1	P9LFP	Maquoit Bay	MQ	Freeport	*	SB
Little Iron Island1	P10LI	Middle Bay	MB	Harpswell	*	SB
Littlejohn Island	LJN27	Western Bay	WB	Yarmouth		SB
Long Island, New Meadows	LNM75	New Meadows River	NMR	Harpswell		SB
Lookout Point	LPT74	Middle Bay	MB	Harpswell	*	SB
Lowells Cove, Orrs Island	LWC28	Harpswell Sound	HS	Harpswell		SB
Mackerel Cove Bailey	MCV29	Harpswell Sound	HS	Harpswell	*	SB
Mackworth Causeway	MAC30	Foresides	FS	Falmouth	*	SC
Mackworth Stone Pier	MSP31	Foresides	FS	Falmouth		SB
Maquoit Bay, Haible	MQH32	Maquoit Bay	MQ	Brunswick		SB
Maquoit Bay, Wallace	MQW33	Maquoit Bay	MQ	Brunswick		SB
Marine East	MRE64	Portland Harbor	PH	South Portland	*	SC
Mill Cove, Harpswell2	MIL34	Harpswell Sound	HS	Harpswell		SB
New Meadows Causeway	NMC84	New Meadows River	NMR	Brunswick		SB
New Meadows Marina	NMM79	New Meadows River	NMR	Brunswick	*	SB
Orrs & Bailey Island Yacht Club	OBY35	Harpswell Sound	HS	Harpswell		SB
Peabbles Cove	PBL36	Cape Elizabeth	CE	Cape Elizabeth		SB
Peaks Island, Public Landing	PKP38	Western Bay	WB	Portland		SB3
Peaks Island, East	PKE37	Western Bay	WB	Portland		SB
Peaks Island, South	PKS39	Western Bay	WB	Portland		SB3
Pennellville, Middle Bay	PEN40	Middle Bay	MB	Brunswick		SB
Perry's Landing	PRY41	Quahog Bay	QB	Harpswell		SB
Phippsburg Town Pier	PTP76	Eastern Coast	EC	Phippsburg		SB
Pinkham Point, Quahog Bay	PKT42	Quahog Bay	QB	Harpswell	*	SB
Portland Headlight2	PTH59	Cape Elizabeth	CE	Cape Elizabeth	*	SB3
Portland Yacht Club	PYC43	Foresides	FS	Falmouth	*	SB
Portland Yacht Services	PYS44	Portland Harbor	PH	Portland	*	SC
Princes Point, Yarmouth	PPT45	Foresides	FS	Yarmouth		SB
Quahog Bay1	P11QB	Quahog Bay	QB	Harpswell	*	SB
Ram Island Ledge1	P1RIL	Offshore	OFF	Portland	*	SB
Royal River C5	RRC46	Royal River	RR	Yarmouth	*	SB
Royal Yankee Marina	RRY47	Royal River	RR	Yarmouth	*	SB
RT9 Presumpscot Bridge	PRV70	Presumpscot River	PR	Falmouth		SC

Site Name	Site Number	Water Body Name	Water Body Code	Town	DIN Site[4]	Water Class
Seaborne, Yarmouth	SEA62	Foresides	FS	Yarmouth		SB
Seameadows	SEA73	Western Bay	WB	Yarmouth		SB
Sebasco Estates	SEB49	Eastern Coast	EC	Phippsburg		SB
Small Point1	P3SMP	Offshore	OFF	Phippsburg	*	SB
SMCC Pier	SMT50	Portland Coast	PC	South Portland	*	SC
South Freeport Town Landing	SFP51	Harraseeket River	HR	Freeport	*	SB
Stockbridge Point	STK52	Harraseeket River	HR	Freeport		SB
Stovers Point	STV53	Harpswell Sound	HS	Harpswell		SB
Stroudwater Bridge	STR54	Portland Harbor	PH	Portland	*	SC
The Basin	BAS68	New Meadows River	NMR	Phippsburg	*	SB
Two Lights, Cape Elizabeth	TWO55	Cape Elizabeth	CE	Cape Elizabeth		SB
Waites Landing	WAI56	Foresides	FS	Falmouth		SB
Whartons Point	WPT78	Maquoit Bay	MQ	Brunswick		SB
Willard Beach	WIL57	Portland Coast	PC	South Portland		SB3
Winter Point	WIN82	New Meadows River	NMR	West Bath	*	SB
Wolf Neck State Park	WLF58	Eastern Bay	EB	Freeport		SB
York Landing, Falmouth	YOL66	Foresides	FS	Falmouth		SB

[1] The eleven profile sites, <u>note:</u> P8LBI was discontinued in 2001, and replaced with P11QB
[2] these five surface sites are also sampled year-round.
[3] These five sites were reclassified from SC to SB waters based on FOCB data.
[4] DIN sites were selected based on good long-term coverage, site access, and ability to collect samples at all tides.

NOTE: A map of all site locations has been provided in APPENDIX 4.

TABLE 4. MONITORING PARAMETERS

Parameter	Method	Units	Field Measurement or Processing
Temperature	Thermometric	degrees Celsius (°C)	Record to nearest 0.5°C
	Electrometric*	degrees Celsius (°C)	Record to nearest 0.1°C
pH	Colorimetric (Narrow & Wide-Range Octet Comparators)	standard units	Record to nearest 0.1 units (0.5 if using wide-range comparator)
	Electrometric*	standard units	Record to nearest 0.1 units
Dissolved Oxygen	Modified Winkler Titration	milligrams per liter (mg/l)	Record to nearest 0.1 mg/l
	Electrometric*	milligrams per liter (mg/l)	Record to nearest 0.1 mg/l
Salinity	Gravimetric	specific gravity (converted to ppt salinity)	Record to nearest 0.0005 specific gravity
	Electrometric*	parts per thousand (ppt)	Record to nearest 0.1 ppt
Limit of Visibility	Secchi Disk Depth	meters (m)	Record to nearest 0.1 m
Sample Depth	Marked Line	meters (m)	Record to nearest 0.1 m
	Pressure transducer*	meters (m)	Record to nearest 0.1 m
Observations	-----	-----	Record descriptions of water, weather, etc.
Dissolved Inorganic Nutrients	Filtration	micromole (μm)	Collect samples in plastic 20 ml scintillation vial, store in kit away from direct sunlight
Fecal Coliforms	Membrane Filtration	number of colony forming units (CFU) per 100 ml	Collect samples in sterile plastic bags using sampling tongs; store at 4-10°C

* Methods to be used at stations monitored from BayKeeper boat.

Detailed procedures for measuring pH, salinity, chlorophyll fluorescence, and water clarity are described in sub-chapter D since the methods being used are not EPA-approved. For pH, a colorimetric method using a pH octet comparator will be employed rather than the electrometric method. For salinity, a gravimetric procedure using a hydrometer will be employed rather than the electrometric method. For both pH and salinity, the non-electrometric methods are more appropriate for the CSWQM program. These methods have been approved for use by citizen programs in other EPA regions, i.e. Region 3, Chesapeake Bay Citizen Monitoring Program and Region 6, Galveston Bay Foundation TEST Program.

The methods used to measure dissolved oxygen and water temperature are EPA-approved methods and are described below.

Dissolved Oxygen (DO)

Dissolved oxygen is measured with a Dissolved Oxygen test kit using the azide-modified Winkler Titration method.

Collection and Fixation:

1. In order to avoid contamination, a 60-ml water bottle is thoroughly rinsed with the water from the sampling bucket three times. The rinse water is discarded.

2. The bottle is tightly capped and submerged in the sampling bucket. The cap is removed, and the bottle is allowed to fill. Any air bubbles clinging to the sides of the submerged bottle are removed by tapping. The cap is replaced while the bottle is still submerged. After retrieval, the bottle is examined to make sure that no air bubbles are trapped inside. Once a sample without any air bubbles has been collected, Steps 3 & 4 are performed immediately.

3. 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide are added to the sample. The bottle is capped and inverted gently several times to mix. A precipitate forms. After the precipitate has settled below the shoulder of the bottle, the bottle is inverted again. The precipitate is allowed to settle again.

Titration: The titration should be completed no longer than 8 hours following fixation. When necessary, samples may be collected and fixed in the field for later titration. Samples should be protected from light and excess heat.

4.   8 drops of Sulfuric Acid (1:1) are added to the sampling bottle. The sample is mixed
        by gently shaking until both the reagent and the precipitate have dissolved. A
        clear-yellow to brown-orange color develops, depending on the oxygen content of
        the sample. After the addition of the acid, the analysis must be completed within 45
        minutes.

5.   A 25-ml graduated cylinder is filled to the 20 ml line with the sample solution. The
        solution is then transferred to the titration tube.

6.   The plunger of a direct-reading titrator, a small syringe, is depressed to expel air.
        The titrator is inserted into the plastic fitting of a bottle of Standard Sodium
        Thiosulfate Solution (0.025N). The bottle is inverted, and the plunger of the titrator
        is slowly withdrawn until the bottom of the plunger is past the zero mark on the
        titrator scale. A plastic tip is then attached to the titrator. The plunger is pressed
        slowly until the plastic tip is full and the lowermost rim of the black rubber shoulder
        of the plunger is opposite the zero mark.

        If air bubbles appear in the titrator barrel during the filling process, the titrator is
        removed from the reagent bottle. The plunger is pressed until the bubbles are
        expelled. The titrator is then reattached to the reagent bottle. Any solution expelled
        during this process is discarded.

        Occasionally air bubbles appear on the tip of the plunger which can not be removed
        by the above process. If this process has been repeated three times and air bubbles
        remain, they may be removed by drawing about a centimeter of solution into the
        titrator and then forcibly expelling the solution back into the reagent bottle. This
        step is repeated until there are no more air bubbles.

7.   1 drop of Sodium Thiosulfate is added to the titration tube and mixed by swirling the
        tube. Another drop of the Sodium Thiosulfate is added and swirled again. The
        titration process is continued, adding one drop at a time, until the yellow-brown
        solution in the titration tube just begins to fade or get lighter. The color of the
        solution at this point should be about the shade of pale straw.

8.   8 drops of Starch Indicator Solution are added to the titration tube, which is mixed
        by swirling. The solution turns from light yellow to dark blue.

9.   The titration process is continued (as described in Step 7) with the remaining Sodium
        Thiosulfate, until the test solution turns from blue to clear. No more Sodium
        Thiosulfate is added than is necessary to produce the color change.

        If 10 units of Sodium Thiosulfate are added without accomplishing the final color
        change, the titrator is refilled as described in Step 6 and the titration is continued.

10. The scale on the side of the titrator is used to count the <u>total</u> number of units of Sodium Thiosulfate used in the experiment. If it is necessary to refill the titrator, the total is 10 units plus whatever units were used from the second filling. The number of units equals the milligrams per liter (mg/l) of oxygen dissolved in the sample.

<u>Water Temperature</u>

Water temperature is measured thermometrically using an alcohol-filled thermometer.

1. The thermometer is placed in the water sample immediately after it is collected. The bucket is protected from direct sunlight and/or wind as much as possible.

2. At least 3 minutes are allowed for the thermometer reading to stabilize.

3. The temperature is read while the thermometer is immersed in the water sample, and the temperature is recorded to the nearest 0.5°C.

B. Methodology for Stations Monitored from BayKeeper Boat

For stations monitored year-round from the BayKeeper boat, water temperature, salinity, dissolved oxygen, pH and chlorophyll fluorescence will be measured electrometrically. The procedures are described below. Although electrometric methods of measuring temperature are not EPA-approved, the procedure is included here because it is part of the salinity and dissolved oxygen measurements. For simplicity, the procedure for measuring salinity is described separately from those for measuring water temperature and dissolved oxygen. In practice, all five parameters are measured at each profile depth before moving the probes to the next depth.

<u>Water Temperature & Dissolved Oxygen</u>

Water temperature and dissolved oxygen are measured electrometrically using a YSI Model 58 Dissolved Oxygen meter or 6600 Data Sonde with a digital display.

The following procedures describe in sub-chapter A. are for the YSI Model #58 ONLY. Procedures outlined in sub-chapter B. are for the YSI 6600 Data Sonde.

A. YSI Mod. #58

1. Before leaving the laboratory on the day of use, the probe is inspected to make sure that the membrane at the tip has not dried out and that the gold cathode is bright and untarnished. If necessary, the cathode is cleaned by wiping with a clean lint-free cloth or hard paper. The sensor is rinsed several times with electrolyte, the electrolyte reservoir is thoroughly flushed and then refilled, and a new membrane is installed.

2.   The probe is connected to the PROBE receptacle and the retaining ring is screwed finger tight.

3.   The stirrer is connected. The stirrer battery condition is checked by turning the STIRRER switch to its spring-loaded BATT CHK position. The warning LOBAT will show on the display when approximately 5 hours of battery life remain.

4.   The meter is zeroed by setting the function switch to ZERO and adjusting the display to read 0.00 with the O_2 ZERO control.

5.   The probe takes at least 15 minutes to stabilize. Time for stabilization must be allowed whenever the meter has been OFF or the probe has been disconnected.

6.   Before the first measurement on the day of use, the probe is calibrated with water-saturated air as follows:

      a. The function switch is set to the % air saturation mode.

      b. A moist sponge or piece of cloth is placed in the plastic calibration bottle. The bottle is slipped over the probe guard up the body. The probe is protected from temperature changes.

      c. The function switch is set to ZERO and the display readjusted to read 0.00. The switch is set back to the % air saturation mode.

      d. When the display reading has stabilized, the O_2 CALIB control locking ring is unlocked. The display is adjusted to the CALIB VALUE indicated in the pressure/altitude chart on the back of the meter. At an altitude of 0 ± 40 meters, the CALIB VALUE should be 100. The locking ring is relocked to prevent inadvertent changes.

7.   At each station, the probe is lowered to the first depth to be measured. The stirrer is turned on. The function switch is turned to ZERO and readjusted if necessary.

8.   At each depth to be measured, the function switch is turned to the temperature mode. The probe temperature is allowed time to come to equilibrium with the water temperature: at least two minutes before the first reading at each station, and 20 to 30 seconds at each subsequent profile depth. Once the meter reading has stabilized, the temperature is read to the nearest $0.1°C$.

9.   The SALINITY control is adjusted to the salinity read using a YSI Model 33 S-C-T meter for the depth being sampled.

.

10.   The function switch is turned to the 0.1 mg/l mode. The dissolved oxygen value is read to the nearest 0.1 mg/l when the meter reading has stabilized.

11.   The meter is left ON until the last station of the day has been sampled.

<u>Salinity</u>

Salinity is measured electrometrically using a YSI Model 33 Salinity-Conductivity-Temperature meter with an analog display.

1.   Before the meter is turned on, it is adjusted to zero (if necessary) by turning the bakelite screw on the meter face so that the meter needle coincides with the zero on the conductivity scale.

2.   The meter is adjusted by turning the MODE control to REDLINE and adjusting the REDLINE control so the meter needle lines up with the redline on the meter face. If this cannot be accomplished, the meter batteries are replaced. The REDLINE check is performed at each station.

3.   The probe is plugged into the probe jack on the side of the instrument if this has not been done already.

4.   The probe is lowered to the desired depth. At least two inches of clearance are allowed from non-metallic underwater objects, and at least six inches of clearance are allowed from metallic objects such as piers or weights. The probe is agitated gently during the measurement to ensure the flow of water through the probe.

5.   The °C dial on the instrument is set to the water temperature read using a YSI Model 58 DO meter for the depth being sampled.

6.   The MODE control is switched to the SALINITY position. The salinity is read on the red 0-40 ppt meter range to the nearest 0.1 ppt.

7.   The meter is left ON until the last station of the day has been sampled.

B. YSI Mod. # 6600 Data Sonde

All calibrations performed on the YSI Mod. #6600 Data Sonde are executed with the use of a field lap-top computer and with YSI PC6000 software or YSI Ecowatch software.

Data collected by use of YSI 6600 Data Sonde is recorded by the use of YSI PC6000 software and will log the following parameters simultaneously:

Date	Time	Depth	Temp	Salinity	DO Conc	DO%	DO Charge	pH	Chlorophyll	Turbidity	Battery
M/D/Y	hh:mm:ss	m	C	ppt	mg/L	%			μg/l	NTU	Volts

Methods for Capturing Data Are as Follows:

1. Visually inspect the dissolve oxygen (DO) probe for any obvious damage. Also check membrane for surface flaws, nicks, or KCL discoloration.

2. At each station the probe is lowered to the first depth to be measured. PC 6000 software is initialized and mode of data acquisition is selected to "Sonde". All data captured at this time will be logged within the Data Sonde minimizing battery power required by the laptop. At the "#" prompt, type MENU and ENTER. Main menu will appear.

3. At the prompt select OPTION #1, the RUN category.

4. At the prompt select OPTION #1, DISCRETE SAMPLE.

5. At the prompt select OPTION #1, START SAMPLING.

6. Sonde will prompt with a message indicating probes stabilizing in 4..3..2..1..

7. The probes will take a few seconds to equilibrate to all parameters selected.

8. Logging for all 12 parameters will occur once every 4 seconds simultaneously but no data will be captured until the operator has observed three or more continuous lines of parallel data. Once the operator has determined that this objective has been met the operator must select key stroke #1on the key pad. This command will capture the last set of data logged ONLY for that specific second and store the data in a pre-assigned file.

9. Sonde is then lowered to the next desired depth and the same capturing procedures are used until all desired data has been collected.

10. Duplicate samples will be collected and noted on data sheet at a preselected depth determined by random selection. Data collected at that depth for the first sample as well as the duplicate must be within DQO criteria as stated on pages 8-10.

11. Before moving from sampling site, the data file is viewed for completeness. Any data missed will constitute the execution of a second attempt to capture data at that specific site.

12. Upon satisfaction of successfully completing data collection at a station, operator will inspect Sonde for any damage, create a new file for the next station and will exit PC6000 software to minimize battery usage.

Note: Pre-calibration of Sonde is not compromised by exiting PC6000 software. Sonde will be checked during post-calibration procedures for any faulty data acquisitions.

C. Methodology for Fecal Coliform Analyses

Fecal coliform analyses will be conducted using the Membrane Filtration technique pioneered and perfected for citizen use in mid-coast Maine by Esperanza Stancioff, then a Marine Program Assistant in the Cooperative Extension Service at the University of Maine. This method is approved by the EPA. It was chosen for the CSWQM program because of the relative ease of the test procedure, inexpensive long-term cost, and less risk of contamination.

Fecal Coliform Analyses

Fecal coliform analyses will be done using the Membrane Filtration technique with M-FC medium. The filtering system consists of a glass or plastic microanalysis filter assembly held by a rubber stopper in a side-arm flask, which is connected with plastic tubing to another flask and then to a vacuum pump.

1. The filter apparatus and glass petri dishes are sterilized in an autoclave or placed under UV light for at least 3 minutes. The apparatus and dishes are resterilized between samples, and care is taken that the dishes are separated so that the UV can get to all surfaces.

2. The working surface is sterilized with alcohol.

3. The cover and the bottom of a petri dish are marked in indelible marker with the sample number. A sterile absorbent pad is placed in the dish. The contents of a 2-ml glass ampule of M-FC medium are tapped into the larger part of the ampule. The narrow part of the ampule is sterilized by wiping it with alcohol. A plastic ampule breaker is used to break open the ampule at the narrow part. The medium is tapped onto the absorbent pad in the petri dish, and the petri dish cover is replaced. The dish is then placed in front of the filter apparatus.

4. The bottom half of the filter apparatus is placed on the vacuum flask.

5. The forceps are sterilized by dipping them in alcohol and flaming. Using the forceps, a sterile filter is placed with the grid side up on the stainless steel mesh support screen of the filter apparatus.

6. A filter funnel is placed over the screen. The funnel is clamped with a metal clamp if a glass filter apparatus is being used. The plastic apparatus is magnetized and doesn't need a clamp.

Note: The first and last samples run are 100 ml of a sterile pH 7.0 phosphate buffer to check for sterilization, providing a negative control. A sample of known *E. coli* is also run as a positive control. The *E. coli* culture is prepared on a slant by personnel at the Maine Department of Marine Resources (DMR) laboratory.

7. The sample is shaken vigorously approximately 100 times to facilitate even distribution of bacteria. Then, 100 ml of the sample is poured from the sample bag into the graduated filter funnel, making sure that neither the pouring surface of the bag nor the funnel is touched. The exact volume can be more or less than 100 ml, but it must be recorded. The time is also noted and recorded at this point.

8. The vacuum pump is turned on to 15 lbs of pressure. After the sample has run completely through the filter funnel, the sides of the funnel are rinsed three times with sterile pH 7.0 phosphate buffer to pick up any bacteria clinging there. The vacuum pump is turned off.

10. The filter funnel is removed. The filter is removed from the mesh support screen and placed in the labeled petri dish. Care is taken to handle the filter only by the edges. It is also important not to trap air bubbles underneath the filter. If air bubbles do get trapped, the filter is carefully picked up and placed in the dish again. If this fails, another 100 ml of the sample is run; the new filter is placed in a fresh petri dish. All petri dishes are checked for air bubbles before being placed in the incubator.

11. Two covered petri dishes containing filters are placed upside down in a sterile plastic bag. As much air is expelled as possible. The bag is rolled at least 7 times and sealed to prevent leakage, then placed in a rack in the water-bath incubator. **The petri dishes must be placed in the incubator within 20 minutes of filtering.**

12. The petri dishes are incubated for 24 ± 2 hours at 44.5 ± 0.2°C. In order to ensure that the temperature is stable within the incubator, the temperature is recorded in the Incubator Temperature Log before placing the dishes in and before removing them. The temperature is also checked once during the 24 hour period.

13. After 24 hours, the petri dishes are removed from the incubator. A binocular microscope is used to count the number of colony forming units with a blue metallic sheen on the filter paper. Each filter should have between 20 and 60 colony forming units for an accurate count. If the number of CFU's is outside this range, the actual number is recorded if possible; if the colonies are too numerous to count, TNTC will be entered on the data form.

Because the maximum holding period between collection and analysis is 24 hours, further analyses of the same sample can not be done at this point. However, when water collected from the same site in the next monthly sampling event is analyzed, two petri dishes will be prepared. One preparation will use 100 ml of the sample. The other will use an adjusted sample volume based on the previous out-of-range results.

D. Detailed Procedures for pH, Salinity & Water Clarity Not EPA Approved

pH Oakton Waterproof pHTestr 2 or YSI

pH is measured electrometrically using an Oakton Waterproof pHTestr 2 meter with automatic temperature compensation or 6600 Sonde.

1. The pHTestr cap is removed. The electrode is rinsed with distilled water and dried with a Kim-Wipe. The meter is powered on by pressing the "ON/OFF" button.

2. The electrode is immersed into a container of pH 7.0 buffer at least 1 cm deep and used to stir the buffer once.

3. The "CAL" button is pressed to enter the calibration mode. The abbreviation "CA" flashes while the current pH reading shows on the display. At least 30 seconds are allowed while the display flashes to get a stable sample reading.

4. The "HOLD/CON" button is pressed to confirm the calibration. "CO" and a pH reading of 7.0 are displayed.

5. The electrode is rinsed in distilled water and dried with a Kim-Wipe.

6. Steps 2 through 5 are repeated for pH 4.0 and 10.0 buffers. When the "HOLD/CON" button is pressed, the display reads 4.0 and 10.0 respectively.

7. At each station, the pHTestr cap is removed. The meter is powered on by pressing the "ON/OFF" button. (This instrument has an automatic shutoff that turns the instrument off after 8.5 minutes.)

8. The electrode is immersed 1-2 cm into the sample and used to stir the sample once. The display is allowed 2-3 minutes to stabilize.

9. The pH reading is recorded to the nearest 0.1 units. The meter is turned off by pressing the "ON/OFF" button.

pH Colorimetric Method

pH will be measured by a colorimetric method using a narrow-range pH octet comparator

and/or a wide-range comparator as appropriate.

1. The sample test tube and cap supplied with the test kit is rinsed three times with water from the sampling bucket.

2. The sample test tube is filled to the mark with water from the bucket.

3. The number of drops of pH indicator specified on the comparator label are added, and the sample is mixed thoroughly.

4. The test tube is put in the comparator slot and the sample color is matched to the closest color in the comparator.

5. The value is reported to 0.1 pH units with the narrow-range comparator, to 0.5 units with the wide-range.

Specific Gravity

Specific gravity will be measured using a hydrometer (Standard Methods, 16th Edition, Method 210B).

1. A clean hydrometer jar is rinsed three times with water from the sampling bucket, and then filled about 3/4 full with the sample to be measured.

2. The thermometer is hung in the jar so that it is totally immersed.

3. The hydrometer is inserted into the jar with a twisting motion. Care is taken that it will not hit the bottom hard and break, and that drops are not splashed on to the hydrometer stem above water level. The hydrometer is allowed to float freely.

4. The temperature of the water sample in the jar is read and recorded to the nearest 0.5°C. The thermometer is removed.

5. The specific gravity is read and recorded to the nearest 0.0005 using the lines printed between the labeled graduations. The reading is taken at the point where the scale crosses the surface of the water sample in the jar, not the top of the meniscus. The reading is taken at eye level since viewing up or down at an angle can give an incorrect reading.

6. A table is used to convert the hydrometer reading at the measured temperature to salinity. (This conversion is verified by computer calculation upon entry into the database.)

Secchi Depth: Water Clarity Determination

An indication of water clarity will be obtained using a Secchi disk.

1. The reading is taken while the monitor is standing with the sun to her or his back and is not wearing sunglasses.

2. The Secchi disk is lowered into the water until the disk barely disappears from sight. The depth reading, in meters, is noted based on the length of suspension line that is submerged.

3. The disk is lowered further, then slowly raised. The depth at which it reappears (barely perceptibly) is noted.

4. An average is calculated from the two depth readings obtained above. The average of the two readings is considered to be the limit of visibility or index of transparency. The reading is recorded to the nearest 0.1 m.

B.12. SAMPLE HANDLING AND CUSTODY REQUIREMENTS

This section currently applies to this program for fecal coliforms, and dissolved inorganic nutrients. At this time, all other monitoring procedures are conducted by the monitors in the field. The CSWQM program commitment includes the investigation of additional testing. If other tests are identified which require sample custody procedures, they will be developed and added to this section.

As a minimum, the sample custody form shown in Figure 5 will be used.

For fecal coliform, all samples along with a chain of custody form will be transferred from FOCB staff to a locked cooler (equipted with ice packs and thermometer), and deposited at a predetermined location. Samples and chain of custody form will be retrieved by the regional DMR representative, Laura Livingston, for processing and analysis at their lab in West Boothbay Harbor, ME.

For dissolved inorganic nutrients, volunteers samples will be required to be stored in volunteers kits (out of direct sunlight) for no more than two hours after sample collection. Samples must be frozen ASAP and kept frozen until the end of season when samples are to be transferred to FOCB staff. One half page of the *DIN Chain of Custody Form* (Figure 6.) will be supplied to all volunteers collecting DIN. The form must be filled out and included with all frozen vials upon transfer from volunteer to FOCB staff. All samples will be packed and shipped in dry ice via FedEx and relinquished to Maura Thomas at the University of Maine School of Marine Sciences Lab.

Samples collected by FOCB staff on the Baykeeper boat during profile trips will be preserved with 2 drops of chloroform per vial and immediately put on ice. Upon return from field sampling, all vials will be frozen and stay frozen until relinquished to U Maine lab personnel as stated above.

FIGURE 5. CSWQM SAMPLE CUSTODY FORM

FRIENDS OF CASCO BAY							CHAIN OF CUSTODY RECORD				Page ___ of ___
PROJECT:							COLLECTOR(S): *(Signatures)*				
LOCATION:											
DISTRIBUTION: • ORIGINAL - To accompany samples							• COPY - To Program Coordinator				

Station Number	Replicate	Date	Time	Sample Type	Container Vol.	Container Type	Preservative	Analysis Required	Due Date	Remarks	No. of CFU's

Relinquished by: *(Signature)*	Received by: *(Signature)*	Date	Time	Method of Shipment: ....
Relinquished by: *(Signature)*	Received by: *(Signature)*	Date	Time	Destination: ....
Relinquished by: *(Signature)*	Received by: *(Signature)*	Date	Time	....
Dispatched by: *(Signature)* Date Time	Received for Laboratory by: *(Signature)*	Date	Time	

FIGURE 6. DISSOLVED INORGANIC NUTRIENTS CHAIN OF CUSTODY FORM

Friends of Casco Bay ~ Dissolved Inorganic Nutrient Chain of Custody Form

Site Name:_____
Monitor Name (s):_____
_____

Time Samples were removed from Freezer_____

DIN Vial #	Date Sampled	Time Sampled

Samples transported with Ice: Yes ☐ No ☐

Relinquished by: _____
Date:_____ Time: _____

Received by: _____
Date:_____ Time: _____

Time Samples arrived at lab Freezer_____

Remarks:_____
_____
_____

NOTE: This Chain of custody form is to be completed with a Sharpie pen, folded, and inserted into Ziploc® bag along with the frozen DIN samples for transport.

B.13. ANALYTICAL METHODS REQUIREMENTS

Procedures for measuring dissolved oxygen, water temperature, and fecal coliforms are EPA-approved and are described in Section B11. For pH and salinity, EPA sampling procedures were not appropriate for widespread use in the CSWQM program. The alternative methods used for these parameters and for the Secchi disk procedure are outlined in section B11:

TABLE 5. FIELD ANALYSIS PARAMETER TABLE

Parameter	Method	Reference (a)	Modification
Temperature	Thermometric	170.1	Alcohol-filled thermometer
	Electrometric	(c)	YSI Model 58 DO Meter YSI Model 6600 Sonde
pH	Colorimetric	(c)	
	Electrometric	150.1	Oakton Waterproof pHTestr 2 YSI Model 6600 Sonde
Dissolved Oxygen	Modified Winkler Titration	360.2	Micro method; 60 ml bottle
	Electrometric	360.1	YSI Model 58 DO Meter YSI Model 6600 Sonde
Salinity	Gravimetric	(c)	
	Electrometric	120.1	YSI Model 33 S-C-T Meter YSI Model 6600 Sonde
Turbidity	Nephalometric	(g)	YSI Model 6136
Chlorophyll	flourometric	(g)	YSI Model 6025
Limit of Visibility	Secchi Disk Depth	(c)	
Sample Depth	Marked Line (e)	NA	
Fecal Coliforms (d)	Membrane Filtration	(b)	
Dissolved Inorganic Nutrients (DIN)	Membrane Filtration	(f)	

NA = not availableFootnotes on following page.

(a)   U. S. Environmental Protection Agency. 1979 (revised 1983). Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Environmental Monitoring and Support Laboratory, Cincinnati, OH.

(b)   U. S. Environmental Protection Agency. 1978. Microbiological Methods for Monitoring the Environment, Water and Waste, p. 124. EPA-600/8-78-017. Environmental Monitoring and Support Laboratory, Cincinnati, OH.

(c)   The EPA-approved method is not appropriate for all purposes of the CSWQM program. Comparative measurements will be made with EPA-approved methods during QA sessions where possible.

(d)   Samples will be stored at +4 to +10°C. The **maximum** holding time for fecal coliform samples will be 24 hours. Holding time will be recorded for all samples; data from samples with a holding time of greater than 6 hours will not be compared with data from samples held for longer than 6 hours.

(e)   Sample Depth is also recorded by use of a pressure transducer integral to YSI 6600 Sonde.

(f)   Analysis of dissolved inorganic nutrients is done at the University of Maine School of Marine Sciences Townsend Lab. The method is described in: Whitledge TE, Veidt DM, Mallow SC, Patton CJ, Wirick CD (1986) Automated nutrient analyses in seawater. Publ Brookhaven Natl Lab (BNL) NY 38990.

(g)   YSI Environmental Operations Manual – 6 Series, (2000)

B.14. QUALITY CONTROL REQUIREMENTS

The CSWQM program will be constantly evaluated to determine the major causes of missed observations and data quality deficiencies. Based on the experience of our program, the most common causes of monitoring deficiencies are:

- Failure of monitors to sample at scheduled times.

- Failure of monitors to return data and/or chain of custody forms to the Program Coordinator.

Occasional problems have also arisen due to:

- Failure of monitors to clearly identify sites, sampling dates, and times on data forms.
- Failure of equipment.
- Unsafe weather conditions

Monitoring deficiencies due to a lack of sufficient chemical reagents, sometimes reported by other programs, have not been observed in the CSWQM program. Monitors are given a fresh supply of reagents at the beginning of each season in quantities that should be sufficient to last through the season. Monitors have demonstrated an extremely responsible attitude in reporting reagent shortages on a timely basis.

The following protocols have been proposed to eliminate as many problems as possible.

We have assumed that all monitors may miss a few weeks during the year due to vacation, illness and emergency situations, or severe weather. In order that as few sampling events will be missed as possible, alternate, and/or teams of monitors will be trained and identified to the monitors who have primary responsibility for sampling the sites. In addition, a few monitors will be asked to volunteer as regional coordinators for their section of the Bay. If a primary monitor anticipates missing a sampling event, it is the monitor's responsibility to contact the alternate(s) assigned to that site. If an alternate is not available, the primary monitor will contact the regional coordinator for that region. Only if the regional coordinator can not find a trained monitor to cover the site will the Program Coordinator be contacted to find a replacement.

Monitors will be requested to return their data forms to the Program Coordinator as soon as possible after sampling in pre-addressed envelopes supplied by FOCB. (More detail on the handling of data forms is given in Section D.23) The Program Coordinator will contact monitors who are not sending in their data forms on a timely basis.

Each primary monitor will be supplied at the beginning of the season with a supply of preprinted labels for the site to which the monitor is assigned. The labels will be preprinted with the site code and site name, and with the codes and names of the primary and alternate monitors for

that site. The monitors will be instructed that when sampling the site, they should attach a label to the data form and circle their name. If an alternate monitor is going to sample the site, they should receive the supply of labels along with the kit from the primary monitor. If a monitor other than the regular primary or alternate is going to sample the site, they should receive the supply of labels from the primary monitor and write their name in. This should ensure that the site will always be referred to by a consistent name which does not duplicate the name of another site.

Upon receipt of the data forms, the Program Coordinator will check them for missing or obviously incorrect data, including the sampling date and time. As described in Section A9, monitors will be contacted by phone (or e mail) to answer questions about data that appear to be in error.

All equipment, meters, and kits will be checked by the Program Coordinator to ensure that operations are within technical specifications before being issued. Thereafter, equipment will be evaluated at QA sessions, and any faulty kits and equipment will be replaced. All records on the equipment checks, maintenance, and replacement will be kept on file by the Program Coordinator. The Program Coordinator should keep replacement equipment and reagents on hand at all times, and will also distribute equipment and reagents to the regional coordinators to establish local depots.

The FOCB Citizens Water Quality Monitoring Training Manual describes the proper handling and maintenance of equipment. These aspects will be emphasized during the training and annual QA sessions. Monitors will be asked to contact their regional coordinator if any equipment fails to operate properly. The regional coordinator will arrange for delivery or pickup, or send requested replacements by return mail immediately. If the regional coordinator does not have the required supplies, the Program Coordinator will be contacted and will then be responsible for getting the supplies to the monitor.

The activities to be included in the QA exercises constitute performance and system audits. All of the performance and system audits described in this plan, including training sessions, QA sessions, and field site visits will be performed.

Volunteer monitors will be required to attend the CSWQM training program and complete minimum training requirements before monitoring. The minimum training requirements include the following:

- Demonstrations with detailed instructions of the temperature, pH, dissolved oxygen, salinity, dissolved inorganic nutrients, and Secchi depth procedures.
- Hands-on practice of all sampling, testing, and safety procedures.
- On-site training session with each monitor covering monitoring and safety procedures.

Volunteers involved in fecal coliform analyses will attend a minimum of two lab sessions. During the first, they will observe a demonstration of the analytical procedures, have a chance to ask questions, and get hands-on practice in laboratory techniques. During the second, each volunteer

will perform an analysis under the observation of a trainer . Volunteers involved in fecal coliform sampling will practice sampling techniques during a field training session and will demonstrate their proficiency in these techniques during the training session.

With each batch of fecal coliform samples collected on a given sampling trip two "field blanks" will be collected at a randomly selected time and added to the batch. Each blank will be given a station ID number and time so as to preserve their anonymity. All blanks will be made from distilled water and decanted into a whirlpack bag. The location and status of blanks will be left unknown to lab personnel until all samples have been completely processed. In addition, positive and negative samples will be added to lab analysis on a frequency of 5% per sampling season. Split samples (of positive and negative plates) will be conducted by FOCB lab personnel and by The Portland Water District lab personnel to measure interlab precision.

Additional on-site sessions will be conducted, if necessary, until proficiency in all required techniques is demonstrated by the monitor. Training will be conducted by FOCB trainers with input and help from the DEP and from SMTC faculty. A training checklist (Figures 5 and 6) will be completed for each volunteer trainee, and these checklists will become a part of the training certification and maintained in the volunteer's records.

Group QA sessions will be held before the start of each seven-month monitoring season by the Program Coordinator. Monitors will be required to attend one session per year. (Due to the relatively short length of the sampling season in Maine, it is impractical to hold semiannual QA sessions as some more southerly groups do.) Monitors are sometimes unable to attend one of the group QA sessions due to scheduling conflicts or to residence out of the area during the winter. For these monitors, the Program Coordinator will arrange for an individualized "on-the-road" QA session at the monitor's site or home using a QA kit developed by FOCB to duplicate the exercises performed in the group QA sessions.

The results of the group and individual QA exercises will provide a measure of how well monitors perform individually and as a group. Data collected at the QA sessions will be used to assess the accuracy and precision of the data collected in this program (see Section B16 for more details). Results and analysis from the QA sessions will be kept on file by the Program Coordinator.

The Water Quality Advisory Committee will review and suggest additional testing procedures to be evaluated in the program. This may include new parameters to be measured or changes to any existing procedures being used.

The project will be open to EPA system audits at their discretion.

FIGURE 7. CSWQM MONITOR TRAINING RECORD, SIDE 1

FRIENDS OF CASCO BAY - CITIZENS WATER QUALITY MONITORING PROGRAM
MONITOR TRAINING RECORD, SIDE 1

NAME:_____ MONITOR #:⌷⌷⌷⌷⌷
ADDRESS:_____
TOWN, STATE: _____ ZIP:_____
TELEPHONE #'S: HOME:_____ WORK:_____
E MAIL ADDRESS: _____

INFORMATION ON ASSIGNED SITE
SITE NAME:_____ SITE #:⌷⌷⌷⌷⌷
AKA: _____ KIT #:   ⌷⌷

INITIAL TRAINING SESSION   DATE:⌷⌷/⌷⌷/⌷⌷
TRAINER(S): _____

	Demonstrated by Trainer (Y/N)	Performed by Monitor (Y/N)	Comments
Observations:			
Weather			
Wind Direction & Speed			
Water Surface			
Tide Stage (calculation of)			
General			
Test Procedures:			
Air Temperature			
Water Temperature			
pH			
DO Sampling			
DO Titration			
Salinity			
Secchi Depth			
Fecal Sampling			
Fecal Analysis			

Additional Information: _____
_____
_____
_____
_____

c:\wpwin60\wpdocs\wq\training\trainrec.wpd

FIGURE 8. CSWQM MONITOR TRAINING RECORD, SIDE 2

NAME: _____ MONITOR #: └─┘└─┘└─┘└─┘└─┘

ADDRESS: _____

TOWN, STATE: _____ ZIP: _____

TELEPHONE #'S: HOME: _____ WORK: _____

E MAIL ADDRESS: _____

INFORMATION ON ASSIGNED SITE

SITE NAME: _____ SITE #: └─┘└─┘└─┘└─┘└─┘

AKA: _____ KIT #: └─┘└─┘

INITIAL TRAINING SESSION DATE: └─┘└─┘/└─┘└─┘/└─┘└─┘

TRAINER(S): _____

	Demonstrated by Trainer (Y/N)	Performed by Monitor (Y/N)	Comments
Observations:	========	========	=====================
Weather			
Wind Direction & Speed			
Water Surface			
Tide Stage (calculation of)			
General			
Test Procedures:	========	========	=====================
Air Temperature			
Water Temperature			
pH			
DO Sampling			
DO Titration			
Salinity			
Secchi Depth			
Fecal Sampling			
Fecal Analysis			
Dissolved Inorganic Nutrients			

Additional Information: _____
_____
_____
_____
_____
_____

B.15. & B.16. INSTRUMENT CALIBRATION, MAINTENANCE AND FREQUENCY

The calibration equipment used for comparison measurements during QA sessions will be available from FOCB. FOCB will maintain and calibrate the YSI Model 58 Dissolved Oxygen meter, the YSI Model 33 Salinity-Conductivity-Temperature meter, YSI Model 556 multi parameter system (MPS), Orion Model 140 Salinity-Conductivity-Temperature meter and the more precise YSI Model 6600 Data Sonde. FOCB will also provide the NIST certified thermometer and portable pH meter. Backups for all of the above equipment can be provided, as availability allows by SMCC, Bowdoin College, Normandeau Associates, Pine Environmental Services or MER Consulting.

Calibration and maintenance procedures will be as follows:

Temperature

Monitored with:
- Armored, alcohol-filled thermometer; Model 545; range -5.0 to +45.0°C in 0.5°C increments. LaMotte Company; Cat. No. 1066.

Monitored from BayKeeper boat with:
- YSI Model 6600 Data Sonde with YSI Model 6560 Conductivity/Temperature probe; temperature range -5.0 to + 45.0°C in 0.01°C in 0.01°C increments; accuracy ±0.15°C.

- YSI Model 58 Dissolved Oxygen meter with YSI Model 5739 probe and Model 5795A stirrer and cable assembly; temperature range -5.0 to +45.0°C in 0.1°C increments; accuracy ±0.5°C (including probe error). VWR Scientific Products; Cat. Nos. 52458-001 (meter), 52457-010 (probe); 52457-031 (stirrer with 50-foot cable; no catalog number for customized 125-foot cable as used in CSWQM program).

Calibrated with:
- Thermometer factory-certified against National Institute of Standards and Technology (NIST) standards and traceable to NIST; range -10.0 to +55.0°C in 0.1°C increments. Brooklyn Thermometer Company Inc.; Cat. No. 3231RM-A-FC.
Or: ANSI/SAMA accuracy thermometer calibrated and certified against equipment whose calibration is traceable to NIST; range -1.0 to +51.0°C in 0.1°C increments. VWR Scientific Products; Cat No. 61027-205.

The monitors' thermometers will be calibrated before initial use and during QA sessions thereafter. Comparisons will be made with a calibration thermometer for two different temperature solutions within the -5 to +45°C range. The YSI DO meter will be calibrated on each day of use with a calibration thermometer for one solution within the -5 to +45°C range. The ANSI/SAMA thermometers will be calibrated annually with the NIST thermometer for two different temperature solutions within the -5 to +45°C range.

Monitors will be instructed to visually inspect thermometers for separation of red or green fluid before entering the field, to handle thermometers carefully, to avoid storing them in hot places, and to rinse them with fresh water after use.

pH

Monitored with:

- Octet comparator test kits; wide range 3.0 to 10.0 pH units in 1.0 unit increments; narrow range 7.2 to 8.6 pH units in 0.2 unit increments; Thymol Blue range 8.0 to 9.4 pH units in 0.1 unit increments. LaMotte Company; Cat. Nos. 2192 (3.0 to 10.0 units), 2186 (7.2 to 8.6 units) and 2187 (8.0 to 9.4).

Monitored from BayKeeper boat with:

- YSI Model 6600 Data Sonde with YSI Model # 6561 pH Probe; range 0.0 to 14.0 units. pH units in 0.01 unit increments, accuracy ± 0.2 units.

- Oakton Waterproof pHTestr 2; range -1.0 to 15.0 pH units in 0.1 unit increments; accuracy ±0.2 units. LaMotte Company; Cat. No. 5-0010.

Comparator test kits calibrated with:

- Oakton Waterproof pHTestr 2; range -1.0 to 15.0 pH units in 0.1 unit increments; accuracy ±0.2 units. LaMotte Company; Cat. No. 5-0010.

Oakton Waterproof pHTestr 2 calibrated with:

- pH buffer reference standards calibrated against NIST certified solutions by manufacturer, 4.0, 7.0, and 10.0 pH units; accurate to ±0.01 units at 25°C. VWR Scientific Products; Cat Nos. 34170-106 (pH 4.0), 34170-115 (pH 7.0), and 34170-124 (pH 10.0).

The pH test kits will be calibrated during QA sessions by comparative measurements using a portable pH meter and a seawater sample. The Oakton & YSI pH meters will be calibrated on each day of use using three pH buffer reference standards.

Monitors will be evaluated during QA sessions for their ability to accurately interpret pH readings. pH levels outside the range of the narrow-range octet comparator are identifiable in that their colors don't match any in the comparator and are more intense than the colors of the lowest and highest comparator readings. This will be demonstrated to monitors using pH 4.0 and 10.0 buffers.

Wide-range test kits will be distributed to monitors whose stations have demonstrated pH values outside the 7.2-8.6 range in previous years. In the field, these monitors will be asked to double check any samples that appear to match the lowest or highest readings on the narrow-range comparator by measuring a second sample against the wide-range comparator. Monitors who do not have wide-range test kits will be asked to call the Program Coordinator if they observe samples that appear to match the lowest or highest readings on the narrow-range comparator. Data from all monitors will be reviewed for pH readings of 7.2 or 8.6, and additional wide-range test kits will be distributed on the basis of such data.

Monitors will be given instructions on how to take care of the indicator solutions so that they will give reliable results. The shelf-life of the indicators will exceed the amount of solutions supplied. Nonetheless, monitors will be asked to check the solutions for formation of a precipitate. They will be supplied with new indicator solutions annually.

Salinity

Monitored with:
  - LaMotte hydrometer with 500-ml hydrometer jar; range l.0000 to 1.0700 specific gravity in 0.0005 increments (0 to 42 ppt salinity). LaMotte Company; Cat. Nos. 3-0011 (hydrometer) and 3-0024 (jar).

Monitored from BayKeeper boat with:
  - YSI Model 33 Salinity-Conductivity-Temperature meter with YSI 3300 Series probe; salinity range 0.0 to 40.0 ppt; accuracy (above $+4°C$) ±1.6 ppt at 33 ppt, ±0.7 ppt at 10 ppt (including probe error). VWR Scientific Products; Cat. Nos. 66121-254 (meter) and 66121-298 (probe with 50-foot cable; no catalog number for customized 125-foot cable as used in CSWQM program).

  - YSI Model 6600 Data Sonde with YSI Model 6560 Conductivity/Temperature probe; Salinity range 0 to 70 ppt; accuracy ± 1.0% of reading or 0.1 ppt, which ever is greater.

Hydrometer calibrated with:
  - Orion Model 140 Salinity-Conductivity-Temperature meter with Model 014010 4-electrode cell; salinity range 0.0 to 70.0 ppt; accuracy (at 5 to 25°C) ±0.1 ppt. VWR Scientific Products; Cat. Nos. 23197-953 (meter) and 23197-955 (cell).

YSI and Orion S-C-T meters calibrated with:
  - NIST certified conductivity standard, 10,000 & 50,000 µmhos, YSI No. 3163 & 3169 respectively. VWR Scientific Products; Cat. No. 23202-285.

The hydrometers will be calibrated using three different saline solutions within the 0 to 35 ppt range. Calibrations will be performed before initial use and at QA reviews. The YSI and Orion S-C-T meters will be calibrated on each day of use using NIST certified conductivity standards.

Monitors will be evaluated for their ability to correctly read the hydrometer. They will be shown how to calculate the salinity from the specific gravity measurement using the conversion table. Monitors will be instructed to record the specific gravity from the scale in the hydrometer stem at the point where the scale crosses the level of the water sample in the jar, not at the top of the meniscus. Monitors will also be instructed to read the hydrometer with their eyes level with the water surface in the hydrometer jar; viewing up or down at an angle can give an incorrect reading.

Hydrometers are fragile instruments and are subject to breakage. The hydrometers will be carefully packaged when distributed to the monitors - they will be enclosed in the plastic cylinder in which they are shipped and secured in a foam insert in the supplied carrying case. Monitors will be instructed to use care when handling the hydrometer and to return it directly to its protective case immediately after use. The hydrometer and hydrometer jar should be rinsed with fresh water and dried after use.

Dissolved Oxygen

Monitored with:
- Precision Dissolved Oxygen test kit, azide modification of Winkler titration method; range 0.0 to 20.0 mg/l in 0.1 mg/l increments. Reagents sufficient for 25 tests at 0.0 to 20.0 mg/l range. LaMotte Company; Cat. No. 5856/XDO.

Monitored from BayKeeper boat with:
- YSI Model 58 Dissolved Oxygen meter; range 0.0-20.0 mg/l; resolution can be set to 0.1 or 0.01 mg/l; accuracy ±11% of reading at 0°C, ±7% of reading at 25°C. VWR Scientific Products; Cat. Nos. 52458-001 (meter), 52457-010 (probe); 52457-031 (stirrer with 50-foot cable; no catalog number for customized 125-foot cable as used in CSWQM program).

-YSI Model 6600 Data Sonde with YSI Model 6562 Rapid Pulse DO Probe; DO range 0 to 50 mg/l; accuracy ± 2% of reading or 0.2 mg/l of reading (which ever is greater) up to 20 mg/l; ± 6% of reading from 20 mg/l to 50 mg/l.

Calibrated with:
- Standard Winkler titration with azide modification. EPA-approved method 360.2.

The test kits and the YSI Model 6600 Data Sonde will be calibrated against each other during QA sessions. The YSI Model 58, 556 & 6600 will also be calibrated semiannually against the standard Winkler titration. One of these calibrations will be done shortly before the first QA session of the year. On each day of use the DO meter will also be calibrated with water-saturated air.

To ensure the reliability of the results obtained using the LaMotte Dissolved Oxygen kit under conditions that preclude measuring against a standard each time a test is conducted, monitors will be trained on certain precautions to be followed. Monitors will be instructed to perform duplicate measurements each sampling time. They will be told to store the reagents in a dark, cool place. They will be cautioned about possible contamination and instructed in how to prevent it: never return any unused titrant to the reagent bottle, check for particulate matter in the reagent bottle, and thoroughly rinse all equipment after each use.

Water Clarity

Monitored with:
- Secchi disk, 20 cm diameter, stretch-resistant line. LaMotte Chemical Products; Cat No. 0171-CL.

Secchi disks with black and white quadrants are used to determine the limit of visibility. The lines supplied by LaMotte are marked at 0.5 meter intervals up to 20 meters. Additional markings at 0.1 meter intervals (of a different color from the 1.0 meter marks) will be added by FOCB up to seven meters before the disks are distributed to the monitors. Few stations require more than seven meters of line for measuring either water depth or Secchi depth. If a monitor reports that they are

using more than seven meters of line, markings at 0.1 meter intervals will be added for the required length. The accuracy of the depth markings will be checked before initial use and during QA sessions thereafter.

Fecal Coliform Analyses

Monitored with:
          - Membrane Filtration Technique; see Table 7 for monitoring equipment.

          All personnel involved in sampling fecal coliforms should be aware of the concept of "aseptic technique" and the integrity of sterile systems. It is imperative, especially under primitive field conditions, that precautions be taken against bacterial contamination or cross-contamination of containers and samples. Protection against contamination of the sample and container before, during, and after collection will be emphasized in training. The use of aseptic techniques in collecting samples and in handling the sterile nylon membranes during analysis will be practiced during QA sessions by all monitors who will be sampling or analyzing for fecal coliforms.

          Another important factor in fecal coliform analyses is the incubation temperature. Too low a temperature allows nonindicators to grow; too high a temperature prohibits fecal coliform growth. The incubator temperature will be recorded in an Incubator Temperature Log before petri dishes are placed in the incubator and before they are removed. The log will be kept on file at the laboratory.

Vendors of Monitoring and Calibration Equipment

Albert Mojonnier Inc., P.O. Box 473, Eaton, Indiana 47338. (317) 396-3351.

Brookyln Thermometer Company Inc., 90 Verdi Street, Farmingdale, New York 11735. (516) 694-7610.

LaMotte Company, 802 Washington Avenue, P.O. Box 329, Chestertown, Maryland 21620-0329. (410) 778-3100.

Nasco, 901 Janesville Avenue, Fort Atkinson, Wisconsin 53538. (414) 563-2446.

VWR Scientific Products, P.O. Box 483, 501 Heron Drive, Bridgeport, New Jersey 08014. (609) 467-2605.

YSI Incorporated, 1700/1725 Brannum Lane, Yellow Springs, Ohio 45387 USA. (800) 765-4974.

TABLE 8. MEMBRANE FILTRATION EQUIPMENT & SUPPLIES FOR FECAL COLIFORM BACTERIA ANALYSES

ITEM	VWR CATALOG #
Precision coliform water-bath incubator, small capacity	13307-064
Petri dish rack for incubator	13307-505
Thermometer for incubator, 34.5 to 46.0°C in 0.1°C increments	61069-941
Bath cover for coliform incubator	13307-196
Gelman magnetic filter funnel apparatus (polysulfone funnel) with stainless steel mesh support screen **or**	28144-832
Glass microanalysis filter apparatus with stainless steel mesh support screen	KT953805-0000
Gelman filters (GN6, 47 mm, grid style)	28148-733
Gelman absorbent pad kit with dispenser	28150-677
Glass fecal coliform ampules containing premeasured M-FC broth	28145-655
Petri dishes, 60 x 15 mm	25384-060
Filter forceps	28198-975
Glass alcohol burner	17805-005
Sterile plastic sample bags, 4 1/2 x 9" (522 ml), 4 1/2 mil, flat wire closure	(a)
Stainless steel tongs	(b)
pH 7.0 buffer	34170-115
Side-arm 1 liter filtering flask	29415-121
#8 one-hole stoppers	59581-367
Vacuum pump	54908-035
3/8" ID vacuum tubing	62994-241
Autoclavable wash bottles, 500 ml	16651-904
Kimwipes, 4.5 x 8.5 in	21905-026

(a) Obtained from Albert Mojonnier Inc., Cat. No. 459FSW.

(b) Obtained from Nasco, Cat. No. B1079WA.

B.17. INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

In 1992 and 1993 FOCB staff worked extensively with vendors to find equipment appropriate for CSWQM program that met the QA/QC requirements as outlined in Section A.7.

In collaboration with technical support personel from LaMotte Co. and the Friends of Casco Bay, the Casco Bay Tidal Water Monitoring Kits, Mod.# XX00143 & Mod.# XX00144, were established and put into circulation. Each kit is supplied with the necessary equipment to perform tests for dissolved oxygen, temperature, salinity, pH, & water clarity.

All equipment and chemical reagents for the Casco Bay Tidal Water Monitoring Kits are inspected annually during QA training, immediately upon return from any volunteers leaving the program, and at the end of the season. Any equipment determined to have failed will be replaces prior to use in the field.

All chemical reagents for the kits are inspected for expiration dates when purchased and will be used only if they are within the recommended shelf life. All reagents will be replaced annually to insure the best quality obtainable. At annual QA sessions with volunteers, lot numbers and expiration dates are recorded on special QA data sheets. If a vendor reports any reagent to be defective, it will be removed from those kits.

All supplies for DIN sampling are purchased through VWR scientific. Each vial supplied to staff and volunteers are prelabeled with a unique identifiable code. Each volunteer will be supplied with (20) 20 ml scintillation vials, (20) Pall Life Sciences *Acrodisc*, single use 0.45 µm filters, (2) 60 ml B&D syringes and 1 Large Zip Loc freezer bag for sample storage in freezer. Also included in DIN supply kit is a chain of custody form.

B.18. DATA ACQUISITION REQUIREMENTS

For the CSWQM Program U.S.G.S. topographic maps and/or NOAA Navigational charts No. 13290 & 13292, or approved chart reproductions "Water Proof Chart" # 101E are used to identify site locations. Printed copies with marked site ID's are provided to each volunteer and will be filed in a site folder containing further descriptive information pertaining to that specific site.

B.19. DATA MANAGEMENT

The data will be reviewed by the Program Coordinator for decimal point errors, missing site and/or monitor numbers, apparently anomalous data, and general problems. Monitors will be contacted by phone to answer questions about data that appear to be in error or missing. Contact with the volunteers regarding data problems is the responsibility of the Program Coordinator.

After adjustment and review, the data will be entered into the MURPHY 2.12 database program, a computer program developed by FOCB under contract to the Estuary Project. Among other checks and calculations, MURPHY adjusts pH data measured using the narrow-range, cresol red indicator to compensate for known errors resulting from interferences with cresol red at medium to high salinities. The raw data is decreased by factors ranging from 0.21 units at 14 ppt salinity to 0.27 units at 32 ppt salinity. Both the raw and corrected data are stored in the database.

Where salinity data have been measured using a hydrometer, MURPHY uses the specific gravity and temperature readings to calculate salinity values which can be used to confirm the salinity values calculated by the monitors. MURPHY also uses temperature, salinity, and dissolved oxygen concentration data to calculate values for percent saturation dissolved oxygen.

Checks will be made by FOCB between the data listing and the raw data whether the data were entered by FOCB or by the monitor. The data will be evaluated for the mean, minimum, and maximum values for each parameter with site and time series plots of data every three months. A data documentation file will be kept current. Data will be presented using the graph and report formats being developed for the MURPHY program. Copies of the data printouts will be sent to the monitors so that they may review them and report any errors to the Program Coordinator.

All data generated by the CSWQM program will be sent to Maine DEP on disk by the Program Coordinator. The data disk will also be sent to the CBEP Director for possible entry into the Estuary Project GIS.

C.20. ASSESSMENT AND RESPONSE ACTIONS

All data reported for the CSWQM program will be subject to checks by the CSWQM Program Coordinator for errors in transcription, calculation, or computer input. Additionally, all data forms will be reviewed to ensure that they are complete and signed by the volunteers. All data forms must be signed and dated on the back of the original data form by the reviewer. Any changes made to the data form must be initialed, and any action taken as a result of the data review must be recorded on the data form below the reviewer's signature.

Only data that meets the following conditions will be accepted and entered into the CSWQM Data File:

- •Monitors have appropriate levels of training for the tests being conducted.

- •Monitors have successfully participated in required training or QA reviews.

- •Equipment has been checked and approved prior to or during an annual QA review.

- •Data forms are signed by monitors, and date, time, station number, and station description are recorded.

- •All required equipment calibrations have been completed and recorded.

- •Data entries are legible.

C.21. REPORTS

Status reports will be submitted monthly by the Program Coordinator to the Director of the Casco Bay Estuary Partnership. The content of these reports will be determined by the workscope amended yearly and approved by CBEP. The reports will include any significant progress or changes for the following QA elements:

- Status of the monitoring program including the stage of planning and implementation.

- Results of any performance checks.

- Identification of significant QA/QC problems and recommended solutions.

- Outcome of corrective actions.

- Completeness of CSWQM data set to date.

- Updated list of trained monitors and monitoring sites.

D.22. DATA REVIEW, VALIDATION AND VERIFICATION REQUIREMENTS

As part of the data review and validation, all field and lab data will be reviewed and discussed by the Program Coordinator and Program Associate to determine if the data meet the objectives as outlined in the QAPP. Decisions will be made to accept or reject the data before presenting the information in any publications or reports. Errors in data entry will be corrected and any outliers will be flagged for further review. Any data deemed to be not acceptable will be noted in the "comments" fields of the CSWQM database and will be removed from any statistical calculations.

The data will be used by Friends of Casco Bay to support its mission; *"to improve and protect the environmental health of Casco Bay"*. Data will also be provided to support the efforts of the Casco Bay Estuary Partnership under the guidance of the Casco Bay Plan - Public Education Action Item #9, Technical Assistance Action Item # 7, and Planning and Assessment Action Item # 6. Data will also be provided to the Maine Department of Environmental Protection for use in state 305B reports.

D.23. VALIDATION AND VERIFICATION METHODS

Data validation and verification is a multi-step process performed by two or more people. Data will be reviewed by the Program Coordinator before being entered by volunteers, student interns or FOCB staff into the CSWQM MURPHY 2.12 database. After being entered, the data sheets will then be checked against the data entry in the database by someone other than the person who initially entered the data. If entry errors are found, edits will be made and the data sheet will be re-checked (by someone other than the entry person) vs the database. If entry checked vs the database are parallel the data sheet will then be filed in a site specific folder for future data queries. All data entry procedures require signoff by the data enrty personel as illustrated in table 9.

TABLE 9. VALIDATION & VERIFICATION SIGN-OFF

Staff use ONLY	Date	Initials
Sheet rec'd		
Data ck'd		
Data entered into database		
Entry ck'd vs sheet		

D.24. RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data quality objectives and validation procedures for this program have been designed to ensure that volunteers and/or the Program Coordinator will be able to identify and correct problems in data collection and reporting. Should the results of data validation measures or quality assurance reviews indicate that the integrity of data is questionable and data quality objectives are not being met, the data set (or that portion which is deficient) must be flagged as unacceptable for inclusion in the CSWQM Data File.

Quality assurance and control reviews are part of this monitoring program and are designed to ensure that work is performed by volunteers who are well trained and understand the objectives and methods being used. QA sessions will be conducted by FOCB trainers and reviewed by the Program Coordinator. Results recorded at QA reviews will be discussed with the monitors during each session, and any difficulties or differences in technique can be corrected immediately. If a monitor's performance fails to meet the data quality objectives or demonstrates a lack of safety

measures, the monitor will be required to have additional training. Also, defective equipment or outdated reagents detected during QA sessions will be replaced.

The responsibility for deciding to take any corrective action rests with the Program Coordinator. The Program Coordinator is responsible for ensuring that all corrective measures recommended from QA reviews are implemented by monitors. The Program Coordinator has the authority to question data, call for re-training, and recommend replacement of monitors when necessary.

APPENDIX I

FRIENDS OF CASCO BAY
CITIZENS WATER QUALITY MONITORING PROGRAM
WATER QUALITY ADVISORY COMMITTEE

Diane Myrick Gould, Ph.D.
USEPA
1 Congress Street, Suite 1100 COP
Boston, MA 02114
p. (617) 918-1569
f. (617) 918-0569
gould.diane@epa.gov

Lee Doggett
Division of Environmental Assessment
Land and Water Bureau
Department of Environmental Protection
Station #17
Augusta, ME 04333
p. (207) 287-7666
f. (207) 287-7191
Lee.doggett@maine.gov

Charles J. Gregory
Professor of Marine Sciences & Allied Health
Southern Maine Community College
2 Fort Road
South Portland, ME 04106
p.(207) 741-5643
f. (207) 741-5645
CGregory@smccme.edu

Dr. David W. Townsend
Professor of Oceanography, and
Director, School of Marine Sciences
5706 Aubert Hall, Rm 341
University of Maine
Orono, ME 04469
p. (207) 581-4367
f. (207) 581-4388
davidt@maine.edu

Christopher Heinig
President, MER Assessment Corporation
RFD #2 Box 109
South Harpswell, ME 04079
p.(207) 729-4245
f.(207)-729-4706
mer@maine.com

Kathleen Leyden
 Director, Maine Coastal Program
 Maine State Planning Office
 State House Station 38
 Augusta, Maine 04333-0038
 p. 207-287-3144
 f. 207-287-8059
 kathleen.leyden@maine.gov

John Sowles
Director of Ecology
Maine Department of Marine Resources
P.O. Box 8
West Boothbay, ME 04575-0008
p. (207) 633-957
f. (207) 633-9579
John.Sowles@maine.gov

APPENDIX 2

Nortek Aquadopp profiler (QAPP addendum)

Approved August 25, 2005

Quality Assurance Project Plan for Friends of Casco Bay

As of August 1, 2005, Friends of Casco Bay will use a Nortek Aquadopp 1 MHz Acoustic Doppler Current Profiler (ADCP) as part of our water quality monitoring program. This instrument measures water current speed and direction in multiple layers throughout the water column. The Nortek Aquadopp profiler integrates Doppler velocity with temperature, pressure, tilt, and compass measurements.

Data collected through the Friends of Casco Bay monitoring program suggest that reduced water quality at several locations might be the result of poor tidal flushing. Deploying an ADCP at these sites should provide insight into how water moves into and out of these select embayments. By better understanding the movement of water throughout the water column we can begin to determine what influence tidal flow and water residence time have on water quality.

The information collected with the ADCP will be used to address fundamental questions identified through our monitoring program. The water current speed and direction data will also be useful in estimating water volume and ultimately in modeling individual embayments. The expected outcome of using the Aquadopp is a better awareness of one possible mechanism behind reduced water quality in Casco Bay.

For the Standard Operating Procedure, please see the attached **Aquadopp Current Profiler User Manual** APPENDIX 6

APPENDIX 3

YSI 6136 Turbidity Probe (QAPP addendum)

Approved April 5, 2006

Quality Assurance Project Plan for Friends of Casco Bay

As of April 1, 2006, Friends of Casco Bay will use a Yellow Springs Instruments (YSI) model 6600 EDS data sonde to measure water temperature, conductivity, dissolved oxygen, pH, and turbidity at the mouth of the Presumpscot River, Maine. The sonde will be deployed unattended and will collect data at pre-set intervals that will be used to evaluate upstream remediation efforts. The unattended data sonde monitoring component and the remediation projects are supported through an Environmental Protection Agency Targeted Watershed Initiative grant.

The goal of the Presumpscot River Targeted Watershed Initiative grant is to lower overall loading of sediment, bacteria, nutrient, and toxics to the Presumpscot River and tributaries. Remediation efforts will include a suite of projects aimed at improving water quality, enhancing riparian habitat, reducing contaminant loading, and fostering increased stewardship and awareness among watershed inhabitants. Friends of Casco Bay will monitor water quality parameters at the mouth of the Presumpscot to provide some indication of measurable progress.

The measurement of turbidity is a new addition to the existing suite of Friends of Casco Bay data sonde parameters. The data sonde incorporates a turbidity probe to measure the concentration of particulates in the water.

Data Quality Objectives for the YSI 6136 Turbidity Probe

Parameter	Method/Range	Units	Sensitivity	Precision	Accuracy	Calibration Method
Turbidity	YSI 6600 Sonde/0 to 1000 NTU	NTU, Nephalometric Turbidity Units	0.1 NTU	NA	$\pm$ 2 % of reading or 0.3 NTU, whichever is greater	NIST Certified Turbidity Standards

A data sonde will be deployed unattended six months out of every year under a fixed platform at the mouth of the river. Every two weeks the recorded data will be uploaded and the deployed sonde will be removed to be cleaned and have the calibration checked. As the first sonde is retrieved, a second sonde, cleaned and calibrated, will be deployed under the fixed platform to take the place of the first. In this way, two data sondes will be rotated so that monitoring can continue uninterrupted and instrument calibration is assured. Full calibration of the instrument will take place prior to deployment, and a check of the calibration against known standards will follow retrieval.
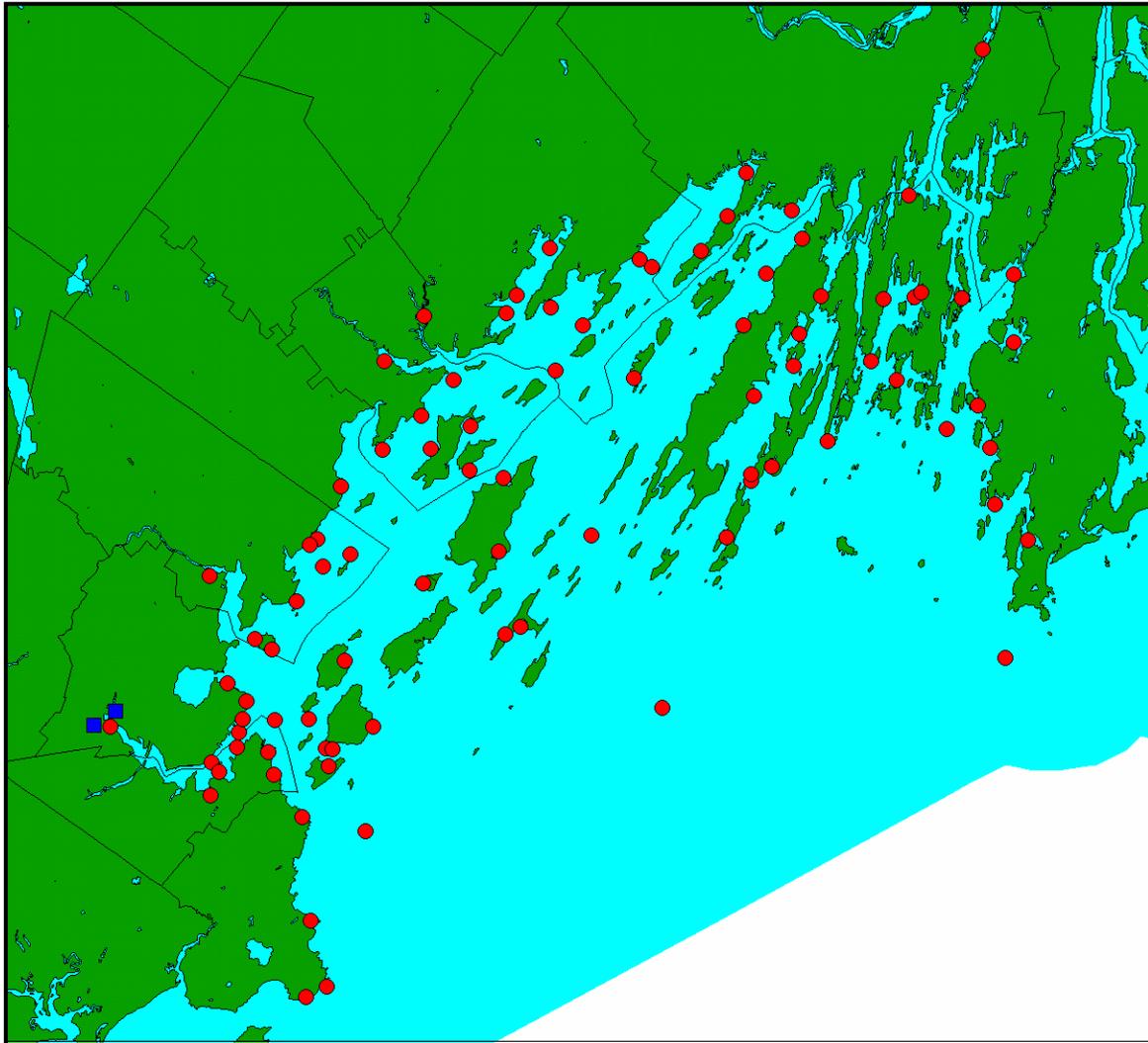
FOCB Water Quality Monitoring Sites 1993-2005
(freshwater sites in blue)

APPENDIX 5

Reference for the University of Maine
Dissolved Inorganic Nutrients
Standard Operating Procedures

Whitledge TE, Veidt DM, Mallow SC, Patton CJ, Wirick CD (1986) Automated nutrient analyses in seawater. Publ Brookhaven Natl Lab (BNL) NY 38990.

Note: An electronic version of this document does not exist. Hard copies can be furnished by FOCB staff upon request.

AQUADOPP CURRENT PROFILER

USER MANUAL

www.nortek-as.com

NortekAS Phone: +47 67 55 62 00
Industriveien 33 Fax: +47 67 54 61 50
1337 Sandvika E-mail: inquiry@nortek.no
Norway Web: www.nortek-as.com

TABLE OF CONTENT

1. INTRODUCTION

Thank you for purchasing a NORTEK Aquadopp Profiler.

The Aquadopp Profiler uses the Doppler effect to measure current velocity by transmitting a short pulse of sound, listening to its echo and measuring the change in pitch or frequency of the echo. You hear the Doppler effect whenever a train passes by - the change in pitch you hear tells you how fast the train is moving.

Getting started

Before you start using the Aquadopp Profiler, please familiarize with it by reading sections 1, 2 and 3 of this user manual.
Perform tests of the Aquadopp Profiler according to procedures in section 4.
Start using the Aquadopp Profiler according to procedures in section 5.
Perform regular maintenance according to procedures in sectiont 6.

1.1. Software updates and technical support

Please visit our website for software updates and technical support:

www.nortek-as.com

1.2. Your Feedback is appreciated

If you find errors, misspelled words, omissions or sections poorly

explained, please do not hesitate to contact us and tell us about it at:

inquiry@nortek.no

We appreciate your comments and your fellow users will as well.

1.3. Nortek Forum Support

If you have comments, application tips, suggestions to improvements, etc. that you think will be of general interest you should register on Nortek's Forums at

www.nortek-as.com/cgi-bin/ib/ikonboard.cgi,

and post your message there. The Forums also offer a great opportunity to share your experience using Nortek sensors with other users around the world, and to learn from their experience.

1.4. Warranty

The Aquadopp Profiler is covered under a one year limited warranty that extends to all parts and labor and covers any malfunction that is due to poor workmanship or due to errors in the manufacturing process. The warranty does not cover shortcomings that are due to the design, nor does it cover any form of consequential damage as a result of errors in the measurements.

If there is a problem with your Aquadopp Profiler, first try to identify the problem by using the troubleshooting ideas outlined in this manual.

Please contact your representative or NORTEK AS if the problem is identified as a hardware problem or if you need additional help in identifying the problem. Please make sure you receive a Return

Merchandise Authorization (RMA) number before the Aquadopp Profiler or any module is returned to the factory.

For systems under warranty, NORTEK AS will attempt to ship replacement parts before the malfunctioning part is returned. We encourage you to contact us immediately if a problem is detected and we will do our best to minimize the downtime.

Every effort has been made to ensure the accuracy of this manual. However, NORTEK AS makes no warranties with respect to this documentation and disclaims any implied warranties of merchantability and fitness for a particular purpose. NORTEK AS shall not be liable for any errors or for incidental or consequential damages in connection with the furnishing, performance or use of this manual or the examples herein. The information in this document is subject to change without notice.

1.5. Copyright statement

2. MAIN DATA

2.1. Weight and outline dimensions

Transport weight: 7 kg (transport box, all inclusive) Transport box dimensions: 70 x 38 x 11 cm (w,l,h) Weight in air: 5.6 kg Weight in water: 2.5 kg Length: 561 mm Diameter: 75 mm

2.2. Power

DC Input: 9 - 16 VDC Maximum consumption at 1 Hz: 0.2 - 1.5W Sleep consumption: 0.0013W Transmit power: 0.3 - 20W, 4 adjustable levels

2.3. Environmental

Operating temperature: -5°C - 35°C Storage temperature: -20°C - 45°C

Shock and vibration: IEC 721 - 3 - 2

2.4 Sensors

Temperature (thermistor embedded in head) Range: -4°C - 30°C
Accuracy/Resolution: -0.1°C/0.01°C Time response: 15 min

Compass (flux gate with liquid tilt)

Maximum tilt:	30°
Accuracy/Resolution:	2°C/0.1°C
Tilt (liquid level) Accuracy/Resolution:	-0.2°C/0.1°C
Up or down:	Automatic detect
Pressure (piezoresistive) Range:	0 - 100 m (standard)
Accuracy/Resolution:	0.25% / Better than 0.005% of F.S. per sample

2.5. Data Communication

I / 0:	RS232 or RS422
Baud rate:	300 - 115200 (user setting)
User control:	Handled via "AquaPro" software

2.6. Water Velocity Measurements

Velocity range:	± 10 m/s horizontal, ± 5 m/s along beam (inquire for higher ranges)
Accuracy:	1% of measured value ± 0.5 cm/s

2.7. Software ("AquaPro")

Operating system: Functions:

WIN95 and above. Deployment planning, data retrieval, ASCII conversion, online data collection, and graphical display.

2.8. Data Recording

Capacity (standard): Profile record:

5 MB, expandable to 25 MB or 81 MB 32 bytes + 9* Ncells

2.9. System

Acoustic frequency: Acoustic beams: Operational modes:

0.6, 1, or 2 MHz 3 beams, slanted at 25º Stand-alone or long term monitoring

2.10. Current profile

Maximum range: Depth cell size: Number of cells Maximum output rate: Internal sampling rate:

50-60 m, 12 - 25 m, 5 - 12 m (0.6, 1, or 2 MHz respectively) 0.1 - 4 m Typical 20 - 40, maximum 128 1 s 6 Hz

2.11. Wave data

Data types: Maximum sampling rate (output): Internal sampling rate: Number of samples per burst:	Pressure and PUV velocity 2 Hz 6 Hz 512, 1024, or 2048

3. TECHNICAL DESCRIPTION

3.1. Aquadopp Profiler Profiler components

The figure below shows a 1 or 2 MHz Aquadopp Profiler. The 600 KHz model has a lightly larger head.
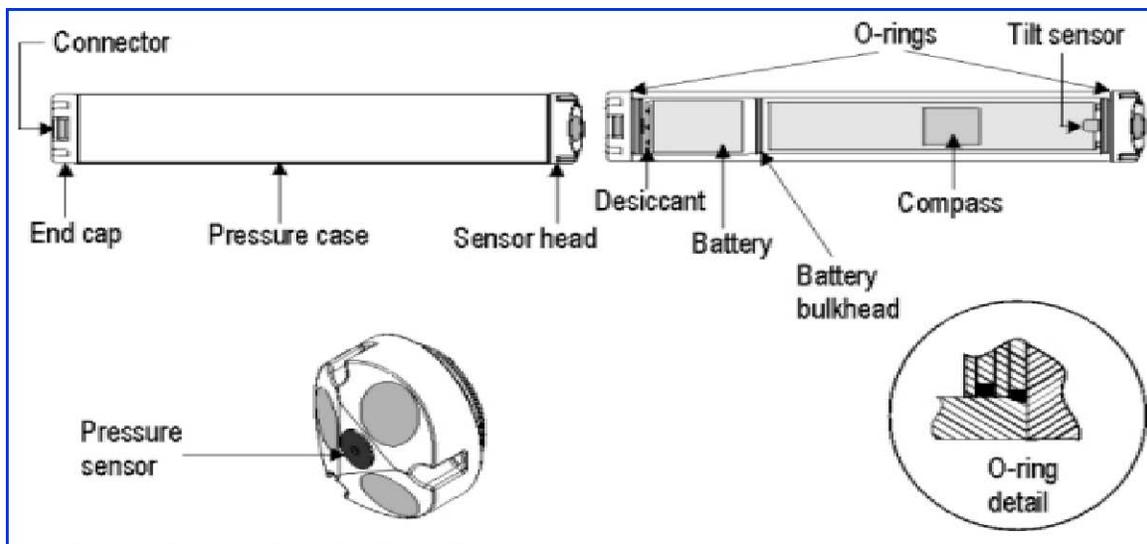
The Aquadopp Profiler with the inside parts

3.1.1. The Sensor head

Head Configurations

The sensor head contains three acoustic transducers and a pressure sensor, all visible from the outside. The sensor head also holds the following sensors:

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<u>Tilt sensor</u>

The tilt sensor is on a small round daughter board attached to the head, inside the case. The tilt sensor orientation is set in accordance with the system orientation during normal operation. The standard Aquadopp is designed for vertical orientation. Tilt sensors in heads designed for horizontal orientations will be mounted at right angles. The tilt sensor can be inverted 180 degrees - you can use it pointing up or down.

<u>Temperature sensor</u>

The temperature sensor, standard on all Aquadopp Profilers, is mounted internally in the sensor head.

<u>Pressure sensor</u>

The pressure sensor is mounted in the Aquadopp Profiler sensor head.

3.1.2. Electronics module

The electronics consist of two boards that hold the power transmitter, analog and digital signal processing circuitry, power conditioning module, and a 2 MB data recorder.

3.1.3. Compass

The compass measures the earth's magnetic field. Combined with the tilt sensor on the head, the compass enables the Aquadopp Pro-filer to obtain the heading. Without a compass, the Aquadopp Pro-filer still measures tilt. These data enables the Aquadopp Profiler to convert velocity measurements to Earth coordinates.

3.1.4. Internal battery pack

The internal battery pack is located inside the pressure case, and enables autonomous deployments of up to a year. It also provides backup power in the event of failure of the external supply. Standard alkaline battery packs use 18 AA cell batteries at a nominal starting voltage of 13.5VDC.

3.1.5. Battery Pack Voltage and Remaining Capacity

NORTEK alkaline battery packs start life at a voltage of 13.5 VDC or higher. The voltage of alkaline batteries falls quickly at the beginning, slowly during most of its life, then again quickly at the end. Thus a 13.5 VDC battery pack will spend the largest part of its life somewhere in a voltage range of 10.5-12.5 VDC.

3.1.6. Power & communication cable

The power and communication cable is connected to the external connector. The cable supplies external DC power (9-16 V) and connects an external computer to the Aquadopp Profiler for 2-way serial communication.

Cable Wiring
The Aquadopp Profiler comes standard with an 8-conductor connector and cable. The signals that are available in the Aquadopp Profiler depend on the internal harness that has been installed. Any one of the harnesses described in table 5-8 can be used.
The Aquadopp Profiler power and battery lines are diode protected, so you don't have to worry about wiring the Aquadopp Profiler power backwards - this will not damage your instrument.

Table 1: RS232 cable with analog inputs

Pin numbers, looking at the pins	Underwater connector		Purpose		Termination		
	Pin number			Wire color	Pins	Description	
	3	black	RS232 Tx	twisted pair	2	9-pin Dsub, female Facing sockets 1 5 6 9	
	4	white	RS232 Rx		3		
	5	black	RS232 ground	twisted pair	5		
	6	white/purple	power output		Red wire		
	7	black	analogue input 2	twisted pair	Green wire		
	8	white/orange	analogue input 1		Yellow wire		
	1	black	power ground	twisted pair	Black wire	5.5 mm (-) 2.1 mm (+)	
	2	white	power positive		Red wire		
	screen	bare	ground	3 bare wires for grounds, connected internally to power ground			
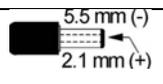
Table 2: Wiring of 8-conductor cable for RS422 communication.

Pin numbers, look- ing at the pins	Underwater connector		Purpose		Termination		
	Pin number				Wire color	Pins	Description
	3	Black	RS422 Tx+	twisted pair	2		
	4	White	RS422 Tx		3		
	7	Black	RS422 Rx	twisted pair	1		9-pin Dsub, femaile Facing sockets 1 5 6 9
	8	White/purple	RS422 Rx+		9		
	5	Black	Synch out	twisted pair	5		
	6	White/purple	Synch in		6		
	1	Black	Power ground	twisted pair	black wire		
	2	White	Power positive		red wire		
	Screen	Bare	Power greound	three ground lines through shield			

Please note that TX and Rx refers to the Aquadopp Profiler and not the PC

3.2. Functional description

This section briefly describes some of the underlying principles that control the operation and application of the Aquadopp Profiler.

3.2.1. Modes of operation

The Aquadopp has three different modes of operation:

Command Mode
Data Acquisition Mode
Power Down Mode

Command Mode

An Aquadopp in command mode is powered up and ready to accept your instructions. If it gets no commands for about five minutes, it automatically powers down and goes into sleep mode.

You cannot send commands directly to the Aquadopp. Instead, you must enter commands through the Aquadopp software. The Aqua-dopp software and hardware interact with each other using low-level binary data structures. This approach simplifies the design of the Aquadopp hardware and increases its overall reliability.

Data Acquisition Mode

The Aquadopp enters data acquisition mode when you click any of the

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"Start " commands (i.e. "Start Recorder Deployment") in the Aquadopp software. When you initiate a deployment sequence, the software converts your setup parameters into binary structures, downloads the structures to the Aquadopp and tells it to start data collection.

To get the instrument out of data collection mode, use one of the "Stop" commands in the Aquadopp software. You might notice that sending a break to an Aquadopp in data acquisition mode gets a response, but that data collection does not stop. The purpose of this design is to protect the system from stopping after an accidental break.

Power Down Mode
The power down mode saves power during deployments and prevents your battery from dissipating between deployments. The Aquadopp automatically powers down from command mode after about five minutes of inactivity.

To conserve your battery when the Aquadopp is on the shelf, be sure it is not in data acquisition mode. Stop data collection using one of the "Stop" buttons before you store an Aquadopp.

NOTE: If you set the Aquadopp to collect data, remove power, then reapply power later, the Aquadopp will immediately resume data collection. Remember that the time may be lost.

3.2.2. Using the Doppler Effect

You hear the Doppler effect whenever a train passes by - the change in pitch you hear tells you how fast the train is moving. The Aqua-dopp Profiler uses the Doppler effect to measure current velocity by transmitting a short pulse of sound, listening to its echo and measuring the change in pitch or frequency of the echo.

There are many ways to measure the Doppler effect, each with its own advantages and drawbacks. NORTEK implements a narrowband autocovariance method because it has been established as robust, reliable and accurate.

Sound does not reflect from the water itself, but rather from particles suspended in the water. These particles are typically zooplankton or suspended sediment. Long experience with Doppler current sensors tells us that the small particles the Aquadopp Profiler sees move on average at the same speed as the water - the velocity it measures is the velocity of the water.

3.2.3. Doppler Beams.
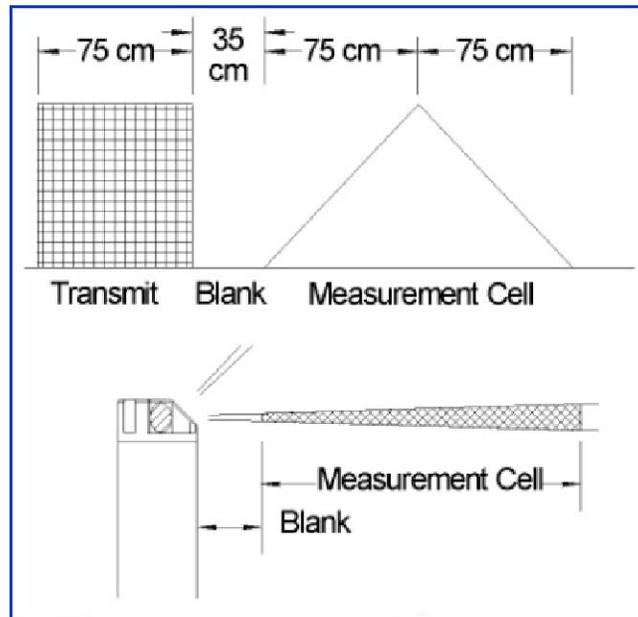
Measurement cell location. The 75 cm dimension that applies to the transmit pulse and measurement cell is fixed by the Aquadopp software, but you can adjust the blank. Given the default 35 cm blank, the center of the measurement cell is located at 110 cm (=35+75) from the sensor head.

Doppler current sensors use large transducers (relative to the wavelength of the sound) to obtain narrow acoustic beams. The Aqua-dopp Profiler's beams have a beam width of 1.7°. Narrow beams are essential for obtaining good data.

Each beam measures velocity parallel to the beam and does not sense the velocity perpendicular to the beam at all. The Aquadopp Profiler senses the full 3D velocity with three beams, all pointed in different directions. If you assume the flow is uniform across the three beams, simple trigonometry is sufficient to compute the 3D velocity vector.

The measurement cell are shaped like triangles. The triangular shape means that they are more sensitive to currents in the middle of the cell than at either end. The maximum extent of the cell is double the length of the transmit pulse.

Coordinate System

The Aquadopp Profiler measures velocity components parallel to its three beams, or in beam coordinates, but it reports data in east, north and up or ENU coordinates. To get to ENU components, it first converts the data to XYZ coordinates, an orthogonal coordinates system relative to the Aquadopp Profiler. The Aquadopp Profiler then uses its compass and tilt measurements to convert this velocity to components relative to the earth, or ENU coordinates.

NOTE: Please contact NORTEK if you want detailed information about the coordinate transformation equations used in the Aquadopp Profiler.

Attitude Correction

Typical moorings allow the Aquadopp Profiler to tilt and rotate freely. It measures its tilt and heading and uses this information to correct the data to true earth coordinates. Because the compass uses energy, the Aquadopp Profiler reads heading only as often as it needs to. In a near-surface mooring, it will read the compass more often that it would on a fixed bottom mount.

Velocity Uncertainty

The Aquadopp Profiler velocity is an average of many velocity estimates (called *pings*). The uncertainty of each ping is dominated by the *short-term error*. We reduce the measurement uncertainty by averaging together many pings. There is a limit to how much you can reduce your uncertainty. We call this limit the *long-term bias*.

The long-term bias depends on internal signal processing, especially filters, and by your beam geometry. The long-term bias in the Aqua-dopp Profiler is typically a fraction of 1 cm/s. *The Aquadopp Pro-filer software predicts errors based on the short-term error of a single ping and the number of pings averaged together*.

The short term error of a single ping depends on the size of the transmit pulse and the measurement volume, and it depends on the beam geometry. Beams parallel to the dominant flow will have smaller short-term errors than beams at a steep angle relative to the flow.

- Technical Description

Averaging multiple pings reduces errors according to the formula:

$$\sigma V mean = \frac{\sigma V ping}{\sqrt{N}}$$

*where σ is standard deviation and N is the number of ping*s
you average together.

NOTE: The Aquadopp Profiler software predicts only the instrumental error. In many situations, the environment itself dominates the short-term error.

In a wavy surface and in turbulent flow such as boundary layers and rivers, your data collection strategy should take into account the nature and the time scales of the environmental fluctuations. Here are two examples:

Waves. A good rule of thumb to follow when measuring mean velocities in the presence of

waves is that you should sample velocity at roughly ¼ the interval of the dominant wave period, and you should sample through 6-10 wave cycles. If your peak wave velocities tend to be around 5 or 6 s, then sampling at a 1 s interval for a minute would make sense. In this case, you could reduce the measurement load to a relatively small fraction (say 4 or 8%).

Turbulent flow. A rough rule of thumb in boundary layers is that the rms turbulent velocity is 10% of the mean velocity. If, for example, your mean velocity is 1 m/s, you could estimate turbulent fluctuations to be 10 cm/s. Obtaining 1 cm/s rms uncertainty would require at least 100 pings.

4. PREPARATION

Please perform the following procedures to prepare your new Aqua-dopp Profiler for future successful operation:

Perform a reception control, refer to section 4.1. on page 19.
Install the internal battery pack, refer to section 6.1.3. on page 41.
Install the Aquadopp Profiler Software on a PC, refer to section 4.2. on page 20.
Perform a functional test of your new Aquadopp Profiler, refer to section 4.3. on page 20.
When you are ready to perform data acquisition, mount the Aquadopp Profiler according to guidelines in section 4.4. on page 22.

4.1. Reception control
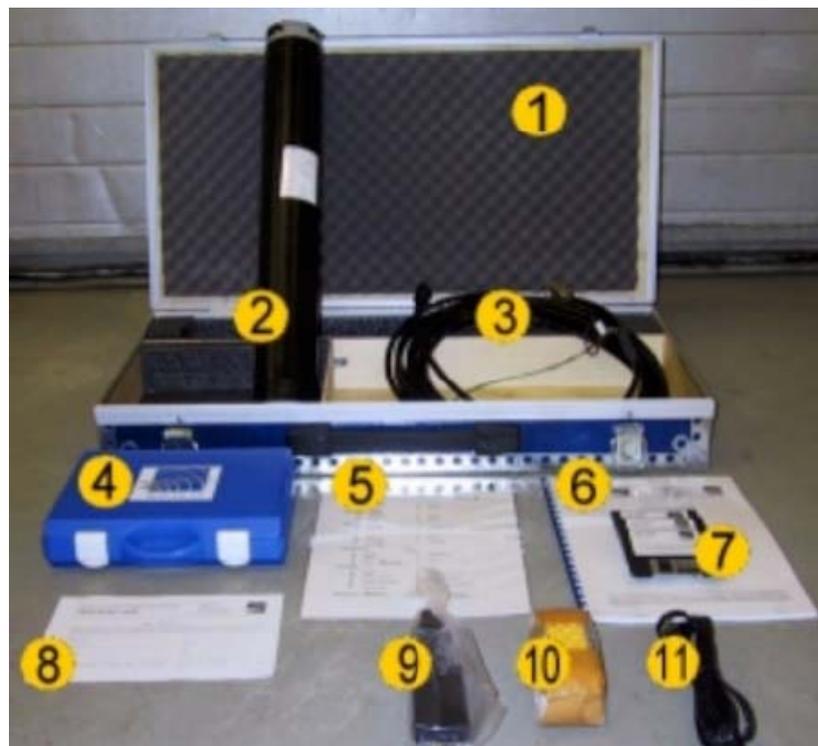
Please check that the following equipment is included in the delivery:
- Preparation

1	Transportation box
2	Aquadopp Profiler
3	External power/signal cable
4	NORTEK equipment storage box
5	Packing list
6	Aquadopp Profiler user manual
7	Aquadopp Profiler software
8	Warranty card
9	Voltage transformer (230 VAC to 9-16 VDC)
10	Internal battery pack
11	230 V power cable

Please contact NORTEK immediately if you find parts of the delivery are missing.

4.2. Install the Aquadopp Profiler software on a PC

1 Insert Disk 1 and run the Setup.exe file.
2 Follow the instructions presented "on-screen". Accept default settings.
3 Restart your PC to finalize the installation process.

4.3. Perform a functional test

1 Plug in the AC adapter and connect the Aquadopp Profiler to the PC serial port.
2 Select Serial Port from the Communication menu to specify the port number to use.
3 Accept the default baud rate settings (9600 baud), which is also the default instrument baud rate.
4 Check the instrument communication and verify that the instrument is alive by activating the Terminal Emulator window and press the Send Break button to send a BREAK signal over the serial port. A break causes the instrument to report an identification string.
5 First check the noise level of the instrument. Pinging in air should produce signal strength (Amplitude) of 15-30 counts. This signal level is called the noise floor. When the instrument pings in air, the velocity measurements will be nothing but noise. Put the instrument in water and observe the signal strength and the velocity. The signal strength should rise noticeably for the first range cells and the velocity data should appear less noisy.
6 Check sensor readings
7 Tilt and rotate the Aquadopp Profiler to verify that the readings are sensible.
8 Temperature should be close to your room temperature, assuming the Aquadopp Profiler has been in the room for a while. The temperature sensor is located inside the sensor head.

9   Pressure should be near zero. Check the pressure sensor in 50 cm deep water, or put your mouth over the pressure sensor and blow to create a pressure around 50 cm.

10   Battery voltage shall be greater than 13 V DC (new battery).

4.3.1. Test the recorder function

You can test the recorder with the same set-up as the above.

1   Start data collection with "Test" followed by "Start With Recorder".
2   Write a name to use for the file you will record internally.
3   After a few minutes, stop the data collection.
4   Retrieve your data by clicking "Deployment" followed by "Retrieve Data".
5   Convert it to ASCII by clicking "Deployment" followed by "Data Conversion".
6   Review the collected data with an ASCII text editor (i.e. Notepad).

NOTE: If you leave the Aquadopp Profiler collecting data, it will continue to run until the batteries are dead. Always make sure to stop data collection when testing is complete. This puts the Aquadopp Profiler into command mode and it will then enter into a sleep state (the lowest possible power) after 5 minutes of inactivity.

4.4. Mounting guidelines

CAUTION: The best way to hold an Aquadopp Profiler onto a fixed structure is to clamp it around its circumference.

The Aquadopp Profiler is often used in areas with large waves. Large waves generate strong orbital currents, which again means that the mounting frame will be subject to strong forces. To survive the wave forces the mounting frame should be compact at the same time as it should be heavy. Contact NORTEK if you need ideas on what the mounting frame should look like.

4.4.1. Other Mounting Considerations

The Aquadopp Profiler has been designed for easy mounting and deployment. The following guidelines should give you the best possible data.

When mounting the Aquadopp Profiler near large obstructions (bridges, piers, walls, etc.), ensure that the acoustic beams do not "see" any obstructions. Objects interfering with the beams may damage or destroy your data.

Keep the Aquadopp Profiler away from magnetic materials. Consider the frame or

cable holding the Aquadopp Profiler, and the structure it is mounted on. Nearby magnetic materials could cause the directional readings to be in error.

Consider the effects large objects will have on the flow itself. A rough rule of thumb is that objects disturb the flow as far as 10 diameters away from the object. Flow disturbance is greatest directly downstream in the wake behind the object. Flow disturbance affects your measurements by changing the flow and by making it non-uniform across the Aquadopp Profiler's beams.

All acoustic transducers must be submerged during data collection. Operating with the transducers out of water will not cause damage, but your data will be meaningless.

The pressure sensor can handle pressure that is about double its maximum reading. For example, the standard 50 m pressure sensor can safely withstand 100 m depth.

4.5. Using long cables

RS232 data communication at 9600 baud will normally work fine for cables up to 50-100 m long, depending on the environment. If you want to run a longer cable, you can switch to RS422 by installing a different wiring harness you can get from NORTEK.

You can also try using RS232 with longer cables by reducing the baud rate. Keep in mind that RS422 is a more reliable means of communication than RS232 - changing environmental conditions could cause RS232 communications to fail over a long wire without apparent reason.

You should consider the voltage drop across the cable, particularly if you use High- or High power. Design your power supply and cable so that the voltage stays below 16 VDC, and never falls below 9 VDC.

4.5.1. Changing the Baud Rate

You are allowed to set two baud rates for the Aquadopp Profiler. The primary baud rate setting applies to normal communication and data transfer. You can also set a separate baud rate for data download and firmware upgrades (the "download/configuration baud rate"). A higher baud rate speeds up large file transfers and is appropriate when you have a short serial cable and a relatively noise-free envionment.

The standard baud rate is 9600, and you should use this baud rate unless you have a good reason to change it. To change the baud rate and make it permanent, do the following:

1   Set up the Aquadopp Profiler and connect it to your computer.
2   Set the baud rate in "Communication", "Baud Rate" to the baud rate you prefer.
3   Start a deployment, and then stop it.

> The last step makes the new baud rate permanent. If you remove power and reapply it, the Aquadopp Profiler will re-awake with the new baud rate.

NOTE: If data download is interrupted the Aquadopp Profiler could be left with a baud rate setting other than the one used for normal communication. Then, when the software tries to connect to the Aquadopp Profiler, it may spend a few moments searching for the current baud rate.

5. OPERATION

The Aquadopp Profiler program is designed to aid in the planning, execution, recovery and processing of autonomous Aquadopp Pro-filer deployments. It also contains a test section, including all functions required to operate the Aquadopp Profiler in real-time applications.

5.1. Introduction to the main menu

Operation of the Aquadopp Profiler is controlled from the main menu:
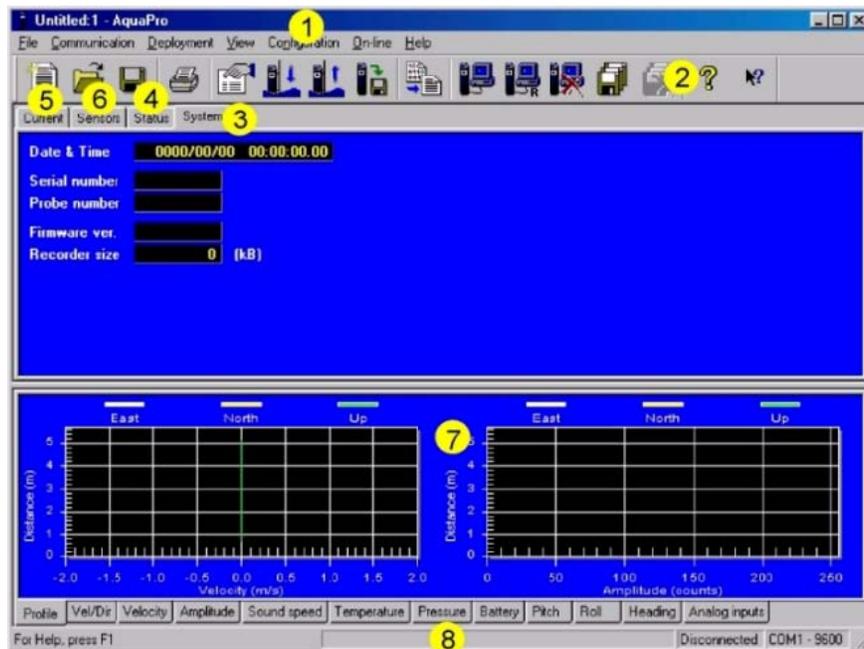
The main menu is divided into 8 areas:

1   The top menu gives easy access to all functions included in the Aquadopp Profiler software.
2   The second row contains shortcuts to main functions. Click on the preferred icon to access the preferred function.
3   The system window contains product data for the Aquadopp Profiler.
4   The status window displays current system status.
5   The current window displays profile data.
6   The sensor data window displays sensor status.

1   The graphic view gives a graphical presentation of data selected in the data selection menu (8).
2   The data selection menu is used for selecting the types of data to be viewed.

NOTE: Please familiarize with the on-line help system integrated in the Aquadopp Profiler software. Click on the symbol shown to the right and select a menu item. A detailed explanation of the selected item is presented on-screen.

5.2. Data collection

The Aquadopp Profiler system allows for both self-recording and real-time data collection. A typical sequence includes:

1   Install and/or plug in battery pack. Refer to procedure in section 6.1.3. on page 41.
2   Install new desiccant, if necessary. Refer to procedure in section 6.1.2. on page 41.
3   Test the Aquadopp Profiler according to procedure in section 4.3. on page 20.
4   Set PC time.
5   Use the Aquadopp Profiler software to plan deployment. Click "Deployment", "Planning".
6   Erase recorder. Click "Deployment", "Erase Recorder".
7   Start deployment. Click "Deployment", "Start Deployment".
8   Enter a 6-character deployment name.
9   Set the Aquadopp Profiler time to PC time.
10   If appropriate, set a delayed start-up time.
11   Disconnect cable and install dummy plug.
12   Verify pinging with an AM radio just prior to the deployment.
13   Install on site. Ensure the acoustic beams point where you want and that they are not obstructed.
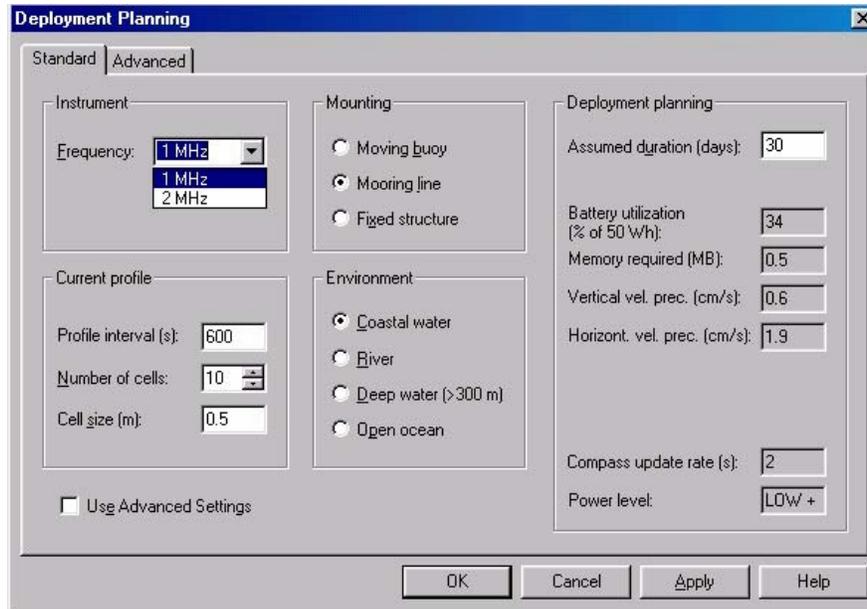
5.2.1. Deployment planning

On the main menu, select **Planning** from the **Deployment** pull-down menu or press the **Deployment Planning** toolbar button to activate the planning dialog box. The **Planning** submenu displays three options that may serve as a starting point for your deployment planning.

1. Select **Use Existing** to start with the previous settings (This selection corresponds to the Deployment Planning toolbar button).
2. Select **Load From File** to read settings from a deployment (.dep) file.
3. Select **Load From Instrument** to read settings from the instrument.

The dialog contains all parameters required to specify the operation of the instrument. The Deployment planning frame on the right hand of the dialog displays performance parameters that are automatically updated as you change the parameter settings. When finished, press **OK** to accept the changes. By using the **Open/Save** commands in the **File** menu (or the corresponding toolbar buttons) the deployment parameters can be saved to file at any given time and re-loaded when it is time to actually deploy the instrument
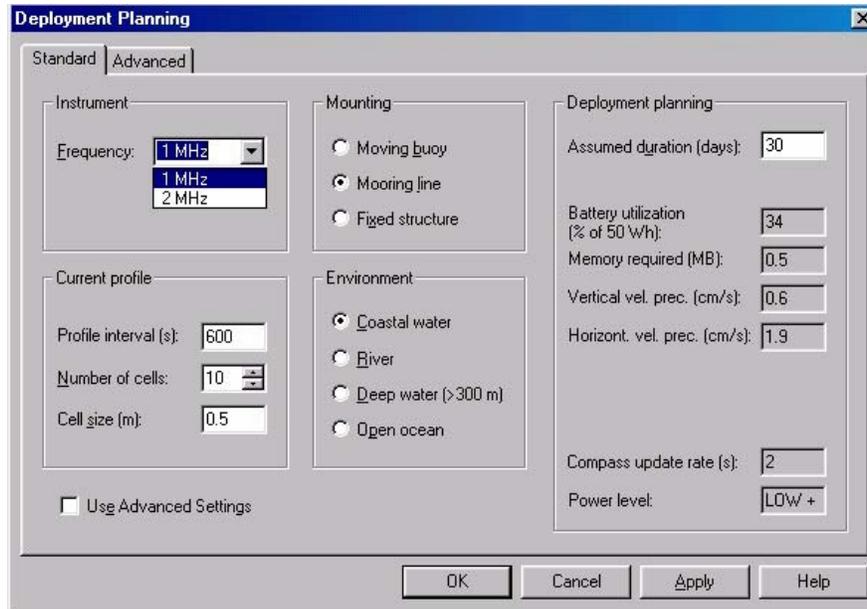
The deployment planning dialog allows you to specify the instrument operation at two levels. Use the Standard tab to configure the system with default settings for various environments and mounting arrangements. Use the Advanced tab to fine tune the operation parameters. Note that the **Use Advanced Settings box** (Standard tab) must be checked for the advanced settings to be effective. To show the advanced parameters that correspond with the current standard settings press the **Update from Standard** button (Advanced tab).

Standard tab

Frequency
Choose 600 KHz, 1 MHz or 2 MHz depending on the frequency of your instrument.

Profile interval
The time between each measurement, i.e. the data output rate.

Number of Cells
The number of levels vertically where you want to measure the 3D current.

Cell Size
The vertical extent of each measurement cell.

Environment and Mounting.
Choose the setting that best fits your deployment. The setting determines the Aquadopp Profiler transmit level. To see the consequence of the different choices watch the effect on battery utilization. For direct control, use the **Advanced** tab.

NOTE:　　Because coastal waters and rivers normally have high backscatter, these choices reduce transmit power (and therefore battery utilization). If you are working in such areas but still know you have low backscatter, select Deep water and/or Open ocean instead.

Use advanced settings
Must be checked for the advanced settings to be effective.

Assumed duration
Enter the number of days you would like to collect data. This value, together with the other deployment parameters and the hardware configuration, will be used for calculating the performance parameters, i.e. battery utilization, recorder memory requirements and velocity range.

NOTE:　　This value has no other effect on the actual deployment configuration and the system will not stop after the number of days entered here.

Battery utilization
The expected battery life based upon total battery capacity and current duty cycle.

Memory required
The recorder memory required to fulfil the planned deployment as entered by the user configuration parameters and the planned length of the deployment.

Vertical/Horizontal velocity precision
An estimate of the velocity precision along the vertical axis and in the horizontal plane.
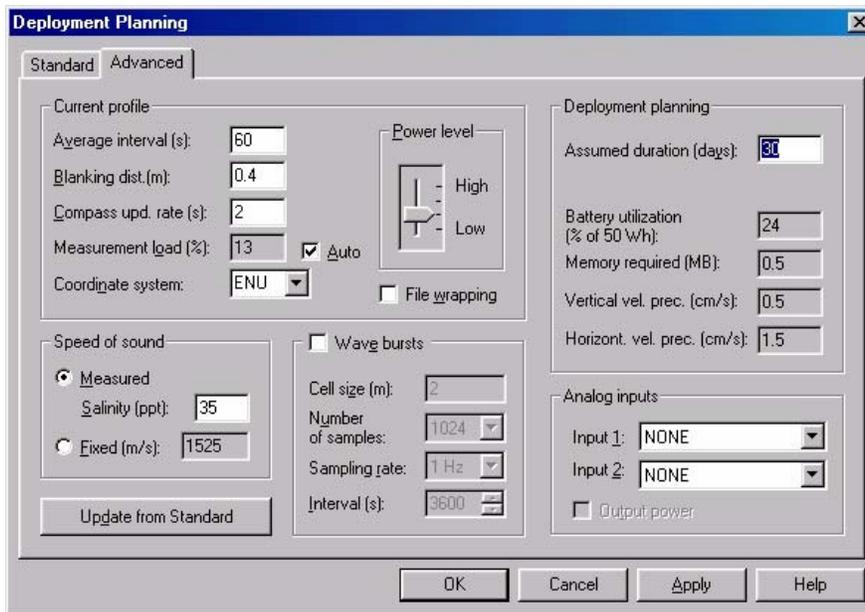
Advanced tab **Average interval**
The period during which the Aquadopp Profiler should be actively measuring through the
profile interval. The sensor will be in sleep mode the remaining part of the profile interval.

Blanking distance
The distance from the sensor to the start of the measurement area. See section 3.2.3. for an
illustration of this.

Compass update rate
Sampling the compass consumes energy. It can be done every second but if not needed you can
set this to a much longer interval.

Measurement load
Within each second, the instrument can either be in active mode (collecting data) or in idle mode
(not collecting data). The Measurement load is the relative time spent in active mode within each
second and can have value from 0 (no data collection) to 100 (always in active mode).

Power level
The power level bar sets how much acoustic energy the instrument transmits into the water. The
difference between the highest level and the lowest level is about 20dB. Unless you know your
environment has high backscatter, you should generally use HIGH power.

Wave bursts
Check the wave bursts box if you want your Aquadopp Profiler to measure waves.

Cell size
Sets the vertical size of the cell used for wave measurements (two horizontal components).

Number of samples
The number of samples used as basis for FFT calculation, and subsequent statistical wave calculations. This is why number of samples is either 512, 1024, or 2048. A higher number gives you better accuracy, but requires more computational power.

Sampling rate
Wave sampling can be done at 1 or 2 Hz. Sampling rate, together with number of samples determine the length of the wave time series. Use 2 Hz if the Aquadopp Profiler is deployed in shallow waters, and the shortest possible waves are to be measured.

Interval
The time between each new wave measurement.

Coordinate system The coordinate system can be selected to **Beam, XYZ,** or **ENU**. **Beam** means that the recorded velocities will be in the coordinate system of the acoustic beams. **XYZ** means that the measurements are transformed to a fixed orthogonal XYZ coordinate system and **ENU** means that the data are converted to geographic coordinates every second.

File wrapping
If checked, data are logged to the internal instrument recorder in ring-buffer mode. This ensures that the recorder always holds the latest data. If not checked data logging will stop when the recorder is full.

Speed of sound Speed of sound can be set by the user **(Fixed)** or calculated by the instrument based on the measured temperature and a user-input value for salinity **(Measured)**. The salinity is 0 for fresh water and typically 35 for the ocean.

Analog inputs
The instrument can read two analog inputs at the same time. The input range is 0-5 Volt, where 0 Volt equals 0 counts, 5 Volts equals 65535 counts and 2.5 Volts equals 32768 counts.

Check the **Output power** box to supply power from the instrument to your external sensor. The voltage output is fixed in production to either 5 Volts, 12 Volts or to the instrument voltage. The use of analog inputs requires a special internal harness. Some systems are equipped with this at the time of purchase. It is also possible to purchase the harness separately and upgrade the Aquadopp Profiler.

The **deployment planning** is described under the previous section for the Standard tab.

5.2.2. Start recorder deployment

Before you start a deployment, either define a new deployment configuration or load a saved configuration fromfile or click the shortcut button:

Then click "Deployment", "Start Deployment". Enter a short deployment name (used for the internal data file). The program allows you to set the Aquadopp Profiler's internal clock (see below), and the gives you a final review on the instrument set-up, just before you start it up. The software creates a log file using your deployment name with the set-up parameters. You should keep this file in your records.
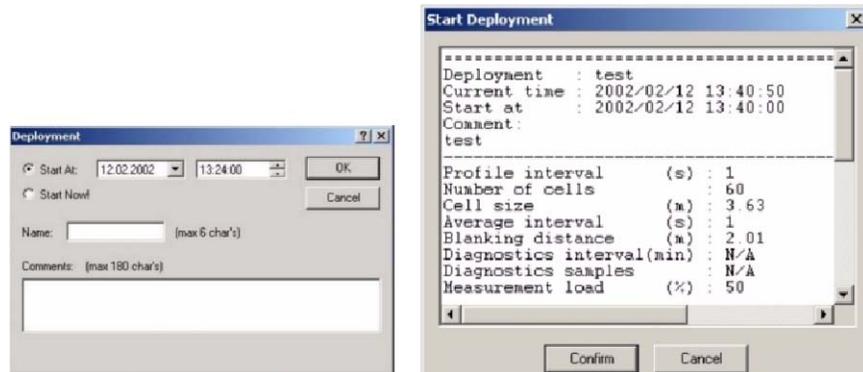
Setting the Time and using Delayed Start-up
The software allows you to set the Aquadopp Profiler time and a delayed start-up time when you start the deployment. The easiest way to set the Aquadopp Profiler time is to make sure the PC time is set correctly before you start the deployment. An important reason to set the correct time may be to synchronize a group of Aquadopp Profilers with one another or with other sensors.
- Operation
.
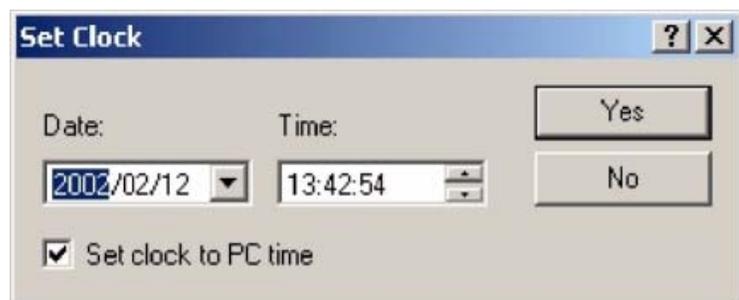
Use a delayed start-up either to make sure the Aquadopp Profiler starts data collection on the hour or to conserve batteries for a deployment that starts some time in the future. You can start an Aquadopp Profiler deployment well in advance of when you plan to install it on site, and use a delayed start-up to conserve the Aquadopp Profiler's battery and recording resources for the actual deployment.

5.2.3. Stop recorder Deployment

Before you tell the Aquadopp Profiler to stop collecting data, verify that the computer time is accurate. The software will compare the computer time with the Aquadopp Profiler time, and you can use this information to quantify clock drifts. After you connect the Aquadopp Profiler to your computer, click "Deployment", "Stop Deployment" or click the shortcut button:

When the program tells the Aquadopp Profiler to stop collecting data, it displays both the Aquadopp Profiler time and the computer time. Keep a record of the differences.

5.2.4. Recording Data Internally as a Backup

You can set the instrument to record data internally as it sends data out the serial port. To do this, use "Online", "Start with recorder" or click the following shortcut button:

The Aquadopp Profiler has two modes of internal recording. The standard mode is to stop recording when the recorder is full. The Aquadopp Profiler can also use a wrap-around mode in which it keeps only the most recent data, overwriting the oldest data when the recorder is full. Wrap-around data recording makes good sense when you are backing up external recording against the possibility of power failures.

5.2.5. Getting Data out of the Aquadopp Profiler

Use the Aquadopp Profiler software to retrieve data from the instrument. To do so, click "Deployment", "Data retrieval" or click the shortcut button:

In a moment, you will see a list of the recorded data files - the most recent file is the last one listed. Highlight the file(s) you want, click "Retrieve" and select the location for the file. The software recovers the files you select and puts it on your hard drive.

You can immediately convert the data into an ASCII format by clicking "Deployment", "Data Conversion" or click the shortcut button:

When the conversion is complete, you will find three files on your hard drive:

1. Data file (".DAT")
2. Header data (".HDR") including set-up parameters
3. System data (".SYS").

5.2.6. Finish operations

Stop data recording using one of the "Stop" buttons before you store an Aquadopp Profiler.

NOTE: To conserve your battery when the Aquadopp Profiler is on the shelf, be sure it is not in data acquisition mode.

5.2.7. Erasing Recorded Data

Erase the recorder by clicking "Deployment", "Erase Recorder". Before you do this, make sure that you have recovered your data, that the data file has not been corrupted and that you have stored a backup copy.

5.3. Interpret and analyse data

5.3.1. Viewing Aquadopp Profiler Current Profiles

You will find that the ASCII data are easy to import into most spreadsheets and data analysis programs.

The current profiles (including the sensor data) are best displayed by converting the Aquadopp Profiler data to the standard NORTEK file format for current profilers. The program to carry out the conversion is called "Prof2ADP" and the resulting file can be displayed with Explore for Profilers (ExploreP) or any other software program written for NORTEK's Acoustic Doppler Profilers.

5.3.2. Binary Data Files

Binary files created by the Aquadopp Profiler program all use the same format, whether internally recorded or recorded using the online "Record to Disk" option. The binary file format is not documented, but the Aquadopp Profiler software makes it easy to convert the data to an ASCII format. Binary data files include a header (500100 bytes long), and each data record (whether normal or diagnostic) adds 40 bytes.

NOTE: We highly recommend that you use our internet pages to get access to the latest tech-notes and user experiences regarding i.e. data analysis.

5.3.3. Raw data

Here are some points to consider when looking at the raw data:

The pressure signal should be smooth and clean. The resolution of the pressure sensor is usually a fraction of a cm (about 14-bit resolution at 1Hz), and there should be no sudden jumps or discontinuities in the time series. The raw pressure signals give an immediate indication about the wave condition; long waves (T>8 s) give a strong pressure signal at the bottom and a variation of 1 m in the pressure signal means that the wave height is at least the same. On the other hand, a very weak signal in the pressure sensor (variations of only a few cm) usually means that the waves are small.

The raw wave velocities will appear noisy even at moderate sea states. Only at times with large waves can you expect a smooth signal. Even so, the noise should not be excessive and it should be possible to see the wave signal when there are significant wave action on the surface.

5.4. Operational concerns

5.4.1. My data don't look right

The Aquadopp Profiler cannot measure velocity properly if the water has too few scatterers. Your data will be questionable when signal levels are down around the noise level (around 20-30 counts).

If your data don't look right, particularly if you have unrealistic vertical velocities, consider the possibility that one or more of the beams were blocked. If the blockage is somewhere inside the measurement cell of one beam, you should see elevated signal strength for that beam. If the blockage is closer to the instrument, the signal strength may not look very different from the other beams, or it could be substantially reduced. If you can collect data in real time while the instrument is deployed, run the range check function to see if there are any obvious obstructions in any of the beams.

5.4.2. Boundaries

In open waters, boundaries are not a concern, but if you want to use the Aquadopp Profiler near the bottom or surface, you should think about the boundaries as you design your experiment.

NOTE: If one of your beams crosses a hard boundary, whether surface, bottom or wall, data from that beam will be bad. There are several different ways to improve the situation:

1   Change the orientation. For example, you can turn the Aquadopp Profiler upside down.
2   Use XYZ coordinates instead of ENU and coordinate transform your data later. You could use this approach when the water level changes a lot, and ignore the vertical velocity when the surface is in beam 3. This approach works only if your system is fixed in place and not allowed to move while measurements are taken.

5.4.3. Sidelobes

Transducer sidelobes are rays of acoustic energy that go in directions other than the main beam. Because the Aquadopp Profiler's beams are narrow, sidelobes are not always a factor in your measurements. In general, sidelobes may be unimportant in water with strong backscatter (i.e. sediment-laden rivers), but they may contaminate your data when backscatter is weak.
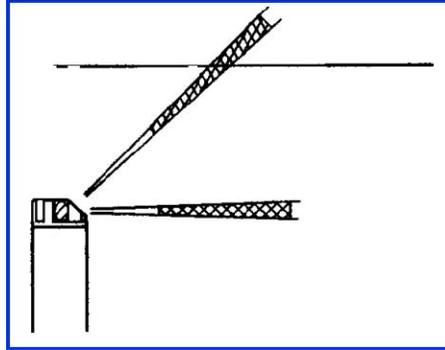
When the Aquadopp Profiler is near a boundary, avoid letting the measurement cell touch the boundary.

If you are concerned about sidelobes, the following figure illustrates how to minimize the influence of sidelobes on your data, when you are near the water surface.
- Operation
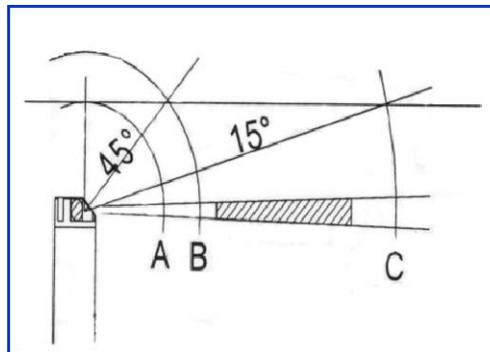
The figure above defines three positions along the beam:

1   Position A is where the distance along the beam equals the distance straight up to the surface.
2   Position B is the distance along the beam equal to the distance to the surface along a 45° angle.
3   Position C is the distance along the beam equal to the distance to the surface along a 15° angle.

Sidelobes returning vertically from a smooth water surface (Position A) pose the most likely source of contamination. Even though side-lobes in this direction are very weak, a smooth water surface is the strongest reflector you will encounter - it behaves like a mirror. As the angle increases (i.e. between Positions A and B), the strength of the surface echo weakens substantially. Inside a 15° cone around the beam (Position C and beyond), sidelobes begin to increase and your beam may begin to be affected by surface velocities. This may not be such a problem because the surface velocity is typically close to the velocity just below the surface.

If you turn the picture upside down and place the Aquadopp Profiler near the bottom, the situation changes. Echoes vertically from the bottom are typically much weaker than the mirror reflection from the surface, so contamination at Position A will be less serious. However, contamination at Position C could be more serious, for two reasons:

1. Backscatter from hard reflectors (i.e. rocks) can be large.
2. The bottom does not move.

5.4.4. Grounding problems

Tests in laboratory tanks can sometimes lead to grounding problems, which show up as elevated noise levels, but only after the instrument is placed in the water. You will not automatically see the increased noise level in your data if your signal from the water is above the noise, but the increased noise level could look like signal.

If grounding problems cause elevated noise levels, you may be able to reduce your problems by coiling your cable into a tight bundle and raising the cable above the floor (i.e. placing it on a chair). Also, feel free to call NORTEK for further guidance. Keep in mind that grounding problems occur around man-made structures, and are not normally a problem in the field.

5.5. Troubleshooting

5.5.1. Simple Problems

Most initial problems can be traced to forgetting to power the system, the DB-9 connector falling out of the computer, or using the wrong serial port. Remember that new Aquadopp Profilers ship with the battery disconnected.

Computers don't always behave as they should and not all of them have serial ports available. If one computer is giving you a problem, try another one instead.

### 5.5.2. Problems detecting the instrument on the Serial Ports

If you cannot connect to the instrument, first try sending a break to the Aquadopp Profiler. Send a break by clicking "Communication", "Terminal emulator", and then clicking the "Send Break" button. If the Aquadopp Profiler is powered and properly connected, and if the terminal is set to use the correct serial port, then you will see the Aquadopp Profiler's wakeup message.

If you see a response consisting of garbled text or strange characters, then the Aquadopp Profiler and terminal program are probably using different baud rates -you could experiment by trying different baud rates ("Terminal", "Serial port").

If you suspect your computer is having problems, try a different one. You can also verify your serial port and cable with a serial loop-back test.

Serial loop-back test
The serial loop-back test verifies that the serial port can receive the same characters it sends. First, make a loop-back connector (Figure next page) and plug it into your serial port. Run the test by typing characters -whatever you type should be echoed to the screen. When you remove the connector, the characters stop echoing back.
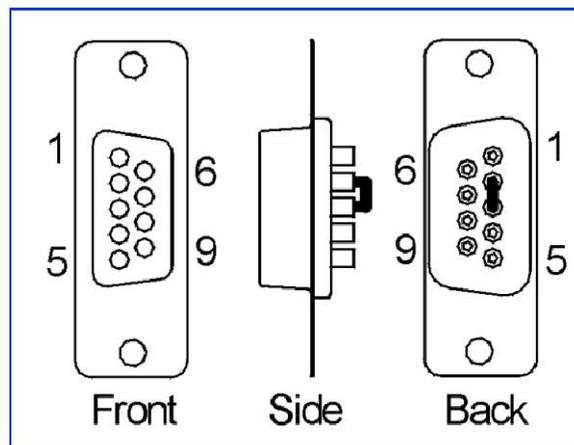
Make a serial loopback connector by soldering pins 2 and 3 together, as shown.

Run the test with the Aquadopp Profiler's built-in terminal emulator, and if that doesn't work, try HyperTerminal instead (a terminal program that comes with Windows).

Test your serial cable the same way. Plug the cable into the computer and put a loop-back connector on the end of the cable. If your serial cable passes the test and you still cannot wake up the instrument, there is a chance that your cable is a null modem cable - if so, it crosses wires 2 and 3. You can test this by substituting a different cable or by using a null-modem adapter in series with the cable (which crosses wires 2 and 3 back).

5.5.3. Data transfer problems

The Windows operating systems are not all the same when it comes to transferring data to the serial port at high speed (115kB is the highest a PC can do). Nor are

computers; some have serial ports with buffers and some do not. In general, new computers have fewer problems than older ones, NT has fewer problems than W95/98, and desktops seem to have less problems than laptops. If you encounter any disruptions when transferring the data file from the Aquadopp Profiler to the computer, simply reduce the "recorder/configuration baudrate" until everything works fine. If problems persist, try to find another computer.

6. MAINTENANCE

Before you assemble a system that involves custom cables, power supplies or the like, first assemble and test the Aquadopp Profiler using just the cables and battery that come with the system. This is the easiest way to get the system to work, and if you have trouble you can always return to this setup to confirm that problems are not caused by a faulty instrument.

6.1. Preventive maintenance

6.1.1. Cleaning

Perform regular cleaning of the Aquadopp Profiler. Use a mild detergent to clean the Aquadopp Profiler. Pay special attention to the transducers.

Check the pressure sensor and remove any dirt from the two front holes.

6.1.2. Replacing the desiccant

Keep water out of the open pressure case. Both fresh and salt water can corrode the circuitry.

At least once a year, replace the desiccant located inside the Aqua-dopp Profiler housing.

6.1.3. Installing/changing batteries

NOTES: Batteries should be degaussed before you use them in your instruments - you can do this yourself by placing the padded end of the battery up against the center of your PC monitor and using the monitor's degaussing function.

Always be sure to include desiccant in the pressure case. Humid air can condense enough water to damage the electrical circuitry.

The Aquadopp Profiler is shipped with a battery pack installed in the pressure case, but disconnected. The following procedure outlines how to connect the battery pack or to install a new one.

1 Remove the four screws (1) and washers holding the end cap to the pressure case and remove the pressure case.
2. Disconnect the 2-pin connector (2) and pull the old battery (3) out of the pressure case.
3. Slide in a new battery and connect it to the 2-pin connector.
4**.** Insert the end cap to the pressure case and mount the four screws and washers. Tighten the screws carefully to avoid damaging the threads in the pressure case. Tighten the screws only until the end-cap touches the pressure case and you can just feel that they are seated. Keep in mind that ocean pressure holds the end cap in tightly - all the screws have to do is to keep the end cap from falling out when the system is above water.

CAUTION: Be careful of the O-ring and the O-ring surfaces.
4. Test communication with the Aquadopp Profiler's built-in terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the Aquadopp Profiler's wakeup message on the screen (it will give you the model of your instrument plus the firmware version number). If you get a string of garbage characters try another baud rate setting. When the instrument responds to a 'break' properly then the communication lines are correctly connected. An easy alternative for using the terminal emulator is to read the configuration file directly from the instrument ("Deployment", "Planning", "Load from instrument"). If the instrument is set for a different baud rate than the software expects, it will search for the correct baud rate and connect automatically.

1 Test the instrument by collecting data without using an external power source to ensure that the battery is properly connected. Make sure to stop data collection so that the instrument will power down after you are through testing it.
2 Check and/or reset the clock if necessary.

Because the battery pack uses standard alkaline batteries, you do not normally need to observe any special precautions when you dispose of old

batteries.

CAUTION: If you have lithium batteries, keep in mind that you must be very careful and that disposal requires special precautions and/or procedures. Rules for disposal of batteries, especially lithium batteries, vary from country to country.

6.2. Corrective Maintenance

Only qualified personnel are allowed to perform corrective maintenance activities. Please refer to the separate service manual or contact NORTEK for further assistance.

7. SPARE PARTS

Always use the spare part number (next pages) when ordering spare parts from NORTEK.
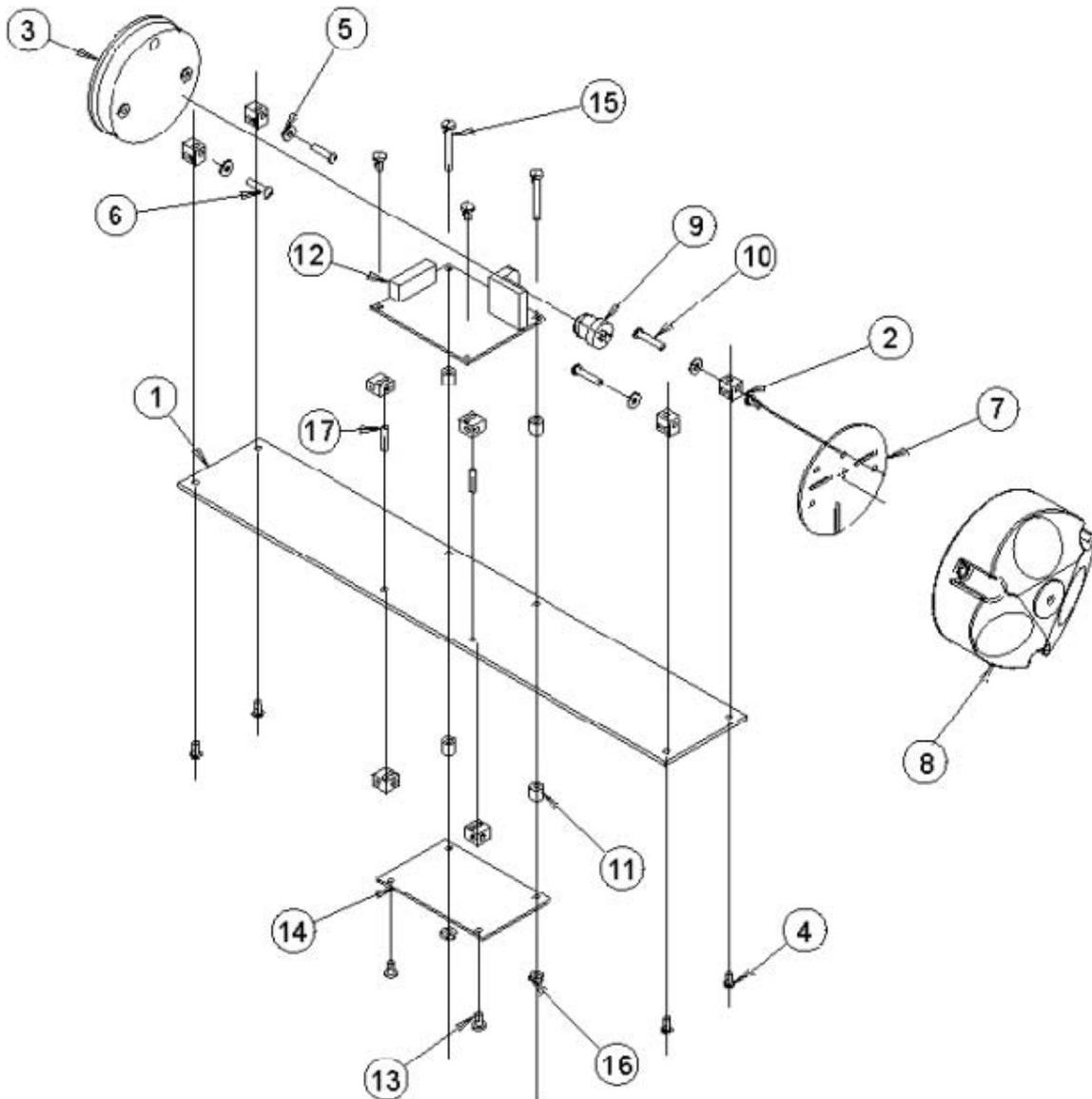
Item # Title	Part Number	Material	Quantity
1 Aquadopp Main Board	N2001-003	1	
2 PCB mounting block	N2001-008	Delrin POM	8
3 Aqua PCB Bulkhead	N2011-014	1	
4 4-40x1/4" Button head	92949A106	18-8 SS	5
5 #4 Flat Washer	92141A005	18-8 SS	4

6 4-40x1/2" Button head	9249A110	18-8 SS	2
7 Paradopp Head PCB	N2002-003		1
8 Aquadopp Profiler Head assy.	N2011-038		1
9 Paradopp Tilt Sensor	A166004-B-002		1
10 4-40x5/8" Button head	92949A112	18-8-SS	2
11 #4x1/4" Nylon Binding Hd.	95000A106 Binding	Natural Nylon	4
12 Compass	TCM-2-20		1
13 4-40x1/4" Nylon Binding Hd.	95000A115 Binding	Natural Nylon	4
14 Aqua/Vector Recorder PCB	N2012-003		1
15 4-40x1" Nylon Binding Hd.	95000A115 Binding	Natural Nylon	2
16 #4 Nylon Nut	94812A112	Natural Nylon	2
17 4-40x1/2" Cup Point	92311A110	18-8-SS	2
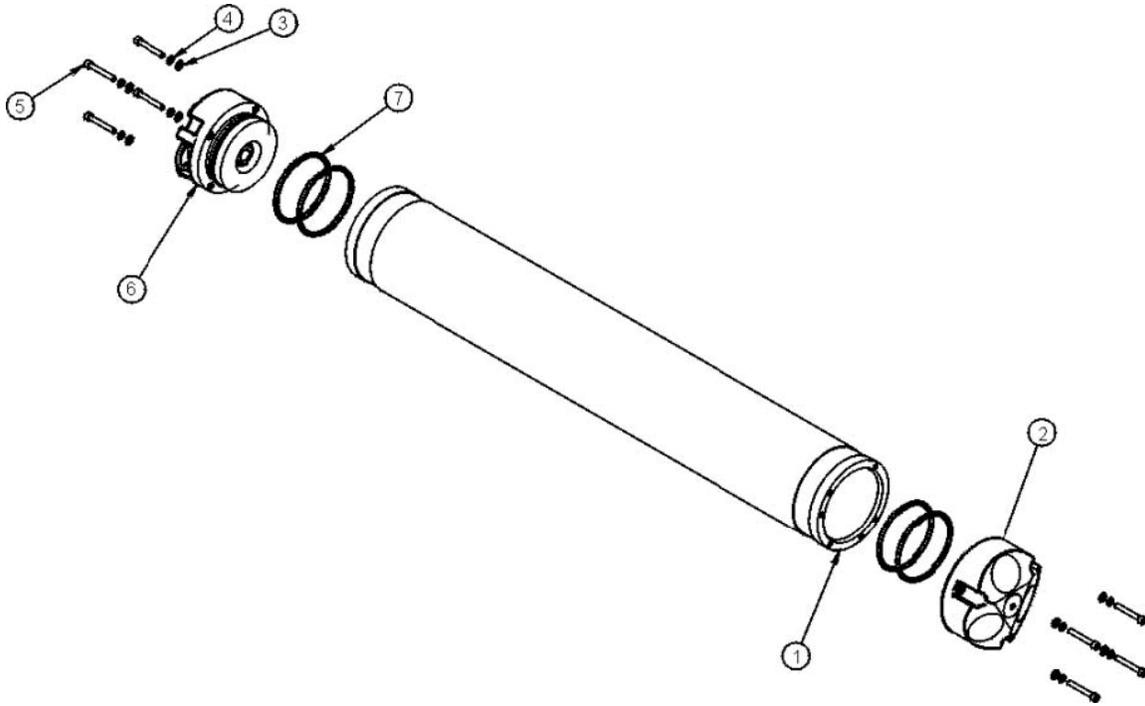
Item #	Title	Part Number	Material	Quantity
1	Aquadopp Housing	N2011-007	Delrin (POM) Black	1
2	Aquadopp Profiler Head Assy.	N2011-038		1
3	#6 Titanium Washer		Titanium gr.2	8
4	#6 Spring Washer		Titanium gr.2	8
5	6-32x1" Titanium Bolt		Titanium gr.2	8
6	Aquadopp Endbell Assy.	N2011-003		1
7	O-ring 55,25 x 2,62		Nitrile N70	4

- Spare Parts

8. OPTIONAL CONFIGURATIONS AND FEATURES

8.1. Active-X components

If you wish to create real-time software to operate an Aquadopp Profiler, NORTEK can provide an Active-X control which you can integrate into Windows-based software. The software modules gives you full control over the instrument and its data structures, and simplifies your software development job.

Please contact NORTEK for further information.

8.2. Available Head Configurations

8.2.1. Symmetric Sensor Head

The symmetric sensor head is used to measure the current profiles with vertical orientation of the sensor housing.

8.2.2. Side-looking Sensor head

The side-looking sensor head is used when the Aquadopp Profiler is placed horizontally. It is particularly useful when low profile deployment frames are used in boundary layer current profile applications.

8.2.3. 2D Side-looking Sensor Head.

The 2D side-looking sensor head measures 2D flow, for instance in river discharge calibration measurements or if horizontal profiles are needed with the Aquadopp Profiler mounted horizontally on a fixed structure.

The availability of the different head configurations is not the same for all frequencies.

9. RETURNING THE INSTRUMENT FOR REPAIR

1   Please contact Nortek for Return Merchandise Authorization (RMA number).
2   Please use the Proforma Invoice template on the following page or make your own invoice containing the same information.
3   Please enclose copies of all export documents inside the freight box.

IMPORTANT: **NORTEK AS does not cover freight insurance on repairs.** Please make sure your goods are insured before shipping. **NORTEK AS is not liable if the instrument is damaged or disappear during shipping.**

We will insure the instrument upon returning the goods to you and invoice you along with the freight cost.

If the instrument is under warranty repair the return freight and insurance will be covered by NORTEK AS.

PROFORMA INVOICE

SENDER RECEIVER

Name:	**Name:**	Nortek AS
Address:	**Address:**	Industriveien 33
City:	**City:**	1337 Sandvika
Country:	**Country:**	Norway
Tel.:	**Tel.:**	+4767556200
Fax:	**Fax:**	+4767546150
Ref.:	**Ref.:**	
Date:	**Units:**	
Freight forwarder:	**RMA no:**	
	Customs account no:	28605-56
AWB no.:	**VAT/company no:**	976119185
Description:	**Value:**	